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Prefacio

La Sociedad de Ergonomistas de México A.C. (SEMAC), como parte relevante de su actividad e interés en la difusión, promoción y apoyo a la ergonomía, ha organizado desde 1999 y de forma anual, su Congreso Internacional de Ergonomía. En Abril de 2016, la progresista ciudad de Tijuana, en Baja California y en especial el Instituto Tecnologico de Tijuana y la Universidad Autonoma de Baja California, Campus Tijuana, nos abre sus puertas para recibir el XVIII Congreso Internacional de Ergonomía, con la participación de ergonomistas profesionales e interesados en esta área.

Este año está lleno de retos y esperanzas. Tenemos una nueva legislación laboral que entro en Vigor en Febrero del año pasado. Este nuevo Reglamento tiene como novedad, a propuesta de SEMAC, un artículo dedicado a la Ergonomía en los centros de trabajo y aunque parece muy poco, tendrá un gran impacto en la salud de los trabajadores debido a que los centros de trabajo deberán evaluar los puestos de trabajo y realizar las mejoras cuando sea necesario. Aunado a este Reglamento, se está trabajando en una Norma Oficial Mexicana para la aplicación adecuada del mismo, esperando que este año sea publicada y poder tener certeza, tanto los trabajadores, los empresarios y los académicos de los alcances y limitaciones de este nuevo instrumento legal.

Se reúnen en este libro una selección de los trabajos, presentados en este congreso, más representativos de las diversas áreas que participan en la ergonomía, aportando diferentes investigaciones y soluciones a problemas específicos, con la finalidad de contribuir a la difusión, apoyo en la educación e investigación, de temas de interés para la ergonomía. En este evento académico, concurren ponentes de Universidades de Colombia, y Chile, así como investigadores y estudiantes de diferentes Instituciones de nuestro país, desde Mérida hasta Tijuana además de empresas que están aportando los resultados de sus intervenciones, lo que nos indica que la semilla que sembró SEMAC está dando frutos.

Los editores, árbitros y comité académico, a nombre de la Sociedad de Ergonomistas de México, A.C., agradecemos a los autores de los trabajos aquí presentados su esfuerzo, e interés por participar y compartir su trabajo y conocimientos en el XVIII Congreso Internacional de Ergonomía de SEMAC. También agradecemos a los participantes y asistentes, provenientes de muy diversos lugares y formaciones, así como a todo el equipo de organización de este congreso, su valiosa aportación que estamos seguros derivará en el avance de la ergonomía en las Instituciones de Educación Superior y en la planta productiva nacional y mundial.

Enrique de la Vega Bustillos

Presidente SEMAC 2002 – 2004

SOCIEDAD DE ERGONOMISTAS DE MÉXICO A.C.

“Trabajo para optimizar el trabajo”

Tijuana, Baja California, Abril de 2016

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ANTHROPOMETRIC MEASUREMENT PROTOCOL FOR PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY

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Resumen: Las mediciones antropométricas en pacientes con Distrofia Muscular Duchenne deben ser consideradas como un trabajo con población especial, debido a las características físicas, musculares y estructurales óseas que presentan los pacientes.

El objetivo de este trabajo es proponer un protocolo de medición antropométrica en población con Distrofia Muscular Duchenne, ajustando los parámetros existentes a las condiciones que presenta esta población.

Como resultado de este trabajo se completó una cedula antropométrica con 32 mediciones de las cuales 4 fueron representativas en cuanto al grado de dificultad para la toma de medición, principalmente por las desviaciones articulares que presentaron los pacientes que se midieron y la incapacidad del paciente para mantener una postura en bipedestación.

Se espera que todos los pacientes con distrofia muscular Duchenne puedan tener a su alcance herramientas, aditamentos, materiales e instrumentos que les servirá durante su proceso de rehabilitación y en actividades de la vida diaria.

Palabras clave: Distrofia muscular Duchenne; Protocolo antropométrico

Abstract: The anthropometric measurements in patients with Duchenne Muscular Dystrophy it should be considered a special population work, due physical bone, muscle and structural characteristics presented by patients.

The aim of this paper is to propose a protocol in population with anthropometric measurement in Duchenne Muscular Dystrophy, adjusting existing parameters to the conditions presented by this population.

As a result of this work it completed with 32 anthropometric measurements, 4 of which were significant as to the degree of difficulty for taking measurement, mainly by joint deviations presented patients were measured and the patient's inability to maintain a position in bipedalism.

It is expected that all patients with Duchenne muscular dystrophy may have to reach their tools, hardware, materials and instruments of therapy that will help them during their rehabilitation process and in activities of daily living.

Key words: Anthropometric protocol; Duchenne muscular dystrophy.

CONTRIBUTION TO ERGONOMICS

The anthropometric profile of a population group allows to have access people's own needs; patients with Duchenne muscular dystrophy will be beneficiated from a vision of universal design to an overview of social inclusion.

1. INTRODUCTION

The Duchenne Muscular dystrophy (DMD) is a severe muscular disease linked to X chromosome. His name comes from Duchenne de Boulogne, who contributed to define its characteristics in 1868. Duchenne's dystrophy is the most frequent muscular dystrophy in infants and affects 1 from each 3,500 male newborns. DMD is due to the absence of Dystrophin, a fundamental protein in the maintenance of muscular fiber.

Its presence starts with muscular weakness in the early childhood, which follows a progressive and stereotyped course. Without any intervention, patients tend to lose the ability to walk before adolescence, subsequently death comes in the second or half of the third decade of life due to a respiratory failure, or hearth complications (Camacho, 2014). Nowadays, does not exist a recovery treatment, but physical rehabilitation therapy joined with multidisciplinary cardiorespiratory and orthopedic treatment has changed DMD's natural history.

From the perspective of Ergonomics, objects, spaces, systems and services most comply to user's characteristics and requirements (IEA, 2016), according to the activities related with them; in that sense, the interdisciplinary condition of Ergonomics has allowed to develop in multiple aspects involved with the pursuit of adapting the context to people. A clear example of this is the development of Anthropometric techniques that have permitted to characterize populations in dimensional terms (Avila Chaurand, Prado León, & González Muñóz, 2007), making possible to adjust objects dimensions in a coherent manner with population's physical dimensions.

In that sense, great efforts have been made in standardize the way of obtaining peoples dimensions on the different body segments in order to have a more reliable dimension obtaining process, developing specific instruments, establishing somatomethric points and particular techniques according to the used measuring tools (Ulijaszek & Komlos, 2010). However, this standardization is possible in accordance with the idea that people have similar physical characteristics, which allows to normalize the technique; nevertheless some individuals have physical proportions and conditions and/or disabilities, that differ from the typical conditions considered by the standardized techniques which keeps off from using the traditional Anthropometric techniques. This occurs with people suffering from DMD, who, like we said in previous lines, experience motion loss and extremity deformation caused by muscular rigidity.

In the case of anthropometric measurements with Duchene Muscular Dystrophy, is very important to consider different conditions, in that sense is necessary to adjust the way how the measurements are taken, in order to ensure consistency between physics characteristics, muscular and bone structure which the patients have, and the anthropometric method to use to obtain adequate and reliably data. Unfortunately, there are no such adjustments; in fact, the development of specifics anthropometric technics for populations with different physical conditions is very limited and it includes people with DMD, which leaves such populations without the possibility of characterizing their physic dimensions. Translating this into applied terms, the possibility of adjusting the physical conditions of the environment to their needs and characteristics can be diminished.

According to the age range and based into the reviewed literature, patients with DMD lose the ability of walking between the ages of 8 and 10 years, therefore after losing the ability to walk in a short period of time they are no longer available to hold a standing position. DMD is a progressive and disabling disease, because of this patients in the ages between 12 and 16 years tend to lose the ability of controlling their body trunk and therefore maintaining a sitting posture. The previous, are a few of the main reasons by which patients cannot take the conventional postures needed in a regular anthropometric protocol, which is one of the main troubles while recollecting the measuring data.

Besides the preceding information, must be aware that most of the muscles of DMD patients, suffer a contracture process that limits the possibility to maintain their body segments aligned, which in the most severe cases results into a flexing pattern in hips and knees, besides an important deviation of the spine. In that sense it will be needed to consider that traditional anthropometric measuring in patients with DMD can be only used in those who are available of holding a sitting and standing posture, which probably occurs only before the age of 8 years, after that the technique must be adjusted.

Based in the previous information, this article presents a proposal of an anthropometric measurement specific for people suffering from DMD, using the traditional direct technique and their instruments, but making adjustments to the physical and motor conditions presented by this population.

2. OBJETIVE

To propose a protocol of anthropometric measurement in Duchenne Muscular Dystrophy population, adjusting existing parameters to the conditions presented by this sector.

3. METODOLOGY

3.1 Delimitation

The Anthropometric measurement protocol is proposed for patients with Duchenne Muscular Dystrophy. These persons will be males from 8 years old, which is the age when they lost the walking and standing capability.

The pilot study was made at the “Care Center for with patients Dystrophy.” facilities, in Guadalajara, Jalisco, where therapy is provided to young with this condition. In that test seven patients with Duchenne Muscular Dystrophy between 9 and 21 years where measured. The pilot test was made in November of 2015.

This tool is addressed to be used by every actor or sector involved in the understanding of the condition, anthropometric examiners or special groups designers.

The protocol aims to analyze the general measures for people with Duchenne Muscular Dystrophy. For special designs or studies some measures can be omitted according to the interest.

3.2 Strategy

The Project is divided into 3 phases:

1) In the first place, a literature reviews about the conception of anthropometric protocols. Then a revision of bibliography about Duchenne Muscular Dystrophy condition, the evolution of the patient's capabilities. This allowed identifying: all differences between people with and without any dystrophy, differences between individuals with the condition but in different in age and differences in the evolution of the condition.

2) Once identified the anthropometric protocols currently existing incompatibilities for this population: the standing posture for some measures, the sitting posture without supports and the wheelchair influence; we proceeded to make changes to adjust the protocol.

3) Finally, the evaluation phase. It consists of test the protocol with real Duchenne Muscular Dystrophy patients. For this test stadiometer and calipers (UdeG models) were use.

4. RESULTS

The application of the technique adapted from anthropometric measurement in patients with Duchenne muscular dystrophy, results in an anthropometric identity card with 32 measurements.

The 32 items were classified into 3 different positions in which they could be positioned securely to the patient during measurement. The measure posture where sitting position on wheelchair, sitting position on the edge of the bed and lateral decubitus on the bed.

During the application of the anthropometric measurement protocol it was found that subjects had dissimilar conditions between 2 hemi bodies, so that is not enough to perform measurements in the right hemi body of the patient, as suggested in conventional protocols.

Also, it was found that there is wide variability in the morphological characteristics of the same age group of patients with Duchenne muscular dystrophy, among other conditions by the presence of different degrees of stiffness in joints, different degree of scoliosis and the tendency to presenting obesity or malnutrition, therefore, age groups should be considered at lower age ranges and continue using the 5th percentile and 95 and is conventionally employed anthropometric data.

4.1 Instruments

For the application of the protocol a stadiometer, cone handle, wheelchair bascule, stretcher and crane for patient transport are needed.

4.2 General considerations

In order to make the measurement in a standard and safety way some considerations may be taken:

Make sure the patient know about the anthropometric measurements that will be made, and have their consent informed.

Where measurements are made, it should be a broad place, enough to the movements of the patient in the wheelchair.

Changes in patient position should be done with extreme caution, always supported by a family member or a specialist.

The patient should wear light clothing, do not wear accessories that will interfere with the measurements.

To have a reliable data, we suggest the measurement of the 4 extremities of patients, since they present contractures and joint deformities in varying degrees, it may have a significant variation between hemi bodies.

The measurement procedure should be quick and nimble to avoid fatigue in patients.

Consider a caregiver who hold the patient in the sitting position, the caregiver must be previously trained for that at all times try to keep the patient as aligned as possible.

Having a crane to transport patients from the wheelchair to the gurney.

4.3 Procedure

Weight: a scale for wheelchair will be use; make a first measurement of weight with the patient sitting on the wheelchair, the second weight measurement will be performed to the empty wheelchair; it concluded subtracting the result from the second measurement to the first measurement.

Height: will be obtained by performing the sum of measurements of the segments corresponding to the lower limbs, trunk and head; these measurements were taken considering the height at the sitting knee, length buttock - popliteal and maximum seated height.

Chest depth and maximum depth of the body: Patient being measured in a sedestation –or sitting- position on the edge of a stretcher. It will be necessary to provide support to the patient holding his shoulders not to lose control of the trunk. For maximum depth of the body, the protocol propose the use of a vertical and rigid element, like a board to be place in the prominent portion of the body, on the back – the back or buttock, depending on patient- and with the caliper find and take the maximum depth.

Head width, length of the face and head depth: the patient will be measure with the patient being in a sedestation position on wheelchair. The patient head being placed in the Frankfort plane. Once patient are placed in this position, generally the still can maintain the position, will measure under traditional measurement protocol.

Width of the thorax, maximum body width, maximum width bideltoidea, elbow width - elbow and width of sitting hip: Patient measured while in sedestation position on a stretcher, patient supported holding from his shoulders and it will be necessary to supervise that the pelvis and trunk remain aligned as due to scoliosis presented in the column and pelvic girdle can resulted in an imbalance.

Thickness hand and handle diameter: All patients measured in a sedestation position on wheelchair, Patient's hands positioned and will be help to extend the phalanges so they could open their hands and hold the measuring cone . At all times, patients will be help to hold the cone because do not have enough strength to hold it by themselves. All patients have contracture fingers in some degree which keeps them in a position of static semi flexion.

Foot length, foot width and heel width: Patients will be measure being in sedestation position on the edge of a stretcher. Foot length taken from the tip of the first toe to the heel; the examiner have to consider the contraction and retraction of the Achilles of some patients, this will be that patient may have not the capability to have heel contact with the ground, so the measurement will be in the neutral position of the patient’s feet.

Sitting height, shoulder height sitting, elbow height sitting, thigh height sitting, knee height sitting, popliteal height and height ankle: Patient will be measure while in sedestation position on the edge of a stretcher. Provide support to him holding the shoulders so not to lose control of the trunk. Pelvis aligned and feet flat –where possible- on the floor lined up, most patients will support on the floor with the front and outer edge of the foot, due to the retraction of the Achilles tendon.

Length buttock - popliteal length and buttock - knee: Patient will be measure while in sedestation position on the edge of a stretcher. Variation can be found between one end and another of the same patient because the scoliosis they will have, led them to an imbalance of the pelvis.

Arm length and forearm length: the measurement was taken while patient being in sedestation position on the edge of a stretcher. It will be necessary to provide support to the patient holding his shoulders so not to lose control of the trunk. Patients will be assist to elevating his arms and positioning aligned when making the measurement.

Ankle angle, knee angle, hip angle and elbow angle: Patient in lateral decubitus being measured on a stretcher. A two-arm goniometer will be need. For all measurements the patient be ask to help mobilizing them and bringing into flexion and maximum extension of these joints to make the corresponding records.

5. DISCUSSION

The implementation of a special anthropometric measurement protocol is necessary in patients with Duchenne muscular dystrophy; since there is a great variability in these anthropometric patients. It is expected that all patients with Duchenne muscular dystrophy may have access to hardware, tools, materials and therapy instruments that will help them during their rehabilitation process and in activities of daily living.

The development of an anthropometric measurement protocol implies the knowledge of the population to be measure; this meant, have the capability to find new solutions for take measures in an unconventional way, but also, have the sensibility to recognize the needs and limitation of the patients.

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RELATIONSHIP BETWEEN ANTHROPOMETRIC CHARACTERISTICS IN HANDS AND MAXIMUM GRIP STRENGTH

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Resumen: Este documento tiene como objetivo determinar la relación entre las características antropométricas en las manos y la fuerza máxima de agarre para los hombres y mujeres universitarios con edad de trabajar de 18 a 28 años, nacidos en el estado de Sonora. Se utilizó el método directo para obtener los datos y se llevó a cabo en el lugar de estudio, con una muestra de 110 personas, teniendo en cuenta 26 tipos de medidas antropométricas y 3 puntos diferentes de la fuerza máxima, tanto en la mano dominante y no dominante. Una base de datos fue desarrollada con la información de cada hoja de datos para el procesamiento, con el fin de realizar el análisis estadístico: correlaciones, una media y desviación estándar de cada dimensión medida y la fuerza máxima en la mano dominante y no dominante, además del cálculo de percentiles para cada sexo. Se encontró una fuerte correlación para ambos sexos en la medición de la circunferencia de la mano con las tres fuerzas tomadas en la mano dominante. La mayor fuerza para las mujeres fue identificado en la posición 2 a una distancia de 2,5 cm y u hombres en la posición 3 con una distancia de 6,4 cm.

Palabras Clave: Antropometría, máxima fuerza de agarre

Abstract: This document aims to determine the relationship between anthropometric features in hands and maximum strength of grip for college men and women with working-age from 18 to 28 years old, born in the State of Sonora. The direct method was used to obtain the data and was held at the site of each subject of study, with a sample of 110 people, considering 26 types of anthropometric measures and 3 different points of maximum strength in both dominant and non-dominant hand. A data base was developed with information from each sheet of data for processing, in order to perform the statistical analysis: correlations, an average and standard deviation of each measured dimension and maximum strength in hand dominant and non-dominant hand; calculating percentiles for each sex. It was found a strong correlation for both sexes in the measurement of the circumference of the hand with the three forces taken in dominant hand. The greatest strength for women was identified in the 2 position at a distance of 2.5 cm and or men in position 3 with a distance of 6.4 cm.

Keywords: Anthropometry, maximum strength of grip

Contribution to ergonomics: In this research were obtained relevant data such as the anthropometric characteristics of the hands, the maximum strength of grip in several positions and the variables that are related to the maximum grip force. It is essential for product designers to use anthropometric data that are appropriate and updated for the design and development of products for users who use hand tool. However, these data are scarce in Mexico, and it is the main motivation of this study.

1. INTRODUCCIÓN

1.1 Background.

According to Lee & Jung (2013), many researchers in the field of ergonomics have been trying to understand how humans use their hands and what factors affect the ability of the hand - function. Different studies present the grip strength as a standard parameter to evaluate the function of the hand, it is common for evaluating the efficacy of surgical procedures, job skills or other clinical conditions.

Chandra, Chandna, & Deswal, (2011) mentioned that the economic growth and technological improvements have led to greater demand and development of machines and devices used in industrial environments. Anthropometric data are one of the essential factors in the design of machines and devices. The incorporation of such information would facilitate more effective designs, which will be easier to use, more secure, and could allow higher performance and productivity.

1.2. Approach of the problem.

The INSHT (2015) mentions that it is common that workers do not regard the signals that their body gives them about any muscle-skeletal disorder, because they fear losing their jobs, but are putting their health at risk, since if they do not heed time, causes them serious illness and even death.

Gripping is an important and fundamental role for several movements. The manipulation of objects with a stable grip is one of the most frequent movements made in the activities of daily life and occupational fields (Seo, Sindhu & Shetechman, 2011).

In Mexico, according to statistics of the STPS (2010), workplace accidents occur more in the anatomical region of the hand and wrist nationally according to statistical reports of the IMSS.

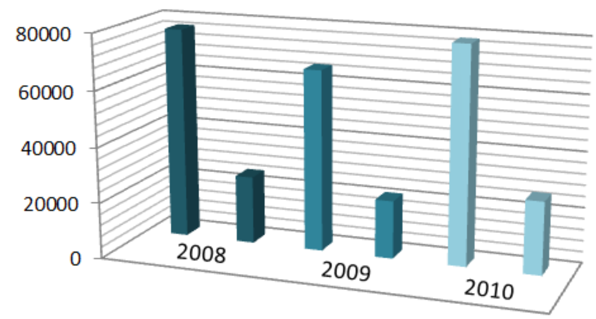

Figure 1. Accidents at work for the anatomical region of the hand and wrist in Mexico.

It is possible to point out by observing the table that accidents decreased in 2009, but in 2010 they increased, fact which exceeds the 2008 statistics.

1.3 Objectives

1.3.1. General objective.
Check if there is relationship between anthropometric characteristics and maximum grip strength both in dominant hand as in non-dominant hand.

1.3.2 Specific objectives

- Determine the anthropometric characteristics of the hand
- Determine the maximum grip strength in dominant and non-dominant hand

1.4 Justification

This study aims to understand the anthropometric characteristics of hands and determine if there is relationship with maximum gripping force both in dominant and non-dominant hand, as well as to assess whether there are significant differences between both hands, in such a way to allow having the parameters or bases sufficient to prevent illness or injury by the use of tools not suitable for people.

Currently in the State of Sonora, there are few studies that determine the anthropometric characteristics and its relationship with maximum grip force both in dominant and non-dominant hand, this could be a possible causal of serious musculoskeletal disorders due to effort originated by poorly designed manual operations, generating affectations in joints and tendons of the hands.

The hand represents the most sophisticated and differentiated skeletal muscle tool in the human being, demanding the greater capacity of the nervous system in relation to its size. Functioning and adequate strength of the hand are preconditions to deal with the demands of everyday life (Angst, Drerup, Werle, Herren, Simmen & Goldhahnn, 2010).

1.5 Delimitation.

The study considered people of both sexes who have not suffered an injury or disease in the hands and with place of birth in the State of Sonora, within a range of age between 18 and 28 years old.

2. METHODOLOGY

2.1 Study subjects.

Subject to the study population were people born in the State of Sonora with ages from 18 to 28 years. Selecting cases that comply with the specifications of the place of birth and age; with a total of 110 samples of both genders (male and female).

2.2. Measurement Instruments.

The instruments used for data collection were: A manual dynamometer of the brand Lafayette, 78010 model. The dynamometer has adjustable handle to the size of the hand and it measures the force between 0 and 100 kg at intervals of 0.1 kg.

Before using the dynamometer it was set to three different positions from the handle to the end, to obtain the greater strength during the measurments; also, it was used an small anthropometer to measure length, breadth and depth of the hand, the anthropometer has a range of 0 to 30 cm in increments of 0.1 cm; besides, a tape of fiberglass for circumference measurements, with graduation in mm; and finally a cone was used to measure the grip diameter, which consists of a conical body lengthwise, graduated in intervals of 1mm in diameter.

All of these instruments are analog and manual, they do not require calibration and are similar to those used in previous studies. The reliability of data was measured using the intraclass correlation coefficient (CCI) which is widely used to assess the reproducibility of the measurements between the evaluators, laboratories, technical, or devices (Zaki et al., 2013).; it was obtained a CCI of 0.98; What it defines is that the observed variability is explained by differences between subjects and not by differences in the method of measurement.

It was used Table 1 as support for collecting data, compiling information about the subjects of study, such as age, sex, place of birth, occupation, laterality and registration number

Table 1. Data collection sheet

No.	Edad	Sexo	Lugar de Nac	MD	1		2		3		4		5		6		7		8		F1		F2		F3		F4		F5		FM1		FM2		FM3	

2.3 Procedure

The process of data collection was conducted at the site of each subject of study, it was explained them the purpose of the activity and its importance. For the measurement of the dimensions of the hands they were requested to take the correct position for a precise measurement (seated subject), they were asked for information about age, sex, place of birth, occupation and dominant hand; the measurements were carried out with the corresponding instruments and they were collected in the data sheet.

A data base was developed with information from each sheet of data for processing them, in order to perform the statistical analysis, presenting a mean and deviation standard of each taken dimension and maximum strength in dominant and non-dominant hand; calculating percentiles for each sex. For this research is considered a direct measurement through anthropometric measures according to Mohammad (2005):

1. Hand length.
2. Hand width.
3. Palm of the hand length.
4. Palm of the hand width.
5. Hand thickness.
6. Grip diameter.
7. Palm of the hand circumference.
8. Hand circumference.

F1. Thumb length.
F2. Index finger length.
F3. Middle finger length.
F4. Ring finger length.
F5. Little finger length.
FM1. Maximum grip strength to 1.5 cm.
FM2. Maximum grip strength to 2.5 cm.
FM3. Maximum grip strength to 6.4 cm.

3. RESULTS

3.1 Anthropometric data

A descriptive analysis of the measures considered in this study is presented in Tables 2 to 5.

Table 2. Anthropometry of dominant hand in men, the measures are in centimeters.

MEASUREMENT	MEAN	S.D.	P5	P10	P25	P50	P75	P90	P95
1	19.19	0.97	17.59	17.95	18.54	19.19	19.85	20.44	20.79
2	10.72	0.57	9.77	9.98	10.33	10.72	11.10	11.45	11.66
3	11.13	0.49	10.32	10.50	10.80	11.13	11.46	11.75	11.93
4	8.74	0.47	7.97	8.14	8.42	8.74	9.05	9.33	9.50
5	3.28	0.23	2.89	2.98	3.12	3.28	3.43	3.57	3.66
6	4.93	0.35	4.35	4.48	4.69	4.93	5.16	5.37	5.50
7	20.54	1.14	18.65	19.07	19.77	20.54	21.30	22.00	22.42
8	24.48	1.38	22.21	22.71	23.55	24.48	25.40	26.24	26.75
F1	7.46	0.48	6.68	6.85	7.14	7.46	7.78	8.07	8.24
F2	10.76	0.58	9.80	10.02	10.37	10.76	11.15	11.50	11.71
F3	12.11	0.61	11.11	11.34	11.70	12.11	12.52	12.89	13.11
F4	11.42	0.57	10.48	10.69	11.04	11.42	11.80	12.15	12.36
F5	9.20	0.58	8.25	8.46	8.81	9.20	9.58	9.93	10.14

Table 3. Anthropometry of the non-dominant hand in men, the measures are in centimeters.

MEASUREMENT	MEAN	S.D.	P5	P10	P25	P50	P75	P90	P95
1	19.28	0.96	17.70	18.05	18.64	19.28	19.92	20.50	20.85
2	10.71	0.56	9.79	9.99	10.34	10.71	11.09	11.43	11.64
3	11.08	0.46	10.33	10.50	10.78	11.08	11.39	11.67	11.84
4	8.64	0.43	7.94	8.09	8.36	8.64	8.93	9.19	9.35
5	3.21	0.24	2.81	2.90	3.05	3.21	3.37	3.52	3.61
6	4.98	0.35	4.41	4.53	4.75	4.98	5.21	5.43	5.55
7	20.36	1.06	18.61	19.00	19.65	20.36	21.07	21.71	22.10
8	24.27	1.36	22.02	22.52	23.35	24.27	25.18	26.01	26.51
F1	7.45	0.38	6.82	6.96	7.19	7.45	7.70	7.93	8.07
F2	10.66	0.56	9.74	9.94	10.29	10.66	11.04	11.38	11.59
F3	11.99	0.55	11.09	11.29	11.62	11.99	12.35	12.68	12.88

F4	11.24	0.63	10.21	10.44	10.82	11.24	11.66	12.04	12.27
F5	9.03	0.54	8.14	8.34	8.67	9.03	9.39	9.73	9.92

Table 4. Anthropometry of dominant hand in women, measures are in centimeters.

MEASUREMENT	MEAN	S.D.	P5	P10	P25	P50	P75	P90	P95
1	17.40	0.86	15.99	16.30	16.82	17.40	17.97	18.50	18.81
2	9.31	0.55	8.40	8.60	8.94	9.31	9.68	10.01	10.21
3	10.10	0.54	9.21	9.41	9.74	10.10	10.46	10.79	10.98
4	7.63	0.39	6.99	7.13	7.37	7.63	7.90	8.14	8.28
5	2.81	0.20	2.48	2.55	2.67	2.81	2.94	3.07	3.14
6	4.55	0.32	4.03	4.14	4.34	4.55	4.77	4.96	5.08
7	18.27	0.91	16.78	17.11	17.66	18.27	18.88	19.43	19.77
8	21.49	1.26	19.42	19.88	20.64	21.49	22.33	23.10	23.56
F1	6.79	0.54	5.91	6.11	6.43	6.79	7.15	7.48	7.67
F2	9.70	0.50	8.88	9.07	9.37	9.70	10.03	10.33	10.52
F3	10.95	0.50	10.13	10.31	10.61	10.95	11.29	11.59	11.77
F4	10.31	0.47	9.54	9.71	10.00	10.31	10.63	10.91	11.08
F5	8.23	0.51	7.39	7.58	7.89	8.23	8.58	8.89	9.08

Table 5. Anthropometry of the non-dominant hand in women, measures are in centimeters.

MEDIDA	MEDIA	DESV.	P5	P10	P25	P50	P75	P90	P95
1	17.43	0.89	15.96	16.28	16.83	17.43	18.02	18.57	18.89
2	9.29	0.52	8.42	8.62	8.94	9.29	9.64	9.96	10.15
3	10.07	0.55	9.17	9.37	9.70	10.07	10.44	10.77	10.97
4	7.60	0.41	6.92	7.07	7.32	7.60	7.88	8.13	8.28
5	2.77	0.22	2.41	2.49	2.62	2.77	2.92	3.06	3.14
6	4.61	0.30	4.11	4.22	4.40	4.61	4.81	4.99	5.10
7	18.07	0.93	16.53	16.87	17.44	18.07	18.69	19.26	19.60
8	21.26	1.25	19.20	19.65	20.42	21.26	22.10	22.87	23.32
F1	6.77	0.53	5.90	6.09	6.42	6.77	7.13	7.45	7.65
F2	9.60	0.48	8.81	8.98	9.28	9.60	9.92	10.21	10.39
F3	10.81	0.49	10.00	10.18	10.48	10.81	11.13	11.43	11.61
F4	10.16	0.52	9.31	9.50	9.81	10.16	10.51	10.82	11.01
F5	8.09	0.51	7.25	7.43	7.75	8.09	8.43	8.75	8.93

3.2 Maximum hand force.

From a total of 110 samples, the analysis of information separated by sex in dominant and not dominant hand, for three positions of the instrument, were carried out. In Figures 2 and 3 are shown the behavior of the maximum strength of grip in the different groups.

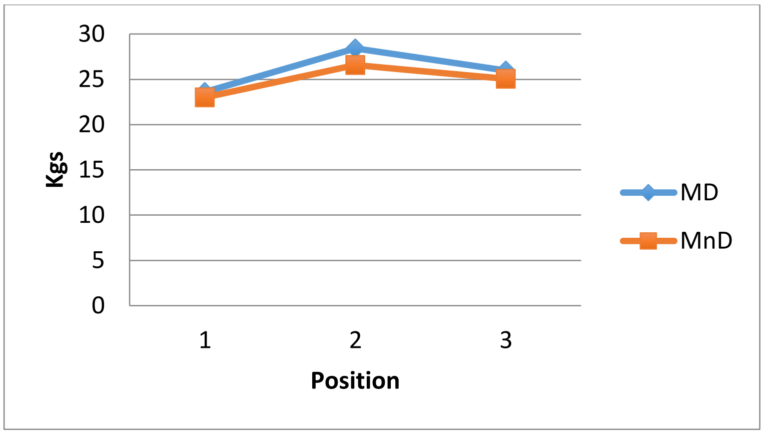

Figure 2. Strength of the dominant and non-dominant hand in women. The unit presented is Kg.

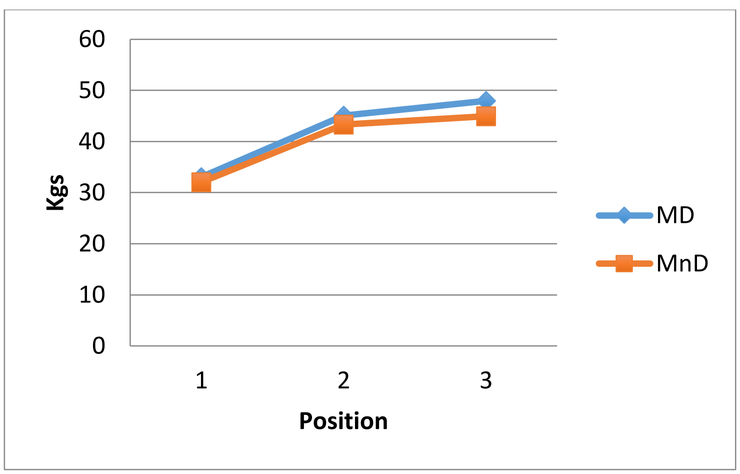

Figure 3. Strength of the dominant and non-dominant hand in men. The unit presented is kg.

3.3 Correlation Analysis

From a total of 110 samples, an information analysis was conducted to determine if there is a correlation between maximum force by sex in dominant and non-dominant hand, to three positions of the instrument. Tables 6 and 7 show the main findings, where you can see that in the case of women there is correlation ($p < 0.05$) between the forces and different measures of hand, practically in all measures of the dominant hand with the FM2 and FM3, while in the case of men does not occur the same behavior, finding that for the three different positions of the dynamometer there is correlation only on the circumference of the hand.

Table 6. Correlation between the Anthropometry of hand and the maximum grip strength in women, P-value < 0.05

Measurement	**P-value, FM1**		**P-value, FM2**		**P-value, FM3**	
	MD	**MND**	**MD**	**MND**	**MD**	**MND**
1	0.003	---	0.001	0.003	0	0
2	0.017	0.032	0	0.007	0	0.001
3	0	0.022	0	0.001	0	0
4	0.003	0.006	0	0	0	0.001
5	0.024	0.047	0	0.008	0.002	0.008
6	---	---	0.033	---	0.001	0.006
7	0.006	0.017	0	0.001	0	0.002
8	0.008	---	0	0.006	0	0.002
F1	---	---	0.014	---	0.007	---
F2	0.007	---	0.001	0.001	0	0.002
F3	0.017	---	0.002	0.019	0.001	0.019
F4	0.008	0.049	0.001	0.017	0.013	0.01
F5	0.001	0.013	0	0.005	0	0.001

Table 7. Correlation between the maximum grip force, and the Anthropometry of hand in men, P-value < 0.05

Measurement	**P-value, FM1**		**P-value, FM2**		**P-value, FM3**	
	MD	**MND**	**MD**	**MND**	**MD**	**MND**
1	---	0.001	---	---	---	---
2	---	0.017	---	---	---	---
3	---	0.043	---	---	---	---
4	---	---	---	0.016	---	0.022
5	---	---	---	0.034	0.001	0.001
6	---	0.014	---	---	---	---
7	---	---	---	0.035	0.009	0.009
8	0.014	---	0.036	0.002	0	0.003
F1	---	0.023	---	---	0.045	---
F2	---	0.007	0.007	---	0.023	0.008
F3	---	0.001	---	---	---	---

F4	---	0.027	---	---	---	---
F5	---	0	---	---	---	---

5. CONCLUSIONS

The results of the studied population allow to know anthropometric variables that are related to the maximum grip force in three-point of distance. Several correlations were found in the female data, and for both men and women, a strong correlation of the circumference of the hand was found with the three levels of force measured in the dominant hand.

The maximum gripping force for women identified a greater force in the distance of 2.5 cm and for men at 6.4 cm, in hand dominant for both. In this study the fact that women are stronger to lower distance, in accordance with the information presented, can be attributed to her anthropometric characteristics and allows to conclude that the proper adjustment of tools or utensils to anthropometric characteristics is important to increase efficiency in its use

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ANTHROPOMETRIC STUDIES IN CORN TORTILLERIA CITY OF LOS MOCHIS

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RESUMEN: Este estudio se lleva a cabo con la idea de tener una base de datos de medidas antropométricas en las tortillerías de maíz de Los Mochis Sinaloa, debido a la falta de información en esta área de la ergonomía. Donde se pretende sentar bases sobre futuros estudios sobre el diseño del espacio de trabajo, la modificación de espacios y objetos de uso.

PALABRAS CLAVE: Ergonomía, tortillerías y estación de trabajo.

ABSTRACT: This study was carried out with the idea of having a database of anthropometric measurements in corn tortilla Los Mochis Sinaloa, due to the lack of information in this area of ergonomics. Which aims to lay foundation for future studies on the design workspace, changing spaces and objects of use.

KEYWORDS: Ergonomics, tortillerías and workstation.

CONTRIBUTION TO ERGONOMICS: With the percentiles miller is has a database with which millers can redesign your work area to help improve occupational health miller to improve the welfare and quality of life of these workers.

1. INTRODUCTION

There are few studies on anthropometric measures millers plying their trade in tortillerías of Los Mochis, Mexico is increased demand of society on the inclusion of information on anthropometric specific data for later use in designs work areas, improve accessibility and make studies concerning measures for these workers.

The main problem that hinders is that the work areas miller (tortilla corn) are not designed properly for workers, as these are the paradigm adapt to the work area whatever the situation, which is often harmful on several factors such as productivity by slowing activity and quality of life by making unnecessary overexertion by bad design area.

The results arising from this study will bring benefits to both workers and tortillerías because millers may have a suitable work area as well as the inclusion of new enhancements, which means an increase in safety, quality of life and the company will with suitable millers which brings profit increased productivity in tortillerías facilities. This research was developed with anthropometric measurements millers of corn tortilla in Los Mochis Ahome Sinaloa, where data from thirty millers who were willing to cooperate with this study were taken.

Currently, anthropometry is a fundamental discipline in the workplace, both in relation to safety and ergonomics. Anthropometry allows creating a suitable working environment allowing proper equipment design and proper distribution, enabling you to configure the geometric characteristics of the job, good design furniture, hand tools, of personal protective equipment, etc. According to Esperanza Valero (2007), knowledge of static dimensions is essential for the design of jobs and allows for the required distances between the body and its surroundings. The structural dimensions of the different segments of the body are taken into individuals in static postures, standard good standing or sitting. The human body can take many different static anthropometric data that may interest, depending on what you are designing.

Ultimately, it comes to organizing and designing jobs determining the necessary space to develop the activity so that the person can carry out their work doing all the movements required by the job without being exposed to potential risks arising from the lack of space . The percentile is very useful because it allows us to simplify when we talk about the percentage of people who will be considered for the design. All this is done in order to improve the quality of life of workers.

2. OBJECTIVE

The overall objective of the research focuses on having a current anthropometric data base Millers city of Los Mochis. The database will serve for future research, in which they intended to redesign the workspace of a miller, design tools and design the machinery that handles.

3. METHODOLOGY

The collection of anthropometric data sits as a basis for the design of workspace tortilla corn, where it was determined who will be the users (millers) and consider human variability already mentioned, also the functions they will perform in that space and dimensions that are required for it, objects or equipment to be used, determine whether users will labor among individuals with disabilities.

Since many times is virtually impossible to measure all individuals of a given population it was selected individuals (millers) to serve as an example of the entire population (corn tortilla). The wider the sample, the more representative of the total population will, in this case thirty measures millers of Los Mochis, Sinaloa were taken.

To carry out measurements there are a variety of tools and methods, which were used to carry out the investigation were the anthropometer and measuring tape. formats anthropometric identity card which measures to take important for the development of the activity of the miller, after taking measurements of 30 millers, data is captured in a database in which the percentiles were taken indicated were used suitable for the activity of the miller.

4. RESULTS

Then the data collected in the most important area for design work or other activities percentiles are presented. Percentiles are 100, 95, 90, 75, 50, 25 and 5 (cm).

Table 1. Table of percentiles

Partes del cuerpo	percentiles (cm)						
	5%	25%	50%	75%	90%	95%	100%
A-Longitud de alcance desde planta del pie a mano	198,5	205,25	213,5	221,75	226,7	228.35	230
B-Longitud parado	168,85	172,25	176,5	180,75	183,3	184,15	185
C-Ancho de la cintura	83,4	89	96	103	107,2	108,6	110
D-Longitud de pierna	83,8	87	91	95	97.4	98,2	99
E-Longitud de alcance de brazo	64	68	73	78	81	82	83
F-Longitud de la planta del pie al hombro	137,9	141,5	146	150,5	153,2	154,1	155
G-Longitud del pie a espalda baja	100,9	104,5	109	113,5	116,2	117,1	118
H-Longitud del pie a la rodilla	31,3	36,5	43	49,5	53,4	54,7	56
I-Ancho del cuello	38,35	39,7	41,5	43,25	44,3	44,65	45

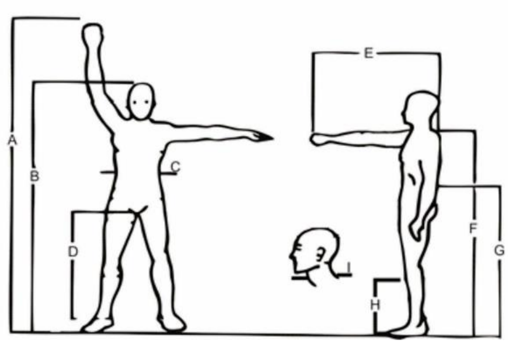

Figure 1. Measures taken miller

5. CONCLUSION

With the identified body percentiles you can develop strategies to improve the workstation miller, adapting the work area to your body based on the right to develop its activity percentiles increased physical well-being of these workers and increasing productivity their work can also be adapted hand tools that facilitate the activity without making a total redesign of the workstation.

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STUDY OF REPEATABILITY AND REPRODUCIBILITY BY LONG METHOD FROM ANTHROPOMETER TO DETERMINE THE CAUSES OF ERROR IN THE PROCESS OF MEASUREMENT

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Resumen: En esta investigación se describe de manera detallada el método de repetitividad y reproducibilidad (R&R) de medias y rangos, conocido como método largo. En el caso de estudio se utilizó como instrumento de medición un antropómetro marca LAFAYETTE MODEL 01290, con una resolución de 1 cm, con un rango de medición de 0-60 cm, que se empleó en la medición de una variable de longitud antropométrica, conocida en Ergonomía como "anchura de hombros" abreviada como HH. Con la obtención de los datos se llenó una tabla en Excel, para su análisis estadístico y exposición de resultados. La finalidad de este estudio fue la identificación de causas de error en el proceso de medición.

Palabras clave: Repetitividad, Reproductibilidad, Antropometría, Ergonomía, Metrología

Abstract: This research describes in detail the method repeatability and reproducibility (R & R) of averages and ranges, known as long method. In the case study was used as a measuring instrument mark an anthropometer LAFAYETTE MODEL 01290, with a resolution of 1 cm, with a measuring range of 0-60 cm, which was used in the measurement of a variable length anthropometric known Ergonomics as "shoulder width " abbreviated HH . By obtaining data table filled in Excel, for statistical analysis and presentation of results. The purpose of this study was the identification of sources of error in the measurement process.

Keywords: Repeatability, Reproducibility, Anthropometer, Ergonomics, Metrology.

Relevance to Ergonomics: To design and make a safe and reliable ergonomic research is necessary that the measuring instruments are as robust as possible, and this research a statistical application through a long method repeatability and reproducibility of a anthropometer is done to determine if the instrument meets the measurement criteria.

1. INTRODUCTION

The term comes from Greek anthropos anthropometry (man) and metrikos (measure) and is the quantitative study of the physical characteristics of man. (Valero Cabello, 2013).

The instrument for this measure is known as Anthropometer, which is described as (Valero Cabello, 2013), as a metric scale with two branches, one fixed and one moving that is used to measure linear dimensions.

Any instrument dimensional measurement is subject to error, which affects the quality measurements, errors can be for two main reasons, the measurement method and the instrument is not calibrated or conditions for use, a way to find out is with a study of repeatability and reproducibility. According (Llamosa, 2007), methods to determine the repeatability and reproducibility of measurements are based on the statistical evaluation of the dispersions of the results, either as a range or its representation as variances or standard deviations. The methods used are: Range, Average and Range, and ANOVA (analysis of variance). Below the average and range method implemented in this research, it is shown.

2. OBJECTIVE

Determine whether the measuring instrument (anthropometer) is suitable for anthropometric measurements.

3. METHODOLOGY

The development of the method was carried out with a group of students Research Workshop sixth semester of Industrial Engineering, the Higher Technological Institute of Guasave. Research subjects are 10 male students participated with an age range of 20 to 22 years as a measurement object, three students of different took steps three times in each of the 10 students at random, this as tracking and long RR method known as a method of averages and ranges, which is carried out as follows by (Pulido Gutierrez, 2009):

1. Select three operators to conduct the study on the measuring instrument interest.
2. Select randomly a set of 10 persons to whom they will measure the shoulder width HH, which will be measured several times by each operator.
3. Decide the number of times each test or operator measures the same part. Three trials were conducted.
4. Label each part and randomize the order in which the parties give operators. In this case, each person was called by name and the part is to measure specific operators.

5. Identify the area or point in the part where the measurement will be taken, as well as the method or technique to be applied.
6. Get in random order the first measurement (or test) for all persons selected to operator.
7. Return to randomize people and get the first measurement the operator B.
8. Continue until all operators have made the first measurement of everyone.
9. Repeat the three steps above to complete the number of selected trials.
10. Do the statistical analysis of the data.

4. RESULTS

Averages and ranges of R & R long study analysis: the method is illustrated with data and applying the format and formulas which are described in tables 1 and 2.

5. CONCLUSION

Following the criteria of the method reproducibility and repeatability, the percentage of R & R results in 55.60 %, exceeding the 30 % error thus concludes that the measuring instrument needs to be calibrated or otherwise changed by one of best quality with calibration certification. As observation regarding the method of measurement , it is necessary to instruct the operator to take the same measurement points on each of the parties, persons or pieces depending on the case and make the right reads , taking care of the basic principles of metrology

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Table 1. Results R & R Anthropometer

Repeatability and Reproducibility (Long Method)

K_1	Number of Tests	Must be between 2 or 3	3	OK
K_2	Number of Workers	Must be between 2 or 3	3	OK
K_3	Number of samples	Any value between 2 and 10	10	OK

Denomination:		Measuring device:	Anthropometer	Center:	ITSG
Feature:	Shoulder width HH	Measuring device nº:	Range 0-60 cm	Deparment:	Industrial Engineering
Tolerancia:	6 cm	Type measuring device::	LAFAYETTE	Made by:	MC.Viridiana Humarán
		Next Rev.:		Date:	18 marzo 16

WORKER		P		A		R		T			RESULT	
Tests		1	2	3	4	5	6	7	8	9	10	AVG
A	1	42.8	43.4	41.0	43.2	44.8	44.7	43.8	42.7	41.4	43.8	A_1 43.16000
	2	44.1	43.4	40.9	43.4	44.5	44.8	43.6	43.6	41.4	43.7	A_2 43.34000
	3	43.2	43.5	40.6	43.6	44.8	43.0	43.1	42.9	41.5	43.9	A_3 43.01000
Mean		43.36667	43.43333	40.83333	43.4	44.7	44.16667	43.5	43.06667	41.43333	43.8	$\bar{X}_A$ **43.17000**
Range		1.3	0.1	0.4	0.4	0.3	1.8	0.7	0.9	0.1	0.2	$\bar{R}_A$ **0.62000**
B	1	44.0	43.0	41.0	43.0	42.0	44.0	43.2	44.0	40.0	42.5	B_1 42.67000
	2	43.5	42.5	40.0	42.5	43.0	43.3	43.0	42.0	39.8	42.0	B_2 42.16000
	3	43.2	42.8	41.0	42.4	43.0	43.0	42.5	41.8	40.0	42.3	B_3 42.20000
Mean		43.56667	42.76667	40.66667	42.63333	42.66667	43.43333	42.9	42.6	39.93333	42.26667	$\bar{X}_B$ **42.34333**
Range		0.8	0.5	1.0	0.6	1.0	1.0	0.7	2.2	0.2	0.5	$\bar{R}_B$ **0.85000**
C	1	44.0	44.0	39.9	43.5	43.1	44.0	42.6	44.5	40.0	43.5	C_1 42.91000
	2	42.4	43.4	40.1	43.7	43.0	44.8	43.5	43.2	39.1	42.5	C_2 42.57000
	3	43.1	43.5	40.6	43.0	42.4	44.0	43.2	42.8	39.9	42.0	C_3 42.45000
Mean		43.16667	43.63333	40.2	43.4	42.83333	44.26667	43.1	43.5	39.66667	42.66667	$\bar{X}_C$ **42.64333**
Range		1.6	0.6	0.7	0.7	0.7	0.8	0.9	1.7	0.9	1.5	$\bar{R}_C$ **1.01000**
Med. Mean		43.36667	43.27778	40.56667	43.14444	43.4	43.95556	43.16667	43.05556	40.34444	42.91111	$\bar{\bar{X}}_{Pieza}$ = 42.71889
Range Mean												R_{Pieza} = 3.61111

$\bar{\bar{R}}$ = R_A+ R_B + R_C / N.of workers =		0.62000	+	0.85000	+	1.01000	/	3	$\bar{\bar{R}}$ = 0.82667
$\bar{X}_{DIFF}$=[Max $(\bar{X})_{ABC}$] - [Min $(\bar{X})_{ABC}$]	=	43.17000	-	42.34333					$\bar{X}_{DIFF}$ = 0.82667
UCL_R: $\bar{\bar{R}}$	* D_4 =	0.82667	*	2.580					UCL_R = 2.13280
LCL_R: $\bar{\bar{R}}$	* D_3 =	0.82667	*	0.000					LCL_R = 0.00000

WORKER	NAME OF WORKER
A	Narda Guadalupe Hernández Vea
B	Maria Fernanda Murillo Berrelleza
C	Marisol Ruelas Rodríguez

NOTES: All calculations are based on the prediction of 5.15 σ (99 % of the area of the normal curve) . A negative value under the square root sign , causes the variation of the estimate is zero.

DATA SHEET	$\bar{\bar{R}}$ = 0.82667	$\bar{X}_{DIFF}$ = 0.82667	R_{Pieza} = 3.61111

Table 2. Results R & R Anthropometer (Part 2)

Analysis measurement units			**Based on the variation in samples**
Repeatability - Equipment Variation (EV) EV = $\bar{\bar{R}} * K_1$ **EV =** 2.52133 $\sigma repeti = \frac{EV}{5.15}$ = 0.4895	**Essays** 3	**K_1** 3.05	% EV = 100[EV/TV] **% EV =** 42.02
Reproducibility - Change Operator (VO) AV= $\sqrt{[(\bar{X}_{DIFF} * K_2)^2 - (VE / nt)]}$ **AV=** 2.18401 $\sigma reprod = \frac{AV}{5.15}$ = 0.4240	(n parts, t trials) **Workers** 3	**K_2** 2.70	% AV = 100[AV/TV] **% AV =** 36.40
Repeatability & Reproducibility (R & R) R&R= $\sqrt{(EV^2 + AV^2)}$ **R&R=** 3.33572			% R&R = 100[R&R/TV] **% R&R = 55.60**
Variation sample (PV) PV= $R_{Pieza} * K_3$ PV= 5.85000	**Samples** 10	**K_3** 1.62	% PV = 100[PV/TV] **% PV =** 97.50
Variation Total (TV) TV= $\sqrt{(R\&R^2 + PV^2)}$ **TV=** 6.73421			**THE MEASUREMENT DEVICE IS REJECTED** ***All ranges are OK***

Guide for accepting gauge repeatability and reproducibility (% R & R) :
10% LOWER ERROR: Calibre OK .
10% to 30 % ERROR : Can be accepted depending on the importance of the application.
SUPERIOR 30 % ERROR : Calibre needs improvement. IDENTIFY problems and correct them.

THE CONCLUSION IS...	MEASURING EQUIPMENT IS REJECTED , you NEED IMPROVEMENT

.

ANTHROPOMETRIC MEASURES OF BARBERS CITY FROM LOS MOCHIS SINALOA

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Resumen: En este trabajo, se presentan las medidas antropométricas tomadas a peluqueros de la ciudad de Los Mochis, Sinaloa. La principal aportación de esta investigación consiste en la obtención de datos antropométricos que sirvan para futuros rediseños de estaciones de trabajo para peluqueros, así como, herramientas de mano utilizadas por los mismos con el objetivo de erradicar posibles DTA's o incluso fatiga y que éstos a su vez puedan ser utilizados en la región o hasta en el estado para fines benéficos a la sociedad. Se busca posibilitar y facilitar el rediseño del área de trabajo de los peluqueros. El estudio se realizó en un periodo de dos semanas, en diferentes peluquerías de la cuidad de Los Mochis donde los peluqueros y clientes ofrecían y recibían un servicio respectivamente.

PALABRAS CLAVE: Peluquero, antropometría, percentil.

Abstract: This paper presents anthropometric measures taken from hairdressers in the city of Los Mochis, Sinaloa. The main contribution of this research is to obtain anthropometric data, which will serve for future redesigns of workstations for hairdressers, as well as hand tools used by them in order to eradicate possible DTA 's or even fatigue, and that they in time can be used in the region or even in the state for beneficial purposes to society . It seeks to enable and facilitate the redesign of workspace hairdressers. The study was conducted over a period of two weeks, in different barber shops of the city of Los Mochis where hairdressers and clients a service offered and received respectively.

KEY WORDS: Hairdresser, anthropometry, percentile.

Contribution to ergonomics: The data collected above may provide a basis for further work in the rest of the country on the economically active population. Anthropometry gives a great contribution in order to prevent risks related barbers using their own equipment, furniture and tools. Thus enable them to prevent musculoskeletal injuries.

1. INTRODUCTION

Anthropometry as (Roebuck, 1993), is the science of measurement and the art of application set physical geometry, mass properties, and resistance capabilities of the human body. It is considered as the science that studies the human body measurements, in order to establish differences between individuals, groups, races, among others. Cueva (2014) comments, anthropometry, as a discipline was founded by the Belgian mathematician Quetlet in the mid-nineteenth century, however, since ancient times the Greeks and Romans studied the dimensions of the human body, in order to meet standards and ratios to be applied in architecture and mainly sculpture.

2. OBJECTIVE

The overall objective of the research focuses on having a current anthropometric data base of hairdressers in the city of Los Mochis.
• To serve as a reference for future research, in which they intended to redesign the workstations and barbers' tools.

3. METHODOLOGY

Participants willing to collaborate in the project were 20 hairdressers in the city of Los Mochis. All hairdressers are men who work an eight-hour period from Monday to Saturday. They were sampled in a period of two weeks.

The measures were taken with a flexometer due to the lack of an anthropometer since they are really expensive to acquire; the information was collected using anthropometric sheets and captured in Microsoft Excel.

4. RESULTS

Data analysis and presentation of results of various measures is observed here. Once the measures were defined it proceeded to complete the database with percentiles 100, 95, 75, 50, & 5 (cm).

Table 1. Nomenclature

Table 2. Percentiles

Tabla de percentiles

Percentil	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
100.0	8	9.5	14	2	2.3	2.4	2.3	3.8	12	7.8	9.6	10	8.8	8	22	9	68	11	34	84	108.5	78
95.0	8	9.33	11.79	2	2.215	2.23	2.05	3.12	10.3	7.715	9.09	9.745	8.545	7.405	21.58	8.15	61.2	10.32	31.45	80.6	103.4	74.6
75.0	7.5	9	11.1	1.5	2	2	2	2.65	9.725	6.575	8.75	9.35	8	7	20.9	7	54.25	10	30	78.75	86	72.75
50.0	7.1	9	11	1.5	1.75	1.85	1.85	2.25	9.35	6.5	7.9	8.85	7.9	7	20.2	5.9	50.45	9.6	26.5	75	79	70
5.0	6	7.7	10.09	1.3	1.485	1.5	1.4	1.6	7.85	5.8	6.97	7.725	7.265	6	15.6	4	47.93	7.425	21	70.7	73.4	60.25

K	Largo dedo índice	V	Largo del hombro al puño

5. CONCLUSIONS

Great accuracy is needed when making measurements to make tool designs or work areas that are of benefit to the workers evaluated. Therefore, the need for an anthropometer is crucial in order to get accurate measures. The measures presented above me include a bias since the tool used is not as accurate as an anthropometer. The research needs to go further, beyond the city of Los Mochis, and add more accurate data with more accurate measuring tools.

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SITUATIONAL AWARENESS FOR CONTROLLING INFORMATION SHARING IN INCIDENT MANAGEMENT AT MAJOR EVENTS

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Resumen: El propósito de este artículo es descubrir cómo la comprensión de las situaciones (CS) permite y controla el intercambio de información (II) para la colectiva CS. Ésta es necesaria para la toma de decisiones dentro del contexto de la operación rutinaria de los eventos grandes incluyendo el manejo de incidentes rutinarios y contingentes. Este contexto de trabajo es considerado inexplorado, dinámico, con tiempo restringido y complejo proveyendo condiciones naturales para estudiar el II. Un paradigma interpretativo considerando perspectivas cognitivas y sociales fue escogido para obtener su profundo conocimiento. Revisión de documentación organizacional, observación de la práctica y entrevista de personal experimentado fueron los métodos utilizados para recolectar información en conciertos y partidos de béisbol. La teoría de la actividad fue empleada como marco conceptual y herramienta analítica. La información fue categorizada descubriendo significados, riesgos y estimulantes del medio ambiente y la comprensión de los individuos como construcciones subjetivas e inter-subjetivas requeridas en este contexto.

Palabras clave: Conocimiento de la situación, intercambio de información, gestión de incidencias, grandes eventos, teoría de la actividad

Relevancia a la ergonomía: La comprensión de cómo la conciencia situacional (SA) mejora y controla el intercambio (IS) en la gestión y operación de rutina incidente en los principales eventos de información. Esta relación hacia SA colectivo no ha sido declarado claramente, por lo que este se abre una brecha de conocimientos, que se trata aquí.

Abstract: The purpose of this paper is to uncover how situational awareness (SA) enhances and controls information sharing (IS) towards collective SA. This is needed to make decisions within the context of routine operation of major events involving the management of both routine and contingent incidents. This working context considered unexplored, dynamic, time constrained and complex provided naturalistic conditions to study IS. An interpretive paradigm considering cognitive and social approaches was chosen to gain in-depth insights about it. Review of organizational documentation, observation of practices and interview of experienced personnel were the methods used to collect data in concerts and baseball matches. Activity theory was used both as a conceptual framework and an analytical tool. Data were categorized uncovering meanings, risks and stimulation from the environmental elements and awareness of individuals as the subjective and inter-subjective social constructions needed in this context.

Keywords: Situational awareness, information sharing, incident management, major events, activity theory.

Relevance to Ergonomics: The understanding of how situational awareness (SA) enhances and controls information sharing (IS) in the routine operation and incident management at major events. This relationship towards collective SA has not been clearly stated, so this opens a gap of knowledge, which is treated here.

1. INTRODUCTION

Routine operation of major events implies the alignment of its principal activities to prevent routine incidents and to minimize the impact of contingent incidents. Major events are broadly defined as public or social things that taking place with the purpose of entertaining a group of people who have leisure objectives within a place or venue. Routine operation is the set of activities, actions and operations that are performed before, during, and after the normal operation with the goal of preventing incidents or managing potential or active incidents. Incident means any unusual situation that could lead to the loss or disruption of the routine operation. Incident management is the set of activities, actions and operations that are performed before, during and after the routine or contingent incidents with the goal of preventing casualties, reducing their impact on infrastructure and returning to a state of normalcy as routine operation. Activities are consequently focused on the creation and preservation of SA at individual and collective levels preventing and managing those incidents, and serving to understand continuously what has happened, what is happening and what could happen in the working context over time (Endsley, 1995). The goal is to gain a clear picture of the context to make informed decisions.

At that level of situational understanding, IS is crucial to pass from individual SA to collective SA because diverse types of SA are demanded by organizations. This is because each organization is centered on achieving its goals and has significantly different understandings of the context. The context treated here helps in corroborating different situational meanings that served as mediators of IS. Consequently, the environmental elements included in SA have different relevance to individuals and their organizations. So, passing from individual SA to collective SA is a challenge. Specifically, this includes the diverse mediators employed by IS involving different technologies. They are principally represented by the information and communications technologies (ICT's) as material tools. These technologies are aligned to facilitate and command it; however, some abstract technologies are not incorporated in the current research. For example, language is seen as a control variable. For this reason, Richardson and Ashtana (2005) suggest that language is an important element of IS by incorporating levels of efficacy and efficiency in it.

2. INFORMATION SHARING, ABSTRACT TOOLS AND SITUATIONAL AWARENESS

The goal of information sharing is to change the image of the world of individuals that they should use in a working context. Furthermore, it is seen as a nested component of information behavior, which has both cognitive and social dimensions (Wilson, 2006). This approach allows study of it from interpretive strategies enriching its understanding by using diverse paradigms, assumptions and methods. This also permits researching its motivations, types, technological mediators and challenges (Sonnenwald, 2006), specifically, the abstract mediators or tools. Thus, this literature review is only focused on abstract tools and SA.

Language is the principal abstract tool utilized to mediate and control human activity (Engestrom, 1987) and used during social interactions between individuals underpinning face-to-face interaction. It is contextualized as the language of emergency management (Mishra, Allen and Pearman, 2011); the military (Sonnenwald and Pierce, 2000); the police (Allen, 2011) among others. Nonetheless, Richardson and Ashtana (2005) stated that professional language is an element of IS helping in clarifying relationships between individuals from diverse organizations using shared images of the world. Expertise is another abstract tool and is an element of behavior that facilitates and regulates IS, but it is strongly linked to positive attitudes. Other abstract tools are training; information culture; body language; shared meanings of symbols and implications of information, among others. However, their efficacy and/or efficiency are not commented on in terms of facilitating or regulating IS. For example, it is necessary to deal with ambiguity of language in dynamic and complex environments because it can lead to misunderstandings in creating usable images.

Situation awareness or situational awareness are two terms used interchangeably, but situational awareness (SA) is preferred because to point out the necessity of individuals to be aware of diverse situations in context, which are analyzed and not measured. This allows the understanding of naturalistic situations with unique characteristics and attributes. SA is defined “as the perception of elements in the environment within a volume of time and space, the comprehension of their meaning in terms of task goals, and the projection of their status in the near future” (Endsley, 1995, p.36). Its value is critical to control dynamic, time constrained and complex environments (Sonnenwald and Pierce, 2000) by helping in projecting future states of environments permitting the making of informed decisions. SA is considered a product being a complete understanding of specific situations resulting in a mental model o picture. SA is also considered a process for achieving stages to complete situational understandings. Furthermore, SA is informed by two perspectives. The information perspective involves four stages summarized as perception of environmental elements, comprehension of those elements in context, projection of states of those elements and prediction of what external variables may affect that projection. The ecological perspective summarizes the dynamic interaction between individuals and the environment defining SA in context. Flach (1995) stated that SA is the creation of "meaning with respect to both the objective tasks constraints (i.e. the situation) and the mental interpretation (i.e. awareness)" (p.151) at individual level. It is considering "who understand via awareness (the cognitive agent) and the implications of the situation (objective reality)" (p.151). It also includes the affordances (Gibson, 1983), which are attributes of objects or environmental elements that allow individuals to perform actions. That is, SA is created in relation to the situation in context shaping the tasks performed at individual and collective levels.

The individual SA or SA implies the discovery of information in context to create and maintain awareness of what is going on around individuals (Millward, 2008) and it can lead to IS (Solomon, 2002), if individuals create meanings of the environmental elements. This is because differences in the mental model can lead to IS and can be observed in the diverse relationships emerging between individuals during routine work (Endsley et al., 2003). The response can be seen in how individuals manage the information obtained and how information is shared and this starts with SA at individual level considering other individuals in context. However, certain individuals are not prepared to add their pieces of situational information in time-constrained environments. Therefore, it is important to recognize that each individual should have particular goals to accomplish, plays a specific role, or performs a certain function in interacting with elements in the task environment by passing from individual to collective SA playing an important role for generating and preserving that SA.

The collective SA refers to the shared SA or shared understandings between at least two individuals in context. It was found as team, distributed, shared and interwoven SA. Team SA is treated as an element required by diverse members of teams to achieve their roles by helping them with the understanding of what is happening in situations in context, and how this understanding aids with their responsibilities, accomplishing organizational processes as communication, coordination, collaboration and performance backed up by IS. Distributed SA is related to the interaction between individuals with devices providing knowledge and information to understand situations. Shared SA is seen as the overlaps between individuals in context and in consideration of shared requirements and is defined as "a process of knowing what is going around oneself and others with whom one interacts" (Millward 2008, p.13), being two types: one does not demand IS (called type I) and another demands IS (called type II). Interwoven SA stressed the necessity of diverse types of SA to "facilitate task completion" (Sonnenwald and Pierce, 2000, p.471) and is defined as the "interwoven patterns of individual, intra-group and intergroup SA" (p.476). This implies the recognition of their roles, distinguishing their physical position and using tools for facilitating the interaction. However, if multiple types of SA are shared and received these can lead to misinformation and information overload. Using diverse sources can generate tensions with/between individuals and their organizations. The relationship of IS and SA towards collective SA has not been clearly stated, so this opens a gap of knowledge treated here.

3. CONTEXT AND METHODOLOGY

3.1. The Context of the Routine Operation and Incident Management at Major Events

This research was undertaken at concerts and baseball matches at cities located in northeast Mexico. The local government of Tijuana organized the concerts and the managers of the baseball teams of Los Mochis and of Guasave, the baseball matches. The organizers deployed a pyramid/hierarchy organization to control the routine operation following guidelines included in the General Law of Civil Protection (Estados-Unidos-Mexicanos, 2012), which suggests the formation of a command and control area (C2) assembled by the leaders of all participant organizations. From here the individuals are involved in coordinating the activities of a number of different organizations not all of which are necessarily used to working together with each other. It was usual that some individuals stayed in determined areas while others patrolled some areas of the venues over time. These patrols help in understanding what is happening over time within the venues and in discovering those areas that might be seen as problematic, because they can suddenly change over time. Contrarily, the located individuals were alert to manage the contingent incidents.

3.2. Participants and Their Organizations

13 diverse organizations were included in the study: two baseball teams (serving as organizers of baseball matches), a department of the local government (serving as organizer of the concerts), two divisions of the Police (active and commercial), the Fire Department, two Civil Protection areas, the Red Cross, two voluntary organizations and two security organizations. This allowed inclusion of individuals with experience in incident management and with roles at tactical and operational levels forming the pyramid/hierarchy organization: their leaders constituted the C2. Additionally, each organization and its members wore uniform to distinguish between each other in context.

3.3. Gathered Data

Observation of current practices, interview of incident responders using the Critical Incident Technique (Flanagan, 1954), and review of organizational documentation were the methods used to gather data in the fieldwork. The first phase involved the observation of practices in two concerts with an audience of 55,000 and 35,000 spectators respectively. The organizational documentation was reviewed and 17 semi-structured and face-to-face interviews were conducted. The next phase included the baseball matches. Practices were observed in 19 matches that incorporated the semifinals and the finals of the season. The organizational documentation was reviewed and 19 interviews were conducted. The final phase covered the review of organizational documentation of the concerts and 19 interviews. The fieldwork overall resulted in 55 interviews with operative and tactical personnel with experience managing incidents reporting 119 incidents; nearly 100 hours of observations in 21 events discovering 56 incidents, and the review of 147 documents.

3.4. Analysis of Data

Activity Theory (AT) "can be quite a powerful analytical tool and conceptual framework of inquiry" (Wilson, 2006, p.9). Specifically, AT as framework has been found useful to study IS (Hassan Ibrahim and Allen, 2012) and gives the opportunity to study the human activity in everyday practice considering the cultural and historical context and the individual and social levels (Wilson, 2006). This is because the "human mind…and can only be understood within the context of human interaction with the world, and this interaction, that is, activity, is socially and culturally determined" (Kaptelinin, Nardi and Macaulay, 1999, p.28). The notion of IS helps to "understand not only what people are doing but also why they are doing it" (Kaptelinin, 2005, cited in Nardi, 2005, p.38). Additionally, AT as analytical tool enables the understanding of the context where IS is studied, that is an integrated whole containing diverse elements including the tools and artifacts within the activity system (Engestrom, 1987). It starts by clarifying the activity elements; following with exploring those with the lens of the activity principles; and finalizing with discovering inner contradictions that entail tensions in situations involving subjects that consequently change the nature of activity to overcome those strains. Thus, it permits to study in detail the mediation of its elements by analyzing separately each element and after as a whole.

This analysis also includes "an interpretive, naturalistic approach" (Denzin and Lincoln, 2000, p.3), permitting to gain in-depth understanding of IS and SA in this naturalistic context, which is "little known". This approach also offers to gain in-depth understanding of the SA demanded at individual and collective levels associated with the personal subjective and inter-subjective meanings while individuals interact with the context. Here, reality is a social construction of individuals that similarly includes other realities, a consequence of continuous interaction between them. Hence, these multiple-voiced constructions permit accessing the meanings individuals shared between them (Denzin and Lincoln, 2005). Furthermore, the research captures the unpredictability of situations through the meanings given by individuals offering extra understandings of the context.

NVivo9 was chosen to facilitate the handling, management and analysis of qualitative data. The language of analysis was Spanish because the collected data was in it, bringing transparency of the phenomenon under study for working with transcripts of naturally occurring data and only some used quotations were translated to English. Furthermore, the employed inductive approach permitted the discovery of "frequent, dominant, or significant themes inherent in raw data, without the restraints imposed by structured methodologies" (Thomas, 2006, p.238), helping to link concepts and themes. The richness of description of incidents was crucial to subsequent analysis. Initially, the coding process is "a process of simultaneously reducing the data by dividing it into unit of analysis and coding each unit" (Calloway and Knapp, 1995, p.2). This started using the open coding process in which data were coded interpretatively and using the constant comparative method until new codes were not discovered (Strauss and Corbin, 1998). The next step was axial coding. It is related to linking categories at the level of properties and dimensions until the point of selective coding was reached, or no new properties, relationships or dimensions emerged. For example, the role of information providers and receivers and individual SA were themes classified inside of the theme collaborative SA as an outcome of IS in face-to-face interactions.

4. FINDINGS

Findings suggest that if individuals were able to obtain meaning from situations (Flach, 1995), they may forecast future states of those elements, so they were likely to share information with other individuals. Furthermore, the findings suggest similarities with discoveries in other investigations in collaboration, in the military and in team performance. For example, Sonnenwald (2006) argued that SA included elements from the context, socio-emotional aspects and characteristics of tasks and processes performed. In this line, the findings uncovered similar sources discarding emotional aspects for ethical reasons. Furthermore, Endsley and Jones (2001) and Millward (2008) argued that SA provided the elements for creating collaborative SA in others via communication. This investigation found the same elements and via considering that in this paper communication is seen as IS -as a two-way process-. Moreover, the findings confirmed that SA mediated and controlled IS using other abstract and material tools as means to achieve that collaborative SA.

4.1. Meanings of Environmental Elements

The elements included in SA captured the situational meanings created from environmental elements that continuously were updated. This permitted projecting the states of the situations and predicting what factors may affect them (Endsley, 1995). In this line, individuals suggested two elements required in context including the state of the situation in terms of what is and what should be (Hancock and Diaz, 2002). One was in relation to what was happening in a determined place and time. The other was in reference to what is the best state of the routine operation in major events (no incidents or fast return to this state). Both implied the discovery of complexities in situations, which were included in the SA created. Consequently, individuals located those environmental elements that mismatch the expected state of the situations. This was seen in the continuous interaction and immersion in the environment (Gibson, 1983) allowing the adaptation of individuals to the environment. For instance, when individuals understood that "*beer sellers left bottles to the spectators during the baseball matches (e21)*" means that they were immersed in the environment and their tasks were shaped by it uncovering their role mediating consequently IS. This was seen when one-another noticed, "*they (bottles) can cause damage (e21)*" suggesting future states of the situations because "*bottles are used as projectiles (e21)*". For this reason, it is suggested additional research on investigating what other elements are included in SA, what meanings they have and how they are connected with future states in context.

4.2. Discovery of Risks in the Environment

The discovery of environmental risks was considered relevant in context. Individuals pointed out the requirements to open the vision at the moment of evaluating the incidents so that they can broadly understand their situations and risks. For instance, certain individuals should "*open the vision and evaluate the scene (e7)*" in order to "*report what happened (e7)*". Individuals should focus their attention on certain environmental elements and others should be discarded. This phenomenon is named *attentional tunnelling* (Harrald & Jefferson, 2007, p. 6)" or "*tunnel vision (e7)*". In other words, the environmental evaluation "*served to assess the risks included in the problematic area and what type of resources would be required to manage that incident (e7)*" triggering information sharing. Furthermore, the "*evaluation of the scene helped to intervene in a safe way…because safety is relevant to individuals (e7)*". However, this generated tensions between individuals for expecting to manage incidents fast, but they should first be completely sure of what was going on. An example is when individuals evaluated the situations, they wanted to "*know if there was an incident, or they (spectators) were only try to confuse us in order to gain attention of uniformed people (policemen) and left uncovered other problematic areas (e46)*". Thus, it is important to study how risks are located, what risks are relevant to safety and security areas, to what extent individuals are connected with those risks and are trained to discover them, and what type of training effectively improve the skills and abilities to avoid *attentional tunnelling*.

4.3. Stimulation from Environmental Elements

The next element of interest was the reception of the stimulation from the environmental elements which subsequently were transformed and processed (Hancock and Diaz, 2002). For instance, when individuals saw that "*there was a circle within the crowd (e49)*", individuals suggested that this was an "*unusual crowd movement (e49)*" which should be managed. Being sure of what was going on triggering IS involving those individuals who can manage the incidents and notifying those who can control and coordinated them. An example was when certain individuals "*observed something unusual in the middle of the crowd, because it is notorious (e51)*", they subsequently notified to those individuals located near to that area because they knew the localization of others. Here, their positions were updated continuously verbally or by being visible using uniforms. Tensions arose in context "*until the incident has been managed (e51)*" because in certain incidents, spectators "*could be invited to abandon the event (e51)*" for being involved in incidents and IS was employed with this goal. Some questions arose related to what crowd movements are considered unusual and why, and how IS is used to invite spectators to abandon the events and in what types of incidents are crucial to do so.

4.4. Awareness of Individuals

This element was in relation to discover individuals in context and specifically, to be aware of the identity of those individuals (Glaser and Strauss, 1964), the perceptions of their competence (Treurniet, Besseling and Wolbers, 2012) and the definition of their role confirmed by their uniform. For example, guards were aware of policeman, but they did not want to "*spend the relationship (e21)*" in minor incidents so that they prefer to manage them without their support. In those cases, the guards weighted the support that could be given by policeman so that it would be solicited "*only when it was required (e21)*". Furthermore, individuals also expected that other individuals performed their roles; otherwise, additional individuals would be required to assist them when they failed or required support. For this reason, those individuals were "*located behind of the firemen and policemen (e19)*" to back them for providing "*oxygen and open (ning-added-) more space (e19)*". Moreover, additional research was suggested to answer the questions what skills and abilities are expected to perform supporters, what roles are required, how individuals comprehend that support is required, and to what extent individuals are located near to back others managing incidents.

5. CONCLUSIONS

In this paper, the significance of SA as an abstract tool is presented. It serves to enhance and control IS in the routine operation and incident management at major events. This naturalistic context is considered unexplored, dynamic, time constrained and complex and includes the management of both routine and contingent incidents. The findings suggest that individuals employed SA to mediate and control IS towards collective SA. Individuals obtained information from context including tasks, processes and other individuals. This helped to obtain meanings for being immersed in it (Flach, 1995) allowing their adaptation to the environment. Subsequently, this information was utilized to project future states of the situations (Endsley, 1995) in which other individuals were included providing information to them (Millward, 2008). This was seen when individuals discovered risks and stimulation from the environment (Hancock and Diaz, 2002) and served to identify other individuals (Glaser and Strauss, 1964) and their competences (Treurniet et al., 2012). Thus, the evidence exhibited that SA is likely to mediate and control IS for creating and maintaining collective SA.

Referring to the methodological implications, the approach taken is proved to be as a feasible tool to study IS and SA. Specifically, the AT helped to uncover the influences of the context by discovering the relevant environmental elements included in the SA demanded. This was confirmed with the activities performed by individuals in strong relation with this context. In addition, the use of three methods to gather data provided enough information to obtain a holistic view of what is happening in the context. This also helped on understanding what environmental elements were crucial to trigger IS towards collective SA. Furthermore, the framework employed provided additional factors that were relevant in context. For example, the responsibility implied in the SA that triggered IS.

The practical implications uncovered the uses of individual SA in the development of knowledge, abilities and expected performance of the individuals implicated in context. Training is one way to achieve this. Moreover, the comprehension of what environmental environments were mentioned by whom put on manifest the relationships between the organizational goals and the information seeking strategies using the human sensory systems. This can be studied under the information behavior providing additional insights.

To sum up, this research helped in uncovering the significance on how SA enhances and controls IS towards collective SA. Findings serve to put on manifest diverse relevant environmental elements included in SA so that this permitted to infer the necessity of projecting those elements for making informed decisions. Here, the use of sensory systems in context was crucial to create SA permitting to include other individuals by sharing information with them. Furthermore, this research presents significant results in a different context as usual (far removed from the military and C2). On the other hand, additional research is needed to explore these issues involving other organizations and their personnel that were excluded and considering other major events in Mexico and other countries.

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ANALYSIS OF MENTAL WORKLOAD AND HUMAN ERROR IN THE TASK OF WATCHING A MOVIE USING A HOME ENTERTAINMENT DEVICE

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Resumen: En la actualidad, el uso de equipos para el entretenimiento en casa, representan un reto cognitivo para los usuario. En este caso de estudio se presentan dificultades en buscar y seleccionar películas de forma fácil y eficiente al utilizar un dispositivo para el aparato de televisión. Esto genera un incremento en la carga cognitiva del usuario; además, de la posibilidad de cometer diversos errores humanos que reducen la eficiencia en el uso del dispositivo. Por ello, este artículo, tiene como objetivo, realizar un análisis de la tarea de esta interacción entre el usuario y el equipo de entretenimiento; así como, de la carga mental a través del método NASA-TLX, así como el Task Analysis For Error Identification (TAFEI) para el error humano. Los resultados muestran que la tarea representa una carga mental de trabajo con puntuación baja ; además, debido a su dificultad de acceso a los menús, es posible que suceda alguno de siete errores posibles donde el más frecuente es el de que la película comience antes de estar completamente cargada.

Palabras clave: HTA, NASA, TAFEI

Relevancia a la ergonomía: El estudio de la magnitud de las tareas cognitivas de las personas en la interacción con los objetos es relevante para la ergonomía para evitar el error humano y el mejorar la optimización utilizando la tecnología

Abstract: Home entertainment is now available using several television electronic devices. Users of these devices present difficulties to search and select movies easily and efficiently. This device is controlled remotely so the user can interact with the interface. This is a study about the analysis of a mental workload and human error during the task of see a movie. As methods, the NASA-TXL for mental workload and the (Task Analysis for Error Identification) TAFEI for human error were used. Previously a hierarchical task analysis (HTA) was developed. Results show that mental workload is at an average punctuation and there are seven possible errors that can occur while performing the task and the most common is that the movie starts before it is fully charged.

Keywords: HTA, NASA, TAFEI

Relevance to Ergonomics: The study of the magnitude of cognitive tasks of people in the interaction with objects is relevant for Ergonomics to avoid the human error and the improve the optimization when using technology

1. Introduction

Actually, the task of watching a movie using home entertainment devices is the most common activity among people. However, for some users the interaction with this kind of technologies represents a cognitive challenge to complete a task efficiently due to their high level of sophistication and complexity. This device, known as third generation perform tasks such as video gaming, see movies among other activities. However, for every task selected, user must be able to navigate among multiple options such as channels and menus that increase the mental workload and the possibilities of human error.

Mental workload is defined as "that part of the limited capacity of think necessary to realize a particular task" (Tsang, 2006). For their evaluation, usually the NASA-TLX (Task Load Index) method is used (Hard, Steven land, 1988). This multi-dimensional rating procedure derives an overall workload score based on a weighted average of ratings on six subscales. These subscales include Mental Demands, Physical Demands, Temporal Demands, Own Performance, Effort and Frustration. It can be used to assess workload in various human-machine environments such as aircraft cockpits, command, control, and communication (C3) workstations; supervisory and process control environments; simulations and laboratory tests.

In other hand, human error is defined as an inappropriate or undesired decision or behavior that may reduce the efficiency, security or activity of a system. In this case, the common method used is Task Analysis for Error Identification (TAFEI); it allows the prediction of errors in the use of devices modeling their interaction with the user.

Due to everyday people should be able to interact with new technologies, the analysis of mental workload that this interaction generates; as well as reducing the chances of making human error becomes relevant. In this way, this paper was realized using both methods described above in the task of see a movie using a home entertainment device.

1.1 Objectives

The general objective, the specific objectives as well as the scope and delimitation of this research are as follow:

1.1.1 General Objective

Analysis of mental workload and Human error in the task of see a movie using a home entertainment device

1.1.2 Specific Objectives

- Perform a hierarchical task analysis (HTA) when users see an undefined movie
- Perform the mental workload analysis using the NASA-TLX method when completing the task of searching, selection and finally user see the movie.
- Perform the human error analysis using the TAFEI method when completing the task of watch a movie.

1.2 Scope and Delimitation

In terms of scope, this research includes the analysis of the six mental workload sub scales when a home entertainment device is used to see a movie. In addition, human error was obtained. A HTA was necessary to describe this task.

With respect to the delimitation of this research, only ten users were observed performing this task during several days and times.

2. METHODOLOGY

2.1 Materials

2.1.1 Home entertainment device

The device uses series of decoders; provide over-the-top content in the form of channels. A device in streaming obtains data through a cable or Wi-Fi connection to an internet router. The data is emitted through an audio cable, a video cable or the two signals through an HDMI cable. The device can be connected to any television (or another device) with corresponding input connections. This device uses a stream source in the internet channel that offers contents under demands or direct video streaming. User has the option of see free channels or pay to see specific content; also, users has the opportunity of add or eliminate different channels through a channel store.

2.2 Methods

The methodology consists in elaborate a HTA for the task of see a movie, using a home entertainment device, then the NASA-TLX method was used to evaluate the mental workload. Finally, for human error evaluation TAFEI was developed

2.2.1 Hierarchical Task Analysis

The HTA implies a description of the activity as an analytical object in terms of a hierarchy of objectives, sub-objectives, operations, and plans. The result is an exhaustive description of all the activities developed. This method is popular for its flexibility and scope of additional analysis that offers to the Human Factors and Ergonomics practitioners.

Stanton (2005) suggest the following steps to perform a HTA:

- Decide the purpose of the analysis.
- Define the main task.
- Data retrieval
- Acquire data and prospect of table or diagram decomposition.
- Verify the validity of the composition with the interested parts.
- Identify significant operations
- Generate and if possible, test out the hypothesis relative to the task execution.

2.2.2 Mental Workload

Mental workload is defined as “The portion of processing resources that a person requires to accomplish a task” (O’Donnell and Eggermeier, 1986). One of the main purposes of measure it, is the evaluation of their level with the objective of identifying and eliminating the demands related with the workload that reduces the performance (Wilson & Eggemeier, 2006). There exist three levels under when it is less than 500 points, means when it is greater than 500 and less than 1000 points and high when it is greater than 1000 points. Sandra Hart, NASA-Ames Research Center, Moffett Field, CA. (2006)

2.2.3 NASA-TLX

It is a subjective method that proposes a procedure to evaluate the mental workload from a multidimensional perspective, and that provides a global score from the workload starting with the weighted average of the scores from six sub scales which are described in Table 1. Its objective is diagnosing the factors of workload placed.

Table 1. Sub-scales of NASA TLX

Scale	Question	Example
Mental Demand	How much mental and perceptive activity was necessary?	Thinking, deciding, calculating, remembering, looking, investigating, etc. Is it a difficult or easy task, simple or complex, heavy or light?
Physical Demand	How much physical activity was necessary?	Pushing, throwing, turning, pulsing, etc. Is it a difficult or

		easy task, slow or fast, relaxed or tiring
Temporal requirement	How much time pressure felt due to the rate at which tasks or task items were happening?	Was the slow, slow or fast and furious pace
Effort	In what measurement has there been physical or mental work to reach the levels of result	If the task involves extra effort
Level of Frustration	During the task, in which measurement has there been feelings of insecurity, frustration, tension, or worry; or on the contrary, has there been feelings of security, joy, relaxation and satisfaction	if the task is so complicated to the extent of not wanting to do it, and your mood changes
Performance	Up to what point do you think you have had success in the objectives established by the investigator or by yourself? What is the grade of satisfaction with your level of execution?	rerun the task until the desired results and to feel a sense of satisfaction

The method application contained from 2 phases:

- Weighting phase (previous to the execution of the task): The subjects perform a weighting with the purpose of determining the weight of each factor according to the workload of each specific task. Later, 15 binary comparisons are realized for the six dimensions chosen for each pair that the user perceives as the major source of workload. Table 2, indicate the comparison of the dimensions

Table 2. Dimension Comparison

F-M	T-F	T-Fr
T-M	R-F	T-E
R-M	Fr-F	R-Fr
Fr-M	E-F	R-E
E-M	T-R	E-Fr

For each dimension a weight is obtained depending of the number of times that was selected in the binary comparisons. It could be between 0 (the dimension has not been chosen in any of the comparisons) and 5 (the dimension has been chosen in all comparisons in which it appeared).

- Scoring Phase (immediately after the execution): The workers evaluate each task or sub-task that was completed in each of the proposed dimensions. For this a scale of 0-20 (starting from low to high).

Once these two phases are completed, a table is filled out. Weight indicates the time in which each variable wins in the weighting phase. Scoring means to the scoring column obtains the values of the evaluation that is realized by the workers. Converted scoring is obtained by multiplying the values of the punctuation column by 5. Weighted score is obtained by multiplying the scoring column converted by the weight column. Global weighted Average is the sum of the weighted score divided by 15 which is the total of the weight. Finally equation 1 is used for the global index calculation of the mental workload caused by the task. Where IC stands for the workload, Pi is the weight obtained by each dimension in the weighting phase and Xi is the score obtained by the dimension in the value phase. Results can be seen in the weighted score, it reflects the importance of each factor as workload causers and it subjective importance in each task, and conclusions are obtained from diverse indole: risks can be identified, predominant factors can be analyzed, and the workload for two determined tasks that require a series of different responses can be compared.

$$IC = \frac{(\sum pi\ Xi)}{15} \tag{1}$$

2.2.4 Human Error

According to Cañas and Waerns (2001), there are different types of errors, which are classified in different ways:

- Error by omission: it occurs when forgetting to do something.
- Error by allocation: occurs when something is made incorrectly.
- Sequence Error: Occurs when one person completes a series of steps or sequence in the incorrect order.
- Time Error: Occurs when one person does not do what he or she is supposed to do with the assigned time.

According to Kuselman, Pennecchi, Fajgelj y Karpov (2012) the procedure for TAFEI method occurs in 3 steps:

- First step: is to complete a HTA to identify the task objectives, it focuses in a specific goal and provides the secondary task.
- Second step: complete state-space diagrams (SSDs), for the device functionality, it is the series of issues suffered by the device.
- Third step: The possible errors of each tasks are visualized in a transition matrix.

3. Results

The results of the 3 analysis completed are presented in this investigation.

3.1 Results of the Hierarchical Task Analysis

The HTA is shown in Figure 1. In the task of watching a movie, two sub-goals were identified. The sub-goal of finding a movie implies the selection of the movie type among six alternatives; this task requires that the user interact with a remote control and search among more than 1,500 movie channels available. This sub-goal is tedious and it presents difficulties for the user. The subtask of watch the movie, user must select the language of his/her preference and then select a subtitle as well. In this subtask the interaction with several buttons, menus and submenus on the TV screen presents difficulties for the user.

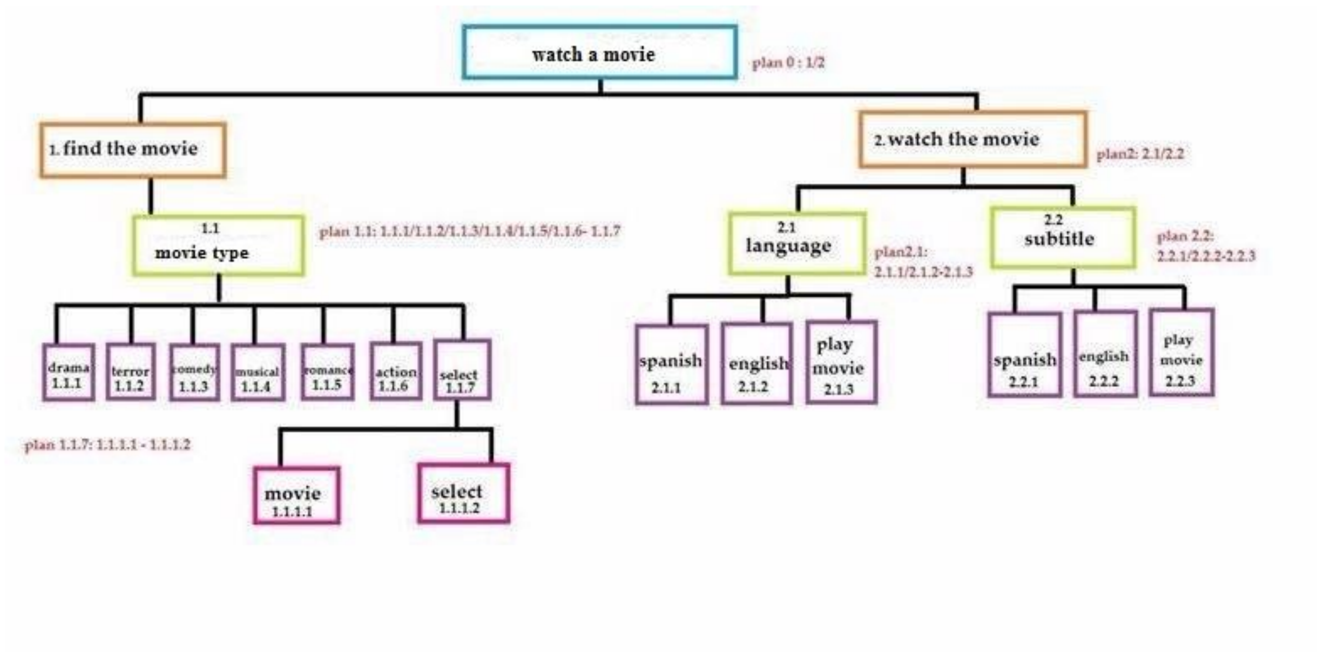

Figure 1. State-Space Diagrams (SSDs) of watching a movie

3.2 Results of the NASA-TLX Mental Workload analysis

The average mental workload obtained from the 10 people who participated in the study are shown in the Table 3. Table 4, shows that the average mental around 43.53. Where the scale is less than 500 points is low level, and 500 points below the 1000 average level and above the 1000 points is a high level.

Table 3. Global Weighted Average of the sample.

User	Global Weighted Average
1	37.33
2	47.33
3	35.33

4	63
5	34.33
6	31.33
7	36.33
8	72
9	48.67
10	29.67

Table 4. Average weighted averages of the 10 individuals

Total of User	Mental workload average
10	43.53

3.3 Results of TAFEI Human Error analysis

In this part we will see the results that were obtained through the TAFEI method in its three phases:

- Phase 1: The HTA elaboration that is presented in Figure 1
- Phase 2: The SSDs is presented in Figure 2 where the status of each activity is appreciated.
- Phase 3: The transition Matrix is presented in Table 5. It shows the description and solution of the possible errors.

Table 5. Transition Matrix of the task of see a movie.

	Off	On	Watching	Waiting	Loading	Start	End	Off
Off	-	L (1)	I (B)	-	-	-	-	I (A)
On	-	-	I (C)	-	-	-	-	L (2)
Watching	-	-	-	I (D)	I (E)	L (3)	-	L (4)
Waiting	-	-	-	-	L (M)	I (F)	-	L (5)
Loading	-	-	-	-		L (M)	I (G)	L (6)
Start	-	-	-	-		-	L (M)	L (7)
End	-	-	-	-		-	-	L (8)
Off	-	-	-	-		-	-	L (9)

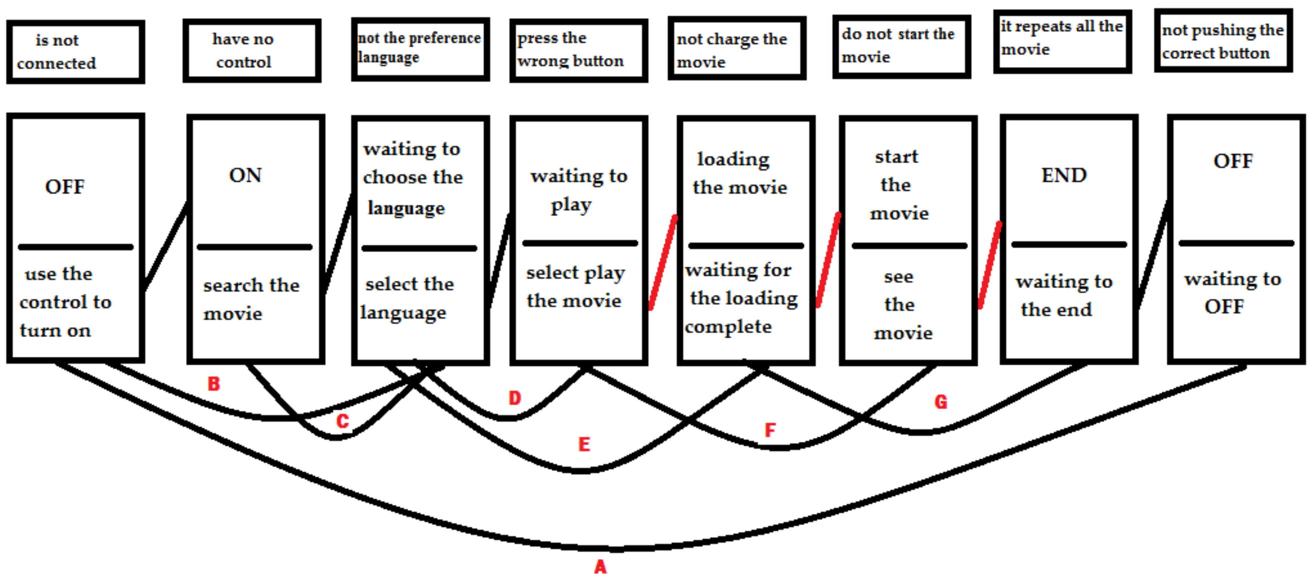

Figure 2. State-Space Diagrams (SSDs) of see a movie.

Table 6. Description of errors and solutions for the task of watching an undefined movie

Error	Transition	Description	Solution
A	1 to 8	Want to see the movie when the device is off	Put a button with focus on
B	1 to 3	Off when already is off	Put a button with focus off
C	2 to 3	Want to turn now to start movie	Programming movies
D	3 to 4	Appears with language	Programming language
E	3 to 5	Not to charge the movie	Download movies before
D	4 to 6	Start the movie with not complete charge	The movie doesn't start if it is fully charge
G	5 to 7	Want to end when even not start	Recommend interesting movies

4. Conclusions and Recommendations

4.1 Hierarchical Task Analysis

Regarding the analysis of the ETS task of watching a movie using an entertainment device in the home, it was concluded that the menus are very confusing for the user, as there are many menus and sub menus for choice of each movie and the alternatives that exist are equally complicated that the main task that all menus are based on the same instructions to play any movie is recommended

According the method, is recommended to redesign the way in which the user navigates in the menu.

4.2 *Mental Workload*

Regarding the mental workload analysis is concluded that, users showed a low level of mental workload. This means that method individuals are not hard the task because frustration grew during the navigation through multiple menus and alternatives. Methods applied were effective finding the causes of mental workload and error during tasks can be individually or as research shows a sample.

4.3 *Human Error*

With regard to human concern error method TAFEI identified possible errors that can be made to perform the task and possible design solutions. For example, seven were found seven errors, the most common is that the movie starts before being fully charged were found, and the most difficult solution is to find a way that the movie does not start until the load is complete.

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COGNITIVE ANALYSIS OF THE MUSIC'S IMPACT IN THE INDUSTRIAL SCOPE OPERATORS

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Resumen: La productividad es un parámetro de gran importancia para una empresa de manufactura; si los tiempos de ciclo de una actividad se reducen, esto incrementa la producción, afectando directamente a la utilidad de dicha empresa. En el presente artículo, se analizará el efecto que tiene la música en el ritmo de trabajo de los operadores, haciendo un análisis detallado del entorno en el que se efectúa dicha operación.

Palabras Clave: Ergonomía Cognitiva, Estimulación auditiva, Método Tomatis, Línea de Producción

Relavancia a la Ergonomía: Este artículo tendrá un impacto en el campo de la ergonomía cognitive ya que mejorará el trabajo del operador ayudandolo a disminuir los probable errores que se puedan presenter y mejorar el ritmo de trabajo al cual están expuestos. Su publicación es muy importante debido a que apoyará a las compañías a recortar sus tiempos de ciclo, los cuales afectan directamente en sus utilidades.

Abstract: Productivity is a parameter that plays a huge role in a manufacturing company; if an activity's cycle times are reduced, this increases the production numbers, affecting directly to the utility of the after mentioned company. In this article, the effect that the music has in the operator's work rhythm will be analyzed, making a detailed study of the environment where the operations are done.

Key Words: Cognitive Ergonomics, Auditory Stimulation, Tomatis Method, Production Line

Relevance to Ergonomics: This article will make an impact in cognitive ergonomics by improving the operator's work by diminishing the probable mistakes they could do and by improving the work rhythm they are exposed to. Its publication is important to help companies improve their Cycle Times, which affects directly to the company's revenue.

1. INTRODUCTION

Last December of 2015, by observing the production line simulations of the Industrial Engineering students, specifically in the subject of Ergonomics given in 5th semester at Instituto Tecnológico de Hermosillo (ITH), a change in productivity and work rhythm was appreciated, according to the change of the different rhythms of commercial music. These changes varied depending on the music genre according to the preferences of each operator.

The idea of studying how the music affected the operators came up, focusing on an statistical analysis where we could prove mathematically if there is an actual and significant difference between working with or without music.

We already know that productivity is a very important factor in the manufacturing world, since time equals money, if we perform an operation in less time, without affecting the quality of the product, the physical or mental integrity of the operator, the utilities of the company will raise automatically. The change might not be huge, but it could make a significant impact in the long run.

We strongly believe that there will be a positive and significant difference when working in a place where there is background music. First of all, we have to make a research of which music genres are suitable for the study. This is why we went to the Centro Tomatis de Sonora, where auditory therapies are given.

2. OBJECTIVES

The main objectives of the present article were to analyze the behavior of the operators when they were exposed to a change in the background, focusing in weather or not there was music in the workplace.

We aimed to evaluate how the productivity of the operators changed when they was classical music present, which is perfect to stimulate human brain and body.

We focused on demonstrating if there was a significant difference in the production rhythm when there was no music and when there was Mozart's compositions.

3. METHODOLOGY

In order to do this project we started by analyzing the Tomatis Method of Auditory Stimulation, which gets its name thanks to Dr. A Tomatis. It is based in an auditory stimulation through which we can get, in first place, an improvement in hearing, language, learning skills, and in second place, emotional and physical wellbeing, in kids, adolescents and adults.

In this way, the ear, its neuro-physiology and its functions where the Tomatis method focuses its axioms. They affirm that the ear is the human organ that forms in the first place and any auditory stimulation can reach any part of the body, weather it is via aerial or osseous, to heal the problem that people have in that moment.

Its objective is to stimulate and regulate the functions that the ear represent (hearing, equilibrium, energy). This is why they use a specialized headset through which sounds are sent, such as classical music (Mozart), Gregorian songs, the mother's voice, kid's songs…in which most of the cases in a filtered way, they allow to combine the low-pitched and high-pitched sounds and stimulate this way the functions of the ear.

If we go in depth in the after mentioned ear functions (hearing, equilibrium, energy) we can observe that by stimulating the hearing function we obtain a better capacity of information integration (register, memorize, reproduce, imitate), consequently, improving the aspects of language, reading, writing. In the same way, by stimulating the vestibular function (equilibrium) we obtain an improvement in coordination, muscular tone and verticality, healing as well motor disabilities or problems, hypotonia, impulsivity, space-temporal, and finally working in the energetic function, we obtain a better brain activity, given that 80% of the brain energy comes from the ears.

The ear cannot be under constant stimulation, it is necessary to have interruptions or pauses once in a while. Just as the brain has the need of an intensive and repetitive stimulation, it needs as well periods where it is not stimulated in order to construct and consolidate the change. We can find this rule in any training given that the construction is made after the effort during a phase of apparent passiveness: the reality is that it is a phase of assimilation. The stimulation causes an "annoyance" to our organism; that is why we have to have rest phases where assimilation takes place.

The fact of choosing Mozart's music among every other composer/writer is not a random fact. Tomatis used at the beginning of his researches the most diverse music applied in different cities from Orient and Occident, and he proved that the only music everyone admitted was Mozart's. This is how he started to prove the reason of this fact and to study the concrete characteristics that allow this music to have that positive influence in every patient.

If we take into consideration the theory that different frequencies have influence in concrete aspects of the evolutionary development and quoting Sylvia Carrasquilla (Consultant at a Tomatis Center in Bogota) the music of this composer is the ideal for the treatment, since Mozart worked with high pitched frequencies – specially with flutes and violin- and is ideal for the auditory therapy, given that it is between 125 and 9000 hertz, the ones needed for the therapies.

It is not only the ideal because of the frequencies he uses, but the music itself has special characteristics that differentiate one from another and give them this therapeutic characteristic: it is about freshness. This is given the fact that Mozart started to write at 4 years old before going in the strict framework and cultural models.

The ear has more functions than just hearing.

According to the music and auditory therapy expert from the Centro Tomatis Sonora, Dr. Leticia T. Varela Ruiz, we have to pay attention to 6 important aspects in the therapies:

- Rhythm
- Velocity of the rhythm
- Instrumental timbre
- Volume
- Relation of the person with the music
- Stimulation Time

The rhythm need to stimulate the body delicately, it does not have to be something complex. It must have an undulating fluency.

The velocity must be according to the activity that it's being done.

The low quality instrumental timbres, this is the ones coming from instruments manufactured with low quality materials, they only drain energy from the brain, that is why they are not the proper ones to stimulate, for example the ones made from bronze. Electric instruments are not recommended either. The best ones we can use are the acoustic instruments, on the condition that they are not strident or too loud, such as the drums and cymbals. If we play heavy rock, the test subjects would be mentally exhaust in less than 10 minutes, since it demands a lot of wearing of energy for being really strong stimulation. The recommended is a mix of low pitched and high pitched sounds; combine violin, flute and clarinet with the trombone, trumpet, classic guitar and violoncello.

The volume at which we must play the music must be moderated, not so low but not so high, the one that allows to have a normal conversation while we are working. In a lot of restaurants very high volumes are used, that do not even let u hear the person that is next to you. It only destroys people's neurons.

With the relation of the person with the music, it has to be a song that doesn't bring memories to people's minds or make them sentimental. If we play banda music, there is a high probability that the operators remember about last weekend's party, and instead of stimulating them, it might distract them. It is better If there is just instrumental music, with no lyrics, because it can distract the operators as well, this is why it is recommended as well that if it has lyrics, the song is in another language.

The stimulation time is the last aspect we need to consider. If the stimulation is done for a long time, it can saturate the operators and if it is done for a short period of time, there could be no stimulation at all. In this case the recommended is to do it is in an alternate way, playing music for 30 minutes and other 30 minutes in silence. By doing it this way, we would obtain optimal results, avoiding the saturation of the operators, which doesn't make the stimulation work.

Every considerations are applied with the assumption that every operator has ears in perfect conditions. It would be much better if they take therapies to reactivate or try to give the ears more capability to work properly, because most of the people in the world have auditory problems, even though we do not realize it.

4. RESULTS

An activity was selected to be performed and be measured using a stopwatch and at the end, compare the results when we were playing classical music and when using no music.

We did not focus in physical ergonomics since what we were working with is cognitive ergonomics.

The process consisted in the assembly of three pieces of the "Meccano" Kits using 4 screws and 4 nuts as it can be seen in the image. The pieces of metallic color have a specific place, which was not specified in order for the operators to make a decision at the moment of the assembly. The production run was made for 2 hours, taking a sample of times in each case to perform the statistical analysis. When working with music it was done by alternating and playing Mozart music for 30 minutes and then with no music, to prevent the operators overload, as mentioned by the expert Leticia Varela.

Once the learning curve was done with each operator, we measured the times that were needed to do the statistic test.

To determine if the use of music and the different rhythms affect in a positive way the operator when doing a specific task, a multiple linear regression and a hypothesis test were performed, which allowed us to verify and demonstrate in a mathematical way if there is an actual change in the time that take the operators do the task. Classical music was used, specifically Mozart compositions, since it was the one recommended by Leticia Varela. We excluded other rhythms such as reggaeton, banda and norteño, due to the fact that his do not present any stimulation in people; they are just noises that affect people's concentration. The following hypotheses where used for both operators:

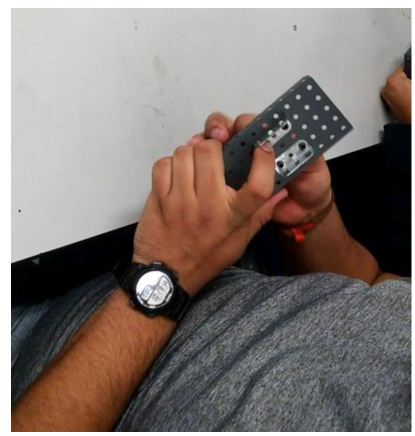

Figure 1. Assembly Operation

H_0: There is no significant difference between working with music (classical) and without music

H_1: There is a significant difference between working with music (classical) and without music

In the first operator, a simple of 10 times was measured with and without music.

Table 1. Operator 1 Times	
Without music	With music
71.18	50.5
70.15	46.22
88.06	66.16
59.1	57.57

52.6	55.34
56.22	48.47
61.97	38.1
57.65	46.42
58.65	37.66
50.82	36.77

Table 2. Regression Statistics

Multiple Correlation Coefficient	0.57455417
Determination Coefficient R^2	0.33011249
R^2 adjusted	0.24637655
Error	8.27314389
Observations	10

Table 3. ANOVA Table

	Degrees of freedom	*Sum of Squares*	*Squares average*	*F*	*F Critical Value*
Regression	1	269.830611	269.830611	3.9423035	0.08234171
Residuals	8	547.559279	68.4449099		
Total	9	817.38989			

After applying the corresponding formulas, we got the conclusion that with the first operator there is a significant difference between the registered times, since the value of F is over the Critical Value, rejecting the null hypothesis, where there is no difference.

In the same way, we obtained a sample of 10 data for the second operator. They were by doing the exact same operation.

Table 4. Operator 2 Times

Without Music	With Music
57.72	51.55
46.15	57.1
38.44	51.18
71.59	81
44.63	49.46
38.47	62.44
67.28	52.13
39.16	46.44
62	53.25
54.69	69.31

Table 5. Regression Statistics

Multiple Correlation Coefficient	0.46784723
Determination Coefficient R^2	0.21888103
R^2 adjusted	0.12124116
Error	10.0058443
Observations	10

Table 6. ANOVA Table

	Degrees of freedom	*Sum of Squares*	*Squares Average*	*F*	*F Critical Value*
Regression	1	224.43388	224.43388	2.24171779	0.17270518
Residuals	8	800.93536	100.11692		
Total	9	1025.36924			

Just as with the first operator, there is a significant difference between the operation done with music and without music, rejecting the null hypothesis.

5. CONCLUSION

As it was considered in the hypothesis and after knowing that the proper music genre to be used was classical music (Mozart) and testing both of the operators, we got to the conclusion that besides none of the operators being familiarized or having previous contact with classical music, they reacted positively to its stimulation, lowering the average time that took them to perform the operation compared to the one done without music.

With this conclusion we can take our project more deeply and analyze furthermore, other cognitive aspects in the close future in order to have a more complete project.

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REDUCING RISK FACTORS ON RE-AMPUTATION OF DIABETIC FOOT THROUGH ORTHOTICS DESIGN

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Resumen: La amputación parcial de pie es una complicación que se presenta frecuentemente en diabéticos al pasar los 40 años de edad. Es consecuencia de diabetes mellitus (DM), la cual causa trastornos en el pie por problemas en las arterias periféricas. Estos trastornos hacen que los pacientes sean más propensos a desarrollar úlcera en el pie y a consecuencia de las dificultades de cicatrización, es posible llegar posteriormente a la amputación. Por estas mismas dificultades y complicaciones, los amputados presentan múltiples problemas para sanar su herida del muñón, llegando a la re-amputación a nivel proximal. El objetivo de esta investigación es identificar los factores de riesgo post-amputación parcial de pie en diabéticos para proponer un diseño de ortesis enfocado a ellos protegiendo su piel y disminuyendo que se generen nuevos hematomas y puntos de presión plantar, también identificar y entender qué elementos de diseño son los responsables para una restauración efectiva del pie, con el fin de acercar la marcha del amputado a una marcha natural. Se realizó una revisión bibliográfica retrospectiva de varios artículos relacionados al tema central de la investigación. Se planteó además una evaluación ergonómica de diseño de dos ortesis, fabricadas con base en la información recaudada de investigaciones previas. Se utilizará como herramienta principal para el análisis de la presión plantar las plantillas instrumentadas, las cuales permiten medir la presión en condiciones de movimiento, esto con el fin de identificar los puntos de mayor presión y poder eliminarlos a través del diseño.

Palabras clave— Diabetes mellitus – Amputación parcial de pie – Diseño – Ortesis

Abstract: Partial foot amputation is a complication that becomes common in diabetic patients over the age of 40. It is a side effect of diabetes mellitus (DM), which causes foot disorders due to irregularities with the peripheral arteries. These disorders make patients prone to foot ulcers and scarring difficulties, which can lead to amputations. These same complications are present on amputees and can lead to a re-amputation at proximal level due to stump healing problems. The objective of this research is to identify the risk factors on partial-foot amputation patients to propose an orthosis design focused on protecting their skin and preventing new hematomas or plantar pressure points to appear. Another objective is to identify what elements of design are responsible for an effective restauration of the foot that allows a more natural walk for the amputee. A retrospective bibliographical review of various journals related to the topic of this research took place. The ergonomic evaluation of two experimental models made based on the gathered information was set. Instrumented insoles will be used a primary tool to analyze plantar pressure, which allow measurements during movement. This will allow to identify mayor pressure points and eliminate them through a new design.

Keywords— Diabetes mellitus - Partial foot amputation - Design – Orthotics

Relevance to ergonomics: with the information gathered through research, an ergonomic design of an orthosis for transmetatarsal amputation can be proposed. This will contribute to improving life quality of amputees by allowing them to walk with comfort, natural mechanics and preventing friction, hematomas, discomfort and other risks that might end up in re-amputation. The information gather can be useful for future research and for the ergonomic design of foot equipment or devices.

1. INTRODUCTION

Partial foot amputation (PFA) describes the loss of any anterior part of the foot. Most of the times it is caused by diabetes mellitus (DM). Neuropathy is one of the side effects of diabetes and it diminishes touch sensitivity, this can get to a point where the patient can't feel pain on its wounds, making them to pass unnoted and eventually causing ulcers that can lead to amputation.

Foot wounds are one of the most common, complex and expensive consequences of diabetes mellitus. Even for superficial wounds, treatment is usually difficult and with low success rate. Amputation wounds are one of the most difficult to heal in lower limbs given that they are deep, exposing bone and tendons, and in diabetics, lower scarring capabilities complicate this further.

During the last four decades, comprehension of walking mechanics of patients with partial foot amputations and the influence on prosthetic intervention has been based on theoretical analysis of force. This were derived from observation of walking mechanics of persons without limb loss and preceded the assumption that partial foot prosthesis would be able to restore the length of the lost foot.

Nevertheless, recent studies have revealed that only some devices are capable of fully restoring the foot's length. Traditionally, many orthopedic designs have been utilized for partial foot amputations, including prosthesis fillings, individual reinforcements, ankle immobilization AFO's, and a combination of these; but without considering the ergonomic factors necessary for protection, which is essential on diabetics. Therefore, what are the ergonomic principles necessary to design an orthosis that adequately restores walking and protects the amputated foot?

2. OBJECTIVES

The objective of this research is to identify post-amputation risk factors that could produce new ulcers, hematomas, changes in pressure, and understand what ergonomic and design elements are responsible for an effective restoration of the amputated foot. This in order to propose an orthosis for diabetics that would reduce chances of re-amputation by protecting the foot and granting natural walk mechanics.

3. METHODOLOGY

Transmetatarsal amputation was selected as the base of this research because it presents deformity to clubfoot and alters walking mechanics.

An analytical-documental method was used to manage instruments like interviews, observations, tests and polls that were applied to specialists in the topic, such as diabetlogists, surgeons, footwear producers, orthotists, prosthetists, and patients and users alike.

A bibliographical review of scientific journals from diverse sources was made in order to gather data about foot amputation aftermath and orthosis design. The findings were divided in two categories.

4. BIBLIOGRAPHICAL REVIEW

4.1 Problems after partial foot amputation

Many authors have taken interest for investigating partial foot amputation problems, weather it is for improving the healing process or walking mechanics.

A big percentage of diabetics with partial foot amputation are submitted to re-amputation within the first three years after their surgery. Sometimes the re-amputation is caused by the excessive effort of carrying an extra load or unequal distribution of force (Goicoechea, 2013).

In a study about healing of partial foot amputation, Armstrong & Lawrence (2005) used negative pressure therapy (NPT) on the wound of diabetics. They reported that the most common problems were infections and infestations; 25 patients (32%) of the group healed with NPT and 27 of the control group (32%) had one or more adverse events associated with this class. They reported that using NPT through the healing process reduces risks for the patient.

Ploeg, Lardenove, Vrancken, & Breslau (2005) analyzed the association of multiple clinical factors with the morbidity of 1,028 consecutive amputations on 786 patients during a period of 13 years. The operation mortality rate was 7% (57 out of 786 patients). 345 amputations were above the knee and 626 below it. After the operation, 15.4% of the amputations failed to heal and required revision. Fail rate of amputations above knee was 9%, while those below was of 19%.

Malayo, Margolis, Hoffstad & Bellamy (2006) calculated the insufficiency to heal after initial foot amputation. They published that in the 1,775 personas that met criteria of having diabetic neuropathic foot ulcer (DNFU) treated by foot amputation, there were a total of 5,314 wounds. Mean age of patients was 64.78 ± 13.24 years old and 58.26% of the wounds were grade 2 or inferior.

Kennedy & Meier (2011) confirmed that complications of pressure and shearing on an amputated foot are caused by less Surface area and disequilibrium created by the loss of the distal parts of the foot

Another consequence of partial foot amputations, specifically of transmetatarsal amputation is that this generates a bigger state of incapacity, given by the loss of force needed for foot launch where there is no fulcrum point anymore. Another consequence of transmetatarsal amputation is clubfoot, which is a malformation of the foot where the plant turns inside and may appear when a good orthosis is not used. Clubfoot and limited articular movements have been associated with changes in walking mechanics and can cause the skin on the stump to rupture because of the pressure (Dillon, 2010).

4.2 Design of Orthoses and Prostheses for partial foot amputation

Various studies and proposals have been made for the design of orthoses and prostheses, much of which have been based on analysis of walking mechanics plantar pressure of the partially amputated foot.

Regarding foot pressure, Dillon, Fatone & Hansen (2011), analyzed the effect of plantar pressure on the prosthesis design, demonstrating that the most effective components of a partial amputation prosthesis to restore an effective foot length are the ones that combine the following: a rigid front part for the foot, restraining dorsiflexion, and a shell for the anterior part of the leg. This study was made on patients with transmetatarsal amputation and lisfrank.

Kennedy & Meier (2011) commented that an inadequate design or a poorly adjusted shoe can give forth to a situation where excessive friction is created, resulting in blisters and skin cracks. They state that materials with a smooth Surface like Plastazote (thermoformable polyethylene foam) would be less susceptible to causing harm. They proposed a ball and socket with an anterior wedge and complemented with an AFO orthosis.

The ball and socket and wedge limits dorsiflexion and reduces the angle between leg and foot. The AFO device aligns it, assuring a uniform distribution of pressure throughout the shell. This combination also generates a better walk.

Dillon & Barker (2008) came to a similar result, where their observational study on patients with partial foot amputation showed that reducing the power of the ankle can be helpful to reduce pressure located on the frontal part of the stump. They proposed an orthosis with an extensive tibial shell (a device that is clamped to the leg).

5. RESULTS

On the first stage for this research, field work was made as an observatory exploration. 2 Doctors, 2 orthotists and 1 patient were interviewed. As a result, and based on the doctor's experience regarding their patients, partial foot amputation healing time is approximately 3 years. They also mentioned that new ulcers are formed because plantar pressure points change after the procedure. These new ulcers are harder to heal and play an important role on the healing process and chances or re-amputation at proximal level.

After reviewing the data gathered from the bibliographical research, it was determined that it is important to study the user-orthosis relation during movement with orthoses available in the state of Jalisco to identify plantar pressure points. The study is correlational-descriptive, the method will be experimental.

An ergonomic analysis is needed to obtain particular and specific solutions that would guarantee its efficiency. For this, observations of walking will be made from a lateral perspective; this allows the clubfoot walk, heel support, and foot launch at first metatarsal level to be analyzed to detect problems and design opportunities. After the first stage of theoretical revision, the necessary information for the development of 2 types of orthoses was acquired: One with a front shell and another with a back shell that work as a leg clamp that limits dorsiflexion. Once both prototypes are built using adequate materials for contact with the amputee's stump, they will be submitted to observations using instrumented insoles as a primary tool to measure pressure and make a comparative analysis of both prototypes.

A comparison between both models will be made based on walking mechanics: walking rhythm, foot launch, inclination to clubfoot and plantar pressure points. The information will be collected through the use of lateral observation, and instrumented insoles, as well as surveys to include subject comfort in relation to material and orthosis form.

Tests will be run with the voluntary help of 4 subjects from the state of Jalisco that present transmetatarsal amputation. They will be asked to utilize both experimental models, which will be fabricated based on user requirements and the data acquired from the bibliographical review.

Finally, in the formal development stage the object factors will be analyzed to start the development of the final product. The factors are the following: dimension, volume, technology, color, texture, form, finish and weight.

6. DISCUSSION

This research consists on establishing the bases for designing an orthosis focused on persons with diabetes mellitus and that present a transmetatarsal amputation.

It is important to highlight that other types of partial foot amputation exist: lisfrank, chopart, toe amputation and symes. Each of this amputations presents different alteration to walking mechanics and variations to pressure points.

Transmetatarsal amputation, whenever feasible, is the logical preference of amputation because it is the only procedure with the potential of supporting weight. In theory, a good prosthesis should allow a transmetatarsal amputation to have better mobility (Lakshmanan, 2014).

Another important factor that affects the correct healing of the patient is communication between doctors and orthosists. In some cases, communication is minimal and follow-ups are left aside, ignoring the patient's needs and/or progress.

Instrumented insoles (Figure 1) are an alternative tool to make the analysis and comparative measures between orthoses. These are designed to make dynamic recordings and analyze pressure points between sole and footwear. This tool is clinically used to evaluate the post-traumatic foot, and the information is used to improve treatment and evaluate results after surgery. (Figure 2)

Lastly, a guide on foot anthropometry would be useful for the design of the orthosis. Given that each orthosis is custom design, a list of anthropometric measurements and the tools necessary to take them would help establish design guidelines.

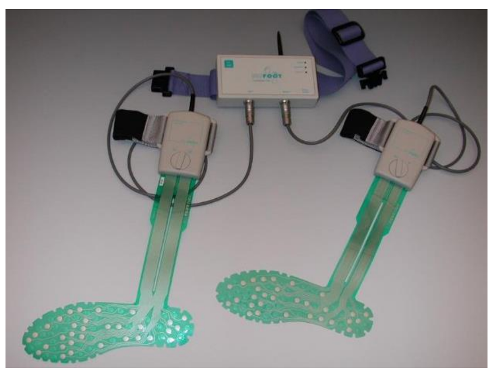

Figure 1: instrumented insoles

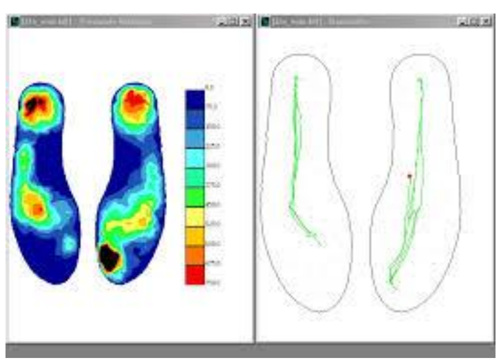

Figure 2: Software view

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MECHANICAL ADVANTAGE FOR MANUAL CUTTING IN FLORICULTURE ACTIVITY

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Resumen: La evidencia muestra que entre los factores de riesgo asociados con el síndrome del conducto carpiano (SCC), están la fuerza que se requiere para realizar el gesto de aprehensión y la postura de la muñeca, entre otros. Esta patología afecta considerablemente a la población colombiana, siendo uno de los más importantes problemas de salud pública en el ámbito laboral. El sector floricultor tiene los mayores índices, debido a las demandas propias de la actividad en el corte de flores, ya que se presenta mayor grado de mecanización pero con una mayor incidencia de SCC, lo que sugiere que el desarrollo industrial aplicado hasta ahora en el sector, no ha estado orientado a reducir los factores de riesgo que favorecen la aparición de la patología. Por tanto se debe buscar soluciones que mitiguen esta problemática, asociada directamente a la actividad, presentando los factores de riesgo desencadenantes de ésta patología. Este artículo presenta el desarrollo de una herramienta manual para corte de flores que permite mitigar algunos de los factores de riesgo asociados al SCC, al disminuir el esfuerzo resultante en la aprehensión y mantener una postura neutral de la muñeca. De esta manera, se propuso una herramienta manual de corte que al ser comparada con la usada tradicionalmente en la floricultura, se consiguió aumentar la ventaja mecánica de corte sin detrimento de la ventaja biomecánica propia del usuario en un 180%. El proceso de desarrollo se realizó mediante la conceptualización de alternativas, prototipos, digitalización y simulación en paquetes CAD-CAE y un modelo funcional para validación.

Palabras claves: Presión táctil, modelado CAD-CAE, floricultura.

Abstract: Evidence shows that within risk factors associated with Carpal Tunnel Syndrome (CTS) are the forces required to make the gesture of apprehension and wrist posture, among others. This pathology significantly affects Colombian population, being one of the most important public health issues in work sphere. Floriculture activity has the highest CTS rates, due to the flower cutting demand, because this activity has higher degree of mechanization but also has a higher incidence of CTS, suggesting that industrial development applied so far in the sector has not been aimed at reducing risk factors that increase the pathology's development. Therefore, it must be seek for solutions to mitigate this problem directly associated with the activity, presenting risk factors of this disease. This article presents the development of a hand tool for cutting flowers that mitigates some of the risk factors associated with SCC, by reducing the effort for the apprehension and maintaining a neutral risk posture. In this way, this article wants to show the development of a manual cutting tool which, compared to those traditionally used in floriculture, succeeded in increasing the mechanical advantage without cutting the biomechanical advantage in 180%. The development process was performed by alternative conceptualization, prototyping, digitization and simulation CAD-CAE and a functional model for validation packages.

Keywords: Touch pressure, CAD-CAE modelling, floriculture.

Contribution to ergonomics: Contribute to develop tools aiming to improve and to advance work conditions of workers, cutting force and posture risk factors that affect productivity and therefore reducing costs caused by absenteeism, surgical intervention, work diseases or disability. Likewise, this design can be used for other work activities that use manual cutting tools, like meat and agricultural sectors.

1. INTRODUCTION

Evidence shows that among the risk factors associated with CTS are the force required to make the gesture of apprehension, the wrist posture and repetitive movements (R., 1972) (Armstrong, 1989) (Hertzberg, 1955). This condition significantly affects the Colombian population, being one of the most important public health problems in the workplace ((ACED), 2014). The floriculture sector has the highest rates of this kind of work issues due to the specific demands of the activity in the cut flower, since there is a more increased mechanization with an increased incidence of CTS (Maria F. Maradei-Garcia, 2012), suggesting that the Industrial development applied so far in this sector has not been aimed at reducing risk factors that increase the development of the pathology. Thus, the 2nd National Survey of Health and Safety Conditions at Work, showed that the CTS cases diagnosed in Colombia in 2010 was on average 42.5% compared to other pathologies, where the floriculture, livestock and hunting sector, concentrated 3.7% of all. Floriculture activity ranks as the second largest exporter worldwide, generating more than 92,082 direct jobs and 25% of rural female hand work (Superintendencia de Sociedades., 2015). This scenario and the rise increased of CTS issues in this population, highlights the need for solutions to mitigate the problem of public health. Therefore, the redesign of tools used in repetitive tasks such as flower and meat products cuttering, dental procedures, hairdressing and manufacturing, promote the proper execution of force applied to the cutting tool and reduces the presence of fatigue during working hours (I. Arvidsson, 2012) (HC Chen, 2010) (H. Dong, 2007) (JL Boyles, 2003) (GA Mirka, 2002). Based on the above, the purpose of this paper is the development of a hand tool for flower cutting that may help mitigate some of the risk factors associated with CTS, to reduce the stress resulting in the gesture of apprehension. It seeks to take advantage of biomechanical and physiological characteristics of the hand and retain the already known ergonomic features.

2. OBJECTIVES

To develop a manual cutting tool, under the ergonomic criteria of neutral posture and less force applied to the apprehension gesture.

3. METHODOLOGY

The development of the Project was carried out by two design phases with a systematic approach. The objectives of phase one were to determine the aspects related to the environment, manual cutting tool and the user in floriculture; compare different mechanisms in manual cutting tools and determine the ergonomic design considerations through literature review in the “EBSCOhost Research Databases” database, and secondary sources. Therefore, two design proposals were generated based on the determinants of the project and mechanical principles, supported by three reference books: “Machines and Mechanisms” by Myszka H. Davis, “Machine Design” by Robert L. Norton and “1700 Animated Mechanical Mechanisms” by Nguyen Duc Thang. Also it took into account the efficiency of power transmission and motion. In phase two, the two proposed alternatives were evaluated considering the most relevant requirements, that is, those identified as having a direct impact on the development of CTS: The force necessary to perform the apprehension gesture, the strength of final cut and the length of the force displacement apprehension. Each one of these variables were evaluated according to the parameters of the corresponding part of the system, with the scale of 1, 3 and 5; where 1 does not meet the requirement, 3 meets the requirement but needs some modification to 5 fulfil the requirement. Moreover, the forces and displacements were obtained from the analysis of forces in each mechanism. Finally, the creative process is developed with the formalization of the alternative, the prototyping for decision making, the simulation with CAD-CAE software to allow the manufacturing process stablishing protocols for experimental testing and defining new design criteria. Based on this, a functional mechanical model is developed for validation purposes. This model features all formal, structural, and technical characteristics of the final product.

4. RESULTS

The creative process results in two possible alternatives for tool design. This alternatives were assessed by a CAE strength analysis, to check the performance of each one compared to current tools used in Colombian agriculture sector.

In this way, the development of the manual cutting tool was defined and shows an increase on the cut strength from 2.2 to 6.16 kg, this means that the mechanical advantage growth 180% without detriment on the biomechanical advantage.

5. CONCLUSIONS

A mechanic system that increases the mechanical advantage and potentiates the biomechanics advantage. By the other hand, by studding the necessary cutting posture in real floricultural conditions, it was possible to keep the neutral position of the wrist. By last, the cutting tool proposed in this paper, can relieve the exposition to postural and force risk factors.

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FACEBOOK INTERFACE DESIGN FOR OLDER ADULTS

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RESUMEN: El uso de redes sociales ha ido sustituyendo a los medios tradicionales de comunicación como el correo postal, el telégrafo y el teléfono fijo. Hoy en día más personas se integran a estos nuevos medios de comunicación social excepto aquellos grupos de usuarios como los adultos mayores, a pesar de que existe el interés en hacer uso de estos medios en especial de Facebook, quienes han quedado al margen de los avances tecnológicos por diferentes causas.

Diversas investigaciones muestran cómo el uso de un Sitio de Red Social como Facebook puede ser benéfico para un adulto mayor al reforzar los lazos sociales y la integración social, el bienestar psicológico y la salud mental.

PALABRAS CLAVE: Adultos mayores, usabilidad, diseño inclusivo, redes sociales

ABSTRACT: The use of social networks has been replacing traditional media as the postal, telegraph and landline phone. Today more people are integrated to these new social media except those user groups such as the elderly, although there is interest in using these media especially Facebook, who have been disadvantaged by progress technology for different reasons.

Research shows how the use of a Social Networking Site like Facebook can be beneficial for an older adult to strengthen social ties and social integration, psychological well-being and mental health.

KEYWORDS: Older adults, usability, inclusive design, social networks.

RELEVANCE TO ERGONOMICS: A proposed design of the Facebook page suitable to the limitations and capabilities of older adults can contribute to the study of human-computer relations and meet the needs of a greater number of possible people as it is this group of special users what it will help to emphasize the user-centered design.

1. INTRODUCTION

In the last 20 years the development of technology has been so rapid that equipment, electrical and electronic devices dating from those years (such as slide projectors, CRT televisions and landline phones) are obsolete today. In the field of communications the emergence of personal computers, cell phones and the Internet enabled the development of applications that allow instant communication between individuals and groups anywhere in the world resulting in what is known as Social Networks (e-mail, Facebook, Twitter, LinkedIn, etc.) displacing traditional media such as writing mail, landline, telegram, etc.

However, the use and development of these technologies requires knowledge, experience and abilities that some sectors of the population did not assimilated because of their generational lag or geographic isolation. One of those sectors is the population of older adults.

Data from the National Population Council (CONAPO, for its acronym in Spanish) indicate that in 2014 live in Mexico 11.7 million people over 60 years, which represents almost 10% of the total population. These figures indicate that the number of older adults has doubled in less than a quarter of a century since in 1990 was five million, according to data from INEGI figure is expected to double in 15 years.

In our country, the states with the largest number of user of social networks for the Federal District, State of Mexico and Jalisco; 9 out of 10 Internet users have an account in social networks and of these 90% have a Facebook account (IIifebelt.com, 2015). According to UNESCO data just over 2 million people over 51 years in Mexico are users of Facebook (Merca2.0 Magazine, 2014).

However, a large number of older adults has not been able to integrate the use of social networks like Facebook, although there is evidence of need and motivation from them, which would facilitate their communication with relatives by effects of migration they found in other latitudes.

One of these science that helps solve these problems is ergonomics, which in one of their specialties, is focused on studying the human-computer relations and meet the needs of as many people as possible including the special user groups such as older adults to consider their particular needs.

In this sense and in the field of ergonomic studies human-computer interface, this study will try to propose a new website design for Facebook that allows older adults an easy, convenient, efficient and satisfactory access, and so can expand their possibilities of social communication.

2. OBJECTIVES

Propose a website design for Facebook suited to the capabilities and limitations of older adults.

3. METHODOLOGY

A literature review was conducted to know the studies conducted to date and to draw theoretical concepts, methods and techniques to know in detail the problems of the elderly in the use of human-computer interfaces and particularly in the use of Facebook. From this review questionnaires and scales to gain knowledge about the problems of older adults in their interaction with Facebook be designed.

A study of the level of usability of the Facebook page in young subjects will be made and compared with the resulting greater usability in adult subjects. It will be conducted an assessment where young users and older adults participate directly performing specific tasks on the Facebook page as they observe and record the behavior in order to identify design flaws that cause errors and difficulties in the interaction of users Facebook page. The variables to consider will be the time to complete task, the task completion rate, the number of errors and the type of errors.

There are different methods of assessing accessibility and usability in existing literature. The World Wide Web Content Consortium (W3C) is in charge of promoting recommendations to address problems of accessibility to the needs of people with disabilities and older adults, particularly for the latter group of users has created the Web Accessibility Initiative: Ageing and Harmonization (WAI-AGE) which has the mission to promote the updating of the accessibility recommendations tailored to the needs of the elderly. Another initiative by Commission Web Content Accessibility Guidelines 2.0 (WCAG 2.0) containing a series of general principles, guidelines and compliance levels for accessible design. From these principles, standards and compliance levels and ergonomic concepts for web design principles will be reviewed.

In order to verify whether the Facebook page meets the guidelines and compliance levels of WCAG 2.0 an assessment of the Facebook page will be made by automatic verification tool (eg.: Hera, TAW, WAVE, etc.) that locates and specifies the type of defects.

Another important aspect to consider is the User Experience Design (UX Design) to get to know users to design a Facebook page that meets your needs and fits your abilities, expectations and motivations.

From all this information will design a new Facebook page and will be tested with older adults, feeding back design to optimum performance.

4. RESULTS

We are now at the stage of review of the literature found the following:

It is known that as age advances decreased motor, cognitive and perceptual abilities (Kroemer et al., 2001; Matthews et al., 2000) this is more relevant when using technology is made. When it comes to using the computer and internet cognitive abilities or “fluid abilities” are particularly important (Czaja and Lee, 2007; Garfein et al., 1988), including the ability of short-term memory, speed information processing, spatial skills and abstract reasoning (Hanson, 2009). Considering the above, the “fluid abilities” are important for adapting to new situations, including the adoption and use of new technologies resulting in an impairment in older people.

In addition, skills such as spatial thinking or memory are crucial to build mental models of correct interface (Brunsman-Johnson et al., 2015). These mental models are essential to use an interface as a website (Pak et al., 2006). As cognitive abilities decline with age, they seem to have influence on the performance of older people when they make use of technology.

In one study the result shows that women are more familiar with the term “online social networks” and are the most frequent users compared with male. Age, gender and education appear to be the most important factors that have a direct or indirect impact on the use of online social networks (Vošner, Bobek, Kokol, & Krečič, 2016).

Another study indicates that adoption of Internet and digital can be an important channel to increase life satisfaction among the elderly and the weakest social groups: people of low economic strata and those suffering from health problems that interfere with day to day operation (Lissitsa & Chachashvili-Bolotin, 2016).

Further study contributes to the current understanding of the acceptance of the technology in tree main ways. The study examined the technology used by an understudied population: the elderly and the way this population is beginning to embrace Internet technologies in higher percentages. This study sought to understand more about what predicts the use of social networks among older Internet users (Braun, 2013).

Another study links the four dimensions of the constraints faced by the elderly while dealing with computer-based technologies: intrapersonal, interpersonal, structural and functional limitations. These results indicated that older users could face several obstacles at different stages of age (Lee, Chen, & Hewitt, 2011).

A study in the College of Communications in Pennsylvania, USA. yielded results that older adults have four main motivations for using Facebook: social bonding, build social bridges, curiosity and respond to requests from family members (Jung & Sundar, 2016).

At the Department of Computer Science in Ensenada, Mexico developed a system able to adapt and move the capital of Social Networking Sites like Facebook in a domestic environment to support offline interactions of older adults with their family whose results show besides strengthening social relationships and social integration it is beneficial to the psychological well-being and mental health (Cornejo, Tori, & Favela, 2013).

In the UK other research reveals that in the rest house seniors adopt Internet technologies if they have access at any time to the Internet, if the connection is fast and reliable, if they have capable devices, support from family and apparent privacy (Choudrie & Vyas, 2014). In this same study cited Schaefer (2008) who says that “*social online networks are considered relevant to society as they are an enabling digital technology form of daily tasks that allows groups such as older adults remain independent for long time*”.

A study in Norway shows in their results that older adults rarely participate in online communities and share visual content but embrace some aspects of the new media. In the same study in Belgium shows that older adults are highly motivated to contribute to creating their own content if the right conditions are met and it is important for them to be able to use the new technology if they find it easy even recognized their concern about its use (Karahasanović et al., 2009).

In contrast to a study in Serbia found that young and adults users and their behaviors show social anxiety problems, poor social adaptability and interests as seeking sexual partners (Bodroža & Jovanović, 2016) while in adults over its main motivation is to strengthen family ties being more in touch with their children and grandchildren.

Another study in Budapest, Hungary crated a questionnaire on the Multidimensional Facebook Intensity Scale whose results suggest that this questionnaire is able to distinguish reliably between different aspects of the intensity of use of Facebook: persistence, boredom, over use and auto expression in users 18 to 62 years (Orosz, Tóth-Király, & Bőthe, 2015).

In Turkey the relationship between welfare and the problematic use of Facebook in young university with an average age of 20.86 years is investigated. They were studied life satisfaction, subjective vitality, flourishing and subjective happiness that were negative significant predictors of problematic use of Facebook. The importance and limitations of the study are discussed and mention that you cannot generalize the results (Satici & Uysal, 2015).

5. DISCUSSION/CONCLUSIONS

The revised literature mentions that the percentage of older adults participating in any online social networking and other activities of the media are growing; so it is believed that the results of studies could be generalized for the rest of the population. According to studies the impact on the lives of older adults can be deep to help they connected, current and more satisfied as indicated by other studies. However, other results indicate that older adults are slow to adapt to the use of Internet so it is necessary to put more attention on how to support this group of people.

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PREVENTIVE ERGONOMICS APPLIED TO CHOOSE BAMBOO MACHINERY IN MEXICAN WORKSHOPS.

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Resumen: La investigación que se presenta se desarrolla en la Carrera de Diseño Industrial de FES Aragón de la Universidad Nacional Autónoma de México. Se enfoca a la incipiente industria del bambú en México que utiliza maquinaria importada de China e India, principalmente. En consecuencia se ha iniciado con enfoque preventivo el estudio ergonómico de algunas máquinas ubicadas en talleres del estado de Puebla y Veracruz, las que se han adquirido con criterios únicamente económicos considerando la productividad y eficiencia, descuidando la seguridad y bienestar de los trabajadores.

El objetivo principal de este estudio es identificar los riesgos físicos, químicos y posturales a los que están expuestos los trabajadores que utilizan la maquinaria para procesar el bambú y proponer lineamientos básicos para elegir la herramienta y el equipo adecuados considerando las capacidades y limitaciones de los trabajadores.

Al vincular la Ergonomía con el Diseño Industrial, es factible obtener resultados preliminares para proponer los fundamentos y generar un manual que se difunda entre los interesados en la industrialización del bambú.

Palabras clave: Ergonomía preventiva, diseño industrial, bambú, industria.

Abstract: This paper presents the development of the research that is held at Industrial Design School at FES Aragón / UNAM (National Autonomous University of Mexico).

It is focused on the emerging bamboo industry in Mexico that uses machinery mainly imported from China and India. Therefore preventive approach has begun with ergonomic study of some machines in workshops of Puebla and Veracruz, where some business owners have started buying motivated only by economic criteria considering productivity and efficiency, ignoring the basic principles of safety and welfare of workers.

The main objective of this study is to identify physical, chemical and postural risks to which workers are exposed using bamboo-processing machinery and propose basic guidelines for choosing bamboo tools and equipment considering workers' capabilities and limitations.

By relating ergonomics and industrial design, it is possible to obtain preliminary results in order to recommend the basics of ergonomics and write a handbook that can be spread among people interested in the development of bamboo industry.

Keywords: Preventive Ergonomics, Industrial Design, Bamboo, Industry.

Relevance to Ergonomics:

1. Male population data considered in the Ergonomic research.
2. Special topics such as ergonomic guidelines for the design of workstations related to bamboo processing machines.

This article is important because there is no information available on this the subject.

1. INTRODUCTION

Since the 80s of the last century, the interest on bamboo harvesting and uses arose in Cuetzalan and Hueytamalco in Puebla; Huatusco and the municipality of Teocelo where the village of Monte Blanco stands in the state of Veracruz; all these places are situated in the Sierra Madre Oriental. In these locations coffee grew up and for different reasons including low prices, communities moved to bamboo harvesting and started promoting its wide range of uses in building, industry and handcrafts.

Figure 1. Where bamboo grows

Analyzing bamboo production chain at the industrial design school two projects were developed, a solar dryer and bamboo preservation equipment regarding primary transformation. In the secondary transformation stage, three workbenches were developed for crosscutting, drilling, frames and bodies assembly, planned for the handcrafts area.

In different sectors attention has been given in bamboo as raw material for building houses, “palapas”, restaurants, etc. It is also intended to implement the bamboo industry in Mexico and some business owners have started buying some machines manufactured in China and India ignoring the basic principles of productivity, efficiency, safety and welfare of workers.

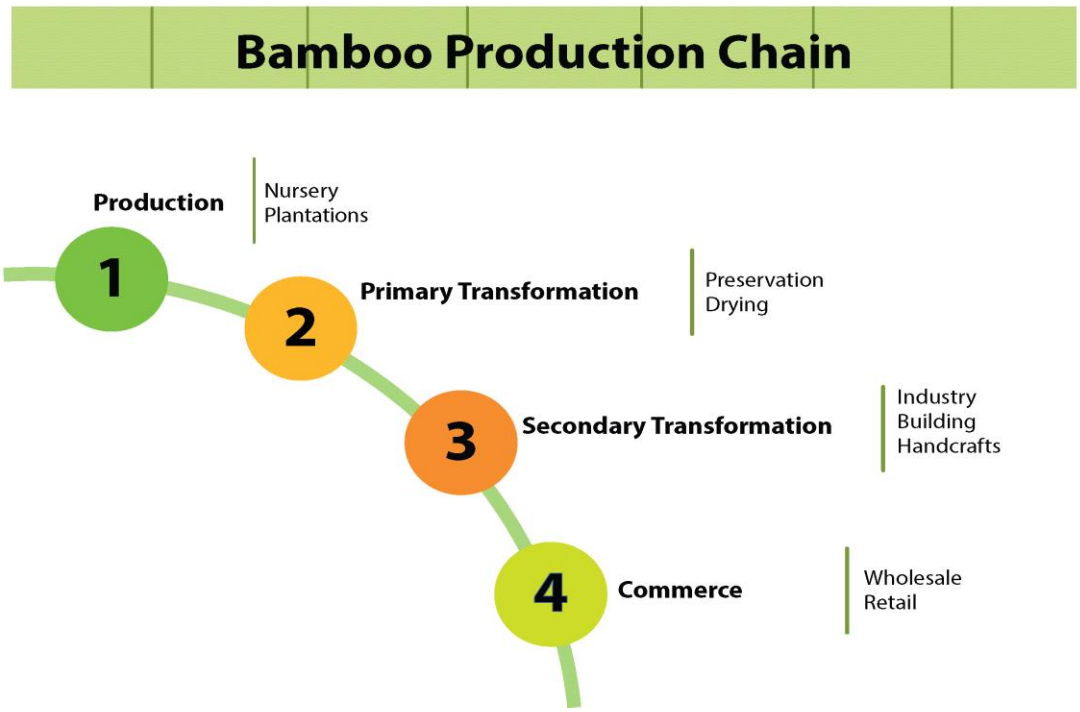

Figure 2. Bamboo Production Chain

2. OBJECTIVES

Identify the intrinsic risks in the use of bamboo machinery considering workers abilities and limitations, based on ergonomics and industrial design.

Gather information to summarize problems related to physical, chemical and postural risks.

Generate a final report so that basic guidelines for choosing bamboo tools and equipment could be recommended.

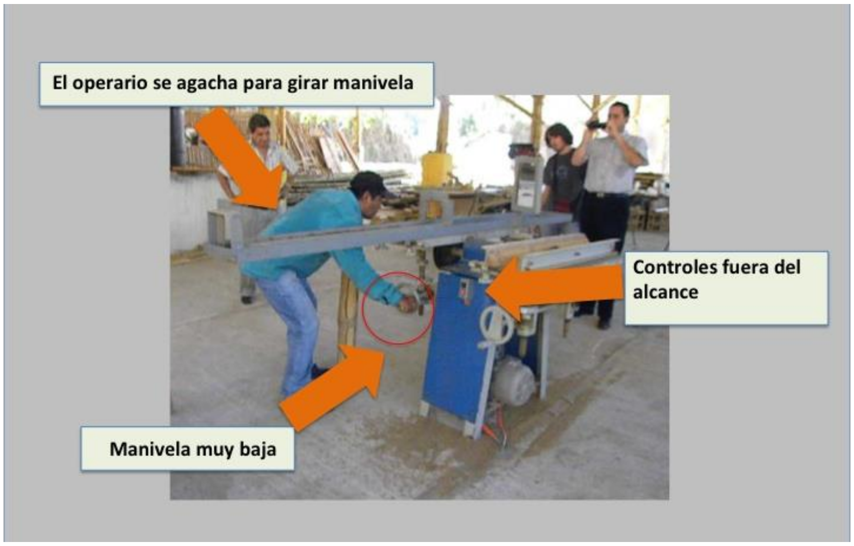

Figure 3. Working with the automatic splitting machine. Hueytamalco, Pue.

Figure 4. Working with the preservation equipment. Huatusco, Ver.

3. METHODS

First Stage.

- Documentary and field research in order to get acquainted with bamboo processing machinery.
- Ergonomic analysis of bamboo processing machines installed in three workshops located in the states of Puebla an Veracruz, based in:
    - Direct Observation
    - Images and videos

- Conclusions of this stage.

Second Stage.

- Ergonomic analysis based in videos and bamboo machine sales brochures.
- Identification of problems related to posture, repetitive movements and larger risks.
- Select bamboo transformation processes based in design criteria.
- Review of literature on the subject.
- Conclusions of this stage.

4. RESULTS

In the first stage it is important to gather information to summarize documents on problems related to posture, repetitive movements and other risks (physical: hear loss, effects of vibration; and chemical as allergies, for example).

At the end of the research, with all the information gathered a final report or/and a handbook could be produced so that basic guidelines for choosing bamboo tools and equipment could be recommended.

Even though, we are at the beginning of this project we have had the opportunity of meeting people interested in what we are studying. Last year in October we attended the 3rd International Symposium of Bamboo and Guadua in Bogotá, Colombia. Also, we joined the organizing committee of the 3rd Mexican Bamboo Congress and met important people related to the world of bamboo. In both occasions we delivered lectures related to ergonomics applied in the field of bamboo.

5. CONCLUSIONS

With Ergonomics and Design in mind, first results will be achieved so as to propose basic guidelines that would help assessment and selection of bamboo machinery.

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INFLUENCE OF COLOR IN ARCHITECTURAL CONTEXTS: AN ERGONOMIC PERSPECTIVE

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RESUMEN: El uso del color en los contextos arquitectónicos es algo que se ha estudiado a lo largo de los años y que es un tema de importancia en la ciencia de la ergonomía cognitiva dentro de la *“soft ergonomics”* término introducido por McDonagh en el año 2000.

Se ha encontrado en diversos estudios como el uso de los diferentes colores y sus temperaturas pueden afectar en diversos aspectos de las personas, tanto en lo físico como en lo emocional e inclusive en el desempeño de sus actividades cotidianas.

Esta revisión bibliográfica tiene como objetivo demostrar la importancia del color en la ergonomía por medio de 32 artículos referentes a diversos tópicos que respectan a los efectos que producen los colores en las personas, estudios experimentales, de encuestas descriptivas, encuestas comparativas y revisión de casos servirán para conocer como el uso del color puede beneficiar o afectar un contexto arquitectónico.

Dentro de los efectos que suelen causar los colores en las personas destacan las emociones positivas o negativas, alteraciones del ritmo cardiaco, mayor o menor número de errores en el desempeño de trabajo para demostrar el rendimiento y la productividad así como en el estado de ánimo de los trabajadores, también se ha demostrado que los estudios del color pueden variar de una cultura a otra o inclusive entre hombres y mujeres.

En la ergonomía es vital el conocer los efectos que estos producen en las personas, ya que como la *“soft ergonomics”* lo indica, las necesidades emocionales así como los aspectos cualitativos intangibles que afectan la relación de las personas con un entorno o producto son igual de importantes que los aspectos de la *“hard ergonomics”.*

Palabras clave: Color, contextos arquitectónicos, ergonomía cognitiva y diseño

ABSTRACT: The use of color in architectural contexts is something that has been studied over the years and it is an important issue in the science of cognitive ergonomics into the "soft ergonomics" term introduced by McDonagh in 2000.
It has been found in several studies as the use of different colors and temperatures can affect various aspects of people, both physically and emotionally and even in the performance of their daily activities.

This literature review aims to demonstrate the importance of color in ergonomics through 32 articles on various topics about the effects of colors on people, experimental studies, descriptive surveys, comparative surveys and case review will serve to learn how the use of color can benefit or affect an architectural context.

Among the effects that often cause the colors in people emphasize the positive or negative emotions, heart rhythm disturbances, more or fewer errors in the performance of work to demonstrate the performance and productivity as well as the mood workers, has also been shown that color studies may vary from one culture to another or even between men and women.

Ergonomics is vital to know the effects these have on people, because as the "soft ergonomics" implies, the emotional needs as well as intangible qualitative aspects that affect the relationship of people with an environment or product names are equal of important aspects of "hard ergonomics".

Keywords: color, architectural contexts, cognitive ergonomics and design

Relevance to Ergonomics: An appropriate color can contribute to improving learning for example in academic classrooms and improve the performance of industry workers or offices, influences mood, positive emotions and perceptions about the environment.

Knowing more about the effects of color is important in cognitive ergonomics as it serves as a reference for designers and other design professionals or construction to create an enabling environment for the various tasks of daily life, whether in work or personal environments, its publication is of importance because it is an issue that is thought to have little relevance or little studied, but are equally important cognitive factors in people with physical factors.

1. INTRODUCTION

1.1 Cognitive ergonomics and "soft"

Cognitive ergonomics focuses on mental processes, such as perception, memory, reasoning and motor response, affect interactions between human beings and other elements of a system. Relevant topics include mental workload, decision making, specialized performance, human machine interaction, human error, work stress and performance and how it can relate to the way humans work in systems, according to (IEA, 2000-2003).

Within cognitive ergonomics in 2000, McDonagh defines a new topic "soft ergonomics" which includes the emotional needs and other intangible qualitative aspects that affect the user's relationship with a product or in our case can be used for a context . For example emotional ties, familiarity aspirations, desire, sentimentality, aesthetics, personal taste, touch, smell, and personality.

They are just as important as the "hard ergonomics" concerning how a product or environment works, what it does, its construction and materials, which is tangible.

Emotional ergonomics or "soft ergonomics" is a relatively new field of ergonomics, and many companies such as Sony, Philips and Apple, are aware of the importance of applying methods to meet the perceived needs of the consumer; this in order to achieve an emotional bond between the product or design and users (McDonagh, 2000).

1.2 Color

Humans receive 80% of environmental information. The color belongs to the environment and is therefore a means of communication and information absolutely necessary for the interpretation and understanding of the natural or artificial environment. The perception of color in the atmosphere always brings effects of association, whether synesthetic, symbolic or emotional (Manhke, 1996). Thus, the color has effects on the psychological level, evokes emotions, feelings and other aspects.

2. OBJECTIVES

Analyze the effects of color on behavior of humans in architectural contexts from the perspective of cognitive ergonomics based on "soft ergonomics".

3. METHODOLOGY

The search was conducted in databases that compile design, ergonomics and medical literature using the keywords "color", "ergonomics", "emotions", "perception", "soft ergonomics", “color effects”. Titles and abstracts of articles identified as potentially useful documents were read, the articles were read in full.

The articles presented belong to publications of international scientific journals, in the fields of architecture, ergonomics, design, medicine and science department of color. The publications range from 1990 to 2015. Search through academic search engines and internet consultation was carried out.

A classification of these studies was divided in 4 topics or main aspects:

- Emotional
- Physiological
- Mood
- Performance
- Theoretical review

4. RESULTS

Based on the literature in this paper 32 color investigations dating from 1990 to 2014, grouped in the table below are summarized.

Table 1. Revised Articles

Autor	Context	Evaluation				
		Emotional	Physiological	Mood	Performance	Theoretical review
1. Ou et al. (2004)	Laboratories	X				
2. Ou et al. (2004)		X				
3. Ou et al. (2004)		X				
4. Ou et al. (2012)		X				
5. Manav (2007)		X				
6. Alexandrino et al. (2014)		X	X	X		X
7. Jalil et al. (2013)		X				
8. Aoki et al. (2011)		X	X		X	
9. Jin et al. (2005)		X	X			
10. Hirschmüller et al. (2008)		X				
11. Küller et al. (2009)	Office / Workspace		X	X	X	
12. Kwallek et al. (2007)		X			X	
13. Kwallek et al. (1997)		X		X	X	

14. Kwallek et al. (1996)				X	X	
15. Kwallek & Lewis (1990)				X	X	
16. Ainsworth et al. (1993)				X	X	
17. Stone & English(1998)		X		X	X	
18. Kaya & Epps (2004)		X				
19. Bakker et al. (2013)					X	
20. Chebat & Morrin (2007)	commercial space	X		X		
21. Yildirim et al. (2012)		X				
22. Yildirim et al. (2011)	Livingroom / Home / Virtua			X		
23. Tsunetsugu et al. (2005)		X	X			
24. Reddy et al. (2012)		X	X	X		X
25. Jalil et al. (2011)	All kind	X	X	X	X	X
26. Dzulkifli & Mustafar (2013)					X	X
27. Elliot & Maier (2014)		X	X		X	X
28. Read & Upington (2009)	School	X				
29. Read (2003)					X	

30. Maier et al. (2009)		X			X	
31. Dalke et al. (2005)	Hospital		X	X		X
32. Barrick, Taylor & Correa (2002)		X		X		
Total		23	9	13	14	6
% of the 32 articles		72	28	41	44	19

4.1 Emotion in the context

Based on the literature review, it is possible to find that 72% of the studies focus on the topic of the emotional state of the subject.

In assessing the emotional state the following tools to assess the mood is mainly used, (POMS) profile of mood state, (MAACL) Multiple Affect Adjective Check List and (PANAS) Positive and Negative Affect Schedule.

Further it is observed that of the 32 articles, 23 of them focused on the emotional aspects in different contexts; laboratories, offices and work spaces, commercial spaces, at home, schools and hospitals, being more studied color within laboratories, with color studies isolated by means of color patches with 31%, second offices with 28% in experimental studies , third schools and homes with color studies mainly in children and college with 9.4% and in fourth place with 6.3% commercial spaces and hospitals.

4.2 Physiological assessment

9 studios referring to the study of color within physiological aspects, consistent with Jin et al found. (2015) which states that most of the research being conducted are based more on the study of color from psychological rather than physiological assessments. In this review we managed to find a similar event where the physiological approach in color research is limited, Jalil et al. (2011) suggest that this may be due to accessibility in the process of experimentation and the search for variables.

To measure the physiological to the color stimulus responses, various methods were used to signal changes body galvanic skin response (GSR) was used for the evaluation of brain electrical activity in the brain (EEG) is used to view brain wave, neuroimaging with optical topography (OT) to see the hemodynamic responses and (RCBF) to measure the activity of the central nervous system.

Tsunetsugu et al. (2005) indicated that the brain and body changes in bodily responses, showed that after showing a stimulus in the environment increases the heart rate. In brain research detected that there is an increase in blood flow in the left frontal area and this indicates that the subject has been affected by the stimulus, Jin et al. (2005) found that the activity decreases in the nervous system, blood pressure, heart rate and respiratory rate and therefore a stimulus can affect the body and mind.

4.3 Evaluation of performance

44% of the studies measured job performance with color as a stimulus, the context in which it was largely taken into account the color as a variable affecting work performance was in workspaces or office and schools.

Studies are associated in learning performance, fewer errors in performing the tasks and the time when the work is done.

4.4 Color Theory in ergonomic perspective

Previous studies show some inconsistencies in the study of color, Kwallek and Lewis (1990) found that the red used in an office space, was the least errors committed participants, although they believed find as color more distractor, whereas the white color, which for many is considered the best color for office space, was the least distracting, however in the experiment subjects were committing most errors.

It also found that in the study of colors, they change their meaning or effect depending on culture, gender and age (Ou et al 2004;.. 2012, Manav, 2007, Jalil et al 2011, Maffei et al . 2014 Kwallek and Lewis, 1990).

Among the negative effects it was found that the red produces low attention in work of high demand and decreased attention on the tasks (Maier et al. 2009, Stone & Inglés, 1998), gray and beige colors (Dalke et al. 2005) minimize attention and concentration, the blue has an effect of drowsiness as tested by Kuller (2009) using an electroencephalogram (EEG).

Therefore, color is an important element of the focal information that will determine human behavior to their environment.

From this review, it was found that too many research focuses primarily on some colors like red, blue, white and green. Research should take into account a wider range of color selection for the broader perspective of color effects.

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5. CONCLUSION

From the review of articles, most previous studies used the color red as the warm, followed by blue for cold color within a context. Therefore, the effects of red and blue color are supplied in abundance compared with other colors.

Jin et al. (2005) found that color has a positive effect if the brightness level is adjusted to individual preference, this should be further investigated.

In addition to the physiological response it should be studied with color as a stimulus because most of the studies are psychological aspect as well as having a greater focus in other contexts that are not only those of workspaces as you can observed in the review are the most abundant.

An appropriate color can contribute to a long lapse of concentration on learning, improving performance and the influence of positive emotions and perception of their environment.

Learn about color effects for future reference serves designers, other professionals and institutions specializing in the design, in order to create enabling environment for humans.

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ERGONOMIC MOBILE STATION, A PROTOTYPE MULTIPURPOSE

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Resumen: El presente proyecto es una propuesta desarrollada para el Instituto Tecnológico de Mexicali con el fin de participar en la activación física y evitar las posturas incorrectas que promueven de manera indirecta algunas áreas de descanso existentes. Para lo anterior se desarrollan estudios de la problemática general y de las alternativas que pueden mejorar distintos aspectos contraproducentes para el trabajo educativo y la salud.

Es pertinente resaltar el alto grado de sedentarismo y obesidad en la población estudiantil. Se desarrollaron análisis ergonómicos de las posturas de los estudiantes durante sus consultas de internet.

Mediciones antropométricas, encuestas y entrevistas a los estudiantes involucrados se aplicaron en el estudio para validar los resultados obtenidos de conformancia.

La estación móvil propuesta se validó conforme a los estándares establecidos para su diseño biomecánico y finalmente proponer un diseño ergonómico de una estación móvil de consulta o de estudio que permite un uso confortable.

Palabras clave. Análisis Ergonómico, Sedentarismo, Biomecánica

Abstract: This project is a proposal developed for Instituto Tecnológico de Mexicali in order to participate in physical activities and avoid incorrect postures that promote indirectly some existing rest areas. For the above studies of general problems and alternatives that can improve various aspects counterproductive for educational work and health are developed.
It is pertinent to note the high degree of physical inactivity and obesity among the student population. Ergonomic analysis of the positions of the students during their internet consultations.

Anthropometric measurements, surveys and interviews with students involved in the study applied to validate the results of conformance.

The mobile station proposal validated according to the standards established for their biomechanical design and finally the ergonomic design of a mobile station consultative or advisory allows comfortable use.

Keywords: Ergonomic analysis, Sedentary, Biomechanics

1. INTRODUCTION

Work chairs and seating. No one posture is suitable all of the time or for all people. Regular changes in sitting postures are necessary to reduce the effects of straining the same muscle groups and fatigue. Tasks should be organized so that people can take breaks periodically. If people are seated for most of the working day, they need well-designed seating including adjustments and padding. No chair will seat people comfortably for more than about an hour at a time. Even the best designs become uncomfortable over time. Work seating should be adjustable at least in seat height and backrest angle. Adequate lumbar support at the base of the spine is important for comfort and back care. Where computers are used some adjustability in keyboard height and in screen height, position and angle are important. Desk and chair height should allow users to sit with their feet flat on the floor and their thighs horizontal with minimum pressure on the back of the thighs. Where a chair is too high due to a need to adjust the work height, a footrest should be use.

An ergonomic office chair is a tool that, when used properly, can help one maximize back support and maintain good posture while sitting. However, simply owning an ergonomic office chair is not enough it is also necessary to adjust the office chair to the proportions of the individual's body to improve comfort and reduce aggravation to the spine.

The first step in setting up an office chair is to establish the desired height of the individual’s desk or workstation. This decision is determined primarily by the type of work to be done and by the height of the person using the office chair. The height of the desk or workstation itself can vary greatly and will require different positioning of the office chair, or a different type of ergonomic chair altogether.

Once the workstation has been situated, then the user can adjust the office chair according to his or her physical proportions. According to fig.1 these are the most important guidelines distilled into a quick checklist to help make sure that the office chair and work area are as comfortable as possible and will cause the least amount of stress to the spine:

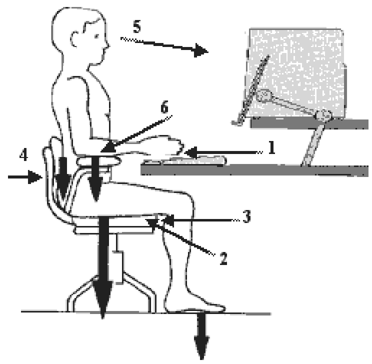

Fig. 1 Guidelines for Office Chair Setup

1. Elbow measure
   First begin by sitting comfortably as close as possible to your desk so that your upper arms are parallel to your spine. Rest your hands on your work surface (e.g. desktop, computer keyboard). If your elbows are not at a 90-degree angle, adjust your office chair height either up or down.
2. Thigh measure
   Check that you can easily slide your fingers under your thigh at the leading edge of the office chair. If it is too tight, you need to prop your feet up with an adjustable footrest. If you are unusually tall and there is more than a finger width between your thigh and the chair, you need to raise the desk or work surface so that you can raise the height of your office chair.
3. Calf measure
   With your bottom pushed against the chair back, try to pass your clenched fist between the back of your calf and the front of your office chair. If you can't do that easily, then the office chair is too deep. You will need to adjust the backrest forward, insert a low back support (such as a lumbar support cushion, a pillow or rolled up towel), or get a new office chair.
4. Low back support
   Your bottom should be pressed against the back of your chair, and there should be a cushion that causes your lower back to arch slightly so that you don't slump forward or slouch down in the chair as you tire over time. This low back support in the office chair is essential to minimize the load (strain) on your back. Never slump or slouch forward in the office chair, as that places extra stress on the structures in the low back, and in particular, on the lumbar discs.
5. Resting eye level
6. Close your eyes while sitting comfortably with your head facing forward. Slowly open your eyes. Your gaze should be aimed at the center of your computer screen. If your computer screen is higher or lower than your gaze, you need to either raise or lower it to reduce strain on the upper spine.
7. Armrest

Adjust the armrest of the office chair so that it just slightly lifts your arms at the shoulders. Use of an armrest on your office chair is important to take some of the strain off your upper spine and shoulders, and it should make you less likely to slouch forward in your chair. (John J. Triano, DC, PhD, 2010)

The proposal for an ergonomic mobile work station it's changing the desk offered by wewatt in order to be adjustable in tilt and also that can be adjust up or down to the proportions of the individual's body. As for the sitting area also to make it adjustable up or down and forward or backward this way will improve comfort and reduce aggravation to the spine.

Steven Blair, an exercise scientist, has been researching the health benefits of physical activity for more than 25 years, first at the Cooper Institute in Dallas and currently at the University of South Carolina's Arnold School of Public Health. He is a former president of the American College of Sports Medicine, quote "I and others believe it's because we have essentially engineered energy expenditure out of our daily life at work, at home and in recreational activities. It's something we've never seen fit to measure, so we don't have data to support the notion that energy expenditure in daily life has been driven way down.

The proposal for this project is a mobile work stations for hallways at the ITM that allow students to pedal while they consult the web, study or chat, instead of been sitting on uncomfortable seats or floor fig. 2 and 3.

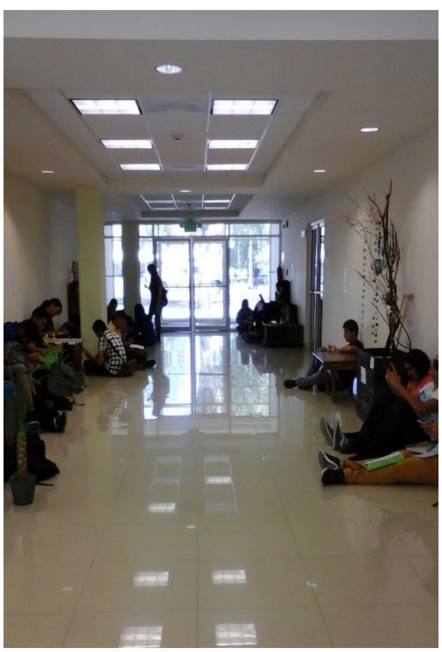

Fig. 2 Hallway at ITMexicali hallways.

Fig. 3 Students studying in

Research has linked sitting for long periods of time with a number of health concerns, including obesity and metabolic syndrome a cluster of conditions that includes increased blood pressure, high blood sugar, excess body fat around the waist and abnormal cholesterol levels. Too much sitting also seems to increase the risk of death from cardiovascular disease and cancer.

One study compared adults who spent less than two hours a day in front of the TV or other screen-based entertainment with those who logged more than four hours a day of recreational screen time. Those with greater screen time had:

- A nearly 50 percent increased risk of death from any cause
- About a 125 percent increased risk of events associated with cardiovascular disease, such as chest pain (angina) or heart attack (James A. Levine, M.D., Ph.D., 2015)

2. OBJETIVES

Redesign a mobile station to obtain a seat and desk with an ergonomic design for hallways.

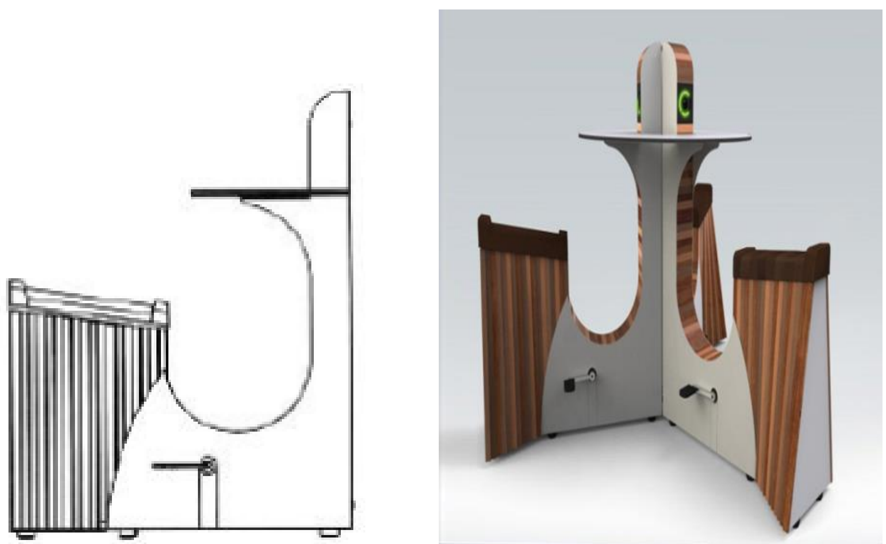

Figure 4.WeWatt Co. Design

3. METHODOLOGY

3.1. Observation and analysis of design.
As a first step we analyze the design offered by WeWatt Company (Figure 4); which aims to redesign the desktop and seat. Proposing to be adjustable in height and tilt table. As for the seat position, also to be adjustable according to the anthropomorphic measures.

Apply a survey to allow us to gather information regarding the need of an ergonomic mobile station and if this would be useful for students in the ITM while waiting for next class or free time.

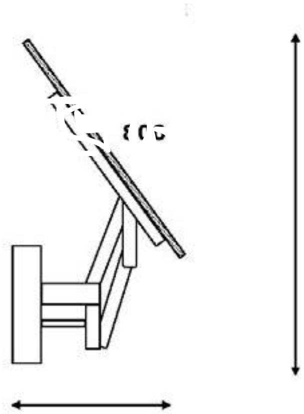

Figure 5 Proposal for adjustable desk

Figure 6.Proposal for an anthropometric chair.

3.2. Proposal.

Recommend a prototype that allows a self-adjusting table and seat, according to the anthropomorphic analysis performed. The table should be adjustable in height and tilt (Figure 5), as for the seat propose an ergonomic seat with reclining backrest and sitting rapid adjustment in height and depth. (Figure 6) (Health & Fitness, 2016)

4. RESULTS

Through a survey apply to students from Instituto Tecnológico de Mexicali the need to install mobile work stations on hallways and libraries was identified.

Anthropomorphic measurements were made to students according to given mobile station, which result was not ergonomic according with table 1.

Fig. 7 Do you think it is important to have a mobile station on campus?

According to fig.7 from the students surveyed 81.8% think it is a good idea to install these mobile work stations.

Fig. 8 Would you use the mobile work station?

The 76.8% of students surveyed think on use a mobile work station, while the 19.9% think they may use it.

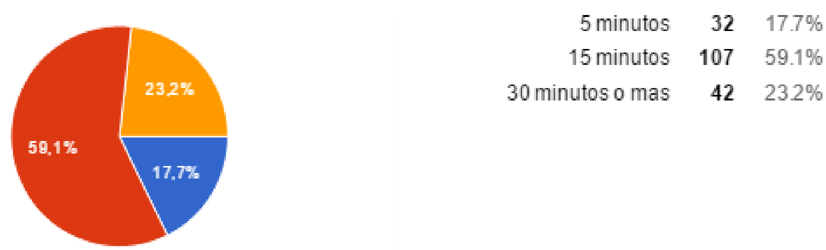

Fig. 9 For how long you use the mobile station?

The 59% of surveyed students think they would have available 15 minutes between classes to use the workstation suggested, but the 23.2% could use it more then 30 minutes when they have free time.

Fig. 10 What type of electronic device you would like to connect the mobile work station?

The cell phones are the devices that students would connect more with a 68% of acceptance, and laptops would follow with 23% of the surveyed answers according to fig.10.

Table 1.Percentile

	Code	5 Percentile	Average	95 Percentile
1	**920**	60.65	82.701923	117
2	**805**	159.55	171.86923	183
3	**328**	143.55	159.93462	174
4	**23**	129.1	143.14038	155.45
5	**309**	97	109.75192	123.845
6	**949**	91.11	101.00192	116.89
7	**398**	71.1	85.536538	110
8	**973**	36.43	82.211538	93.95
9	**265**	60	71.211538	78.45
10	**797**	75.55	149.48077	187.9
11	**798**	77	87.075	99.45
12	**80**	66.85	81.776923	95.025
13	**752**	57.85	75.846154	89.9
14	**122**	36.3	55.784615	59.585
15	**223**	28.825	45.532692	91.35
16	**457**	29.55	40.286538	56
17	**639**	32.75	42.029412	50
18	**230**	50.1	105.63654	134.15
19	**931**	58.35	96.525	116.35
20	**178**	57.55	102.75192	124.95
21	**595**	18.55	30.382692	37.05
22	**441**	18.275	21.7	27
23	**420**	14.365	18.969231	25
24	**656**	8	14.131154	15.45
25	**411**	3	9.9134615	12
26	**402**	3	6.9230769	12

27	**758**	78	87.909615	98.495
28	**330**	64.3	76.371154	87
29	**25**	56	61.896154	69.68
30	**312**	3.55	31.382692	48.2
31	**856**	10	23.451923	77.75
32	**914**	113.435	129.01019	143.45
33	**912**	109.4	150.11154	150.35
34	**2FGM**	102	128.22692	142.035
35	**4FGM**	41.55	49.036538	63.25
36	**200**	32.1	43.451923	50.45
37	**194**	51.1	58.851923	74.15
38	**678**	29	47.636538	75.25
39	**529**	34.55	53.219231	73
40	**381**	35	45.015385	61
41	**507**	37.415	45.598077	54
42	**459**	30.55	44.025	58
43	**859**	25	40.021154	56.9
44	**775**	21.425	37.086538	129.9
45	**777**	8.55	10.861538	14.225
46	**776**	3.61	8.6038462	14

The table 1 shows the anthropomorphic measures taken to two groups of students from industrial engineering who participated in the study this table shows that the mobile work station offered by wewatt it doesn't have an ergonomic design, it was feasible to identify all critical dimensions to begin a proposal for a different design.

5. CONCLUSIONS

Students surveyed at the ITM show great interest in the mobile work station, but they discovered after taken the anthropomorphic measures that the station shown is not ergonomic, so in order to promote a healthy posture got to redesign an adjustable desk and seat as the proposal.

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THEORETICAL REVIEW OF THE APPLICATION OF ERGONOMICS IN THE WORK OF THE PHYSIOTHERAPIST IN THE REHABILITATION THERAPY FOR CHILDREN WITH DISABILITIES

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Resumen: En la concepción del diseño del *SRM* (Sistema de Rehabilitación Motriz), una interfaz de apoyo para fisioterapeutas en las terapias de rehabilitación que realizan con niños con discapacidad motriz y que actualmente se encuentra pendiente para entrar en su etapa de producción, se encontró que se analizaron y resolvieron correctamente los requerimientos respecto a la función de la rehabilitación específica y el contacto directo con el niño con discapacidad, pero existe una falta de evaluación ergonómica de las condiciones de trabajo en las que se verá envuelto el fisioterapeuta al usar el sistema. Para esto, es necesario, realizar dicha evaluación para determinar los riesgos ergonómicos que podrían derivarse en problemas músculo-esqueléticos en el fisioterapeuta.

El objetivo de esta revisión es describir los estudios existentes sobre la aplicación de la ergonomía en el trabajo del fisioterapeuta en terapias de rehabilitación motriz en niños con discapacidad.

La búsqueda de artículos se realizó en revistas científicas de los campos de la medicina, ergonomía aplicada, rehabilitación física, ingeniería médica, neurofisiología, fisioterapia y salud, se clasificaron los artículos por temas específicos y tipos de estudio para discriminar aquellos que no tuvieran relación directa con el trabajo del fisioterapeuta. Finalmente, se hizo la revisión completa de 34 artículos seleccionados de los temas de mayor interés para el estudio.

Para fines del proyecto que se está desarrollando, no se encontró suficiente literatura que aborde el tema de la terapia de rehabilitación motriz específica de vestibulación ni de los riesgos ergonómicos que podría ocasionar al fisioterapeuta al llevarla a cabo con niños con discapacidad.

Palabras clave: Ergonomía del diseño, rehabilitación, inhabilitación, vestibular.

Abstract: In the conception of the design of the *MRS* (Motor Rehabilitation System) an interface support for physiotherapists in the rehabilitation therapies that are performed with children with motor disabilities that is currently pending to enter its stage of production, we found that they were analyzed and resolved correctly the requirements with respect to the role of specific rehabilitation and direct contact

with the child with disability, but there is a lack of ergonomic assessment of working conditions in which the physiotherapist will be involved when using the system. For this, it is necessary to conduct such an evaluation to determine ergonomic risks which could result in musculoskeletal problems for the physiotherapist.

The objective of this review is to describe the existing studies on the application of ergonomics in the work of the physiotherapist in therapies of motor rehabilitation in children with disabilities.

The search for articles was made in scientific journals from the fields of medicine, applied ergonomics, physical rehabilitation, medical engineering, neurophysiology, physiotherapy and health, and they were classified by specific topics and types of study for discriminate those who did not have a direct relationship with the work of the physiotherapist. Finally, the complete review was made of 34 selected articles from the subjects of higher interest to the study.

For purposes of the project that is being developed, it was not found enough literature that deals the issue of specific vestibular motor rehabilitation therapy or ergonomic risks which may cause in the physiotherapist to carry out with children with disabilities.

Keywords: Design ergonomics, rehabilitation, disability, vestibular.

Relevance to Ergonomics: Provide information that supports the ergonomic assessment of the physiotherapist work in vestibular motor rehabilitation therapy in children with disabilities and the theoretical basis of ergonomics for the design of medical products, especially support systems for rehabilitation.

1. INTRODUCTION

It was performed the development of a new product that is pending to enter its stage of production, a support system for physiotherapists in the rehabilitation therapies that perform with children with motor disabilities: *MRS* (Motor Rehabilitation System).

The *MRS* serves as an interface between the physiotherapist and the patient. Proposes a mechanical way of supporting physiotherapist in vestibular movements that the body of the child with disabilities can learn, create, design and evolve, with natural and autonomous ways, in their physiological and neurological processes of movement. The main concept is that, by working with this system, the child recover and rehabilitate its ability to move and walk, trying to avoid replacing it with other solutions, for example, surgically.

Its function is based on three main needs: the specific therapeutic function of rehabilitation through vestibular movements, the ergonomic factor that prevents possible discomfort and musculoskeletal symptoms in the physiotherapist, and psychological factor that favors a pleasant therapy for the child.

In the development of the design of the *MRS* it was found that the function requirements were resolved correctly in specific rehabilitation and direct contact with the child with disabilities, but there is a lack of ergonomic assessment of working conditions in which the physiotherapist will be involved when using the system. It is necessary, therefore, to carry out this assessment together with an in-depth analysis of ergonomic risks which could arise in musculoskeletal problems for the physiotherapist.

As part of this study, it was made the theoretical review of scientific publications that have a relationship with the application of ergonomics in the work of the physiotherapist for motor rehabilitation therapy, from different areas of interest and research settings.

2. METHODOLOGY

The articles search was done systematically by topics of interest through academic web search engines, specialized and general consultation, and databases of articles published via the internet. The publications were found, mostly, in journals of international level in the fields of medicine, applied ergonomics, physical rehabilitation, medical engineering, neurophysiology, physiotherapy and health.

To make a reliable search, it was evaluated the authorship and the lodging of the publication, noting that both the author and institution as the site where it was found, support the credibility and authenticity of the information.

The content of the publications was assessed using criteria of accuracy for the precision and reliability of information; criteria of objectivity, to have a study impartially and absent of ideological bias in the information; coverage criteria, that is the level of detail and integrity in scope and depth to match the public to which it is focused; validity criteria, to determine the temporary validity of information, its timeliness and updating; and finally, criteria of relevance for assessing the pertinence of the information for the interest and convenience of the project.

Once the search was complete, was assessed the purpose of what is proposed in articles for discriminate those who did not have a direct relationship with the reason for the study, in this case, with the work of the physiotherapist. It has been analyzed the value that was necessary to give information, selecting those publications which included "pure" information, i.e., that their claim is merely to report objectively and to spread or promote the work, ideas, or interests of a specific topic.

In this way, it proceeded to classify the articles for specific topics and types of study to synthesize them in the following topics: Anthropometry, biomechanics, musculoskeletal disorders, rehabilitation, physiotherapy, disability and medical product design.

Finally, it was made the complete revision of articles selected by the close reading of each one of them, rescuing the most important concepts for the project in question.

The articles reviewed belong to publications ranging from the years 2000 to 2014, with the exception of two articles that were published in 1990 and 1994.

3. RESULTS

The review consisted of a total of 34 scientific articles, of which 3 (Kejonen, Kauranen & Vanharanta, 2003; Dwivedi, Shetty & Narendra, 2009 & Hobson & Molenbroek, 1990) deal with the subject of anthropometry from the perspective of design for disability, the relationship that exists with the postural balance and its application in the adequacy of medical devices. Hobson and Molenbroek (1990) explain in his study how enhanced technical solutions and the development of technology that will be emerging in the design of tools and systems, can remove some of the barriers that currently impede the economic and social performance of persons with disabilities and thus lead to a march toward greater independence, self-determination and integration in their day-to-day work. It is important, therefore, to have not only information on dimensions of body segments but also on the ranges of proprioception, balance and postural balance, which usually are affected in people with cerebral palsy and disability.

Five articles (Carpes, Reinehr & Bolli, 2007; Mazzoleni, Toth, Munih, Micera & Guglielmelli, 2009; Ortolan et al., 2010; Reyes, Clapés, Ramírez, Revilla & Escalera, 2013 & Ribeiro & Ramos, 2013;) deal with the topic of biomechanics, its application in rehabilitation, the forces used in therapies and dynamic and static analysis of postures in physiotherapy. Complementing the importance of improvements in the anthropometric analysis, it was found that biomechanics applied to rehabilitation also allows the development of systems, equipment and functional artificial supports, effectively contributing to improve the quality of life of the physically impaired patients. Biomechanical concepts are constantly used in several areas, for example in engineering rehabilitation and bioengineering, where he developed new techniques for the rehabilitation of patients with motor problems of neurological or musculoskeletal nature, as lesions of the spine, paraplegia, quadriplegia, and trauma injuries (Ortolan et al., 2010).

Other 15 articles cover the subject of musculoskeletal disorders from the point of view of the practice of physiotherapy in patients with disability, the repetitive strain injury in therapies and problems related to the work of the physiotherapist. As already it was mentioned above, the balance and the equilibrium in the postures play an important role. The relationship between them about orthopedic and rheumatologic disorders are complex. If we discard complicated diseases by neurological deterioration, many studies confirm the idea of a repercussion of these pathologies in the balance. This is particularly clear in disorders of the joints of the lower limbs, where the notion of stability is closely linked to the joint proprioception (Missauri, Portero, Bendaya, Haktie y Thoumie, 2008).

In addition to these studies, also six of the articles (Clark, Röijezon, & Treleaven, 2014; MacKay, Davis, Mahomed & Badley, 2009; Marques, Lacerda, Seabra, Silva & Ariel, 2010a; Marques, Lacerda, Seabra, Silva & Ariel, 2010b; Oliveira et al., 2013 & Silva, Scardocelli, Amate & Frère, 2010) talk about motor rehabilitation and have their focus in the design of systems and devices designed for rehabilitation, proprioception in musculoskeletal rehabilitation and, again, the relationship between balance and disability. Alemán, Perez & Sanchez (2003) present the vestibular rehabilitation as one of the most important therapeutic modalities in patients with physical instability. It is based on the physiological phenomenon of compensation balance and tries to mimic its processes, taking into consideration each one of the systems involved in the maintenance of the balance: vestibular, visual and proprioceptive. Deficiencies or misuse of each one of them can be corrected by performing exercises specially designed for a short period of time.

Three other articles deal with this approach of physiotherapy from the role of the physiotherapist in motor rehabilitation, ergonomic risks in therapies and the most common musculoskeletal problems that can arise in the physiotherapists. Adegoke, Akodu & Oyeyemi (2008) in his study in Nigeria, ensure that the practice of physiotherapy and his character increasingly more fragmented and specialized, creates musculoskeletal problems to persons professionally engaged in this, and that the question of injury within this profession is widespread since the form of physiotherapists' work is intimately linked to the musculoskeletal health. There are many factors that contribute to injuries and the implications are of concern; but the susceptibility of physiotherapists (particularly young people) to the musculoskeletal injury is greater since it is exposed to the risks of the profession and it also has consequences for the patient care (Glover, 2002).

Finally, 2 articles (Zätterström, Fridén, Lindstrand & Moritz, 1994 & Murray & Carroll, 2001) that deal with the topic of disability, encompass all of these concepts from a more general perspective: the main motor, sensory, and cognitive effects that presents the person with a disability, for example, the disability in lower extremities and its effects on important movements such as flexion of the legs and pelvis swing.

4. CONCLUSIONS

The literature reviewed presents important information from different perspectives of motor rehabilitation and the influence that is, physically, for physiotherapists to providing a therapy. According to these studies, physiotherapists are constantly exposed to the effects of the therapies that they performed, it means, the impact of repetitive movements, constant efforts and postures taken, for example in balance and equilibrium therapies, may mean some ergonomic risks and present potential musculoskeletal disorders. Also having direct contact with the use and operation of product design for rehabilitation may lead to the physiotherapist to suffer injury if they are not well adequate to the specific therapy or cannot be controlled effectively by himself.

However, for the purpose of the project that is being developed, it was not found enough literature that deals the issue of specific vestibular motor rehabilitation therapy or ergonomic risks which may cause in the physiotherapist to carry out with children with disabilities or with the use of a support system.

Not finding enough information, that is required for the design and development of products for the rehabilitation, assumes a deeper search and requires the development of new literature, by means of ergonomic studies, which provide reference material for future projects.

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FROM KNOWLEDGE TO ACTION; ANALYSIS OF THE LIGHTING AS PSYCHOSOCIAL FACTOR IN THE DESIGN OF THE WORK STATION

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Resumen: En este artículo se describen las actividades desarrolladas por el Capitulo Universitario (CAPUNI) de la Universidad Autónoma de Baja California campus Tijuana en lo relacionado con el proyecto de factores psicosociales con enfoque hacia las condiciones ambientales de un trabajador en operación. Es así como hacemos constar que el rendimiento del capital humano se ha medido, desde siempre, en cifras. Aunque ciertamente forma parte del engranaje empresarial, muchas veces se deja de lado la naturaleza de este tipo de capital. Se ve como un bien, no como seres humanos. La realización de esta práctica es con el fin de poder saber en promedio cuantos productos puede armar un operario en un intervalo de tiempo determinado en condiciones normales de iluminación, y siendo el armado del producto su única tarea, para poder comparar los resultados con prácticas futuras en las cuales las condiciones de iluminación cambiaran y también se agregaran otras tareas que se tendrán que realizar al mismo tiempo que se ensambla el producto, generando de esta manera un mayor estrés en el trabajador. Este artículo fue realizado principalmente porque esta temática está muy descuidada en nuestro país y más en el nivel educativo. La enseñanza de la ergonomía en México se enfrenta a un sinnúmero de problemas, de entre los cuales hay que destacar la falta de profesores de ergonomía. “La competencia en la nueva globalización de los mercados requiere mayor eficiencia y productividad en condiciones de salud laboral con el fin de alcanzar la calidad demandada para la subsistencia en los mercados mundiales. Estos propósitos son imposibles sin la participación de la ergonomía” (Norberto Enrique Camargo Cea, 2013)
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Palabras claves: Factor, psicosocial, ergonomía, iluminación.

Abstract: This article describes the activities carried out by the Capitulo Universitario (CAPUNI) of the Autonomous University of Baja California campus Tijuana in matters related to the Project of factors psicosociales with approach towards the environmental conditions of a worker in operation. Human capital performance has been measured, since always, in numbers. Although it certainly is part of the gear business, many times the nature of this type of capital is set aside. It looks like a good, not as human beings. The accomplishment of this practice is in order to be able to know in average all the products an operative can arm in an

interval of time determined in normal conditions of lighting, and being armed with the product his only task, to be able to compare the results with future practices in which the conditions of lighting were changing and also they were adding other tasks that will have to be realized at the same time as the product is assembled, generating hereby a major stress in the worker. This article was realized principally because this subject matter is very neglected in our country and more in the educational level. The education of the ergonomics in Mexico faces a sinnúmero of problems, of between which it is necessary to emphasize the teachers' lack of ergonomics. " The competition in the new globalization of the markets needs major efficiency and productivity in conditions of labor health in order to reach the quality demanded for the subsistence in the world markets. These intentions are impossible without the participation of the ergonomics " (Norberto Enrique Camargo Cea, 2013).

Keywords: Psychosocial factors, Lighting, Ergonomics, Operative.

Relevance to Ergonomics: That is why ergonomics education should be comprehensive, somehow that is a reflection of the complexity of the human being, which has multiple aspects addressed for study, but not disintegrates in parts. For this reason, the ergonomics should be considered as a methodological tool for the approach to the study of the user.

1. INTRODUCTION

The project of this article was developed at the Faculty of Chemical Sciences and Engineering in the 6G building at the 104 area. Where this ergonomic study focuses on the knowledge of prevention and detection of risks ,generally, rather than on whether the safety and health of workers in their work area as many companies are not made aware of the importance this entails in the industry. These systems should be a little more sensitized since there must be a mutual benefit, which allows both parts win, without neglecting the responsibilities incumbent on each. A very difficult goal to achieve is that workers could see physical and mental exhaustion as a game and these conditions lead you to not only accept responsibilities, but also, to find them in order to obtain better results. We believe that this article is a sample of the interest you could have for students to acquire the skills that the sector are requesting. The research carried out focuses on the effects that new forms of work have on health and in how lighting affects in workplaces, the importance of the lighting goes beyond; It is create, transform, directing and apply light correctly (Norberto Enrique Camargo Cea, 2013) . Lighting systems can significantly alter the perception of space and more that this is an essential element of our ability to understand the environment, since most of the information that we receive through the senses get it through the view (Enel, 2014), indeed is considered 50% of the sensory information that man receives is visual and this helps stimulate our state of mind: warm or cold, dynamic or relaxing, happy or severe environments.

2. OBJECTIVES

This paper focuses on psychosocial risk factors and work stress, because this issue is very neglected in our country and in education. The realization of this practice in order to be able to know on average how many products can build an operator in a given interval in time normal lighting conditions , and product assembly being their only task, to compare the results with future practices where the lighting conditions change and other tasks that have to be performed while the product, thereby generating greater stress on the worker is assembled shall also be attached .

3. PROBLEMATIC

It is easy to raise our problem because if we analyze, Inadequate lighting in the workplace can affect your job and your health? Where this question has an answer as verdarera. Workers refer disagreements with the lighting conditions in which they carry out the activity, lighting anywhere is critical, is a home, an office or other place, not only for the economic aspect when talking of a comfortable working environment, but because of its direct influence on the visual health of people. From this it arises regarding the need to determine the physical conditions of lighting in the jobs of the employees. Clearly, the issue of poor lighting considerably increases the likelihood that people make mistakes when they are at their workplace increasing the likelihood of accidents. In addition, poor lighting can cause the appearance of eyestrain, "with relevant damages that this represents for the health of people: eye problems such as dryness, itching or burning; headache, fatigue, irritability, moodiness, among other problems "(Chavarría, 2003). At present deficiencies in lighting in the workplace employees should make every effort to see, as long this situation can cause some visual disorders like myopia, tearing, decreased visual acuity, headaches, etc., inconvenience forced to go to a doctor, affecting the normal performance of employees (Bestratén and Nogareda, 2007). Therefore it is necessary to understand that when talking about the lighting in the company or workplace involves treating a problem for health and safety of workers who work there. The predominant symptoms in the population are associated with the lighting conditions in which they develop their work, information that is important to consider to implement programs and strategies to improve the working conditions of employees by the area of occupational health (Jhon Jairo Beltran Molina, Claudia Merchan Elizabeth Arevalo, 2013)

4. – METHODOLOGY

The working method consisted on the following steps in chronological order: (1) instruct from the place you are going Perform the operator (2) After the start of practical , inspect the operator with Focus on Efficiency and Quality (3) When the

Time of the End , collect the data (4) Ask the operator paragraph able to determine S. Psychosocial Risks Associated.

Figure 1.1 instruct from the place you are going Perform the operator.

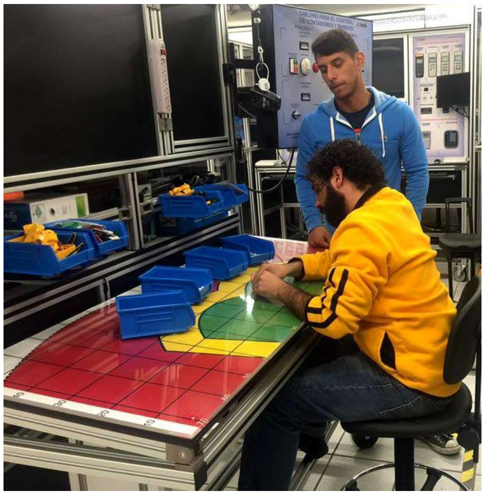

Figure 1.2 After the start of practice , inspect the operator with a focus on efficiency and quality.

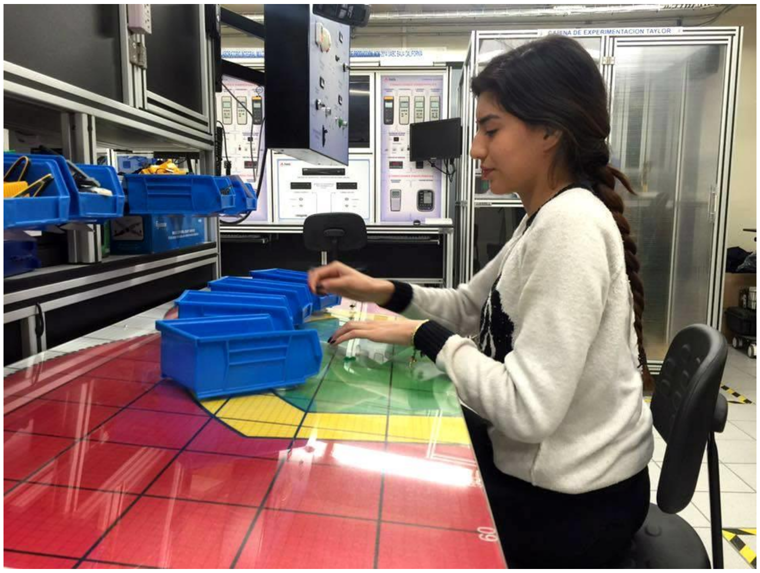

Figure 1.3 Monitoring work Enabling Physical Space hosting teams

Figure 1.4 When the Time of the End , collect the data.

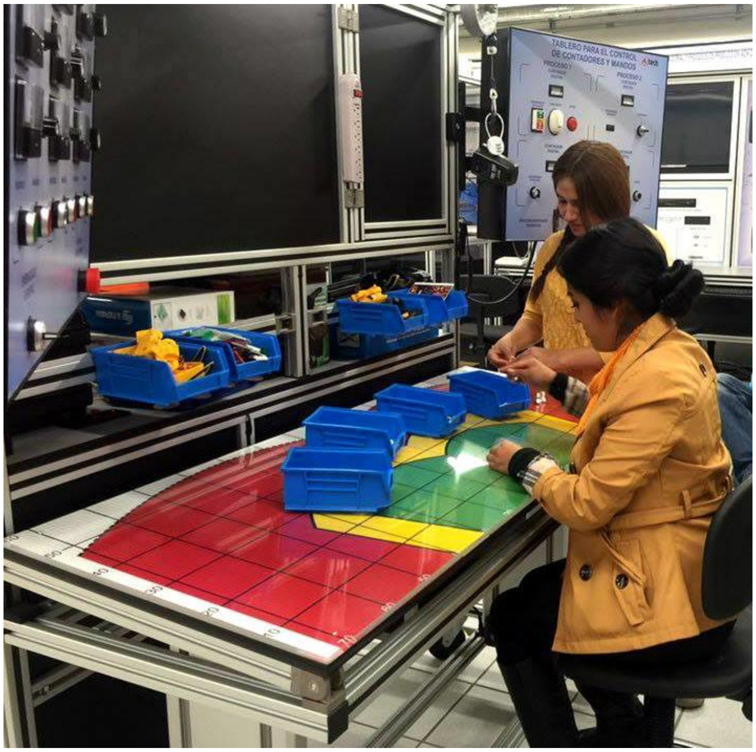

Figure 1.5 Ask the operator paragraph able to determine S. Psychosocial Risks Associated

5. RESULTS

It is as well as students of the Autonomous University of Baja California in Tijuana, Mexico carried out a study with students from the Industrial Engineering degree on psychosocial factors, where each one focused on a factor to treat using the station's design of the work which has a panel of lights in different shades and based on which causes greater fatigue was that applied to each of the participants , where it is simulated in real state that performs an operator, seeking in this way face the problems of the national reality and thus be in cooperation with the companies.

6. CONCLUSIONS

Today, the lighting is an art, it is understood as a way to create pleasant atmospheres and as a means to provide comfort. It is important to attend the new emerging risks of these fields, which is without doubt a real challenge for occupational health, should prevent properly illnesses or accidents that can be generated in and by the work. It wouldn't surprise that you unknown full ergonomics to study many other dimensions of the human being. As a result, the design process do not have more than technical data for the preparation of their proposals. Definitely, as mentioned, ergonomics is a discipline essentially theoretical but rather experimental, and which based their progress on the investigations; that means that use with simulators, just for example, represents one of their primary tools for its implementation.

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ERGONOMIC DESIGN OF SCHOOL FURNITURE
A LITERATURE REVIEW

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Resumen: En México el diseño de mobiliario escolar ha sido escasamente estudiado y actualizado a pesar de los cambios antropométricos y pedagógicos de la población y educación respectivamente. Es importante su actualización para prevenir síntomas muscoloesqueléticos en los alumnos y asegurar una buena interacción entre el alumno, el mobiliario escolar y las actividades que realiza en el salón de clases. Se concluye que en la mayoría de los artículos revisados sólo se toma en cuenta la interacción física del alumno con el mobiliario y no la actividad que realiza dentro del aula. Son muy pocos los artículos que se preocupan por el ambiente escolar y por lograr flexibilidad en el aula de clases en dicha interacción física y pedagógica. Por tales motivos, el objetivo de este estudio es hacer una revisión y análisis de las últimas investigaciones que se han realizado en relación al mobiliario escolar. A partir de este estudio se obtendrá una guía con los principales factores a considerar para el proceso de diseño del mobiliario escolar actual.

Keywords: Mobiliario escolar, Ajuste antropométrico, diseño ergonómico

Abstract: In Mexico the design of school furniture has been poorly studied and updated despite the anthropometric and pedagogical changes in population and education respectively. It is important update to prevent musculoskeletal symptoms in students and ensure good interaction between student, school furniture and the activities in the classroom. It is concluded that in most of the articles reviewed only takes into account the physical interaction of the student with the furniture and not the activity performed in the classroom. Very few articles are concerned with the school environment and to achieve flexibility in the classroom in such physical and educational interaction. For these reasons, the objective of this study is to review and analyze the latest research that has been made in relation to school furniture. From this study a guide will be obtained with the main factors to consider in the design process of the current school furniture.

Keywords: School furniture, anthropometric adjustments, ergonomic design.

Contribution to ergonomics: Help establish different methods and trends in the design of school furniture through a review of the literature.

1. INTRODUCTION

In recent decades in Mexico, since the program of CAPFCE (from spanish Comité Administrador del Programa Federal de Construcción de Escuelas) developed the infrastructure for high schools, it has not been paid enough attention to studying the issue of school furniture and therefore, its design has been poorly studied and updated despite the anthropometric and pedagogical changes undergone, in recent years, by the population and education respectively.

Taking into account the RE (form spanish Reforma Educativa), which came into force in 2013, with which it aims to improve the quality of education, states that one of its main objectives is to improve the facilities. Accordingly, was published on the website of the DOF (from spanish Diario Oficial de la Federación) the general guidelines for the operation, application of resources, monitoring, accountability and transparency of PED 2015 (from spanish Programa Escuelas Dignas 2015), which mentions that:

> Educational infrastructure requires updating and maintenance, as well as the incorporation of elements derived from the technological advances that facilitate and promote the pedagogical task, so it is not enough to have the necessary physical infrastructure, this must be updated and adapted for effect of dignifying the tasks of teachers and particularly the development of students in spaces that having the best conditions as mark the components of PED. (DOF, 2015, par. 1)

As mentioned in the previous paragraph, it is not enough that schools have the necessary infrastructure, is also needed updating. To carry this out it is necessary take into account the anthropometric factors, which include overweight and obesity of the Mexican population.

According to figures from the last CEMABE 2013 (from spanish Censo de Escuelas, Maestros y Alumnos de Educación Básica y Especial), there are 25 million of students from elementary school in México and, according to the latest ENSANUT 2012 (from spanish: Encuesta Nacional de Salud y Nutrición), schoolchildren (both sexes) from 5 to 11 years, showed a combined national prevalence of overweight and obesity of 34,4 %. Likewise, 35 % of adolescents between 12 and 19 years are overweight or obese, that is, one of every five adolescents are overweight and one out of ten obesity.

Another important anthropometric factor is the growth of the students, because, when it comes from a population with constant changes, there is a wide variation in dimensions within the same age range. Quintana et al. (2004) state that:

Indeed, from 3 to 13 years old, a child grows at a rate of about 6 cm/year on average (Garcia and Page, 1992). Within this growth must take into account that children begin to grow by the lower limbs, and is at the beginning of puberty where an increase in the length of the trunk occurs. (Viel and Michele, 2001).

Also found that the musculoskeletal factors play an important role in furniture design. It was emphasized that students spend most of their day at school in a sitting posture, " posture in which a considerable part of the body weight is transferred to a work surface between 60% and 80% of the school day" (Canté, Kent, Vasquez & Lara, 2010). Several studies have shown that exposure to long hours of physical inactivity in poor posture leads to children and adolescents to musculoskeletal problems (Balagué, Troussier and Salmine, 1999; Murphy, Buckle and Stubbset, 2004).

As for pedagogy, it is important to take into account the activities performed in the classroom because to have furniture designed both to support the educational objectives and to meet the people who will use it, it must provide efficiency, comfort, safety and satisfaction to their activities the main users (students) and secondary users (teachers) to support their teaching methods because "the furniture plays an important role in allowing a learning environment to be flexible" (HEFCE 2006).

It is because of the lack of consideration of all these factors that the present work aims to make a review and analysis of the literature about the latest studies carried out on this subject, and with this, make a guide with the most important features that should be considered when designing the furniture, and help update the information used by specialists in charge of design.

2. OBJECTIVES

The aim of this paper is to review and analyze the latest research that has been done in relation to the school furniture in the last 20 years. From this, and the incorporation of concepts and ergonomic principles, a guide of the main factors to take into account for the design process of modern furniture will be obtained.

3. METHODOLOGY

3.1. Selection and classification

Two kinds of literature were selected: texts with anthropometric approach and pedagogical approach. For their study, the work has been divided according to the purposes for which they were made, these are: obtaining measurements for furniture, comparison of furniture with student's anthropometry, musculoskeletal, experimental musculoskeletal and learning ergonomics.

From this scheme is it analyzes and compares the methodology and the results obtained in each of the articles to detect similar results between them and the new discoveries that brings each. By getting the results of each work, these are classified according to the subject of the contributions. With all this, a matrix containing the most important factors to take into account for the design was performed.

For better representation, articles were numbered according to their classification containing the original article title and year of publication (*Table 1*). This preliminary list will serve for the second table which are organized according to the contributions of each item (*Table 2*).

The result was an array where the results of each item are classified according to four main themes identified: recommendations for the furniture design, mismatch in furniture, pros of adjustable furniture and positive effects in the interaction of the students.

3. RESULTS

Studies related to the anthropometric topic, specifically for a student population of 6 to 18 years, is that a high percentage of students are using unsuitable furniture for their anthropometric characteristics causing them physical discomfort (*Table 2*).

In articles with pedagogical approach, it was found that having a more dynamic and flexible environment, motivation of students grew. This was reflected in increased participation in class, student-teacher interaction and interactions between students.

Table 1. List of articles.

No.	Publication name	Publication year
1	Ergonomic Designfor Senior High School Furniture in Taiwan	2000
2	Revision of the design of a standard for the dimensions of school furniture	2003
3	Definition of sizes for the design of school furniture for Bogotá schools based on anthropometric criteria	2007
4	Ananalysis of biomechanical and anthropometric parameters on classroom furniture design.	2008
5	Analysis of the most relevant anthropometric dimensions for school furniture selection based on a study with students from one Chilean región.	2012
6	Classroom furniture dimensions and anthropometric measures in primary school.	2003
7	Classroom furniture and antropometric caracteristics of Iranian highschool students: Proposed dimensions based on anthropometric data.	2011

8	Applying different equations to evaluate the level of mismatch between students and school furniture.	2014
9	Ergonomic design of classroom furniture for university students of Bangladesh.	2014
10	Match Between Classroom Dimensions and Student's Anthropometry: Re-Equipment According to European Educational Furniture Standard.	2014
11	Anthropometric Evaluation of the Design of the Classroom Desk for the Fourth and Fifth Grades of Benghazi Primary Schools	2015
12	The effects of ergonomically designed school furniture on pupils attitudes, symptoms and behaviour.	1994
13	The effect of Seated Positioning Quality on Typical 6- and 7-Year-Old Children's Object Manipulation Skills.	2004
14	Comparing the effects of two school workstations on spine positions and mobility, and opinions on the workstations – A 2-year controlled intervention.	2009
15	Ergonomically adjustable school furniture for male students.	2013
16	Mismatch of Classroom Furniture and Student Body Dimensions. Empirical Findings and Health Implications.	1999
17	Classroom posture and self-reported back and neck pain in school children.	2004
18	Examination of pre-school educational environments in respect of some variables.	2009
19	Use of swivel desks and aisle space to promote interaction in mid-sized college classrooms.	2011
20	Promoting active learning in technology-Infused TILE classrooms at the university of Iowa.	2012
21	The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis.	2015

Of the 21 revised texts can be explained by the following results:

81% of the reviewed articles focus only on anthropometric issues. Only 19% of them focuses on educational issues. Became apparent that the most recent studies (5 years old) conducted in developed countries, beyond the analysis of physical issues, these also incorporate pedagogical factors of development of education in the classroom, preventing the fact that the school furniture is support for dynamic developed within the classroom.

5. CONCLUSIONS

In performing this review article, it is clear that the problems studied, are of anthropometric and postural type. There have been many works with different methods to address these issues where the main concern of ergonomists is looking for the perfect fit between furniture and students.

Only takes into account the physical interaction of the student with the furniture and not taken into account the activity performed in the classroom. Of the articles reviewed are few who care about the school environment, to achieve flexibility in the classroom to encourage interaction between students and teachers. According to the design guide for effective learning spaces "A learning space should be able to motivate learners and promote learning as an activity, support collaborative as well as formal practice, provide a personalized and inclusive environment, and be flexible in the face of changing needs". (HEFCE, 2006).

It is important that the design specialists have the appropriate information tools to ensure that the furniture meets the needs of users, since they are the creators of the final product with which the user comes into contact.

Below, is the guide of factors for the design of school furniture formed of the contributions of all items.

As for the design of school furniture:

1. Is recommended that the school furniture have various sizes, this to cover different grade levels and variability in anthropometry of students.
2. In addition to different sizes of furniture, it is also suggested to be adjustable, this is to be sure to cover the different ranges of variability and achieve a better fit between the furniture and students.
3. Should pay particular attention in both the chair and desk height, since it was the mismatch with more presence in articles

As for the selection of the furniture:

1. One of the most important actions to achieve a good fit between the furniture and the students is the selection. It did not matter much the design phase if in the end it is not distributed properly. We recommend taking the following considerations:
    - The selection of furniture for each student must be based on the popliteal height, which, according to the literature, is the most important measure to achieve a good fit.
    - It is not advisable to base the selection of the furniture according to the ages. It has been observed that there is much variability among the same age range.

Table 2. Classification of articles according to the main themes

		Contribution of articles by topic of study											
		Furniture design			Mismatches in furniture			Reactions furniture - student interaction				environment - student interaction	
Articles clasification	**Article number**	Consider more than one size for furniture	Adjustable furniture	Elección de mobiliario basada en altura poplítea	Incorrect height of the	Incorrect height of the desktop	Choice of furniture based on height popliteal	Acceptance by users	Improvement in performing tasks	Musculoskeletal complaints decreased	Feeling of comfort	Influence of furniture	Influence of the organization of the furniture in the classroom
Obtaining measurements for furniture	**1**	X	X										
	2			X									
	3	X		X			X						
	4				X								
	5			X									
Comparison of furniture with students anthropometry	**6**				X								
	7				X	X							
	8				X								
	9				X								
	10						X						
	11				X								
Musculoskeletal	**12**							X			X		
	13								X				
	14							X		X	X		
	15												
Experimental musculoskeletal	**16**		X		X	X							
	17					X							
Learning ergonomics	**18**												X
	19											X	X
	20											X	X
	21												X

As for furniture-student interaction:

1. Furniture with ergonomic design can be well received in the classroom, students who used it sat more comfortably, correctly and had less physical discomfort.
2. Children who were placed in ergonomically designed furniture performed tasks significantly better than children who were tested in the standard furniture.

3. Subjective opinions showed that students were more comfortable using the new sets of furniture.

As for the location of furniture in the classroom:

1. In general, teachers and students reported that the arrangement of the furniture in the classroom offers more opportunities to interact with other students and contributes with his willingness to ask questions or participate in class discussions.
2. By improving the movement of the master through the classroom, had positive effects on student participation.

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HEALTY AND PROPERLY WAY TO DEFECATE, ERGONOMIC STUDY FOR A FOOT-TOOL

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Resumen: En el área occidental se va al baño de una forma que puede decirse incorrecta o anti-natural, esto porque al momento de sentarse en una posición de noventa grados a evacuar la materia fecal, el recto queda doblado en cierta forma, lo cual hace que la persona ejerza una mayor fuerza para lograr evacuar, lo que ocasiona que se dejen residuos en el intestino.Es por eso que en el presente estudio, se centra en proponer una herramienta especial para que las personas de diferentes alturas puedan defecar en una correcta posición aproximándose a treinta y cinco grados, lo que trae consigo el poder evacuar toda la materia fecal así como evitar diferentes enfermedades como cáncer de colon. Hemorroides, estreñimiento, entre otros.

Palabras claves: Ergonomía, posición en cuclillas, herramienta de pie.

Abstract: The western area goes to the bathroom in a wrong or unnatural way. This because when a person sit in a ninety degrees position to evacuate, the rectum is bent in a way that makes the person need for a greater force for evacuation, which causes waste left in the intestine. That’s why this study focuses on proposing a special tool for people of different heights to defecate in a correct position approaching thirty-five degrees, which brings the benefit of evacuating all fecal matter and avoid various diseases such as colon cancer, hemorrhoids, constipation, among others.

Key words: Ergonomics, Squat, Foot tool.

Relevance to Ergonomics: gives a great contribution in order to prevent risks related using furniture and appropriate tools to prevent gastrointestinal problems.

1. INTRODUCTION.

Hand tools are devices that assist the work, and characterized by amplifying or reducing some of the functions owned by the hand, increasing the functionality thereof; either by increasing the strength, accuracy, surface, generating more torsional power, impact and increased resistance to temperature and so on.

In this study a hand tool is developed, which it's main goal is helping the human to defecate properly; making an emphasis in the American continent because Asians already have the culture of defecating to 35 °.

1.1 JUSTIFICATION

The purpose of this study is of vital importance for humans, since bowel movement is a daily necessity that must done. The result of various studies is that it's not being done in the right way, and causes serious health problems inadvertently. That's why it is convenient to carry out and make the people know about this investigation.

Because with the use of this prototype when defecating, a variety of health benefits are obtained, preventing a simple stomachache, to a serious illness such as colon cancer. This study would be a great importance for society, because it is a tool that all people of all ages could use. The results would be reflected with satisfaction since the begging and over time.

1.2. GENERAL PURPOSE.

Develop a prototype to help the human to defecate in a correct, comfortable and natural position being.

1.2.1. SPECIFIC OBJECTIVES

- Facilitate the evacuation of stool so it will Avoid diseases by wrong postures while defecating such as colon cancer, constipation, hemorrhoids, appendicitis, etc.
- Reduce obesity.

1.3. DELIMITATION.

This study is aimed to all people in general, regardless of age and sex.

1.4. THEORETICAL FRAME

Squatting is the best excretion position.

When sitting on the toilet, the lower end of the descending colon is doubled, **which requires considerable muscular effort to move the bowels**. The intensity of this effort can pop or obstruct the tiny capillaries that feed the anal sphincter, resulting in subsequent bleeding. When crouching, **the colon is naturally aligned with the rectum and anus** that opens completely and effortlessly. This way the evacuation occurs naturally, unstressed. Daniel Reid (2014).

Are you going properly to the bathroom? Meet the sitting posture.

The Stanford University revealed in a study that the best position to go to the bathroom is squatting. This position relaxes muscles and creates the perfect angle to facilitate the evacuation. According to Dr. Henry L. Bockus in his Gastroenterology book explains: "Squatting position is ideal to defecate, with bent muscle on the abdomen. Thus decreases the ability of the abdominal cavity and increases intra-abdominal pressure, which favors the expulsion ".

In this regard, the French doctor Frederic Saldmann, in his book The best medicine is you explains: "Think of a garden hose filled with water half bent: it’s hard for the water to run. It is exactly what happens when sitting. When the person crouches down, the angle opens, the crease disappears and the water can be drained easily. "

1.5 METHODOLOGY.

1.5.1 Work Design

The few existing tools, use a fixed and stable design, on which they handle the same height, which favors only part of the population as are people with an average anthropometry. Below is a tool that served as a reference for the development of what we call “Art Studio”. The ergonomic tool to defecate Squatty Potty is an example of an alternative of a fixed design (Figure 1).

Figure 1 Squatty Potty.

1.5.2 Prototype Formulation or tool

To begin with the design of the prototype various factors were taken into account such as the Mexican anthropometry and height of children, youth and adults. So we opted for the design of a dynamic tool that varies in height, which would provide greater user comfort and fit the needs of it , as it can be adjusted to the desired size by a piston which is in the inside of the prototype .

2. RESULTS

With the design of this prototype and tool has achieved progress and innovation in the way the stool is evacuated, benefiting users, reducing illness and difficulties when going to the bathroom, (figure 2,3,4 ,5).

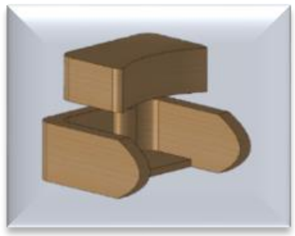

Figure 2 and 3.

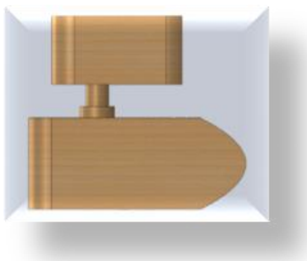

Figure 4. Frontal view.

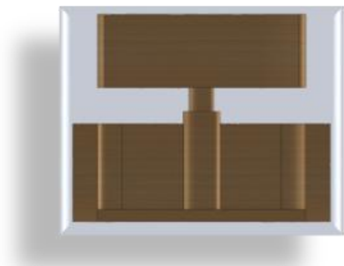

Figure 5. lateral view.

3. CONCLUSIONS

Hand tools represent a small investment making huge ergonomic benefits in a quickly and concisely way, defecating is a necessity of daily life of people, which is important to be done in a proper manner, to the body dispose necessary and function properly, which is why we must make people aware of how to defecate naturally to counteract diseases and health problems.

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EVALUATION TOOL FOR ACTIVITY AND USABILITY OF ECOLOGICAL STOVES

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Resumen: La quema de combustibles sólidos como: la leña, los residuos agrícolas y forestales, entre otros, a partir de fogones tradicionales o abiertos, en hogares rurales, se considera una de las fuentes de mayor contaminación intramuros a nivel mundial. La combustión de biomasa tiene como fin cubrir necesidades básicas familiares —cocinar, hervir agua y proveer calor—, sin embargo, la ejecución de estas actividades produce impactos negativos a la salud debido al monóxido, bióxido y partículas pequeñas que se generan. Así como afecta la economía familiar como consecuencia del gasto para la compra de leña. Además contribuye a la deforestación. Para solucionar estos problemas, se han instaurado programas de instalación de estufas con chimenea, denominadas "ecológicas" o "mejoradas". Sin embargo, el impacto ha sido limitado debido a la resistencia al cambio por parte de los usuarios. Esto ha sido, consecuencia de la poca consideración de las necesidades de contexto y de uso, que no han podido ser reflejadas en las características técnico-funcionales de una estufa ecológica. Por lo tanto, el objetivo del estudio es proponer un prototipo de evaluación de usabilidad y de actividad del usuario de estufas ecológicas en San Luis Potosí, de modo que esto contribuya a una mejora en el diseño para promover su adopción. Para ello, se propone una herramienta con interface intuitiva, con el fin de poder ser aplicada por distintos sectores e implementadores de estufas ecológicas. Los aspectos que evaluará serán los relacionados a: 1. La estufa ecológica: aspectos técnico-funcionales, 2. Actividad de calentado y 3. Funcionamiento de la estufa. A partir de esto se realizó una prueba piloto de esta herramienta con cuatro modelos de estufas ecológicas, que representan las diferentes tipologías existentes actualmente. Esto permitió la priorización de categorías y la determinación y puntuación de las variables de análisis de dichas categorías. La siguiente etapa consistirá en la comprobación de la validez y confiabilidad del método. Las características técnicas de los modelos de estufas actuales, han presentado poco o nulo cumplimiento de los requisitos: de uso, del contexto y de la cultura de las usuarias. Por lo tanto, el realizar un análisis de las actividades de las usuarias durante las acciones de calentado, de las características técnicas de la estufa ecológica y del contexto, permitirá dar un mayor entendimiento de los elementos aptos para mejorarse o para la selección del modelo más adecuado para cada situación.

Palabras clave: Usabilidad; estufas ecológicas, evaluación

Abstract: The use of solid biofuels like: firewood, forest and farm residues, among others, in open fires in rural homes, it's the main source of house pollution worldwide. The biomass combustion for basic needs –cook, boil water and heat source- has negative impacts in health, because of monoxide and small particles generated. Also, affects familiar economy due spend of purchasing firewood. And finally contributes deforestation. As a solution for these problems, government and non-government institutions have settled chimney-stoves installation programs, known as "ecological stoves" or "improved stoves". Nevertheless, the impact of this technology has been limited due to the resistance to change by the owners of the ecological stoves. The main consequence is the poor consideration of the use and context necessities, which have never been reflected in the technic and functional characteristics of the ecological stoves. The objective of this project, is to propose a prototype tool to evaluate the use and user activity of improved stoves in San Luis Potosí; this will contribute to enhance the design of the ecological stoves and their adoption. The instrument will have an intuitive interface, aimed to be applied by every implementer of improved stoves. The valuation aspects will be related with: 1. Technical and functional requirements, 2. Heating activities and 3. Stove operation: Starting from this, a pilot test was done with four stove models that represented the different typologies at present. This allowed prioritizing categories and to define and score the variables of each group. The next phase will consist in the tool validity and reliability. The technical characteristics of the actual ecological stoves, have represented few or null accomplishment of the consumer necessities of: use, context and cultural aspects, that's why the estimation of the user´s activities during the heating work and the technical and functional characteristics of the ecological stoves, will permit a better understanding of the elements needed to be improved or the selection of a more adequate model for every condition.

Keywords: Usability; Ecological stoves, Evaluation

Relevance to Ergonomics: The ergonomics main domain is to understand the relationship between user and constructed environment. Also, it attempts to optimize the way objects fulfill the users needs. The extent that an object makes the task in an effective, efficient and satisfactory way is called usability. To gather the usability indicators, there are a variety of methods with several approaches. Nonetheless, there is no tools that enables the evaluation between the relationship among users and improved stoves; therefore, proposing an evaluation method to this particular object, will allow making the task analysis easier and more descriptive and standard. These aspects bring ergonomics to new sectors that influence the improved stoves design, and finally will benefit users.

1. INTRODUCTION

The use of solid biofuels, such has firewood, agricultural and forestry residues, among other, in traditional open fires in homes is considering one of the major sources of indoor pollution worldwide. Biomass combustion has the propose fulfill basic needs for the daily life of families –cooking, boiling water, provide heat-nonetheless, this use have negatives impacts in the users health, due monoxide, carbon dioxide and small particles generated (Smith, 1993; Pandey et al, 1989 in Westhoff and Germann, 1995). Besides, the use of open fires affects the family economy, because the resources expend in the firewood purchase. Also, has been found that contributes to deforestation (Westhoff and Germann, 1995).

For 2006, the World Health Organization reported near 33 thousands millions people that use open fires. In Mexico, it was estimated that 22.5 million peoples were open fire users in 2010; this represented the 20% of the population, and was found that the 16.8% of the population were exclusive user of biofuels (Masera et al., 2007; Díaz et al., 2011) this mean that this people use exclusive biomass as fuel for cooking and heating activities.

San Luis Potosí is one of the states that have more locations with residential use of firewood (Díaz, et al., 2011). It has 144,018 housings; it means 22.6% of all inhabited housing (SEDESORE SLP, 2012). To decrease the negative effects, it has been realized improved stoves-or ecological stoves- implementation programs worldwide.

The program's success is defined by the number of ecological stoves put into service and the percentage of open fires that use biofuels, taken away from the housing (Riojas et al., 2014). In México, specifically San Luis Potosí, these programs had a limited impact, due to the change resistance by the users. This as consequence of the programs approach: stoves design, at only technical aspects, without considering the user necessities (Rentería Guzmán, 2011). However, to do a correct study of the users' necessities it is essential to utilize a method to evaluate them, to bring that, this study starts from the methods of ergonomics to propose a tool that permits to evaluate the usability on ecological stoves with the purpose to improve its design and adoption.

2. OBJECTIVE

To propose a usability and activity evaluation tool for ecological stove user in San Luis Potosí State.

3. METODOLOGY

3.1 Delimitation

The study is limited in the Zona Huasteca in the state of San Luis Potosí where are the biggest concentration of open fire users and therefore a wide range of ecological stoves implemented. This tool is addressed to be used by every actor or sector involved in implementing stoves, that is why it must have an intuitive interface.

The tool aims to analyze the use and activity of improved stove users. These activities get prioritized in accordance the degree in which the improved stove replaces the open fire, this degree will be the frequency of the activity execution.

3.1 Strategy

The Project is divided into 3 phases:

1) In the first place, a literature reviews about the conception of: ergonomics and usability was made. Then a revision of bibliography about activity studies related with improved stoves and principal problems allied with technical and functional characteristics of the ecological stoves. This allowed identifying: all activity moments of heating at rural houses, the more important functional problems during the use of the stoves and the technical problems related to maintenance and durability.

2) Once identified: activity moments and functional and technical necessities, the first pilot test was made at GIRA, A.C. facilities in January of 2016. For this test a cognitive walkthrough was made, where the scenario consists of a woman between 25 to 55 years, user of open fire and living in a rural zone, making heating activities for the daily life. For this test 4 different models of improved stoves were chosen. This permitted to adapt and change the tool. Also, this was the first test of the tool interface.

3) Finally, the evaluation phase. Consists of test the tool by different actors and organizations in different contexts, with the purpose of objectify the variables and to standardize the instrument.

4. RESULTS

The first approach of the tool resulted in categories related with: necessities during heat activities and ignite activity, as well as frequency and lapse of time for cleaning and maintenance. The classifications are not settled; they can be changed depending on context needs. Every category is analyzed separately, with the components of security and efficiency. The security is related with improved stove elements and characteristics which interact with the user, as: heating emission from de stove body, the heating surface (dimensions, deformities, warming irradiation and workspace height) and the steadiness of the stove; as well with external objects used on each activity: cookware.

Efficiency is aimed to stove functionality. It is determined from the space heating needed to do the heating activities. Cleaning is linked with the activities that are done every day to assure a good performance, those are: cleaning stove plates, clear the wood ashes and wash the stove body. Maintenance is related with the elements, which need to be disassembled sometimes. Durability of the components will be defined with great score for the elements with higher useful time and with facility to get its replacement parts.

In table 1-the first aproach- are 12 different heating activities, this activities are the most common for users in a Mexican rural context, each activity was proposed to be evaluated in technical – functional qualities, such efficiency –stove capability to heat to desired temperature and space enough to perform the activity-, security – stove temperature in the user's body near areas and heat issued of the body stove-, modification - quality to maintain the original design without user intervention- and maintenance – activities having to perform before the activity-. Also, a bottom line can be fill with special equipment to perform the activity, such as pans, pots, o anything that the examiner consider.

Table 1. First approach of the evaluation tool prototype for heating activities.

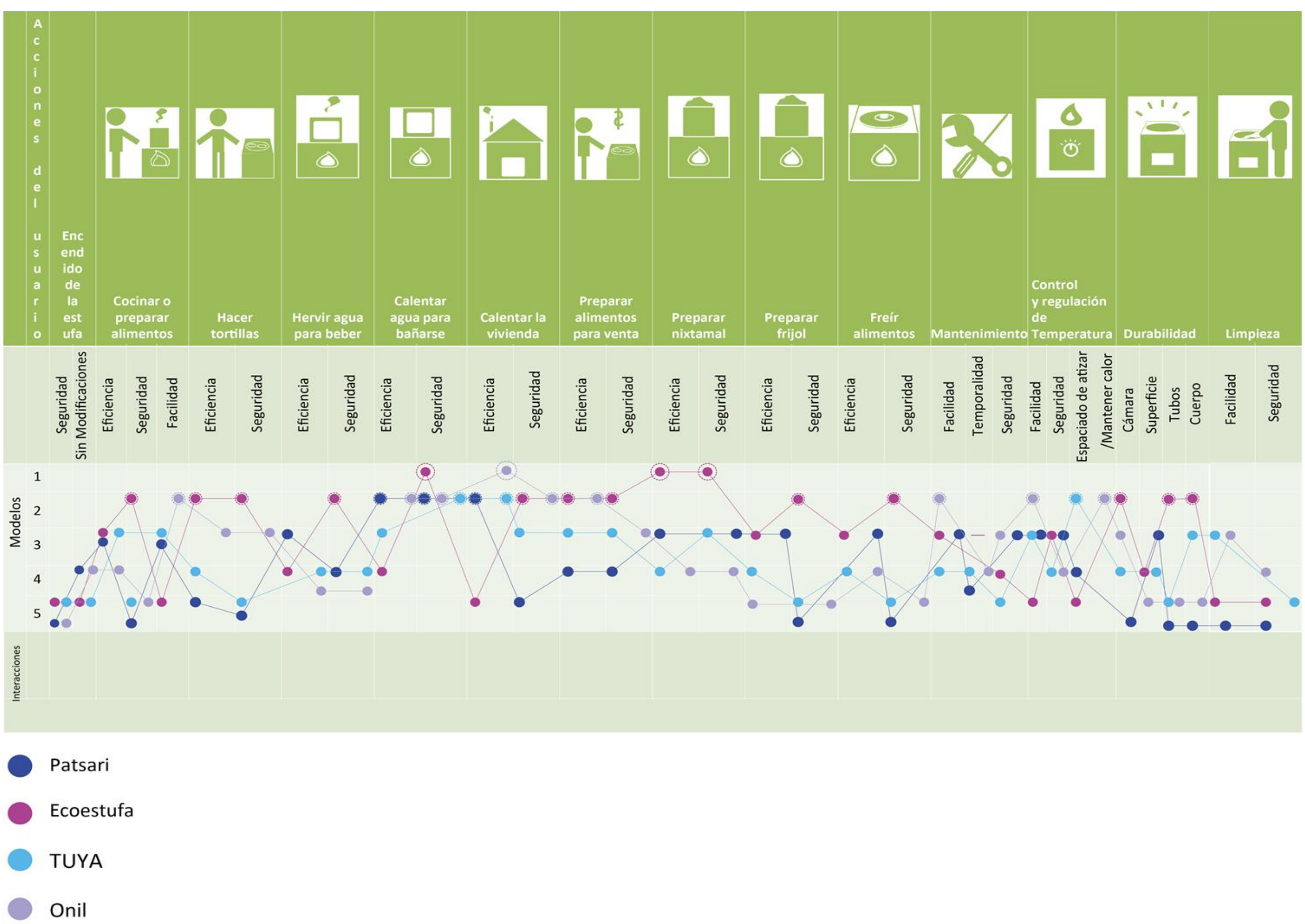
	Acciones del usuario	Encendido de la estufa		Cocinar o preparar alimentos				Hacer tortillas				Hervir agua para beber				Calentar agua para bañarse				Calentar la vivienda				Preparar alimentos para venta				Preparar nixtamal				Preparar frijol				Freír alimentos				Secar carne				Mantener limpios los techos de animales				Secar leña			
		Seguridad	Modificaciones	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento	Eficiencia	Seguridad	Modificaciones	Mantenimiento
Modelos																																																			
Interacciones																																																			

The pilot was made with four improved stoves models, representing different types currently existing. Such evaluation took place with technical builders, manufacturers and researchers. This first approaching allowed the prioritization of categories such as: turning on, cleaning, maintenance and general durability; these elements are a category for their own, rather than be a criterion for heating activities. Besides, the analysis variables were determined for each category. For a simplified tool, was chosen limit the criterions to efficiency and security.

The test results for the four improved stoves models showed a clearly difference in the activities performance and usability. For instance, the in situ constructed model the durability was found to be the highest score, while the premade models oscillated between low and high scores; even they vary in the scores of the components of the model.

After the first approach, a few adjust where made. The table 2 shown the reduction of the 12 heating categories to 9, but increase in the general performance activities to 5, for a total of 14 general categories. The items to evaluate each heating category now are efficiency an security.

Table 2. Second approach of evaluation tool applied to four improved stove models.



5. DISCUSSION

To develop the tool it was necessary to make it intuitive, so that it could be use by every person involved in improved stoves implementation, who did not need a previous experience applying the instrument. At first the tool was made like as a cognitive walkthrough, but it is going to be propose as a check-in list, to make easier and faster the valuation by any implementer or somebody who use it .

The tool was proposed to evaluate the technical and functional aspects, because these are susceptible to be redesigned. For: light up, cleaning and maintenance activities, the variables are frequency and time needed to execute each one. These can't be skipped because they are essential for good functioning of the ecological stove. All categories are proposed to be changeable according to requirements of the context.

The next step will be the evaluation phase, where the different sectors involve in the implementation programs –researchers, manufacturers, technicians, designers- use and validate the tool. The ideal scenario will be the translation of a cognitive walkthrough into a check list, to make the task analysis easier and to bring ergonomics to new sectors that influence the improved stoves design, and finally will benefit users.

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ERGONOMIC AND PRODUCTIVE IMPROVEMENT IN LATHES AND MILLING MACHINES

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Resumen: Se analizó un Taller de máquinas herramientas, para obtener mejoras ergonómicas y productivas, que se pueden aplicar a empresas metalmecánicas
Los diagnósticos permitieron identificar áreas de oportunidad a través de verificación de riesgos ergonómicos aplicando Sue Rogers y RULA en estaciones de máquinas.

Se determinaron los parámetros de diseño óptimo, a través de mediciones antropométricas, así como iluminación y ruido conforme a normas mexicanas.

Se obtuvieron mejores posturas ergonómicas y disminuyeron perdidas productivas, aplicando además herramientas Lean y Sistema MOST.

Se diseñó estación ergonómica intermedia, para suministro de herramientas, conforme a condiciones de trabajo y percentiles obtenidos.

Palabras clave: Matriz de Riesgo, RULA, Sue Rodgers, MOST, Herramientas Lean

Abstract: We analyzed a workshop of machine tools, to obtain productive, and ergonomic enhancements that you can apply to metalworking companies.

Diagnostics helped identify areas of opportunity through verification of ergonomic risks applying Sue Rogers and RULA in stations of machines.

Parameters optimum design through anthropometric measurements, as well as lighting and noise according to Mexican regulations were determined

Best ergonomic positions were obtained and decreased lost production, applying Lean and MOST system tools.

Designed ergonomic intermediate station, for the supply of tools, according to working conditions and obtained percentiles

Keywords: risk matrix, RULA, Sue Rodgers, MOST, Lean Tools

Contribution to Ergonomics: To design a workstation, we can simulate the results using the MOST system because we can validate times to evaluate changes in a workstation. Should be used together, appropriate ergonomic analysis tools, risk matrix in combination with Lean tools for decision making

1. INTRODUCTION

Workshop of machine tools of Autonomous University of Baja California was analyzed, for ergonomic and productivity improvements, which can be applied to metalworking companies, was analyzed for providing tools.

The diagnosis helped identify areas of opportunity through verification of ergonomic risks by applying Sue Rogers and RULA stations machines.

Parameters of optimal design were determined through anthropometric measurements as well as lighting and sound according to Mexican standards.

Better ergonomic positions were obtained and decreased production losses also applying lean tools and MOST system.

Intermediate ergonomic station is designed to supply tools , according to working conditions and percentiles obtained.

The ergonomic improvements of this work is valued

2. OBJECTIVE

Evaluate and Design intermediate stations work, lathes and milling machines, through verification of ergonomic hazards and manufacturing systems in a machine shop tools, with national and international recommendations

3. METHODOLOGY

The ergonomic study focuses on the machining process. risk matrix, analysis of ergonomic risks , anthropometry, lighting measurements in operating conditions and noise measurement and the application of Sue Rogers, RULA , MOST System Tools and Lean method was applied.

3.1 Risk matrix, surveys and interviews

Table 1. Risk Matrix Machine Tool Laboratory

Actividad (Estaciones)	Tipo y clase de peligro	Origen del peligro	Riesgo	Cargos expuestos	Numero de expuestos	Horas de exposición	Probabilidad	Consecuencia	Requisito legal	Grado de importancia	Prioridad
Fresado Torneado Esmeril (F1, F2 y F3) (T1 hasta T9) (E1, E2 y E3)	Ergonómico diseño de puesto	Altura del puesto de trabajo, ubicación de los controles, equipos,.	Alteraciones de la salud (lesiones óseo musculares, fatiga, alteraciones vasculares, accidentes de trabajo)	Fabricante de pieza laboratorio	9	2	500	200	10	710	Significativo
	Físico Ruido	Motores, Ruido de desbaste de metales	Se tienen tapones para los oídos, sin embargo, el peligro se presentaría en caso de no utilizarlos. Alteraciones de la salud (efecto audición baja, trauma acústico, alteraciones del sueño y descanso, estrés, etc.)	Fabricante de pieza laboratorio	3	2	200	500	10	710	Significativo

The risk matrix of Table 1 is a reference tool workspace to determine any change in user comfort. (Garcia , 2008)

Table 2. Results of survey.

Descripción de Evaluación	Resultado	Observación
1. Iluminación	Muy buena	Mejorar en nocturna
2. Ruido	Aceptable	
3. Temperatura	Regular	
4.Ventilacion	Buena	
5. Condición física interviene en trabajo	10%	Calor y humedad
6.Condicion de Equipo y Herramienta	Aceptable	Caja de herramientas
7. Altura de mesa	Bueno	
8. Distancia de componentes a ensamblar	Bueno	
9. Consideran regular puesto de trabajo	90%	
10.Molestias atribuibles a condiciones de trabajo	0%	Solo 16 días

The results are shown in Table 2 , are a survey of students from 19 to 23 years in 10 different groups , 3% on average have 2 hours of overtime at the end of the semester for errors in pieces.

3.2. Lighting and Noise measurements

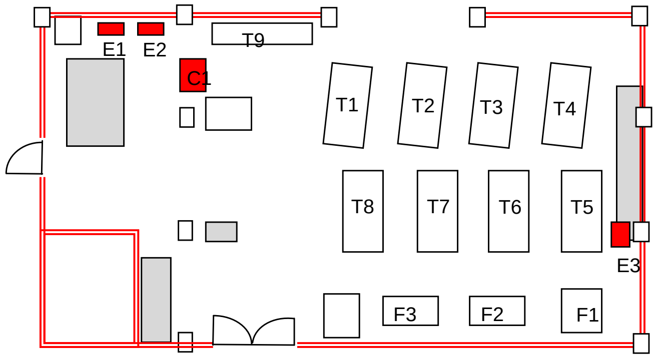

Figure 1. Workshop Distribution

Figure 2. Lux meter y Sound meter

Table 3 shows measurements at noon, with light meter on each of the workstations.

Tabla 3. Lighting measurements

Maquina Medida	Nivel de Iluminación de trabajo en el equipo								
	1	2	3	4	5	6	7	8	9
Torno	480	474	372	370	366	370	470	480	510
Fresa	300	320	340						
Esmeril	512	520	311						
Requiere	300	300	300	300	300	300	300	300	300

Lighting levels shown in Table 4 are set by the American Society of Engineering Lighting (IESNA) in 1995.

Table 4. Levels of indoor lighting

Intervalo de iluminación (fc)	Tipo de actividad	Iluminación de Área de referencia
Categoria D 20-30–50	Realización de tareas visuales de alto contraste o gran tamaño, como lectura de, inspección normal, ensamble grueso.	Sobre la tarea
Categoria G 200-300-500	Realización de tareas visuales de bajo contraste y tamaño muy pequeño durante un periodo prolongado, como ensamble fino, inspección muy difícil, trabajo manual o con máquinas muy fino y ensamble extrafino.	sobre la tarea mediante una combinación de luz y suplementaria local.

As shown in Table 5 noise levels pose no risk to work in any of the stations of the machining center as they are below the provisions of the Occupational Safety and Health Administration (Niebel , 2009)

Table 5. Noise levels measurements

Maquina Medida	Nivel de Ruido de trabajo en el equipo								
	1	2	3	4	5	6	7	8	9

Torno	70	69	76.6	77	78	73.9	75	73	76
Fresa	76	77	75						
Esmeril	80	76	77						
Protegido									

3.3 Anthropometric Measurement and analysis Ergonomic Sue Rodgers / RULA

Table 6 shows the results used in lathes and milling machines, the ergonomic analysis method Sue Rodgers , shown scores of l , 3 and 4 are low levels

Table 6. Ergonomic Analysis Method Sue Rodgers

	Preparación en Torno				Preparación en fresa			
	Intensidad	Duración	Por minuto	Puntaje	Intensidad	Duración	Por minuto	Puntaje
Cuello	2	1	1	3	2	1	1	3
Hombro	2	1	1	3	3	1	1	4
Espalda	2	1	1	3	2	1	1	3
Brazo y Codo	3	1	1	4	3	1	1	4
Muñeca, mano, dedo	3	1	1	4	3	1	1	4
Piernas y tobillos	1	1	1	1	1	1	1	1

Table 7 shows the results used in lathes and milling machines, the ergonomic analysis RULA , scores shown from , 4 to 7 are of a level 4 , requires urgent changes in the job or task.

Design proposal based on the preparation of lathes and milling machine, working with tool (Riesolab , 2015) is required

Table 7. Ergonomic Analysis Method with RULA

RULA Puntuación global grupo 	Prepara	
	Torno	Fresa
A. Antebrazo y Muñeca	7	5
B. Cuello, Tronco y Piernas	6	6
C. Postura y Posición	7	7
D. Postura y Posición	6	6
Final	7	7
NIVEL	4.	4
Nivel 4 Requiere cambios urgentes en el puesto o tarea		

Table 8. Students anthropometry machine tools 2011-2016

Descripción de Medición(Cm) 	Percentil Mujer			Percentil Hombre		
	5	50	95	5	50	95
1. Estatura	144.1	157.1	170.0	166.0	177.7	189.4
2. Altura de la vista al suelo	134.5	147.3	160.1	154.5	166.6	178.7
3. Altura hombro al suelo	118.9	130.6	142.4	135.8	148.1	160.3
4.Altura codo al suelo (brazo colgando)	87.7	98.8	109.8	105.1	113.1	121.1
5.Altura cadera al suelo	82.3	91.8	101.2	91.7	102.0	112.3
6.Altura Rodilla al suelo	38.7	45.1	51.4	48.0	52.4	56.8
7.Altura dedos de la mano al suelo (brazo hacia arriba mano abierta)	179.9	205.5	231.1	206.5	226.8	247.1
8.Altura codo al suelo (brazo extendido hacia arriba)	135.4	157.7	179.9	167.7	182.6	197.5
9. Extensión brazo doblado, antebrazo pegado a cuerpo	31.9	35.9	39.9	36.1	44.3	52.5
11.Extension hacia el frente (tomado desde espalda)	42.2	65.2	88.2	68.9	80.6	92.4
12.Extensión ambos brazos	141.9	161.2	180.5	167.0	181.3	195.5
13.Ancho hombro a hombro	32.9	37.1	41.4	41.4	47.6	53.7
14.Ancho codo a codo	39.1	41.2	43.2	43.3	50.2	57.1
18.Calzado	24.3	25.9	27.5	27.7	29.9	32.1

3.4. Application of order, SMED and MOST

A template tool for the reduction or elimination of delays and transportation and create order in a workbench with tools and convenient measures according to the percentiles shown in anthropometry was implemented.

Figure 3 shows a template grouped by function tools, arranged in sequence of use , which allows to display the tools and equipment used in the specific (Hiroyuki, 1999) (Socconini, 2007)

Figure 3. Template tools with table and chest of drawers

Figure 3 shows: the worktable with wheels for handling, compliance with measures for operator comfort, without unnecessary movements. Applying SMED improvements outer configuration is obtained including refining, storage and transport of parts and tools (Shingo) (Hiroyuki, 1999).

Classification of internal and external for quick setup activities. The default decision and return of the tool through the MOST system, considering that the toolbox is available with a template that identifies the position of the tool and reduce the time search time calculation was performed thereof, this calculation was carried out only with a tool, because the handling of other tools is carried out by the same procedure, in Table 9 the results in seconds are shown . (Zandin, 2003)

Table 9. Results predetermined time simulation using MOST system.

Actividad	Secuencia MOST														Tiempo en seg.
Tomar herramienta de la caja de herramienta	A	1	B	0	G	1	A	0	B	0	P	0	A	0	0.72
Regresa la herramienta a la caja, la accomoda en el shadowboard de la caja	A	0	B	0	G	0	A	1	B	0	P	1	A	0	0.72

4.RESULTS

Table 10 Sue Rodger Method with improvements

	Preparación en Torno			Preparación en fresa		
	Before	After	Improvements	Before	After	Improvements
Neck	3	1	66%	3	3	0%
Shoulders	3	1	66%	4	4	0%
Back	3	1	66%	3	3	0%
Arm and elbow	4	4	0%	4	4	0%
Wrist, hand and fingers	4	4	0%	4	4	0%
Legas and anckle	1	1	0%	1	1	0%

Table 11. RULA method with improvements

	Preparar Torno			Preparar Fresadora		
	Before	After	Improvements	Before	After	Improvements
A. Forearm and Wrist	7	3	57%	5	4	20%
B. Neck, trunk and legs	6	4	33%	6	6	0%
C. Posture y Position	7	3	57%	7	6	14%
D. Posture y Position	6	4	33%	6	6	0%
Final	7	3	57%	7	7	0%
Level	4	2	50%	4	4	0%

1. At night, lighting levels were below permitted in machine shop tools, auxiliary lamps were placed
2. Noise levels are acceptable represent no risk to nearby stations machining center,
3. Workstations bad to take up work tools, so adjustable intermediate station design Table 9 and Table 10 show improvements
4. The need for changes ergonomic workstations with high rates, could not be modified strawberries

5. CONCLUSIONS

1. Intermediate stations were designed ergonomic lathes and milling machines to improve working postures, applying ergonomics, MOST, order and SMED
2. Was simulated before making decisions, which are model before its physical construction, for validation MOST in order to apply improvements inside the task and reduce operation time
3. Establishing improved forecasts through other modeling tools enable better decision together with optimization of production, MOST and Ergonomics
4. The projects have been launched in firms with full satisfaction of its operators
5. The results were not only ergonomic but had a direct impact on production optimization

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COMPARISON OF ELICITED EMOTIONS WHILE USING PRODUCTS. USABILITY AND VISUAL AESTHETICS.

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Resumen: El desarrollo tecnológico ha permitido la evolución de muchos productos para satisfacer las variadas necesidades de los usuarios, sin embargo, hay ocasiones en que los usuarios tienen dificultades usando estos productos debido a la complejidad en la operación de los mismos. Es así que la Interacción Humano-Computadora entra en acción resaltando la importancia de la usabilidad. Sin embargo, hay autores que resaltan la relevancia de no dejar de lado la funcionalidad suave, la que incluye las necesidades emocionales así como otras necesidades intangibles, y que son aspectos cualitativos que afectan la relación del usuario con el producto. La presente revisión de literatura tiene como objetivo identificar los estudios realizados al respecto y la manera en que abordan el problema.

Palabras clave: Emociones, medición de emociones, emociones en uso de productos.

Abstract: Technological development has allowed the evolution of many products to meet the diverse needs of users, however, there are times when users have difficulty using these products due to the complexity in the operation thereof. Thus, the Human-Computer Interaction comes in highlighting the importance of usability. However, some authors emphasize the relevancy of not neglecting the soft functionality, this one includes the emotional needs as well as other intangible needs, which are qualitative aspects that affect the user's relationship with the product. This literature review aims to identify the studies performed and how they approach the problem.

Keywords: Emotions, measuring emotions, emotions using products.

Relevance to Ergonomics: As the subject matter of Ergonomics is the Human-Object-Environment system and its objectives, and thus optimize human well-being, by means of safety, comfort, efficiency and satisfaction, therefore if product designers start to worry about creating a positive emotion while using products mixing usability and visual aesthetics, this implies that the design process would be participatory, so it would be more user-centered.

1. INTRODUCTION

During the first quarter of the twentieth century, mass production of objects and facilities design lacked aesthetic considerations (Tractinsky, Katz & Ikar, 2000). The industrial designers Loewy and Dreyfuss are accredited by Petrosky (1993 cited by Tractinsky et al., 2000) as the responsible ones for the introduction of aesthetic considerations to the mass production, as well as the development of industrial design as an explicit marketing tool. Gradually aesthetic considerations gained ground, but as designers focused on these considerations, they left aside usability, so the Human-Computer Interaction (HCI) entered the field in order to highlight the relevance of usability over aesthetics.

In the 1980s, objects designers accepted usability, but it was in the 1990s when it was recognized as an important feature of the quality of systems and products (Kurosu & Hashizume, 2014). Technological development has enabled the development of many products to meet the varied needs of users, however, there are times when users have difficulty using these products due to the complexity in the operation thereof (Seo, Lee, Chung & Park, 2014). Nielsen & Levy (1994) simply set the aim of usability engineering, which is to improve interactive systems and user interfaces. But the most accurate version is that usability is a general concept that cannot be measured, but is related to several usability parameters that can be measured (Nielsen, 1993 cited by Nielsen & Levy, 1994). Usability parameters that can be measured have two very broad categories: subjective user preferences dimensions, that assess how much the user likes the system; and objective performance dimensions, assess how capable the user is at using the system (Nielsen & Levy, 1994). And although a positive correlation between both dimensions is expected (people prefer to do their job well and use computers to help them, rather than use those ones that will hinder their job), there are cases in which users don't prefer the system that seems to be according to the objective dimensions of performance (Nielsen & Levy, 1994). Because of this Human Factors and Ergonomics has insisted that usability can be achieved as the result of a continuous process of user-centered design (Bevan, 1995). Thus McDonagh, Bruseberg & Haslam (2002), argue that the functional adaptation is key to the success of a product on the market as well as its suitability for use.

And although it is noteworthy that the three objectives of usability are effectiveness, efficiency and satisfaction, some authors emphasize the importance of not neglecting a type of functionality, which can be called as soft functionality (McDonagh-Philp & Lebbon, 2000 cited by McDonagh et al., 2002). This one includes the emotional needs and other intangible needs, qualitative aspects that affect the user's relationship with the product (McDonagh et al., 2002).

With this in mind, some authors classify the aesthetic design as part of an effective interaction design (Alben, 1993 cited by Tractinsky et al., 2000). In a way, both usability concept as aesthetic concept represent two orthogonal dimensions of the HCI, since aesthetics usually refers to the subjective and emotional aspect of the experience of usage system, while usability commonly relates with the nearly objective appearance and locates efficiency as the main criterion (Tractinsky et al., 2000).

Thus in 1998 arises a new concept coined by Norman, the user experience, since for him "the terms human interface and usability were too narrow" (Merholz & Norman, 2007 cited by Kurosu & Hashizume, 2014). It is noteworthy that the term has been well received in the HCI community, as researchers and practitioners are aware of the limitations offered by the traditional theoretical frame of usability.

Within the field of HCI, especially in the context of research on User Experience (UX), the aesthetics of user interfaces has become a topic of interest. A recent review of empirical studies on UX has shown that aesthetics is one of the most frequently searched dimensions in this field (Tuch, Roth, Hornbæk, Opwis & Bargas-Avila, 2012).

In addition Dormann (2001) states that there are market studies that demonstrate the critical role of emotions when purchasing a product. Satisfaction and pleasure that is obtained during use of products, has gained ground as a key to achieve a competitive advantage (Karlsson, 2007). Negative emotions encourage individuals to reject the object cause of the excitement, while positive emotions encourage individuals to accept de object (Frijda, Kuipers, & Schure, 1989 cited by Desmet, 2012). Therefore the aim of this article is to identify the studies performed and how they assess the elicited emotions.

2. LITERATURE REVIEW

Of the different types of study spotted to know the elicited emotions while using products, we found that they can be grouped into: psychological and physiological. Also, it was found that the methodological approach was descriptive study or experimental study. The majority of studies were conducted as experiments.

2.1. Descriptive study

In these studies, there is only one population, which is to be described in terms of a set of variables; around it there aren't central hypothesis, or perhaps there are a set of hypotheses, but they refer to the systematic search for associations between certain variables within the population.

2.2. Experimental study

In this type of study one or a few variables of the studied phenomenon, are modified at the researcher will. In general the modified variables are the ones considered as causal (in a causal-effect relationship).

3. INCLUSION CRITERIA LITERATURE

The majority of searches were conducted in literature databases on Ergonomics and computer or computer systems. The keywords used were "emotions", "measurement of emotions" and "emotions in use of products". From the yielded results, titles and abstracts of articles identified as relevant were read. Among them were selected to be read in its entirety, those as potentially useful.

4. RESULTS

Next a summary of the revised articles, which are shown as previously described methodological approach, is presented.

4.1. Descriptive study

Yoon, Pohlmeyer & Desmet (2014), explored the importance of understanding the nuances of emotions in product development, particularly designers' Positive Emotional Granularity (PEG). They recruited 25 design professionals, to which is applied a semi-structured interview, consisting of three phases: 1) Sensitization to stimulate general awareness of nuances between emotions; 2) Interview where they had to present three product examples with which they had experienced the emotions of pride, confidence and fascination, respectively; and 3) Discussion, where they were asked to give ideas on how and when high PEG could support the development process of their tasks and potential benefits in other areas. The results revealed seven major opportunities, in which the beneficial effects of PEG in relation to specific activities and roles during product development can be expected, namely: a) Getting in-depth understanding of user emotions; b) Determining emotional impact of a product; c) Dealing with organizational support; d) Keeping continuity of emotional impact in communications; e) Facilitating design creativity; f) Strengthening emotional coherency; and g) Managing emotions within a product development team.

Cho, Jung, Myung, Lee & Jordan (2014), conducted their study with the aim of creating both systematic and flexible tools for emotional UX design and to show how these tools can be applied to mobile interfaces. To do this they applied three empirical studies (user diaries, user trials and focus groups), plus a workshop and a subsequent series of work-sessions carried out on 32 subjects (16 users of Android smartphones, 8 users iOS smartphones –Apple iPhone–, and 8 users of other smartphones such as Blackberry and Nokia). Based on these tests and experts' knowledge they were able to develop 30 emotional solutions, 14 general solutions, and 23 UX solutions. To reach such solutions, the obtained emotions were classified reaching a final list of 24 negative emotions and 30 positive emotions. Emotional solutions consist of elicit certain positive emotions in order to help improve the user experience. The general solutions are high-level design principles to elicit emotional solutions and are based on linking positive and negative emotions produced with the product qualities and product performance. Finally the UX solutions represent design guidelines that incorporate principles behind a general solution, which were developed based on general solutions.

In another study presented by Jakobs, Trevisan & Schmitt (2014), they used the Kano method to investigate user satisfaction and to what extent gender had a role in the game. To do this they recruited 27 advanced design students, to which the method was applied in two steps: a pre-study consisting of focus groups, at this stage the students represented the professional guild of product designers; and a main study in which a Kano questionnaire was applied, the students represented, unlike the previous phase the end user. The results indicated that to produce user satisfaction, the same product requirements are more or less relevant to both sexes. However, there are slight differences in the perception and evaluation of product requirements, while women give great importance to hedonic features such as attractive, men tend to be indifferent to product requirements.

Ahmadpour, Robert & Lindgaard (2014) research comfort in real time and the emotional response of 17 passengers during a flight using the Experience Sampling Method (ESM), which requested the participants from time to time, to report a detailed description of his/her mental state through a questionnaire. Of the total participants, 10 took long flights (> 4hrs), mainly from North America to Europe or Asia, and 7 took short flights (< 4hrs) only in Canada. The results showed that comfort remains constant in real time during flight, suggesting that the first impression of the passengers' cabin could determine potentially the overall comfort. The results of the emotional evaluation highlighted two groups of emotions as significant in the passenger's overall comfort on long flights, which were (e.g. joy/feeling good) and emotions based on expectations (e.g. frustration/disappointment), raised by passengers' assessment to different aspects of the cabin, depending on your concerns to have a sense of security, peace and relaxation, and satisfaction. Improving passenger comfort must involve improving his experience with these features, however compliance concerns by offering a greater degree of joy and reducing frustration.

4.2. Experimental study

The experiment presented by Tractinsky, Katz & Ikar (2000), explores the relationship between aesthetics and usability perceived by users on an ATM. They used an application on the computer as a substitute and recruited 132 third year students of Industrial Engineering, whose academic program didn't include product design or aesthetic components design. They decided to use a 2 x 2 between groups factorial design, the first factor interface aesthetics had three levels low, medium and high. In contrast the other factor usability, they included only low and high levels. They presented 9 layouts, of which three had high aesthetic, three low aesthetic and the remaining were in the middle. All designs contained the same objects, but differed in the way they were showed on screen. Also, the authors asked the participants to perform 11 tasks. The factor usability was manipulated introducing difficulties on the interaction in the design with low usability. They divided the experiment into three stages, in the first one, participants were asked to rate the designs according to one of the following dimensions: 1) aesthetics; 2) ease of use; and 3) amount of information displayed on the screen. In the second stage presented a design with a certain kind of aesthetic condition, and the participants were asked to perform several tasks. For the last stage, participants rated the system with which they worked. This study corroborates the results of previous studies, in which a strong correlation between the aesthetics of the interface and usability of the entire system perceived by the user is found. It was also shown that users are able to distinguish between various properties of the system.

Mahlke & Thüring (2007), developed a model of Components of User Experience (CUE) and made an experiment to test the central assumption of this model, which implies that the user experience can be described in terms of the interaction between different components (the perception of instrumental and non-instrumental qualities, emotional user reactions, and overall system judgments). Participants recruited for the study were 48 subjects, which evaluated portable digital audio players simulated on a computer. Two versions of the interface were made to produce a different impact on the perception of the instrumental qualities. With regard to the system features that should influence the perception of non-instrumental qualities, visual aesthetics was manipulated by creating two different body designs for simulation. They used the SUMI questionnaire (for its acronym Subjective Usability Measurement Inventory) to assess the instrumental qualities. To collect data on the emotional reactions of users, they used the Self-Assessment Manikin (SAM) as well as instruments that measured electrodermal activity, heart rate and electromyographic responses. Their results showed that compared with the low usability system, high usability system led participants to obtain the highest percentage of correct answers to the tasks presented with the shortest solutions. The analysis of subjective usability and corresponding aesthetics data showed that variations entailed the predicted differences in perceptions of users quality. With respect to perceived instrumental qualitites, significant differences were found on SUMI questionnaire test scores for usability factor. As for the perception on non-instrumental qualities, there were significant differences between the two treatments of aesthetic factor. The analysis of subjective emotions data revealed a significant effect for controlling usability and aesthetic factors in valence and arousal dimensions. For both factors the “low” treatment led to less positive valence and a higher arousal, compared to the “high” treatment.

Seo, Lee, Chung & Park (2014) study, examined the relationship between perceived usability/aesthetics and emotional valence/arousal/engagement experimenting with 15 existing websites, whose contents were different from each other (cars, books, movies, clothing, estate, science, etc.). 45 enrolled students, pointed out their emotions in terms of valence and arousal, prior to interaction with websites, soon they browse the first site without limitations for 5 minutes. After the timeout, they had to fill out an evaluation form with 33 items, consisting of two parts: the first one contained 8 statements of perceived usability and 11 statements for perceived aesthetics; the second part contained pairs of adjectives antonyms, and included 5 pairs to evaluate the valence, 5 to assess the excitement, and finally 4 pairs to assess the emotional engagement. The process was repeated until each participant completed the assessment for each of the 15 websites, with a break of 2 minutes between each. Participants were not asked to perform specific tasks, to avoid some perceptual and judgmental biases caused by the same tasks on websites with different context of use. The results showed that both the perceived usability and perceived aesthetics, were positively correlated with emotional valence and negatively with emotional engagement. No specific relationship between perceived usability/aesthetics and emotional arousal was found. Perceived aesthetic has a potentially greater impact on valence than the perceived usability. Unlike the valence, emotional engagement might be more influenced by the perceived usability than the perceived aesthetics.

Abegaz, Dillon & Gilbert (2015) sought to determine whether the presence of a low level of visual stimuli in the form of colors (background and figure) and shapes (round, angular and mixed), could induce certain emotions to people exposed to these stimuli. They designed a study in which they explored three conditions of emotional design elements: a) foreground color as text property, with blue, black and red to induce high, medium, and low levels of positive affect, respectively; b) shape as polygonal property, they illustrated round, mixed and angular shapes to also cause high, medium, and low levels of positive affect, respectively; and c) color/shape combination as background color and polygonal property, in which the combinations used to cause high, medium, and low levels of positive affect were blue/round, gray/mixed, and red/angular, respectively. They applied a SAM evaluation presenting the emotional design combinations previously exposed to 13 subjects through a computer screen, toggling the screen on which the participants were asked to rate their emotional state at the time, and blank screens to neutralize the previous emotions produced by presented stimuli, the process was repeated nine times for all combinations, and was used a Likert 5-point scale to assess their emotional mood (1=strongly negative, 2=negative, 3=neutral, 4=positive, and 5=strongly positive). Their findings revealed that the presence of color blue tends to induce positive emotions, color black neutral emotions, and color red fewer positive emotions. Regarding shapes, the results show that the use of them with sharp corners causes less positive emotions, and shapes with rounded corners induce more positive emotions. Also, in the case of color/shape combinations, the results suggested that the blue/round combination induced a more positive emotion on participants, opposed to the red/angular combination that caused a less positive emotion. Gray/mixed combination induced a more neutral emotion.

5. CONCLUSIONS

Through this review of literature, it can be observed than both descriptive and experimental studies, prefer the questionnaire as an assessment instrument. Two descriptive studies obtained data through focus groups. On the side of the experimental studies, only two used the same questionnaire (SAM), and all others used a different one, arguing that each adapted to the needs of their study. Also, there were studies using instruments meant to measure the physiological responses as a support. Regarding the manipulation of variables, one can observe that two experiments also used a factorial design.

As for the findings reported, it is observed that by joining usability attributes with pleasing visual aesthetics attributes on the designs and/or interfaces, the emotions obtained are superior to those that have only one or another of them. It is concluded that more research is needed in this regard, but the results shown encourage concluding also, that if product designers start to worry about creating a positive emotion during use of the product, combining both usability and visual aesthetics attributes, this implies that the design process would be more participatory, so it would be more user-centered.

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ERGONOMICS AS A TOOL TO IMPROVE QUALITY OF LIFE OF OLDER PEOPLE: A LITERATURE REVIEW

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Resumen: La población envejece y existe la necesidad de ser independientes para obtener un mejor bienestar que permita ser activos en la sociedad. La calidad de vida depende de factores sociales, cognitivos, físicos y económicos, sin embargo la capacidad de las personas mayores de ser independientes no debería depender de la pérdida de las funciones físicas y cognitivas, sino de la adaptabilidad de las características de los productos a las capacidades del usuario. La preocupación sobre este fenómeno aumenta debido a las falta de productos y servicios ergonómicos que consideren a la población de adultos mayores. Se considera la ergonomía como herramienta para generar estrategias que mejoren el bienestar y calidad de vida.

Palabras clave: Ergonomía, adultos mayores, actividades instrumentales de la vida diaria.

Aportación a la Ergonomía: Con la presente revisión de literatura se puede visualizar un panorama del uso de la Ergonomía para proponer estrategias, métodos y soluciones a los problemas que la población de adultos mayores enfrenta. El envejecimiento poblacional demanda mayores esfuerzos en el desarrollo de investigación en Ergonomía para cubrir las necesidades de los adultos mayores y así ayudar a mejorar su calidad de vida.

Abstract: The population is aging and there is a need to be independent for better well-being that allows to be active within the society. The quality of life depends on social, cognitive, physical and economic factors, but the ability of older people to be independent should not depend on the loss of physical and cognitive functions, but in the adaptability of the characteristics of products to the user´s capabilities. The concern about this phenomenon increases due the lack of ergonomic products and services including the aged population. Ergonomics is considered as a tool to generate strategies that enhance the independence of people and consequently the well-being and quality of life.

Keywords: Ergonomics, older people, instrumental activities of daily living.

Contribution to Ergonomics: With this literature review it can be shown an overview of the use of Ergonomics to propose strategies, methods, and solutions to problems that the older population faces. The aging population demands greater efforts in the development of ergonomic research to meet the needs of older adults and improve their quality of life.

1. INTRODUCTION

Aging is a biological condition consequence from the passage of time and affects all people. According to the United Nations, (2013) the demographic trend called ageing population is identified as the process of rapid increase in the number of people aged 60 and more within the total population. The number of older persons was 841 million in 2013, it is expected to increase 3 times by the year 2050, when it is expected to exceed the two billion mark.

This demographic trend is considered one of the great challenges, since global ageing will increase economic and social demands on all countries (WHO, 2002). Aceves-González, (2014) mention that great improvements have been made in supporting the ageing population, especially in developed countries. One of the solutions mentioned by the World Health Organization (WHO, 2007) is to increase active ageing process for optimizing opportunities for health, social participation and security in order to enhance quality of life as people age.

As the aging process advances increases the loss of physical, sensory and cognitive capabilities, thus preventing or hindering the use of products and services by older people. According to the World Health Organization (WHO, 2007) 'in both developed and developing countries, people think that their city was not designed for older people' and they also report that the provision of commercial and public services presents problems in meeting older people's needs.

Independence is a factor of the quality of life and well-being, improving the role of a person in their home and allowing to be an active citizen. An older adult should be able to perform basic activities of daily living (BADL) to be considered as an independent individual, however a successful independence requires the ability to successfully perform instrumental activities of daily living (IADL) (Lawton & Brody, 1969). Katz, Downs, Cash, & Grotz, (1970) named six BADL, and based on previous studies Lawton & Brody, (1969) identified eight IADL shown in Table 1 and Table 2 respectively.

Table 1. Basic activities of daily living

Bathing
Dressing
Toileting
Transferring
Continence
Feeding

Table 2. Instrumental activities of daily living

Using the telephone
Shopping
Preparing food
Housekeeping
Doing laundry
Using transportation
Handling medications
Handling finances

Perform IADL demand to interact with products and services that often lacks of ergonomic design that considers the needs, capabilities and limitations of the older users, which results in a decreased sense of well-being and quality of life of the person. Persad, Langdon, & Clarkson, (2007) define user capability and product demand as concepts to provide a framework for analyzing user-product compatibility (Figure 1) and it works as a useful starting point for the analytical assessment by focusing on ways to relate the product or service demand to user capabilities.

2. OBJECTIVE

The aim of this work is to identify the contributions of ergonomics research to improve the welfare of the quality of life of older adults through a literature review.

3. METHODOLOGY

The literature review was conducted within the journals Applied Ergonomics and Ergonomics, a parameter of publication date of 10 years from 2005 was used. Ergonomics and Aging were taken as references for guiding the review. The keywords used in the search criteria were the instrumental activities of daily living, as shown in Table 2. The process of literature review initiated by selecting items using keywords and abstract, abstract analysis and finally the reading of the full papers that contributed to the knowledge of the research topic were chosen.

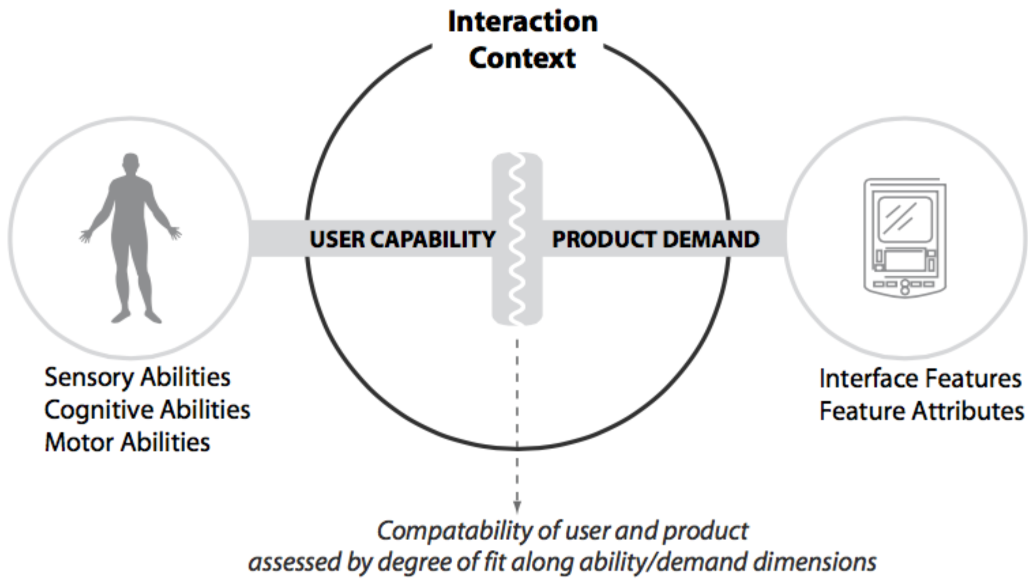

Figure 1. Relationship between user sensory, cognitive and physical capabilities and the demands made on the user by the product (Persad et al. 2007).

4. RESULTS

From the literature review, 16 scientific articles were identified based on Ergonomics criteria for designing or evaluating products and services including older people as users. Papers were classified according to the IADLs focus. This section presents a brief description of those papers and one illustration (Figure 2) where papers are shown according IADLs and the user capabilities implied in each study.

Kawahara & Narikawa, (2014) explains that in a society with a latent increase on the older population, people with reduced physical and sensory functions would be a majority, and efforts must be made to prepare the urban environment, housing, and household equipment and appliances to these people can live safely and comfortably. To provide solutions is needed the development of creative and innovative designs that can be adapted to the needs of older people by making investigation and analysis from the Ergonomics point of view, contemplating the motor, sensory and cognitive limitations of the elderly population.

Waller, Bradley, Hosking, & Clarkson, (2013) describe the Engineering Design Centers (EDCs) of the University of Cambridge as an example to solve design problems through Ergonomics and Inclusive Design. Their approach describes Inclusive Design as the understanding of the diversity of users to improve decisions in the development process of products and services in order to satisfy the needs of more people. Successful cases show that products that are more inclusive can reach a wider market, improve customer satisfaction and lead to successful business.

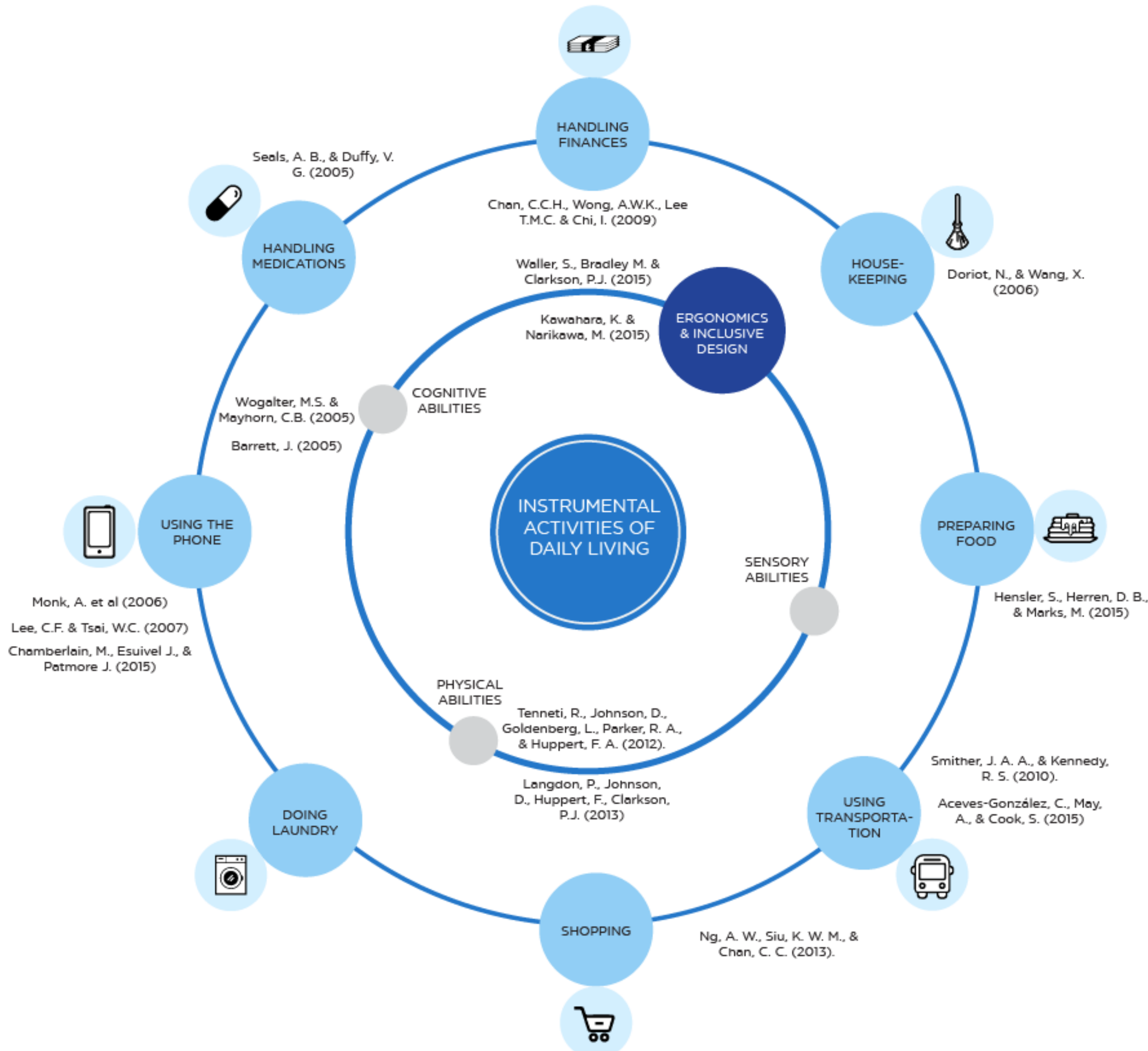

Figure 2. Diagram of literature review results

Tenneti, Johnson, Goldenberg, Parker, & Huppert, (2012) developed a set of criteria and suggestions for the design of a national survey to assess the capacities of individuals in order to identify measures to facilitate the prediction of use skills. A pilot test with a sample of 100 people aged form 50 to 80 years old was performed. It was evaluated the use of various household products that required physical and psychological abilities. The resulting database is a set of tools and information for designers to use within Inclusive Design.

Langdon, Johnson, Huppert, & Clarkson, (2013) used the Tenneti, et al. study and determines that in order to know the capabilities and needs of people is necessary to include individual activities at home, at work and in most environments of interaction, if possible. The authors point out that the results could create predictive ergonomic models. They mention that the evaluation of ADLs could cover a high range of activities, however, only it is applicable for determining capabilities and limitations of older people. A key outcome for a future research will be the specification and organization of capabilities in psychological, social and economic contexts for inclusive design.

Older adults have more limitations for IADL than younger people, the design of the spaces require reaches of the upper extremities, the study of Doriot, Nathalie & Wang, (2006) determined that the most difficult movements to performance in older adults are neck and trunk so these should be minimized in the organization of living and work spaces for older people.

Over the years, the visual acuity decreases, Smither & Kennedy (2010) developed a tool to measure more precisely the dynamic visual acuity (DVA). On their study, they showed that aging and automobile accidents are related to DVA scores. The loss effects of visual acuity in older adults could generate insecurity when they are in strange environments, this study suggest a model of the effects of age on visual, cognitive skills and components associated with driving that can be used for further research in the design of support devices for people with this condition.

The use of public transport is an IADL that promotes development of physical, mental and social state of the elderly. It is necessary for most older adults who are active outside their home, Aceves-González, May, & Cook, (2015) shows the difference on the use of public transport between young and older adults. Older ones being more affected by the lack of consideration in the design. The public transport service is aggravated by social and urban dynamics of the city. Since the extent of the problem, the need of developing public transport services based on the inclusive service design approach that considers the needs of all users of public transport is mentioned.

Ng, Siu, & Chan, (2012 conducted an experiment to improve the identification of utility icons using the stereotype production method. User´s factors and the characteristics of the references shown during the experiment are considered important for the development of symbols. As conclusion they determined that this could help in optimizing the stereotype production method of designing symbols between users and design professionals.

Eating is considered as a BADL, however a person who spends a lot of time alone should be able to prepare food (IADL) which can be a challenge for an older adult because of the limitations that could experience. Hensler, Herren, & Marks (2015) revealed in their research the possibility of produce easy-to-open food packages for people with hand disorders, which can benefits the majority of the population and generate greater consumer satisfaction.

Seals & Duffy, (2005) describe in their research that people aged 65 years and older are estimated to consume 30% of all prescription drugs and to purchase 40% of all over-the-counter medications. Often older people have to appeal to another person to fulfill its medical indications. The study analyzes the performance of older people´s caregivers in the task of administrating medications, which can be used as reference for the development of a drug assistant management system for older people to improve the individual independence.

The information and communication technology can help to increase independence and quality of life of older or disabled people living in their own homes. Monk et al., (2006) proposes a risk management framework to help select and evaluate applications that meet the needs and desires of individuals and improve their independence.

The study performed by Chan, Wong, Lee, & Chi, (2009) used a modified automatic teller machine (ATM) to prove the participatory design method for satisfying the needs of older people. The experiment shows favorable results, however the system functions were reduced consequently it was concluded the need of more investigation to include a wide range of users.

Barrett, (2005) determines support and information needs of older and disabled people in the UK. She found that the increasing of age is significantly associated with increased dissatisfaction with receiving practical help in various tasks. Older people have difficulty in obtaining help from services as age increases. Older people need information on appropriate sources of support, practical help and counseling services in a language they can understand. According to this study the performance of the IADL, home maintenance and financial activities are considered by older adults as vital for a sense of well- being and satisfaction. The growing aging population means that the demand for information and assistance providers will increase in the near future.

Technology can improve the accessibility of information and the cognitive support. The principles of warning interactivity, the dynamic modification and personalization are applications of technology that should improve the effectiveness of future technological warning systems. Technology-based warning systems provide to the user better access to safety information and cognitive support for each of the components of the warning process. One goal of cognitive support is the prioritization of the interactive capabilities of technology and the ability to customize alerts information through changes in content that can improve user safety through higher quality decisions related to risk using technology (Wogalter & Mayhorn, 2005).

The mobile phone is the most common digital product with great technological scope and functions, however digital products are relatively new and designed for younger consumers. Research of digital products has shown that interface mode has effects on the effectiveness and efficiency of use. Another criterion intervening is the space between buttons from digital product: more separated buttons can enhance operationalization of the task (Chang-Franw Lee & & Tsai, 2007).

British Telecom used the inclusive design method to design phones and improve customer usability of older adults. The research of Chamberlain, Esquivel, Miller, & Patmore, (2015) recorded from the design process used by BT the following considerations to incorporate inclusive service in a business: 1) support from the management service, 2) company support to its own staff, 3) make small changes that include most of the population, 4) focus on identifying potential market, 5) training to the product design department, and 6) provide practical support in the design process.

5. CONCLUSIONS

The overview of this literature review shows that ergonomic research are used as a tool to provide solutions that improve the well-being and quality of life of older adults. The rapid increase of aging population demands greater ergonomics research to meet the needs, capabilities and limitations of older people.
Finally it is important to mention that the papers analyzed in this study were conducted mostly in developed countries. Only one article was developed in Mexico, therefore this represents an opportunity for ergonomics research in the contexts of developing countries, and particularly in Mexico.

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APPLICATION OF STEPWISE REGRESSION METHODS FOR THE ANALYSIS OF MANUAL FORCE.

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Resumen: La descripción del comportamiento de la fuerza manual a lo largo de la jornada de trabajo puede ser estudiada mediante análisis de regresión. Factores como la edad, estatura y ancho de la mano, son determinantes en el ámbito laboral y en el ejercicio físico de los trabajadores. Mediante un análisis de regresión por segmentos, se puede hacer una representación mediante un modelo de dichos esfuerzos manuales considerando los factores antes expuestos.

Palabras claves: Regresión por segmentos; Esfuerzo manual; Análisis de regresión.

Abstract: The description of the behavior of the manual force throughout the working day can be studied by regression analysis. Factors such as age, height and width of the hand, are determining factors in the workplace and in the exercise of workers. By stepwise regression analysis, can be made a representation by a model of such manual effort considering the factors set forth above.

Keywords: Stepwise regression methods; Manual exertion; Regression analysis.

1.- INTRODUCTION

Performing manual labor efforts during practice it can be analyzed with regression methods. These studies are useful when you need to evaluate several regressors involved in practice and it is computationally difficult to assess. Three methods have been developed to evaluate a small amount of regression models, adding or deleting one by one regressors.

In order to evaluate various regression models, we proceed to apply the stepwise regression methods using three segments: forward selection, backward elimination and stepwise regression. When analyzing the regressors age, time, height and width of the hand by these methods, we obtain as a result a model that reliably represents the expected behavior of manual efforts.

2.- OBJECTIVES.

General: Conduct an analysis of the behavior of the manual force in manufacturing activities by applying stepwise regression methods.

Individuals:
• Get regression models, representing the gripping force being made in manufacturing regressors based on age, time, height and width of the hand.
• Determine the expected strength of hand grip according to the obtained models.
•Using statistical tools for data processing.
• Describe the manual force that can be generated based on the factors described above over time.

3.- METHODOLOGY.

For this study, they were asked participants to apply maximum force handgrip they consider acceptable for a day of 8 hours, taking into account the nature of the operation, it will be required to be applying the force in the form repeated, thus simulating a workstation where it requires the application of gripping force for the production of electrical components.

For this research, randomly they selected a group of 57 operators with work experience and perform daily activities in manufacturing, in the community of Hermosillo. Test subjects were subjected to medical examination to prevent injury. A study of anthropometry to test subjects was made, in order to obtain their physical measurements and to characterize them based on them. The age range of the group of operators is between 18 and 42 years old, its average age, height and width of the hand is obtained.

3.1 Data collection

Dynamometers were prepared to measure the strength of hand grip. Test subjects were instructed to stand in front of a structure holding the dynamometer at a height that forms a right angle with your elbow. The wrist was kept in a neutral position with the hand resting on the dynamometer. Test subjects were instructed to perform hand grip strength on the dynamometer. 3 shots grip strength were performed manually at the beginning, middle and end of the working day, for five weeks. Test subjects were instructed to apply the maximum acceptable force, assuming that the grip level that can be sustained repeatedly selected.

Data were recorded in a spreadsheet for easier handling. The peak force was recorded for each insert with dynamometers. Use of Minitab 16 software was used to analyze the main effects of the data and obtain the regression models using stepwise methods (Montgomery & Peck, 1992).

Considering the force as a response variable and age, height and width of the hand as regressors, regression analysis in the category forward selection obtained the results presented in Figure 1

Stepwise: Hand strength vs. Age, Height.
Forward Selection

Step	1	2	3	4
Constant	-41.23	-23.83	-43.59	-43.08
Width Hand	12.06	12.06	11.50	11.45
T Value	22.35	23.36	21.24	21.22
P Value	0.000	0.000	0.000	0.000
Time		-2.48	-2.48	-2.48
T Value		-6.83	-6.90	-6.93
P Value		0.000	0.000	0.000
Height			0.149	0.124
T Value			3.21	2.62
P Value			0.001	0.009
Age				0.148
T Value				2.31
P Value				0.021
S	6.91	6.61	6.55	6.52
R-sqr	50.32	54.63	55.56	56.04
R-sqr(aj)	50.22	54.44	55.29	55.68
Cp Mallows	62.7	16.7	8.3	5.0

Figure 1.- Forward selection.

With this method, four steps are applied to obtain the model presented in equation (1):

$$\hat{y} = -43.08 + 11.45(\text{width of the hand}) - 2.48(\text{time}) + 0.124(\text{height}) + 0.148(\text{age}) \quad (1)$$

A second method applied is the backward elimination, where it starts without regressors in the model and is input variables to a suitable model, the results are shown in Figure 2

Stepwise: Hand strength vs. Age, Height.

Backward elemination

Step	1
Constant	-43.08
Age	0.148
T value	2.31
P value	0.021
Height	0.124
T value	2.62
P value	0.009
Width of the Hand	11.45
T value	21.22
Valor P	0.000
Time	-2.48
T value	-6.93
P value	0.000
S	6.52
R-sqr.	56.04
R-sqr.(adjusted)	55.68
Cp of Mallows	5.0

Figure 2.- Backward elimination.

In this case it applies a single step where it got the same model shown in equation 1.

The third method is to use stepwise regression, where each step all covariates that had come before the model are reevaluated. In Figure 3 the results shown.

Like the above two methods, the model obtained is the same as presented in equation 1, where they are considered the 4 regressors: width of the hand, time, age and height, so that should be considered as part of the model constitution.

4.- RESULTS.

The model obtained in Equation 1 shows the expected behavior that represents the force that is exercised over time considering the factors age, height and width of the hand. . Consider the example of a 20-year-old, height of 163 centimeters and a width of hand 7.0 centimeters, the force would be exercised by hour as shown in Table 1:

Stepwise: Hand strength vs. Age, Height.

Stipewise regression

Step	1	2	3	4
Constant	-41.23	-23.83	-43.59	-43.08
Width Hand	12.06	12.06	11.50	11.45
T value	22.35	23.36	21.24	21.22
P value	0.000	0.000	0.000	0.000
Time		-2.48	-2.48	-2.48
T value		-6.83	-6.90	-6.93
P value		0.000	0.000	0.000
Height			0.149	0.124
T value			3.21	2.62
P value			0.001	0.009
Age				0.148
T value				2.31
P value				0.021
S	6.91	6.61	6.55	6.52
R-sqrd.	50.32	54.63	55.56	56.04
R-sqr.(adj)	50.22	54.44	55.29	55.68
Cp Mallows	62.7	16.7	8.3	5.0

Figure 3.- Stepwise regression.

Table 1. Force to exercise per hour.

TIME	STRENGTH HAND
0	60.242
1	57.754
2	55.266
3	52.778
4	50.29
5	47.802
6	45.314
7	42.826

The information obtained in Table 1, shows that a person of 20 years, height 163 centimeters and hand width of 7.0 centimeters, manual force shall initially be 60.242 pounds, for the seventh hour, manual force which shall be of 42.826 pounds.

This information is displayed graphically in Figure 4:

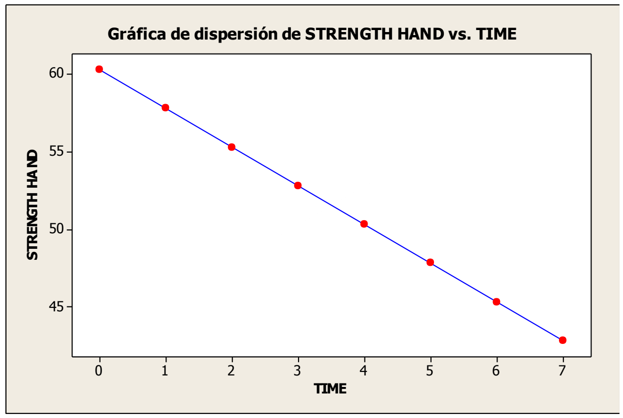

Figure 4.- Manual force per hour.

5.- CONCLUSIONS.

With the application of stepwise regression methods, we can get a model that represents the behavior of the manual force in manufacturing activities throughout the workday.

The regression model obtained shows a good representation of the expected forces, backed this with models derived in the three methods was the same. The model represents the grip force being made in manufacturing regressors based on age, length, height and width of the hand.

This information can help us to determine the level of stress or fatigue that has accumulated this person and thereby contribute to the prevention of injury or accident.

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DETERMINATION OF FATIGUE IN VULCANIZING LOS MOCHIS SINALOA.

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RESUMEN: La presente investigación se buscara medir los niveles de fatiga en los trabajadores de 8 vulcanizadoras que fueron muestreadas en los Mochis, Sinaloa. Se muestrearon 24 desponchadores, a los cuales se les aplicaron los métodos de estudio yoshitake y 4 puntos de Luke. Los métodos antes mencionados demostraron que si existe fatiga en los trabajadores de estas vulcanizadoras, ya que sus actividades diarias requieren gran esfuerzo y por consecuencia afecta el rendimiento de los empleados. Como resultado de los métodos aplicados obtuvimos que si se presenta fatiga laboral de tipo física y mental.

Palabras clave: Fatiga, Lesiones musculoesqueléticas, daño físico

ABSTRACT: This research seeks to measure levels of fatigue 8 vulcanizing workshop who were sampled in Los Mochis, Sinaloa. 24 workers were sampled, to which were applied the methods Yoshitake and Luke's 4 points. The above methods showed that there is fatigue in these vulcanizing workers, as their daily activities require great effort and consequently affects the performance of employees. As a result of the applied methods we obtained that if labor physical and mental fatigue type occurs.

KEYWORDS: Tire, fatigue, physical damage

1. INTRODUCTION

From the need to transport us, the invention of the car, until the creation of the first pneumatic tire in 1845, the human has seen the need to avoid the waste of material, this is why that they figured out that tires were an unnecessary expense to change them every time. The vulcanizer have formed part of the solution respect to this service for many years without nobody noticed them, facilitating the development of a variety of methods of fixing tires, damage caused by lack of education on the correct positions of work.

There are different factors that influence the development of a worker at the time of a task, this research seeks to determine the existence of any kind of fatigue which could affect the development of the employee and determine each of the factors involved to make such fatigue develops.

The results of the study as well as the interpretation of these are shown.

2. JUSTIFICATION

Employment physical fatigue that occurs in the vulcanizing machines from Los Mochis is a social issue since it affects the performance of workers and therefore the quality of life of the people.

The research was carried out since there is a lot of vulcanizing machines, in which employees present discomfort by activity that play in losMochis.

3. GENERAL OBJECTIVE

The determination of fatigue (physical or mental) on workers working in the tire of the city.

SPECIFIC OBJECTIVES

- Determine the level of fatigue in workers of vulcanizing machines.
- Identify the main symptoms in which workers are affected.

4. DELIMITATION

This research aims to determine the level of fatigue in workers of vulcanizing machines located in the city of Los Mochis Sinaloa.

5. REFERENCE FRAMEWORK

The accumulation of tiredness or fatigue can occur in the vulcanizer for various situations that may arise during their everyday work, a clear example of this is the handling of heavy objects with tyres for automobile and in some cases, extremely heavy objects such as tract truck tires.

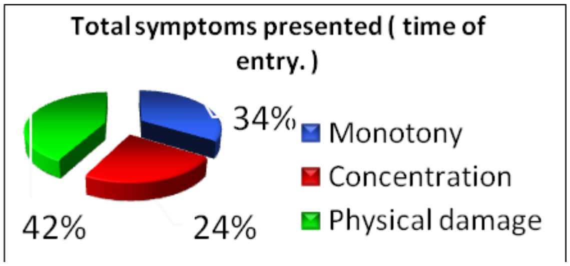
As mentioned López Millán, De la Vega Bustillos, Vázquez Quiroga and Guzman Hernández (2013) in his article "design to link standards force posture and sustained efforts" point where the factors in which a person can lift a heavy object by varying the amount of force based its stance, and although that study is specific for women, the vulcanizer used postures inadequate and tired as he mentions them the article.

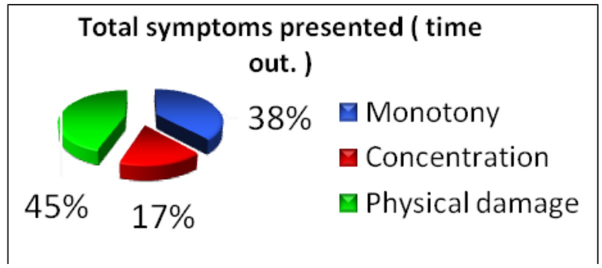
6. METHODOLOGY

We identified the presence of fatigue by the workers in the vulcanizing machines, by which it was decided to carry out field study in order to determine the existence of fatigue, whether physical or mental. The corresponding measurements using the percentile questionnaire were carried out and 4 points luke applied 24 workers followed for 3 weeks.

7. RESULTED

Yoshitake

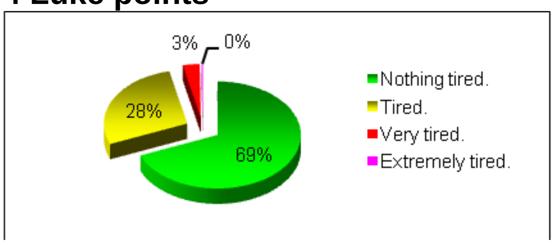


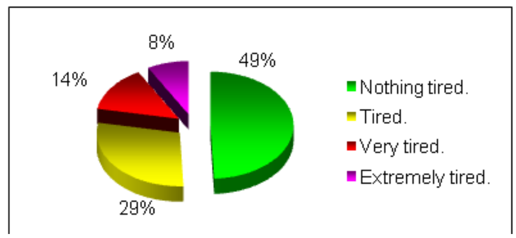


Graphic 1

Graphic 2

4 Luke points





Graphic 3: 4 Luke points of entry time

Graphic 4: Luke points of time out

8. CONCLUSIONS

Based on the results obtained in the methodology 4 points Luke, we can conclude that there is fatigue in the rubber at the end of their daily hours of work.

Complementing this, and focusing on the results obtained by yoshitake methodology, the main symptom of fatigue that present the vulcanizer is physical damage, followed by symptoms by monotony and mental fatigue (concentration) respectively.

Returning to the previous results of the study of the field with a duration of 3 weeks, it has enough statistical evidence to say that Yes you have fatigue mental type mainly fatigue and physical type in the region of Los Mochis Sinaloa vulcanizer.

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CONCIERGES OF SCHOOLS IN THE CITY OF LOS MOCHIS, SINALOA, A STUDY ON THE LABOR FATIGUE

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Resumen: El trabajo del hombre es el punto de partida del desarrollo de una sociedad en todas sus formas, el punto de apoyo y sostén de la productividad, no siempre está exento de riesgos, es por tal razón que en esta investigación se estudió el oficio de conserje, los cuales son responsables del mantenimiento y conservación de un área designada, incluyendo cierto número de edificios y el área circundante.

En el presente estudio, se informan los resultados que arrojaron las encuestas de Yoshitake y la escala de cuatro puntos de Luke. Dichos métodos de evaluación se realizaron a conserjes de diferentes escuelas de los Mochis Sinaloa con el objetivo de saber si tienen o presentan algún tipo de fatiga.

Palabras clave: Ergonomía, método subjetivo, esfuerzo físico.

Contribución a la Ergonomía: La presente investigación ha contribuido en gran medida a reforzar el objetivo principal de esta ciencia por los principios fundamentales tales como: evitar y evaluar los riesgos que no se puedan evitar, combatir los riesgos en su origen, adaptar el trabajo a la persona, especialmente en lo que respecta al diseño de puestos de trabajo, como así como la elección de los equipos y los métodos de trabajo y de producción, con miras, en particular, a atenuar el trabajo monótono y repetitivo, para reducir sus efectos sobre la salud, así como también dar soluciones adecuadas a los trabajadores

Abstract: Man's work is the starting point for the development of a society in all its forms, the fulcrum and bra of productivity, not always it is without risk, it is for this reason that in this investigation was studied the occupation of the concierges, which are responsible of the maintenance and upkeep of a designated area, including a number of buildings and the surrounding area.

In the present study, is disclosed the results that threw the surveys of Yoshitake and four-point scale of Luke . These evaluation methods were performed at concierges of different schools of Los Mochis, Sinaloa with objective to know whether they have or had some type of fatigue.

Keywords: Ergonomics, subjective methods and physical effort.

Relevance to Ergonomics: The present research contributed greatly to strengthening the main objective of this science by key principles such as: Avoiding and assess risks that cannot be avoided, combating the risks at source, adapt the work to the individual, especially as regards the design of jobs, as well as the choice of equipment and methods of work and production, with a view, in particular, to alleviating monotonous and repetitive work, for reduce its effects on health, as well also as giving appropriate solutions to workers.

1. INTRODUCTION

The present study, are was reported the results thrown by the surveys of Yoshitake and the scale four-point of Luke regarding to fatigue are reported. These evaluation methods were performed at different concierges of schools of Los Mochis Sinaloa in order to know whether they have or have some type of fatigue.

It should be noted that the concept of fatigue is a common effect to all activities that require effort and strain and appears when the amount of effort required exceeds the possibility of individual response, which translated into a series of physical dysfunction and psychic accompanied by a subjective perception of fatigue and decreased performance.

2. OBJECTIVES

2.1 General objectives

Assess the state of the concierges who work in different schools of Los Mochis Sinaloa, by the methods of subjective evaluation of Yoshitake and 4 Luke points to detect if they present some kind of fatigue.

2.2 Specific objectives

- Recognize the physical conditions of the work area, in order to meet and explore whether the concierges has general symptoms of fatigue, type: mental, physical and muscle.
- Analyze work activities of the concierges, researching whether exist or not alterations ergonomic.

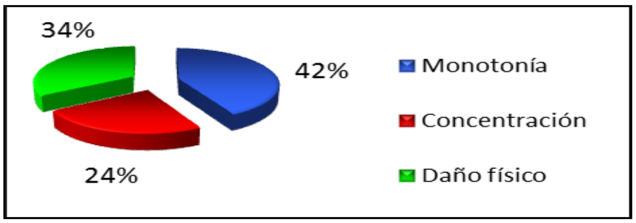
3. METHODOLOGY

The research it develops with a descriptive study and field in order to meet work activities and detect any possible fatigue in concierges who work in different schools of Los Mochis Sinaloa, noting the potential risks and damage to those exposed those doing this work, and thus determine control measures, using analytical methods and aiming to obtain results that could be the basis for the development of the project. To successfully achieve planned, the relevant activities for the advancement of research a sample of 32 concierges of the city of Los Mochis.

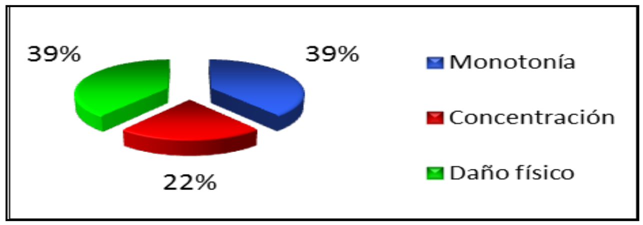
In the study of field, they were used two methods Yoshitake and Luke 4 point and was conducted for three weeks at the start and end of the workday, finally it has been performed a survey of general activities of work, for observe the influence who have this activities.

4. RESULTS

After performing the evaluation of methods Yoshitake it was obtained minor importance in to the difficulty concentrating although contributes a significant percentage, but the problem was the appearance of monotony and aspects bodily or projection of physical damage, as well also it is noted an increase of complaints



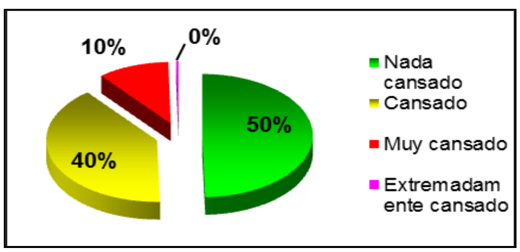
Graph 1. Total symptoms presented (input).



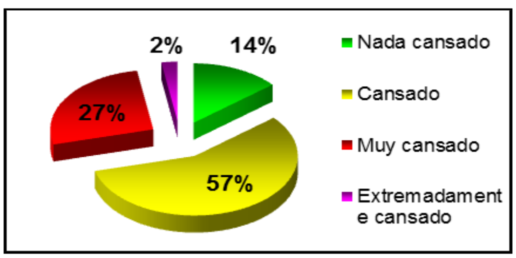
Graph 2. Total symptoms presented (output).

of fatigue through six working days.

On the other hand the study Luke 4 point indicates that 40% of the sample obtained during the three weeks when start the workday are tired, and 27% of the days week ends very tired the workday.



Graph 3. Luke 4 point (input).



Graph 4. Luke 4 point (output).

5. CONCLUSIONS

In Based on the results obtained it can be concluded that presents an increasing complaints by fatigue through of the 6 business days, for this we must take into consideration that the 71,875% of the sample start their work too early every day the morning and also observed, that women have more fatigue, this is due to different situations one is their marital status, since most arrive of their work to his home to continue housework.

Moreover much depends on the workload that on that day it is carried out or the conditions in that perform. Finally it is important to stress that is impossible to find an activity that does not generate fatigue.

5.1 Recommendations

After this study it is necessary that is done an ergonomic evaluation as soon as possible, so that the area of position and / or work is designed and / or redesigned, and adapt the right tools.

Meanwhile, we need other solutions to protect, such as changing the way we work, wear appropriate clothing (eg ergonomic tennis), and use tools freight allowing you to perform activities in a better way, with the order to prevent fatigue and injuries to workers.

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DETERMINATION OF FATIGUE TAXI DRIVERS IN LOS MOCHIS, SINALOA

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RESUMEN: El servicio de taxis es una actividad que se realiza por un conductor que proporciona un servicio de transporte local. Que consiste en trasladar personas a distintos sitios de la ciudad por una tarifa determinada por el tipo de servicio y tiempo realizado.

En la realización de la presente investigación se evaluó el estado que presentaron 33 taxistas de Los Mochis Sinaloa por medio de métodos ergonómicos como la prueba de Yoshitake y 4 puntos de Luke. Con el objetivo de analizar las actividades realizadas por los taxistas para detectar si existen alteraciones ergonómicas y si alguna de esas actividades se ven reflejadas en el rendimiento y salud de los taxistas.

Para la elaboración de la investigación se realizó un estudio de campo durante 3 semanas utilizando como principal recurso la observación y como principal herramienta la encuesta (Yoshitake y 4 puntos de Luke) con la cual fue posible detectar los posibles riesgos y daños presentados por los taxistas al momento de llevar acabo su jornada laboral.

Después de haber aplicado los métodos se procedió a interpretar los resultados aplicando métodos estadísticos y en ellos se reflejaron los resultados obtenidos. Se obtuvo que los taxistas arrojan problemas de monotonía y de concentración, al igual que en los daños físicos los cuales se ven afectados al final de la jornada laboral. Los taxistas presentan cansancio y fatiga conforme van pasando los días de trabajo, incrementándose la fatiga conforme transcurre la semana.

PALABRAS CLAVE: Agotamiento físico, Yoshitake, 4 puntos of Luke.

Relevancia para la Ergonomía: Contribuye a mejorar la salud ocupacional de los conductores de taxi. Proporciona datos reales de un estudio de campo. Proporciona un punto de referencia para futuras investigaciones.

ABSTRACT The taxi services are an activity performed by a driver who provides local transportation service. It consists in moving people or small groups of passengers to different destinations in exchange for a fee.

In this research we evaluated 33 taxi drivers in Los Mochis, Sinaloa using ergonomic methods like the Yoshitake Test and 4 points of Luke. With the purpose of analyze the activities of the drivers and determine if there is an ergonomic alteration and if this problem is affecting the performance and health of the worker.
We did a field study during 3 weeks using our observation and a poll as the main tool
With witch we detected the possible risk and damage presented in the drivers during his workday.

After the application of the methods we proceeded to the data analysis. Using statistical methods, we confirmed that the drivers have monotony issues and concentration problem. Furthermore, we determinate the presence of physical damage and fatigue within his workday, increasing the problem during the week.

KEYWORDS: Physical exhaustion, fatigue, Yoshi take, 4 points of Luke

RELEVANCE TO ERGONOMIC: It contributes to improve the occupational health of taxi drivers. It provides real data from a field study. It provides a benchmark for future research.

1. INTRODUCTION

The taxi services are an activity performed by a driver who provides local transportation service. It consists in moving people or small groups of passengers to different destinations in exchange for a fee. This service has been operated in the city of Los Mochis for some time to be a great support reducing road accidents due to alcoholism, families without their own car, people who need to move quickly, or people who need to travel late at night.

The city has about 400 taxis available to citizens, but because the needs taxi drivers extend their working hours to almost 12 hours to any service call. This causes problems to taxi drivers because their workday increases, generating problems such as fatigue, poor diet, lack of sleep and rest, among others. This will be studied for diagnostic and detection of fatigue. Therefore help to care for and improve their workplace, since this could be a factor that causes problems because of its poor design to use for long periods.

2. OBJECTIVES

General Objetive:

- Evaluate the state of taxi drivers using the subjective methods of Yoshitake and 4 points of Luke.

Specific objective:

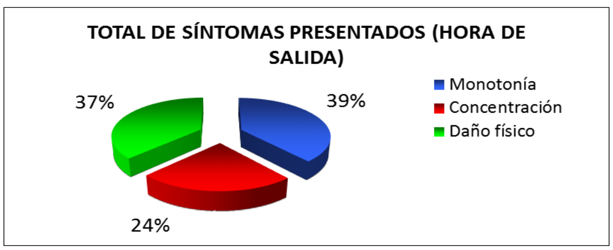
- Analyze the taxi driver’s activities and determinate the presence of ergonomic problems
- Evaluate the obtained results

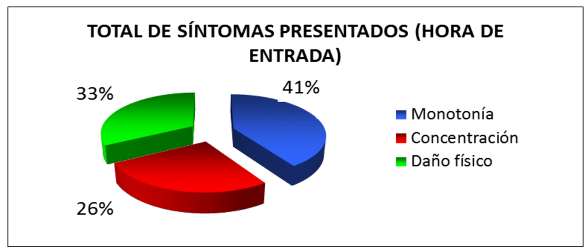
2. METHODOLOGY

We did a field research to observe conditions of the drivers and detecting potential risks, we applied Yoshitake test to obtain a precedent in which focus our investigation. In addition, we applied statistical methods to determinate presence and percent of drivers with fatigue to position them into a scale.

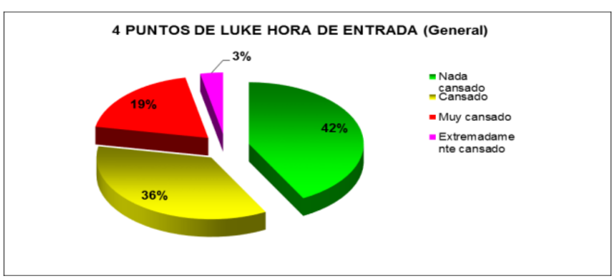
3. RESULTS

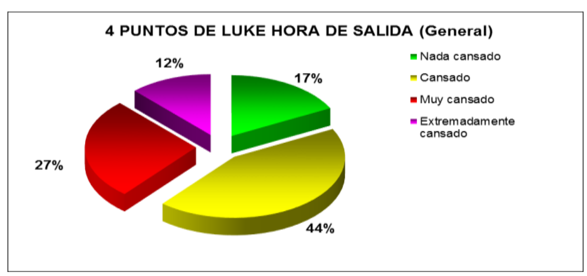
After applied ergonomic methods during 3 week with 33 drivers, with 5 of them were females and 28 males. We obtained as minor problem, the concentration. In the other hand, monotony is a big problem in taxi drivers witch is found at the beginning of the day, followed of physical damage that is presented at the end of workday. In the research we could see that the fatigue increased during the days.





We applied 4 points of Luke, and we determinate that 36% of the drivers have fatigue at the beginning of the workday, 27% end his work very tired, 3 % start the day extremely tired and during the week it increased to 12% when they finish their working day.





4. CONCLUSION

In conclusion, there is a high index of fatigue in the taxis drivers from the city of Los Mochis, where the drivers who begin to work at 3 Am present more fatigue, because more of them didn't rest enough and the conditions are unfavorable for them. Moreover, they presented problems with the concentration for stress, noise and fatigue. In the case of female taxi drivers they present more tired than men, which may be because besides being cab drivers are mothers, and after work instead of resting serve their children and perform domestic work, which it has greater fatigue when going back to their workday. In some cases some taxi drivers besides having this craft have other jobs, which causes fatigue and increase your risk.

The presence of fatigue can also be due to the lack of adequate food presented by taxi drivers, because over many hours working are not given the time to eat, or if they do, do it healthily bringing different problems reflected in its health.

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ERGONOMIC RESEARCH ON FATIGUE POSSIBLE SHOEMAKER (SHOE REPAIRERS) CITY OF LOS MOCHIS, SINALOA.

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RESUMEN: En este artículo se presentan los resultados de una investigación ergonómica registrada en la ciudad de Los Mochis Sinaloa durante el período de noviembre y diciembre, con una duración de tres semanas, con el apoyo de dos métodos de evaluación subjetiva, Yoshitake y la escala de 4 puntos de Luke. Los resultados obtenidos en este estudio se analizaron estadísticamente, y se demuestra que hay un trabajo con fatiga física y mental en el trabajo de zapatero.

PALABRAS CLAVE: Zapatero, Yoshitake, 4 puntos de Luke, fatiga.

Relevancia para la Ergonomía: El objetivo es proporcionar los conocimientos ergonómicos necesarios al grupo de trabajadores implicados para mejorar su salud en el trabajo.

ABSTRACT: This paper presents the results of an ergonomic research done on September 1 Shoemaker (shoe repairers) registered in the City of Los Mochis Sinaloa during the period of November and December with a duration of three weeks , supported by two subjective assessment methods as Yoshitake and scale 4 Points of Luke. Results obtained in this study were statistically analyzed, which showed that there is a class labor Fatigue Physical and Mental type in the shoemakers respondents.

KEYWORDS: Shoemaker, Yoshitake, 4 points of Luke, fatigue.

Relevance to Ergonomic: It seeks to provide ergonomic knowledge necessary to the group of workers involved to improve their occupational health.

1.- INTRODUCTION

In this study, the interest is to know whether fatigue in workers at shoe repairs in Los Mochis, Sinaloa is presented.

This office is one of the oldest in the world, so the processes used for this work have not been fully automated and most work is still done manually yet.

2.- GENERAL PURPOSE

Determine if there is physical fatigue because of the work of shoemakers (shoe repairers) in the city of Los Mochis, Sinaloa.

3.- METHODOLOGY

For this study it's used the Yoshitake questionnaire; the questionnaire is divided into 3 groups of 10 questions each, the first group of questions associated with symptoms of drowsiness and monotony , the second takes into account the difficulty of concentration and third relate to physical symptoms or physical damage projection .

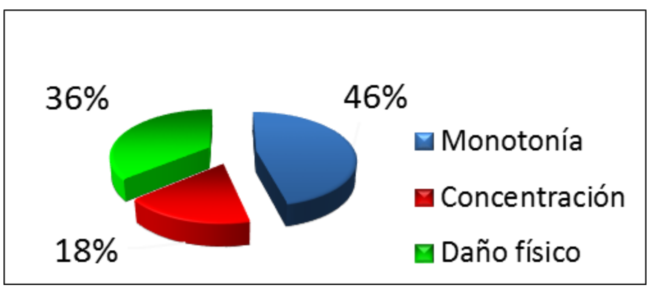
Similarly , it was used a scale to determine the level of fatigue called the 4 points of Luke, this fatigue levels are categorized after a normal working day , where the measurement scale is as follows: "Nothing tired " 1 point " tired " 2 points " very tired " 3 points and " extremely tired" 4 points.

Method for determining fatigue: It was applied to them daily assessment to people who agreed to cooperate with the investigation , one at the check in time and the second departure time , this for three weeks , filling formats for determining fatigue Yoshitake and 4 points Luke .

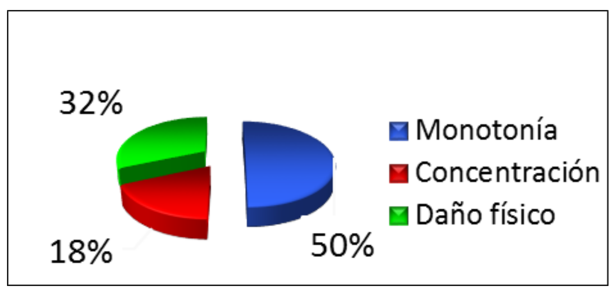
The information collected during the study period was captured later in Excel. He ended with the interpretation of the answers to suggest recommendations.

4.- RESULTS YOSHITAKE

Figures 1 and 2 show overall percentages of 3 weeks when the research was conducted. It is noted that at the beginning of the day 46% of the sample symptoms of monotony, while at the end of the day continues to increase to 50% thereby reducing physical damage and being equal concentration.



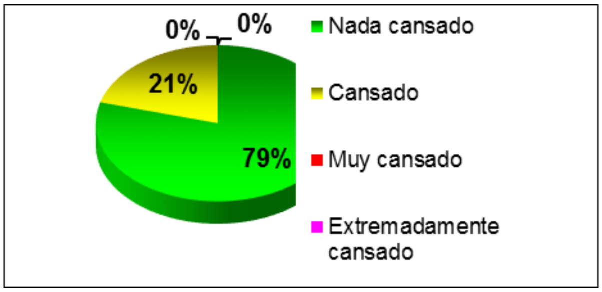
Graphic 1. Total symptoms presented (check in time)



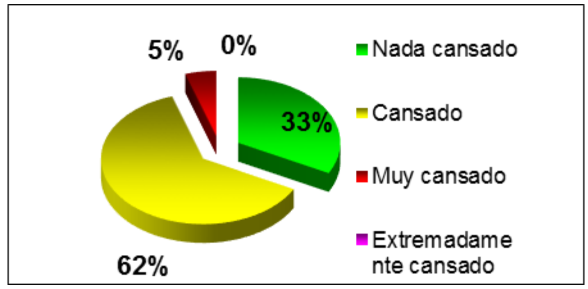
Graphic 2. Total symptoms presented (departure time)

5.- 4 POINTS OF LUKE

In Figure 3 and 4 overall percentages of 3 weeks when the research was conducted is. One can see that at the beginning of the day 79% of the sample is nothing tired, while the remaining 21 % are tired. At the end of the day shoemakers they are tired by 62 %, very tired by 5 % and nothing tired decreasing to 33%.



Graphic 3. Luke 4 point input time (general)



Graphic 4. Luke 4 point departure time (general)

6.- CONCLUSIONS

With regard to the results of the 4 points of Luke, one can conclude that there is a fatigue with progressive form while mostly worked this change reflects the end of the workday. The Yoshitake study reveals that like the 4 points of Luke as a whole there is an increase in the monotony and physical damage shoemakers at the end of the day.

With regard to the results of Yoshitake, the main symptom is present shoemakers physical damage and monotony, followed by concentration problems. There is sufficient statistical evidence gathered during the 3 weeks to determine that the work presented is physical fatigue and mental kind in the shoemakers of the city of Los Mochis Sinaloa, data obtained from the people who participated in the survey.

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DETERMINATION OF FATIGUE IN RECEPTIONISTS OF THE MOCHIS, SINALOA

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Resumen: Recepcionistas suelen adoptar posturas incorrectas, la realización de movimientos repetitivos, muebles usados no adecuado, si estas situaciones se desarrollan muy rápido manera, o por períodos largos pueden llegar a causar una disminución de las capacidades físicas. La adopción de malas posturas en la mayoría de los casos es causada por las herramientas de trabajo deficientes con la que cuenta, o actividades rutinarias realiza, dependiendo de la situación o la gravedad produce la enfermedad y / o lesión. Identificar, analizar y evitar este tipo de situaciones, en este estudio de investigación se llevó a cabo mediante la aplicación del método de Yoshitake 30 mujeres que trabajan como recepcionistas en la ciudad de Los Mochis, Sinaloa, durante el período de diciembre de 2015 y enero de 2016, con una duración de tres semanas aplicados a tres situaciones, que el método Yoshitake se divide como síntomas de somnolencia y la monotonía, dificultad para concentrarse y síntomas corporales o proyección de daño físico, que tiene una fatiga escala de medición en un día normal de trabajo, y que también se basan en el método de la escala de 4 puntos de Lucas, que se relaciona a la fatiga durante un día de trabajo normal 1 a 4, que representan 1, no fatiga y 4 el contrario, siendo esto muy cansado. Sin antecedentes de ninguna investigación anterior sobre el tema, hemos tratado de determinar las posibles recepcionistas fatiga que afectan a la calidad de vida de las actividades individuales no sólo en el trabajo sino también en su vida fuera del trabajo. El análisis de los resultados obtenidos durante esta investigación muestra evidencia de que hay una recepcionistas fatiga mental de la ciudad de Los Mochis, Sinaloa.

Palabras clave: Fatiga, servicio al cliente, cansancio, Yoshitake.

Relevancia para la Ergonomía: Día tras día recepcionistas realicen un trabajo de rutina, donde su salud física y mental son parte de sus herramientas de trabajo, por esta razón es necesario para mantener las condiciones óptimas para su trabajo.

Abstract: Receptionists often adopt incorrect postures, performing repetitive movements, used furniture unsuitable, if these situations occur very soon way, or for long periods may actually cause a decrease in physical abilities. The adoption of bad postures in most cases is caused by poor working tools with which account, or routine activities performed, depending on the situation or severity occurs illness and / or injury. To identify, analyze and avoid such situations, in this research study was conducted by applying the method of Yoshitake 30 women who work as receptionists in the city of Los Mochis, Sinaloa, during the period December 2015 and January 2016, with a duration of three weeks applied to three situations, which the Yoshitake method is divided as symptoms of drowsiness and monotony, difficulty concentrating and bodily symptoms or projection of physical harm, having a measuring scale fatigue on a normal working day, and we also rely on the method of the scale of 4 points of Luke, which is related to fatigue during a normal working day 1 to 4, representing 1, no fatigue and 4 the contrary, this being extremely tired. With no history of any previous research on the subject, we sought to determine the possible fatigue receptionists affecting the quality of life of the individual activities not only in work but also in your life outside of work. Analyzing the results obtained during this research shows evidence that there is a mental fatigue receptionists city of Los Mochis, Sinaloa.

Key words: Fatigue, customer service, tiredness, yoshitake.

Contribution to Ergonomics: Day after day receptionists perform routine work, where their physical and mental health are part of their working tools, for this reason it is necessary to maintain optimal conditions for their work

1. INTRODUCTION

Exposure to adverse working conditions can result in momentary pain or long-term injuries. Also, poorly designed work environments contribute to lower efficiency and production, and permanent disabilities.

2. OBJECTIVES

2.1 General Objective

Determine and publicize the existence and the factors causing fatigue in the receptionists Mochis, Sinaloa.

2.2 Specific objetives

- Determine the possible presence of symptoms of concentration, monotony and physical damage in the receptionists working in the city of Los Mochis Sinaloa.
- Determine the scale on which presents the fatigue through the scale 4 point of Luke.

3. METHODOLOGY

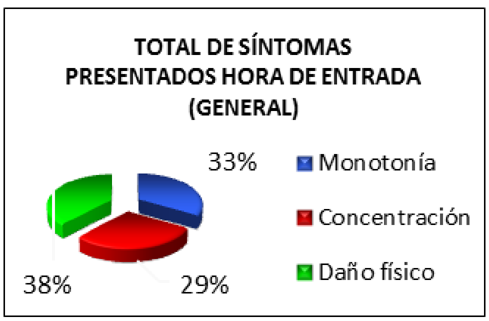
Is took a minimum sample of 30 receptionists in the city of Los Mochis Sinaloa, due to the ease of analyzing data statistically.

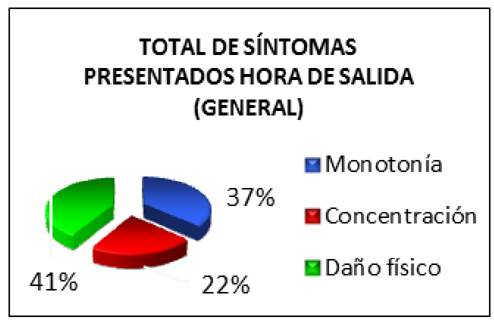
Started by selecting employees to be surveyed, informing them ahead of time that the study was to ask for your cooperation in this. Those who agreed to collaborate, is conducted it a daily assessment for three weeks, filling the formats for the determination of fatigue with Yoshitake and 4 points of Luke.

The information obtained during the period of study was captured later in Excel, to analyze the statistical data to determine the existence of factors physic fatigue or mental

4. RESULTS

4.1 YOSHITAKE

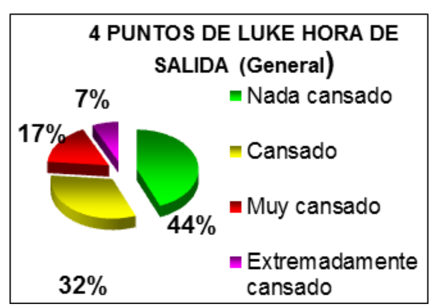




Graphic 1 and 2 TOTAL OF SYMPTOMS PRESENTED (DEPARTURE TIME)

The graphic 1 and 2 shows the general percentages of 3 weeks in which the investigation was realized. It is observed that the biggest concentration is in the monotony.

4.2 4 POINTS OF LUKE



The graph 2 shows general percentages of 3 weeks in which the investigation was realized. It is observed that the biggest concentration is in the section of tired.

5. CONCLUSIONS

Considering the results Yoshitake, the main symptom that they present the receptionists are the monotony, followed by physic damage, and problems of concentration in less percentage.

In regards to 4 points Luke, it can be concluded that if there is tiredness mainly at the end of the workday. it has statistical evidence for 3 weeks to say that if there is physical and mental fatigue by the receptionists in the city of Los Mochis, Sinaloa

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EMERGENCY MEDICAL TECHNICIANS WORKING IN MEXICAN RED CROSS DELEGATION LOS MOCHIS, SAN BLAS, EL FUERTE AND THE HONORABLE FIRE DEPARTMENT EL FUERTE. A STUDY OF FATIGUE.

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Resumen: En el siguiente estudio se busca conocer si presentan fatiga laboral en paramédicos que laboran en Cruz Roja Mexicana de Los Mochis, Ahome, San Blas, El Fuerte y el H. Cuerpo de Bomberos de El Fuerte, Sinaloa, los cuales al realizas sus actividades laborales pueden presentar dicha fatiga y como consecuencia tener un bajo rendimiento laboral y desarrollar enfermedades como lo son estrés, depresión, entre otras. Según los paramédicos que laboran y cooperaron durante la investigación al ser realizadas las encuestas se determinó que los resultados de los síntomas de monotonía y síntomas de dificultad de concentración permanecen en mismo rango debido a que la concentración la obtienen con la experiencia al realizar las diferentes tareas y el cansancio físico aumenta de manera notoria en la finalización de la jornada laboral.

Palabras clave: Fatiga, malestar, cansancio.

Contribucion a la Ergonomía: Este análisis es importante para la ergonomía, al igual que para los paramédicos, ya que ayudan a preservar la salud de las personas, que es el objetivo principal de ambos. Por lo tanto, esta investigación proporciona datos para futuras investigaciones. A través de esta, las personas relacionadas con dicha información puede mejorar su nivel de vida y al mismo tiempo, proporcionar un mejor servicio a la población en necesidad de conocimientos profesionales aplicado

Abstract: In the following study seeks to know if they have work fatigue paramedics working in Mexican Red Cross of Los Mochis, Ahome, San Blas, El Fuerte and H. Fire Department of El Fuerte, Sinaloa, which to perform their work activities can file such fatigue and consequently have a low working efficiency and develop diseases such as stress, depression, among others. According to the paramedics who work and cooperate during the investigation being conducted surveys it was determined that the results of the symptoms of monotony and symptoms of difficulty concentrating remain in the same range because the

concentration of the gain with experience in performing different tasks and physical fatigue increases markedly at the end of the workday.

Keywords: Fatigue, discomfort, exhaustion.

Relevance to ergonomics: This analysis is important for ergonomics, just as for paramedics because they help preserve the health of people, is the main objective of both. Therefore, this research provides data for future research, overwhelming information, through this, people related to such information can improve their standard of living and at the same time provide a better service to the population in need of professional knowledge applied.

1. INTRODUCTION

During the following research, the information obtained is based on knowing if fatigue occurs in paramedics working in different institutions providing prehospital service. The Royal Academy of the Spanish Language defines a paramedic as "one who is related to medicine without belonging to it."

"Fatigue is one aspect that is present in any work situation. However, when it is excessive or not an adequate level of rest that allows control occurs, may arise some situations that could affect the welfare of workers, such as the occurrence of absenteeism, fatigue, exhaustion, accidents and incidents labor". (Valdivieso, 2013)

2. OBJECTIVE

Determine whether labor fatigue in the Mexican Red Cross paramedic from Los Mochis, San Blas, El Fuerte and the Honorable Fire Department from El Fuerte.

3. METHODOLOGY

The results of this study were based on the number of people who worked based on Mexican Red Cross delegation Los Mochis, San Blas and El Fuerte, also the fire department working in El Fuerte and agreed to them analyzed for the study. To develop work techniques were chosen Yoshitake and 4 points of Luke as the main tools were chosen.

3.1 Fatigue measurement

To measure occupational fatigue there are various tools and methods that help us capture quantitative or qualitative level of fatigue of the workers way. In this study is applied the Yoshitake questionnaire. The questionnaire is divided into 3 groups of questions, the first consists of 10 questions related to symptoms of drowsiness and monotony, the second has 10 questions related to the difficulty of concentration, and the latter are 10 questions related to physical symptoms or projection of damage physical.

Similarly, a scale was used to determine the level of fatigue. On this scale, called the 4 points of Luke, fatigue levels are categorized after a normal working day, where the measurement scale is: "nothing tired" 1 point "tired" 2 points "very tired "3 points and" extremely tired "4 points.

4. RESULTS

4.1Yoshitake

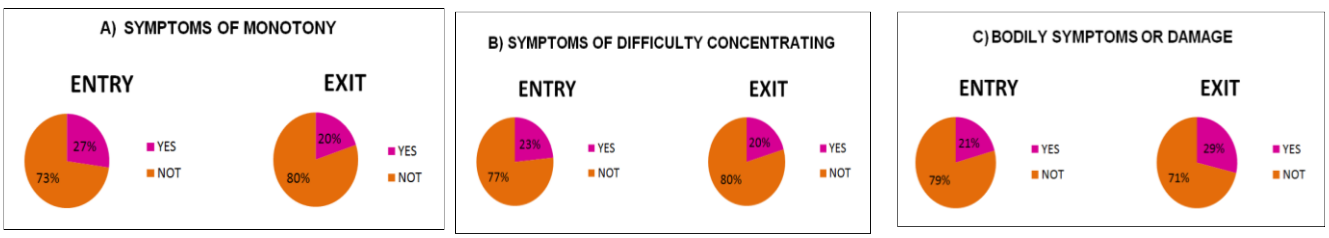

Figure 1. Comparison of the 3 groups between entry and exit time a) Monotony, b)Difficulty concentrating and c) physical damage

Generally shows the existence of fatigue that occurs during the period of four weeks that the research was conducted. It is observed that remains above 50% which have no drudgery in their workday (see Figure1.a). It is observed that do not have too much trouble when you focus on core activities remain as the start and end their day with 77% and 80% respectively (see Figure 1.b). It is noted that present little problem regarding these symptoms of damage performing the activities of the day with a percentage lower than 30% (see Figure 1.c).

4.2 4 points of Luke

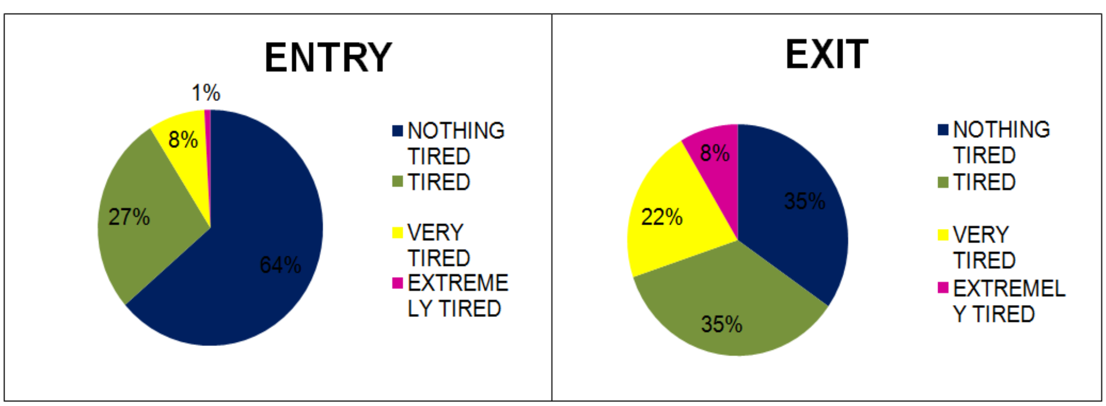

Figure 2. Comparison entry-exit fatigue with 4 points of Luke

Based on the results we can conclude that at the beginning of the day the paramedics not found anything tired while at the end of the working day there is an increase in terms of fatigue and extremely tired.

5. CONCLUSION

Based on the results of 4 points of Luke, we can conclude that there tired and extremely tired at the end of the workday, because of the tasks they perform as paramedics. With regard to the results of Yoshitake, the main symptom is present monotony to start the day, followed by physical symptoms or damage projection at the end of the workday. As for the symptoms of concentration they were not observed as much for paramedics perform tasks that are repetitive and are experienced activities become more simple and require little concentration. There is enough evidence gathered during the four weeks to say, if little work fatigue occurs in the paramedics who participated in the survey because they have bedrooms where they can rest when they perform a service of their respective institutions.

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POSTURAL RISK ASSESSMENT USING MOBILE APPLICATIONS

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Resumen: La evaluación ergonómica de puestos de trabajo es importante ya que detecta los diferentes factores de riesgo ergonómico que pudieran repercutir en los empleados, analizan a detalle las diferentes actividades que engloban los procesos de trabajo así como la relación entre estos con las características físicas de las máquinas y herramientas que manejan. La finalidad de este trabajo es desarrollar una aplicación para dispositivos móviles que permita evaluar los riesgos posturales en diversos sectores laborales de la región, de forma que contribuya en eliminar la presentación de lesiones músculo-esqueléticas (TME). Para ello se seleccionaron estaciones de trabajo por tipo de sector donde se realicen actividades posiblemente riesgosas, a estas se les aplicó el método RULA; después se realizó un bosquejo para desarrollar la aplicación para dispositivos móviles basándose en la hoja de campo del método aplicado; posteriormente se analizaron las actividades mediante esta herramienta, permitiendo validar la información arrojada y finalmente se establecieron propuestas de mejora a cada uno de los puestos de trabajo. Como conclusión se tiene que el generar evaluaciones permitió validar la nueva aplicación, determinar el alto nivel de riesgo ergonómico en las posturas evaluadas lo que hace indispensable ampliar el estudio y generar propuestas de mejora de la actividad desarrollada contribuyendo en la disminución de los TME. Por último se puede aseverar que la nueva aplicación será de gran ayuda en el proceso de enseñanza aprendizaje en las Instituciones educativas.

Palabras clave: Análisis, ergonomía, LME, aplicaciones para dispositivos móviles.

Relevancia para la Ergonomía: Facilitar la aplicación de la ergonomía utilizando tecnologías de la información.

Abstract: The ergonomic evaluation of workstations is important to detect different ergonomic risk factors that could affect employees, also analyze in detail the different activities that includes work processes and the relationship between these with the physical characteristics of the machines and tools that employees use. The purpose of this work is to develop an application for mobile devices for postural risk assessment in various business sectors in the region, so that it contributes to eliminate the presentation of musculoskeletal disorders (MSD). To achieve this, workstations were selected by type of industry where potentially risky activities are carried out, on them was applied the RULA method; then a sketch was done to develop the application for mobile devices based on worksheet of RULA method; after that the activities were analyzed using this tool, allowing to validate the obtained information and finally improvement proposals were established for each workstation. As conclusion it was obtained that generating evaluations allowed to validate the new application, also to determine the high level of ergonomic risk in the evaluated positions which makes it essential to extend the study and generate improving proposals for the activity contributing to the reduction of MSD. Finally it can be stated that the new application will help in the teaching-learning process in educational institutions.

Keywords: Analysis, Ergonomics, MSD, applications for mobile devices.

Relevance to Ergonomics: Facilitate the application of ergonomics using information technologies.

1. INTRODUCTION

Musculoskeletal disorders (MSD), are damages to muscles, joints, tendons, ligaments, bones and nerves of the body that they develop over the time and are caused by the activity and/or work environment (Agencia Europea para la Seguridad y Salud en el Trabajo, 2013). According to the Instituto Nacional de Seguridad e Higiene en el Trabajo in Spain, MSDs worldwide are related to back pain (50.3%), followed by neck (32.0%), shoulders, arms, elbows, wrists, hands-fingers (26,6%). Of the cases registered in Sonora between 2010- 2012, it was obtained that Hermosillo city has the highest number of incidents with 350 cases, followed by Guaymas with 90, during the same period the Instituto Mexicano del Seguro Social (IMSS) paid for laboral inhability around 18 millions of Mexican pesos because of such conditions and 5 million of them were spent in Guaymas(Sandoval & Gil, 2014), the economic impact of these injuries is because they cause a large number of days of absenteeism either by medication of employee and losses in production, promoting the ratio between direct and indirect costs of these injuries as 1: 4 (Vallejo, 2002). In this situation it has been observed that government agencies have demonstrated an increased interest in generating regulations to allow analysis, diagnosis and improvement of worksites through the use of proper Ergonomics techniques, techniques that can take advantage of the new possibilities that technology creates given the relationship between the organization and information systems (Restrepo, 1999).

2. OBJECTIVE

Develop a postural risks assessment in various employment sectors in the region of Guaymas through the use of applications for mobile devices, which allow contribute to avoid presenting musculoskeletal injuries.

3. METHODOLOGY

For the project development, DMAIC methodology by Socconini (2008) was applied, which it is composed of: a) Select or define workstations potentially risky, for this a characterization of the system under study will be made, describing the activity made by the worker; b) Measure risky positions, applying ergonomic assessment methods, specifically by the RULA method worksheet, then the mobile application will be designed allowing to use it as described above with the purpose of optimize resources, to finally validate and establish a comparison of results; c) Analyze, the results of each activity will be reviewed with the purpose of verify the results of the assessments made, allowing a comparative leading to the identification of areas of opportunity; d) Improve, in this section will be intended to improve the job in the most feasible way for those involved, avoiding possible injury or disease to future; e) Control, for this, there will be regular visits to the area with the purpose of auditing changes in working methods and new positions that could affect workers.

4. RESULTS

To Select workstations, there was a talk with managers of the workers to decide according to the characterization and description of activities, the potentially risky of them in each of the business sectors, in example, in the industrial sector were selected the preparation of sterilizing chamber and inspection under microscope; in the service sector receiving and storage; and fishing industry washing and head removal of the marine product (figure 1).

Figure 1. Workers washing and making head removal of the marine product (Fishing Industry).

Once the selected activities to measure, scores were obtained, these are described in Table 1, through the implementation and use of the worksheet stipulated by the RULA method, and the result, in most of the cases exceeding the value of 5, allows to make sure that exists a need to study the complete activity and in that case and if it is necessary modify immediately because the high risk involved to the physical integrity of the worker.

Table 1. Score of the activities through RULA method

Industrial Sector		Fishing Sector		Service Sector	
Operations	Score	Operations	Score	Operations	Score
Preparation of sterilizing chamber	7	Washing of the marine product	5	Receiving	7
Inspection under microscope	3	Head removal of the marine product	5	Storage	5

For the development of the mobile application an initial sketch was made considering the desirable characteristics with the aim of facilitating the use of them and based to the method worksheet. Once application development was completed (figure 2), proceeded to use in the analysis of the operations described with the purpose to establish a comparison between the results obtained through the method worksheet and the results obtained by the application, in this comparison there were not differences, allowing their validity and reliability.

Figure 2. Images of the developed application

While it is true that is necessary to extend the study through another postural method analysis, the following proposals were generated with the aim to improve conditions in a short term: in the activities of the industrial sector it is required adapt the cabin sterilized so that the worker does not raise his arms above his shoulders; for workers in the fishing and service sectors, the use of work tables suitable with the anthropometric dimensions of the employees, with flexible heights and allow the weight of the work equipment were suggested. Finally, as a control measure, was designed and assigned the frequent use of a checklist by the supervisors in each sector; in this checklist are considered issues about the work instruction, new process, postures of workers (static and dynamic), furnitures, scheduled work breaks, among other points that identify possible changes generated in the work activity.

5. DISCUSSION/ CONCLUSIONS

Ergonomics is a discipline that allows the analyst to take decisions for make better tasks taking care of the physical integrity of the worker to avoid awkward postures that involve in the future the happening of various musculoskeletal injuries. In conclusion, it is necessary to develop assessments in these sectors to allow, besides demonstrating the validity and benefit of the new application, to have sufficient information to determine the high ergonomic risk of the postures evaluated, generate pertinent proposals according to the situation presented contributing to prevent musculoskeletal injuries, and to determine the need to expand the study considering a larger number of workstations. Added to this, the fact of having available a reliable, easy and friendly to use tool. Finally, it is important to mention that the mobile application does not replace the traditional method of analysis, but it will be of great help as a support tool in the initial evaluation of postural risks and teaching - learning process at educational institutions, at the same time representing a good input for businesses to attend what it was specified in the draft regulation 036 issued by Secretaria del Trabajo y Previsión Social (STPS) related to the obligation for periodic ergonomic assessments of the workstations, so it is essential to continue the present study to provide optimal working conditions for employees.

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REDESIGN OF WORKSTATIONS TO REDUCE ERGONOMIC RISK FACTORS IN A ELECTRONIC MANUFACTURING COMPANY

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RESUMEN: En este trabajo se muestran las evaluaciones que se realizaron dentro de una empresa manufacturera electrónica ubicada al noroeste de México, con la finalidad de detectar las condiciones de riesgo tanto ambientales como las relacionadas con el diseño de la estación de trabajo, este estudio se centró principalmente en la iluminación en un área de la empresa que demanda esfuerzo visual por la naturaleza de las tareas allí realizadas. El análisis de posturas y levantamiento de cargas realizadas por los operadores se llevaron a cabo dentro de diferentes áreas en las instalaciones ya que, por decisiones de la empresa, se consideró mejor no tomar en cuenta la misma área en la que se evaluó la iluminación; a su vez se hizo uso del método NIOSH para comprobar la existencia riesgos potenciales para los operadores en la realización de tareas específicas. Como parte del presente trabajo, para cada situación riesgosa se presentan soluciones tentativas con el fin de que éstas sean tomadas en consideración por la empresa.

Palabras clave: rediseño de estaciones de trabajo, la iluminación, los factores de riesgo ergonómico

Relevancia pata la Ergonomía: En este artículo, se ha podido confirmar la eficacia de la aplicación sistemática de un conjunto de herramientas y metodologías ergonómicas validados con el fin de proponer mejoras para una empresa dedicada a la manufactura de productos electrónicos. Es importante reconocer la eficacia de las herramientas mencionadas en la detección de factores de riesgo de alta prioridad, con el objetivo de mejorar el nivel de productividad en la empresa objeto de estudio, así como las condiciones de trabajo en que los operadores realizan sus tareas cotidianas relativas a las empresas industriales

mexicanos. Además, una propuesta de mejora se ha hecho en lo que se refiere de la media para el transporte de cargas mediante la incorporación de un nuevo dispositivo de transporte que fue especialmente adaptado a la actividad realizada, con la observación de una disminución significativa en el esfuerzo exigido por la tarea.

ABSTRACT: In this paper, assessments from an electronic manufacturer located in the northeast of Mexico are shown, aiming to detect the risk conditions regarding both environmental and workstation layout. This study is primarily focused in illumination conditions inside an area where high visual performance is needed due to the nature of the tasks required. Both, postural and lifting assessments performed by operators, were developed within different areas in the facilities, since the company considered more appropriate not taking into account the area where the illumination conditions were evaluated; additionally, the method NIOSH was used to confirm the existence of potential ergonomic risks for the operators in performing some specific job duties. As part of the present work, tentative solutions for each risk situation are presented, aiming to be taken into consideration by the company managers.

Key Words: Workstation redesign, illumination, ergonomic risk factors

Relevance to Ergonomics: By this article, it has been possible to confirm the effectiveness of the systematic application of a toolkit and validated ergonomic methodologies in order to propose improvements for an electronic manufacturer. It is important to recognize the effectiveness of the aforementioned tools in the detection of high priority risk factors, aiming to improve the productivity level in the company under study, and the work conditions where the operators perform their everyday tasks concerning the Mexican industrial companies. Additionally, an improvement proposal has been made in regards of the mean for transporting loads by incorporating of a novel transportation device which was specially adapted to the activity performed, observing a significant decrease in the effort demanded by the task.

1. INTRODUCTION

1.1 Company description

The present project was developed in a technologic international manufacturer which is mainly focused in offering connectivity and sensors solutions for a high demand market. The main activity of the company located in Sonora, México is the assembly of electronic products for industries such as automotive, telecommunications, healthcare, aerospace, navy and military defense.

1.2 Problem description

Part of the work will be developed in an area where small components are assembled mostly for customers from the military industry. In this location the illumination measurements will be collected, creating a record of the lux level in the area to evaluate whether the illumination conditions are adequate.

By assessing the workstations, it was found that many situations and factors both environmental and layout-related produce physical inconveniences in the operators when it comes to perform their daily tasks.

The small pieces to be manufactured require a specific orientation to be correctly assembled. After the operators have spent a significant time working in the line the activity becomes difficult, this is caused by the nature of the pieces and additionally, a significant focus level is demanded in order to allow the precise movement. The other part of the research was conducted in different parts of the facilities, aiming to detect additional unconformities in the layout station, that may be improved by the application of ergonomic tools.

It was corroborated whether the environmental conditions of illumination comply with the limits currently allowed by the Secretaría del Trabajo y Precisión Social (STPS) which is the official Mexican organism in charge of this matter; there is a proposal made for every inadequate situation founded after the analysis.

1.3 Definitions

Responsible or supervisor: person in charge of applying the safety and health actions in the workplace, according to the correspondent norms (STPS, 2006)
Safety and health in the workplace: actions in matter of safety and health that must be performed in the workplaces aimed to prevent work risks according to the correspondent norms (STPS, 2006).
Ergonomics: is a preventive specialty, which has the function of examine the work conditions in order to achieve the best possible harmony between the man and his work environment, and additionally, obtaining optimal comfort conditions and production efficiency (Llaneza, 2010).
Noise: sound which levels of acoustic pressure, in combination with the exposure time, may be harmful to the health of the workers (STPS, 2001).
Work Area: is the place of the work center where normally a worker develops his tasks (STPS, 2008).
Illumination: illuminance: is the relationship of the incident luminous flow in a surface per area unit, expressed in lux (STPS, 2008)

1.4 Framework

According to Bridger (2003), the importance of ergonomics lays in its application, because the obtained benefits can be: layout design improvements, organization safety and compliance with the legal norms related to safety and work hygiene. Melo (2009) considers that ergonomics is important because its approach addresses the adaptation between the environment (noise, temperature, vibration and weather), the company (tasks and work pace), and the place to work (risks related to the equipment and machines).

Workstation and assembly stations are the heart of many manufacturer operations. Both working space and workstations play a vital role in worker productivity (Lešková, 2014). Planning and design of activities at manual stations, and establishing an appropriate work method for the employee are challenging tasks (Ben-Gal & Bukchin, 2002). Moreover, it is important to take into consideration a design that be as flexible, ergonomic and efficient as possible (Lešková, 2014).

Górny (2012) argues that a crucial factor to achieve success in any commercial entity is the health and occupational safety; some of these considerations are contained in the work environment, which impacts the satisfaction level of the interested parts. The work environment is increasingly considered as a key factor to an efficient execution of the tasks.

In the ergonomics field, a big number of tools and evaluation methods have been established, these techniques allow to know and measure work conditions (Dalmau & Nogareda, 2008). There are several methods that take into account factors such as noise, temperature, among others, in order to assess the conditions of the workplace (Asensio-Cuesta et al., 2012). Yasmin et al. (2013) established that it is important to have a surveillance system in the workplaces, by a proper inspection of the safety and maintenance of the industrial hygiene.

2. OBJECTIVES

General objective:

- Detect work conditions in order to propose corrective actions that produce an improvement in the operators' wealth and in the efficiency of their activities performance.

Specific Objectives:

- Detect risk work conditions in which the workers operate and may affect the quality life of them and the efficiency observed at work.
- Develop an improvement proposal in regards of the environmental conditions and the structure of the workstation where they are currently operating.

3. METHODOLOGY

It was conducted a measurement record of the relevant factors in the work areas according to the procedures established by the STPS in matter of the environmental conditions of bigger impact for the operators. In this case, the illumination will be taken into consideration.

Next, the real conditions of the work environment that were recorded and analyzed; then, these were compared to the limits established in the Mexican

Official Norms (NOMs) emitted by the STPS. After that, the root causes of the non-conforming conditions were searched and tentative corrective actions were presented to improve the current situations.

A report containing the measurements records and the respective comparisons with the official limits, accompanied by a list of feasible tentative solutions was developed aiming to create better environmental conditions; this report was given to the engineer in charge of the work area.

Additionally, a tour has been done in the plant floor to identify tasks that may affect the health of the worker. We proceeded to create improvements in the layout design of stations by implementing tools and equipment, both engineer-based, considering the conditions and harmful factors, in order to reduce as much as possible those undesirable effects for the wellness of operators.

4. RESULTS

4.1 Diagnosis

4.1 Diagnosis of environmental conditions

In Figure 1 is presented the area where several activities are performed, such as insertion, packaging and inspection of electronic components. The illumination measurements were recorded within this area.

The illumination conditions were verified in concordance with the STPS. The measurements were taken by an electronic lux meter and are shown in Table 1.

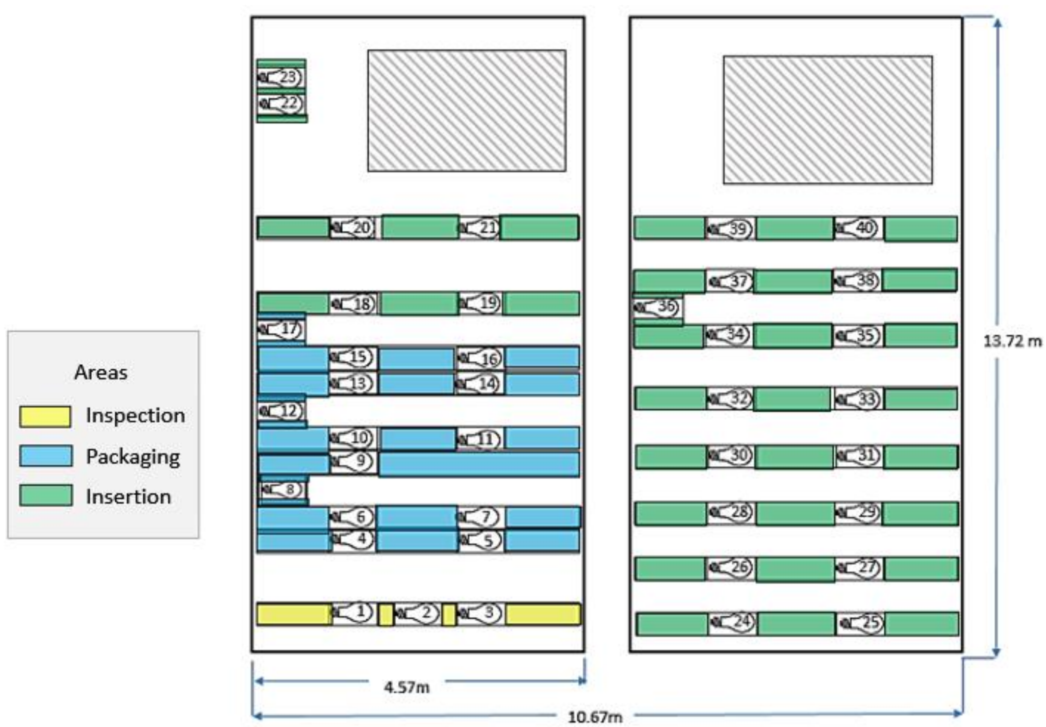

Figure 1. Location of measure points

Table 1. Illumination levels (part 1)

Aarea	Activty	Task Requirement	Minimum lux level	Lux observed	Comentaries
1	Inspection	Clear distinction of details	500	1024	White-light microscope
2	Inspection	Clear distinction of details	500	460	Warm-light microscope
3	Inspection	Clear distinction of details	500	836	LED light, magnifying glass 4x
4	Assambly	Morerate distinction of details	300	588	
5	Assambly	Morerate distinction of details	300	562	
6	Assambly	Morerate distinction of details	300	430	
7	Packaging	Simple visual requirement	200	483	
8	Assambly	Morerate distinction of details	300	500	There are no lights
9	Assambly	Morerate distinction of details	300	320	There are no lights
10	Assambly	Morerate distinction of details	300	452	
11	Assambly	Morerate distinction of details	300	482	
12	Assambly	Morerate distinction of details	300	424	There are no lights
13	Assambly	Morerate distinction of details	300	341	There are no lights
14	Assambly	Morerate distinction of details	300	300	There are no lights
15	Assambly	Morerate distinction of details	300	447	
16	Assambly	Morerate distinction of details	300	478	
17	Assambly	Morerate distinction of details	300	365	There are no lights
18	Assambly	Morerate distinction of details	300	272	There are no lights
19	Assambly	Morerate distinction of details	300	250	There are no lights
20	Assambly	Morerate distinction of details	300	479	
21	Assambly	Morerate distinction of details	300	511	
22	Packaging	Simple visual requirement	200	398	The lights are located perpendicularly to the table
23	Packaging	Simple visual requirement	200	256	The lights are located perpendicularly to the table

Table 1. Illumination levels (part 2)

Table 1. Illumination levels (cont.)

Aarea	Activty	Task Requirement	Minimum lux level	Lux observed	Comentaries
24	Assambly	Morerate distinction of details	300	462	
25	Assambly	Morerate distinction of details	300	617	
26	Assambly	Morerate distinction of details	300	277	There are no lights
27	Assambly	Morerate distinction of details	300	338	There are no lights
28	Assambly	Morerate distinction of details	300	360	1 light is out of service
29	Assambly	Morerate distinction of details	300	540	1 light is out of service
30	Assambly	Morerate distinction of details	300	227	There are no lights
31	Assambly	Morerate distinction of details	300	251	There are no lights
32	Assambly	Morerate distinction of details	300	569	
33	Assambly	Morerate distinction of details	300	520	
34	Assambly	Morerate distinction of details	300	429	There are no lights
35	Assambly	Morerate distinction of details	300	433	There are no lights
36	Assambly	Morerate distinction of details	300	509	
37	Assambly	Morerate distinction of details	300	455	
38	Assambly	Morerate distinction of details	300	439	
39	Assambly	Morerate distinction of details	300	418	There are no lights
40	Assambly	Morerate distinction of details	300	307	There are no lights

4.2 Diagnosis of the workstation

4.2.1 Loads lifting

The weight of the loads or objects that must be manually lifted up is one of the risk factors more incident. Evidently, as the weight increases, the risk level increases too (Martínez-Vila & Irimia, 2009) In Image 1 is shown how the person lifts the load almost from the ground level. There is evident that the box does not have a grip, which directly affect the demanded effort from the operator, making this activity significantly harder to accomplish.

Image 1. Manual load lifting

4.2.2 Assessment of the lifting

For this evaluation it was carried a study aided by the NIOSH method in the packaging area, where the operator must lift a charge periodically and then take it to the rack for this purpose, located approximately to 5m of distance from the lifting point.

It was decided to select this particular activity to perform the NIOSH analysis due to the evident high risk for the operator, especially for the potential harm to the lumbar region. In the Image 2 it is possible to see the origin point of the lifting task.

Image 2. Origin position

Once the operator has filled the boxes with containers, she must manually lift it and walk with it towards the allocated rack, these boxes are kept there until they are inspected. The target position adopted by the operator during this part of the activity is shown in the Image 3.

The aforementioned information was used to calculate the index lifting with the proper equation by applying the NIOSH evaluation method. The lifting index was: 0.98, which indicated that the task may be performed by most of the operators without problems.

Image 3. Target position

4.2.3 Tentative Solution to the load lifting

In order to solve the problems related to the load lifting process for loads at the ground level, it has been proposed to use freight elevators, which have to be activated by a foot pedal, and when this gets activated make the elevator lifts, raising the load up to the center of the body, as shown in Figure 2.

Figure 2. Location of measure points

4.2.4 Tentative solution to the lifting process assessed by NIOSH method

In the evaluation by the NIOSH method it was found a tentative solution in order to avoid the manual transportation to the racks. The box 1 is the one that has to be moved and is located in a structure, which is fixed to the work table, as observed in Image 4. The box 2 is the one that contains the tubes with the electric components, once these tubes are filled must be placed in the box 1 (which is not in the following Image).

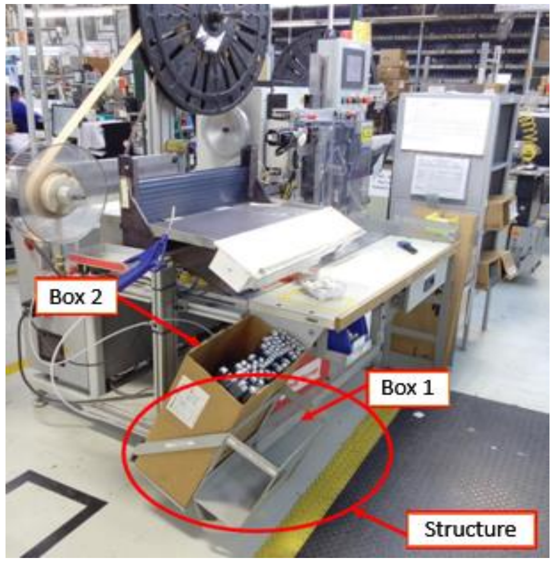

Image 4. Components of the workstation

In order to avoid this lifting process of taking the box 1 to the target rack, it has been proposed the use of a transportation cart, as shown in Figure 3, which das similar characteristics to the structure to support the boxes, but this is not fixed to the table.

Figure 3. Transportation cart

In Figure 4 the transportation cart is shown, once installed.

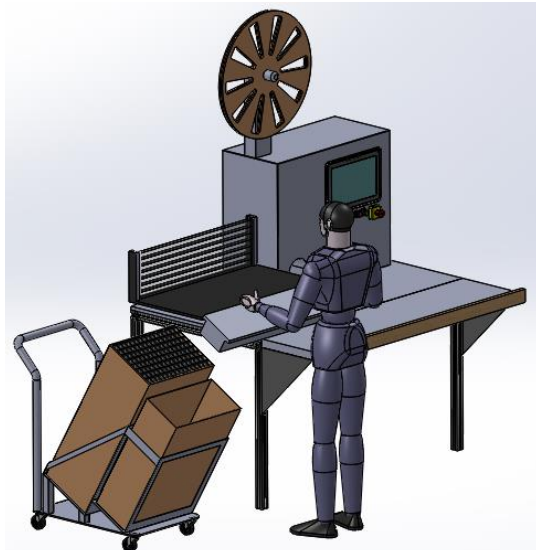

Figure 4. Design of the cart into the proposed station

4.2.5 Tentative solution to the illumination problem

As mentioned before, the area under study had some problems due to illumination inefficiencies, and the operators have to make a considerable vision effort to perform their activities. Aiming to solve this problem, the placing of individual lamps for those operators who need them. The lamps are shown in Figure 5.

Figure 5. Individual lamps for industrial use

4. CONCLUSIONS

After performing the data collection, analysis of the findings and improvements proposals, it has been possible to confirm the significant positive impact of the systematic application ergonomics in a manufacturer. Also, it was possible to identify feasible solutions in order to make the work easier and more comfortable, as well as more safety, at the same time that costs are reduced (i.e. implementation of a simple transportation device for a workstation redesign).

As a result of the many observations within the workstation, a list of findings, observations and proposals was developed and given to the engineer in charge of the area. It is highly recommended an objective estimation of the total investment, braked-down and showing the feasible options for each of the problems observed, with the amount of money required as well as the impact level for each of the solutions.

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DISERGONOMIC RISKS, STRESS LEVEL AND MUSCULOSKELETAL ILLNESSES IN INDUSTRIAL WORKERS

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RESUMEN: El presente trabajo evalúa la asociación entre la exposición a riesgos disergonómicos y riesgos psicosociales y la presencia de molestias y padecimientos músculo-esqueléticos en trabajadores industriales de 14 centros de trabajo. El estudio presenta evidencia inicialmente sobre la relación entre la exposición a riesgos disergonómicos y molestias y enfermedades musculoesqueléticas.

Palabras clave: riesgos, disergonomía, estrés, músculo-esquelético

Relevancia para la ergonomía: Este trabajo proporciona elementos de cómo las características físicas del trabajo y las exigencias del contenido de actividad pueden estar asociados con un mayor riesgo de enfermedades musculoesqueléticas

ABSTRACT: This study evaluates the association between exposure to disergonomics and psychosocial risks and the presence of discomfort and musculoskeletal conditions in industrial workers from fourteen industrial workplaces. This study provides evidence on the relationship between exposure to disergonomics risks and discomfort and musculoskeletal diseases. Also, the study identify the association between poor ergonomic conditions and the stressful nature of the job.

Key words: risks, disergonomics, stress, musculoskeletal

Relevance to ergonomics: This work provides elements of how the physical characteristics of the job and the demands of the activity content may be associated with an increased risk of musculoskeletal diseases.

1. INTRODUCTION

This study has an interdisciplinary approach between ergonomics and health psychology. Given the current importance of the study of these risks in our country this study contributes to the control of health damage caused by these two types of working conditions, the ergonomic and psychosocial risk factors.

Several authors have reported the association between discomfort and musculoskeletal diseases and exposure to disergonomics risks and stressors at work. (Gerr, et al., 2014; Widanarko, et al., 2014). The objective of this study was to identify the relationship between a simultaneous exposure to disergonomics risks and stressful work and the presence of discomfort and musculoskeletal diseases in industrial workers.

2. METHODOLOGY

This is a cross-sectional analytical study. During the period from 2013 to 2015, we studied 1414 active workers of 14 companies in the manufacturing sector.

For information on disergonomics risks to which workers were exposed it was applied the CESTUNAM questionnaire, using its section on disergonomics risks that evaluates maneuvers at work, postures, loads, movement repetition and use of tools, creating a general indicator of the degree of risk. Through the CESTUNAM questionnaire, information on musculoskeletal conditions diagnosed by a doctor in the 12 months prior to the study and the discomfort presented in the last 15 days was obtained. To assess the exposure to stressful work the Job Content Questionnaire of Karasek was used, this questionnaire allows us to classify the job positions in stressful or not, and according to the level of stress in: high, active, passive and low stress.

The information was captured in Excel and analyzed using the SPSS 20 program (2012). The odds ratio of having discomfort and diseases on workers to exposed to high disergonomic risks and stressful job, with confidence interval of 95% significance test was calculated. The value of the odds ratio (OR) indicates how many times it is more likely that these problems occur in exposed workers

3. RESULTS

In the studied population the exposure to disergonomics risks was significantly associated with an increased likelihood of having discomfort in the arms, hands and legs, as well as having taken an accident at work (Table 1)

Table 1. Risk of musculoskeletal discomfort complaints among workers exposed to a high disergonomic risk

	Discomfort	OR	95% CI
Disergonomic Risk High vs. Medium/Low	Neck	1.23	(1.04-1.50)
	Back	1.47	(1.26-1.72)
	Hands	3.72	(2.88-4.81)
	Arms	5.16	(3.73-7.13)
	Legs	3.03	(2.36-3.90)
	Work injury	4.32	(2.90-6.45)

Similarly, high exposure to disergonomics risk was significantly associated with an increased likelihood of having medical diagnosis of diseases such as osteoarthritis, low back pain and sufferings of hands (Table 2)

Table 2. Risk of musculoskeletal disorders in workers exposed to a high disergonomic risk

	Diseases	OR	95% CI
Disergonomic Risk High vs. Medium/Low	Osteoarthritis	6.08	(3.5-10.40)
	Low Back pain	2.31	(1.68-3.16)
	Hand disease	4.47	(3.02-6.61)

Disergonomics simultaneous exposure to risks and stressful job was significantly associated with an increased likelihood of having discomfort in all regions evaluated and have had an accident at work; while in non-exposed to stressful work, disergonomics only had a significantly related risks to discomfort in arms, hands, legs and accidents at work (Table 3)

Table 3. Risk for musculoskeletal complaints in workers exposed to a disergonomic risk and a stressful job.

		Discomfort	OR	95% CI
Stressful job	Disergonomic Risk High vs. Medium/Low	Neck	1.97	(1.47-2.66)
		Back	1.94	(1.50-2.52)
		Hands	2.86	(2.05-3.99)
		Arms	3.92	(2.61-5.90)
		Legs	2.58	(1.85-3.59)
		Work injury	2.37	(1.47-3.81)
Non-Stressful job	Disergonomic Risk High vs. Medium/Low	Neck	0.89	(0.70-0.88)
		Back	1.23	(0.99-1.52)
		Hands	4.53	(3.04-6.73)
		Arms	6.07	(3.57-10.33)
		Legs	3.13	(2.11-4.64)
		Work injury	9.43	(4.52-19.68)

Regarding related diseases the simultaneous exposure to disergonomics risks and stressful job has a significant association with suffering the differente diseases, but in the non-exposed group the suffering of hand osteoarthritis had higher risks (Table 4)

Table 4. Risk of musculoskeletal disorders in workers exposed to high disergonomic risks and stressful job.

		Diseases	OR	95% CI
Stressful job	Disergonomic Risk	Osteoarthritis	2.54	(1.40-4.61)
	High vs. Medium/Low	Low Back pain	1.58	(1.05-2.39)
		Hand disease	2.79	(1.70-4.57)
Non-Stressful job	Disergonomic Risk	Osteoarthritis	31.18	(7.58-128.21)
	High vs. Medium/Low	Low Back pain	3.35	(2.06-5.46)
		Hand disease	7.46	(3.95-14.07)

The risk of discomfort related to the level of stress and disergonomic risk, shown that the groups of passive and active work had the highest risk of discomfort and accidents (Table 5)

Table 5. Risk of musculoskeletal complaints among workers exposed to risks nonergonomics degree of job stress

Level of stress		Discomfort	OR	95% CI
High	Disergonomic Risk High vs. Medium/Low	Neck	1.91	(1.22-2.98)
		Back	1.71	(1.20-2.42)
		Hands	1.96	(1.29-2.97)
		Arms	3.35	(1.93-5.82)
		Legs	1.92	(1.27-2.93)
		Work injury	2.18	(1.01-4.68)
Passive	Disergonomic Risk High vs. Medium/Low	Neck	1.36	(0.70-0.88)
		Back	1.45	(1.11-1.88)
		Hands	4.04	(2.74-5.96)
		Arms	7.36	(4.46-12.15)
		Legs	4.03	(2.63-6.18)
		Work injury	6.28	(3.62-10.88)
Active	Disergonomic Risk High vs. Medium/Low	Neck	1.36	(1.04-1.79)
		Back	1.97	(1.26-2.42)
		Hands	9.19	(3.41-24-73)
		Arms	6.18	(2.25-16-92)
		Legs	5.01	(2.20-11.40)
		Job injury	5.01	(1.16-21.55)

Low	Disergonomic Risk High vs. Medium/Low	Neck	0.91	(0.64-1.31)
		Back	1.22	(0.89-1.66)
		Hands	5.02	(2.56-9.84)
		Arms	3.71	(1.59-8.68)
		Legs	2.44	(1.39-4.30)
		Work injury	5.74	(1.95-16.85)

The risk of musculoskeletal diseases related to the level of stress and disergonomic risk, shown that showed that the passive and active stress groups had the higher risks of presenting different diseases (Table 6)

Table 6. Risk of musculoskeletal disorders in workers exposed to disergonomics risks by level of job stress

Level of stress		Diseases	OR	95% CI
High	Disergonomic Risk High vs. Medium/Low	Osteoarthritis	1.77	(0.57-5.51)
		Low Back pain	1.27	(0.65-2.48)
		Hand disease	3.01	(1.36-6.64)
Passive	Disergonomic Risk High vs. Medium/Low	Osteoarthritis	8.13	(4.40-15.01)
		Low Back pain	4.33	(2.74-6.83)
		Hand disease	5.96	(3.43-10.36)
Active	Disergonomic Risk High vs. Medium/Low	Osteoarthritis	--	(0.99-1.10)
		Low Back Pain	1.71	(0.73-3.99)
		Hand disease	2.84	(0.97-8.25)
Low	Disergonomic Risk High vs. Medium/Low	Osteoarthritis	--	(7.58-128-21)
		Low Back pain	1.43	(0.63-3.22)
		Hand disease	7.17	(2.50-20.59)

4. CONCLUSIONS

This study provides evidence on the relationship between exposure to disergonomics risks and discomfort and musculoskeletal diseases. Also, the study identify the association between poor ergonomic conditions and the stressful nature of the job. This association mainly was shown in active and passive stress groups, different to that reported in other studies. These results may be influenced by the precarious employment conditions of most industrial workers in our country. In other reports should be analyzed more in detail the characteristics of disergonomics risks and tasks involved in producing discomfort and musculoskeletal disorders.

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CONTRIBUTIONS FROM ERGONOMICS TO THE DESIGN OF HEALTHCARE SERVICES: A LITERATURE REVIEW

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Resumen: Los sistemas de servicios de salud son diferentes a otros debido a la constante interacción entre sus usuarios y la naturaleza dinámica de los mismos. La complejidad de estos servicios puede implicar mayor vulnerabilidad, fallas y errores, lo cual puede repercutir directamente en el estado de salud del paciente, la seguridad y bienestar de los otros usuarios involucrados, así como en la calidad del servicio. Dentro de los usuarios del área de salud, los adultos mayores deben ser considerados como una prioridad durante la prestación del servicio debido a que presentan una reducción de las capacidades motoras, sensoriales y cognitivas dadas por la edad. Desde la ergonomía y con la visión del diseño inclusivo se pueden generar estrategias para hacer que los servicios en general sean más accesibles y usables, para una gama más amplia de personas y situaciones. El objetivo de este trabajo fue identificar los criterios ergonómicos para diseñar y evaluar el uso del servicio de salud por parte de los adultos mayores mediante una revisión sistemática de la literatura existente. Para realizar la búsqueda se enlistaron varias palabras claves, luego se eligieron según el título y finalmente se revisaron aquellos artículos que en su resumen respondían al objetivo de la búsqueda. En total se revisaron 30 artículos que relacionaban criterios para el diseño y evaluación de los servicios de salud. La revisión permitió clasificar los artículos seleccionados en 5 subtemas: 1) Los servicios de salud en general, 2) interacción objeto-usuario-tarea, 3) importancia de los pacientes, 4) importancia de cuidadores y profesionales de la salud, y 5) contexto específico de pacientes con demencia. Las investigaciones han considerado la ergonomía como componente integrador de los elementos que interactúan constantemente en los servicios de salud, esto desde una perspectiva internacional. En el caso de los servicios que atiente adultos mayores, es de importancia considerar el detrimento cognitivo puesto que aumenta las barreras que se presentan durante la interacción con los servicios y el uso de productos en la vida diaria.

Palabras clave: Ergonomía, Diseño de Servicios Inclusivos, servicios de salud

Relevancia para la Ergonomía: Con esta revisión de literatura se puede visualizar el panorama de los servicios de salud y las barreras que se generan para los adultos mayores, los cuidadores y los profesionales de esta área, cuando usan el servicio. Por tanto subraya la importancia de investigar desde el campo de la ergonomía los elementos que faciliten el uso del servicio por parte de los usuarios que poseen mayor dificultad para acceder y ser parte del mismo, y con ello mejorar su calidad de vida.

Abstract: Service systems for healthcare are different from other because of the high intensity of interaction between users and the dynamic nature of it. The complexity of these services may involve greater vulnerability, mistakes and errors, which can directly impact on patient's health, safety and well-being of other people involved, but also on the service quality. Among the users within the healthcare services should be considered elderly population and particularly those with dementia disease since they have a reduction in the abilities of the motor system, sensory and cognitive.

Ergonomics and Inclusive Design can offer strategies to provide more accessible and usable services for a wider range of people and situations. The aim of this work was identify, through a systematic review of the literature, the ergonomic criteria for designing and evaluating the use of healthcare services by elderly people. A list of various keywords was used for the review, then the articles were chosen by title and finally the abstracts were read and selected those that met the criteria of the search.

Thirty scientific articles were reviewed in relation with the criteria for the design and evaluation of healthcare services. The review allowed the classification of selected articles in 5 sub-themes: 1) Healthcare services overall, 2) interaction object-user-task, 3) importance of patients, 4) the importance of caregivers and health professionals, and 5) the context of patients with dementia. Researches, from an international perspective, have considered ergonomics as integrator of the elements that constantly interact within healthcare services. In the case of services for older adults is important to consider cognitive decline due to it increases the barriers during the interaction with the use of products and services in everyday life.

Keywords: ergonomics, inclusive service design, healthcare service

Relevance to Ergonomic: Literature review can show an overview of healthcare services and the barriers that older people, caregivers and health professionals could face when using or providing the service. Therefore, research using

Ergonomics is relevant to generate knowledge about the elements that can help to easily use healthcare services, especially for those users that have major difficulties for accessing this kind of systems, and thereby improve their quality of life.

1. INTRODUCTION

Among the users of healthcare services should be considered the population aged 60 years and over, which it will double by 2050 compared to 2006 (WHO, 2007) and the increase will be greater in developing countries. This should be considered due to older people need more care since they are more likely to have physical complications and cognitive impairment such as dementia, that prevent them to perform their daily life activities (WHO, 2015).

Healthcare Systems depend on the work of a variety of people, which in turn must interact with products, spaces and technology, among other elements (Carayon, Bass, Bellandi, Gurses, Hallbeck & Mollo, 2011). Consequently these systems should be considered of a dynamic nature because the connection between physical, organizational and environmental aspects are important to enabling the provision of a good service. However, the complexity due to high interaction between elements of the system increases the vulnerability to errors, which affects the service quality.

According to the Institute of Medicine (2001), the quality of service can be defined in 6 items namely safety, effectiveness, patient-centered care, timeliness, efficiency, and equity. Meanwhile Ergonomics has provided conceptual and methodological contributions to different dimensions of quality of healthcare services (Carayon, Bass, Bellandi, Gurses, Hallbeck & Mollo, 2011). In addition, from the approach of Inclusive Design, user's needs of users can be met with consideration of their abilities and what the service demand them when accessing and interacting with it (Persad, Langdon, Brown & Clarkson, 2007).

2. OBJECTIVE

The aim of this work was identify the ergonomic criteria for designing and evaluating the use of healthcare services by elderly people through a systematic review of the current literature.

3. METHODOLOGY

The literature review was performed through the Elsevier and Taylor & Francis databases. The keywords used in the search equation were classified into three topics: healthcare service, users and quality, as shown in Table 1. The selection of articles began with the inspection of the titles which allowed related with the topics of the review, followed by the analysis of the abstract. After that, the articles that contributed to the knowledge of research topic were chosen. In addition, part of the review focused on the attention given for the authors towards older adults with dementia, since this kind of users can be more vulnerable in the service due to the decline and loss of cognitive and motor abilities.

Table 1. Keywords for articles search

Service	Users	Quality
Healthcare service	Patient	Safety
Internal consultation	Caregivers	Effectiveness
Hospitals	Older people/ elderly	Efficiency
Medical care	Disability	Equity
	Dementia	

4. RESULTS

From the literature review 30 scientific articles were identified providing information about the ergonomics criteria for designing or evaluating the use of healthcare services. The articles were classified into five subgroups according to the area of research each they focused: 1) healthcare service in general, 2) interaction between object-user-task, 3) importance of patients, 4) importance of caregivers and healthcare professionals, and 5) specific context of patients with dementia.

The first thematic group included articles about service healthcare systems. In this group a research paper that identified the issues that prevent the acceptance of the use of public transport by older people from a design approach of inclusive services (Aceves, Cook & May, 2015) was added because it was considered useful for the evaluation and design of health services. From the context of the delivery of healthcare services, the quality of service has been assessed, which differs from the perspective either of the user or the service provider (Miranda Chamorro, Murillo & Vega, 2010). Furthermore, quality has been assessed by satisfaction and loyalty from users towards service (Lee, Lee & Kang, 2012). Participatory ergonomics has evaluated and identified the needs of the medical environment through simulations (Andersen & Broberg, 2015). Joshi & Woll (2015) defined the elements to provide a good interaction during the use of telecare service for both patients and their caregivers.

Another group concentrated the articles that increased the knowledge about interactions between objects, users and tasks. Within the medical context was investigated the faults in the procedure of oral medication, which were due to incompatibility between the characteristics of the packaging and capabilities of users (Ward, Buckle & Clarkson, 2010). On the other hand, medical rounds were redesigned to improve family engagement in the process (Xie, Carayon, Cox, Cartmill, Li, Wetterneck, et al., 2015). In addition, the design of medical devices, such as monitoring systems were evaluated to show the importance of human factors on the interaction (Hossain, 2014). Other research has shown the relevance of the creation of a database on the characteristics of people and their degree of disability (Gyi, Sims, Porter, Marshall & Case, 2004). The measurement of capabilities of older adults during the use of certain products allow to have aware about the needs and capabilities of users for whom is designed, as much to facilitate the use of products indifferent of context of use (Tenneti, Johnson, Goldenberg, Parker & Huppert, 2012). For example, Chamberlain, Esquivel, Miller & Patmore (2015) applied an inclusive design approach centered to facilitate the use of products of a telephonic company by older adults through applying small changes.

Within the research conducted regarding to the users of the healthcare systems, a study raised four categories (emotional, lack of knowledge, cognitive and physical impairment) to evaluate the capabilities and limitations of patients and health professionals according to the demands of the service tasks (Beer, McBride, Mitzner & Rogers, 2014). Meanwhile, Barret & Kirk (2000) provides considerations for the participation of elderly and disabled people in focus groups. The same study allowed to determine that this population has greater difficulty in home routines and that they require more physical effort, and experience the lack of information to perform activities of daily living (Barret, 2005). Chen & Chen (2014) related positively the accepting of gerontechnology with attitudinal and behavioral factors. In turn, the physical and psychological satisfaction of older adults were evaluated as predictors of comfort (Kahya, Zorlu, Ozgen, Sari, Sen & Sagsoz, 2009); also the user experience has been associated with the perception of service quality (Sauceda, Wirtz, Santa Ana & Kageyama, 2010).

Regarding to caregivers or the healthcare staff, the studies have focused on patient safety. Kostopoulou (2006) states that the causes that may affect patient safety are usually internal, external and from efficiency at the organizational level. Other studies have shown that personal and organizational factors of work as probable causes of safety problems (Fogarty & McKeon, 2006). Satisfaction of health professionals and the organizational support were related to the occurrence of medical errors (Lee, Lee & Schniederjans, 2011). The errors during distribution and delivery of medicines has been related with the transfer of information and differences on practices (Buckle, Clarkson, Coleman, Bound, Ward & Brown, 2010); Similarly, the lack communication with the caregiver of patients with dementia put on risk the patient's safety (Deeks, Cooper, Draper, Kurrle & Gibson, 2015). The inconsistency in the documents when transfering information between medical staff makes inefficient the communication processes (Collins, Mamykina, Jordan, Stein, Shine, Reyfman, et al., 2012). These formats to gather medical information show the lack of usability of their designs (Preece, Hill, Horswill, Karamatic, Hewett & Watson, 2013).

The last group of articles contemplated patients with dementia. Goodman, Baron, Machen, Stevenson, Evans, Davies, et al., (2011) showed lack of a diagnosis of dementia in the elderly population, which becomes a barrier to recognize the patients' needs. However, the study of Chou, Waszynski, Kessler & Clarkson (2015) showed that the effects of drawings of familiar elements for patients with dementia, caused positive emotions, which can be relevant to the design of support material. The construction of programs for dementia care should be a collaborative work between academics and end users for have a good result (Callahan, Boustani, Weiner, Beck, Livin, Kellams, et. al., 2011), also the work should be in and out of the hospital to generate a better quality of care and reduce barriers relate to dementia (Boustani, Sachs, Alder, Munger, Schubert, Guerriero, et.al., 2011). Similarly, consideration of the skills of professionals for the care of patients with dementia with the inclusion of education plans and training can change behavior, commitment, responsibility and understanding of their patients (Moyle, Venturato, Cooke, Hughes, van Wyk & Marshall, 2013). Additionally, the organizational support of work should be consider to provide a comfortable care, as well as aspects of personality and burnout has been associated with the ability of medical personnel to meet their patients' needs (Hunter, Hadjistavropoulos, Thorpe, Lix & Malloy, (2015).

5. CONCLUSIONS

Within the literature review were found studies that focused on knowing what is the user satisfaction and the quality of service from the perspectives of Inclusive Design and Participatory Ergonomics. These studies help to identify the importance of research focused on the interaction between users and the objects or the tasks to be performed. From the ergonomic point of view is highlighted the importance of considering the skills and abilities of users for a satisfactory use of a product or service. The studies have been conducted in contexts of specific use, or focused on a product or activity which contributes to the knowledge of requirements of use, service quality or user satisfaction. However, the review did not provide information on the elements that facilitate or hamper the use of a service for older people as users of it.

Moreover, in the case of services related to the field of Gerontology, especially with diseases that produce cognitive detriment and, therefore, increases the barriers that arise in the interaction with the service, should be considered an additional user, the caregiver. It is of great importance to recognize that in Latin America has not been found research focused on healthcare services or directly in gerontology, thus research is necessary from the Ergonomics perspective to recognize elements within the service that affects the ease of use for older people, their caregivers, as well as for service providers.

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RELATIONSHIP BETWEEN STRESS, MUSCULOSKELETAL SYMPTOMS AND ERGONOMIC RISK FACTORS OF NURSING STAFF. THEORETICAL REVIEW.

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Resumen: el estrés laboral, los síntomas musculoesqueléticos y los factores de riesgo ergonómico son aspectos estudiados por diversos autores, en algunos casos como elementos independientes y en algunos otros de manera integrada. El objetivo del presente estudio es discutir los enfoques con los que se ha estudiado la relación entre el estrés, los síntomas musculoesqueléticos y los factores de riesgo ergonómico en personal de enfermería a nivel mundial. La revisión de artículos científicos se llevó a cabo en bases de datos y revistas indexadas mediante el uso de palabras clave relacionadas con el tema de revisión. Los artículos encontrados inicialmente se seleccionaron según el título, posteriormente según la información encontrada en el resumen se escogieron aquellos que relacionaran las variables de estudio para revisión completa. La revisión final se completó con 30 artículos científicos que cumplieron los criterios de inclusion y posteriormente se clasificaron según las relaciones establecidas entre los elementos estudiados, los enfoques de evaluación y el tipo de estudio.

Palabras clave: macroergonomía, estrés, síntomas musculoesqueléticos

Relevancia para la Ergonomía: A través de esta revisión es posible entender que, aunque hay muchas herramientas y enfoques para la evaluación de un tema tan estudiado en todo el mundo, tales como síntomas musculoesqueléticos, es necesario echar mano de la Macroergonomía como elemento de estudio que puede abordar toda la situación, analizar los elementos y llegar a soluciones que generen cambios positivos en el sistema.

Abstract: work stress, musculoskeletal symptoms and ergonomic risk factors are aspects studied by different authors, in some cases as independent elements and some other integrated manner. The aim of this study is to discuss the approaches that have been studied the relationship between stress, musculoskeletal symptoms and ergonomic risk factors in nurses worldwide. The review of scientific papers was conducted in databases and journals indexed using keywords related to the subject of review. The items found initially were selected by title, then according to the information found in the summary were chosen those that related study variables for full review. The final review was completed by 30 scientific papers that met the inclusion criteria and then were classified according to the relationships between the elements studied, approaches to evaluation and type of study.

Keywords: macroergonomics, stress, musculoskeletal symptoms

Relevance to Ergonomics: Through this review study is possible to understand that although there are many tools and approaches for evaluating a subject as studied worldwide such as musculoskeletal symptoms, it is necessary to take hand of Macroergonomics as an element of study that can address from the whole situation, analyze the elements and reach solutions that generate positive changes in the system.

1. INTRODUCTION

Restrictions in the schedules, limited work spaces, control over the activities carried out and the relationship with partners and bosses, among other aspects, have begun to gain importance in the study of man as a being biopsychosocial, bearing in mind that not only the physical issues are related to the presence of diseases, particularly those of type musculoskeletal (Moncada 2000). In this sense, (Janwantanakul, Pensri, Jiamjarasrangsi, & Sinsongsook, 2009) indicate that various biopsychosocial factors are associated with a high prevalence of self-report of musculoskeletal symptoms in legs in office workers (Janwantanakul et al., 2009). In addition, the review of epidemiological literature by Bongers, Winter, Kompier & Hildebrandt has concluded that the monotonous work, the high perception of workload and pressure due to weather are related to symptoms musculoskeletal (Bongers, Winter, Kompier, & Hildebrandt, 1993). Data from this review also suggests that low control over work and lack of social support from peers are associated positively with diseases of this same type. Likewise, the perceived stress can be an intermediary in this process and contribute to the development of the mentioned diseases.

2. OBJECTIVE

Discuss the approaches that has received the relationship between stress, musculoskeletal symptoms and ergonomic risk factors in nursing staff worldwide.

3. METHODOLOGY

The review of scientific papers was conducted in specialized engines like Google academic and databases which include Pro Quest and Isi Web of Knowledge, besides indexed journals in the field of Ergonomics search. Table 1 presents the keywords used for search, which focused on studies that addressed the relationship between stress, musculoskeletal symptoms and ergonomic risk factors of nurses, published between 2001 and 2016.

Table 1. Keywords for articles search

Stress	Musculoskeletal symptoms	Ergonomic risk factors
Mental load	Work- related musculoskeletal disorder	Job risk assessment
Work stress	Health care workers	Physical workload
Strain	Nursing	Performance
Occupational stress	Work effects	

Articles found initially were selected by title. Then, according to the information contained in the summary, they were chosen those that related study variables for full review. Finally, a summary table by which carried out the analysis of the relationship between the elements that are the subject of this review was developed.

4. RESULTS

The final review was completed by 30 scientific articles, of which 57% studied the relationship between stress or similar and musculoskeletal symptoms; 30% analyzed the 3 elements considered in this review and the remaining 13% established relationships among the elements studied here, in a different way.

With regard to the approach to evaluation, 12 studies made it through the demand - Control model, 3 by means of the effort - reward model and 10 kept relationship with the biopsychosocial model. According to the study, only one was cohort, one review and others cross-sectional.

5. DISCUSSION

Models for the study of the stress, which have served as starting point for other researchers to address the issue, associated with other variables of interest as ergonomic work factors, aspects of organizational type and the presence of (SME-rT) work-related musculoskeletal symptoms have arisen over time. Other authors, on the other hand, have contributed to this field of study through new instruments of evaluation of stress, without necessarily adhering to the classical models.

The demand/Control model proposed by Karasek is based on psychological demands of work, the use of skills, and control over tasks such as predictors of a wide range of consequences for health and behavior in the structure of the work

(Karasek & Theorell, 1992). Accordingly, six cross-sectional studies published from 2001 to 2011 match Job Content questionnaire, JCQ for its acronym in English, to be used to evaluate the variables in the demand - Control model. Mostly, the results suggest that a relationship exists between the lack of control at work and the presence of SME-rT, particularly when the physical workload is high (Daraiseh, Genaidy, Karwowski, Davis, Stambough, Huston, 2003; Hollmann, Heuer, & Schmidt, 2001; Johnston, Jull, Souvlis, & Jimmieson, 2010; Mehta, Nussbaum, & Agnew, 2012; Mehta & Parijat, 2011; Wahlström, Lindegård, Ahlborg Jr, Ekman, & Hagberg, 2003).

Meanwhile, Nahit et al. (2003) conducted a prospective twelve months study in which it was found both high levels of psychological distress in the early stages of employment and adverse psychosocial work factors increase the risk report musculoskeletal pain a year later. The effects were generally common in lumbar back (26% prevalence), shoulder, knee and wrist / forearm.

In the Mexican context, In the Mexican context, Juárez-García (2007) looked at whether there is a statistically significant relationship between psychosocial variables of labor tension (depending on model of Karasek) and insecurity in employment through cardiovascular indicators such as blood pressure (TA) and symptoms cardiovascular in a group of nurses at a public hospital. The results show that there is indeed a statistically significant relationship between these variables (β between.20 and. 24), even considering traditional cardiovascular risk factors. The relationship between TA and job strain model is valid in the Mexican population and highlights the association of job insecurity and cardiovascular indicators, which makes its transcendent importance in the employment context of this country.

Conway, Campanini, Sartori, Dotti, & Costa (2008) studied a group of nurses in Italy and found evidence for the association of imbalance effort / reward and overcommitment with health status. In another study that compared differential occupational stress experienced by the permanent and temporary workers through the ERI model questionnaire, Inoue, Tsurugano, & Yano (2011) found that work-related stress, and the complaints of depression were higher among permanent workers than among the storms in the baseline; However, data obtained a year later indicated that the mental concerns were greater among temporary workers. Therefore, the relationship between work, stress, and the behavior of mental health between temporary and permanent workers is complex to understand.

From the biopsychosocial approach it is possible to find recent publications that cater to the call of the scientific community to develop and use tools to assess job stress and classify the level of risk at work (Marras, Cutlip, Burt, & Waters, 2009).

Thus, Föhr et al. (2015) analyzed the heart rate variability as an objective indicator of stress and found that the higher the subjective self-report of increased stress is objective stress of HRV and minor recovery objective in business days. On the other hand, the findings of Miyake, Kuraoka, Wada (2014) suggest that the rate of low heart rate / high heart rate is not suitable for the evaluation of the mental load since there was no significant difference in the analysis of the observations made.

Another biomarker that increasingly takes more strength, as objective tool, for the evaluation of stress, is Cortisol. Literature reports the relationship between excretion of cortisol in saliva to short term and psychological stress using different tools of self-report (Kudielka, Buchtal, Uhde, & Wust, 2007;) Niu, Chung, Chu, Tsai, Lin, Liao, et al., 2015); However, the results of these studies show different findings. Recently developed a new procedure for measuring the accumulated stress hormone, which is cortisol in human hair. For this reason, excretion of cortisol in the long run can now be measured accurately (van Holland, Frings-Dresen, & Sluiter, 2012)

With regard to the assessment of ergonomic factors of labor, few studies reporting objective assessment methods that allow to establish the extent to which SME-rT can be associated to this variable or work-related stress. Such is the case of Bao, Kapellusch, Merryweather, Thiese, Garg, Hegmann et to the. (2015) who evaluated the biomechanical aspects taking into account the criteria of the American Conference of Governmental Industrial Hygienists (ACGIH) or as Mehta (2012) who used electromyography, pulse oximetry, measuring heart rate and torque on specific joints. Researchers such as Warming, Precht, Suadicani, & Ebbehoj, (2009) have been used less objective methods, such as in blogs, but that in the long run turned out to be more faithful to reality than other types of self-reports.

6. CONCLUSION

Musculoskeletal disorders are one of the leading causes of disability worldwide work, for this reason has been studied the relationship to not only the physical load factors, but also with stress. Currently there are classical theoretical models, multivariate models and some progress in the development and implementation of methods and objective assessment tools; all of this from different approaches to analysis of one or more elements of the situation. However, as concluded most of the reviewed studies are still needed efforts to create better tools for objective assessment and in addition, analyzes that integrate the different elements of the system and not only analyze isolated variables, as has been done in most research.

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EMERGING PROPERTIES AND HUMAN FACTORS AT SOLDIERS ARMY ASPIRING

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Resumen: Se presentan los resultados preliminares del Proyecto Rumiñahui: Macroergonomía Militar, propiedades emergentes del sistema socio técnico y factores humanos, como estructura para la innovación organizacional del ejército ecuatoriano. Su objetivo general el proponer el desarrollo de una construcción analítica bajo el enfoque macroergonómico, de las propiedades emergentes, caracterización del sistema socio-técnico, factores cineantropométrico y fiabilidad humana, de aspirantes a soldados y oficiales del ejército. Como bases teóricas se apoyó en (Márquez, 2011), (Pachón, Gracía, & Segura, 2013); (Salguiro, Barroso, Barbosa, Telles, & Junior, 2015); (Everett, y otros, 2008); (Poy, 2007), Stoltz (2000), (Carrasquero, 2007), (Cacioppo, y otros, 2015.), (García Acosta & Lange Morales, 2008), entre otros. El estudio es observacional, descriptivo y transeccional de campo, en 408 aspirantes varones de la Escuela de Formación de Soldados del Ejército en edades comprendidas entre los 19 a 24 años. Se presentan los avances de las dimensiones propiedades emergentes y antropometría. Los resultados preliminares de la población (n=404) muestran a nivel de las propiedades emergentes, indican que los factores de la empatía toma de perspectivas y preocupación empática y los factores fantasía y malestares personales están por debajo de la media. En el caso de los factores de cognición social en orden decreciente los mismos se presentan como Ira, Hostilidad, Agresión física, Agresión verbal, Confianza. Para el coeficiente de adversidad es moderadamente baja A nivel de factores antrométricos, los índices de ecuaciones antropometrías refieren porcentajes de grasa corporal y masa residual acorde con su composición corporal.

Palabras claves: Propiedades Emergentes; Factores Humanos; Aspirantes a soldados; Macroergonomía

Abstract: Macroergonomía Military, emergent properties of technical partner and human factors such as organizational structure for innovation Ecuadorian military system: preliminary results of the Rumiñahui Project are presented. Its overall aim is to propose the development of an analytical construct under the macroergonómico approach of emergent properties, characterization of socio-technical factors and human reliability cinanthropometric, aspiring soldiers and army officers system. As a theoretical basis it relied on (Márquez, 2011), (Pachon, Gracía, & Segura, 2013); (Salguiro Barroso Barbosa, Telles, & Junior, 2015); (Everett, et al, 2008); (Poy, 2007), Stoltz (2000) (Carrasquero, 2007), (Cacioppo, et al, 2015), (Garcia Morales Acosta & Lange, 2008), among others. The study was observational, descriptive and field transeccional in 408 male applicants of the Training School Army soldiers aged between 19-24 years. Advances in emerging and anthropometry dimensions properties are presented. The preliminary results of the population (n = 404) show a level of emergent properties, indicate that factors of empathy and perspective taking and empathic concern and personal discomforts fantasy factors are below average. In the case of social cognition factors in decreasing order these are presented as anger, hostility, physical aggression, verbal aggression, Trust. For the coefficient of adversity is moderately low. A level antrométricos factors, anthropometry indices refer equations percentages of body fat and keeping residual mass with their body composition.

Palabras claves: Propiedades Emergentes; Factores Humanos; Aspirantes a soldados; Macroergonomía.

Keyword: Emerging properties; Human Factors; soldiers army aspiring; Macroergonomics

POSTURAL ANALYSIS PROPOSAL ON PREFABRICATED WALLS LIFTING TASKS FOR BOOTHS CONSTRUCTION

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Resumen: Se realizó este trabajo como parte y acercamiento inicial dentro del proyecto de tesis de la Maestría en Ergonomía de la Universidad de Guadalajara. Dicha investigación se centra en el estudio de los riesgos ergonómicos de los trabajadores durante el montaje de stands en el interior de los centros de convenciones en México. Para esta propuesta de análisis postural se utilizaron como antecedentes científicos las investigaciones realizadas en la industria de la construcción residencial en EE.UU., específicamente en el manejo manual de paneles o muros prefabricados de madera para delimitar las tareas realizadas, así como la aparición de síntomas musculoesqueléticos y fatiga al realizar las actividades mencionadas.

Palabras clave: análisis postural, síntomas musculoesqueléticos, muros prefabricados.

Relevancia para la Ergonomía: Este trabajo es una exploración inicial que busca comprender, evaluar y analizar los factores que intervienen en el desarrollo de los síntomas de fatiga y músculo-esqueléticos durante la tarea de elevación de muros prefabricados, para contribuir a la seguridad, comodidad y eficacia en aquellos que realizan esta tarea, siendo montadores de stand de feria y los trabajadores de la construcción residencial, entre otros.

Abstract: This work was performed as part and initial approach within the thesis project of the Master in Ergonomics at the University of Guadalajara. Such research focuses on the study of ergonomic risks of workers during assembly of booths, inside the convention centers in Mexico. For this, postural analysis proposal were used as a scientific background research in the residential construction industry in the US, specifically in the manual handling of panels or prefabricated wooden walls to define the tasks performed, and the appearance musculoskeletal symptoms and fatigue when performing these activities.

Keywords: Postural analysis, musculoskeletal symptoms, prefabricated walls.

Relevance to Ergonomics: This work is an initial exploration that seeks to understand, evaluate and analyze the factors involved in the development of fatigue and musculoskeletal symptoms during prefabricated walls lifting tasks, to contribute to the safety, comfort and efficiency in those who perform, being assemblers of exhibition booths or workers of residential construction, among others.

1. INTRODUCTION

Construction activities performed by workers tend to be repetitive and physically demanding. The performance of these tasks in uncomfortable postures can result in fatigue, injury or in severe cases, permanent disabilities (Ray et al. 2012). One of the branches of this industry, the residential construction, is widely developed in the US, in 2006 this great economic activity required more than 1 million workers (Mullins, 2006 in Jia et al, 2011). Residential construction has been recognized as one of the sectors that has a relatively high prevalence of injuries and work-related diseases (BLS, 2008a, b; Schoonover et al, 2010 in Jia et al, 2011). In this sector, overexertion injuries are the second most important source of direct costs, and more than half of these injuries are the result of loads and unexpected postures (Lipscomb et al., 2003a, b at Jia et al, 2011). The work of Nussbaum et al (2009) focuses on residential carpenters and specifically in the process of lifting of panels using prefabricated wall systems. In this study they found that "in the US, the construction of residential buildings is the seventh largest industry, with the participation of approximately 4% of the annual national economic activity (National Association of Home Builders Research Center 2002). Compared to the workforce in general, rates of occupational injuries are high in construction, with more than 150,000 nonfatal occupational injuries and illnesses reported in the US in 2005 (Bureau of Labor Statistics 2005). Approximately 20% of these cases were attributed to overexertion and repetitive motion. In Washington state, the construction of residential buildings was one of the top three industry groups types most common and costly occupational injuries (Bonauto et al. 2006)". The panelized wall systems (or armed by panels) have the potential to increase productivity in residential construction, but may result in an increased risk of injury to workers (Kim et al, 2011), not only in residential construction, but in other activities involving manual handling of prefabricated walls or panels, and exhibition booths assembly, among others.

2. OBJECTIVES

The aim of this text is to describe the stages in which the prefabricated walls lifting task is performed during booth construction and identify postural loads and efficiency in handling the material by means of a postural analysis.

3. METHODOLOGY

3.1 Selecting task and description of stages of manual handling of panels

For this study it was decided to test controlled by the method developed by Kim et al (2011) where possible risks of lumbar disorder were evaluated in construction workers who handled prefabricated walls, in this experiment, determined by observations of field, were defined stages of handling (4 examined tasks: lifting, erecting, carrying, moving) and types of panels and weight (small, medium, large, light, heavy) as well as test subjects (recruited from Virginia Tech university and the local community). For this work the activity of lifting panels was analyzed using a wooden frame with measures: 114mm wide, 164mm high, 40mm deep; with a weight of 9.5kg. The test subject (male, age 19, weight 60kg, height 1.74m, undergraduate) reported being physically active, not having illnesses, injuries or musculoskeletal disorders in the previous year that has limited their daily activities and was willing to collaborate. The participant observed before the test, a video on the Internet of workers performing tasks of manual handling of panels during assembly of booths. An experimental session with 4 replications was carried out to complete the test. The following tasks are performed: 1). Lifting1, 2). Lifting2, 3). Erecting, 4). Holding (See Figure 1).

1. Lifting1	2. Lifting2	3. Erecting	4. Holding

Figure 1. Stages of manual handling of panels.

3.2 Classification of body postures

In the study by Ray et al (2012) to analyze the postures of workers 4 main postures were classified: standing, stooping or bending, squating or sitting, crawling, and other activities such as: work above the head, lift load from the floor surface, and work kneeling or crawling. From this it can be viewed with greater order the way in which the subject manipulates the material (See Figure 2).

Standing	Squatting	Bending

Figure 2. Classification of postures during activity.

3.3 Task analysis

To perform the analysis of the task, this work was based on the methodology proposed by Gómez-Bull et al (2015) which consists of the following steps: recognition, video recording, subtasks separation, video analysis and frame classification.

<u>3.3.1. Activity recognition</u>

The task was defined to be evaluated, the test site and the subject who would perform, carefully observing every detail that was part of the activity.

<u>3.3.2. Video recording activity</u>

8 video shots ranging from 10 up to 15 seconds of recording, 13.12s averaging 8 replicates including the activity were performed. With orthogonal shots of the subject profiles, left and right, including viewing the full body of the participant.

<u>3.3.3. Activity and subtasks separation</u>

The activity of lifting panels was divided into 14 different postures and 4 significant postures on the total, including manual material handling for the final analysis were distinguished, the subtasks were (see Table 1): 1. Standing, 2. Standing with neck bent down, 3. Bending, 4. Squatting, 5. Squating with arms extended to the sides, bent back, 6. Squating with arms extended to the sides, holding the panel, bent back, 7. Squating lifting the panel (Lifting1), 8. Standing with back, neck and knees bent, lifting panel with both hands (Lifting2), 9. Standing with neck bent down, lifting panel with both hands at chest height, 10. Standing with arms at head height, erecting the panel, 11. Standing with arms overhead, erecting the panel, 12. Standing with extended arms at head height, holding the panel in vertical

(Erecting), 13. Standing with extended arms at chest height, holding the panel in vertical (Holding), 14. Standing, neutral position, end of lifting activity.

3.3.4. Video analysis

Of the video 200 frames were selected and obtained, using the program GOMPLAYER®, then, of those 200, 100 frames were selected at random using the internet page Random.org for frame numbers to select.

3.3.5. Frame classification

Once selected frames, each of the 100 were classified within an identified subtask, then the frequency percentages of each were obtained to identify the subtasks to be evaluated. Subtasks with a total of 10% or more were analyzed in more detail.

4. RESULTS

After applying the revised methodology, then the results obtained by performing the postural task analysis are presented. Fourteen stages and continuous positions arose during lifting panel (see Table 1), and 4 within them where the entire manual material handling concentrated (see Table 2), the stage of Lifting 2 had the highest percentage found (26%). Subsequently, an analysis by software 3DSSPP® of the riskiest positions found during the evaluation were 5, on squatting postures a higher risk level of lumbar compression L4/L5 is observed, and on postures during the panel lifting, the most affected body part is the hip (see Table 3).

Table 1. Panel lifting stages and postures.

Stage	**Posture**	**%**	**Time (s)**	**Postural description**
1		4	4.2	Standing
2		7	7.35	Standing with neck bent down

3		7	7.35	Bending
4		5	5.25	Squatting
5		4	4.2	Squatting with arms extended to the sides, bent back
6		4	4.2	Squatting with arms extended to the sides, holding the panel, bent back
7		5	5.25	Squatting lifting the panel (Lifting1)
8		9	9.45	Standing with back, neck and knees bent, lifting panel with both hands (Lifting2)

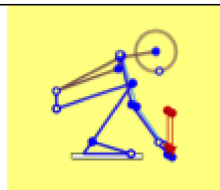
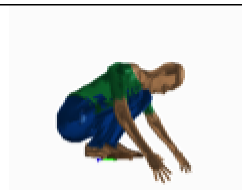
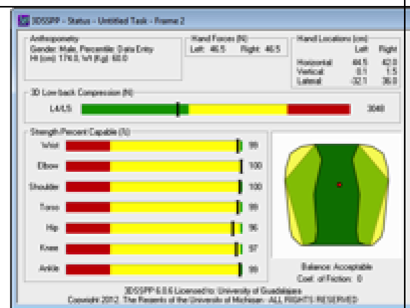
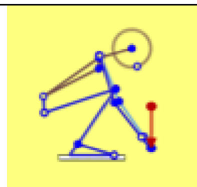
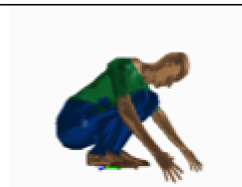
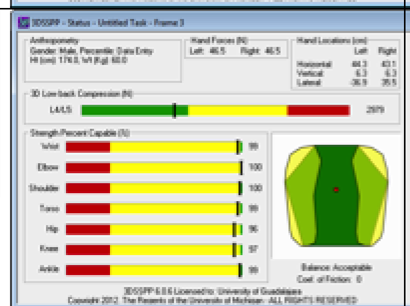
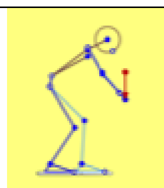
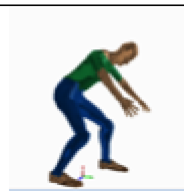
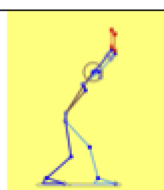
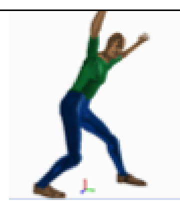
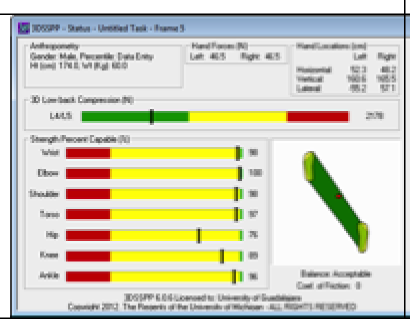
9		9	9.45	Standing with neck bent down, lifting panel with both hands at chest height
10		6	6.3	Standing with arms at head height, erecting the panel
11		5	5.25	Standing with arms overhead, erecting the panel
12		12	12.6	Standing with extended arms at to head height, holding the panel in vertical
13		12	12.6	Standing with extended arms at chest height, holding the panel in vertical

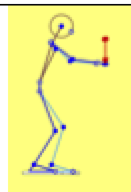
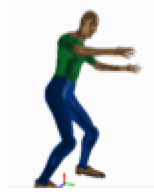
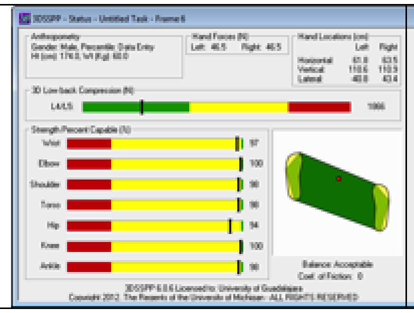
14		11	11.55	Standing, neutral position, end of lifting activity

Table 2. Manual handling of panel

Subtask	**Posture**	**%**	**Time (s)**	**Descripción postural**
Lifting 1		13	8.45	Squatting lifting the panel
Lifting 2		26	16.9	Standing with back, neck and knees bent, lifting panel with both hands
Erecting		18	11.7	Standing with extended arms at to head height, holding the panel in vertical
Holding		12	7.8	Standing with extended arms at chest height, holding the panel in vertical

Table 3. Postural analysis with 3DSSPP®

	Posture	**Side view**	**Oblique view**	**Analysis**	**Most affected area**
1	Squatting motionless				Hip
2	Squatting, performing load lifting				Hip and knee
3	Back, knees and neck flexed, arms extended to the sides making the load lifting.				Hip and trunk
4	Arms above the head performing load lifting				Hip and knee

5	Load holding				Hip

5. DISCUSSION/CONCLUSIONS

The results of the evaluation of the task show the body parts that may be affected during prefabricated walls lifting: hip, torso and knees. This test was performed with dimensions and controlled weights of the material for the test subject would not suffer embodiment injuries. During the real process, the prefabricated walls have larger dimensions (1220mm x 2440mm) and weights ranging from 15kg to 80kg (Cempanel, s.f.), this shows that the activity of lifting prefabricated walls is a risky task that can generate musculoskeletal symptoms in those who perform it, either workers of residential construction, structural carpenters, installers and assemblers of stage sets and exhibition booths, or other similar activities.

This work was conducted by way of exploratory study and preliminary approach for a bigger work in the future, so it is necessary to continue making more observations and tests to determine whether the proposed postural analysis presented is efficient to analyze these activities and generate proposals for intervention.

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INTRODUCING MAC TOOL TO EVALUATE WEIGHT LIFTING TASKS

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Resumen: Actualmente las lesiones musculo-esqueléticas son un factor muy importante a considerar en las estaciones de trabajo, por esto se trata siempre de tener la menor cantidad de lesiones posibles.

Uno de los métodos que más se emplea actualmente es NIOSH. Su ecuación permite evaluar tareas en las que se realizan levantamientos de carga, ofreciendo como resultado el peso máximo recomendado que es posible levantar en las condiciones del puesto para evitar la aparición de lumbalgias y problemas de espalda, además, este método proporciona una valoración de la posibilidad de aparición de dichos trastornos dadas las condiciones del levantamiento y el peso levantado.

La metodología MAC, por su parte, utiliza una escala cuantitativa para medir el riesgo y un código de colores para calificar cada factor. Está basada en antecedentes de biomecánica, psicofísica y factores del entorno físico del proceso. Este método tiene como ventaja su fácil aplicación sin ecuaciones ni cálculos, lo que hace que este sea más rápido en determinar una calificación.

Este artículo propone la utilización del método MAC como apoyo y comprobación de los resultados obtenidos en las mediciones con NIOSH, así mismo se podría utilizar este método en situaciones que requieran un resultado rápido y confiable.

Palabras clave: musculo-esquelética, lesión, levantamiento

Relevancia para la ergonomía: Si la hipótesis no es rechazada y la herramienta MAC parece ser tan fiable como el NIOSH, los ergónomos industriales podrían adoptar en sus empresas esta forma de analizar las operaciones de levantamiento

de cargas, lo que requiere la mitad del tiempo que se tardó en realizar el análisis tradicional de NIOSH. De esta manera, los trabajadores estarán protegidos para no sufrir una lesión debido a los procesos de levantamiento y, al mismo tiempo, las empresas ahorrarán mucho tiempo que utiliza en analizar este tipo de tareas las tareas.

Abstract: Nowadays, musculoskeletal injuries are a very important factor that must be taken in consideration in the workstations; that's the reason why we seek to have the least amount of possible injuries.

One of the most common used method is NIOSH equation, which evaluates tasks where load lifting is involved, giving as a result the recommended maximum weight that can be lifted according to the conditions of the workstation to prevent back pain or injuries; in addition, this method provides an assessment of the probability of occurrence of such disorders given the conditions of the frequency of lifting weight.

MAC methodology, on the other hand, uses a quantitative scale to measure risk and a color code to qualify each factor. It is based on biomechanics, psychophysics, and factors in the physical environment of the process antecedents. This method's advantage is an easy application without equations and calculations, which makes the determination of a score much faster.

This article proposes the use of the MAC to support and verify the results obtained with NIOSH; likewise we suggest the usage of this method in other situations that require a fast and reliable result.

Keywords: musculoskeletal, injury, lifting

Relevance to Ergonomics: If the hypothesis is not rejected and MAC tool appears to be as reliable as NIOSH, industrial ergonomists might adopt in their companies this new way of analyzing lifting operations, requiring half of the time it took to perform traditional NIOSH analysis. In this way, operators will be protected not to suffer an injury due to lifting processes and at the same time, companies will save many of the time they spent to analyze tasks.

1. INTRODUCTION

Manual handling of loads is a task found in most working environments. By itself, it does not represent a major problem, but the cumulative repetition of manual handling, along with the weight of the load and other factors could potentially cause a gradual deterioration of the musculoskeletal system. In order to determine how risky a task is, different ergonomic methods have been proved effective at evaluating workstations.

This paper presents a comparison between the solved examples found in the book "Applications Manual for the Revised NIOSH Lifting Equation" and the obtained results after solving those examples with MAC (Manual handling Assessment Charts).

1.1NIOSH EQUATION

In 1981, the first version of the equation was published by the National Institute for Occupational Safety and Health (NIOSH), in which they proposed the equation to determine the recommended weight for specified two handed, symmetrical lifting tasks. In 1991, a second version of the equation was published in which asymmetric lifts with non-optimal handgrip were introduced.

The lifting index determines the significance of a risk. Depending on the lifting index the following can be determined:

- Lifting Index value < 1 means that the task can be executed by most of the workers with no major difficulty.
- Lifting Index value > 1 but < 3 means that the task represents a risk for a portion of the population.
- Lifting Index value > 3 means that the task represents a risk for the majority of the population and should be fix it as soon as possible.

$$LI = \frac{\text{Load Weight}}{\text{Recommended Weight Limit}} = \frac{L}{RWL}$$

Figure 1. Lifting Index (Source. Waters, Putz-Anderson & Garg, 1994)

The NIOSH equation establishes the recommended weight limit (RWL) obtained from the multiplication of six variables and a load constant. The load constant represents the maximum weight that can be lifted by the majority of the population without difficulty. The variables are expressed as coefficients that should decrease the load constant as they are multiplied.

$$RWL = LC \ x \ HM \ x \ VM \ x \ DM \ x \ AM \ x \ FM \ x \ CM \qquad (1)$$

Where:
LC = Load Constant (Maximum recommended weight)
HM = Horizontal Multiplier (Horizontal position of the load with respect to the body)
VM = Vertical Multiplier (Vertical position of the load with respect to the floor)
DM = Distance Multiplier (The vertical distance that the object is moved)
AM = Asymmetric Multiplier (Angle at which the object is moved)
FM = Frequency Modifier (Frequency and duration of the lift)
CM = Coupling Modifier (Quality of the grip)

1.2 MANUAL HANDLING ASSESSMENT CHARTS (MAC)

The main purpose of the MAC tool is to evaluate the most common risk factors in three different stages: lifting, carrying and team handling operations. For the lifting operations, eight risk factors are assessed using a color code (green, amber, red and purple) that represents a numerical value according to the color. The final result is obtained by summing up every numerical value.

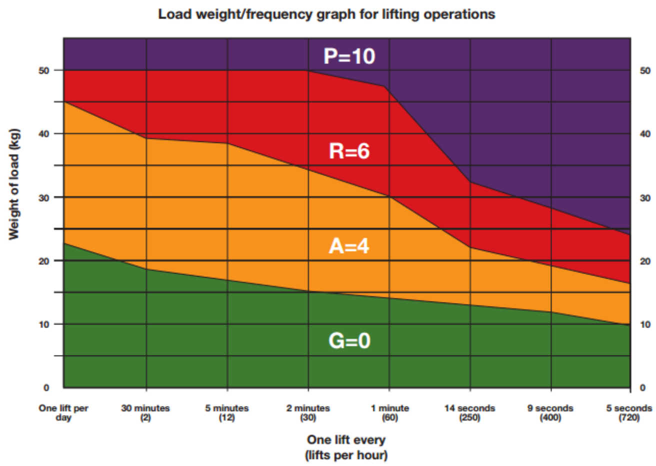

Figure 2. Load weight/frequency graph for lifting operations (Source: Health and Safety Executive, 2003)

A) Hand Distance from the lower back. It is the horizontal distance between hands and lower back. The worst case scenario should always be selected. (Figure 3)

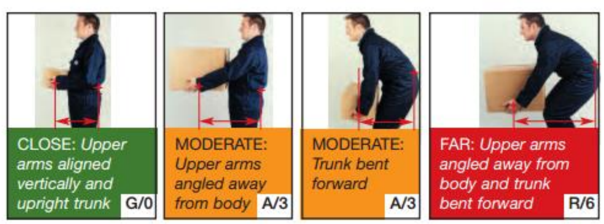

Figure 3. Hand Distance assessment guide (Source. Health and Safety Executive, 2003)

B) Vertical lift region. The worst case scenario should always be selected. (Figure 4)

Figure 4. Vertical Lift assessment guide (Source. Health and Safety Executive, 2003)

C) Trunk twisting and sideways bending. If the operator twists the upper trunk region with respect to the hips or the operator leans to one of the sides to lift the load, amber is the selected color and the numerical value is equal to 1. If both upper trunk region twisting and side bending occur, red is the selected color and the numerical value is equal to 2.

D) Postural Constraints. If no restrictions are found and the operator can freely move, green is the selected color and the numerical value is 0. If the operator has space restrictions such as narrow gaps or workstation design, the selected color is amber and the numerical value is equal to 1. If the operator is highly restricted, the selected color is red and the numerical value is equal to 2.

E) Grip on the load. The quality of the grip on the load can be determined using the table from figure 5.

GOOD G/0	REASONABLE A/1	POOR R/2
Containers with well-designed handles or handholds, fit for purpose	Containers with poor handles or handholds	Containers of poor design. Loose parts, irregular objects, bulky or difficult to handle
Loose parts enabling comfortable grip	Fingers to be clamped at 90 degrees under the container	Non-rigid sacks or unpredictable loads

Figure 5. Grip on the load assessment guide (Source. Health and Safety Executive, 2003)

F) Floor surface. Floor surface can be evaluated using figure 6.

Dry and clean floor in good condition G/0	Dry floor but in poor condition, worn or uneven A/1	Contaminated/wet or steep sloping floor or unstable footing R/2

Figure 6. Floor surface assessment guide (Source. Health and Safety Executive, 2003)

G) Other environmental factors. If they operation is taking place under extreme weather conditions(such as extreme temperatures) or if there are extreme lightning conditions (such as excessive darkness, lightning or contrast), the selected color is amber and the numerical value is 1; whoever, if both of the conditions are present, the selected color is red and the numerical value is 2.

2. METHODOLOGY

This paper follows a comparative study and it aims to understand the existing relationship between the NIOSH equation and the MAC tool for manual handling of loads.

In order to compare both methods, MAC measurements were done in workstations previously assessed with the NIOSH equation and the obtained results were analyzed to identify the level of similarity between both methods and then, verify if the use of MAC to determine the level of risk in workstations that imply manual handling of loads is feasible or not.

The following table 1 shows the ten workstations that were analyzed and at the end the final numerical value given by each method, which can be used to compare the level of similarity between them.

Table 1.- Workstatio analized with NIOSH and MAC

Example No.	Task	Control of the load	Grip	Average weight of load (lb)	Lifting frequency (per minute)	NIOSH	MAC
1	Single	Yes	Fair	44	0.2	3.0	9
2	Single	Yes	Poor	36	0.2	1.9	9
3	Single	No	Fair	40	0.2	2.1	10
4	Single	Yes	Fair	26	3	1.7	11
5	Single	Yes	Good	20	5	1.5	8
6	Single	No	Fair	25	1	1.5	5
7	Multi	No	Fair	12	12	1.4	10
8	Single	Yes	Poor	30	9	2.9	10
9	Multi	Yes	Poor	25	1	1.7	6
10	Multi	No	Fair	18	8	3.6	10

3. RESULTS

The results showed that 80% of the time the outcomes from both NIOSH and MAC coincided. According to the NIOSH methodology, a CLI <1 represents no major risk to the majority of the population and is the equivalent to the green color code of MAC (from 0-4); a CLI >1 but CLI<3 represents that corrective actions must be done, and it is equivalent to the amber color code of MAC (from 5-12) ; and having a CLI>3 represents that corrective actions are immediately needed and it is equivalent to the red color code of MAC (from 13-20). Eight out of the ten NIOSH problems that were solved with MAC coincided.

A Paired T-Test was needed to prove that both methods had an equal assessment outcome. According to the Paired T-Test, both the NIOSH equation and the MAC tool are equally effective (p-value ≥ .05).

Paired T-Test and CI: NIOSH1, MAC1

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Paired T for NIOSH1 - MAC1

             N   Mean  StDev  SE Mean
NIOSH1      10  2.200  0.422    0.133
MAC1        10  2.000  0.000    0.000
Difference  10  0.200  0.422    0.133


95% CI for mean difference: (-0.102, 0.502)
T-Test of mean difference = 0 (vs ≠ 0):
T-Value = 1.50  P-Value = 0.168
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Figure 7. Paired T-Test for NIOSH and MAC (Source. Statistical Package Minitab 17.1, 2013)

4. DISCUSSIONS/CONCLUSION

After analyzing the results obtained in ten different lifting/lowering tasks with NIOSH and MAC, failing to reject the null hypothesis and observing the similarity between both of the tools, we purpose to implement the usage of MAC in production floors.

The main advantage that can make an impact in industry in the comparison of MAC vs. NIOSH is that MAC is a visual, user-friendly, practical tool which study takes half the time and observation than NIOSH.

As mentioned before, there was uncertainty when comparing the results of amber and red catalogued tasks with both methodologies. For an optimal result we suggest to first utilize MAC because of the practicability of the tool. If the task results to be green, then no NIOSH test is needed. In the other hand and to ensure a most accurate and reliable result, if the task appears to be either amber or red, then NIOSH study is required to make a comparison with the previously obtained MAC result. In case both answers differ, the ergonomists in charge may take a decision to assign a category based on their own criteria.

A barrier we face are the actual ergonomists working in industry. Most of the times, engineers would rather use the same old but known technique instead of taking the risk to try new methods. That is the challenge of this research. Anyway, we strongly suggest the usage of MAC tool as a first option.

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STATE OF THE ART IN RELATION TO THE CAPACITY FOR WORK OF OLDER ADULTS, WITH THE GOAL OF BUILDING AN INTEGRATED PREDICTOR MODEL OF THEIR ABILITY TO REMAIN IN THE LABOR MARKET BEYOND THEIR RETIREMENT AGE.

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Resumen: El objetivo del presente trabajo es la elaboración de un modelo integral que pueda ser utilizado por los interesados y por las empresas como instrumento para valorar el estatus de los trabajadores adultos mayores en cuanto a sus capacidades para el trabajo y la posibilidad de permanencia y/o retiro de la actividad laboral más allá de la edad de jubilación, así como el planteamiento de las políticas organizacionales para la fuerza laboral multigeneracional. Para ello, una vez revisado el estado del arte al respecto, se realizara el trabajo de campo para obtener datos cualitativos en relación a la voluntad de continuar trabajando y la habilidad para el trabajo y datos cuantitativos para las capacidades físicas para el trabajo. Posteriormente se efectuará el análisis de regresión de los datos recabados y una variable de clasificación de la capacidad del trabajador la cual se validara para poder hacer una propuesta abierta del modelo integral sobre la que se esperarán aportaciones y sugerencias.

Palabras clave: adultos, trabajo, capacidad, voluntad.

Relevancia para la Ergonomía: Es mundialmente conocido que la esperanza de vida está aumentando constantemente, de tal forma que, en pocos años se tendrá una población bastante numerosa de adultos mayores los cuales requerirán de un entorno especial, especialmente en el ámbito laboral, hasta ahorita inédito. Por otra parte la gran mayoría de los empleadores reconoce que los trabajadores mayores son de gran valor dado que son empleados calificados y productivos, sin embargo, no son suficientemente sintonizados con las capacidades físicas y mentales de los trabajadores de edad y pueden tener problemas de salud y mayor riesgo de accidentes. Como resultado de los imperativos evidentes, un nuevo consenso político internacional está surgiendo y es la eliminación de las barreras de la edad

del mercado de trabajo y se está sustituyendo el término «jubilación anticipada» por el de término "envejecimiento activo"
Por lo anterior se hace necesario contar con un modelo para evaluación de las capacidades para el trabajo de los adultos mayores próximos a llegar a la edad de jubilación, lo cual será muy necesario para las decisiones que habrán de tomarse en relación a la permanencia de los trabajadores dentro de la fuerza laboral así como para el empleador que podrá tomar decisiones equitativas en cuanto a retener, reclutar y entrenar adultos mayores e implementar políticas organizacionales para una planta laboral multigeneracionales lo cual requerirá, indudablemente de la creación de constructos generados en las distintas disciplinas que conforman parte de la ergonomía.

Abstract: The aim of this work is the development of a comprehensive model that can be used by stakeholders and by businesses as a tool to assess the status of older workers in their capacity for work and the possibility of permanence and / or withdrawal of labor activity beyond retirement age and the approach of organizational policies for multigenerational workforce. To that end, after reviewing the state of the art about the fieldwork be conducted to obtain qualitative data regarding the desire to continue working and working ability and quantitative data for your physical abilities for the job. Subsequently, the regression analysis of the data collected will be made and a classification variable capacity of the worker which will be validated to make an open proposal of comprehensive model on which contributions and suggestions will be expected will be defined.

Keywords: Adults, work, capacity, will.

Relevance to ergonomics: It is widely known that life expectancy is constantly increasing, so that in a few years a fairly large elderly population will require a special environment, especially in the workplace, until now unpublished will have. Moreover, the vast majority of employers recognize that older workers are valuable because they are qualified and productive employees, however, are not sufficiently attuned to the physical and mental abilities of older workers and may have health problems and increased risk of accidents. As a result of the obvious imperatives, a new international political consensus is emerging and eliminating age barriers in the labor market and is replacing the term 'early retirement' by the term "active aging"
So before the stay is necessary to have a model for assessment of capacities for work the next to reach retirement elderly, which will be very necessary for decisions to be taken regarding the workers within the workforce as well as for the employer who may take equitable decisions as to retain, recruit and train elderly and implement organizational policies for workforce multigenerational which require undoubtedly the creation of constructs generated in the various disciplines that forma part of ergonomics.

I.- INTRODUCTION

Demography

According to United Nations (2012), globally, the population aged 60 and older are the fastest growing. In more developed regions, the population over 60 years will growing by 1.0 percent annually until 2050 and 0.11 percent annually from 2050 to 2100 so it is expected that by mid-century *XXI*, pass 287 million in 2013 to 417 *MILLION* in 2050 and 440 million in 2100.

In the less developed regions, the population aged 60 and older is currently growing at a faster rate, increased 3.7 percent per year in 2010-2015 and is projected to increase 2.9 percent per year up to 2050 and 0.9 percent annually from 2050 to 2100; it is expected that the number of people aged 60 or more years old will increase from 554 million in 2013 to 1.6 billion in 2050 and 2.5 billion in 2100.

According to Consejo Nacional de Poblacion CONAPO (2006), in 2005-2050 population projections, by 2015 the population over 60 years in Mexico will reach the figure a total of 7.5 million and is growing at a rate of over 3.2 percent per year, which implies that this group has the potential to double in size every 19 years. Because it is anticipated that the above dynamics continue to accelerate, reaching a rate of 4.6 percent by the end of the fourth decade of this century, 2050 is expected to be 25.9 million adults over 60 years.

Moreover, the life expectancy of Mexicans, according to INEGI (2005) is on the rise in 1970 was 61 years in 2000 was 74 years and in 2013 is 74.5 years.

Environment seniors

As Wright (2011) argues that most retirees retained for a time, two or more decades mobility, stamina and functional capabilities enhanced by the experience, and this period continues to expand thanks to higher living standards and improvements in health care, too long to surrender to inactivity. Moreover pensions and public assistance benefits, despite being still insufficient in many cases enough to live a life not too bad. The chances of finding a part-time job are also improving for these people.

Tilja (2010) notes that, in many industrialized countries the population is aging, due to increased life expectancy and declining birth rates. A rather paradoxical development is that, despite the increase in life expectancy, people in most European countries, has reduced the average time spent in paid work, although part of this decline is explained by prolonged education among younger cohorts, which is the most important contributor to the higher rate of exit from the labor market at more advanced ages. As a result, many countries are developing policies to encourage older workers to stay longer in the labor market and delay retirement

Social policy in relation to the work of older adults

According to Taylor P. et al (2013) in industrialized countries they are displaying a wide range of policy instruments to reverse the trend towards early exit from the labor market "in order to address concerns raised by the aging population, such as the costs of social welfare and health. also he claims that numerous studies point to the existence of discrimination in the labor market for reasons of age and are revealed by apparently reluctant to recruit, train and retain older workers employers. Likewise, quoting (Prager and Schoof 2006) notes, as a result of the obvious political imperatives, a new political consensus is emerging and eliminating age barriers in the labor market and is replacing the term 'early retirement” by the term "active aging" and organizations such as the World Health Organization (WHO) and the European Commission have promoted the concept and WHO has set a policy framework for active aging. The European Commission states that the successful active aging policies involving all generations. All actors (government, firms and workers) need to adopt strategies lifecycle to enable workers of all ages to stay longer in employment.

Employers and work of older adults

Taylor P. et al (2013) points out that numerous studies point to the existence of age discrimination in the labor market, citing Butler (2008) notes that this discrimination is expressed trough seemingly reluctant employers to recruit, train or retain older workers. Piktialis (2007) notes that companies realize that their own workforce, aging, requires planning and adaptations, but they cannot be convinced that there is sufficient specific information to justify allocation of economic resources. Further notes that there have been responses which have included review of internal policies and programs to make the language to be used in age neutral. Citing Desbiens (2006) points out that age has become "diversity factor" and the related education age diversity is now a part of training and managers are trained in how to best handle a force of mature work multigenerational. Simone Lewis (2015) notes that occupational health can play an important role in supporting entrepreneurs proactively providing healthy working environment for older workers. Tilja (2010) also notes the socio-economic reasons for increasing labor participation, older workers are of great value to employers, since they are the most qualified and productive employees and therefore of interest to keep at work. However, an older worker differs from a younger colleague in the physical and mental changes that accompany aging, which can have negative consequences for their security and vulnerability at work. Besides the demands of work they are not sufficiently attuned to the physical and mental abilities of older workers can cause health problems and then displacement of the workforce. Therefore, the success of policies to keep older workers depend on a better understanding of the special role of health and characteristics of continuous work in order to prevent market exit.

Will of the elderly to continue working

Geuskens A et al (2012) points out, on the basis of previous studies, that the good health, financial factors as higher satisfaction with pay and job characteristics as a healthy social climate, greater satisfaction with prospects career and flexible work schedules, predict what employees are willing to continue working until the age of 65 years. The reason for satisfaction with flexible working hours was that can provide the opportunity to combine work time leisure activities and prevention of emotional exhaustion and promotion of a climate of social work healthy can support both the will and ability to work until the age of 65 years.

Working capacity of older adults

Lewis (2015) points out that there is a lack of real research to confirm whether or not cognitive impairment in older worker, but lab studies show that people age is likely that some cognitive impairment have and citing Griffiths (2000), one could argue that the lack of cognitive ability of older workers is replaced by its well-established skills, however, research conducted by Kodz et al (1999), cited in Turner and Williams 2005 in the the Work Foundation report suggests that older workers are knowledgeable and reliable, with good customer service skills and are more committed to their role.

Justification for research

It is widely known that life expectancy is constantly increasing, so that in a few years a fairly large elderly population which require a special environment, until now unpublished will have. Moreover pensions and savings have been affected, with low return on investment, which means that people cannot afford to retire from his job so you are forced to work harder and save while still they are working. Therefore this sector of the population will require different socioeconomic conditions existing to date and above this, it becomes necessary in the present prepare the adaptation and innovation of public and private for the care of this reality policies; in particular as regards membership in the workforce of this population.

In another sense the vast majority of employers recognize that older workers are valuable because they are qualified and productive employees, however, are not sufficiently attuned to the physical and mental abilities of older workers and may have health problems and increased risk of accidents; in other cases there is discrimination against them and some employers are reluctant to recruit, train and retain older workers not find justification for resource allocation.

As a result of the obvious imperatives, a new international political consensus is emerging and eliminating age barriers in the labor market and is replacing the term 'early retirement' by the term "active aging"

Therefore it is necessary to have a model for assessment of capacities for work the next to reach the age of retirement as established by the Mexican Social Security Institute elderly, which will be very convenient for decisions to be taken in relation to the permanence of workers within the workforce as well as for the employer who may take equitable decisions as to retain, recruit and train elderly and implement organizational policies for a multigenerational workforce. Said before will have a social relevance and, possibly, employment discrimination is avoided by age and achieved, those who thus qualifying stay in the workforce longer ensuring income and social recognition that surely will influence your mood and becoming an occupational therapy. Finally it is expected to help solve a range of problems in relation to the environment that older adults live within a few years, in relation to labor, social, health and economic.

II.- RESEARCH OBJECTIVES

Make a contribution to science in relation to the evaluation of the capacity for work of older adults, thereby to assist in making decisions to stay or not at work beyond the retirement age and, case, recommend the implementation of organizational policies to support this sector of the workforce, creating a model that integrates three constructs linked together such as: Will, skill and physical capacity for work.

Investigation questions

- How they will relate, skills and physical capacity for work of older adults?
- Is there a hierarchical level between will, skill and physical capacity for work of older adults?

Scope and limitations of the project.

The purpose of this work is a transversal research to develop an evaluation model that integrates the three factors will, skill and physical capacity for work of older adults that can be used by businesses as a tool to define job tenure an elderly and, if necessary, adjust organizational policies in the ruble. It is of mixed type, whose variables are of two types; qualitative measures to assess willingness and ability to work and to evaluate quantitatively the physical capacity of the elderly in the manufacturing sector of the State of Sonora, in order to correlate them in an integrative model.

Theoretical Framework

Methods for evaluating the will to work

According to Reeuwijk et al (2013), who investigated the factors that influence early retirement points: for most employees, a combination of factors played a role in the transition from work to early retirement. Participants reported on several factors such as changes in work organization, conflicts at work, the pressure of high physical demands of work and insufficient use of their skills and knowledge by others in the organization. Employees who reported these factors push towards early retirement often felt unable to find another job. The factors that attract early retirement ("pull factors") include the desire to do other things outside of work, enjoy life, have more flexibility to spend more time with your spouse or grandchildren and caring for others. In addition, the financial opportunity for early retirement played an important role. Factors influencing early retirement through changes in motivation, ability and opportunity to continue working or retire. Geuskens et al (2012) to determine the demands of work, job autonomy and social support use the questionnaire The Job Content Questionnaire (JCQ) Karasek R, et al (1999). At baseline, the willingness to continue working until the official retirement age was assessed with one question you like to work until the age of 65 years?, The ability to continue working in the current job also assessed with one question do you think are able to continue working in their current job until the age of 65 years? And the willingness to continue working was evaluated with a open question: until age you want to continue working?

Methods for evaluating the skills for work

In terms of job skills, Noone et al (2014) citing Taylor (2011) mentions some methods to assess job skills, these methods are:

• Work Ability Index (WAI)
• Work Ability survey (WAS)
• Copenhagen Psychosocial Questionnaire
• European Foundation survey on working conditions
• Household Income and Labour Dynamics in Australia
• Workability forecast next two years

• Mental Vitality

Moreover, for Physical capacity Bugajska (2005) states that one can evaluate the ability to work by Physical work capacity.

Work Ability Index (WAI)

In some countries of the European Union it is spreading the use of the evaluation system of job skills Work Ability Index (WAI). Hasselhorn (2008) notes that, according to Finnish researchers Ilmarinen and Tuomi (2004), the ability to work can be understood as "how well he / she worker can do their job regarding the demands of work, mental health and resources at present and in the near future. This definition is based on the so-called "concept of working capacity" (Ilmarinen, 2004) that the ability to work is the result of the interaction of workers and their work. Ability to work can also be described as the balance of workers resources and work demands. according to Staal (2009) "This assessment is based on the application of an applied regarding self questionnaire to 7 dimensions to know:

• Ability to current work in relation to the better life
• Ability to work in connection with job applications
• Number of current diseases diagnosed by doctors
• Disability in relation to diseases
• Absenteeism last year
• Workability forecast next two years
• Mental Vitality

Work Ability survey (WAS)

Noone et al (2014) states: at first glance, the WAS appears to evaluate the different domains of the ability to work as established by Ilmarinen et al. (2005). Capture aspects of work, community work and leadership, motivation, family and the surrounding community, health and functional capacity. In general, the WAS has a particularly strong focus on the environment of the organization, but less focus on competition, training and work attitudes of workers.

Copenhagen Psychosocial Questionnaire

The Copenhagen Psychosocial Questionnaire (CoPsoQ) is an international instrument for research, assessment and prevention of psychosocial risks which originated in Denmark. The first version was made by a group of researchers from the National Research Centre for the Working Environment in 2000. It is a tool consists of three instruments: 1) a long questionnaire for use in research 2) a questionnaire medium to be used by professionals working environment 3) a short version for use by places of work. The features of the tool are: The survey questions are made to score points on the scale of individual questionnaire and gives equal weight to each of the questions. In most cases the question has 5 response options and weight of each is 0, 25, 50, 75 and 100. The value of the scale is calculated as a simple average of full scale occurs between 0 and 100. Participants who respond less than half of the questions are classified as failure, if the person has answered at least half the questions the scale assesses the average answer questions.

European Foundation survey on working conditions

According to European Working Conditions Survey work it refers to the set of tasks performed by workers in the performance of their work. It is difficult for workers to separate from the job description other than the tasks, so it is necessary to combine different approaches to define and analyze the work. Different conceptualizations of co-existing work across different disciplines described in curves as "curse, freedom, merchandise, occupational citizenship, worthlessness, personal fulfillment, social relationships, identity, care for others and service (Bus and Spencer 2011 p4) these different conceptualizations are important because they affect the assessment of individual welfare for society as a whole, and have an impact on how to measure work.

The perceived sustainability varies considerably across sectors. Particularly in sectors where work is physically demanding, workers commonly think that it will be working until 60. Only in the financial sector 70% think it will continue working into old age in contrast only half of workers in retail wholesale and retail, food and accommodation, transport and industrial sectors feel the same.

Three other methods that have not yet been exported are:

Workability forecast next 2 years (slope description)

Mental Vitality (slope description)

Methods for evaluation of physical capacity for work

Physical Work Capacity

It is to assess the level of physical work capacity, whose maximal aerobic capacity (VO max) indicator, determined by the ability to perform hard or prolonged work, good tolerance and the possibility of eliminating changes due to fatigue. Thus VO max, which determines the potential physical effort capacity, can be a significant element in the perceived subjectively work. VO max is estimated with linear regression equation, which is calculated individually between heart rate and VO max measured during submaximal exercise.

Hollmann et al (2007) points out that the process of functional aging are characterized by a loss of performance capabilities with regard to coordination, flexibility, strength, speed and endurance. The effects of aging processes in the cardiovascular system and skeletal muscle are the focus of attention. After 30 years, the maximum dynamic performance capacity is reduced aerobic average of 8% per decade. The causes are primarily a reduction in the maximum cardiac output and decreases capillarization and in skeletal muscle mass. Improved maximum oxygen consumption by 18% and aerobic-anaerobic threshold by 22% was achieved in untrained men ages 55 to 70 years, in a program ergometer-training 12-week cycling . The skeletal muscle strength decreases particularly after 50-60 years old. The main cause is the reduction in the number of motor units and muscle fibers. Moreover, changes in endothelial function and development of sarcopenia are of particular importance in the process.

III.- METHODOLOGY

To achieve the objectives of the investigation has proceeded to search for the information trying to establish the state of the art in this field. The databases used in this search were:

1. the multidisciplinary area.
    - EBSCOhost Research Database
    - Dialnet portal Hispanic scientific dissemination
    - Emerald
    - Scielo
    - Springer link

2. the area and Biomedical Technology

    - Biomedical Engineering
    - Medline complete
3. statistical databases
    - OECD library
    - INEGI
    - Conapo

From these databases the following documents were obtained:

Articles	5
articles indexed	21
questionnaires	1
encyclopedias	1
Statistical reports	5
Rules	1
presentations	6
technical reports	3
dissertations	1

The documents obtained are included in the references in this protocol 2015 some of it, namely:

articles indexed	7
encyclopedias	1
Statistical reports	5
Rules	1
presentations	2
technical reports	2
dissertations	1

Obviously this information will not be enough to establish the state of the art in this area, however he proceeded to outline the following methodology:

Type of research and variables

The work is a cross joint research, correlational, where it sought to build a regression model to assessing the working capacity of older adults from:

a Variable will the elderly to continue working beyond retirement age.
b Variable ability of the elderly according to methods Work Ability Index (WAI) and / or Work Ability survey (WAS)
c Physical capabilities of older adults as variables: physiological (cardiorespiratory system and physical tests) using VO_{max}, sensory variables to assess conditions and anatomical condition (anthropometry).

Population and sample

The target population are adults over 50 to 60 years, men, belonging to the labor force in the manufacturing sector of Sonora that are active; which, according to Ministry of Labor and Social Welfare, Sonora (2015) would be approximately a population of 19218 so the size would sample n = 98 considering a 95% confidence, an estimation error of ± 0.05 and p = 0.25 considered that in a presample was found that 1 in 4 workers would have the will to continue working beyond retirement age. For validation of instruments 30 workers pilot test was performed.

Hypothesis in this research:

It is possible to evaluate the ability to work beyond retirement age of older adults using a model whose variables are: will, skill and physical ability.

Selection and Validation of sample

In this research data of qualitative variables willingness and ability to work will be collected by two instruments based on questionnaires and Work Ability Index survey which in turn will be validated. Moreover capabilities for physical data in accordance with existing for each of the indicators will be collected protocols. These three constructs will, skill and physical ability will be the independent variables of the model. It will then set a scale for comprehensive evaluation of the ability of a worker taken as a reference the parameters established in the different disciplines involved which will be the dependent variable.

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ERGONOMIC ANALYSIS OF ENVIRONMENTAL CONDITIONS ON A BISCUIT COMPANY IN SOUTHEASTERN MEXICO

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Resumen: Se presenta el análisis de riesgos por ruido y calor en la línea de producción de una empresa productora de galletas y pastas. Los resultados se obtuvieron utilizando metodologías presentes en las normas oficiales mexicanas y en normas internacionales, éstos resultados se compararon contra los estándares nacionales e internacionales y se verificó que existe un riesgo por exposición al ruido, no así por las exposición al microclima laboral.

Palabras Clave: Factores de riesgo ergonómico, Ambiente acústico, Ambiente Termal

Abstract: Risk analysis is presented for noise and heat in the production line of a company producing biscuits and pasta. The results were obtained using methodologies present in the official Mexican norms and international standards, these results were compared against national and international standards and verified that there is a risk from exposure to noise, not by exposure to work microclimate.

Keywords: ergonomic risk factors, acoustic environment, thermal environment

1. Introduction

Currently, the environmental conditions are a risk factor that can affect the worker temporarily or permanently, creating problems of great importance in the health of workers. Any work activity can take risks, and you need to be aware of which are present in our environment. This need, to know what factors hurt workers, has grown over the years due to increased awareness of the consequences of these risks. (International Labour Office, 2001).

In the workplace, a great involvement to worker health is caused by noise and heat factors, and therefore it is necessary to take action to avoid its consequences. (Garcia, 2009.)

In Mexico, there is the Ministry of Labour and Social Welfare, the agency responsible for regulating the activities and labor relations. In the specific case of ergonomic risk factors mentioned, the Mexican Official Rules are NOM- 011- STPS- 2001 for noise and NOM- 015- STPS- 2001 for heat factor factor. (Secretariat of Labor and Social Welfare, 2014)

Despite this, it is necessary to consider international standards and other countries to verify and analyze better the different environmental conditions that are generated at work. By doing this, we can meet and better attack risk factors.

2. Objective

Analyze the current situation of environmental conditions (noise and heat) through existing methodologies, identify areas that can generate ergonomic risk factors, compare the results with other standards and implement preventive or corrective actions if required.

3. Delimitation

On the plant, there are three biscuit production lines, divided into four areas: kneading, machinery, ovens and packaging. For these analyses, the four areas of the three lines were studied. The pasta production area was also studied. Given the large number of processes and products that exist in the company, for all studies, we considered a general process.

4. Methodology

4.1. Analysis of the acoustic environment

NOM- 011- STPS 2001 states that the sound pressure level for an 8-hour exposure should not exceed 90 dB (A).

Following the standard, the location of the 13 points to analyze were chosen, which were identified in a layout. (fig. 1)

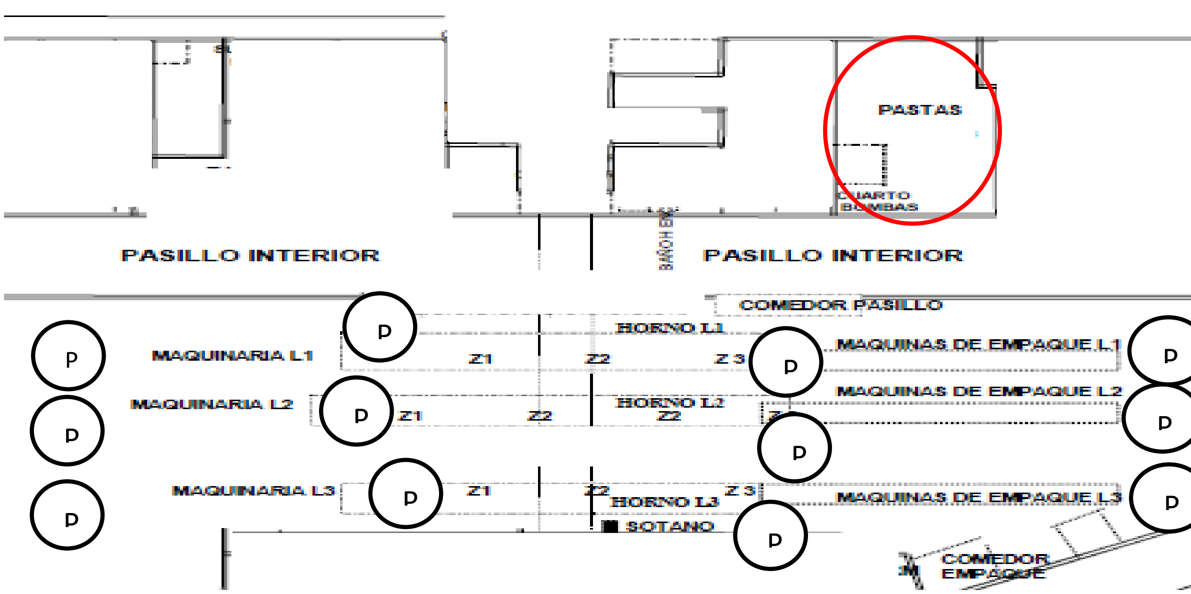

Fig. 1 Identification of the measurement points in the plant layout.

The results obtained using the methodology established by the NOM- 011- STPS-2001 were compared with international standards to verify the presence of ergonomic risk.

4.2. Analysis of thermal environment

In the case of thermal analysis we prefer to use the method which involves Fanger greater number of environmental factors and the corresponding NOM is applied by ISO 7730. This method estimate the percentage of people dissatisfied, under certain environmental conditions. (Vilella, 1983).

For estimating the metabolic rate was used a 2A level (observation of the component of the activity) pointed as valid by ISO 8996.

Level	Methods of metabolism estimation
1. Scoring	1A. Estimation of metabolic rate depending on the profession. (ISO 8996)
	1B. Estimation of metabolic rate depending on the activity type. (ISO 8996 - ISO 7730)
2. Observation	2A. Estimating the metabolic rate from the activity components. (ISO 8996, INSHT- NTP 323)
	2B. Estimation of metabolic rate depending on activity-type. (ISO 8996, INSHT- NTP 323).
3. Analysis	Estimación de la tasa metabólica en función del ritmo cardiaco bajo condiciones determinadas ISO 8996.
4. Expert performance	Measurement of oxygen consumption.
	Measurement of oxygen consumption. Doubly labeled water method
	Direct calorimetry

Table 1. Methods of metabolism estimation

The reference values is in Kcal / min used for body position and type of work were estimated by the Association Occupational and Environmental Health Advancing (ACGIH).

Table 2. Estimated metabolic consumption (M) by ACGIH (Mendaza , 1994)

A. Posición y movimiento del cuerpo			
			Kcal/min
Sentado			0,3
De pié			0,6
Andando			2,0 - 3,0
Subida de una pendiente andando			añadir 0,8 por m de subida
B. Tipo de trabajo			
		Media Kcal/min	Rango Kcal/min
Trabajo manual	Ligero	0,4	0,2 - 1,2
	Pesado	0,9	
Trabajo con un brazo	Ligero	1,0	0,7 - 2,5
	Pesado	1,7	
Trabajo con dos brazos	Ligero	1,5	1,0 - 3,5
	Pesado	2,5	
Trabajo con el cuerpo	Ligero	3,5	2,5 - 15,0
	Moderado	5,0	
	Pesado	7,0	
	Muy pesado	9,0	

The duty cycle of the study areas was analyzed and metabolic expenditure was obtained by work area.

Table 3. Metabolic expenditure by work area.

	Kneading	Machinery	Ovens	Packaging	Pasta
kcal/min	1.7	2.8	2.3	2.0	2.0
kcal/hr	103.0	168.6	136.1	120.0	120.0
MET	1.1	1.9	1.5	1.3	1.3

The final results of the percentage of dissatisfied people were obtained by computer tool available online on the website of the Polytechnic University of Valencia

5. Results

5.1. Acoustic environment

The results of the study of acoustic environment in the areas analyzed were based on an average of 7.3 hours of daily work taken in recent months. The results of the equivalent noise level in dB (A) are shown below.

Table 4. Sound level equivalent dB (A)

	Líne 1	Líne 2	Líne 3
Kneading	78.9	78.4	78.7
Machinery	81.0	80.6	82.2
Packaging	86.8	82.6	80.1
Pasta	88.1		

We observed a high noise level in some areas like pasta and packing line 1. No results exceeds the threshold level permitted by the NOM- 011- STPS- 2001.

However, some parameters that are used for noise in other countries, tell us that a noise level of 85 dB (A) is the maximum allowable for a working day of 8 hours.

Some of these standards are: Supreme Decree No. 594/99 of the Ministry of Health of the Government of Chile, the U.S. Deparment of Health and Human Services or the Canadian Centre for Occupational Health and Safety.

Another valid comparison is with Royal Decree 1316/1989 of Spain , this document dictates preventive measures to be taken in case of exposure levels even from 80 dB (A) to more than 90 dB (A).

5.2. Thermal environment

The results of the study of thermal environment in the areas analyzed resulted in the following data .

Table 5. Medium Rating Index (IVM) Fanger .

	Línea 1	Línea 2	Línea 3
Kneading	2.67	1.72	1.60
Machinery	2.25	2.42	1.87
Ovens	4.07	3.82	3.79
Packaging	1.36	2.44	3.15
Pasta	1.96		

Table 6. Percentage of dissatisfied people (PPI) Fanger

	Línea 1	Línea 2	Línea 3
Kneading	96.3	62.8	56.4
Machinery	86.7	91.6	70.6

Ovens	100	100	100
Packaging	43.4	92.1	99.6
Pasta	74.9		

There are high rates in some areas such as ovens and line 2 and 3 of packaging, where the highest percentage of people dissatisfied presents are taken , according to the method of Fanger .

6. Conclusions

Preventive actions to be taken will be based on the Royal Decree 1316/1989 , which states:

- The need of audio- metric periodical tests every five years , evaluating job every three years and availability of hearing protectors for workers who request when exposed to more than 80 dB (A) which is the case of the workers in machinery area of the three production lines and packing area on lines 2 and 3 .

- The frequency of examination is reduced to every three years, job evaluation is reduced each year and the availability of hearing protectors is for all workers exposed to more than 85 dB (A) , which is the case of the packing on line 1 and pasta production area.

- The kneading area, does not require ergonomic intervention for the noise factor.

In the analysis of thermal stress PPI above 90 % occurred in all areas except the area of pasta. These results are very alarming at first instance , however can be perceived in situ it is not, this because the metabolism per unit time is not as high as a result of long periods of low activity.

Upon analysis using the index of wet bulb and globe temperature (WBGT) recommended by the NOM- 015- STPS- 2001 , it is possible to verify that no activity exceeds the allowable limits.

7. Contribution to ergonomics

We can see that there are ergonomic risk factors that may be affecting workers from Mexico . This biscuit factory is just a small sample of what may be happening in other companies in the industry and have not yet taken the appropriate action. As input must understand that it is always possible to find a process , method or workplace that could be improved for the benefit of workers. In the specific case of these analysis , it was found that noise is the main risk factor , but other companies could be so different , but the important thing is to be aware of its existence and work to eliminate them.

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PROPOSAL FOR IMPROVEMENT IN THE MANAGEMENT OF MATERIALS IN COLD CHAMBER BY ERGONOMIC ANALYSIS METHODS

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RESUMEN: La investigación se desenvuelve en una empresa encaminada a la pasteurización y envasado de productos lácteos. El análisis de la problemática ocurre en el área de almacén de producto terminado de 1750 m^3 brutos 500 m^2 dividida en 2 cámaras de refrigeración frías que operan entre 5ºC y 8ºC y con 2 maniobristas de acuerdo a la carga de trabajo. Se identificaron los riesgos en cámara de refrigeración mediante métodos ergonómicos con el uso de gancho metálico y carretilla de carga. El universo muestral estuvo constituido por 6 trabajadores. Los muestreos se realizaron mes a mes. La evaluación fue con los métodos Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Ovako Working Análysis System (OWAS) y complementados con el método Job Strain Index (JSI). Los resultados muestran las evaluaciones de los métodos ergonómicos en el manejo de materiales con gancho y carretilla de carga, obteniendo que dichas actividades generan mayores riesgos al trabajador. Posteriormente se complementa el estudio con el método JSI. Las medidas correctivas inmediatas son ajuste del método del manejo de materiales y rediseño de la carretilla de carga. Al generarse una mejora en el método del manejo de producto terminado, mediante el rediseño de la carretilla de carga, se podría coadyuvar a eliminar riesgos potenciales de lesiones y accidentes trabajadores, así como la mejora del confort laboral.

Palabras clave: Cámara fría, JSI, REBA, OWAS, Salud ocupacional.

Relevancia para la Ergonomía. Mediante el análisis de los problemas de negocios, la aplicación del método de análisis ocupacional JSI en la zona de almacenes y acciones de mejora que se muestran para eliminar las causas profundas y mejorar las condiciones de trabajo.

ABSTRACT: The research develops in a company dedicated to pasteurization and packaging of dairy products. The analysis of the problem occurs in the area of finished product warehouse 1750 m^3 gross 500 m^2 divided into 2 chambers of cold cooling operating between 5°C and 8°C and 2 stevedoring according to the workload. The risks identified in cooling chamber by ergonomic methods using metal hook and cargo truck. The sample universe consisted of 6 workers. The samplings were conducted every month. The evaluation was with Rapid Upper Limb Assessment methods (RULA), Rapid Entire Body Assessment (REBA), Ovako Working Analysis System (OWAS) and supplemented with Job Strain Index (JSI) method. The results show evaluations of ergonomic methods in handling materials and truck cargo hook, obtaining that these activities generate greater risks to workers. Subsequently the study is complemented by the JSI method. Immediate corrective measures are adjusting material handling and redesign of the truck loading method. By generating an improvement in the method of handling the finished product, by redesigning the truck load, it could help to eliminate potential risks of injuries and accidents workers and improve the working comfort.

Keywords: Cold Chamber, JSI, REBA, OWAS, Occupational Health.

Relevance to Ergonomics. By analyzing business issues, implementation of JSI occupational analysis method in the area of warehouses and shown improvement actions to eliminate the root causes and improve working conditions.

1. INTRODUCTION

In the 2005-2014 report, the Mexican Social Security Institute (IMSS) reports a figure of 10680 accidents in service employees support production in the State of Mexico, of which 7710 are male. Importantly material handling cold chamber is in this area, so it is advisable to conduct a study on the physiological involvement, as well as worker performance in these tasks.

Musculoskeletal disorders of occupational origin (MSDs) are a cause of concern, not only the effects on the health of workers, but also by the enormous economic impact on businesses and the social costs of European countries (Colombini, 2001). The European Agency for Safety and Health at Work (EU-OSHA) reports that some studies have estimated the cost of MSDs higher between 0.5% and 2% of gross domestic product limb. In the European Union the MSDs are the most common occupational disease (European, 2010). Occupational hazards associated with cold chambers as may be the case, originate often due to deficiency of safety factors and technology, such as physical load, static effort awkward postures or heavy lifting, indicating that the level of security a job is based on the difficulties presented by the same (Gil, 2003); This is affirmed by Apud et al. (1999) mentions that longer duration of exposure to risk further injury factor arises.

2. OBJECTIVE

Identify risks in handling materials in cooling chamber by ergonomic methods using metal hook and truck loading and propose alternatives to counter potential risks identified.

3. METHODOLOGY

The research conducted in this paper is descriptive (seen, records and interprets the existing information to define properties and characteristics), documentary (data records were consulted), not experimental (the natural process is observed) and nonparticipating behavior (the researcher not involved in the process).

3.1 Study Area

The study area corresponds to a finished product warehouse 1750 gross m^3 storage density 1440 kilo-liters / m^2 divided into two cooling chambers operating between 5°C and 8°C. It has shelter area / break to warm (21°C). The activities to determine the risks in handling materials are: Management of finished product with metal hook (Activity 1) and finished product handling truck load (Activity 2). The samplings were conducted month August 2015 to February 2016. Below is a brief description of the activities studied is presented.

Activity 1: It takes place in the receiving area of production, has 3 workers (50% of workers in the area) distributed in 3 shifts. The activity begins with the receipt of stowage of plastic cases where the finished product (presentations gallon, half gallon and liter) is then the operator removes the stacks of boxes (6 boxes of 122kg approximately) with metal hook at a distance of 2m conveyor. The cycle of operation is 1.53 min/stowage. This activity is performed during the first 60 minutes of the day. Figure 1 shows the activity of removal of the stowage with hook conveyor.

Activity 2: Following Activity 1, the operator moves and orders stowage according to finished product shipping program a distance of 15m. The task takes place in 3 shifts with the assistance of a wheelbarrow load. The operating cycle is 2 min/stowage. This activity is carried out during the last 6 hours of the day. Figure 4 shows the transfer of stowage with cargo truck.

3.2 Risk assessment for occupational exposure to cold

First risk assessment was performed by thermal stress due to cold with computer application EVALFRIO, in accordance with UNE-ENV ISO 11079: 1998, Evaluation of cold environments and determination of required clothing insulation (ISO TR 11079:1993). The data collected for the evaluation are as follows:

1. Metabolic activity of work (M) = 58 W/m^2,
2. Air velocity (Va) = 6 m/s
3. Air temperature (ta) = 5°C

4. Operating temperature (*to*) = 5°C
5. * Insulation Index (*Icl*)= 4 clo * (short sleeve underwear, jacket and pants thermal insulating, socks and shoes)
6. Relative Humidity (*RH*) = 95%
7. Temperature gradient between the surface of the skin (T_{SK}) = 15oC
8. Surface dress (*TCL*) = 5 ° C

3.3 Evaluation of finished product with hook by ergonomic methods

The first study assessed the transfer hook finished product using the RULA, REBA and OWAS methods. Later analysis is complemented by applying the method JSI. 33 work cycles 2.31 min/stowage duration for worker were considered. Figure 1a shows the hook material handling. You can see the lifting of the stack of boxes for removal conveyor. Figure 1b shows the drag of the battery in cold chamber, lifting the left arm, right hand effort. In Figure 1c the stack arrangement with both arms and push right foot is observed.

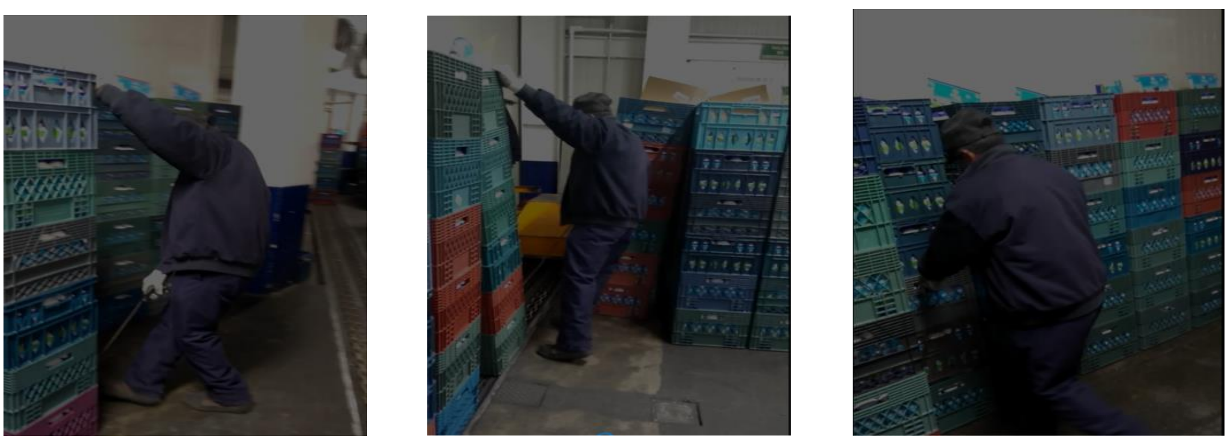

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Figure 1. Material Handling hook in cold room.

Table 1. Comparison of assessment material handling hook.

METODO POR GANCHO				
	RULA	**REBA**	**OWAS**	**Acciones correctivas**
Left arm. Flexure> 90º	4	4	2	Positions with possible damage to the musculoskeletal system, corrective actions are required in the near future.
Right arm. Flexure between 20º y 45º	2	2	2	
Left forearm. Flexure<60º	2	2		Urgent changes are required in the job or task
Right forearm. Flexure <60º	2	2		
Left wrist. Extended 0°- 15º	2	1		
Right wrist. Deflected radial	3	2		

Turn left wrist. average pronation	1			
MediaTurn right wrist. average pronation	1			
Neck. Greater bending 20º.	3	2		
Trunk. Torque/ lateral tilt, flexed between 0° and 20°	2	3	2	Positions with possible damage to the musculoskeletal system, corrective actions are required in the near future.
Legs. Knee bend between 30 ° and 60º, flexing between 0° and 20°	2	3	3	Postures with harmful effects on the musculoskeletal system required corrective actions as soon as possible.
Loads and forces. Over 20 kg			3	

3.4 Evaluation of finished product by JSI hook method

JSI analysis assessed whether workers who occupy them are exposed to cumulative trauma disorders develop in the distal part of the upper limbs due to repetitive movements. 100 cycles measured for each worker (error 10%) were considered work. Each cycle has a duration of 2.31 min/stowage average.

Table 2. Evaluation of traumatic disorders hook method

Intensity of effort (IE)		Anatomic hand position (HWP)	
Perceived exertion	Assessment	Wrist posture	Assessment
Using shoulders or trunk to generate forces	5	bad	4
Duration of efforts (DE)		**Working speed (SW)**	
% Time effort	Assessment	Ritmo de trabajo	Assessment
50%-79%	4	Fast	4
Efforts frequency (EM)		**Performing the task (DD)**	
Effort to minute	Assessment	Task duration/day	Assessment
4-8	2	4-8	4
Strain index			
Record		Assessment	
78		**High risk task, must apply immediately an improvement**	

The analysis of activities includes the videotaping of the workstation with the two activities, so simultaneously observe body angles in real time, the performance of tasks and get multiple postural parameters according to (Cochran, 1999 and Konz, 2004).

3.5 Evaluation of finished product truck loading using ergonomic methods

The evaluation of the transfer of finished product truck loading was made considering 35 working cycles with 1.87 min / battery life for workers. Figure 2a shows the insertion of the trolley base in the lower position of the stack of finished product. Figure 2b shows the drag of the battery in cold chamber, tilt and trunk movements in both arms and legs. In Figure 2c the stack arrangement with both right and sustaining arms run with right foot is observed.

a b c

Figure 2. Material Handling hook in cold room.

Table 3. Comparison of assessment material handling truck.

METODO POR GANCHO				
	RULA	**REBA**	**OWAS**	**Acciones correctivas**
Left arm. Flexure> 90º	3	2	3	Postures with harmful effects on the musculoskeletal system required corrective actions as soon as possible.
Right arm. Flexure between 20º y 45º	4	4	3	
Left forearm. Flexure<60º	1	2		Urgent changes are required in the job or task
Right forearm. Flexure <60º	2	2		
Left wrist. Extended 0°- 15º	2	2		
Right wrist. Deflected radial	3	1		
Turn left wrist. average pronation	1			
MediaTurn right wrist. average pronation	1			
Neck. Greater bending 20º.	2	1		
Trunk. Axis aligned trunk flexed between 0 ° and 20 °	2	3	1	Not require corrective action
Legs. Standing, one leg straight and the other bent, flexed between 0 ° and 20 °	2	3	3	Postures with harmful effects on the musculoskeletal system required corrective actions as soon as possible.
Loads and forces. Over 20 kg			3	

3.6 Evaluation of finished product truck loading method JSI

100 cycles measured for each worker (error 10%) were considered work. Each cycle lasts 2min/stowage average.

Table 4. Evaluation method traumatic disorders truck

Intensity of effort (IE)		Anatomic hand position (HWP)	
Perceived exertion	Assessment	Wrist posture	Assessment
significant effort; changes in facial expression	4	Regular	3
Duration of efforts (DE)		Working speed (SW)	
% Time effort	Assessment	Ritmo de trabajo	Assessment
50%-79%	4	Fast	4
Efforts frequency (EM)		Performing the task (DD)	
Effort to minute	Assessment	Task duration/day	Assessment
<4	1	4-8	4
Strain index			
Record		Assessment	
20.25		**Probably dangerous task**	

3.7 Analysis of the truck

Material handling truck responds to the physical principle of lever. Figure 3 shows the application of force F1 perpendicular to the distance d1 to match the moment generated F2 respect to d2 (Equation 1).

$$F2 * d2 = F1 * d1 \tag{1}$$

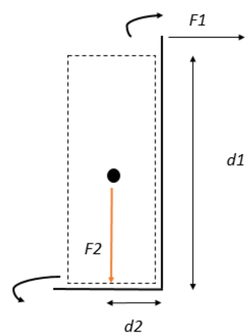

Figure 3. Free body diagram, current truck

As the force exerted is not directly perpendicular, is calculated with respect to the cosine of the angle generated, said angle is calculated based on tables anthropometric measures of staff in the region and a height of 1.8m for charger:

$$F2 * d2 = F1 * d1 * \cos\alpha \tag{2}$$

Therefore:

$$F1 = \frac{F2 * d2}{d1 * \cos\alpha} \tag{3}$$

With the anthropometric measurements of the warehouse, the weight of the finished product boxes and other variables (*d1* = 1.6m, *F2* = 1200N, *d2* =0.25m y *cos α* = 0.55), the value of α is determined α= 57°. Values with the need to apply a force *F1* = 340.9N to match the moment generated by *F2* respect to *d2* follows.

4. RESULTS

The results of the risk assessment of hypothermia and cold discomfort in both activities show a heat index IREQ (insulation required clothing) of 3.7 clo and $I_{cl\ neutral}$ 3.7 clo. Concluding that the clothing worn by the worker does not present unacceptable loss of body heat to break the thermal equilibrium of the body. As for the risk of cooling hands the risk is acceptable with cold unacceptable noise and disturbance. The risk of airway cooling is acceptable.

The ergonomic design of double lever mechanism for handling materials in cold chamber, reduces the effort to lift and move materials due to the increase of 50% of its capacity equivalent to 402.2N.

Recommendations for each of the activities discussed in this study are preliminary proposals and should be discussed with senior management, occupational safety specialists, human resource managers and workers to contribute to the effectiveness of interventions.

4.1 Proposal for improvement in the truck

In order to improve loading conditions and reduce the risk of injury, mechanism design and double lever guide slot it is proposed. The design contemplates measures lever height according to the height to the average shoulder (1359.0 mm) as initial thrust point and height average trochanter (834.0 mm), the support angle to the vertical of 25° sufficient to overcome the line perpendicular to the center of mass of the finished product boxes with inclined during their position. Figure 4b shows that the arm *d2* (545.0 mm) on d1 (650.0 mm) is 18% longer, achieving an increase in proportion of the time, significantly improving the performance of the maneuver lift and push.

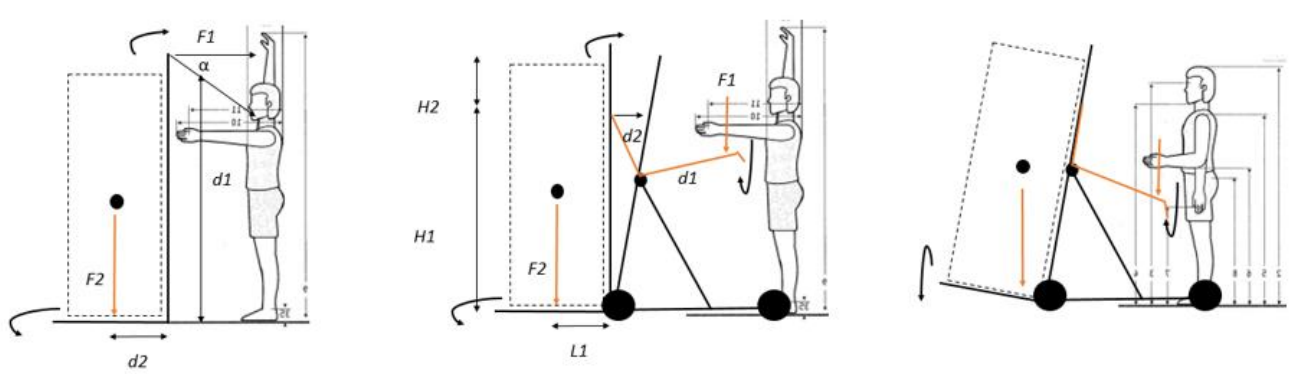

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Figure 4. Comparison of efforts between current truck vs double lever mechanism.

Taking into account the same criteria of normal charger applied to the dynamics of the mechanism, the change in the level of support and changing the α angle of 57° to 22° a force *F1* of 340.9N is obtained to overcome the weight of the boxes to 222.5N. If the resultant force *F1* is added 18% improvement with the application of the lever, you have a total 402.2N increase in lifting capacity of the device, impacting less effort for the worker to dedido the pushing action made with an ergonomic position. The structural design was performed using computer-aided drawing Solidworks® software.

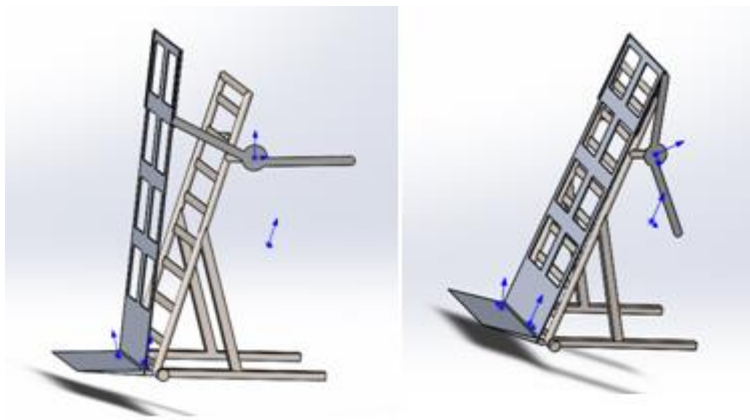

Figure 5. Structural design of trolley double lever mechanism.

5. CONCLUSIONS

The ergonomic evaluation of jobs is a key element in the primary prevention of MSDs. In this study two methods of evaluation are applied, which enriches the analysis and contributes to obtaining more consistent results. Risk levels obtained with the methods agree 2 activities. This research developed a proposal to improve working conditions in cold room with ergonomic approach to eliminate risks of accidents and injuries to workers of the company, improve the working comfort and help to increase the productivity of the company and product handling.

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DETERMINATION OF POSSIBLE CTD'S IN VULCANIZING LOS MOCHIS SINALOA

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Tras un estudio de 24 vulcanizadores de la región de Los Mochis Sinaloa durante el período diciembre-enero, en un lapso de tiempo de tres semanas y basado en la investigación de campo se presenta utilizando los métodos 4 puntos de Luke y mapa de incomodidad corporal de Corlett y Bishop, para determinar la existencia de DTA's en el vulcanizador de Los Mochis, Sinaloa. Donde los 4 puntos de Luke son para priorizar el nivel de fatiga en 4 niveles diferentes, mientras que el mapa corporal Corlett y Bishop es para determinar dolor en diferentes partes del cuerpo. Basándose en los resultados adquiridos con el análisis estadístico, se darán a conocer los resultados, lo que demuestra que hay pruebas suficientes para determinar si hay Trastornos de de trauma acumulativos (DTA's) en los vulcanizadores de Los Mochis Sinaloa.

PALABRAS CLAVE: Llanteras, trastorno de trauma acumulativo (CTD), las lesiones.

ABSTRACT: Following a study of 24 vulcanizer of the region of Los Mochis Sinaloa during the December-January period, in a lapse of time of three weeks and based on field research is presented using the methods 4 points of Luke and map body discomfort Corlett and Bishop,in order to determine the existence of CTD'S in the vulcanizer of Los Mochis, Sinaloa. Where the 4 points of Luke are to prioritize the level of fatigue in 4 different levels, while the map of body discomfort Corlett and Bishop is to determine the aches and pains in different parts of the body. Basing the results acquired with statistical analysis, they will be announced the results, demonstrating that there is sufficient evidence to determine if there are Cumulative Trauma Disorders (CTD's) in vulcanizer of Los Mochis Sinaloa.

KEYWORDS: Tire shop, cumulative trauma disorder (CTD), injuries**.**

1. INTRODUCTION

The Royal Spanish Academy defines tire shop as an "establishment dedicated to fixing punctures the tires" therefore its workers are colloquially called "tire dealers."

Nowdays, having an automobile is one step away from being a luxury to a necessity. This is where the function of the worker emerges providing a service that became a steady job and the need led them to develop methodologies for the development of the activity which may include poorly designed positions, repetitive movements and even excessive weight lifting.

2. JUSTIFICATION

In the city of Los Mochis Sinaloa there is a large number of people who serve as vulcanizer or tire dealers. The activities performed by employees are constant, repetitive and need the application of considerable force, in addition to that there is no precedence over investigations concerning tire dealers in the country. That is why the research presented below. The workers were taken to investigate whether they are exposed to the development of a CTD, or if they already have developed some.

3. GENERAL PURPOSE

Determine the existence of Cumulative Trauma Disorders (CTD'S) in workers at tire shops of the city of Los Mochis.

3.1. Specific objectives

- Determine the extent of the damage in the workers
- Identify the mainareas of affectationtowardsworkers

4. DELIMITATION

This research aims to determine the existence of data in vulcanizing workers located in the city of Los Mochis Sinaloa

5. REFERENCE FRAMEWORK

The development of data in the vulcanizer depends on several factors that may be involved in this, a clear example of this are the tools that they use to carry out their activities, such as the dismantler that although you do not have a specific study on whether CTD's cause fatigue this may be one of the factors that encourage the development of such problems.

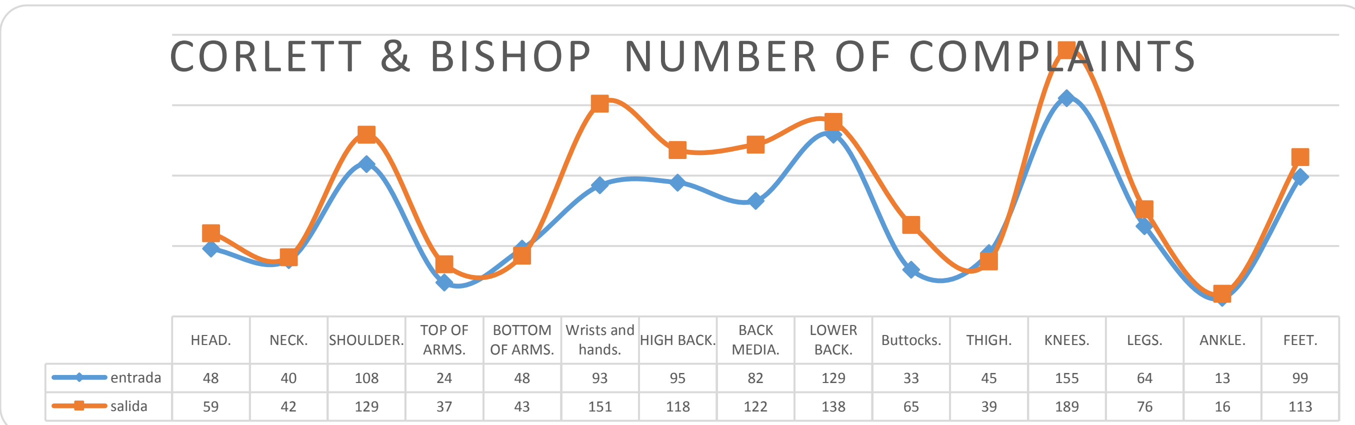
As Washington Tenorio Gualpa mentions in his thesis "IMPLEMENTATION OF A TYRE SYSTEM TO AVOID A MECHANICAL STRAIN IN DESENLLANTADORA HOOPS SERVICE DURING THE vulcanizer vulcanizing" SERVITECNIC SAN MIGUEL "CANTON which indicates the proper positions for the development of activities as well as the correct way of using machinery. These positions were not observed along the field research so we can realize the lack of information to workers.

6. METHODOLOGY

The presence of fatigue was identified in workers of vulcanizer, so it was decided to conduct the field study in order to determine the existence of a cumulative trauma disorder (CTD'S). They were carried out corresponding measurements using 4 points Corlet & Bishop Luke and applied to 24 workers followed for 3 weeks, later conducted data collection in order to determine the CTD'S existence or lack thereof, as well as the main factors which the worker is affected while working and at the end of the task.

7. RESULTS

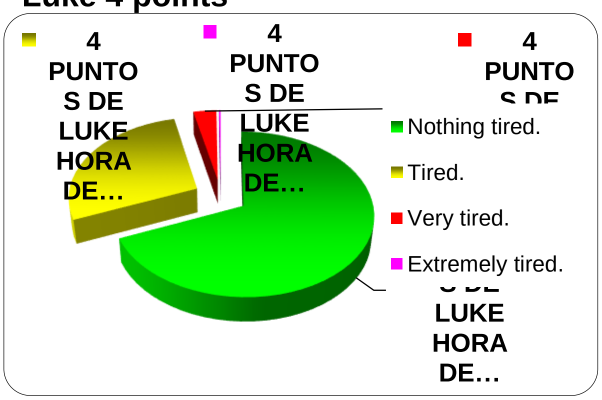
Corlet&Bishop

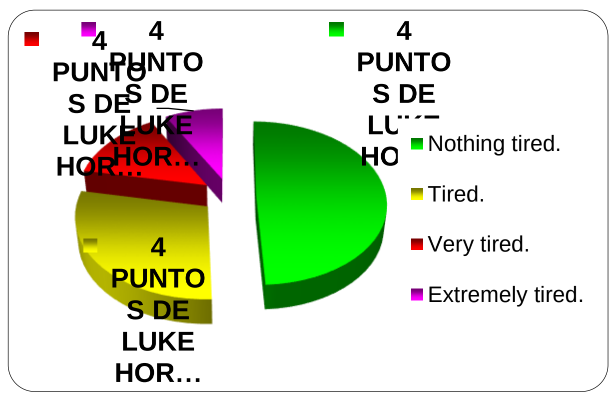


	HEAD.	NECK.	SHOULDER.	TOP OF ARMS.	BOTTOM OF ARMS.	Wrists and hands.	HIGH BACK.	BACK MEDIA.	LOWER BACK.	Buttocks.	THIGH.	KNEES.	LEGS.	ANKLE.	FEET.
entrada	48	40	108	24	48	93	95	82	129	33	45	155	64	13	99
salida	59	42	129	37	43	151	118	122	138	65	39	189	76	16	113

Graphic 1: Corlett &Bishop number of complaints

Luke 4 points





Graphic 3: 4 Luke points of entry time
Graphic 4: Luke points of time out

8. CONCLUSION

Once the data analyzed gave notice that the work of vulcanization is highly variable when it comes to the constancy of work, so the results showed that there is no correlation between weeks and days of work, if not the relationship between them is the amount of work you can get to present and according to the questionnaires there is a correlation between the time of input and output (as shown in Graphic 1, thereby identifying that development work vulcanization generates a cumulative fatigue during the day affect different body areas.

Among the areas most affected are the shoulders, wrists, hands, upper back, middle back, lower back and knees.

Furthermore the study by "four points Luke", the presence of increased complaints was identified by pain in a large number of workers, thereby increasing the percentage level of tiredness.

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ERGONOMIC EVALUATION OF THE LABELING JOB POSITION IN A COMPANY DEDICATED TO THE PROCESSING OF FOOD PRESERVATION

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Resumen: Los riesgos de trabajo representan una de las principales amenazas a la solidez y permanencia en el mercado de cualquier empresa ya que interfieren en el desarrollo normal de las actividades e inciden negativamente en su productividad, por ello el control de los mismos debe ser una de las principales preocupaciones que cualquier empresa debe abordar. En la industria agroalimentaria, a pesar de los avances tecnológicos, se continúan realizando trabajos manuales que implican movimientos repetitivos, adopción de posturas forzadas, esfuerzo físico intenso y manipulación de cargas. El objetivo de este estudio es identificar y caracterizar los factores de riesgo del puesto de trabajo de etiquetado y su impacto en la salud de los trabajadores para generar propuestas que los reduzcan o eliminen, de forma que las actividades que se llevan a cabo en la empresa sean más eficientes, productivas y seguras. Se aplicaron el método propuesto por Suzanne Rodgers y el método RULA (Rapid Upper Limb Assessment) para detectar los riesgos ergonómicos en el área de etiquetado. Los resultados de ambos métodos reportan que existe riesgo moderado y alto de ocasionar DTA's principalmente en el cuello, hombros, espalda, mano y muñeca. Después de analizar los resultados arrojados por los métodos de evaluación ergonómica utilizados y se hicieron propuestas de rediseño y mejora de las condiciones de trabajo.

Palabras clave: Rodgers, RULA, preserves manufacturing & ergonomic risks.

Relevancia a la Ergonomía: Está importante estudiar los factores de riesgo ergonómicos que pueden causar el TME (trastornos musculoesqueléticos) en los operadores de producción y, posteriormente, proponer estrategias que minimicen o las eliminen, para mejorar la calidad del lugar de trabajo y el aumento de la calidad.

Abstract: Work risks represent a major threat to the solidity and permanence in the market for any company because they interfere with the normal development of activities and adversely affect their productivity, thus controlling those risks should be one of the main concerns that any company must address. In the food industry, despite technological advances, they are still doing manual jobs that involve repetitive movements, adopting awkward postures, intense physical exertion and cargo handling. The aim of this study is to identify and characterize risk factors of the labeling job position and its impact on the health of workers in order to generate proposals that reduce or eliminate, so that the activities carried out in the company can be more efficient, productive and safe. The method proposed by Suzanne Rodgers and RULA (Rapid Upper Limb Assessment) were applied to detect ergonomic hazards in the labeling area. The results of both methods reported that there is a moderate to high risk of causing CTD's (Cumulative Trauma Disorders) mainly in the neck, shoulders, back, hand and wrist. After analyzing the results obtained by the ergonomic evaluation methods used redesign proposals and improving working conditions were made.

Keywords: Rodgers, RULA, preserves manufacturing & ergonomic risks.

Relevance to Ergonomics: It´s important to study the ergonomic risk factors that may cause the MSD (Musculoskeletal Disorders) in production operators and subsequently propose strategies that minimize or eliminate it, to improve the workplace and increase quality.

1. INTRODUCTION

The main economic activity in Sinaloa is agriculture (Meyer, 1997). It has 15,000 producers and 10 packing plants in the state. In the food industry (preserved vegetables and fish, meat, etc.) the work carried out involves repetitive movements, the adaptation of awkward postures, intense physical exertion and cargo handling as well. Despite the mechanical technology developed in these sectors, new risk factors have been added linked to the noise, vibration and thermal load as many of these stations lack of ergonomic principles (Martin, 2007).

In Mexico the number of risks and injuries in the agricultural sector has increased, resulting in labor problems in the process by the operator, according to the IMSS (2012), 768 cases of diseases caused by occupational hazards in the agricultural sector were recorded, which leads to subsidize 22, 240 disability days a year. At the Preservation Food plant where the study was conducted, there are 3 shifts of 8 hours leaving 1 hour free to rest and to eat, and at the labeling area 8,000 to 9,500 boxes with cans of food per shift are packed, with four operators per shift. Despite improvements that have been made in workstations operators continue to have musculoskeletal injuries, mainly in the labeling station where injuries to hands, fingers, neck and back are generated. In Mexico, there is insufficient ergonomic studies in food preservation plants that provide a proposal for improvement of work and increase productivity but especially the quality of life of all those involved in the process.

2. OBJECTIVE

To identify and characterize ergonomic risk factors of the job labeling position and its impact on the health of workers in order to generate proposals that reduces or eliminate, so that the activities carried out in the company can be more efficient, productive and safe.

3. METHODOLOGY

A tour was conducted in order to know in a visual way the study area and to identify the workstations with more ergonomic risk, and to select the appropriate methods for evaluating these stations. Each activity carried out by the operator in his/her work area and how it was carried out was recorded.

Subsequently, the 12 workstations of labeling job position located in the company were filmed, with the purpose of capturing in detail the movements carried out by operators in the different activities carried out by them. All stations were evaluated using the RULA (Rapid Upper Limb Assessment) and Suzanne Rodgers methods. The reason for using both methods was to compare the levels of risk and to have greater accuracy.

The Suzanne Rodgers method (1992) is a method of ergonomic analysis that studies three important factors: the level of effort, duration before relaxation (or before moving to a lower level of effort) and the frequency of muscles activation to perform the activity. With these parameters the level of muscle fatigue that occurs in the following body parts is estimated: neck, shoulders, back, arms-elbows, hands-wrists-fingers, legs-knees, ankles-feet-toes. Each factor has the ability to take values from 1 (low) and 3 (high). At the level of effort the appreciation is subjective, but not in the rest of the factors. The value obtained for each body segment is between (1-1-1) and (3-3-3). For comparison the worst result is used, comparing the obtained values against the reference values of the method.

The RULA method was developed by doctors McAtamney and Corlett, of the University of Nottingham in 1993 (Institute for Occupational Ergonomics), to assess the exposure of workers to risk factors that can cause disorders in the upper limbs. RULA uses body postures diagrams and score tables for assessing exposure to the following risk factors: posture, repetitive movements, applied forces and static activity of the musculoskeletal system.

4. RESULTS

The following operations on the workstation of the labeling job were identified: bending over and taking a cardboard box with the left hand, putting the cardboard box in front, taking from the conveyor belt two cans of product in each hand, rotating both wrists to place the cans in the carton box, the last operation is repeated until 24 cans are placed into the carton box.

In charts 1 and 2 risk levels resulting from the application of S. Rodgers and RULA methods are presented, indicating in which activities of the workstation is necessary to apply preventive and corrective measures to prevent injury to operators.

Chart 1. Result of the application of the S. Rodgers method.

Activity/Task	Body Part	Effort	Duration	Frequency	Risk
Taking a carton Box and placing it in front	Neck	3	1	2	Moderate
	Shoulders	2	1	2	Low
	Back	3	1	2	Moderate
	Arms/Elbows	2	1	2	Low
	Hands/Wrists/Fingers	2	1	2	Low
	Legs/Knees	2	1	2	Low
	Ankles/Feet/Toes	2	1	2	Low
Putting cans into a carton box	Neck	2	1	3	Moderate
	Shoulders	3	1	3	Alto
	Back	1	1	3	Low
	Arms/Elbows	1	1	3	Low
	Hands/Wrists/Fingers	2	1	3	Moderate
	Legs/Knees	1	1	3	Low
	Ankles/Feet/Toes	1	1	3	Low

According to the results of the S. Rodgers method, taking the carton box and placing it in front presents moderate risk of causing CTD's in neck and back. Placing the cans into the carton box generates moderate risk in neck and hands, wrists and fingers and high risk in shoulders. On the other hand, the results of RULA indicate the need to investigate and redesign the workstation.

Chart 2. Result of the application of the RULA method.

Activity/Task	Group	Score
Taking a carton Box and placing it in front	A (Arm/Wrist)	3
	B (Neck/Back/leg)	6
	C (Muscle use/Loading)	6
	Final	Investigate and redesign workstation
Putting cans into a carton box	A (Arm/Wrist)	4
	B (Neck/Back/leg)	3
	C (Muscle use/Loading)	5

	Final	Investigate and redesign workstation

5. CONCLUSIONS

From the observation of the results obtained, it is clear that there are potential risks of musculoskeletal disorders (MSD's) in the job position. In order to reduce or minimize the risk, it is necessary:

- Redesign the workstation to anthropometric measures of the workers. It is recommended to increase the height of the boxes container to reduce the neck and back score and minimize the risk of injury to the operator.
- Redesign the method of work. (Avoid inadequate movements like wrist twist that produce injuries at workers).
- Establish periodic breaks and in order to decrease of fatigue in certain muscles, joints and tendons.
- Allow rotation of the staff during the work day.
- Introduce to the company the importance of health care and in this way also satisfy legal requirements.

The above recommendations may be useful to improve the operator's health and the work area in a more optimal way, and thus increase the company productivity and reduce the risk of injury at workers.

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ERGONOMIC RESEARCH ON POSSIBLE CTD IN THE CARPENTERS OF THE CITY OF LOS MOCHIS, SINALOA

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Resumen: El presente trabajo muestra los resultados de una investigación ergonómica realizada a 20 carpinteros de la ciudad de Los Mochis Sinaloa durante el periodo de Diciembre y Enero de 2016 con una duración de tres semanas, apoyado en dos métodos de evaluación subjetiva como Yoshitake el cual se divide en tres grupos de preguntas relacionadas con síntomas de somnolencia y monotonía, dificultad de concentración y síntomas corporales o proyección de daño físico, para fines de interés en DTA's únicamente utilizamos la tercer columna.

Del mismo modo se utilizó el método llamado Corlett & Bishop, el cual estudia individualmente las partes del cuerpo, para así detectar y aislar las partes más afectadas del mismo. Debido a que no existe ningún antecedente de otra investigación acerca del tema de estudio, buscamos determinar la existencia de DTA's en el área laboral en los carpinteros que accedieron a realizar esta investigación. Los resultados obtenidos en esta investigación fueron analizados estadísticamente, los cuales mostraron que existe suficiente evidencia estadística recabada durante las tres semanas para decir que si se presenta DTA laboral de tipo físico en los carpinteros de la ciudad de Los Mochis Sinaloa.

Palabras clave: CTD's, carpinteros, lesiones, seguridad, problemas en el sistema musculo esquelético.

Relevancia para la Ergonomía: Esta investigación facilitará en gran medida al análisis de los trabajos en el área de carpintería, lo que permite evaluar y considerar propuestas para la resolución de problemas. Se tiene la intención de detectar posibles signos de lesiones y problemas que pueden causar en el medio y largo plazo. Del mismo modo, lograr la disminución de este tipo de problemas en las personas de la industria.

Abstract: The present work shows the results of an ergonomic investigation realized to 20 carpenters of the city of Los Mochis, Sinaloa, in December and January 2016, with a duration of three weeks, supported two methods of subjective evaluation, as the third column of yoshitake which is related to the corporal symptoms and physical damage of the groups.

In the same way, Corlett and Bishop which evaluates discomfort at different body parts. Because there isn't any antecedent of another investigation of the studio topic, we searched determine the existence of labor fatigue in carpenters that accessed to realized this investigation. The results obtained in this investigation were analyzed statistically, and showed that exist enough evidence statistic collected during the three weeks to say that there is labor CTD´s in carpenters from Los Mochis, Sinaloa city.

Key words: CTD´s, carpenters, injuries, safety, problems muscle skeletal.

Relevance to Ergonomics: This research will facilitate largely to the analysis of the work in the area of carpentry, which makes it possible to evaluate and consider proposals for the resolution of problems. It is intended to detect possible signs of injuries and problems that may cause in the medium and long term. Likewise, achieve the decrease of this type of problems in the industry people.

1. INTRODUCTION

The Real Academy of Spanish, defines the Carpenter as: "Person who by trade works and styles, ordinarily joint wood".

In this study, the main interest is to know if there are CTD's in employees who work in carpentry from Los Mochis Sinaloa. Supported on different methods of evaluation of CTD labor, such as the subjective questionnaire of physical fatigue of YOSHITAKE (1978) and Corlette & Bishop.

2. OBJECTIVES

2.1 General objective

Determine if there are CTD's due to the work of the carpenters through the application of methods for assessing subjective: Yoshitake, Corlette & Bishop.

2.2 Specific objectives

- Determine the possible presence of lesions (CTD's) of carpenters working in the city of Los Mochis, through the application of assessment methods: third column of Yoshitake, Corlett and Bishop.
- Determine the specific area in which lesions are present (in this case).

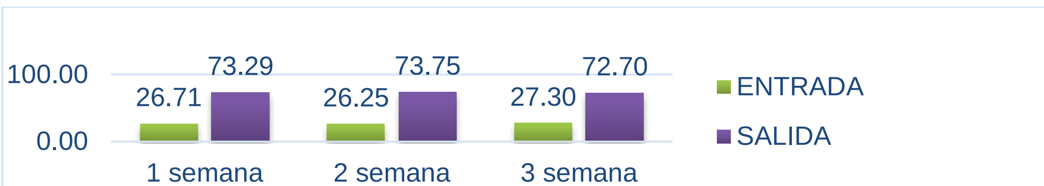
3. METHODOLOGY

Was taken a minimum sample of 20 workers of the different popular carpentry existing in the city of Los Mochis Sinaloa, due to the ease of analysing data statistically.

Started by selecting employees to be surveyed, informing them ahead of time that the study was to ask for your cooperation in this. Those who agreed to collaborate, conducted it a daily assessment for three weeks, filling the formats for the determination of CTD´s with the third column of Yoshitake and Corlett & Bishop.

4. RESULTS

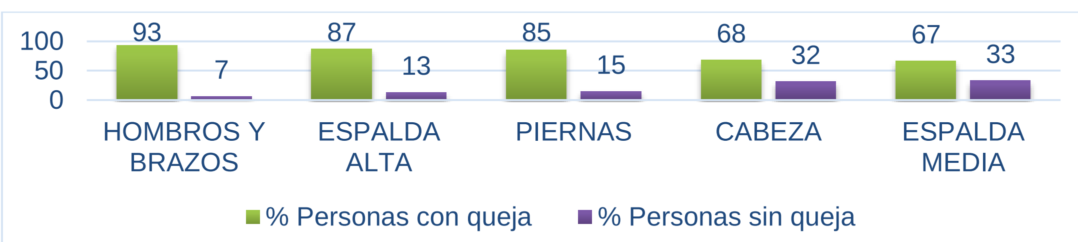
THIRD COLUMN-YOSHITAKE



Graphic 1. THIRD COLUMN OF YOSHITAKE

Graphic 1 shows the general percentages of the 3 weeks in which the investigation was carried out. There is the highest concentration is in the departure time.

CORLETT & BISHOP



Graphic 2. General parties most affected departure

Graphic 2 shows general percentages of affected parties in the carpenters.

5. CONCLUSIONS

Considering the results of the third column of Yoshitake, symptoms of injury are evident by which it is understood that the work is done in a wrong way, and it is recommended to change the same as soon as possible.

As regards the method Corlett & Bishop, it can be concluded that there is injury to the parties most affected that are shoulders, arms, back, legs, head and mid back.

There is enough statistical evidence collected during the 3 weeks to say that if it shows signs of occupational injuries in the carpenters of the city of Los Mochis Sinaloa, data collected from the people that participated in the survey.

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ERGONOMIC RISK ASSESSMENT JOBS

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RESUMEN: Para este proyecto para reducir el riesgo de accidentes y poner en práctica las empresas de seguridad y salud, diferentes problemáticas ergonómica se analizan con la ayuda de herramientas para detectar los riesgos que salvaguardan dar protección a los empleados y mejorar la economía de la empresa.

Esta metodología de detección de riesgos era necesario aplicar una lista de verificación dando prioridad a los diversos problemas causados por el entorno de trabajo de un empleado que era un soldador. Los resultados muestran porque había lesiones relacionadas con el trabajo, tales como hernias discales, Síndrome del túnel del capo, etc.

Se convirtió en un análisis con herramientas de estudio tales como la carga mental, carga física, el NIOSH, REBA para mejorar la seguridad de los empleados.

Obtención de resultados de la investigación, una propuesta para mejorar el beneficio tanto para el empleado como la empresa, iba a ser una manera óptima y eficiente, y también para mejorar la salud física y emocional, así también un gran paso en la infraestructura de la empresa en general.

Palabras clave: Evolución, riesgos ergonómicos, el método NIOSH, método REBA

Relevancia para la Ergonomía: La Ergonomía abarca una gran cantidad de estudios y de puestos de trabajo, lo que es esencial que las empresas hoy en día hacen uso de estas herramientas, el hecho de que un empleado trabaja fuerte y dolorosamente no da lugar a una mayor producción, si no en una disminución de la misma y por lo tanto la empresa sin beneficios y en el mediano y largo plazo resulta en costos tanto a la empresa como a la seguridad social por pagos a los trabajadores por no haber adaptado una posición cómoda y ergonómica.

En lesiones tales como muñecas, síndrome del túnel carpiano, hernia de disco, el estrés mental, entre otros, tal y como se ha mencionado anteriormente, es importante utilizar la ergonomía y adaptarse a las nuevas normas ergonómicas mexicanos y así mejorar y estar siempre para la mejora continúa.

ABSTRACT: For this project to reduce the risk of accidents and implement safety and health companies, different ergonomic problematic are analyzed with the help of tools to detect risks safeguarding employee giving protection and improve the economy of the company.

This risk detection methodology was necessary to apply a checklist thus giving priority to various problems caused by the working environment of an employee who was a welder. The results show there was work-related injuries such as herniated discs, carpal pain tune, etc.

It became one analysis with study tools such as Mental load, physical load, NIOSH, REBA to improve employee safety.

Getting research findings, a proposal for improving profit for both the employee and industry was to be a optimal and efficient manner and also to improve physical health and emotional, so too a big step in the infrastructure for the company in general.

Keywords: Evolution, Ergonomic Risks, NIOSH method REBA method.

Relevance to Ergonomics: Ergonomics covers a lot of studies and jobs, so it is essential that companies today make use of these tools, the fact that an employee works painful forcibly not result in more production, if not in a decrease of the same and therefore the company no profit and in the medium term or long results in costs both to the company and the social insurance payments injury to the worker for not having adapted a comfortable and ergonomic position.

In lesions such as wrists, carpal tunnel syndrome, herniated discs, laceration vertebras, stress, mental stress, among others, so and as mentioned above it is important to use ergonomics and adapt as a company to new Mexican Standards Ergonomics and thus improve and be always up for continuous improvement.

I.- INTRODUCTION

In order to reduce risks to safety and health in companies, through this document, is to study and identify the various ergonomic problems that arise in a company due to poor posture and poor handling of loads, which affect the performance and health of employees and be analyzed by detection tools ergonomic risks, improve worker health, reducing risks and improving the economy of the company and its production.
To carry out this methodology risk detection is first necessary to detect any problem or complaint by a worker can start conveniently with cheklist tell us the work performed by the worker, hours of his day, breaks, weight lifting and anthropometric measures if necessary and types of discomfort or pain that has, for example, complaints about back pain, fatigue, exhaustion, etc.
This is mentioned because usually there is a common denominator for work-related injuries such as herniated discs, carpal tunnel pain, spinal pain etc.
Given this information, will be held a screening test either by lifting, awkward postures, environmental problems or mismatching the team. For which there are as NIOSH study tools, OWAS, RULA, REBA, mental load, etc.

Getting the results of the investigation may make a proposal for improvement and correction to the company, so that it applies the necessary measures to ensure that the worker performs in the most optimal and efficient way and not only that but also improve by far the physical health of the worker and therefore also emotional.

2.- OBJECTIVE

In the company "GIRSA" is an ergonomic problem in a welder with injury prior to his current job herniated disc, which can cause injury either short or long term, this due to poor posture in your work area and for mishandling their daily work loads due to accidents that may occur in the work area, reduce work capacity or have permanent physical injuries.

The employee requires an environment, appropriate equipment and working positions and to carry out their activities without any problem and constantly improve their production levels and physical health.

The employee in charge of welding presents uncomfortable when performing their activities also for his injury at times presents disc pain when lifting some heavy metals positions, so that most of the time the employee is limited to welding or repair already completed tanks, but they still need to take precautionary measures and alternative work.

3.- METHODOLOGY

3.1 Mental Load

Job performance requires a state of attention (ability to "be alert") and concentration (ability to be aware of an activity or set of them for a period of time). We can define mental burden as the amount of deliberate effort that we must make to achieve a particular result.

The mental burden is mainly determined by the amount of information to be treated, the time that is available and the importance of the decisions.

In the mental workload involved also affective, which can be correlated with other concepts: autonomy, motivation, frustration, insecurity, among others.

One checklist applies according to the ERGOS method to determine the mental burden that counts right now an element of the welding area.

3.2 Physical Loading

You can define the physical workload as the set of physical requirements to which the person throughout their workday is subjected. These requirements involve a number of efforts by the worker that will mean increased consumption of energy is the greater the effort. This energy is called work metabolism.
We say that a job has physical load when the type of activity required by the task is mainly physical or muscular.

3.2.1 NIOSH Study

The equation of NIOSH evaluates tasks that lifts cargo carried, offering as a result the maximum recommended weight (RWL: Recommended Weight Limit) it is possible lift in conditions as to prevent the occurrence of back pain and back problems. Furthermore, the method provides an assessment of the possibility of occurrence of such disorders given the conditions of lifting and weight lifted. Intermediate results serve to support the evaluator to determine the changes to be introduced in the position to improve the conditions for lifting.

Several studies claim that about 20% of all injuries in the workplace are back injuries, and about 30% are due to overexertion.

3.2.2 REBA method

The REBA (Rapid Entire Body Assessment) method was proposed by Sue Hignett and Lynn McAtamney and published by the journal Applied Ergonomics in 2000. The method is the result of joint work of a team of ergonomists, physiotherapists, occupational therapists and nurses , which they identified approximately 600 positions for processing.

The method allows the joint analysis of the positions taken by the upper limbs of the body (arm, forearm, wrist), trunk, neck and legs. It also defines other factors considered decisive for the final assessment of posture, such as loading or managed force, grip type or type of muscular activity developed by the worker. It allows to evaluate both static and dynamic postures and incorporates as a novelty the possibility of reporting the existence of sudden changes in posture or unstable positions.

4.- RESULTS

4.1 Measuring mental workload

CARGA MENTAL

PREGUNTA	RESPUESTA	PUNTOS	
PRESION DE TIEMPOS			
¿ La duración de los tiempos de pausa ?	< 5 % Jornada	4	2
	5-15 % Jornada	2	
	15-25 % Jornada	0	
¿ Se puede parar la máquina, el proceso o interrumpir el ciclo de trabajo sin generar perturbaciones?	No	4	2
	A veces	2	
	Sí	0	
¿ Existen fases durante las cuales el ritmo de trabajo se puede calificar de agobiante ?	No	0	2
	A veces	2	
	Frecuentemente	4	
ATENCION			
¿ La demanda perceptiva del trabajo debida a señales, indicaciones, alarmas y/o defectos es..?	Escasa	0	0
	Media	2	
	Alta	4	
¿ Maneja máquinas, elementos o sustancias especialmente peligrosas ?	No	0	4
	Sí	4	
¿El trabajo requiere precisión y/o minuciosidad ?	Escasa	0	4
	Media	2	
	Alta	4	
COMPLEJIDAD			
¿ El trabajo requiere la utilización frecuente de documentos, manuales,etc.?	No	0	0
	Sí	4	
¿ El trabajo precisa el concurso de conocimientos profesionales técnicos y/o científicos ?	Escasos	0	0
	Medios	2	
	Elevados	4	
¿ Los errores tienen gran repercusión ?	No	0	4
	Si sobre el proceso	2	
	Posible accidente	4	
MONOTONIA			
¿Realiza en su trabajo varias funciones, tareas y/o operaciones ?	No	0	4
	Sí	4	
¿ En trabajos repetitivos puede intercambiar su trabajo con otros compañeros ?	Trabajo no repetit.	0	4
	Sí	2	
	No	4	
¿ Aparecen con frecuencia cambios operativos en el proceso ?	Sí	0	2
	Escasos	2	
	No	4	
sobre el proceso y/o la organización del trabajo ?	Sí	4	0

TOTAL A = 28

PREGUNTA	RESPUESTA	PUNTOS	
INICIATIVA			
¿ Puede modificar libremente el orden de las operaciones que realiza ?	Sí	0	4
	Parcialmente	2	
	No	4	
¿ Puede resolver las incidencias del puesto por sus propios medios ?	Siempre	0	0
	A veces	2	
	Nunca	4	
¿ Tiene autonomia para planificar y/o ejecutar el trabajo ?	Sí	0	2
	Parcialmente	2	
	No	4	
AISLAMIENTO			
¿ Está aislado fisicamente ?	Sí	4	4
	No	0	
¿ Necesita para el correcto desarrollo de su trabajo relacionarse con sus compañeros ?	Sí	0	0
	No	4	
¿ Puede comunicarse verbalmente con sus compañeros ?	Sí	0	0
	con interfono	2	
	No	4	
HORARIO DE TRABAJO			
¿ Cual es el tipo de horario de trabajo ?	Jornada Normal	0	0
	Turno Único	2	
	2 TD-2TDF	4	
	2 T4	6	
	3 TD - 3 TDF	8	
	3 T4	10	
¿ Prolonga habitualmente su jornada de trabajo ?	Sí	2	0
	No	0	
RELACIONES DPENTES. DEL TRABAJO			
¿ El trabajo se realiza de manera grupal o en equipo ?	Sí	0	2
	A veces	2	
	Nunca	4	
¿ Debe relacionarse con personas de otros servicios, tanto externos como internos?	Frecuentemente	0	0
	Ocasionalmente	2	
	Nunca	4	
¿ El puesto de trabajo requiere muchas y variadas consignas del mando ?	Sí	4	4
	Solo al principio y mitad de la jornada	2	
	No	0	
tar por escrito (informes técnicos, cartas, etc.. ?	Sólo partes	2	0
	No	0	

TOTAL B = 18

TOTAL CARGA MENTAL 0.83 x (A+B) 38.18

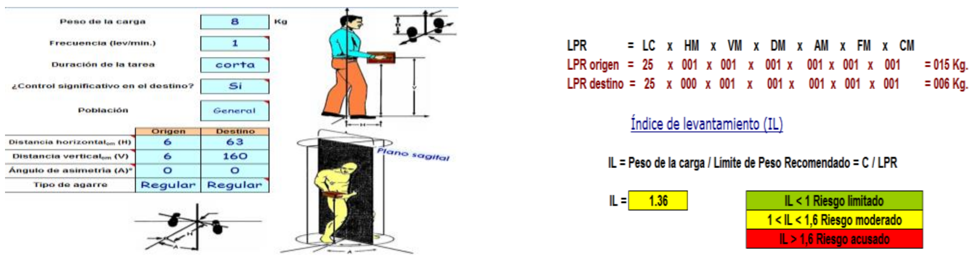
Figure 1

According to the checklist applied the mental load of the person responsible welding is **"Media"** which indicates that this employee needs a few moments of rest, relaxation, or any activity that might distract a little of their work and their cargo Mental originated from home, as not all work pressure is derived from the work area if they can not also come from their homes.

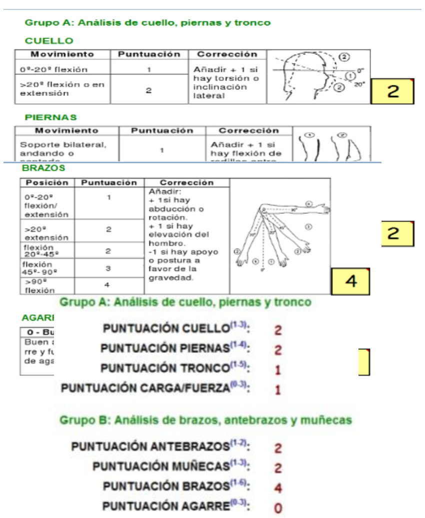
NOTE: The website where the checklist was obtained not allowed to copy the list of possible results only indicates whether low, medium, or high.

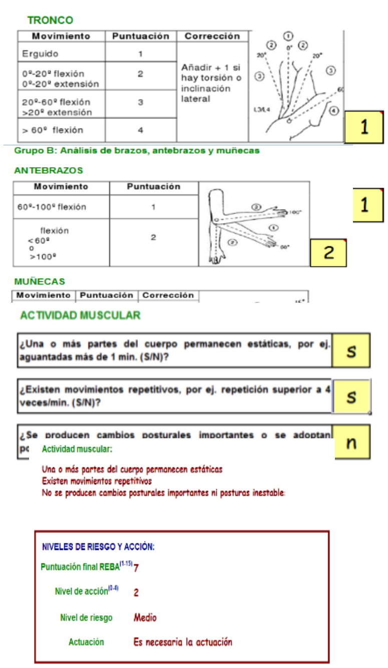
4.2 Physical load

4.2.1 The NIOSH method results medium risk so we can say that the operator is an intermediate level as a potential problem, since the load is not too heavy but several repetitive movements in working hours were obtained and can cause fatigue and muscle aches.



4.2.2.Calculation REBA





(Image 2)

As for the rapid assessment of whole or said by name REBA body, we present a medium level of risk as ergonomic operator positions are awkward and static without mentioning that the work area is quite uncomfortable.

In both cases it requires a solution and rapid action to correct this problem.

5. CONCLUSIONS

It is recommended that the company take immediate preventive measures for the worker responsible for welding since this is in a high intermediate level of ergonomic risk and because it can present an immediate serious injury, which would cause a physical impairment the worker and a delay in its work and losses for the company for breach of work and medical costs, an important element that stands to analyze, is that the welder at the time of high repair up to a band of metal around 50cm x 1.50mts a thickness of not more than 30 cm. which it is tedious to move and that is obviously uncomfortable to move, as proposed a serious not very high cost make the manufacture of a platform with metal steps with antiskid rubber, having the distance of a truck 7 meters on both sides of where the machinery is parked and with a width of 1 m and a height of 50cm to 1m so that going up is going to avoid stretching of arms and neck and only shift sideways instead of getting off, move the bench and back up for another welding.

Possible welding platform (Image 3)

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Ergonautas.com http://www.ergonautas.upv.es/metodos/niosh/niosh-ayuda.php

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ERGONOMIC RISK ASSESSMENT IN A WORKPLACE OF A FACTORY OF GUITARS USING THE OWAS METHOD

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Resumen: Este estudio se llevó a cabo la aplicación de un método para evaluar las diferentes posiciones del cuerpo para realizar una actividad repetitiva, con el fin de determinar los posibles riesgos a los que podría estar expuesto a un operador de una importante empresa fabricante de guitarras. A través de la aplicación del método OWAS (Sistema de Análisis de Trabajo Ovako), analizaron las estaciones de trabajo en el área de montaje final, y el impacto causado a la salud de los empleados, como nunca se ha tenido en cuenta este tipo de estudios dentro de la misma.

Palabras clave: método del riesgo ergonómico OWAS, rediseñar

Contribución a la Ergonomía: La contribución de este proyecto a la ergonomía es la aplicación del método OWAS en el sector industrial, así como la propuesta de rediseño de los lugares de trabajo, ya que anteriormente no le prestará la debida atención a llevar a cabo las medidas necesarias que ayuden a prevenir posibles lesión, si los cambios grandes o pequeños que se ponen en práctica será beneficiosa para el operador y para la misma empresa.

Abstract: This study was conducted the application of a method to evaluate the different positions of the body to perform a repetitive activity, in order to determine the possible risks to which an operator of an important company making guitars could be exposed. Through the application of the method OWAS (Ovako Working Analysis System), analyzed the workstations in the final assembly area, and the impact caused to the health of employees as never has been taken into account such studies within the same.

Key words: Ergonomic risk method OWAS, redesign

Contribution to ergonomics: The contribution of this project to the ergonomics is the application of the OWAS method in the industrial sector, and the proposal of redesign of workplaces, since previously not taken him due attention to carry out the necessary measures that will help prevent possible injury, whether large or small changes that are put into practice will be beneficial for the operator and for the same company.

1. INTRODUCTION

1.1 Backgrounds

The history of ergonomics covers all the existence of man, therefore, since its inception, is valid of their faculties adapting and using the natural resources surrounding it to ensure its survival. He has tried to understand natural phenomena to apply them in the search for the adaptation of its surroundings, (Gómez, 2004).

According to the AEE, (2011), ergonomics is a set of multidisciplinary expertise applied to the suitability of products, systems and artificial environments to the needs, limitations and features of its users, optimizing the efficacy, safety, and welfare.

The OWAS method is a simple method for the ergonomic analysis of postural load. Your application provides good results, the improvement of the comfort of the posts, both in the increase of the quality of the production, this consequence of the ergonomic improvements that can be applied (Asensio-Cuesta, 2012).

In this case of research study the application of one of the many methods and techniques will be held to evaluate the different positions of the body to perform an activity, and the possible muscular skeletal disorders that an operator of a post in a major factory of guitars could be found prone.

1.2 Approach of the problem

Depending on the application of the checklist Advance Ergnomics to delimit the operator under study, is could the problem with the following question:

What are inadequate positions of the back, arms, legs and load, which generate traumatic disorders cumulative (DTA completo), due to the conditions of the job of a responsible operator inspect and stringing guitars, in the area of final Assembly in a factory of guitars?

1.3 Objective

To evaluate the ergonomic risk in a job using the OWAS method, in order to make a proposal for improved ergonomics, reducing muscle skeletal injuries by the postures that adopts operator.

1.4 Delimitation

The study shall be defined to the evaluation of postures and body movement of a worker's final due to the repetitive Assembly and adopted postures, since results could be replicated for the rest (8 similar stations).

2. METHODOLOGY

2.1. Subjects of study

This project is focused on the area of final Assembly of the company, what are the jobs of stringing guitars (8 totals per shift) due to its repetitive activities.

2.2 Procedures

According to Valencia, (2013) el OWAS method based their results on the observation of the different positions taken by the worker during the development of the task, allowing to identify up to 252 positions as a result of the possible combinations of the position of the back, arms, legs and load lifted.

The procedure begins with the collection of the different positions taken by the worker in the performance of the task. The method assigns four-digit for each position observed depending on the position of the back, arms, legs and the load supported, thus configuring your code or "position of the"(Prado, 2001) code and subsequently different codes is classified into four levels or categories of risk.

3. RESULTS

The OWAS method analysis was performed using picture-taking to the operator, which were obtained every 30 seconds to determine the analysis of the positions taken by throwing the following:

- Witnessed the operator during the working cycle, which could raise the images or samples required to carry out the analysis of this method. See Figure 1.

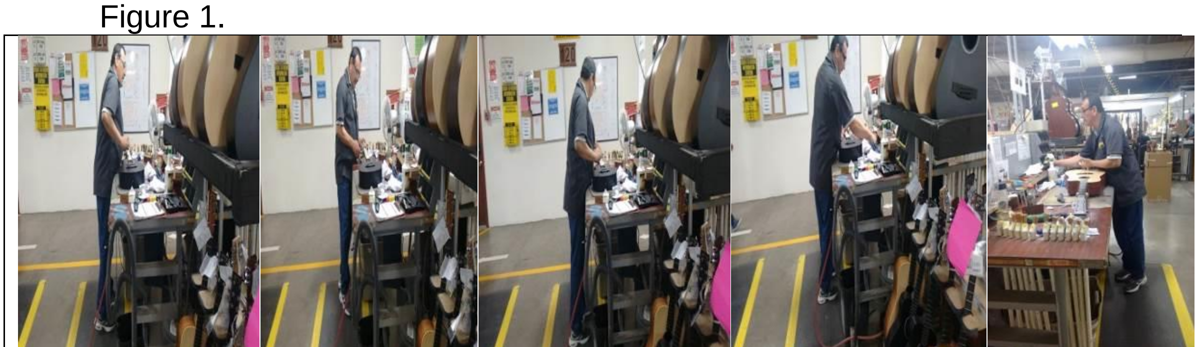

IMAGE #1	IMAGE #2	IMAGE #3	…	IMAGE #241

Figure 1. Evidence collected

Subsequently analyzed the data obtained (in a time interval of 30 seconds), yielding a sample of 241 data, which are presented in table 1.

Table 1. Sample data concentrate

Number observations	Back	Arms	Legs	Load
1	2	1	2	1
2	1	1	2	1
3	2	1	2	1
4	2	1	3	1
5	1	1	2	1
6	1	1	2	1
7	2	1	2	1
8	1	1	2	1
…	1	1	7	1
241	4	1	3	1

A sequence of images was established in order to establish each of the positions identified in the process, with the help of coding positions presented in this method which can be seen in Figure 2.

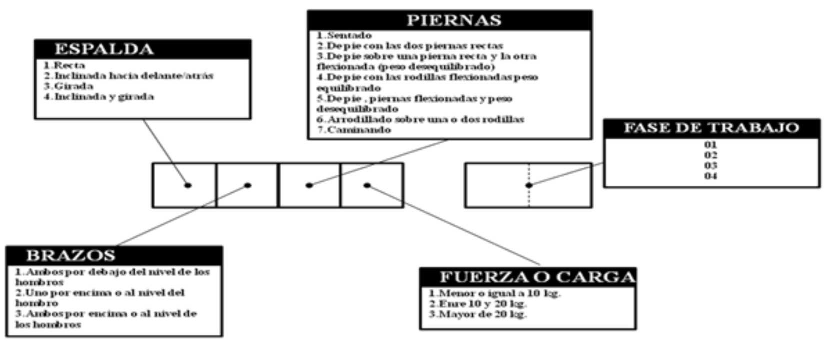

Figure 2. Coding of postures of the OWAS method

Each posture adopted by the operator, with different frequencies were determined by code with its respective percentage and level of risk, whereas the foregoing position 1.5 and 9 representing the higher risk, see table 2 was coded.

Table 2. Observed the operator positions

NO.	Back	Arms	Legs	Load	Frequency	% Frequency	Risk
1	2	1	2	1	53	21.99%	2
2	1	1	2	1	41	17.01%	1
3	2	1	3	1	15	6.22%	2
4	1	1	7	1	1	0.41%	1
5	4	1	3	1	44	18.26%	2
6	1	2	2	1	15	6.22%	1
7	2	2	2	1	8	3.32%	2
8	2	3	2	1	2	1%	2
9	3	1	2	1	17	7.05%	1
10	4	1	2	1	31	12.86%	2
11	3	1	3	1	4	1.66%	1
12	4	2	3	1	1	0.41%	3
13	1	2	7	1	2	0.83%	1
15	3	2	2	1	1	0.41%	1
16	2	2	3	1	2	0.83%	3
17	2	1	7	1	1	0.41%	2
18	1	1	7	1	1	0.41%	1
19	2	1	5	1	1	0.41%	3
20	4	2	2	1	1	0.41%	2
				Total = 241			
				Total = 20			
						Observations postural	

We calculated the percentage of repetitions of the positions adopted by the operator, which were: positions of the back, arms poses, postures of legs and load or effort, which gave as a result the following:

Back

As shown in Figure 3, from the positions of the back 241 samples taken to this method

- 48% the worker presents the back straight.
- The 34.02% worker presents the leaning back to back/forward.
- THE 9.13% worker presents the rotated back.
- The 31.95% worker presents the sword turned and tilted.

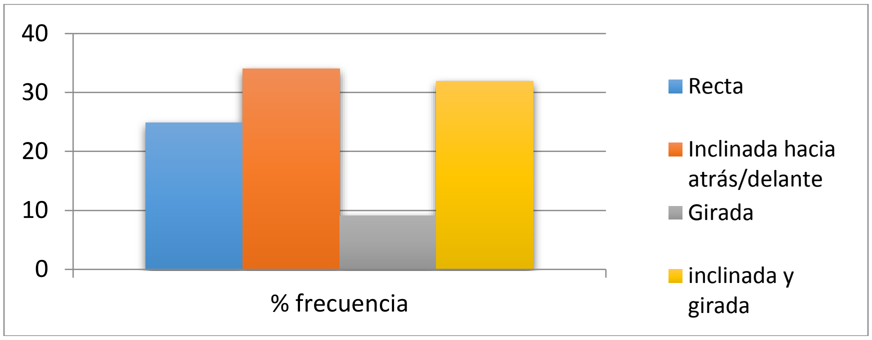

Figure 3. Results of frequency of back postures

Arms

As shown in Figure 4, the positions of the arms of 241 samples taken to this method

- The 86.72% operator works with both arms below shoulder level.
- The 13.28% operator works with one arm above or at the level of the shoulders.

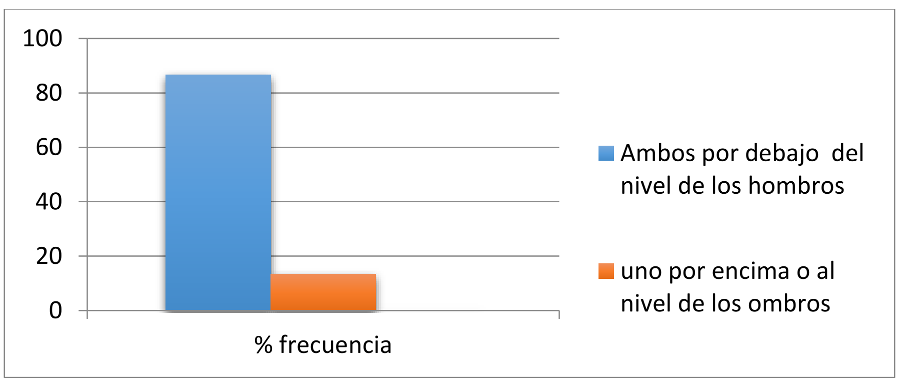

Figure 4. Frequency of positions of arms adopted by the worker

Legs

As shown in Figure 5, 241 samples taken to this method

- The 70.12% operator works stand with both legs straight.
- THE 27.39% operator works standing on one leg straight and the other bent (balanced weight).
- The 0.41% operator works standing up, legs bent (unbalanced weight).
- THE 2.07% operator works walking.

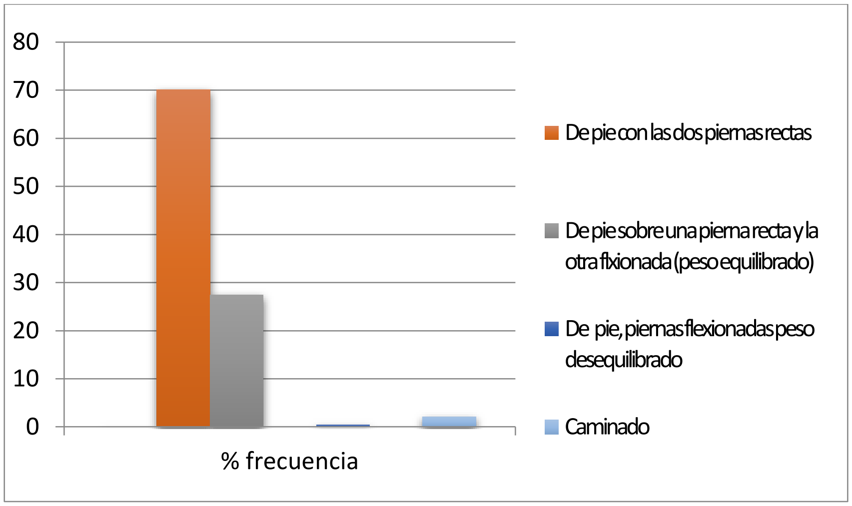

Figure 5. Results of positions of legs

Force/load

In this figure we can see that 100% of lifting loads performed by the worker were lower or equal to 10 kg, (see Figure 6)

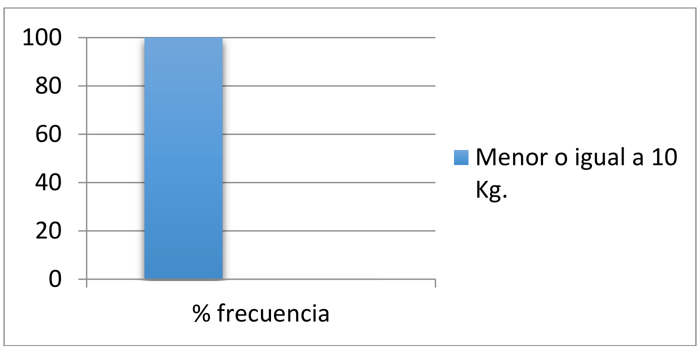

Figure 6. Results of force/load

By the method result-based, can determine that job needs a redesign, which could bring benefits to the worker or to the same company, since they would decrease injuries that generate bad postures that worker adopts, as 64% of the identified positions is presented in table 3 are risk 2.

Table 3. Level of risk

risk 1	34.02%
risk 2	64.32%
risk 3	1.66%
risk 4	0%
total	100%

4. CONCLUSIONS

The assessment to the selected job threw as a result levels of postural loads that workers, in conjunction with the results of the factors evaluated in direct observations operators are exposed. Through the application of the method OWAS 4 positions were obtained with the back tilted and rotated, 7 different positions from which the operator was most of the time leaning back and which is harmful to the spine and neck, it is recommended to perform a redesign in the workplace such as climb the artboard and zoom tools as possible since they are the furthest possible due to that company cares much for the quality of the guitar.

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ANALYSIS OF THE INTERPRETATION OF GUITAR FROM THE PERSPECTIVE OF ERGONOMICS : REVIEW ARTICLE

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RESUMEN: Los guitarristas están expuestos a distintos factores de riesgo desde el punto de vista ergonómico que pueden afectar su desempeño profesional. Durante su formación académica, los músicos deben desarrollar habilidades que les permitan conocer de forma integral su instrumento musical; para esto es necesario que se lleve a cabo un entrenamiento que involucra largas sesiones de estudio caracterizadas por la presencia de movimientos repetitivos, posturas forzadas, carga estática muscular, y en el caso del guitarrista como otros instrumentistas de cuerda, estrés por contacto, lo que los convierte en una población vulnerable al desarrollo de desórdenes musculoesqueléticos. Considerando lo antes mencionado, el objetivo de este trabajo es construir un panorama general que permita comprender la actividad profesional del guitarrista desde la perspectiva de la Ergonomía, esto mediante el reconocimiento de los distintos estudios que han surgido en relación con este tema.

PALABRAS CLAVE: ergonomía, músicos, el guitarrista, factores de riesgo ergonómico.

Relevancia para la Ergonomía: Con las nuevas investigaciones relacionadas con la práctica musical es posible ayudar a los guitarristas a tener un rendimiento más saludable.

La contribución de la ergonomía en la educación musical podría ser útil para guitarristas para identificar posibles factores de riesgo, relacionados con la práctica profesional de un instrumento. Además, podría ser posible hacer un análisis de la actividad interpretativa de los músicos a través del método científico, lo que resulta en una visión objetiva de la actividad profesional del instrumentista.

Será posible, si se sigue avanzando en este tema, crear nuevos programas y métodos para el estudio de la guitarra clásica, pero ahora desde un enfoque ergonómico y mediante el uso de métodos y principios objetivos.

ABSTRACT: Guitarists are exposed to different risk factors from perspective of ergonomics that may affect their professional performance. During their academic training, musicians must develop skills to know their musical instrument; therefore it is necessary to accomplish a training that involves long sessions characterized by the presence of repetitive movements, awkward postures, static muscular load, and in the case of guitarists as other string players, contact stress, which make them a vulnerable population to suffer musculoskeletal disorders. Considering the above mentioned, the objective of this research is to build an overview for understanding the professional activity of guitarists from the perspective of ergonomics, by recognizing the various studies that have arisen in relation with this topic.

KEYWORDS: Ergonomics, musicians, guitarist, ergonomic risk factors.

RELEVANCE TO ERGONOMICS: With new research related to musical practice it is possible to help guitarists to have a healthier performance.

The contribution of ergonomics in musical education could be helpful for guitarists to identify potential risk factors, related with the professional practice of an instrument. Also, it could be possible to make an analysis of the interpretative activity of musicians through the scientific method, resulting in an objective view of the professional activity of instrumentalist.

It will be possible, if progress continues on this issue, to create new programs and methods for the study of classical guitar, but now from an ergonomic approach and by using objective methods and principles.

INTRODUCTION

The tasks performed by musicians can be studied from an ergonomic point of view, if we consider that ergonomics is the study of the relationship between humans and an object or product in a specific environment (Prado León & Rey Galindo, 2014).
The guitar is a versatile musical instrument, which is used for the interpretation of many musical genres; therefore, the understanding of the musician-instrument-enviroment system becomes a very important challenge for ergonomics. Then, if the interaction between musician and instrument is understood it is possible to open new research area to solve problems related to the instrumental practice, but applying ergonomic principles.

According to Prado León and Rey Galindo (2014), if the activity of the musician is analyzed, different risk factors could be identified, for example:

1. Awkward postures.
2. Overexertion.
3. Overuse: repetitive movements and long practice sessions are examples of this.
4. Static load on the muscles; for example sitting positions in guitarists.
5. Contact stress: the constant pulsation of the strings.

There is documented evidence which reported that the presence of risk factors are linked to long periods of practice under uncomfortable positions, competition among instrumentalists, constant pursuit of perfection and high levels of anxiety. In a study by Roset Llobet (2000) it was reported that more than 77% of musicians at some point of their career can develop medical problems related to their professional activity.

Traditionally, the interpretation of classical guitar is performed from a seated position, which must be maintained for several hours while the musician is practicing. It has been found that by choosing this posture the backbone of the musician may have certain pathological changes over time, as explained by Barczyk - Pawelec (2012), when evaluating the spinal curvatures from a sagittal plane and the magnitude of the asymmetries of the trunk from the frontal plane in a group of music students compared to a control group. In that study it was observed that musicians were characterized by a significant kyphosis and more pronounced lordosis in the lumbar spine.

There are many guitar methods such as those proposed by Abel Carlevaro's and Emilio Pujol; they describe in detail the way it should be played guitar; however, these methods lack of an ergonomic approach, since it is based on the personal experience of the authors.

The cognitive aspect is another important factor that has a big influence on interpretation of the guitar, however it is not mentioned in the known guitar methods. There are studies that explain how the musician activity is also influenced by aspects related to information processing and execution of orders, which are mediated by the central nervous system. For example, Wright (2012) conducted a study to compare the cortical potentials related to movement between not experienced guitarists and musicians. The differences reported in that study indicate lower cortical activity, and possibly less effort required during preparation of movement among experienced guitarists. It is possible that differences between the two groups are a result of musical training.

In another study, Krause (2010) investigated how the sensorimotor synchronization is related to the musical specialization, perceptual discrimination and the trajectory of the movements. The data obtained in that study supported the hypothesis that synchronization sensorimotor skills and perceptual discrimination are closely related and both are modulated by the musical specialization.

Another important aspect about the interpretation of the guitar is the technical efficacy; it is defined as the ability to achieve the expected effect after the completion of an action. There are different elements involved in how effectively a musical instrument is played, like motivation, technical improvement and even the perception of the guitarist about what it means to be a good musician.

Stoeber (2007) showed that perfectionism plays a prominent role in motivation, effort, achievement and stress among young musicians. However, not all facets of perfectionism play the same role. Regarding motivation, striving for perfection was associated with autonomous reasons to pursue music studies (intrinsic motivation), while negative reactions to imperfection were associated with controlled reasons (extrinsic motivation).

There are many research in order to develop scales to assess self-efficacy in musicians. For example Ekinci (2013) states that people with strong self-efficacy beliefs do not try to escape from experiences when they have to deal with them for the first time, they are very determined in complete tasks successfully. According to the results in this study, it is concluded that the scale of self-efficacy in musicians, can be used as a valid and reliable tool for measuring the effectiveness of tasks performed.

All works reported in this research are focused on topics related to musculoskeletal disorders, issues related to technical efficiency and cognitive processing in musicians. It is possible to explore other areas of research that are associated directly with the ergonomics. The studies reported in this paper, could help to support for future research related to instrumental practice; however, any of these works have a purely ergonomic perspective.

OBJECTIVES

The objective of this work is to build a framework to recognize the different types of studies from the perspective of ergonomics that have arisen in connection with the professional activity of guitarist and factors influencing their artistic performance. This work also aims to contribute in identifying possible gaps or shortcomings that exist in the theoretical analysis of the professional practice of musicians, focused specifically on issues related to ergonomics.

METHODOLOGY

To achieve these objectives a review of research that address topics that explain some of the human factors related to the practice of playing a guitar was carried out. The research reviewed in this paper deal with topics such as musculoskeletal disorders, effectiveness and technical aspects related to the cognitive process of the musician.

Thirty articles published in journals of physiotherapy, human factors, psychology, neuropsychology and music education were reviewed; the older article was published in 1987 and the latest in 2014. This search was carried out in different database such as ScienceDirect, digital library of the University of Guadalajara and google scholar. Ergonomic Risk factors were taken as reference, to conduct the search for such items. The consultation was held in journals that are published online and the keywords used in the search were musicians, ergonomics, posture, risk factors, cognitive and muskuloskeletal. There were not taken into account items that do not have a direct relationship with musician activity due to the need to present research that could help develop an approach from the ergonomic point of view regarding this profession.

RESULTS

The review of the current research within this subject it is possible to build a framework in which an overview of the professional activity of guitarist is developed. It was found that there are works directly related to the activity of guitarist and can be useful as tools to build an approach from the perspective of ergonomics on the factors influencing the interpretation of classical guitar.

The most recurrent topics in this review are those related to the presence of musculoskeletal disorders in musicians, cognitive aspects related with the interpretation of musical instruments and technical efficacy.

The number of participants per study varied between one and two hundred. According to studies related to the presence of musculoskeletal disorders, spine and upper limbs correspond to the most committed body regions when interpreting a musical instrument.

Some of the most relevant studies found regarding the presence of musculoskeletal disorders in musicians are described in the Table 1.

Table 2 presents some of the work related to cognitive aspects and technical efficacy in musicians.

Table 1. Articles related to musculoskeletal disorders in musicians

Name of the research	Author and year	Objectives	Participants	Methods	Results
Musicians' playing-related musculoskeletal disorders: An examination of risk factors	Zaza, C., & Farewell, V. T. (1997)	To investigate the global risk factors for developing musculoskeletal disorders related to musical practice in different instrumentalists	Two hundred eighty-one professional musicians and music students from the University of Ontario	A questionnaire of 36 pages, divided into five sections was administered. Physical and demographic variables, psychological variables, practice habits, variables unrelated to musical performance and groups of instruments were included	This study confirmed previous findings in which women and strings students have higher risk factors for developing a musculoskeletal disorders
Identification of risk factors for	Roset-Llobet, J.,	The aim was to identify the main risk factors	The study population was defined as all musicians of Catalonia	Questionnaires were distributed (9,795 in total) at professional	The analysis of the data showed that musicians with major problems, in

musicians in Catalonia	Rosinés-Cubells, D., & Saló-Orfila, J. M. (2000).	associated with the onset of health problems in musicians	(Spain) , professionals and students who have been playing their instruments for over two years	conservatories, music schools , different kinds of orchestras , bands and associations of professional musicians	descending order were: percussionists (87%), metals (85.5%), bowed strings (85.1%), woods (84.6 %) and vocalists (84.6 %)
Incidencia de lesiones en profesionales de la guitarra clásica	Sánchez-Padilla, M., Bayo-Tallón, V., Esquirol-Caussa, J., Guerrero-Forteza, E., López-Iglesias, I., & Salas-Gómez, D. (2013)	To determine the incidence of injuries in professional guitarists and analyze the lesional distribution, according to age, years of experience, hours of rehearsal, sporting habits, etc.	Forty participants from two editions of the International Guitar Competition in Barcelona	A self-administered questionnaire that included 15 items with closed answer was given, it included anthropometric data (weight, age, sex, height and dominant laterality). The items were designed to identify any symptom in the last 5 years	This study showed that 67.5 % of participants had suffered an injury in the last 5 years, especially in the spine and upper extremities. A high degree of chronicity of injuries and a significant lack of demand for health care by the musicians was observed
Anterioposterior spinal curvatures and magnitude of asymmetry in the trunk in musicians playing the violin compared with non musicians	Barczyk-Pawelec, K., Sipko, T., Demczuk-Włodarczyk, E., & Boczar, A. (2012)	The aim of this study was to evaluate the spinal curvatures in the sagittal plane and the magnitude of the asymmetries of the trunk in the frontal plane in a group of music students compared to a control group	A total group of 67 students divided into two subgroups. The first subgroup was formed by violin students and the second subgroup by students of physical therapy which did not play any instrument.	The examination included an interview, measurement of somatic characteristics and evaluation of body posture using the photometric method.	Compared with the control group, the musicians were characterized by a significant kyphosis and lordosis more pronounced in the lumbar spine.

Table 2. Articles related to cognitive process and technical efficacy in musicians

Name of the research	Author and year	Objectives	Participants	Methods	Results
Improved effectiveness of performance monitoring in amateur instrumental musicians	Jentzsch, I., Mkrtchian, A., & Kansal, N. (2014)	The objective was to evaluate differences in cognitive control functions between amateur musicians and non - musicians, more specifically the ability to monitor the behavior and implement necessary control settings	Thirty-six subjects were divided into four groups (8-10 participants per group) according to the number of hours of accumulated practice. More than 5000 (high) , from 2000 to 5000 (medium), 200-2000 (low), less than 200 (no level)	Application of Stroop and Simon Task. A continuous electroencephalographic monitoring was performed to measure response times through potential partners to a stimulus	The number of hours of instrumental practice was positively associated with speed. This result suggests that higher levels of musical training could result in greater efficiency in processing information
Brain hemisphericity and Music Performance Level in Undergraduate Music Students and Philharmonic Musicians	Iuşcă, D. (2014)	This study explores the relationship between hemisphericity and musical domain, specifically musical performance	The sample was divided into two groups. The first formed by 130 music students (74 women and 56 men), vocalists and performers of classical music. The second group was formed by 47 professional vocalists (27 women	Hemispheric Mode Indicator McCarthy (McCarthy's mode indicator) was used . Modal hemispheric indicator contains 32 items constructed in a bipolar strategy. Each item consists of a continuum between two different behaviors and there are 4 possible options.	There is a higher incidence of right hemisphericity among students and also a high prevalence of left hemisphericity among professional musicians. This confirms the idea that there is a change of hemisphericity in professional musicians.

			and 20 men)		
Perfectionism in young musicians: Relations with motivation, effort, achievement, and distress. Personality and Individual Differences	Stoeber, J., & Eismann, U. (2007)	The aim was to investigate how many of the different facets of perfectionism are related to motivation , effort , achievement and stress in musicians.	A sample of 146 young musicians (59 men , 87 women) were recruited in two high schools for musically talented students in Saxony	Questionnaires were administered in the classroom during class time. The parameters measured were improvement , motivation , effort and achievement through the application of different scales	The findings of this study showed that perfectionism plays a prominent role in motivation, effort, achievement and stress among young musicians.
Practice strategies of musicians modulate neural processing and the learning of sound-patterns	Seppänen , M., Brattico, E., & Tervaniemi, M. (2007)	This study aims to reveal whether there are differences in auditory processing among musicians preferring or not, listening strategies such as improvisation and playing by ear.	After excluding the pilot participants , 24 participants (12 men and 12 women) were chosen	After completing a questionnaire about musical backgrounds of participants, measurements were made using EEG to assess auditory processing of participants	There are differences between experts in the same field, suggesting the presence of different brain mechanisms .

CONCLUSIONS

The construction of an overview that explains the activity of the guitarist from the perspective of ergonomics can be used to develop new methods to improve the conditions in which the musician perform their musical instrument.

With a solid theoretical foundation it is possible to do interventions within the practice area of the guitarist, in order to make the musical activity more efficient through the application of ergonomic principles.

Finally, it is important to mention that there are still issues that are particularly relevant from the point of view of ergonomics and have not been explored in the current research, not just those that deal with the professional activity of guitarist. Among these issues are those related to biomechanical aspects involved in instrumental practice and ergonomic evaluations of the task of the musician through the application of specialized methods.

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MANUAL HANDLING ASSESSMENT OF LOADS IN A WAREHOUSE OF A CATTLE FEED SUPPLYING COMPANY

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Resumen: En este proyecto se centra en determinar la presencia de riesgos en la carga y descarga de los procesos en el área de almacén de un proveedor de alimentos para el ganado, en el que existen dificultades a la manipulación manual de materiales y signos de malestar en el cuerpo de los operadores. Los problemas ergonómicos con mayor influencia en el área de trabajo se determinaron mediante la aplicación de una lista de verificación y los resultados se analizaron en detalle la obtención de evidencia de un potencial de riesgos para la zona lumbar del cuerpo humano, tales como molestias y trastornos musculoesqueléticos traumáticas. Se aplicó el método Sistema de Análisis de postura de trabajo Ovako (OWAS) para determinar la presencia de factores de riesgo en las posiciones corporales de los trabajadores, este método fue apoyada por la Norma Oficial Mexicana NOM-006-STPS-2014, para la determinación de las condiciones del lugar de trabajo para la manipulación manual de cargas y cargas de elevación límites.

Palabras clave: Riesgos, Manual de Manejo de carga.

Contribución a la ergonomía: La contribución principal de este proyecto es la aplicación del método y el análisis del cumplimiento de las regulaciones mexicanas relativas a la manipulación manual de cargas OWAS, se pretende promover y compartir información con diferentes pymes para que tengan diferentes elementos que contribuyen a la mejora de las condiciones de trabajo de sus empleados.

Abstract: This project was focused on determining the presence of risk in the loading and unloading processes in the warehouse area of a cattle feed supplier, in which there are difficulties for the manual handling of materials and signs of discomfort in the body of the operators. The ergonomic problems with most influence in the area of work were determined through the application of a checklist and the results were analyzed in detail obtaining evidence of a potential risks for the lumbar area of the human body, such as discomfort and Traumatic Musculoskeletal Disorders. The Ovako Working Posture Analysis System (OWAS) method was applied to determine the presence of risk factors in the body positions of the workers, this method was supported by the Official Mexican Norm NOM-006-STPS-2014, for

the determination of the conditions of the workplace for manual handling of loads and loads lifting limits.

Keywords: Risks, Manual Load Handling.

Contribution to the ergonomics: The main contribution of this project is the application of OWAS method and analysis of compliance with Mexican regulations regarding the manual handling of loads, it is intended to promote and share information with different SMEs so that they have different elements that contribute to improving the working conditions of its employees.

1. INTRODUCTION

1.1 Background.

There has always been a risk of mishap and/or accident in the workplace of any company; therefore, there has been a demand without parallel in the pursuit of workplace security since the sixties. It is of great importance to preserve the physical and mental integrity of workers through the implementation of standards, methods and systems to prevent accidents, the improvement of the working conditions to avoid or diminish the causes of diseases or any condition in general that can affect the employees (Meza, 2010).

The key of success for the effective management of the supply chain and distribution of a growing sales organization are the stores, warehouses and distribution centers; however, these factors have not been valued enough by top managers of modern organizations with many shortcomings of organization, but also opportunities for improvement in their storage processes; opportunities that, if known and implemented progressively and effectively, contribute to the generation of added value to the logistics operation of the company through the effective application of the techniques, methods, tools and technological developments (Mora, 2011).

In Mexico the Norms NOM-006-STPS-2014 defines how the handling and storage of materials as an activity that, on a daily basis, is performed on the work centers to make sure that it is performed efficiently, but mainly in a safe way. To accomplish this, there must be a system, method, installation, equipment or procedure for handling and storage.

This norm stipulates that there must be security procedures to consider in the work centers where activities of handling and storage of materials through the manual load, these procedures must consider, at least, the following:

a) The characteristics of the workers involved in these tasks, such as: gender, age, weight, complexion and pathological antecedents of physical deformity or injuries that may decrease the ability of manual load;
b) The weight, shape, dimensions and presence of sharp edges or corners, on the materials or containers for handling;
c) The intensity, distance, repetition, frequency, duration, postures, and speed with which the activities of manual loading and moving must be carried out;

d) The position of the materials or containers to handle, with regard to the position of the workers: lifting or lowering of the load to the floor or to a certain height;
e) The clamping elements present on the materials or containers - ease of handling, holding and transfer of the materials or containers- and visibility that the volume of the load allows the worker;
f) The conditions of the environment that may increase the effort of the worker, such as weather conditions: exposure to solar radiation, temperature and/or conditions of extremes environmental humidity, contaminated environment, rain, snowfall or the presence of heavy winds;
g) The path for the transport of loads, ascending or descending stairs, inclined ramps, platforms, vehicles, walking on slippery surfaces or with obstacles that can generate risks of falls, and
h) The handling of hazardous materials, such as: toxics, irritants, corrosives, flammables, explosives, reagents, with biological risk, among others.

In compliance with these procedures, workers who handle manual loads may handle a load that is greater than 25 Kg. but does not exceed 50 kg. As long as the employer determines the conditions under which the activity should be develop, in such a way that it does not present a risk to the health of the workers.

In that sense, it is necessary to consider that the handling and storage of materials is not limited only to its movement but that it includes actions of lifting, lowering, pulling, pushing, transferring, transporting and/or stowing materials, manually or with the help of machinery. In addition, the place where the storage is done has to have special attention due to the conditions it has to meet in order to avoid accidents to workers.

In ideal conditions, the maximum frequency to manual lifting per minute shall be 15 movements per minute in activities of short length of up to 1 hour; however, this conditions are also going to determine the recommended limit of the mass. These limits are set in Figure 1.

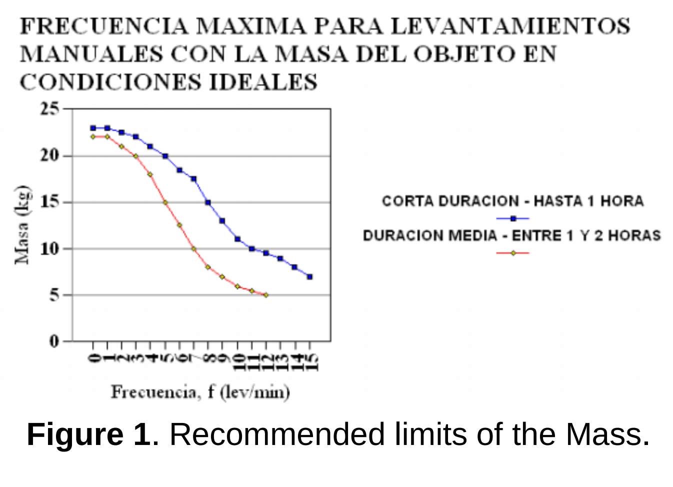

Figure 1. Recommended limits of the Mass.

If the mass and frequency are above the recommended limits in Figure 1, it is necessary to readapt the operation. (ISO 11228-1, 2003)

Based on the above-mentioned factors, it is essential to establish the conditions of safety and health at work, conditions which must be complied with in the workplace to avoid risks to workers and damage to facilities due to the activities of handling and storage of materials.

1.2 Approach to the problem.

In the warehouse of the cattle feed supplier, in the loading and unloading area, operators have complained about discomfort and pain in the lumbar area of their bodies, which is why this work is focused on determining the presence of risk of muscular-skeletal disorders. A recurrence of discomfort in the lumbar area of the operators who have worked for longer time the loading and unloading area of the warehouse area. This situation was the reason for the focus of this research: What is the degree of risk that is presented in the management activities and manual handling of loads of workers in the feed distribution center?

1.3 Objectives.

- Determine the level of risk to which operators are exposed, applying the OWAS method and the applicable norm in order to prevent risks to workers and damage to the facilities by the activities of handling and storage of materials, the loading and unloading in the warehouse area of the cattle feed supplier.
- Recommend improvements to reduce the risk of a musculoskeletal disorder for the operators.
- Determine the ideal conditions for operators and perform adequately during the activities managing materials in the loading and unloading area in the warehouse of the cattle feed supplier.

2. METHODOLOGY

2.1 Subject of study.

This project was focused on the total number of workers considering all the activities of handling loads carried out manually.

2.2 Procedure.

Implementation of a checklist to determine if it is necessary to evaluate the positions taken by the operator during the execution of the task.

In this study was applied the Ovako Working Posture Analysis System (OWAS) method for the identification of risks for operators in the loading and unloading area in the warehouse of the distributor of food for cattle, as well as the Official Mexican Norm NOM-006 STPS-2014 to verify the compliance of the activities of manual handling and storage of materials. The OWAS method is based on a simple and systematic classification of working postures with the observation of tasks and analyzes positions of arms, trunk, legs, head and load of the operator.

2.3 Materials.

- Ergonomic checklist, which purpose is to identify ergonomic problems in the workplace “The Advanced Ergonomics”.
- Official Mexican Norm NOM-006.STPS-2014, handling and storage of Materials - Conditions of Safety and Health at Work.
- Video Camera
- Data Record Sheet

3. RESULTS

3.1 “The Advanced Ergonomics” results.

Below is an abstract of the results obtained from the application of the checklist:

- There are repetitive movements of the arms, wrists and/or fingers, lifting an excess of weight.
- The tasks performed demand excessive tilt to reach or lower the materials to manipulate.
- The task has not been examined to determine whether the requirements of work exceed the capacity of the majority of workers; this can affect its performance and health.
- The workers have not been trained in appropriate techniques for lifting materials, or for the care of their physical well-being.
- All loads weigh more than 30 pounds.
- Each lifting is carried out in less than 2 minutes.
- There is no machinery to help with the lifting, it is all carried out using the physical strength of the operators.
- The liftings are confined to only within the area of knuckles and shoulders according to the height of the operator.
- The objects manipulated do not count with handgrips.
- There are turns, thrusts, pulls and excessive weight carrying.

3.2 OWAS Method Results.

Phase 1. Identify, during the observation of the task or phase, the several positions taken by the worker, some positions are seen in figure 2.

Figure 2. Positions taken

Phase 2. Encode the positions observed (Code of position).
Phase 3. Calculate for each "Code of position" the risk category.
Phase 4. Calculate the frequencies of each position taken, also the codes of posture and risk category, see table 1.

Table 1. Codes of Positions

No.	Back	Arms	Legs	Load	Frequency	% Frequency	Risk
1	1	3	7	3	116	78%	3
2	2	3	5	3	1	1%	3
3	1	3	7	2	1	1%	2
4	1	1	7	1	1	1%	1
5	2	2	5	3	2	1%	3
6	2	3	4	3	1	1%	2
7	2	3	5	3	26	18%	3
				Total	148	100%	

3.2.1 <u>Back Posture</u>.

The positions of the back of the operator in the loading and unloading area, indicate that 80% of the time the worker has a straight back while bearing the load and walking, the other 20% is found with the bent back, which represents a risk. see figure 3.

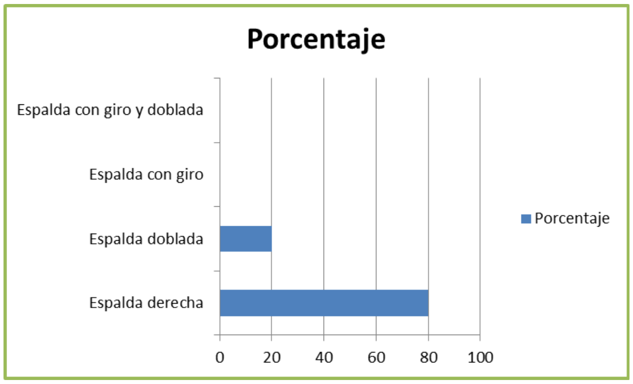

Figure 3. Back posture

3.2.2 Arms Posture.

The positions of the operator's arms while working in the loading and unloading area, indicate that 100% of the time the worker has both arms raised above the level of the shoulders holding the load, thus this position represents a problem, harming this part of the body, figure 4.

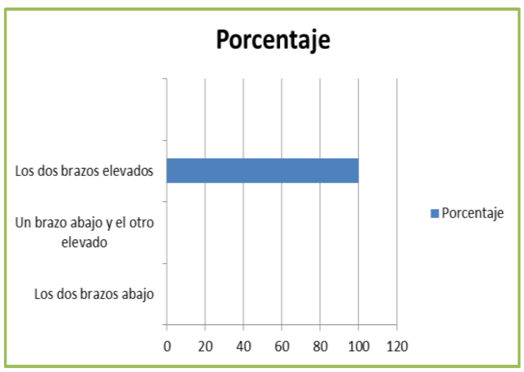

Figure 4. Arms posture

3.2.3 Leg Position.

The positions of the legs of the operator in the loading and unloading area, indicate that 100% of the time the worker is walking with load, which indicates that there is a potential risk of acquiring a Cumulative Trauma Disorder (CTD) caused by harmful positions for this part of the body, figure 5.

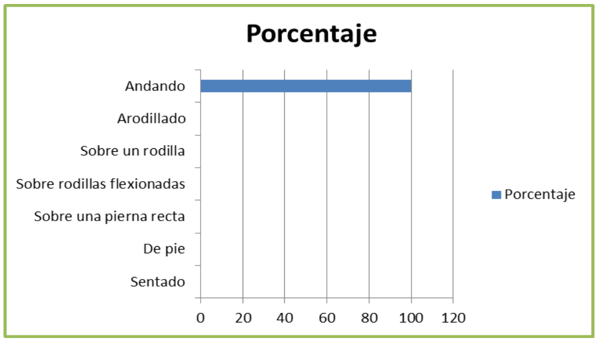

Figure 5. Position of legs

2.4 <u>Loads and strength</u>.

The weight handled by the operator in the loading and unloading area in the warehouse, indicate that 100% of the time the worker lifts weights exceeding 20 kg. This situation represents a potential risk from uncomfortable or harmful positions for this part of the body, figure 6.

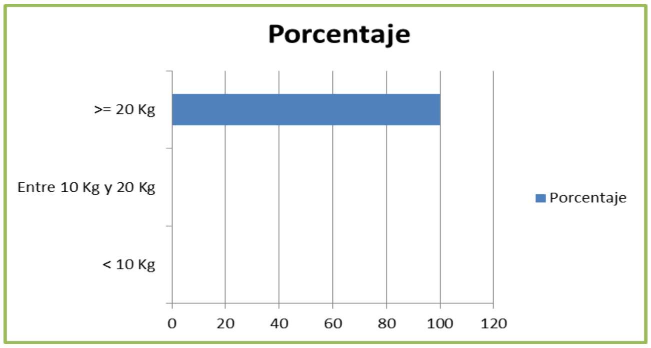

Figure 6. Load Lifted

4. CONCLUSIONS

In general it was concluded that there is a potentially high risk of injury in the lumbar area of the workers who are working in the loading and unloading area in the warehouse of the cattle feed supplier. Important breaches of the NOM-006 were found since the workers are managing 40 kg loads without establishing a safe procedure, training, or the equipment needed for the handling of the product. Another important piece of information is that it was found that 83.4% of the workers do not know the correct way to lift a load. This type of problem should be corrected immediately to change and improve the conditions of the work centers. Furthermore, there should be an implementation of the use of machines and/or mechanical appliances for the handling of materials. This represents an area of opportunity for the company that will help it reduce costs and improve delivery times, maintaining the welfare of its workers.

A proposal for feasible improvement is to generate and to determine the procedures and ideal conditions for the manual handling of materials, adding the use of mechanical support such as trucks, skates, forklifts, among others for the handling of such materials, to reduce the damage caused to the operators and increase productivity as well as to reduce times for the processes of loading and unloading in the warehouse area of the cattle feed supplier.

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ANALYSIS OF CUMULATIVE TRAUMA DISORDER RECEPCIONISTS IN LOS MOCHIS, SINALOA

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Resumen: Recepcionistas suelen adoptar posturas incorrectas, la realización de movimientos repetitivos, muebles usados no adecuado, si estas situaciones se desarrollan muy rápido manera, o por períodos largos pueden llegar a causar una disminución de las capacidades físicas. La adopción de malas posturas en la mayoría de los casos es causada por las herramientas de trabajo deficientes con la que cuenta, o actividades rutinarias realiza, dependiendo de la situación o la gravedad produce la enfermedad y / o lesión. Identificar, analizar y evitar este tipo de situaciones, en este estudio de investigación se llevó a cabo mediante la aplicación del método de Yoshitake 30 mujeres que trabajan como recepcionistas en la ciudad de Los Mochis, Sinaloa, durante el período de diciembre de 2015 y enero de 2016, con una duración de tres semanas aplicados a tres situaciones, que el método Yoshitake se divide como síntomas de somnolencia y la monotonía, dificultad para concentrarse y síntomas corporales o proyección de daño físico, que tiene una fatiga escala de medición en un día normal de trabajo, y que también se basan en el método de la escala de 4 puntos de Lucas, que se relaciona a la fatiga durante un día de trabajo normal 1 a 4, que representan 1, no fatiga y 4 el contrario, siendo esto muy cansado. Sin antecedentes de ninguna investigación anterior sobre el tema, hemos tratado de determinar las posibles recepcionistas fatiga que afectan a la calidad de vida de las actividades individuales no sólo en el trabajo sino también en su vida fuera del trabajo. El análisis de los resultados obtenidos durante esta investigación muestra evidencia de que hay una recepcionistas fatiga mental de la ciudad de Los Mochis, Sinaloa.

Palabras clave: Atención al cliente, lesiones, problemas musculoesqueléticos.

Relevancia para la Ergonomía: Día tras día recepcionistas realicen un trabajo de rutina, donde su salud física y mental son parte de sus herramientas de trabajo, por esta razón es necesario para mantener las condiciones óptimas para su trabajo

Abstract: Receptionists often adopt incorrect postures, performing repetitive movements, used furniture unsuitable, if these situations occur very soon way, or for long periods may actually cause a decrease in physical abilities. The adoption of bad postures in most cases is caused by poor working tools with which account, or routine activities performed, depending on the situation or severity occurs illness and / or injury. To identify, analyze and avoid such situations, in this research study was conducted by applying the method of Yoshitake 30 women who work as receptionists in the city of Los Mochis, Sinaloa, during the period December 2015 and January 2016, with a duration of three weeks applied to three situations, which the Yoshitake method is divided as symptoms of drowsiness and monotony, difficulty concentrating and bodily symptoms or projection of physical harm, having a measuring scale fatigue on a normal working day, and we also rely on the method of the scale of 4 points of Luke, which is related to fatigue during a normal working day 1 to 4, representing 1, no fatigue and 4 the contrary, this being extremely tired. With no history of any previous research on the subject, we sought to determine the possible fatigue receptionists affecting the quality of life of the individual activities not only in work but also in your life outside of work. Analyzing the results obtained during this research shows evidence that there is a mental fatigue receptionists city of Los Mochis, Sinaloa.

Key words: Customer service, injuries, musculoskeletal problems.

Ergonomic importance: Day after day receptionists perform routine work, where their physical and mental health are part of their working tools, for this reason it is necessary to maintain optimal conditions for their work

1. INTRODUCTION

Exposure to adverse working conditions can result in momentary pain or long-term injuries. Also, poorly designed work environments contribute to lower efficiency and production, and permanent disabilities.

2. OBJECTIVES

2.1 General Objective

Identifying and knowing the existence of DTA'S receptionists in the city of Los Mochis, Sinaloa.

2.2 Specific objetives

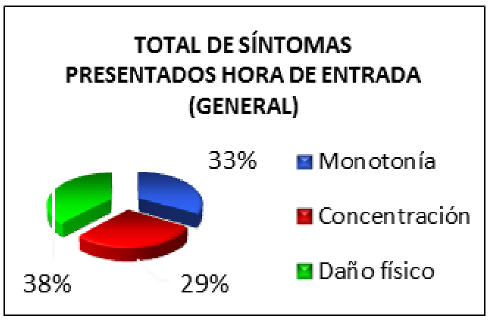
- Determine the possible presence of symptoms of concentration, monotony and physical damage in the receptionists working in the city of Los Mochis Sinaloa.
- Determine the scale on which presents the DTA´S through the scale 4 point of Luke.

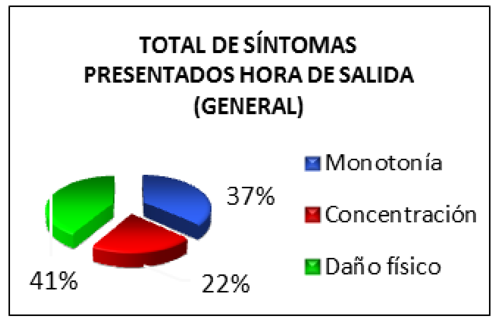
3. METHODOLOGY

Using the method of 4 points of Luke and Yoshitake applied to 30 female receptionists for 6 working days a week both when entering and departure time, for a period of three weeks, the presence of determined DTA'S affecting employee health as well as the causes that cause.

4. RESULTS

4.1 YOSHITAKE

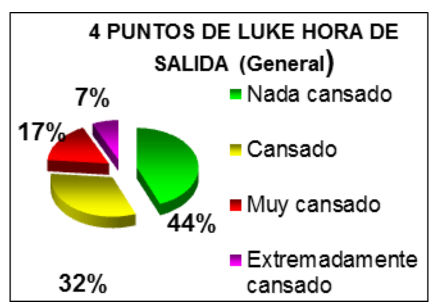




Graphic 4.1.1 and 4.1.2 TOTAL OF SYMPTOMS PRESENTED (DEPARTURE TIME)

The graphic 4.1.1and 4.1.2 shows the general percentages of 3 weeks in which the investigation was realized. It is observed general physical damage output is increased by 3% and decreases the concentration.

4.2 4 POINTS OF LUKE



Graphic 4.2.1 and 4.2.2 4 POINTS OF GENERAL LUKE

Graphic 4.2.1 and 4.2.2 shows the general percentages of 3 weeks in which the investigation was realized. It is observed during the three weeks having fatigue accumulates a decrease of 23% in all tired and increased very tired and extremely tired.

5. CONCLUSIONS

Considering the results Yoshitake, the main symptom that they present the receptionists are the monotony, followed by problems of concentraton, and physic damage in less percentage.

In regards to 4 points Luke, it can be concluded that if there is tiredness mainly at the end of the workday. it has statistical evidence for 3 weeks to say that if there is DTA´S by the receptionists in the city of Los Mochis, Sinaloa

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ERGONOMIC RISK FACTORS RELATED TO THE ENVIRONMENT WORKPLACE THOSE EXPOSED EMPLOYEES IN SMALL AND MEDIUM ENTERPRISES OF METAL- MECHANIC IN SECTOR NAVOJOA, SONORA .

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Resumen: Este documento contiene los resultados del estudio llevado a cabo en la ciudad de Navojoa Sonora con el objetivo de analizar los puestos de trabajo de las pequeñas y medianas empresas dedicadas al sector del metal con el fin de detectar los factores de riesgos ergonómicos en que los trabajadores o empleados pueden estar expuestos y / o suponer un riesgo para la salud, teniendo en cuenta los factores ambientales como el ruido y las vibraciones, confort térmico, confort visual, el proceso de trabajo, las tareas de diseño. Y generar propuestas de mejora a través de recomendaciones basadas en los resultados obtenidos de esta manera pueden evitar lesiones y/o enfermedades profesionales que puedan poner en peligro la integridad tanto del trabajador y el proceso y en consecuencia las pérdidas económicas a la Compañía. Para su realización un total de 19 pequeñas y medianas empresas dedicadas a este sector, en el que los talleres de soldadura, talleres alrededor, talleres incluyeron molienda, así como los que participan son visitados más de una de estas actividades. Dentro de estas condiciones de negocio trabajos basándose en una lista de control para el análisis de puestos de trabajo para el análisis y estudio posterior que se observaron.

Palabras clave: Trabajo ambiental, trabajo del metal, riesgos.

Relevancia para la Ergonomía: Este estudio es importante para la ergonomía y la presentación de los resultados de las evaluaciones ergonómicas en temas relacionados con el medio ambiente en donde el trabajador y sólo el puesto de trabajo físico, la mayoría de las personas cuando escuchan la palabra es "ergonomía" piensa por primera vez en la comodidad o en la reducción de la fatiga, pero pocos toman en cuenta el entorno de trabajo donde se llevan a cabo actividades de trabajo.

Abstract: This document contains the results of the study conducted in the city of Navojoa Sonora with the aim of analyzing the jobs of small and medium enterprises engaged in the metal sector in order to detect factors of ergonomic risks to which workers or employees may be exposed and / or pose a health risk, taking into account environmental factors such as noise and vibration, thermal comfort, visual

comfort, working process, design tasks. And generate proposals for improvement through recommendations based on the results obtained in this way they can avoid injury and / or occupational diseases that could jeopardize the integrity of both the worker and the process and consequently economic losses to the Company. For its realization a total of 19 small and medium enterprises engaged in this sector, in which welding shops, workshops around, workshops grinding included, as well as those involved are visited more than one of these activities. Within these business conditions jobs based on a checklist for analysis of jobs for later analysis and study they were observed.

Key Words: Labor Environment, Metalworking, Risks .

Relevance to ergonomics : This study is important for ergonomics and presenting the results of ergonomic evaluations on issues related to the environment where the worker and only the post of physical work , most people when they hear the word is " ergonomics" think first in comfort or in reducing fatigue but few take into account the working environment where they carried out work activities .

1. INTRODUCTION

As we know in any industry there is a risk that employees suffer any injuries due to accidents and none of these is exempt from suffering these mishaps, but there are so-called high-risk industries where the frequency and severity of accidents is high, such as metallurgy, metal-mechanics and construction, and even most of these accidents are due to human error. (Castillo, 2011).

1.1 Backgrounds

Sector Metal Industries - Mechanical Industries brings together all its activities related to processing, laminating or metal extrusion. (CANACINTRA, 2014)

It is statistically proven that accidents at work within the metal sector have become highly prevalent; therefore the importance of evaluating the conditions in the working environment in which workers perform their functions to identify risk factors that could be harmful to the health of workers or represent a risk factor for its performance.

In Sonora labor risks by occupation in the Metal-mechanical sector account:

Año	**Accidentes de trabajo**
2012	3,372
2013	3,524

1.2 Approach of the problem

Work accidents have demonstrated the high degree of influence on the mechanical Metal- sector; hence the importance of evaluating the conditions in which workers performs their duties to identify risk factors that could be harmful to the health of workers.

The evaluation will take into account the body dimensions , designs machines and tools , postures and body movements , physical exertion, design information devices and controls the work environment together with the interactions in the work process can influence the performance of the task.

1.3 Objective

To determine the occupational risk factors they are exposed workers in small and medium industry Metal-mechanical sector related to the working environment in which they play in Navojoa by applying an ergonomic assessment tool for identification.

2. METHODOLOGY

2.1 Study Subject

Studies show that for small and medium enterprises, one of the industrial activities with greater potential for participation in supply chains of large automotive companies is the metalworking industry. Therefore, this activity was included in the research on technological learning in activities related to the automotive industry in northwestern Mexico. As mentioned (Olea, 2002).

Information of the Ministry of Economy said that the metalworking industry contributes 14% of manufacturing GDP in Mexico. Companies in this sector, according to data Canacintra, group all industries in which its activities are related to the processing, metal rolling or extrusion.

The population object under study was determined by 19 companies in the metal sector in the city of Navojoa, Sonora. Of which most are located south of the city sector. The activities in this sector include the service in general metal-mechanical, ie, design, repair and manufacture items industrial machinery, automotive and metal structures. Some activities of these are: the production of metal parts, welding, grinding, cutting and bending. Besides elaborate pieces tailored hardware such as screws, nails and bolts. The machines most commonly used in the sector are mainly lathe, welding, drilling and milling. Of the 19 companies that were visited, 4 are specifically dedicated to turning parts, 9 only to welding and 6 to both, welding and lathe.

2.2 Procedure

To do this research a list of ergonomic verification consists of a questionnaire organized in thematic blocks, through which different aspects of the machinery that interacts with the worker and that can influence the performance of the task is checked to be applied.

Aspects to consider in the checklist are based on a questionnaire UNE EN 614 on " Safety of machinery: Ergonomic design principles “, this standard establishes a series of ergonomic principles to be followed during the process and project design team, especially the machines. The various issues raised in the list, are developed in the Guide based on various rules on ergonomics.

2.3 Materials:

• Checklist questionnaire which is based on the UNE EN 614 on "Safety of machinery: Ergonomic design principles"
• Application Guide Checklist
• STANDARD Oficial Mexicana NOM-011-STPS-1993, Relative to the security and health in workplaces where noise generated
• Flexometer 3 meter length measuring it.

3. RESULTS

The study object was to conduct an overall assessment of the metal - mechanical sector regarding the conditions of the jobs using a checklist , the results obtained are as follows :

3.1 Noise and vibration

This block was obtained that 57.89% of the workstations accomplished the permissible noise levels, where in addition to asking the operators if the noise were annoying noise measurement was performed in 10 of the companies visited where noise It was annoying to workers. It was also observed if the team vibrations transmitted to the operator to obtain a 42.10% of cases in most noise generated.

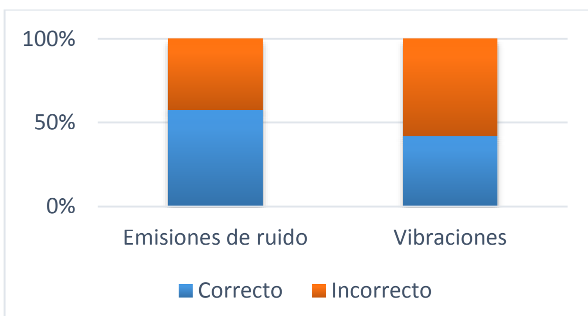

Figure 2. Conditions of Noise and Vibrations

3.2 Thermal comfort

In this section we asked the operator if he considered that the temperature during use of the machine was adequate in all cases the response was negative, with heat being a major factor in the activities of the operator. Also I was wondering if the humidity was correct when using the machine, being in all positive cases, not affect moisture, I also wonder if there are drafts that you find annoying being 100% correct in all cases.

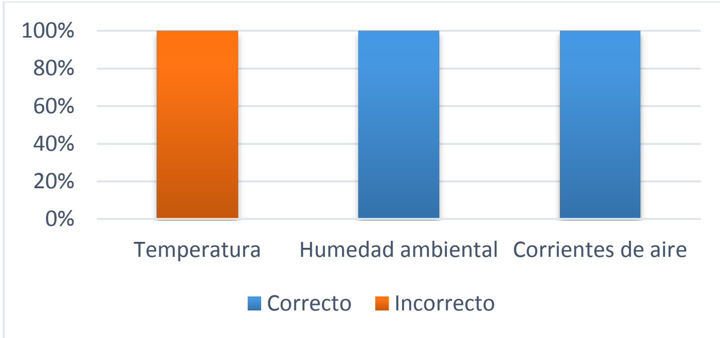

Figure 3. Conditions of Noise an Vibrations

3.3 Visual comfort

Of the 10 measures implemented in the 100% was found that the lighting is far below that required for work in the sector. No oscillations of light that can disturb the workers were observed. It was found that 100% of workstations glare or glare which can be annoying for the operator occurs. All jobs do not have a good placement and entertainment luminaries so it had shadows in 100% of cases also exist large differences in lighting making a poor contrast in 89.47% of cases. Was obtained which could not be discriminated colors on a 94.73% and most workstations lacked auxiliary light if the ambient light is not enough. As can be seen in the following graph:

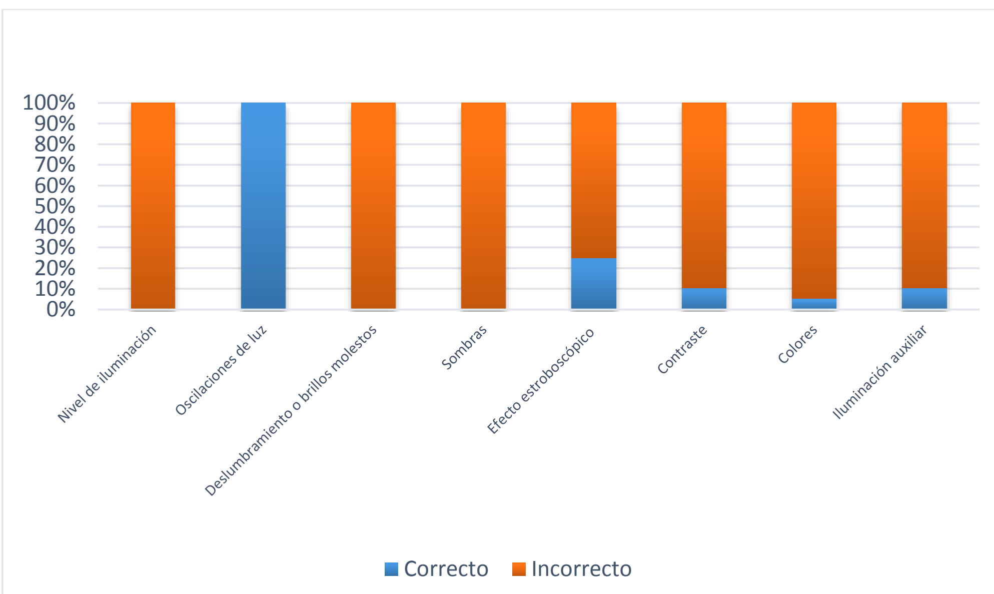

Figure 4. Conditions of Visual Confort

3.4 Working Process

The throw that in 57.89% of jobs are no risks to vision, but in the remaining percentage includes objects that obstruct the vision of the worker study. In the study it was observed that 100% of the machines were adjusted to the pace of work of the operators.

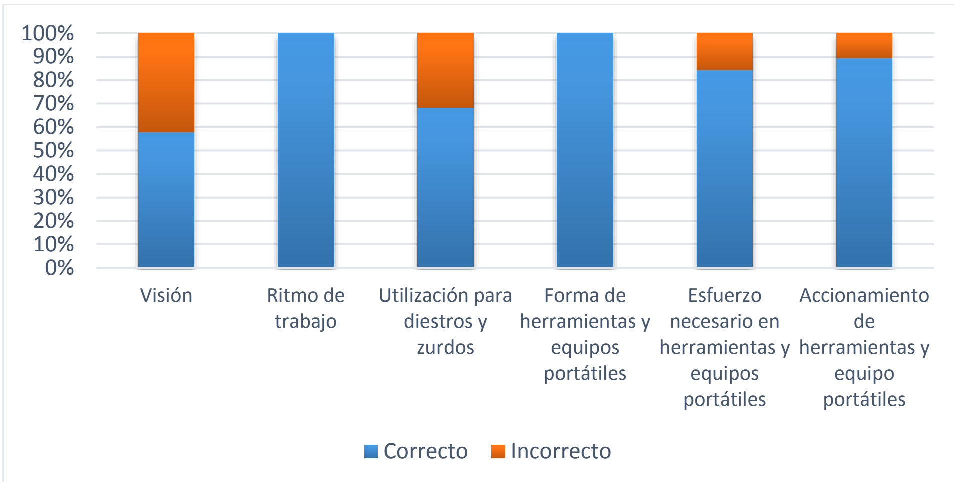

Figure 5. Conditions of Working Process

Design tasks

In this study different aspects were evaluated for the training of workers. It was observed that none of the workers in this sample have previous training on how to perform this type of activated.

Of all the machines that were evaluated only 42.10% have a manual, while the other has to be learned with practice operation. The throw that in 68.42% of the jobs analyzed the work is properly distributed among all members of staff work, while 31.6% tasks fall to a single worker or a part of the workforce study.

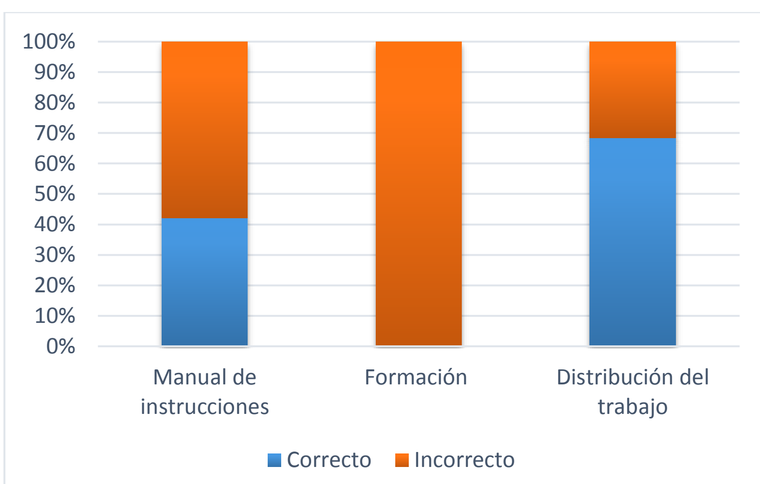

Figure 6. Conditions of design tasks.

4. CONCLUSIONS

The objectives of this study were met to determine the risk factors work to which workers are exposed in small and medium industry Metal-mechanic sector in Navojoa to evaluate aspects marked by the checklist applied, which was obtained in small and medium enterprises in the metal sector is as follows in the aspect of interaction with the physical environment of work: noise was fulfilled with 57.8% and vibration 42.1% in the thermal comfort a factor not 100% was fulfilled temperature, lighting deficiency was detected in 100% of cases, also in shadows and glare by not meet 100%. in the fourth aspect of the interactions of jobs in the working process the operator's vision is hampered in 42.10% of cases, in the fifth aspect of Interactions between the design of machinery and work tasks in the task design, only 42.1% meet to have the manual but is not used, 100% of workers receive no training on machine operation and 68.42% meet in the equitable distribution of work.

Overall it was concluded that the metalworking sector in the city of Navojoa is in a steady state with respect to occupational risk factors, presenting deficiencies in important aspects such as lighting, noise, among others, together with workers not using equipment protection.

Such problems must be addressed immediately to considerably improve the conditions of the workplace. This represents a major area of opportunity within companies in this sector.

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ERGONOMIC RESEARCH ON POSSIBLE CUMULATIVE TRAUMA DISORDER (CTD) OF TACO WORKERS IN LOS MOCHIS, SINALOA CITY.

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Resumen: El presente trabajo muestra los resultados de una investigación ergonómica realizada diversos taqueros de la ciudad de Los Mochis Sinaloa durante el mes de diciembre de 2015, con una duración de 3 semanas, tomando como apoyo el método de evaluación de Corlett y Bishop, el cual consta de un gráfico de las partes del cuerpo señalado con letras que van desde la A hasta la O para identificar en que parte del cuerpo existe dolor o molestia. Al observar y analizar que los taqueros de Los Mochis, Sinaloa, duran una jornada laboral de 8 horas en promedio realizando un trabajo de manera repetitiva, surge la inquietud si se presenta algún Desorden por Trauma Acumulativo. Los resultados obtenidos en esta investigación fueron analizados estadísticamente para localizar donde mayormente ocurre un DTA en los taqueros de Los Mochis Sinaloa.

Palabras Clave: Lesiones, movimiento repetitivo, tiempo.

Relevancia para la Ergonomia: Implementar la ergonomía en los trabajadores de tacos porque se basa en que puede evitar que los trabajadores se lesionan los futuros, del mismo modo, el propósito es preservar su salud y calidad de vida de estas personas

Abstract: The present work shows the results of an ergonomic research different taco workers in the city of Los Mochis Sinaloa during the month of December 2015, with a duration of three weeks, taking as support the evaluation method Corlett and Bishop, which consists a graph of body parts marked with letters ranging from A to O to identify where in the body there is pain or discomfort. By observing and analyzing the taco workers of Los Mochis, Sinaloa, last a working day of 8 hours on average doing work repeatedly, concern arises if a disorder is presented by Cumulative Trauma. The results obtained in this research were analyzed statistically to locate where mostly think of a DTA in taco workers.

KEYWORDS: Injury, repetitive motion, time.

Relevance to Ergonomics: Implement ergonomics in the taco workers because based on it can prevent workers futures injure, likewise, the purpose is to preserve their health and quality of life of these people.

INTRODUCTION

The Royal Academy of the Spanish Language, defines a taco worker as: "someone who makes or sells tacos".

In the next article, it is to know whether a worker who works in a taqueria in the community of Los Mochis Sinaloa has an injury sustained by a cumulative trauma disorder (CTD) and likewise the parts of the body most affected.

OBJECTIVES

Analyze and identify factors that determine whether a CTD and evaluate the conditions of the work area and the task unwraps a taco workers of this community, and likewise the parts of the body most affected.

METHODOLOGY

After sampling, analyze the results of this research using statistics with a normal distribution. Taking a sample of 32 workers from different areas of Los Mochis Sinaloa, at different time, shift, condition, age, gender, among other aspects, this being conducted for 4 weeks in December, using the methods Corlett & Bishop for potential Cumulative Trauma Disorders.

RESULTS

CORLETTY BISHOP

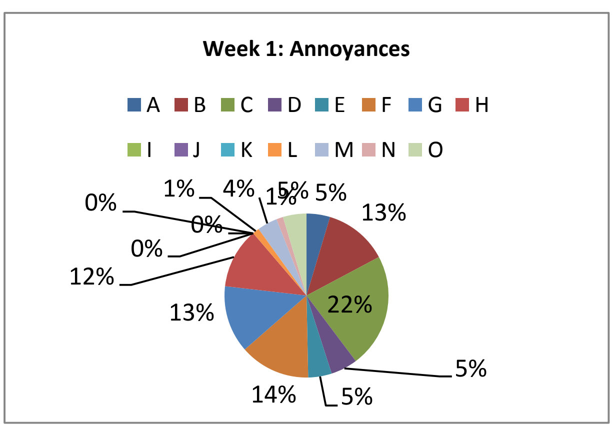

figura 1 Annoyances

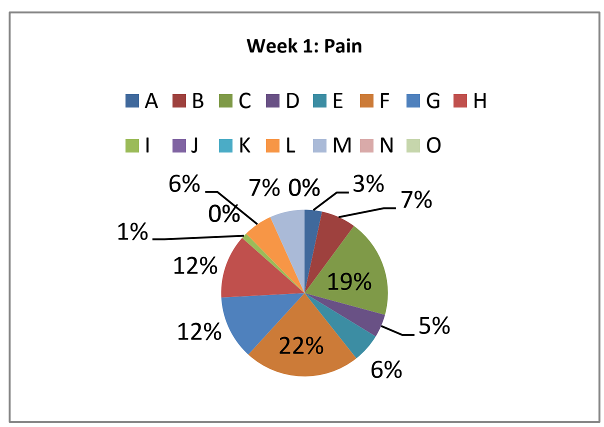

figura 2 Pain

The overall percentages of week 1 in which the research was conducted taco workers all shown. It is observed that most of the taco workers in this first week are more annoyance the shoulder portion as they feel pain in hands at the end of the day

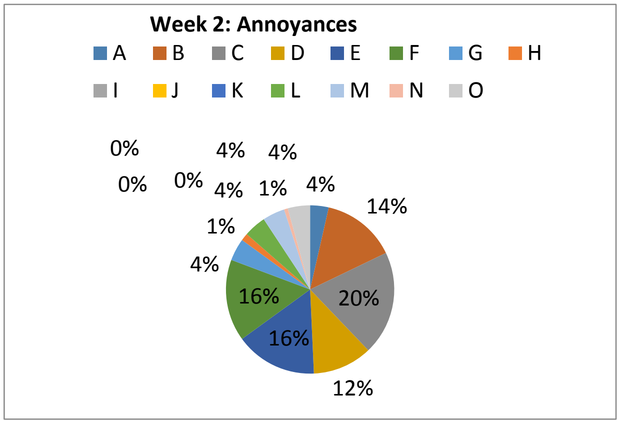

figura 3 Annoyances

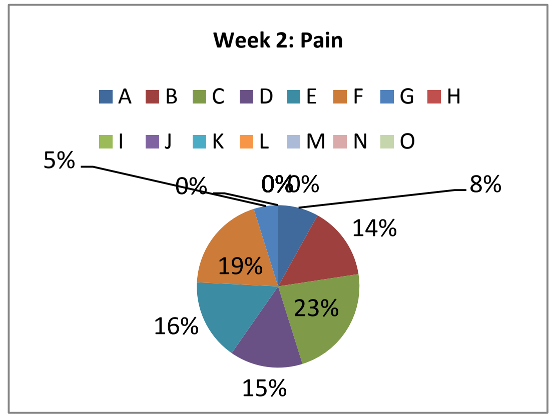

figura 4 Pain

In Figures 3 and 4 shows that in the next week taco workers had more annoyances in the body such as neck with 14%, shoulders 20% lower arm 16% hands and 16%, pain also increased by almost entire body.

Grafico 2

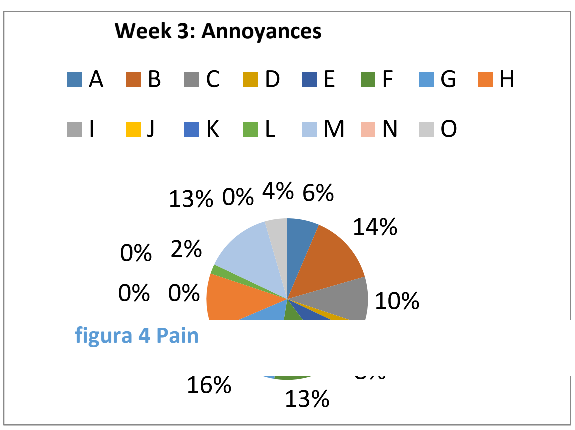

figura 5 Annoyances

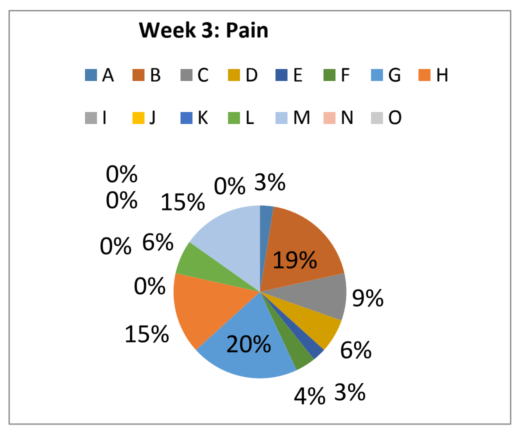

figura 6 Pain

Figures 5 and 6 show overall percentages of week 3 in which the research was conducted. It is noted that in the day taco workers feel annoyances throughout his body and pain in her neck with 19% back to 20%, average 15% back and legs with 15%.

CONCLUSION

Based on the results of Corlett and Bishop, we can conclude that there is little discomfort in the body in the first working week, and how is advancing the weeks the body is feeling more, the same goes with pain each week increases only at certain points

When analyzing the graphs is that most tired part and the end of the day it hurts more is the back, shoulders and neck. There is sufficient statistical evidence gathered during the 3 weeks to say if physical work fatigue type occurs in taco workers city of Los Mochis Sinaloa, data obtained from the people who participated in the survey.

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PROPOSAL FOR IMPROVEMENT OF WORKING CONDITIONS IN THE AREA ARMED WITH" ARMEX "BY ERGONOMIC METHODS COMPANY S.A. DE C.V. CONSTRURAMA

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Resumen: El presente trabajo se desarrolla en Construrama, empresa considerada como la red de distribución de materiales para construcción de mayor cobertura en México y con presencia en Latinoamérica. Fue creada por CEMEX en el 2001 con el objetivo de unificar las fuerzas de sus distribuidores para estar más cerca del mercado de la Construcción. El proyecto, se ubica en Cancún, Quintana Roo municipio de Benito Juárez. Cuenta con 12 trabajadores en el área operativa, distribuidos en 4 áreas específicas: armado de armex, con 2 trabajadores; montacargas, 2 trabajadores; doblado de varillas, se da rotación de personal; y 6 destinados para la distribución de materiales (cal, cemento, varilla, armex y malla).

El presente proyecto es producto del trabajo de investigación de estudiantes de la carrera de Ingeniería Industrial. Está centrado en el área de armado de armex y el enfoque de estudio son a las condiciones a las que el trabajador se encuentra expuesto, comprendiendo el entorno que lo rodea y los medios de trabajo, con el método LEST en el entendido de que las malas condiciones de trabajo repercuten en la productividad y en la calidad del producto y/o servicio ofrecidos al cliente.

Palabras clave: Ergonomía, LEST, OWAS, armex y seguridad

Relevancia para la Ergonomía: El proyecto conoce la importancia del cuidado del trabajador y tiene programas de prevención y el manual para cada posición sin embargo, no garantiza la seguridad y salud de los trabajadores y esto deberá hacerse énfasis en las empresas y cualquier trabajo que hacemos, por tanto, la difusión de esto debe ser constante y fundamental saber.

Abstract : This work takes place in Construrama, company considered the distribution network for construction materials increased coverage in Mexico and with presence in Latin America. It was created by CEMEX in 2001 with the aim of unifying the forces of its distributors to be closer to the construction market.The project is located in Cancun, Quintana Roo municipality of Benito Juarez. It has 12 workers in the operational area, distributed in 4 specific areas: ARMEX armed with 2 workers; forklift, 2 workers; bending rods, it is given turnover; and 6 intended for distribution of materials (lime, cement, rod, ARMEX and mesh). This project is the result of research work of students of Industrial Engineering. It is centered in the area of armed ARMEX and focus of study are the conditions to which the worker is exposed, understanding the surrounding environment and means of work whit the system LEST, on the understanding that the poor working conditions impact productivity and product quality and / or service offered to the customer

Keywords: Ergonomic, LEST, OWAS, armex y security

Relevance to ergonomics: The project knows the importance of taking care of the worker and has prevention programs and manual for each position however it does not guarantee the safety and health of workers and this must be done stress upon companies and any work we do therefore the diffusion of it must be constant and critical to know.

1. INTRODUCTION

Construrama, company considered the distribution network for construction materials increased coverage in Mexico and a presence in Latinoamérica. Was created by CEMEX in 2001 with the aim of unifying the forces of its distributors to be closer to the construction market it consists of 750 professional dealers totaling 1,700 branches, its market range from the general public to various government entities, to architects, foremen and construction for its rough area of labor cares about their workers and allowed the conducting this research which is expected to provide senior management substantiated information enabling them to ascertain the possible disturbances because of poor working procedures, or lack of protective equipment.

1.1 Description of the problem:

Workers in the area, which is responsible for the production of ARMEX, are exposed to multiple risk factors that can impact negatively on health issues. At first glance, an environment in which the noise and the repetitiveness of movements are perceived excessively. However, using the methods applied it can be confirmed if they really are the major risk factors in the process, or if there are others that require a more detailed study for his discovery.

2. GENERAL PURPOSE

Develop a proposal to eliminate risk factors in the area of production of '' armed armex''en Construrama the company.

1.1.1 Specific objectives

- Analyzer assess environmental conditions and postural risks in the study area.
- Delineate risk factors.
- Using Presenter improved ergonomic methods**.**

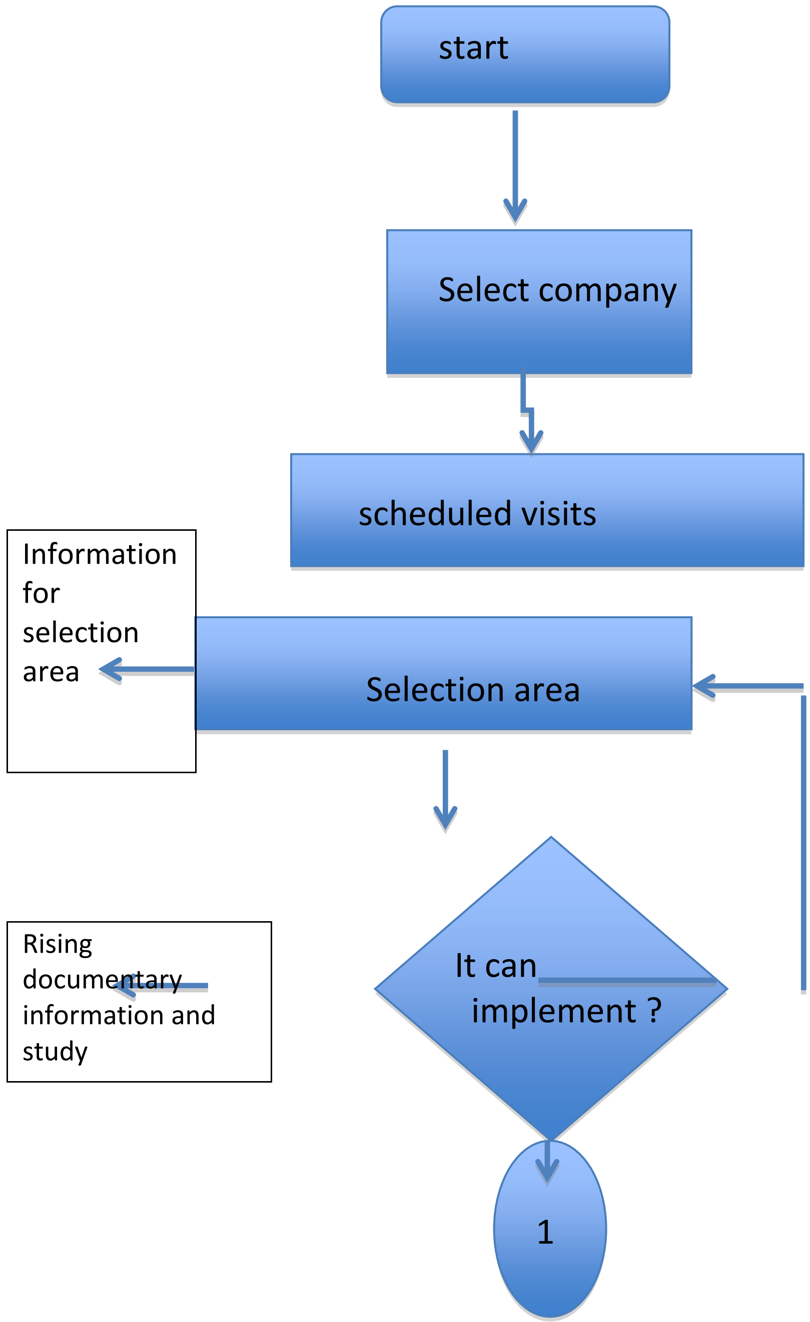
3. METHODOLOGY

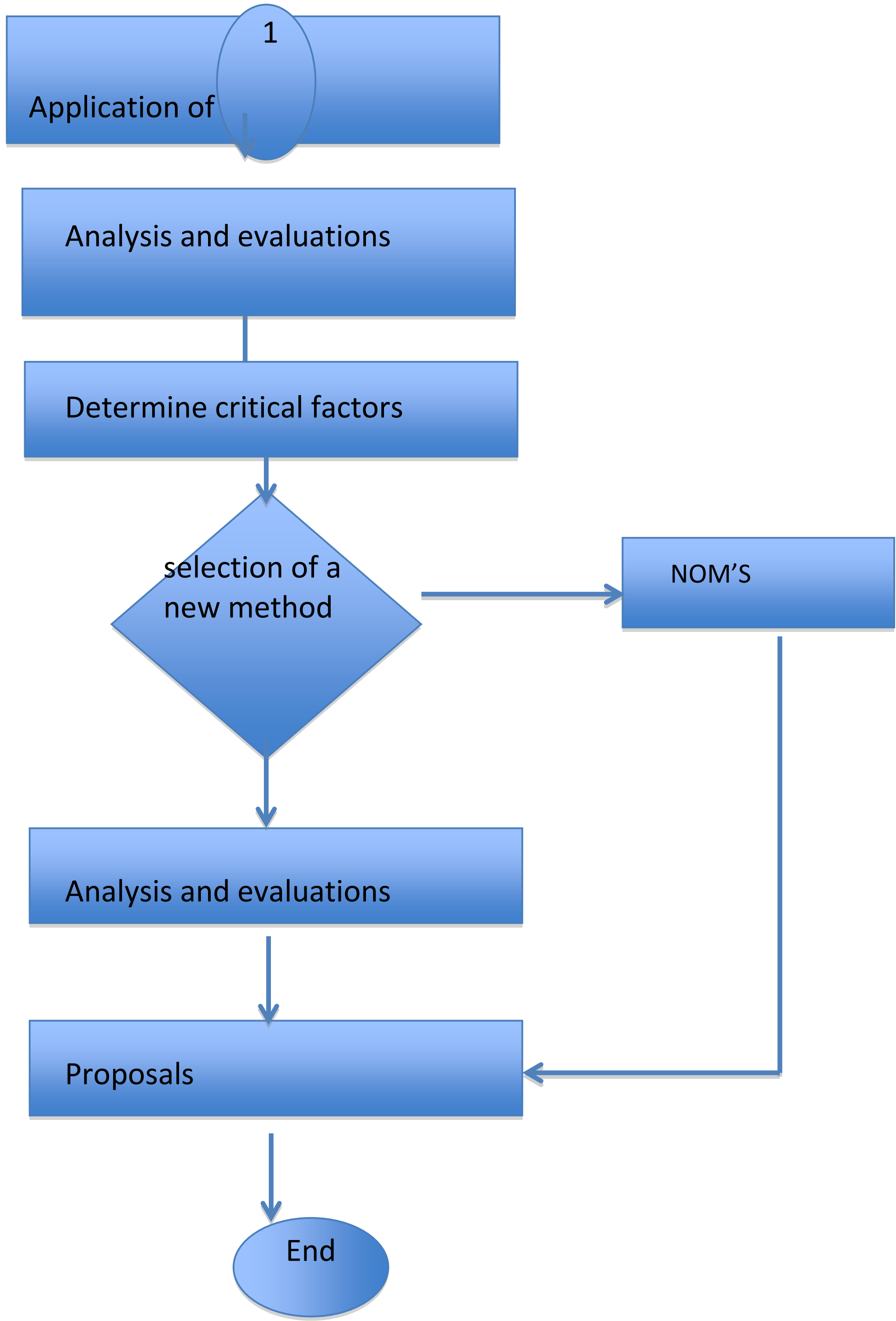
The methodology examines the strategies, procedures, activities and resources required to meet the budget targets and give a solution to the problem.

3.1 Type of research.. The project will study a mixed approach, is a film studio and studio field. The documentary research is one that makes consultations in books, magazines, newspapers science, internet among others. On the other hand, field research activities performed where the studio is done in a timely manner.

3.1.1 Within the project a series of steps, to realize the goals and generate satisfactory proposals for the specific company**.**

A). Diagram flow methodology


start
Select company
scheduled visits
Information for selection area
Selection area
Rising documentary information and study
It can implement ?
1



- Selection of the company which is intended study

Development Company where the project has an area of opportunity because it contains conditions is of consideration against health.

- Scheduled visits

during the development of the company project visits were conducted continuously since the collection of data for the application of methods or standards is an extensive process.

- Selection area

in the assembly process and constant repetitive activities they found.

- Rising documental information

Minus was because they support personal questionnaires is aimed at operators that area of study and collection of personal information
To determine the diagnosis the method considers 16 variables grouped into 5 aspects (dimensional), physical environment, physical load, mental load, psychosocial aspects of the 16 variables considered. Looking for ease of application.

Table 1.

physical environment	**physical load working**	**mental load**	**psychological aspects**	**timephysical load**
thermal environment	electric charge	dynamic load	Initiative	working time
noise	dynamic load	pressure times	social status	
lighting			Communication (workers)	
Vibes			relationship with the command	

to determine physical environment variables using some measuring instruments requires Table 2

INSTRUMENT	**FUNCTION**
psychometer	measure temperature

lux meter	determine the level of brightness
sonometro	measures the sound level
anometro	measures air velocity
flexiometrs or other to measure distances	determining measures for areas
chronometers	measure times

3.2 A**nalysis and evaluation**

taking the physical aspects as dynamic and static process area and personal data of the worker are taken into account and are entered into an online portal: this portal that was used in the verdict of the project is the Polytechnic University of Valencia intended ergonomic studies to work in different places where we give the critical factors.

3.3 The critical factors

which gives us the method LEST are mental burden, physical burden, psychosocial aspects, physical environment and working times, note that critical factor contains variables, static load, dynamic load, light, noise, vibration, thermal environment, initiative, social status, working time, relationship in command, therefore you consider Argonauts portal that has valuation scale of 0 to 10 punctuation and interpretation of this table is as follows.

0,1,2	satisfactory situation
3,4,5	weak disturbances (Some improvements could provide more comfort to the worker).
6,7	half discomfort (there is a risk, fatigue).
8,9	stockings discomfort (fatigue).
10	Noxiousness

4. RESULTS

With the application of LED system 70 workers within the main area of the company as a result of bringing the people are in the areas analyzed through studies are presented below.

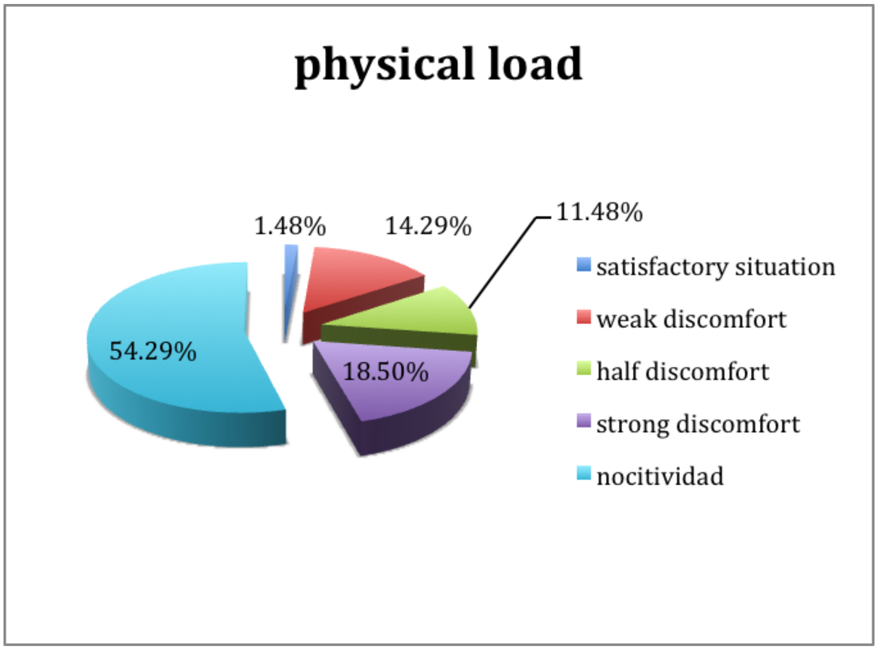


Illustration 1. Percentage of people in each work situation regarding the physical load.

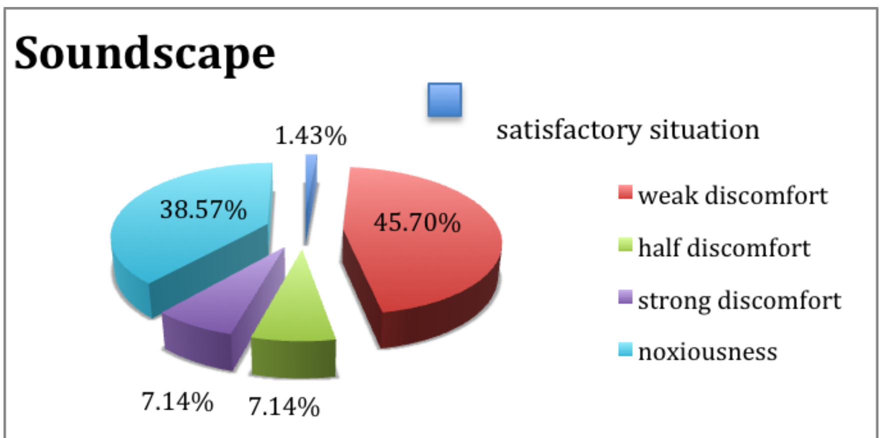


Illustration 2 Percentage of people in each work situation regarding the sound environment.

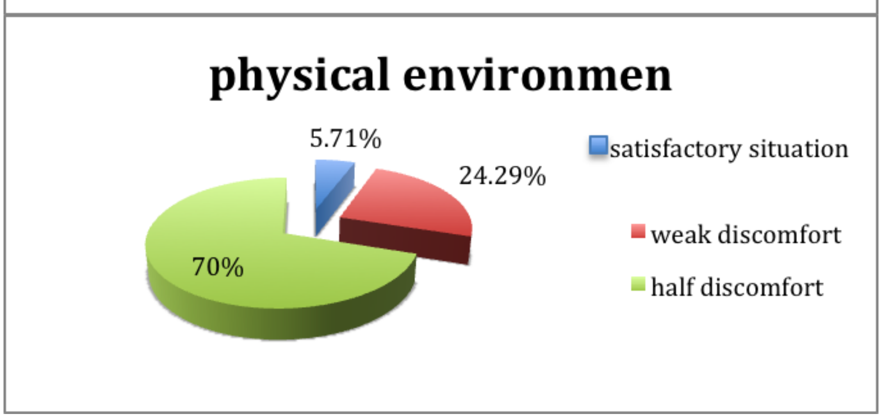


Illustration 3. Percentage of people in each work situation regarding the physical environment

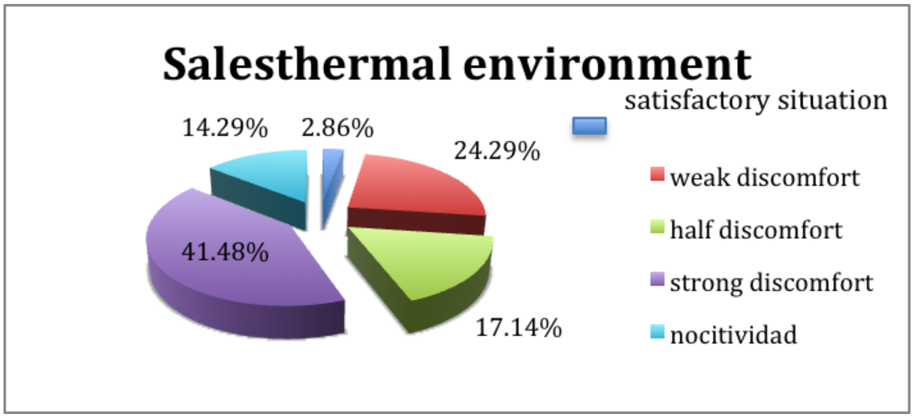


Illustration 4. Percentage of people in each work situation regarding the thermal environment.

5. CONCLUSIONS

With this application of ergonomic method gives us more detailed information but to actually file the problem, so to already have the knowledge of what the problem is based on the repetitiveness study is required, we know that the movement represents a real danger. so you can apply another more accurate method for this study ergonomic.

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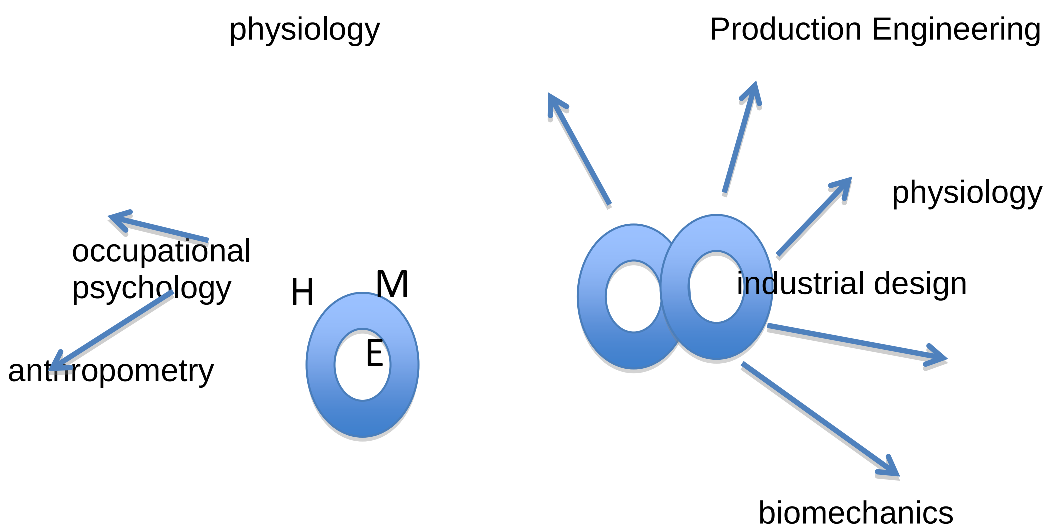
In the article published by COPERSA Engineering (Alfaro, 2006). He mentioned the importance of implantation of ergonomic practices and as in Peru have implemented new Ergonomics programs. Refers to entrepreneurs who invest on machinery, systems, tools in order to seek improvements in productivity and safety of workers, however, are getting the same results. Place where part of the problem to ignore the main part of the production process, the worker. This article also show the objectives of the study of ergonomics, the Man-Machine-Environment (H-M-E), some methods of prevention and the advantages of applying ergonomics. Which highlights that the welfare worker leads to a rise in productivity. The following illustration is part of the H-M-E system according to the author of the book described.

Interdisciplinary Character



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CORRELATION BETWEEN BURNOUT SYNDROME AND MUSCULOSKELETAL COMPLAINTS AMONG NURSES OF A PRIVATE HOSPITAL

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Resumen: La enfermería es una de las profesiones más estresantes que existen desde el punto de vista físico y psicosocial del trabajo. Por ello, estudios demuestran que es también de las más propensas a sufrir del Síndrome de Burnout y ha sido estudiada ampliamente en profesionales de la salud en el sector público en México. Sin embargo, se considera que existe escasez de estudios sobre el Síndrome de Burnout en sectores privados al igual que su relación con las Molestias Músculo esqueléticas en enfermeras. El estudio se realizó a 108 enfermeras de un hospital privado de Ciudad Juárez. Chihuahua, para determinar si existe relación del Síndrome de Burnout con MME. Se utilizó el cuestionario Maslach Burnout Inventory-Human Services Survey Cordoba et al., (2011) y se obtuvo una confiabilidad de Alpha de Cronbach de 0.786. Para el estudio del las MME se utilizó el BodyMap Assessment Method de Marley y Kumar (1996), y se obtuvo una confiabilidad de Alpha de Cronbach de 0.957. La correlación de Spearman muestra significancia al 95% y 99% entre el Agotamiento Emocional y MME. El Cinismo y las MME mostraron correlación significativa al 95%. Las partes del cuerpo donde se manifiestan MME con mayor frecuencia fueron espalda baja, espalda alta, ojos, cuello, piernas, rodillas y tobillos. En cuanto a los grados de Burnout por dimensión tanto en agotamiento emocional como el cinismo presentan un grado bajo y se encontró un grado alto en la dimensión de realización personal.

Palabras clave — Síndrome Burnout (SB), Maslach Burnout Inventory (MBI-HSS), Molestias Músculo Esqueléticas (MME).

Abstract: The nursing is one of the most stressful professions that exist from the point of physical and psychosocial work view. Therefore, studies show that it is also the most likely to suffer from burnout syndrome and has been widely studied in health professionals in the public sector in Mexico. However, it is considered that there is a shortage of studies on the burnout syndrome private sectors as well as their relationship with skeletal muscle discomfort nurses in the. The study was conducted to 108 nurses of a private hospital in Ciudad Juarez. Chihuahua, to determine whether a relationship exists Burnout Syndrome with MC. the Maslach Burnout Inventory-Human Services Survey Cordoba et al. was used (2011) and Cronbach Alpha reliability of 0.786 was obtained. For the study of the MC we used the BODYMAP Assessment Method Marley and Kumar (1996), and Cronbach Alpha reliability of 0.957 was obtained. Spearman correlation shows significance at 95% and 99% between Emotional Exhaustion and MC. Cynicism and MC showed significant correlation to 95%. The parts of the body where MC occur most frequently were lower back, upper back, eyes, neck, legs, knees and ankles. As for the degree of Burnout per dimension both emotional exhaustion and cynicism they have a low grade and high grade found in the dimension of personal accomplishment.

Keywords: Burnout Syndrome (BS), Maslach Burnout Inventory (MBI-HSS), Musculoskeletal Complaints (MC).

Contribution to ergonomics--- knowledge of this condition and its relation to the MC in the population of private hospital nurses. Recommendations to prevent and identify the problem and its impact on vulnerable people suffer the syndrome arise.

1. INTRODUCTION

According to Jaworek et al., (2010) the profession of a nurse is one of the most demanding, stressful and demanding professions that exist, due to the diversity of stressors involved carry out such conflicts with patients' families, contact with human suffering, death of the patient, disagreements with management, difference of opinions with doctors, extensive working hours among others. Also for Marciel (2008), nursing is considered a highly stressful profession. Basset, et al., (2011) indicate that under the labor market, professions that focus on providing services to people, such as nurses is why they are more vulnerable to exhibit the symptoms of burnout. According to Fernandez, et al., (2014), Musculoskeletal Complaints (MC) of occupational origin are alterations suffered by muscles, joints, tendons, ligaments, nerves, bones and circulatory system, caused or aggravated primarily by work and environmental effects in which it develops. Díez et al., (2007) indicate that musculoskeletal complains are a set of inflammatory or degenerative lesions, muscles, tendons, joints, ligaments, nerves. Their most common locations are found in the neck, back, shoulders, elbows, wrists and hands.

The following describes the problem, objectives, justification and delimitation.

1.1 Problem Definition

Nursing is one of the most stressful professions that exist from the point of physical and psychosocial work view. Therefore, studies show that it is also the most likely to suffer from burnout syndrome and has been widely studied in health professionals in the public sector in Mexico. However, it is considered that there is a shortage of studies on the burnout syndrome and its relationship with musculoskeletal complains in private section nurses. To Pegner et al., (2008) the importance of the study of burnout in nurses is because it adversely affects both the service provider and the requesting and decreases the quality of care to patients, even carrying a dehumanized treatment.

1.2 General Purpose

The General Purpose of this case study is to determine the correlation between BS and nurses MC in a private hospital in Ciudad Juarez Chihuahua.

1.2.1 Specific Objectives

1. To determine the correlation of burnout syndrome and MC private hospital nurses.

2. Determine the presence of burnout syndrome in private hospital nurses.

3. Determine the parts of the body with the highest frequency of MC among nurses in the private hospital nurses.

1.3 Delimitation

The sample includes 108 nurses of three working shifts in the private hospital in Ciudad Juarez Chihuahua.

2. LITERATURE REVIEW

Most studies found are related to the subject are focused in public hospitals including Martinez and Lopez (2005), Poegner et al., (2008), Alcaraz (2006), Rodriguez, eta al., (2009) Gonzalez and Perez (2012). Among the studies that have been conducted in private hospitals are those of Balseiro, et al., (2007), Carrillo, (2010), about studies MME nurses are those of Waya and Changb, (2012), Briceño , et al., (2006), Fernandez et al., (2014), Ten (2007), Harrari, (2009). a study showing Burnout syndrome and its relation to the MME in Jaworek nurses found himself alone et al., (2010). Figure 2.1 shows the graph of the comparison of the studies foundFor Fernandez et al., (2002) describes the correlation as to find a most fitting and accurate mathematical measure to determine the degree of relationship between variables. Also is called as the regression mathematical process by which a mathematical in curve approaches the curve points

2.1 History of nursing

Cortina, (2011) shows a brief overview of the history of nursing in past centuries, care were offered by volunteers with little training, usually women of various religious orders, also nursing was considered an occupation of low status, only for those who could not find a better job, because of their relationship with disease and death. Modern nursing was the mid-nineteenth century by the arrival of schools of nursing Nightingale, this woman transform nursing education, establishing bases of modern character as formally recognized profession. Nurses have functions that must be carried out under the orders of a doctor and includes activities such as administering medication, bandaging, wound healing, grooming patients, poses patients to prevent contractures of patients

2.2 Burnout Syndrome

Rodriguez, et al., (2009) define the BS as a response to chronic job stress, integrated with negative attitudes and feelings towards people with whom you work and the professional role itself and be emotionally exhausted, this situation occurs frequently in health sector professionals or work directly with people.

2.2.1 Dimensions of Burnout Syndrome

Maslach and Jackson (1981). Emotional exhaustion is the key element of the syndrome, and concerns that individuals have feelings of being emotionally drained and overwhelmed in when their emotional resources. Depersonalization implies negative, cynical and impersonal attitudes, generating too distant to others feelings and, finally, the low personal accomplishment at work, which refers to decreased feelings of competence and success, as well as attendance to be evaluated negatively likewise, particularly in working with others.

2.2 Musculoskeletal Complaints

The MC of occupational origin according to Fernandez (2014) are alterations suffered bodily structures such as muscles, joints, tendons, ligaments, nerves, bones and circulatory system, caused mainly or aggravated by work and the effects of the environment in which develops. Most of the MC are cumulative disorders resulting from a repeated exposure over a prolonged period of time.

3. METHODOLOGY

This section describes the materials and methods used to carry out research shown.

3.1 Questionnaire of Burnout (MBI-HSS)

To measure the burnout syndrome questionnaire Maslach Burnout Inventory-Human Services Survey (MBI-HSS) Córdoba et was used. al (2011). This questionnaire is made up of 22 items which evaluated in three dimensions, which are formed as follows: emotional exhaustion (9 items), Cynicism (5 items), Personal Accomplishment (8 items). These three scales have high internal consistency, considering the degree of exhaustion as a continuous variable with different degrees of intensity. The Sahili et al., (2010) believes that although there is no cutoff scores clinically to measure whether or not the Burnout, high scores on emotional exhaustion and depersonalization and low personal accomplishment define the syndrome.

3.2 Body map for Musculoskeletal Complaints

To measure the musculoskeletal complaints body map of Marley and Kumar (1996), which indicate that the study sheds result in the assessment of the frequency and level of discomfort that comes to suffer the person in this study would be used the nurses.

3.3 Analysis Software

The software used for research were: SPSS (Statistical Product and Service Solutions) version 20 which is a statistical computer program that generates, charts and diagrams of distributions, descriptive statistics and statistical analysis. Microsoft Excel program was also used.

3.4 Important Concepts

For the study should take into account some points that make our research is valid these points are: Correlation and regression to what Fernández et al, (2002) describes the correlation as to find a most fitting and accurate mathematical measure, to determine the degree of relationship between variables. Also what is called regression is referred to the mathematical process by which a mathematical in curve approaches the curve points it is. We also need to use the validity It refers to whether the instruments used in the research measure or collect data that are supposed to measure. Another point is the reliability that is the degree to which an instrument produces consistent results. Bernal (2006) and finally the Alpha Cronbach according García-Bellido et al., (2010) is a model of internal consistency, based on the average of the correlations between items. Among the advantages of this measure is the ability to assess how improve or worsen the reliability of the test.

4. RESULTS

In conducting the questionnaire MBI-HSS reliability of Alfa Cronbach's syndrome usually Burnout was obtained is 0.786, as reliability for each dimension Table 4.1 shows the results was performed, the questionnaire of the MME shows an Alpha Cronbach of 0.957.

Table 4.1. Crombach Alpha by size of Burnout Syndrome

Dimensión	Number of items	Alpha de Cronbach
Emotional Exhaustion	9	0.755
Cynicism	5	0.530
Personal Accomplishment	8	0.879

With the result of burnout syndrome questionnaire in Table 4.2 shows the mean score per dimension. Table 4.3 shows their grades and scores dimension.

Table 4.2. Mean scores by size of Burnout

Burnout dimension	Mean
Emotional Exhaustion	1.6344
Cynicism	1.1204
Personal Accomplishment	4.4933

Table 4.3 shows both emotional exhaustion and cynicism at a low level and shows a high grade on personal accomplishment.

Table 4.3. Grades and scores dimension

Grades	EE	CYN	PC
Low	**(1.6344)**<7	**(1.1204)**<2	>24
Medium	7-12	2-4	18-24
High	12	>4	**(4.4933)**<18

To determine whether there is a correlation between burnout syndrome and MC Spearman correlation was used the result that there is a significant 99% between the dimensions of Emotional Exhaustion and MC eye, neck, legs, knees, calves, ankles, lower back, upper back, shoulder, forearm, wrist, hand, Cynicism and ME shows a correlation lower back by 99%. As there is a significant correlation of 95% between the dimensions of Emotional Exhaustion and MC forearm, wrist, hand these on the right side, Cynicism and MC shoulders, ankle and lower back. Table 4.4 shows the correlation between burnout syndrome and MC.

Table 4.4. Correlation between Burnout syndrome dimension and MC

	EE	CYN	PF
MD Eyes	.290**	.084	.194
MD Neck	.291**	.152	.150
MD Left shoulder	.201	.215*	.038
MD Left arm	.023	-.012	.006
MD Left elbow	.049	.055	.080
MD Left forearm	-.017	-.093	.054
MD Left wrist	.142	.184	.006
MD Left hand	.126	.110	-.008
MD Buttocks	-.011	.151	-.104
MD Left leg	.385**	.187	.149
MD Left knee	.288**	.201	.069
MD Left lower leg	.401**	.102	.107
MD Left ankle	.314**	.209*	-.005
MD Upper back	.355**	.114	.148
MD Right shoulder	.380**	.246*	.137
MD Right arm	.202	.073	.145
MD Right elbow	.108	-.007	.070
MD Right forearm	.222*	.056	.176
MD Right wrist	.243*	.057	.022
MD Right hand	.223*	.022	-.010
MD Lower back	.413**	.270**	-.002
MD Right leg	.456**	.195	.140
MD Right knee	.387**	.070	.014
MD Right lower leg	.474**	.121	.087
MD Right ankle	.272**	.122	.096

**The correlation is significant at 0.01
*The correlation is significant at 0.05
EE: Emotional Exhaustion
CYN: Cynicism
PF: Personal Accomplishment
MC: Musculoskeletal Complaints

In relation with MC those parts of the body with greater value in frequency of discomfort perceived by nurses were: lower back, upper back, eye, neck, leg, knee and ankle in both sides.

5. CONCLUSIONS AND RECOMMENDATIONS

This part presents the conclusions based on the objectives equally prevention and intervention techniques that can be applied in private hospital nurses are give.

5.1 Conclusions

Based on the first objective Spearman correlation shows significance at 95% and 99% confidence level between the dimensions of BS and MC. Referring to second objective was found not shown that nurses have the SB, because they show low grade on emotional exhaustion and cynicism and personal accomplishment showed high scores and the ultimate objective the methods applied were effective to determine the parts of the body where the MC occur most often.

5.2 Recommendations

As recommendations would implement strategies and programs to detect the burnout syndrome, the magazine Alto Nivel 2013, notes 7 signals that can help observe some of the symptoms of which are: physical and mental exhaustion, lack of concentration, poor health, lack of motivation, irritability, low productivity, poor social life. La nueva españa (2015) points out that you can use a relaxation technique that can be put into practice in the workplace consisting of relaxation exercises for 30 seconds in arms, face and legs this can help reduce stress it is accumulated throughout the day.

To which Lne (2015) emphasizes that a useful worker is not the most time spent, but the one that best uses its resources and is in the best physical and psychological conditions to develop their work.

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Resumen: El siguiente trabajo representa un estudio de campo, realizado dentro de las instalaciones de Continental Guadalajara en área de ensamble final de la división de Commercial Vehicles. Este trabajo fue enfocado a evaluar y mejorar un puesto de trabajo en particular llamado “Cerrado de unidad KW Cluster”, donde se presenta un riesgo hacia los operadores y posible enfermedad de trabajo. Por otra parte para la evaluación del puesto de trabajo se utiliza una herramienta interna llamada BDS (Exposure Documentation System), esta herramienta evalúa cada aspecto de la estación de trabajo, los movimientos generados por el operador, tiempo de operación y genera registro en 3 principales exposiciones: **Exposiciones físicas** (Postura cuerpo y cabeza, Movimiento del cuerpo, Manipulación de cargas, etc.), **Condiciones ambientales** (Ruido, Iluminación, Vibraciones, temperatura, etc.) & **Organización del trabajo** (Responsabilidad de personal, demanda de concentración, carga mental, operaciones repetitivas, trabajo de precisión, agudeza de la vista etc.). Una vez terminada la evaluación se obtiene el resultado y se trabaja en mejorar todos aquellos rubros que estén fuera de los límites máximos de exposición en la herramienta.

Palabras clave: BDS, Physical Exhibitions, Environmental Conditions, Labor Organization

Abstract: The following work is a real study conducted within the premises of Continental Guadalajara in final assembly area, Division Commercial Vehicles. This work was aimed at evaluating and improving a particular job called "Closed KW unit Cluster", which presents a risk to operators and possible work disease. Furthermore for the evaluation of the workplace an internal tool called BDS (Exposure Documentation System) is used, this tool evaluates every aspect of the workstation and the movements generated by the operator and generates record in 3 main exhibits: **Physical Exhibitions** (head and body posture, body movement, handling charges, etc.), **Environmental Conditions** (noise, lighting, vibration, temperature,

etc.) & **Labor Organization** (Personal responsibility, Concentration demand, Mental workload, Repetitive operations , etc.). After the evaluation is done the result is obtained and we start working improving all aspects with a bad result (out of the maximum limits of exposures) in the assessment.

Keywords: BDS, Physical Exhibitions, Environmental Conditions, Labor Organization

1. INTRODUCTION

The following work task show us how to identify risks and exposures in a work center and evaluate them based in an internally developed software in conjunction with Continental ASER Institute (Institut für Arbeitsmedizin, Sicherheitstechnik und Ergonomie), called BDS (Exposure Documentation System) . It´s a tool which help us to analyze the ergonomic risks of different jobs, get an overview of it, where the various characteristics can generate absenteeism or in the worst case a partial or permanent damage to the operators.
This software has the advantage, to perform assessments of physical exhibitions, environmental conditions, work organization, occupational safety, legal requirements and prevention measures previously detected.

1.1 Objective

Ergonomic risk analysis for physical exposures, environmental conditions, work organization, occupational safety, legal requirements and prevention measures previously detected in a particular work center (Closed Cluster unit KW).
Perform work place by evaluating and proposing improvements based on the software results.

2. ANTHROPOMETRICS

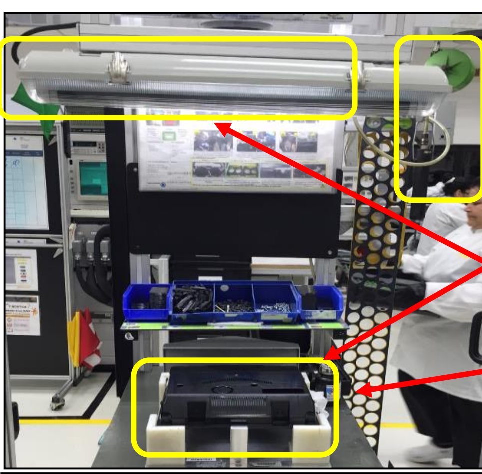
To evaluate workstation an internal anthropometric study must be done in order to define data from population inside location. The first step is to collect a sample from population for Commercial Vehicles division, and then our medical department collects measurements for different parts of the body.

With this data we are able to define height and size for different equipments to help operator to perform their job according to good practices on ergonomics.

Employee Number	Name	Age	Gender	Size	Eye height	Shoulder height	Elbow height	Flex Elbow height	Arm Front Range	Scope Lateral Arm	Vertical maximum range
32429583	LOZANO JIMENEZ MARIA YOLANDA	53	F	149	142	127	100	94	60	78	181
32428982	VALERIO LUNA IRMA	48	F	152	138	125	92	95	52	71	170
32417361	CASTORENA MEDINA MARTHA	59	F	152	138	122	90	93	55	32	182
32424905	ORIZAGA NAVARRO JUAN BERNARDO	41	M	154	137	129	90	93	53	70	176
32420154	ZAMORA FRIAS ABIGAIL	28	F	154	140	127	98	102	56	68	178
32426015	PLASCENCIA HERNANDEZ ALFONSO	46	M	156	155	136	107	101	64	79	192
32434918	RODRIGUEZ GUTIERREZ OLGA ELIZABETH	28	F	158	148	136	108	104	57	54	185.5
32433979	AGUAYO GARCIA ANYELO EMMANUEL	19	M	159	142	127	99	100	57	69	184
32434898	HERRERA VILLALOBOS MAYRA ELIZABETH	32	F	160	145	130	100	104	58	72	190
32435256	HERNANDEZ RODRIGUEZ MARIANA	26	F	164	146	136	100	104	56	74	194
324271266	ZEPEDA AVIÑA MARIA ELENA	38	F	164	150	134	101	107	56	68	186
32418979	RUEDA SALGADO LAURA PATRICIA	38	F	164	144	136	96	100	55	74	200
32000367	LLAMAS VELAZQUEZ MARI CRUZ	30	F	166	148	128	118	113	74	70	197
32426107	RUIZ ALVARADO MAGDALENA	41	F	166	149	134	103	107	61	72	194
32425402	IBARRA GOMEZ FAUSTO TRINIDAD	54	M	168	156	136	111	112	63	74	196
32431795	ROMERO REYES JOSE DE JESUS	37	M	170	148	130	113	104	78	76	200
32433139	LOMELI CHAVEZ VERONICA	34	F	170	160	142	110	112	63	73	216
32435263	HERRERA MARTINEZ DANIEL	28	M	174	154	142	107	110	65	82	210
32000351	SANCHEZ SANCHEZ MARIA TRINIDAD	32	F	180	168	150	123	114	68	67	212
32431933	CISNEROS CRUZ CYNTHIA KARELY	25	F	180	166	164	135	102	67	65	200
32424933	LOPEZ MAGAÑA MARIA ISABEL GUADALUPE	28	F	188	148	128	108	104	71	69	240
		Min value		**149**	**137**	**122**	**90**	**93**	**52**	**32**	**170**
		Max value		**188**	**168**	**164**	**135**	**114**	**78**	**82**	**240**
		Average		**164**	**149**	**134**	**105**	**104**	**61**	**69**	**194**

3. RESULTS

Image shows a poor example where screw driver and ultraviolet lamp is far away from working area and tools are not located in the right positions.

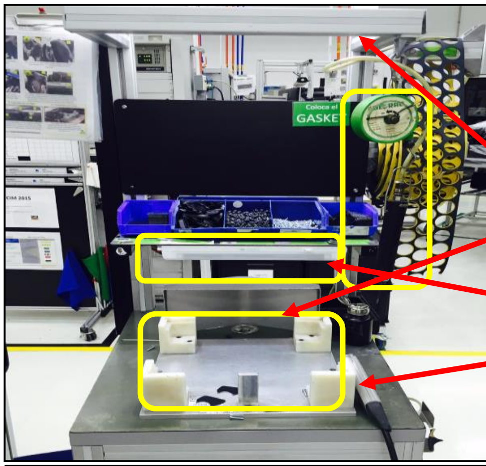


Poor example

- Screw driver far away from the working area and up of the operator shoulder (more than 130 cm).
- Screw driver cable with a high tension to operate.
- The screw driver is far away from the working area and is fixed to the base. There´s a holding activity more than 4 sec with high tension.
- Ultraviolet lamp with a high position.
- The mask must to be closer to the lamp to check the primer application on lens and the operator have to work

Figure 1 Poor example station Closed KW unit Cluster

Image shows a good example where screw driver and ultraviolet lamp is relocated and most parts of the working area is upgrade in order to reduce labor fatigue.



Good example

- Screw driver closer to the working area and does not exceed the shoulder operator position. Reducing too the cycle time of the screwing process
- Screw driver now is installed with a slide rail which helps to reduce the cable tension at the time of screwing.
- Now the screw driver can be slipped between the working area
- Small ultraviolet lamp in a lower position closer to the working (fixture) area and does not exceed the shoulder position high

Figure 2 Good example station Closed KW unit Cluster

After analysis of operation using BDS software, system evaluates different characteristics and calculate operator risk, the figure 3 shows the poor example and how system is showing the assessment of complete workstation.

According to the first evaluation we have 3 main problems, one of them is regarding physical exposures for example, body posture, movement's distribution and muscle dynamic work.

Also we have some troubles with the environmental conditions with illumination.

Table 1 Initial condition BDS Evaluation (Before improvements)

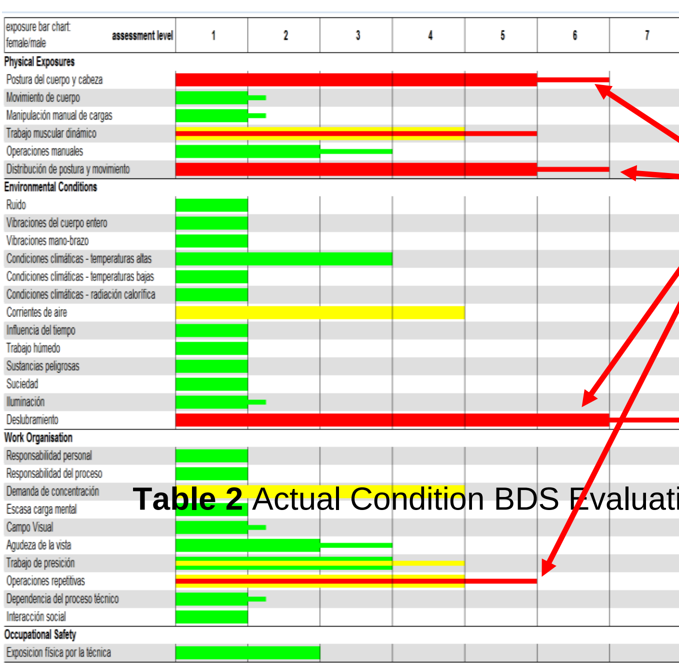
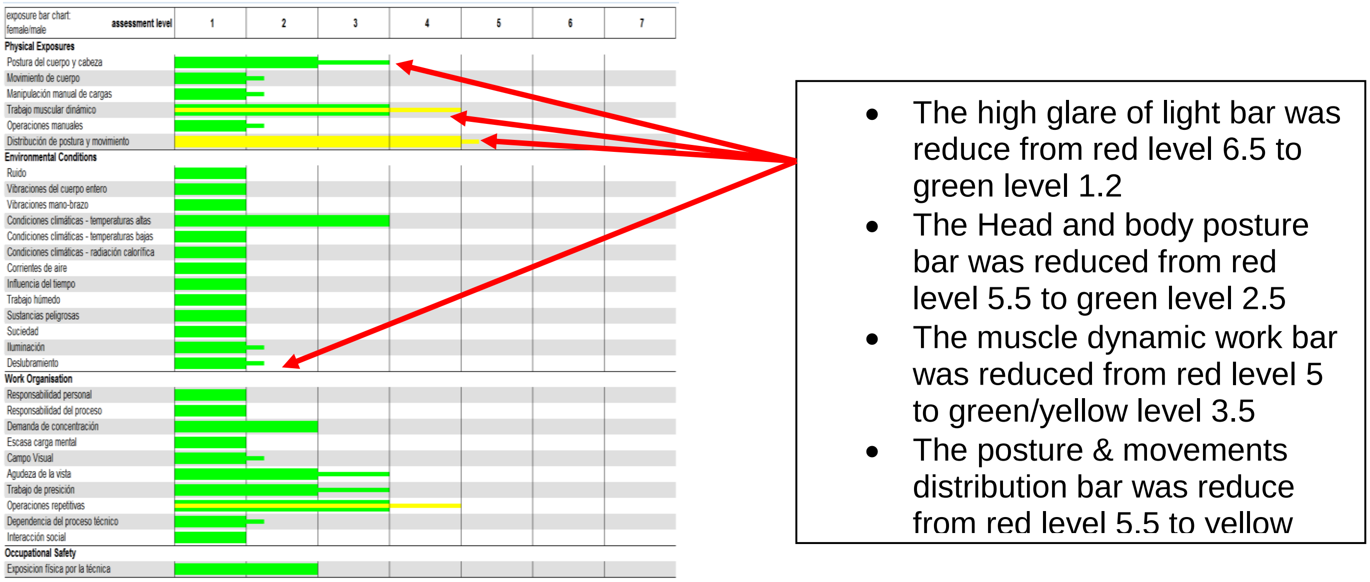


Table 2 Actual Condition BDS Evaluation (

- All red lines must be deleted before release Workstation.
  1. High glare of light
  2. Head & body posture
  3. Muscle dynamic work
  4. Posture & movements distribution
- Yellow ones can be handled with some special instructions.



4. CONCLUSIONS

Based on the results obtained by the Software (BDS) the work station was optimized eliminating the ergonomics risks detected that may affect the operator´s in a short or long term.

Firstly the work above shoulder height was removed from the operation, which can cause damage called "rotator cuff" disease. Equipments were relocated based on anthropometric tables made by our internal medical department.

Moreover the wrist rotation generated at the time of the screwing operation was reduced, which could generate in a long term a carpal tunnel syndrome.

Finally the high glare of the white lamp generated to the operator at the time of the visual inspection was reduced, in order to reduce eye strain and decreases visual acuity in a long term.

MUSCULOSKELETAL DISORDERS ... AN ERGONOMIC RISK FACTOR TEACHERS

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Resumen: Para contar la Organización Mundial de la Salud, un factor de riesgo es cualquier característica, característica o la exposición de un individuo para aumentar su probabilidad de contraer una enfermedad o lesión. En relación con este problema, la ergonomía emergencia como una disciplina científica se centró en la búsqueda de optimizar el bienestar humano, estos factores han ido disminuyendo; Sin embargo y por desgracia, uno de los sectores sociales, en menor medida en que se ha abordado en la educación.

Palabras clave: Trastornos, la ergonomía, Maestros

Summary: To tell the World Health Organization, a risk factor is any feature, characteristic or exposure of an individual to increase your chance of getting a disease or injury. In relation to this problem, the emergence ergonomics as a scientific discipline focused on seeking to optimize human well-being, these factors have been declining; However and unfortunately, one of the social sectors to a lesser extent it has been addressed is education.

Keywords: Disorders, Ergonomics, Teachers.

1. INTRODUCTION

Today, around the world it has become apparent that in the education sector one of the biggest risks of work are called musculoskeletal disorders. Disorders which largely stem from situations on many occasions by teachers imperceptible to the heavy workload, but generate long-term problems of both a personal nature and labor.

This problem has been evidenced through the work done by Tenti (2006), Montgomery and Rupp (2005), UNESCO (2005), Kyriacou (2001), Valdivia *et.al.* (2003), Hargreaves (1997) and Esteve *et.al.* (1997); As well as those of Parra (2007), van der Doef and Maes (1999), Mendel (1993) and Dejours (1990); since they agree that the problems related to mental health and discomfort in the teaching profession, are the result of the various changes that have experienced the educational process, coupled with the existence of a direct relationship of this process with the conditions labor. (Cornejo, 2009)

For its part, the European Agency for Safety and Health at Work (EU-OSHA, 2016) has established that musculoskeletal disorders are one of the diseases most common work- affecting millions of workers across Europe, which it costs billions of euros, and therefore recommends confront this problem to the benefit of both workers and employers.

This coupled with the above is that the teaching is not considered as a work in coming to trigger health risks; although this is one of the professions that for most of the time is subject to high levels of stress (Lozada, 2012). Conceptualization largely repeated in many other Latin American countries, Mexico is no exception.

2. OBJECTIVE

Analyze concerning musculoskeletal disorders as a risk factor in teachers, especially if one considers that the actor is not regarded as a worker.

3. METHODOLOGY

This work is developed based on the analysis of scientific literature, through which it was identified that, to achieve the objective must be addressed concerning the process of teaching work from ergonomics, ergonomic risks and of course the musculoskeletal disorders.

3.1 Ergonomics and occupational hazards in the process of teaching work

In its report on health in the world 2002 - Reducing Risks, Promoting Healthy Life, the World Health Organization states that a risk factor is any trait, characteristic or exposure of an individual to increase your chance of getting a disease or injury. Around it, a labor risk refers to the possibility that a person to suffer harm as a result of their work. (ESCUELA, 2011)

Now the work process and health have been the subject of analysis since ancient times, as in ancient Egypt, this situation was careful to maintain an efficient workforce and long term. In more recent times, this problem began to be attended when in 1919 through the Treaty of Versailles, the principles governing the OIT were established, and thus improve working conditions, as well as boosting medicine labor and give rise to occupational psychology, science latter, which would take charge of studying and researching the man at work, their relationships with others and their adaptation to the workplace. Subsequently, in June 1949, would England through Murrell, who would present all this activity under the name of ergonomics, a concept that would be adopted global way to the Ergonomics Society Rasearch created. (Melo, 2002)

Thus, from the point of view of ergonomics, for analysis of the work process and from it to identify the existence of risk factors need to be considered: 1) The means of work, ie, tools, machines, vehicles, furniture and fixtures; 2) The times and movements must develop the worker to meet the scheduled task; 3) The spaces allocated for the development of the activity, as well as methods or procedures; and 4) The working environment, made it by physical, chemical, biological, social and cultural factors in which is immersed the worker during working hours. (Ripollés, 1997)

Based on the above and putting under scrutiny teaching, this activity comes as prevailing conditions of work efforts in the respiratory system to the continuous use of voice and visual system due to lighting conditions and employment electronic equipment; static, dynamic physical and cognitive loads, where the first lies in taking long positions standing in the classroom, or seated in developing planning activities or study physical loads; the second, due to the need to mobilize or transport essential equipment or teaching materials; and third, as a result of a surprising ability of thought to address and respond to the needs of teaching practice; finally, a psychosocial adverse effect of overwork, long working hours, organization of activities and decision-making. (Lozada, 2012)

3.2 Musculoskeletal disorders as risk factors in the teaching work

As has been observed in the last paragraphs, the teaching faces a host of situations that may well affect both physical and mental health. Physics question being the most frequently affected or suffering evident early. In relation to this condition, known as musculoskeletal disorders, they are risk factors for increased incidence of anything that involves the process of teaching.

Punctually, musculoskeletal disorders are often changes in body structure of muscles, joints, tendons, ligaments, nerves, bones and circulatory system of workers, caused by overexertion and minor trauma following conditions inefficient work, specifically in what safety and health concerns. Which, in presenting the characteristic of being cumulative, may well lead to serious injuries in the medium and long term.

Even when the appearance of such disorders can take a long time, the manifestation of these begins with pain, discomfort, numbness, tingling or tingling, up to the loss of sensation, swelling in the joints, or decrease mobility and strength to grip objects. It is clear that, unlike muscle fatigue, the disorder musculoskeletal does not allow recovery with just rest because as mentioned, they have the characteristic of going to rise gradually and worsen with form over time.

On the other hand, it has been found that the occurrence of these disorders is not due primarily to the working media, because they are closely related to psychosocial, such as job stress, burnout and mobbing factors. Which, regardless of their origin, generate an atmosphere of emotional instability, and consequently, an overload in the soft tissues, as an increase in muscle tension.

Regarding the place of greatest impact on the human body, musculoskeletal disorders mainly affect the upper extremities (shoulder, elbow, wrist and hand), while on the back (back), they are presented both in cervical areas, thoracic and lumbar.

4. RESULTS

The following Table 1 shows the findings regarding those risk factors that give rise to musculoskeletal disorders in the process of teaching; while in Table 2, the diseases associated with these disorders are described.

Table 1. Risk factors that trigger MSDs in teaching.

Risk Factor	***Event***
Small Spaces	*The human body is forced to adopt stress positions, in addition to withstand higher mechanical loads to the contraction of muscles. Added to enter a state of anxiety and stress.*
Excessive Heat	*It generates a condition of fatigue.*
Insufficient lighting	*Induces to incorrect in order to display positions, besides an increase in ocular pressure.*
High Noise Levels	*Increases the level of both muscle tension and blood.*
Physical Capacity	*It allows faster development of having a disorder, or activate past injuries.*
Lack of Experience	*Promotes on physical effort.*
Clothing	*Adopt appropriate limits or comfortable positions.*
Smoking / Obesity	*Decreases body performance and taking appropriate positions.*
Organizational / Psychosocial Needs	*Promotes muscle weakness or loss of functional capacity, in addition to triggering a constant feeling of fatigue, permanent muscle aches, hypertension, migraines and headaches, digestive problems, lack of appetite, insomnia, general irritation, acute anxiety attacks, livid low, loss of sense of humor, inability to concentrate, emotional or unnecessarily aggressive responses and loss of confidence in one's ability.*

Table 2. Pathologies associated with MSDs in teaching

Pathology	*Description*
Muscular Fatigue	*Permanent contractions that prevent adequate oxygenation, producing fatigue in the first place and then pain.*
Lumbago	*Pain that appears in the lower back and drastically limits movement, with possibility to extend to the lower extremities. In most cases, this occurs as a result of poor posture or a violent effort.*
Lordosis	*Curvature of the lumbar and cervical spine, whose convexity is generally exaggerated anteriorly.*
Hiperlordosis	*Or the increase in the curvature of the spine, resulting from an alteration of normal values for many congenital and static or muscle imbalances.*
Kyphosis	*Abnormal curvature of the spine posterior convexity. In which case, when its value is excessive is called kyphosis and is considered to be pathological structural bone level changes.*
Scoliosis	*Side of the spine in the form of "s" deviation, taking higher incidence in females.*
Rheumatoid Arthritis	*Chronic and systemic disorder characterized by deformation of joints. It manifests with inflammatory, continuous pain that does not usually subsides with rest.*
Arthrosis	*Chronic degenerative disease that causes destructive alteration of joint cartilage, where overweight favors their appearance.*
Ankylosing Spondylitis	*Chronic rheumatic autoimmune disease with pain and gradual hardening of the joints. It often occurs with an inflammatory back pain with pain in the thighs and continues with a degeneration of mobility.*
Osteoporosis	*Bone disease characterized by decreased bone density and results in an exaggerated fragile bones. Affecting a larger percentage female.*
Discopathies	*Injury affecting the intervertebral discs of the spine, causing them to lose their cushioning properties. Examples are: herniated disc, vertebral subluxation and disc fissure.*
Spondylolisthesis	*Interruption of the earthquake that is in the area of the posterior arch of the vertebra, between the lower and upper facet joint.*
Carpal Tunnel	*Derived from excessive pressure on the median nerve in the wrist, which is responsible for sensation and movement. Capable of causing numbness, tingling, weakness, or muscle damage in the hand and fingers.*
Tendinitis	*Inflammation of a tendon usually due to a stroke or overexertion.*

5. CONCLUSIONS

Day by day, the number of reports concerning musculoskeletal disorders arising from teaching practice is increasing. Unfortunately, this activity is still conceptualized as a low-risk work.

In this situation, it will implement appropriate strategies, with the support ergonomics, possible to prevent an increase in diseases that are slowly affecting the health of those who have made teaching their way of life. Since, still it is time for educational institutions *-public or private-*, face the responsibility for its employees, as they depend to a large extent the continuity and quality of academic space.

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ANALYSIS AND MEASUREMENT OF INTERVERTEBRAL DISCS DEVIATION CAUSED BY MANUAL HANDLING MATERIAL.

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Resumen: Las Lesiones Músculo–Esqueléticas de origen laboral referenciados específicamente en la zona lumbar, representan uno de los problemas de mayor impacto negativo en la salud de los trabajadores, que llevan actividades de manejo manual de materiales y acciones repetitivas en su estadía laboral. Para el caso de la industria maquiladora y manufacturera localizada en el Noreste del Estado de Sonora, este tipo de problemas representan el 43% de las quejas y dolencias de los operadores. Situación que no se ha visto mejorada con la aplicación de medidas preventivas, correctivas, procedimientos ergonómicos para el manejo manual de cargas, el uso de soportes lumbares y los cálculos del máximo peso permisible. Por lo que se hace necesario complementar estas estrategias con un procedimiento enfocado a la terapia ocupacional no invasiva, que se estructura en una sustancial mejora de la postura del trabajador, a partir de la descompresión del disco intervertebral.

Para el desarrollo del proyecto se contemplan dos etapas, la primera consistente en el desarrollo de un instrumento de medición de las desviaciones de la columna vertebral y el procedimiento por medio del cual se lleva a cabo la medición.

Palabras clave: La manipulación manual, las vértebras.

Relevancia para la Ergonomía: Esta investigación establece un procedimiento para el análisis y la medición de las desviaciones del disco intervertebral que se permite desarrollar las acciones necesarias para el trabajador para minimizar el efecto negativo de la tarea en su estructura y por lo tanto mejora la calidad de vida, por lo al mismo tiempo la competitividad de la estación de trabajo donde funciona aumenta. Estas guías están diseñadas para mejorar las operaciones del factor humano lo que afecta e interactúa constantemente con los objetivos pragmáticos de la ergonomía.

Abstract: Musculoskeletal Disorders (MSDs), which are work-related, specifically referenced in the lumbar area, represents one of the major negative health impact of employees that carry activities of manual handling and repetitive actions in their working stay. In the case of maquiladora and manufacturing industries located in

northeastern Sonora, this kind of problem represents a 43% of the concern and ailments of the employees. This situation has not been improved with the application of preventive and corrective measures, ergonomic procedures for manual handling of loads, the use of lumbar supports and calculations of maximum permissible weight. So it is necessary to fulfill these strategies in a procedure focused on occupational and noninvasively therapy, which is structured in a substantial improvement in the position of the worker or employees from the decompression of the intervertebral disc.

For the development of the project two stages are contemplated, the first consisting of the development of an instrument for measuring the deviation of the spine and the process through which is carried out the measurement.

Keywords: Manual handling, Vertebrae.

Relevance to Ergonomics: This research establishes a procedure for analisys and measuring of deviations of the intervertebral disk that will allows to develop the necessary actions for the worker to minimize the negative effect of the task on its structure and thereby improves the quality of life, at the same time the competitiveness of the workstation where works increases. These guidelines are designed to improve the operations of the human factor which impacts and interacts consistently with the pragmatic goals of ergonomics.

1. Introduction

The research work was developed in the manufacturing industry and export, located in northeastern Sonora, specifically in those intermittent production lines with inline flows for their own requirements, was incipient need of manual assembly and handling of materials (Vazquez, 2012).

In turn, the preliminary study carried have identified a problem situation which is defined as: procedure absence of analysis and measurement for spine deviation caused through the manual handling material, on workstations that integrate intermittent production processes with inline flows.

This implies that the research effort established in this guideline, framing a pragmatic action on the targets and with that, achieve and establish a starting point and comparison, to design an ergonomic machine that manages to reduce the negative impact of assembly and manual material handling, from decompression of the intervertebral discs noninvasively. Procedure that is been performed on the overall conformation of the research project: Design of an ergonomic machine that will allow the decompression of the intervertebral disc.

2.Objectives:

Design a process of analysis and measurement of the spine deviation, caused by the manual handling of material.

Specific Objectives:

1. Elaborate the theoretical framework of the research based on the study of the epidemiological evidence of DME's, making emphasis on the spine lumbar area; risk factors and alternatives to evaluate the deviation of the intervertebral discs.
2. Develop phases of the process analysis and measurement for the deviation of the intervertebral discs.
3. Validate the procedure based on the statistical methods of concurrent and predictive assessment of developed measurements.

3.Methodology:

The scientific basis thereby validating this research is supported by the following set of research tools:

The analysis of the general to the particular, to define the characteristics of the object of study; from simple to complex to describe the causal relationship workstations under study and MSDs, observed particularly in the lumbar area; The analysis of the abstract to the concrete to the theoretical foundation of the scientific problem.

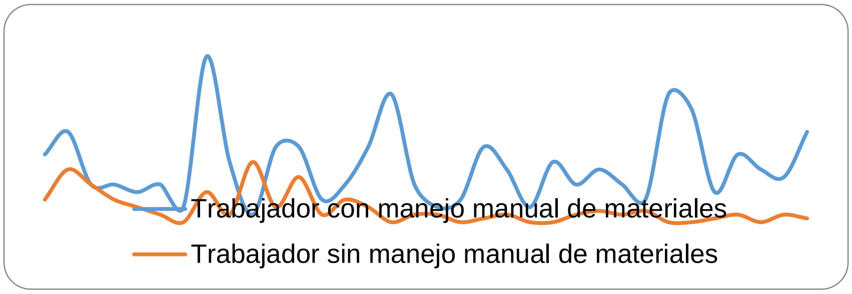
Method of analysis - synthesis, which is used throughout the research process for the review of the specialized literature and synthesizes results; inductive – deductive method, which is used to make generalizations about the object of study and to form the theoretical framework used as the basis for this investigation.

The methodological development of this research is to establish a mechanism that will allow the analysis and measuring of the spine deviation on its axis. This mechanism is directed to the scientific principles of posturology assessment (Ashby, 2003), however, it is necessary to design measurement instruments that will commensurate with the population under study.

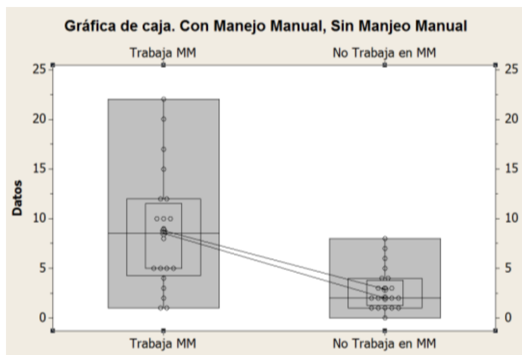
4.Results:

A set of applications of the analysis and measurement process were done during the project realization, which allow us to find the spine deviation and, at the same time to compare between the personnel that develops manual assembly jobs and the ones that doesn’t require that kind of actions.

The statistical analysis from the data shown: in its first case, in graphic 1 there is a bigger misalignment of the spine of the operators that in their daily assignment contemplate manual handling of material, compared to the ones that do not develop this kind of activities. In graphic 2 it is shown that the confidence interval at 95% defined in the first graphic, corresponding to the operators that perform the manual handling of material, contemplate the bigger variability in its measurements, and at the same time, there is a significant difference of bigger proportionality in this graphic, than the corresponding to the operators that do not do.



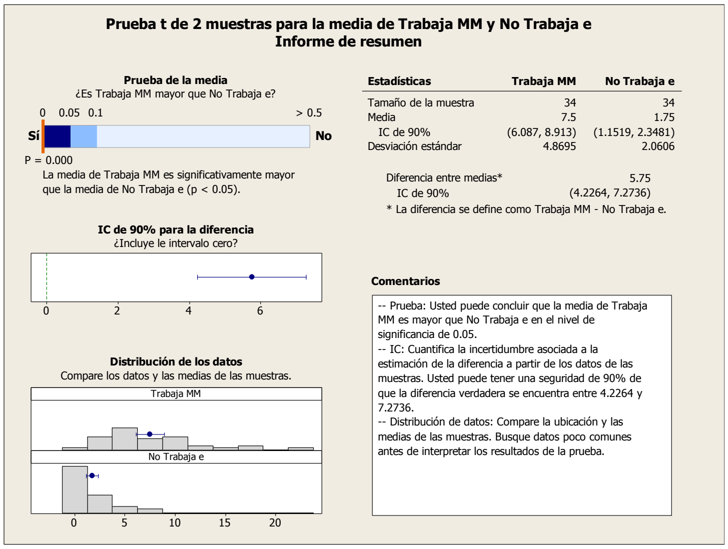
Graphic 1.



Graphic 2.

To reinforce the past analysis and watch the impact from the observational error at the measurement and other causes that could affect at the statistic difference between both samples, it is needed to do a hypothesis testing and a data intraclass assessment, that allow us to identify if the manual material handling factor is what is generating the difference between both study population data.

The following data of the hypothesis testing obtained from "Minitab" and the intraclass correlation coefficients obtained from "SPSS", graphic 3, develop enough statistic evidence to define that the difference shown by the operators that perform the manual material handling and the ones that do not develop this kind of activities data, is due to mainly manual material handling.



Graphic 3.

5. Conclusions:

The present investigations contemplate the usage of statistic tools of high impact that allow to infer with significant statistical sustentation, that the carry activities of manual handling and repetitive actions in their working stay are generating deviations in the normal spine alignment. The measuring process used with the template designed for both vertical and horizontal appraisal of the spine, shows concurrent consistency and validation.

In the investigative process develop at the current presentation findings are of high impact at the Musculoskeletal Disorders generation referred to the spine, specific at the lower back. Added to this, it is possible to stand out that established procedure for manual material handling, low back supports, and calculate the maximum allowable lifting weight, has not been enough positively impacted in the develop of tasks referred to manual material handling

According to the previously exposed, it is recommended to implement no invasive occupational therapy, which allow the intervertebral discs decompression and the spine alignment, thereby reduce the possibility that operators that carry out manual material handling activities build up a Musculoskeletal Disorder.

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CONDITIONS OF RISK AND UNSAFE ACTS IN WORKPLACE: CASE TOOL RECEPTION WAREHOUSE

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Resumen: En este trabajo se presenta un estudio de nuevos riesgos generados por los cambios laborales generados por las nuevas tecnologías y las nuevas formas de organización del trabajo; dando lugar al replanteamiento de sistemas preventivos que minimicen los nuevos riesgos, las nuevas amenazas y deterioros de la salud, tanto de naturaleza psicológica como psicosocial y física, en las que la Ergonomía tiene un papel relevante principalmente cuando se estudian factores biomecánicos y ambientales, se abordan los límites psicológicos y organizacionales para diseñar el puesto de trabajo.

El caso abordado en un accidente generado por la implementación de una maquinaria con nuevas tecnologías, pero sin una adecuación de la estación de trabajo, ni la capacitación del trabajador, el cual trabaja conforme sus paradigmas sin considerar las innovaciones implementadas. La metodología aplicada es un análisis de la Estación de trabajo, específicamente sobre el diseño de tableros y uso de herramientas.

Palabras clave: Nuevas tecnologías, riesgos potenciales, condiciones de trabajo.

Abstract: This paper presents a study of new risks generated by labor changes generated by new technologies and new forms of work organization is presented; resulting in the restatement of preventive systems that minimize new risks, new threats and deterioration of health, both psychological and psychosocial and physical nature, where ergonomics plays an important role especially when biomechanical and environmental factors are studied, are address the psychological and organizational boundaries to design the workplace.

The case addressed in an accident generated by the implementation of machinery with new technologies, but without an adaptation of the workstation, or worker training, which works as their paradigms without considering the innovations implemented. The methodology is an analysis of the workstation, specifically on the design and use of tools boards.

Keywords: New technologies, potential risks, working conditions.

Relevance to Ergonomic: The study contributes to the spread of knowledge and awareness of the importance of ergonomics in the design of workstations and production processes.

1. INTRODUCTION

Companies generally are dynamic places where there is always a rush to carry out the work and incorporating labor and environmental risks is a new social responsibility of companies in the prevention of health and conservation of the environment in which it operates. The study was carried out in an industrial plant, where they have implemented new production systems but do not have enough staff, so a single operator is multifunctional. In addition to that neck workplace was redesigned, they not are given training for operators. Consequently accidents have fallen and even mutilations cuts on fingers and upper extremities, conditions may qualify as unsafe and activity of workers also has many unsafe acts, not to apply the Official Mexican Standard NOM-019- STPS-2011, (STPS 2015).

2. OBJECTIVES

Achieving a prior impact assessment of the production process on potential risks through participation, training and information worker through adequate training and awareness.

3. METHODOLOGY

1.1 THE WORKSTATION.

The machine dimensions (7 x 5 x 2.40 meters), with a drive system and with an air extraction system is performed through two extractors that can evacuate about 17,000 m3 / hour. Thus it is obtained a pressurized cabin, ready to remove possible contaminants. Figure 1.

Figure 1. Workstation.

Operational tasks machining lasts on average 2 hours / day, the rest of the time to complete the eight hours, the operator is responsible to make the packaging of the pieces that have been processed, transport boxes incorporating the various pieces printed and other control tasks.

Figure 1. Work machining.

Production is carried out inside an industrial plant where an operator Figure 2. handles both the preparation of the tools and the own projection through a machine tool.

1.2 RESEARCH AND ANALYSIS METHOD USED: ERGONOMIC METHOD IBERMUTUAMUR, PARTICIPATORY METHODOLOGY.

In a simplified way, with this technique it is possible to relate in real time the behavior of the worker when carrying out their task with simultaneous risk level that is enduring. (Rosal Lopez and Iglesias 2011). Direct measurement instruments: environmental noise sensors, moisture, heat, lighting were used with cellular applications, these instruments are placed on the worker or the environment and are responsible for measuring risk exposure.
Internal Self-assessment methodologies individual or group reflection among participating organizations.
Joint procedures: Methodologies individual or group reflection among participating organizations.

4. RESULTS

Worker participation in risk analysis. Thus comply with current regulations; and increase the motivation of everyone involved and elaborate, from the complete documentation generated, strategies high quality training. Dry Temperature: 30 ° C, Globe Temperature: 32 ° C, relative speed 0.2 m / sec. Relative Humidity: 80%.

5.CONCLUSIONS

This understanding of the work and health prevention from Ergonomics raises other needs on training, training and monitoring of performance in specific work situations.

Although it has made great strides in this aspect, the mental representation we have of normal work from a technical offices, often at great physical and organizational distance between, usually have little to do with what happens on the ground. Regarding the resolution of incidents and anomalies, the lands as you can is the most common.

· Possibility of R & D in the field of prevention of occupational hazards.

· A process in which there is a broad consensus on the need and the active participation of those involved has more chance of success than a process that is questioned, either unidirectional or applied only by the opinion of others.

· All this, with minimal interference in the work activity, with the importance that this point has in achieving the commitment of all parties (Rosal Lopez & Iglesias 2011).

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MUSCULOSKELETAL DISORDERS RELATED TO ERGONOMIC CONDITIONS IN OPERATORS OF CONSTRUCTION IN BUCARAMANGA, COLOMBIA

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RESUMEN: El impacto que genera el aumento de la construcción en Colombia y el mundo, ha hecho que se mire con particular atención el comportamiento de las enfermedades que pueden padecer los trabajadores del sector. **Objetivo.** Ante el aumento considerable de Desordenes Musculoesqueléticos en el gremio, este estudio buscó determinar la prevalencia de estos y mostrar su asociación con las condiciones ergonómicas de la labor en nuestro contexto. **Metodología.** Se realizó un estudio observacional descriptivo, utilizando una encuesta aplicada a 48 trabajadores, seleccionados por conveniencia en una empresa constructora de Bucaramanga. **Resultados.** La prevalencia de DMEs es de 47,9% (n=23) manifestándose principalmente en la espalda seguido por el cuello y los hombros. **Conclusión.** La alta prevalencia de DMEs en la población de estudio amerita una revisión más profunda, donde se estudien factores como la variabilidad de la tarea en las labores de construcción, manipulación de carga y el mantenimiento de posturas prolongadas.

PALABRAS CLAVE: Ergonomía; Carga Física; Sector Construcción

RELEVANCIA PARA LA ERGONOMÍA: Siendo el sector de la construcción uno de los más sensibles a sufrir trastornos musculoesqueléticos, estudios ergonómicos permiten generar estrategias para tratar estos trastornos. La difusión de los datos estadísticos, proporciona un marco para los investigadores en el tema y, ciertamente, que les permite hacer comparaciones entre el estado actual de estos trastornos y su tratamiento en otros contextos.

ABSTRACT: The impact generated by the increase in the construction sector in Colombia and the world, has drawn the attention to the behavior of diseases experienced by workers in this sector. **Objective.** Considering the noteworthy increase of the musculoskeletal disorders in the trade, this study was aimed at determining their prevalence and show their connection with the ergonomic conditions of the work in our context. **Methodology.** A descriptive study was conducted using a survey of 48 workers selected for convenience in a construction company in Bucaramanga. **Results**. The prevalence of MSDs is 47.9% (n=23), manifested mainly in the back followed by the neck and shoulders. **Conclusion.** The high prevalence of EMDs in the population deserves a deeper revision, in which factors such as the variability of the task in the construction work, the manipulation of load, and the maintenance of prolonged postures are studied.

KEYWORDS: Ergonomics; Physical Load; Construction Sector

RELEVANCE TO ERGONOMICS: Being the construction sector one of the most sensitive to suffer Musculoskeletal Disorders, related ergonomic studies allow to generate strategies to address these disorders. The spreading of statistical data provides a framework for researchers in the subject and certainly it allows them to make comparisons between the current state of these disorders and their treatment in other contexts.

1. INTRODUCTION

The construction sector in Colombia continues to show an upward trend, its growth goes hand in hand with the increase in the number of workers therein; by May 2014 the construction took 6.1% of workers in the country and in the same month as employability was recorded in the sector in recent years (Ministerio de Vivienda, 2014). In this context an important fact stands out is that the accentuation of the phenomenon of construction can increase certainly figures MSDs of occupational origin, given the tasks involve, among others, lifting heavy loads and repetitive movements (National Institute for Occupational Safety and Health NIOSH, 2007), making it one of the sectors most likely with the highest chance of occupational disease in Colombia. At a global level, for instance, the European Union registered 3,160 musculoskeletal cases in the construction sector versus 2,650 per 100,000 workers of all productive sectors (Rosel Ajamil, 2012). These figures indicate the magnitude of a global problem that despite the implemented solutions continues to suffer consequences that might become highly incapacitating.

MSDs derived from work also register a high prevalence in Colombia; that is how the last Survey of Occupational Disease in Colombia gives as a result the Syndrome of Carpal Tunnel and the Non-Specific Low Back Pain as EMDs, consequence of their work and thus the ones that generated the most sick-leaves in companies (Ministry of Social Protection, 2007). The complexity and variability of the work tasks in the Construction make the evaluation of the risk of injuries difficult, for instance, the dorsolumbar ones, taking into account that their productive processes are not cyclic and that they have the influence of multiple variables (Cerda, Hernández Soto, Mondelo, Alvarez Casado, & Rodríguez, 2009).

A study by Bellorin and cols. (2007) in 89 workers shows that there is a high prevalence (67.4%) of musculoskeletal symptoms, especially lower back and shoulders; Vernaza and Sierra (2005) conducted a descriptive study of 145 construction workers and found an association between exposure to biomechanical risk factors and the presence of MSDs, indicating that forced work postures signify greater risk, also affecting daily life activities.

2. OBJECTIVE

Upon the increase in world records MSDs related to construction jobs, this study aims to give a look to the local context, with the purpose to determine the prevalence and looking to study correlations without involving fortuity.

3. METHODOLOGY

A descriptive cross-sectional study was done in a convenience sample of 48 workers of a construction company in Bucaramanga; the criteria for entering the study was based on workers operating with minimal labor contract of 6 months prior to the study and were excluded workers with musculoskeletal diseases of occupational origin recognized by the General System of Occupational Hazards of Colombia. An instrument was built by the adoption of the tools of the Technical Guide Epidemiological Surveillance System on Prevention of Musculoskeletal Disorders in Workers in Colombia (Gutiérrez-Strauss, 2008) and its fulfillment was made through a personal interview, whose data were processed in SPSS 22.0 package. Such instrument includes demographic data and information related to the organization of work, reports of symptoms, activities and positions in the work. Within the ethical considerations of this study, it was taken into account, among others, the use of informed consent and warranty of confidentiality of data identifying the participants and the company.

4. RESULTS

The results show that 39.6% (n=19) of workers serve as auxiliary of construction and 16.7% (n=8) as building officers, the remaining 43.7% are distributed in other positions as storage keepers and warehouse workers (4.2%), assistants of blacksmith (2.1%), assistants of ornamentation (2.1%), electricians (2.1%), assistants of structure (2.1%), friezes (2.1%), masonry (2.1%), spindles (4.2%), electrician (6.3%), official of structure (6.3%), machine operators (2.1%), crane operators (2,1%), plumbers (4.2%) and technical electricians (2.1%).

With respect to physical characteristics, 95.8% (n=46) are right dominant hand; as the body mass index 54.2% are within the normal range and a remarkable 39.6% (n=19) in overweight range, as it pertains to the position in this group mostly are construction helpers.

About the factors associated with their health condition, 4.2% (n=2) states that have suffered an illness related to their work throughout their life, 37.5% (n=18) have had an accident or incident with minor work-related injuries. In regards to the presence of medical history, 29.2% (n=14) state that they have presented general diseases in the last 24 months and 33.3% (n=16) have undergone some type of surgical intervention throughout their life. With regard to the prevalence of MSDs, 47.9% (n=23) states that felt a musculoskeletal symptom, where the back is still the structure more susceptible to discomfort, followed by the neck and shoulders (Figure 1).

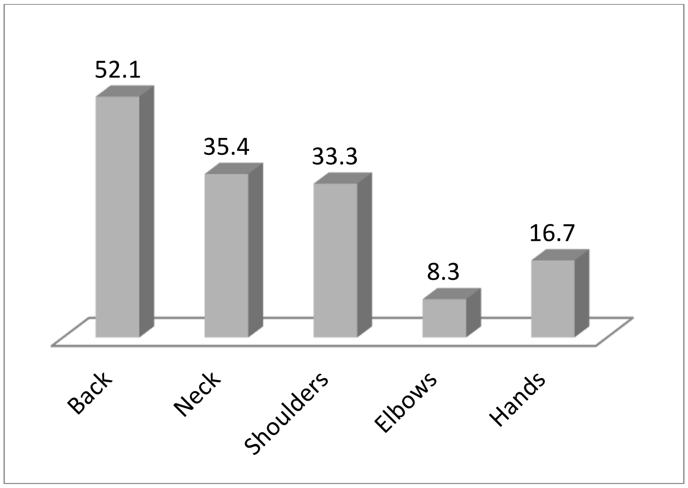

Figure 1. Distribution of symptoms depending on which part of the body they appear

It is observed equally high postural load in carrying out their tasks, stating that, repetitive movements, grasping and bad grips and non-performing breaks or pauses (Figure 2) are contained in almost all activities performed daily plus the fact that they must stand (91.1%) and walk (95.8%) for most of the day. In high-risk activities for MSDs, load (89.6%) and download (87.5%) are considered by workers as the highest prevalence within their tasks, which are associated with the onset of symptoms**.**

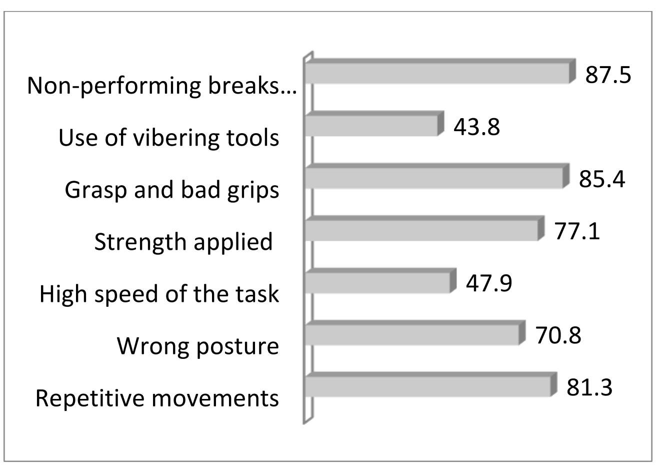

Figure 2. Risk factors present in the tasks performed

Finally, statistically significant association between the MSDs and the high-risk task of loading (P=0.003) was found, which corroborates this strong correlation, as mentioned in the Guide to Comprehensive Care Based on Evidence for Low Back Pain Nonspecific and disc disease related Cargo Handling Manual and other Risk Factors in the Workplace (Ministerio de la Protection Social de Colombia, 2006) and on which work on recommendations for prevention programs in this population of workers will be done.

5. DISCUSSION

The construction workers are particularly considered a susceptible population of developing MSDs, and as studies show in different contexts, the target population of this study shows the same trend. A particular phenomenon observed in this population is that the worker today is conscious of risk and risk factors, but controlling them is wasteful considering that within a work influenced by other components (for example: security) that prevails for them as workplace.

For this particular case, the prevalence sample, as in study by Bellorín, Sirit, Rincon, & Amortegui (2007) and those in Europe, a figure that exceeds 40%, therefore it can be said that we are facing an epidemic of MSDs in a population that requires special attention. Employers recognize the risks and although there are strong campaigns for identification, evaluation and control of them, the task itself, includes a thorough analysis and strengthening of standards that support sustainability of actions on prevention of musculoskeletal diseases.

6. CONCLUSION

MSDs associated with ergonomic conditions present and mostly unfavorable, construction workers, mainly present with symptoms of lower back pain. The high prevalence of MSDs in the study population merits further review, where factors such as the variability of the task in the work of construction, cargo handling and maintenance of prolonged postures are studied, with the urge to be more precise on the strategies, then to observe their impact once symptoms become manifest.

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DETERMINATION OF RISK IN THE PLACEMENT HELIOSTATOS FOR SOLAR PLANTS

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Resumen: En este trabajo se presenta una evaluación de riesgos generados en los trabajadores que colocan heliostatos en las Plantas solares se analizan las condiciones de postura y ambientales en que desempeñan su labor. Es una Investigación de tipo Transversal y los resultados se basan en un análisis y evaluación del estado actual de las condiciones laborales y características del trabajador, para analizar los factores de riesgo que existen dentro del área de producción y desarrollar una propuesta de mejora. Para realizar este estudio se utilizaron los Métodos Empírico, Método Normativo, Manejo de Cargas con el Método NIOSH y RULA. Para obtener información sobre el estudio de las condiciones de trabajo se llevó a cabo mediante fotografías de la actividad específica del trabajador. Además, se tomaron datos sobre equipos de trabajo para la evaluación adicional después de considerar el manejo de cargas. Los resultados muestran que es muy importante para el desarrollo de nuevos procedimientos, la reestructuración del puesto de trabajo y capacitación para los operadores con el fin de prevenir más daños y para introducir el conocimiento de la empresa de la importancia del cuidado de la salud.

Palabras clave: Lesión, riesgo, estructura corporal, lugar de trabajo

Relevancia para la Ergonomía: El estudio arrojó resultados donde la complejidad de la situación, se manifiesta que la solución es proporcionar un entorno flexible, donde el operador puede optimizar una forma específicamente adecuada de los procedimientos

Abstract: This paper generated a risk assessment is presented in workers placed heliostats in solar plants conditions posture and environmental carrying out their work are analyzed. It is a type Transversal Research and results are based on an analysis and evaluation of the current state of working conditions and worker characteristics, to analyze the risk factors that exist within the production area and develop a proposal for improvement. For this study the Empirical Methods, Regulatory Method Cargo Handling used with NIOSH Method and RULA. For information on the study of working conditions was carried out by photographs of the specific activity of the worker. In addition, data on work teams for further evaluation after considering handling charges were made. The results show that it is very important for the development of new procedures, restructuring of job and training for operators in order to prevent further damage and to introduce the knowledge of the company of the importance of health care.

Keywords: Risk, injury, work, body structure.

Relevance to Ergonomic: The study threw results where the complexity of the situation, manifests it might seem that the solution is to provide a flexible environment, where the operator can optimize a specifically suitable form of procedures..

1. INTRODUCTION

The man in an effort to accelerate their work and save effort has had to adapt your workstation due to the large amount of equipment and machinery that is imported from industrialized countries is not designed for the different physical characteristics that exist in different regions and countries; which increases with the use of new technologies such as heliostats that are defined as a set of mirrors on a large surface and move about one or two axes normally altazimuth mount allowing the movements appropriate to maintain the reflection of the solar rays impinging on it are fixed at all times at one point or tiny surface.

They are installed in open areas which means that installers will have to adjust to the environment and endanger their health due to poor posture and bad management tools have resulted in some workers' illnesses.

3. OBJECTIVES

1. Identify and describe the factors that affect the operator by ergonomic methods.
2. Establish clearly the degree of certainty that would bring with it the consequences of occupational health of the worker.

3. METHODOLOGY

3.1 Méthod NIOSH

Method Revised Equation NIOSH NIOSH aims to identify the risk of back pain that are associated with physical load they are subjected workers and to recommend a limit of appropriate weight for workers so that a percentage of the majority population do the task without the high risk of developing back pain. (Morales, Maldonado and Noriega 2015)

Using the Software for Method Revised Equation NIOSH ergonomic evaluation of NIOSH, to assess the handling of loads at work and identify risks appear low back pain associated with physical load and recommend a weight limit for anyone you can perform the task without the risk of injury, the necessary data are:

1. Weight of object (Average and Maximum)
2. Data source dimensions horizontal and vertical
3. Data on target dimensions horizontal and vertical
4. Data on the angle of origin and destination
5. Frequency at which this task is performed
6. Duration of the task
7. Quality Grip

The NIOSH equation of defining an "ideal uprising," that would be realized from what Niosh defined as "standard lifting location" and under optimum conditions; ie in sagittal position (no torso twists or asymmetric postures), making an occasional uprising, with a good grasp of the load and lifting less than 25 cm.

Other study believe that the constant load can take higher values (eg 25 kg.).

For jobs of more than 100 cm values should be reduced by 30% (if the person performing the task is female also should be reduced). (Melo 2009).

The equation calculates the weight limit NIOSH recommended by the following formula:

$$RWL = LC \cdot HM \cdot VM \cdot DM \cdot AM \cdot FM \cdot CM. \qquad (1)$$

1.2 RULA Méthod

The Rula method was developed by McAtamney and Corlett doctors at the University of Nottingham in 1993 (Institute for Occupational Ergonomics) to assess the exposure of workers to risk factors that can cause disorders in the upper limbs of the body: postures, repetitiveness movements, applied forces, static activity of the musculoskeletal system. (De la Vega 2011).

Recommendations for determining an acceptable workload for manual materials handling based on biomechanical analysis, covering various factors such as the weight of the load, the frequency of handling, the height at which you have to lift the load, distance from the load to the body and the physical characteristics of the person. (Laurig and Vedder 2010).

Figure 1. Operator clamping collecting angles.

Figure 2. Load material

4. RESULTS

Evaluation by the order in which the task is done is done. It was evaluated from taking the container until it low to the ground and as a result a high risk level (with score 8-10) was obtained and an action level of change is immediately necessary. After the uprising was evaluated from the container taking the final inspection station until place the pieces in the final container and as a result a medium risk of NIOSH equation was obtained.

5. CONCLUSIONS

Changes in the station at the height at which the operator manipulates the 1st container, performing one, changing the height of the container which was at the height to the floor knuckles were made. So it was manufactured extruded aluminum base to raise the container to 90 cm this to adjust the height and reduce the risk. Improve conditions gripping the load and use appropriate containers with handles or gripper systems.

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PROPOSAL OF AN ASSESSMENT TEST FOR THE PROMOTION, PREVENTION AND EARLY ONSET DETECTION OF THE LOW BACK PAIN SYNDROME IN RISK POPULATION.

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Resumen: El síndrome de dolor lumbar (SDL) es un trastorno que afecta principalmente a los trabajadores que realizan manejo manual de cargas (MMC) y es una de las causas más comunes de ausentismo en las empresas.

El objetivo del estudio fue determinar la precisión diagnóstica del test de flexión - extensión. Además, de probar su rendimiento en tres grupos: sujetos sanos, trabajadores con funciones que implican manipulación manual de cargas y pacientes con SDL diagnosticado actualmente bajo tratamiento.

Se utilizó un diseño transversal de cohorte. 118 sujetos, divididos en los tres grupos, fueron reclutados para realizar un cuestionario de índice de discapacidad y una prueba con electromiografía del test de flexión-extensión. La precisión diagnóstica de la prueba fue determinada por la curva ROC y el análisis de modelo logístico.

Los resultados del estudio validan el uso del test de flexión-extensión en el ámbito clínico para diferenciar a los sujetos que desarrollarán discapacidades debido al SDL de los que no tienen la instalación clínica de la patología lumbar. El modelo logístico, incluyendo las características demográficas fue capaz de clasificar correctamente a ~ 84% de los sujetos con un corte del 0,92 en el modelo de ROC.

La aplicación de la prueba de flexión-extensión en las empresas y el screening clínico permitiría identificar a los sujetos que pueden desarrollar SDL.

Además permitiría a las empresas generar herramientas para prevenir, promover e intervenir sobre el estado de salud de los trabajadores. La implementación del modelo de prueba en última instancia, mejorará la salud de los trabajadores y la productividad de las empresas.

Palabras clave: Región lumbar, dolor, electromiografía, fenómeno de flexión-relajación, diagnóstico.

Aportación a la Ergonomía: En la salud laboral la creación y validación de test diagnósticos que permitan una detección temprana del SDL se traducirá en una intervención oportuna, la cual maximizará la labor preventiva, cumpliendo con las metas sanitarias impuestas en relación a la prevención y tratamiento oportuno del SDL para disminuir el ausentismo laboral.

Es importante la publicación del artículo ya que propone una herramienta evaluativa que entrega una identificación y clasificación precisa de sus trabajadores, tareas y ambientes laborales, generando con ella alertas y vigilancia periódica para detectar cualquier evolución dañina y actuar antes de que la condición sea irreversible.

Abstract: The low back pain syndrome (LBPS) is a disorder that mainly affects workers performing manual load handling. This disorder is one of the most common causes of absenteeism in world companies.

The aim of the study was to determine the diagnose precision of the flexion - extension test applied. In addition, the study tests the performance in three groups: healthy subjects, workers with duties involving manual load handling and LBPS diagnosed patient currently under treatment.

A transversal cohort design was used. 118 subjects, divided in three groups, were recruited to perform a disability index questionnaire and a flexion extension electromyography test. Diagnostic accuracy of the test was determinate by ROC curve and logistic model analysis.

The results of our study validate the flexion extension use in clinical settings to differentiate subjects that will develop disabilities due LBPS from those who not even before the complete clinical installation. The logistic model, including demographic characteristics, was able to classify correctly ~ 84% of the subjects with a cut of 0.92 on the ROC model.

The implementation of the flexion extension test in companies and clinical screening would allow identifying subjects that may develop LBPS. In addition would allow companies to prevent, promote and intervene on individual workers health status. These test model implementation will ultimately improve workers health and companies' productivity.

Key Words: Lumbar region, pain, electromyography, flexion extension test, diagnostic.

Relevance to Ergonomics: The development and tested performance of new protocols to asses LBPS in work related environments, is highly relevant. An early detection of the LBPS onset will have an impact on preventive health, offering early treatment options that will decrease current absenteeism rates.

The aim of our research is to develop a precise quantitative tool to quickly identify and classify workers in their work environment. Thus a periodic screening to detect the onset of LBPS will report benefits for both, companies and workers. Probably even avoiding the chronic installation of the syndrome.

Introduction

The LBS is a highly prevalent musculoskeletal disorder. It is estimated that around 80% of the adult population will or have experience at least one episode of SDL with an effect over their functionality (Warfield & Fausett, 2002). In USA, LBPS is the second cause of absenteeism having an impact over national production (Warfield & Fausett, 2002). At a global scale, 37% of the musculoskeletal disorders of the lumbar region are related to the work that people performs (Punnett et al., 2005). Within work activities, load manual handling is the one with the highest incidence and prevalence rates of LBPS (Punnett & Wegman, 2004). The Chilean national survey of employment, work, health and life quality (Min. Salud, 2009) shows that 8.9% of the population presented at least one episode of LBPS during the last 12 months. Studies reports that 73% of new full time workers with load handling present new episodes of LBPS in short terms (Punnett & Wegman, 2004). The evidence strongly suggest the lack of sensitive criteria for an early diagnose, treatment and discharge of patients. In addition, the recurrence increases with age relative to the first episode of LBPS (Donelson, McIntosh, & Hall, 2012). Chilean national statistics situate the LBPS as the third highest diagnose among its population. This incidence rates encourage the development of the Chilean “technical guideline for assessment and control of risks related to manual handling” (Min. Salud, 2008). Thus suggesting the need of new strategies to control the LBPS.

From the 70’s the use of EMG has been described as many studies focused on the biomechanical and electrophysiological aspects of the LBPS (Cobb, deVries, Urban, Luekens, & Bagg, 1975). Research has report of early changes in the EMG activity of the low back muscles, changes that occur in bot temporal and frequency dimensions when compared with healthy subjects (Alschuler, Neblett, Wiggert, Haig, & Geisser, 2009). Results from this areas are encouraging, a recent study clarifies with precision which most likely are the adequate signal processing procedures to use EMG as diagnostic tool in LBPS, as conclusion the use of a flexion extension test and an EMG ratio from this phases are the most adequate procedures with a sensibility of 0.91 for LBPS.

The flexion extension test was first described by (Floyd & Silver, 1951), it is described as a muscle activation patter during a maximal trunk flexion and its way back to the initial standing position. The test have shown robustness among trials and sessions for healthy subjects as for LBPS patients (Othman, Ibrahim, Omar, & Rahim, 2008; Sihvonen, Partanen, Hänninen, & Soimakallio, 1991). Healthy subjects and patients has shown differences in EMG activation patterns, being a higher activity of patients during the flexion extension test the most noticeable; where patients shows activity during the silent phase of the test (Golding, 1952; Kaigle, Wessberg, & Hansson, 1998; Paquet, Malouin, & Richards, 1994; Shirado, Ito, Kaneda, & Strax, 1995).

The aim of our research was to determine the diagnostic precision of the flexion extension test, through surface EMG, for the early detection of the LBPS by applying it in healthy subjects, workers with load handling and patients under treatment. In addition we will compare flexion extension test results among the three groups in study. Determine the diagnostic precision, as sensibility, specificity and likelihood ratios, of the applied test. And finally determine the predictive capacity of the applied test, including demographic and anthropometric variables from the measured groups.

Methods

A transversal epidemiologic study was performed, the sample was compose by three groups: Healthy, at risk and LBPS patients.120 subjects were recruited by convenience, based on an expected sensibility of the test of 80% and a 40% prevalence across subjects with a precision of 0.1 and a 0.05 alpha error. All procedures were approved by an ethics committee (ACHS) and all subjects were informed of the risks and benefits of the research and signed and informed consent form.

The flexion extension test was applied to all subjects to classify them as either healthy or under a LBPS process. The researcher were blind to the analysis with different forms for the personal information to which the researchers did not had access during the analysis of the data. To first classify the subject in the two mentioned groups, a gold standard was defined as a positive clinical examination and the result of the Oswestry survey (OS) (Fairbank & Pynsent, 2000). The classification results of the EMG test were compared with the gold standard classification, thus the diagnostic precision was determined allowing the calculation of sensitivity, specificity and likelihood ratios

The criteria used to classify the subjects subject as healthy was defined as those who does not report any pain or discomfort and do not perform manual load handling; In addition a 10% score or less was required in the OS. The risk subjects group were those who performed load manual handling task in their works in a daily basis. Finally the LBPS group were those currently under treatment for LBPS and were diagnosed by a medical doctor or either present a >10% score in the OS. The OS based classification was made to reassure that subjects with different levels of LBPS progression and symptoms were included in the LBPS group, preventing spectrum blindness (Whiting et al., 2004) and improving diagnostic accuracy results(Fritz & Wainner, 2001; Whiting et al., 2004).

During the flexion extension test the low back muscle are tested in eccentric activity in its first phase, secondly during maximum flexion the muscle activity is decreased, and finally involves isometric contraction when subjects return to the initial position (Alschuler et al., 2009). EMG signals were recorded (Delsys, Myomonitor IV) during the execution of the test. Signal were acquired bilaterally from rector spinae and multifidus muscles. The skin preparation and electrode position was in accordance with the SENIAM (Hermens et al., 1999) recommendations. Single differential electrodes with an interelectrode distance of one cm. were used. The signals were recorded with a 1024 Hz sampling rate, bandpass filtered (2nd order zero lag 10-400 Hz - 50 Hz stop). The signals were normalized to the maximal voluntary contraction MVC and low pass filtered (6 Hz) to obtain an envelope of the signal. To finally obtain the flexion extension index, the ratio of the mean activity during the flexion phase was divided by the mean activity during the extension phase of the test. All the analysis were performed with MATLAB (Mathworks).

Statistical analysis

To determine the existence of differences between the group variables a MANOVA test was used. To stablish the diagnostic precision of the EMG and determine the test threshold value, either combined or independently for each muscle, a ROC curve analysis was performed for each test. The ROC curve determines the sensibility, specificity, and likelihood ratio and discriminant capabilities of a given test. The discriminant capabilities are given by the calculated area under the curve (AUC) from the ROC analysis, which is used as an index (Bewick, Cheek, & Ball, 2004). The test threshold to classify the subjects in either healthy or with LBPS, was determined as the point within the ROC analysis where both the sensibility and specificity reach their maximum level.

Finally a logistic regression analysis was performed using the flexion extension test, demographic variables were added to determine the impact of the latter on the test prediction capability. All the statistical analysis were performed with SPSS 22 and STATA 12.

Results

From 172 recruited subjects, a total of 118 subjects were included in the analysis. Excluded subjects presented either bad signal quality or were not able to perform the required tasks. The analysed subject were classified as 40 healthy subjects, 40 at risk and 38 as LBPS patients (Table 1).

Table 1.Descrptive statistics of demographic data for the three groups Healthy (S), Risk (R) and low back pain (LBPS).

	Group	Mean	SD

Age	S	21.58	2.241
	R	43.02	11.45
	LBPS	45.89	15.15
Weight (kg)	S	69.70	11.47
	R	78.92	11.29
	LBPS	72.61	14.50
Height (cm)	S	170.07	7.91
	R	169.73	7.36
	LBPS	165.61	9.46

Significant differences were found for all the anthropometric variables, age ($p<0.001$), weight ($p=0.004$), height ($p=0.034$). The risk and LBPS groups were higher in age, weight and of a minor height than the healthy group.

There were also significant difference when the sample was classified as either healthy or LBPS. This differences were present in age ($p<0.001$) and height ($p=0.022$), were the healthy group was younger and taller. Although the weight was similar between the groups.

Table 2 Demographic data of the sample when divided in only two groups, Healthy and LBPS.

	Group	Mean	S.D
Age	S	30.10	11.81
	LBPS	43.72	15.77
Weight (kg)	S	74.31	12.59
	LBPS	73.18	13.45
Height (cm)	S	170.23	7.72
	LBPS	166.68	8.86

MANOVA analyses found significant differences in the flexion extension test EMG data across all groups. LBPS group presented a significant decrease in the calculated ratio when compared with the risk and healthy group ($p<0.01$)[1] Table 3 and 4.

Table 3: Descriptive statistics of the calculated flexion extension test index for each muscle and the three groups.

	GROUP	MEAN	SD
FLX - EXT Ratio R. Multifidus	S	3.24	0.94
	R	2.99	0.84
	LBPS	1.84	0.44
FLX - EXT Ratio R. E. Spinae	S	4.60	1.42
	R	3.54	1.11
	LBPS	2.16	0.72
FLX - EXT Ratio L. E. Spinae	S	4.53	1.26
	R	3.59	1.06
	LBPS	2.17	0.77
	S	3.17	1.08

FLX - EXT Ratio L. Multifidus	R	3.02	0.90
	LBPS	2.03	0.55

Table 4: Descriptive statistics of the calculated flexion extension test index for each muscle when the sample was divided in two groups, Healthy and LBPS.

	GRUPO	PROMEDIO	D.S.
FLX - EXT Ratio R. Multifidus	S	3.25	0.90
	SDL	2.11	0.67
FLX - EXT Ratio R. E.Spinae	S	4.25	1.39
	SDL	2.60	1.10
FLX - EXT Ratio L. E.Spinae	S	4.19	1.31
	SDL	2.66	1.08
FLX - EXT Ratio L. Multifidus	S	3.25	1.04
	SDL	2.22	0.63

ROC curve analysis results are shown in Table 5. The test scored a good performance in all the assessed muscles to detect LBPS. The AUC (Fig. 1) was of 0.82 - 0.86 indicating a good discrimination for the flexion extension test to classify correctly those people with LBPS.

Table 5: Roc Curve analysis results for each muscle.

TEST	THRESHOLD	AUC [95%CI]	SENSIBILITY	SPECIFICITY	CORRECT CLASSIFICATION (%)	LR+	LR-
FLX - EXT Ratio R. Multifidus	2.45	0.86 (0.79 - 0.93)	81.97%	78.95%	80.51%	3.8934	0.2284
FLX - EXT Ratio L. Multifidus	2.53	0.84 (0.76 - 0.91)	85.25%	70.18%	77.97%	2.8582	0.2102
FLX - EXT Ratio R. E.Spinae.	3.34	0.82 (0.75 - 0.89)	68.85%	80.70%	74.58%	3.5678	0.386
FLX - EXT Ratio L. E.Spinae	2.64	0.83 (0.75 - 0.90)	96.72%	59.65%	78.81%	2.397	0.055

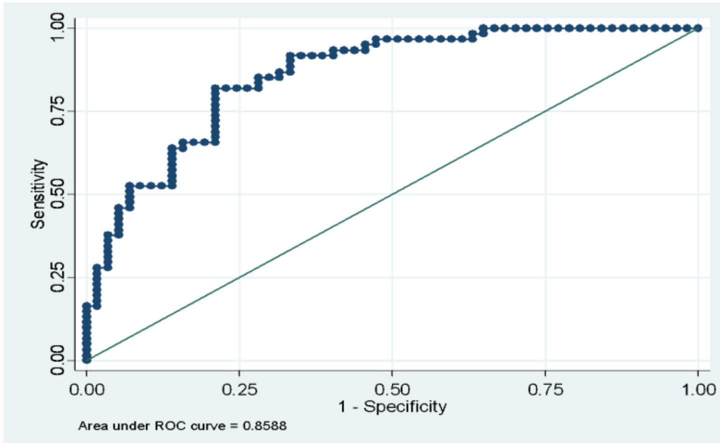

Figure 1.ROC curve analysis of the R. Multifidus muscle during the flexion extension test.

A logistic model was developed to obtain the optimal combination of the measured variables, the purpose is to determine the subject group in either healthy or with LBPS. In the same direction an individual model was constructed and compared for each pair of homologues muscles. The latter two models did not differ from each other (Prob>chi2=0.5) fig 2) this can be interpreted as they had the same discriminant potential.

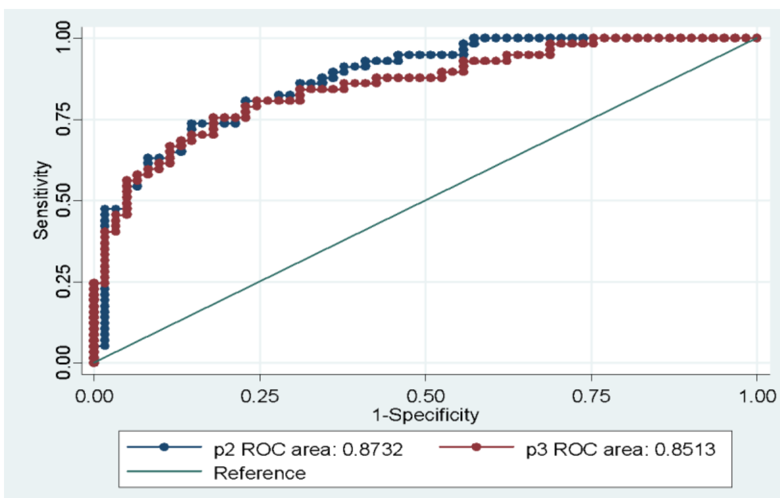

Figure 2. AUC comparison of the two models, in blue is the model only considering the multifidus muscles, in red the model for the erector spinae muscles.

After, another two models were tested. The first included all four muscles and the second included all muscles and the demographic variables. The demographic variables provided a slight increase in the test performance, as AUC value, from 0.89 to 0.92. Nevertheless he models did not showed significant differences (Fig 3). This model make a good classification of the subjects (84%), the 0.92 of discrimination is considered as excellent performance. Sensibility and specificity were of 82.5% and 85.3% respectively.

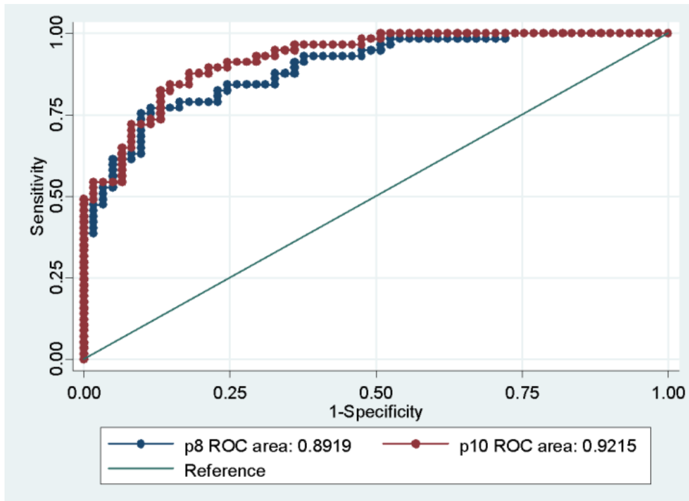

Figure 3. The logistic model comparison of all four muscles (blue) against the model including all muscles and demographic variables.

Discussion

Our research main finding is that the flexion extension test can be used successfully to identify healthy subjects from those suffering of a LBPS process at any stage. These classification could be performed in early stages of the syndrome development allowing to intervene in the process and prevent absentee and further detriment of people health status ultimately this could lead to improve the pathology prognostic. The analysis of the logistic models suggest that the solely inclusion of the flexion extension test of the four tested muscles is enough for an effective classification. Is important to remark that a correct data analysis is essential to achieve these results several other outcomes can be calculated from the EMG signals of the test, but different processing will achieve other results. Thus, the use of a ration between the flexion and extension phases mean activation amplitude of the test is proposed as the most effective calculation to use the test in a clinical setting.

Giving the high impact of the LBPS on workers with manual handling loading, these findings allows to suggest a high applicability of the test within ergonomic assessments. The flexion extension test proved to be highly sensible and discriminant to differentiate healthy subjects from LBPS patients. The inclusion of the test in companies as a periodical health screening will allow to individually determine the health status of each of the proposed low back muscles. Thus allowing the implementation of preventing measurements focused on those workers with increased risk. Among applications of the test, it would be possible to use to identify fake health status claims across workers.

Within a legal point of view within ergonomics, the employee is currently obligated to implement strategies of prevention and supervision, aimed to protect and preserve the workers' health status. This is a special case for the LBPS were employees are obligated to provide safety plans; stablishing guidelines, educate and inform workers about manual handling and supervise the correct performance of the work, among several others. Thus, the risk of LBPS could be more effectively approached with the proposed classification test, implementing general screening program. Providing benefits for the company, insurance and workers by a more complete and precise report of the current health status. Is important to notice that the test takes about 10 minutes to be completed after proper training and planning, suggesting a good cost benefit relationship.

Conclusions

Our research demonstrate the flexion extension EMG signals can be used as a diagnostic tool, highly sensible for the LBPS. With low costs, time of execution, analysis and interpretation of the results, with the proper setup results could be obtained in real time. These characteristics make the flexion extension test a promising tool to assess subjects within the work environment, especially for workers with manual load handling.

The correct use of the test as a screening method could lead to the development of new strategies for early intervention and prevention of the instalment of the LBPS. Ultimately this will produce a better risk management and could be implemented as a physiological biomechanical model intervention for the work places.

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ERGONOMIC ANALYSIS OF THE OPERATIONAL STAFF OF A TELECOMMUNICATIONS COMPANY IN THE STATE OF CHIAPAS.

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RESUMEN: La salud ocupacional en nuestro país requiere de investigaciones sobre ergonomía, para prevenir y tratar lesiones musculo esqueléticas. Actualmente en México, no se tienen datos sobre el riesgo ergonómico postural en que se encuentra el sector laboral de nuestro país. Por lo tanto, el presente trabajo se realizó en una empresa de telecomunicaciones, para conocer el nivel de riesgo ergonómico postural en que se encuentran sus trabajadores, por medio de la observación de los ciclos de trabajo, aplicación de un cuestionario, y la evaluación de las posturas por medio del método RULA. Se registraron los siguientes resultados; 100 % de los trabajadores manifestaron molestias, la principal molestia fue dolor de cuello, 80 % con sedestación. Postura estática, ya que se mantuvo por más de 60 minutos. De tal forma que, la puntuación final promedio RULA fue de 6 y el nivel de riesgo de 3. Por lo tanto, es necesario ampliar el estudio ergonómico, pero hacer modificaciones pronto para mejorar las posturas y prevenir o corregir lesiones músculo-esqueléticas (contracciones) en la zona lumbar y cervical.

Palabras clave: Ergonomía, postura, salud ocupacional, método R.U.L.A.

Relevancia para la Ergonomía: Los estudios descriptivos proporcionan datos sobre la frecuencia y distribución de los problemas musculoesqueléticos que apoyará a la gestión de normas para proteger a los trabajadores y aumentar la eficiencia en los negocios

ABSTRACT: Occupational health in our country requires research on ergonomics, to prevent and treat muscle skeletal injuries, currently in Mexico, there is no data on postural ergonomic risk that the labour sector of our country is. Therefore, this study was conducted in a telecommunications company to know the level of postural ergonomic risk that their workers are, by observing the work cycles, a questionnaire, and evaluation of positions through RULA. The following results were recorded; 100% of employees expressed discomfort, the main complaint was neck pain, 80% were seated. Static posture as held for more than 60 minutes. As a result the average RULA final score was 6 and the risk level of 3. Therefore, it is necessary to extend the ergonomic study, but soon make modifications to improve posture and prevent or correct musculoskeletal injuries (contractions) in the lumbar and cervical area.

Key words: Ergonomics, Posture, Occupational Health, RULA method

Relevance to Ergonomics: Descriptive studies provide data on the frequency and distribution of muscle skeletal problems that will support the management rules to protect workers and increase efficiency in business

1. INTRODUCTION

According to the World Health Organization (WHO), occupational health should promote and protect workers' health in their working environment, controlling environmental factors or activities that threaten the worker (Barrios and Paravic, 2006). Being a public health issue, because diseases and accidents at work have adverse implications for the country, industry, society and family: low productivity, high costs for medical care, hospitalization and compensation to injured or sick worker, economic problems and other for families (Alvarez and Kuri-Morales, 2012). One of the major adaptations for being at work, is the position. Comprising the analysis of anthropometry and biomechanics of the worker, in order to establish preventive measures that create a state of muscular and skeletal balance, protecting the body's supporting structures against injury or progressive deformation regardless of the position. Conditions that cause increased muscle performance and consequently higher labor efficiency (Philippe, 2001).

The occupational health laws and regulations required by a government office to be observed by employers and employees (Alvarez and Kuri-Morales, 2012). However, in Mexico, there is virtually no timely legislation ergonomics, so they do not know specifically the injury statistics in working life and workplaces. According to the Society of ergonomists Mexico A. C. (SEMAC) penalizing companies for accidents, injuries and diseases for ergonomic reasons does not exist.

To build spaces that allow the formulation of rules and laws that promote the prevention and control of health-disease process ergonomic, ergonomic research is needed in Mexican companies.

This research attempts to answer, What is the risk of musculoskeletal injury to the jobs in Comunicación del Sureste del Estado de Chiapas enterprise? RULA is the method to identify the existence of causes that could lead to cumulative trauma disorders (McAtamney and Corlett, 1993).

2. OBJECTIVE

Analyze the position of the operating company personnel telecommunications southeastern state of Chiapas, through the method R.U.L.A.

3. METHODOLOGY

The study was carried out with authorization granted by the company's manager, he asked us to omit company's name, for confidential reasons.

The study was observational; transversal, descriptive. A non-probability sample was used, with two inclusion criteria; be operational employee of the company and be willing to provide their data. The sample consisted of 10 workers (50% of total workforce), to which we explained the purpose of the investigation and the confidentiality of their information.
1) A structured approach questionnaire was applied determining seniority, hassles, pain degree, type and time position, which can generate or exacerbate musculoskeletal disorders. 2) Application of RULA (Rapid Upper Limb Assessment) method. The proceeding under RULA was as follows: a) duty cycles was determined and found to work during these cycles; b) the positions taken by the workers was selected and photographs were taken by plane: frontal, sagittal and transverse; c) both sides of the body were evaluated; d) the score for each body part was determined using the field sheet proposed by the FRBA (Facultad Regional Buenos Aires, National Technological University); e) the final score per worker and total workers average, as well as the levels of action average was obtained to determine the existence of risks. 3) The results were captured and analyzed using SPSS software v. 20, with a confidence interval of 95%, to establish graphs and tables.

Table 1. Level of risk and actions to be taken as the final score

Action level	RULA score	Interpretation
1	1-2	The person is working in the best posture with no risk of injury from their work posture .
2	3-4	The person is working in a posture that could present some risk of injury from their work posture, and this score most likely is the result of one part of the body being in a deviated and awkward position, so this should be investigated and corrected.
3	5-6	The person is working in a poor posture with a risk of injury from their work posture, and the reasons for this need to be investigated and changed in the near future to prevent an injury
4	7+	The person is working in the worst posture with an immediate risk of injury from their work posture, and the reasons for this need to be investigated and changed immediately to prevent an injury

4. RESULTS

Out of 10 workers analyzed, it was found that 80% had a sitting position as head posture, keeping this position for more than two hours in 60% of workers, see figure 1. The results of the questionnaire showed that all workers expressed submit any musculoskeletal discomfort, mainly neck pain (60%), see figure 2. However, during field observation and analysis of the photos by applying the method RULA, the data indicate that there is more tension on the neck and lower back, see figures 3 and 4. The lower back pain and a half, is a condition strongly associated with occupational risk factors (Gallegos and Maldonado-Macías, 2011; Piedrahita

2008). According to Pacheco and Sirit (2008), an ergonomic study to administrative staff in the sitting position, the predominant symptom was musculoskeletal pain located mainly on the upper back, neck and lower back. The final score obtained of R.U.L.A. method was 6, this value allows us to establish the level of risk for the average of the company's workers. The risk level found was 3, indicating to be changed soon posture and expand research (see Table 2). These data coincide with those of Medina et al. (2008), who reported a risk level 3 for workers in clerical positions in a manufacturing company.

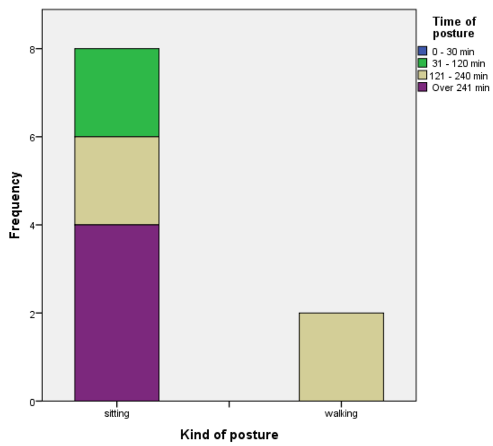

Figure. 1. Posture and time of adopted position by the worker.

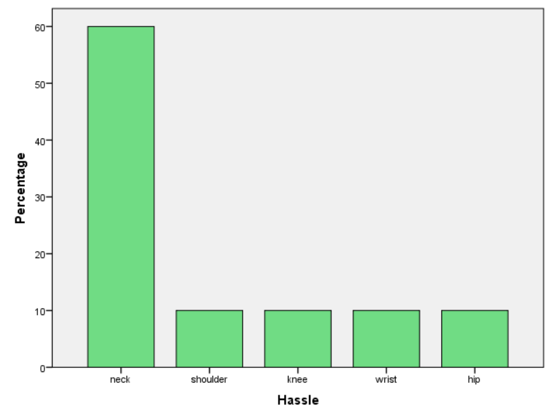

Figure 2. Hassle manifested in the questionnaire by the employee.

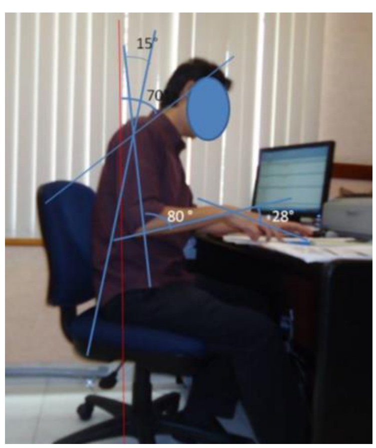

Figure. 3. Vector analysis method with R.U.L.A.

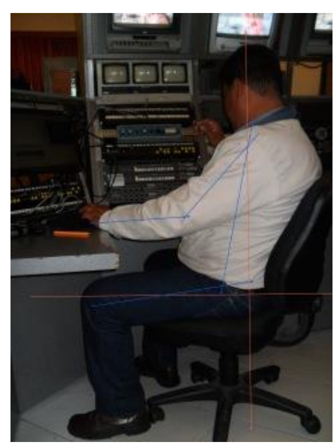

Figure. 4. Muscle tension in the neck and lower back

Table 2. Results of R.U.L.A. Method

		Final Score	Level of Risk
N	Valids	10	10
	Losts	0	0
Half		6.30	3.20
Std. typ.		1.160	.632
variance		1.344	.400

5. CONCLUSIONS

The sitting position was the main position found in the company, 8 of every 10 workers presented it. The position was static, remaining sit more than 60 minutes during the workday. 100% of the workers had of musculoskeletal discomfort, neck pain being the main complaint. The final score average of analysis RULA was 6, with a risk level 3. Indicating that they must change positions early and extend the ergonomic study. Since the result of vector angles notes a cervical and greater trunk flexion at 20 °, associated most static position at 60 min., May cause musculoskeletal injuries (muscle spasms) in the cervical and lumbar area.

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OFFICE WORK AND PRODUCTIVITY, RELATED TO LOW BACK PAIN.

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Resumen: La modalidad de trabajo ha cambiado a lo largo del tiempo, en consecuencia para desarrollar la actividad laboral se requiere posturas mantenidas y prolongadas como la postura sedente. Esta condición aumenta la posibilidad de desarrollar patologías osteomusculares como la lumbalgia, sin embargo existe poca evidencia en términos de productividad que muestren su asociación en el ámbito organizacional, siendo de gran relevancia puesto que es necesario conocer la incidencia de esta patología en el trabajo administrativo. Esta revisión de literatura pretende recolectar los artículos publicados entre el año 2010 y 2015 publicados en las bases de datos ISI Web of Science y Science Direct que relacionaran el trabajo de oficina en postura sedente prolongada con el dolor lumbar y su efecto en la productividad laboral. Complementario a esto, se realizó un análisis bibliométrico, con artículos publicados entre el año 1980 y 2015. Los resultados muestran que el tema de estudio se empezó a trabajar desde el 2001, siendo Estados Unidos el país con mayor número de publicaciones a nivel mundial con trabajo cooperativo entre otros países. Por otro lado, el 45% de los estudios realizados se han desarrollado mediante evaluaciones posturales siendo preponderantes los métodos mixtos.

Palabras claves: lumbalgia, trabajo de oficina, productividad.

Relevancia para la Ergonomía: Este trabajo de investigación muestra la necesidad de llevar a cabo estudios que analizan la actividad de las oficinas de manera integral; mirando hacia adelante para encontrar la influencia de agentes que afectan a la percepción de lumbago, y su incidencia en la eficiencia de las actividades de trabajo de oficina. Del mismo modo, este artículo trata de imaginar el contexto mundial en términos de investigación, soluciones alternativas y metodologías de evaluación ergonómicos en los lugares de trabajo con el fin de promover los sistemas de trabajo de oficina más productivas.

Abstract: Work patterns have change through the time, and as a result of this, it is necessary to adopt specific positions to develop a work activity for long periods of time. Sitting posture is one example. This condition increases the possibility to grow musculoskeletal pathologies such as lumbago. However, it exists little evidence in terms of productivity to show its association in organizational ambits, being highly relevant because is necessary to know the incidence of this pathology in office work. This review pretends to gather relevant articles published in ISI Web of Science and Science Direct databases between 2010 and 2015, which show the relationship between office work in prolonged sitting posture and its effect on work productivity. As a complement, a bibliometric analysis was made using documents published between 1980 and 2015. The results show that this field has been investigated since 2001, being the Unites States the country with the largest number of publications worldwide. By the other hand, 45% of the research have been developed by evaluations of the posture, being mixed methods the most used.

Keywords: Lumbago, work office, productivity.

Contribution to ergonomics: This research work shows the need to carry out studies that analyse the office activity in an integral way; looking forward to find the influence of agents that affect the perception of lumbago, and its incidence on the efficiency of office work activities. Likewise, this article tries to picture the world context in terms of investigation, alternative solutions and ergonomic evaluation methodologies in workplaces in order to promote more productive office work systems.

1. INTRODUCTION

Work as an economic activity has been transformed from antiquity to our time, it changed from being homogenous and with leisure time, to become a structured activity, with rhythms and times that define productivity (Dorronsoro, 1999). According to literature, sitting posture is the most adopted in occupational activities (Juan Alberto Castillo M, 2009) and it is more frequent in 3 domains: workplace, transport and during free time (Wallmann-Sperlich, 2014). Thus, it has been possible to demonstrate that intensive introduction of computers at work has changed the activities carried out by individual workers, causing the start of several prevalent diseases like lumbar pain, which is a commonly diagnosed condition in this population. Office work has a mental workload constraint on workers, forcing them to remain in their workplaces for long periods of time (Juan Alberto Castillo M, 2009). In the global context, the prevalence of low back pain is 50% for acute pain (Lively, 2002) and in Colombia, according to the National Study of Pain VIII 2014, is 23.6%. About 34.8% of patients recognize that this disease affects their job performance (Aura Marixa Liñeiro Guerrero, 2014). Because of this percentage, it is concluded that it is necessary to assign human and material resources to health care for people affected; resources coming from private sector, government and workers themselves. For this reason it is necessary to know how this thematic area has been treated through studies all around the world; a condition that besides being a public health problem, need to be studied to improve human and business productivity.

2. OBJECTIVES

1. Analyse from a literature review about office work and related to lumbago, the factors or agents that originate this pathology, and the effect of the same on productivity.

2. Describe the association of office work and productivity, starting from a bibliometrical analysis of the investigation on work ergonomics worldwide.

3. METHODOLOGY

Initially, it was performed a systematic review in the ISI Web of Science and Science databases about the pre-existing studies related to the review question: How does office work in sitting posture affects the lumbar pain and the worker productivity? Four thematic areas were defined: a) sitting position, b) office work, c) low back pain and risk factors and d) productivity and efficiency at work. From these terms the searching equations were defined a+b+c, b+c+d, b+c, b+d y a+b+c+d. Inclusion criteria were sitting posture, office furniture, administrative work, secretaries, office work, back pain, lumbago, lower back pain, work and force in offices, stress, repetitive office tasks, adult people performing office work, women and men, productivity, work production level, efficiency, productive chain, teamwork; and the exclusion criteria were infants, children, preteens, teenagers, elderly, working out of office, standing posture work and work that requires lifting loads. The selection of the articles was done first by title and abstract reading, secondly, through the reading of the results and finally, from reading the articles that passed the above previous filters, a bibliometric analysis was made using the VantagePoint software.

4. RESULTS

1842 articles were recovered, of which 81, published between 2010 and 2015, had high chances to answer the question. They also showed that studies on this thematic area began in 2001, being the Unites States the country with the largest number of publications worldwide, followed by Canada and the European Union. Likewise, the year with the highest number of publications was 2012, with 21.5% of the publications.

United States promotes the major collaborative research work in this field in partnership with Australia, China, Colombia, Serbia and Brazil, among others.

Instead, research work of France, Iran, India and Italy and other countries is mostly independent.

On the other hand, 45% of the research works have been made by postural assessments, 35% by interventions in the workplace, 14% as a function of productivity and 6% in education and diseases. It was found that office activity in sitting posture is associated as a

Lumbago increasing factor because of prolonged postures, monotonous tasks and low work rhythms. Additionally, these three elements tend to be present in activities with higher levels of concentration, work volume and short time to show results. In terms of productivity, the review found only two relevant articles; in these studies productivity was assessed based on tasks execution times of and work absenteeism.

5. CONCLUSIONS

Work activity in sitting posture is a recent study field, however, postural assessments showed that it great influences the onset of low back pain. Nonetheless, there is little knowledge about the factors that associate this pathology with productivity, especially because current results are ambiguous and contradictory.

Most of the studies have taken into account discomfort, joint angles or repositioning movements. They were carried out in general office activities, measuring time for each posture by interventions in the workplace and the seatback, and looking for ideal positions to detect skeletal-muscle disorders and diseases. Physic and mental agents associated with productivity has not been deeply investigated.

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PERCEPTION OF DISCOMFORT BY OFFICE ACTIVITY AND CHAIR

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Resumen: Los puestos de trabajo sedente con alto tiempo de permanencia, en los que se realizan actividades mediante el empleo de computadoras, aumentan día a día. La disminución de la lordosis lumbar tiene como factor de riesgo inmediato la aparición de dolor. Además, el cuerpo efectúa macro reposicionamientos como respuesta natural para contrarrestar la incomodidad percibida; por tal razón, es necesario el estudio de elementos de oficina que faciliten éste tipo de respuestas como mecanismo de prevención del dolor lumbar. El objetivo de este estudio fue determinar las diferencias de la percepción de incomodidad producidas por el dolor lumbar cuando se cambia la inclinación del asiento durante el desarrollo de dos actividades de oficina. En el estudio participaron 20 participantes entre hombres y mujeres profesionales de oficina y estudiantes de pregrado de último año. Durante el experimento se utilizó la escala de visualización análoga modificada por Corlett and Birshop para registrar la percepción de incomodidad durante la postura sedente. Al iniciar actividades de lectura y escritura en la silla sin basculación (SB) los participantes advirtieron la misma percepción de incomodidad, 45 minutos después se incrementó la incomodidad un 29% para la actividad de escritura. Caso contrario sucedió con la silla basculante (CB), pues al inicio de las actividades, la incomodidad para la lectura fue mayor que para la escritura, con una variabilidad constante (4.9 %) hasta el final de la prueba. El tipo de silla de oficina incide en la percepción de incomodidad de acuerdo con las demandas visuales de la actividad. La basculación en el asiento (CB) mostró menor percepción de incomodidad, de manera que se considera favorable para la ejecución de tareas con demanda visual en el plano horizontal de trabajo.

Palabras clave: dolor lumbar, incomodidad, sillas de oficina.

Relevancia para la Ergonomía: La generación de conocimiento relacionado con el trabajo de oficina es de gran importancia para la Ergonomía debido a que permite generar requerimientos para el diseño de sillas de oficina considerando de las características propias de la actividad.

Abstract: Seated work stations with high residence time, in which activities are carried out through the use of computers, increasing day by day. The decrease in lumbar lordosis is a risk factor for the onset of pain immediately. In addition, the body performs macro repositioning as a natural response to counter the perceived discomfort; for this reason, the study of office elements facilitate this type of response as a means of prevention of low back pain is necessary. The purpose of this study was to establish the variation in the perception of discomfort caused by low back pain when the seat angle is changed during the development of two office activities. The study included 20 participants between men and women professional office and undergraduate students at latest year. Analog display scale modified by Corlett and Birshop to record the perception of discomfort during sitting posture was used during the experiment. At startup reading and writing activities in the chair without tilting (SB) participants noted the same perception of discomfort, 45 minutes after the discomfort was increased by 29% for writing activity. Opposite case it happened with the rocking chair (CB), since the start of activities, discomfort for reading was higher than for writing, with a constant variability (4.9%) until the end of the test. The office chair type influences the perception of discomfort according to the visual demands of the activity. The tilt seat (CB) showed lower perception of discomfort, so it is considered favorable for the execution of tasks with visual demand in the horizontal plane of work.

Keywords: low back pain, discomfort, office chairs.

Relevance to ergonomics: generate knowledge concerning office work is of great importance to ergonomics because it allows generate requirements for the design of office chairs considering the nature of the activity characteristics.

1. INTRODUCTION

Most of labor activities have increased workstations with computers, as demand sitting posture (Karwowski & Marras, 1999) and in turn the manifestation of lumbar pain (Cabezas, Mejia, & Saenz, 2009). Evidence shows that the sitting posture has significantly more load on the spine than standing posture (Callaghan & McGill, 2001); and when prolonged presents higher relative risk of low back pain (Lis, Black, Korn, & Nordin, 2007; Makhsous et al., 2009). An associated risk factor is excessive load, to which is related to the marked decrease in lumbar lordosis caused by the movement of retroversion of the pelvis which generates greater pressure in the anterior part of the lumbar intervertebral discs (Chaffin, Andersson, & Martin, 2006). Consequence of this is in the long term, decreasing nutrition of intervertebral discs due to the adoption of the same posture for long time, which affects aging, deterioration (Chaffin et al. 2006) and diseases such as hernias disc (Neumann, 2007).

Accordingly, the pelvic macro repositionings performed on the seat, are the body's natural response to perceived discomfort due function of time (Na, Lim, Choi, & Chung, 2005; Vergara & Page, 2002). These let liberate internal loads, reduce nociceptive stimuli, improve nutrition of intervertebral discs in the lumbar region (Adams, McMillan, Green, & Dolan, 1996) and reduce fatigue in the buttock-thigh region due to lack of tissue oxygenation (Makhsous, Lin, Hanawalt, Kruger, & LaMantia, 2012). However, the consideration of long time to assume a sitting posture coupled with other factors such as muscle activation and increased burden on lumbar limits the lumbar-pelvic movement (O'Sullivan et al., 2003) at any time during the working activity.

In accordance with the foregoing, studies have shown that there is a relationship between these movements and the perception of discomfort (Fujimaki & Noro, 2005); therefore it has recommended more dynamic seated posture to favor the constant changes of the body (Dunk & Callaghan, 2010; Harrison, Harrison, Croft, Harrison, & Troyanovich, 1999) and few studies have been made in favor of this recommendation.

Connection with the foregoing, the results of a previous project (Galindo Estupiñan, Espinel Correal, Maradei & Garcia, 2014), were recorded discomfort data during the execution of four office tasks. It allowed identify activities with higher and lower perception of discomfort and its relationship to the number of repositionings. This led to observe the existing relationship between low back pain perception and type of activity.

2. OBJETIVE

The aim of this study was to determine the difference in the perception of discomfort due to back pain, according to the type of activity office: read and write, with or without variation of the inclination of the seat.

3. METHODOLOGY

The study involved 10 men and 10 women between 21 and 34 years old, professionals who perform office work and school seniors undergraduate whose body mass index (BMI) ranged from 20 to 30 kg / m2. They were asked about the presence of low back pain during the last twelve months, and was considered as an exclusion criterion to avoid discomfort reports pre-existing causes and not for purposes of study. Participants performed the tests according to corresponding random order of four possible treatments. Additionally, each participant certifies their voluntary participation with reading and signing the informed consent endorsed by the ethics committee for scientific research of Universidad Industrial de Santander.

The independent variables were an arrangement of two factors where the variation of the inclination of the seat (Factor A) and type of activity (Factor B) influence the dependent variable: perception of discomfort due to back pain. The factor A had two treatments with tilting seat (CB) and without this possibility (SB). That is, one of the office chairs it was adapted a system under the seat tilt to allow movement voluntarily. The B factor together two treatments: read on your computer and handwrite. The dependent variable Y was measured from not the scale of Corlett and Birshop modified using a scale of analog display (VAS) to assess the perception of discomfort in the lower back, at the beginning and end of each test.

Data were analyzed descriptively with the average and standard deviation for each group. Furthermore, the normal distribution was analyzed by the application of Shapiro-Wilk test, and the T-student test to compare the perception of discomfort in the lower back when they used chairs SB and CB during execution of writing and reading activities.

4. RESULTS

Table 1 shows the average data compiled with the VAS to evaluate the perceived discomfort after 45 minutes of staying in sitting posture, as well as the difference in the values between the start and end of the test. Three atypical results out of the maximum values were dropped, therefore the analysis was made with the data of the 17 left. The line graphs show the behavior of the discomfort perception values during the test, from the start till the end.

The behavior of the values of perceived discomfort during the test can be evidenced in line graphs, which shows the change from baseline to the end of the test. Figure 1 shows data for the studied activities on chair SB, for which the initial discomfort values is similar. However, the graph slope shows differences during the test in the discomfort perception, showing a greater value for the activity of writing. The variability coefficient was calculated between the slope lines (reading and writing) with a value of 0,29 (29% of variability).

Activity	SB before use	SB after 45 minutes	Difference in discomfort	CB before use	CB after 45 minutes	Difference in discomfort
Reading	1,16	1,82	0,66 (DS 1,34)	1,54	2,44	0,89(DS 1,1)
Writing	1,21	2,21	1,0(DS 1,68)	1,05	1,89	0,84(DS 1,02)

Table 1. Average and difference of discomfort perception

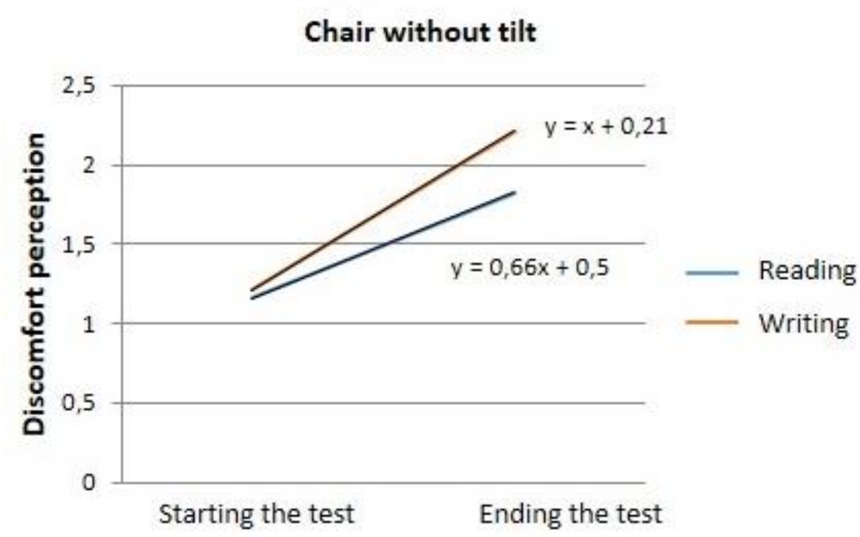

Figure 1. Progress of perception of discomfort on low back while using the chair without tilt

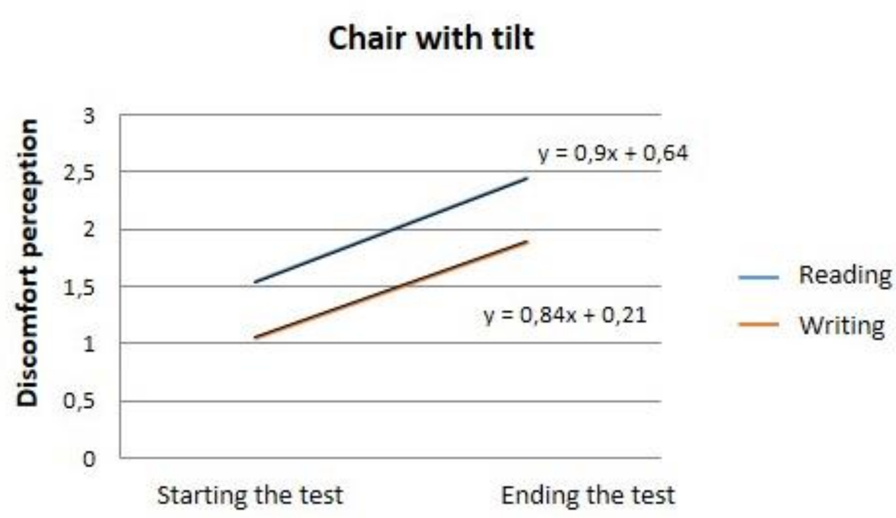

Figure 2. Progress of perception of discomfort on low back while using the chair with tilt

On the other side, the compiled data for the CB chair showed a different behavior, as the perception at the start of the test was not the same. The result for the reading activity was greater than the writing activity. However the increment of the discomfort was similar during the test execution, as shown by the graph slopes in figure 2. The calculated V.C. was 0,049 indicating a low variability for both activities. The latter values showed the differences between the chairs, 29% for the SB chair and a 4.9% for the CB chair.

In order to verify the existence of a difference between the chairs for the reading and writing activities, an initial analysis was made with the Shapiro Wilk test to guarantee a normal distribution of the data. The results of this test showed a normal distribution for the four groups ($p<0,05$). Later, the samples were compared with the T-student test, showing a difference between the activities, reading ($p=0,002$), writing ($p=0,03$).

5. DISCUSSION

The aim of this study was to determine the difference in the perception of discomfort due to back pain, according to the type of activity office: read and write, with or without variation of the inclination of the seat. The results show that according to the activity of office there is a difference in the report of discomfort perception during the use of the chair SB and CB. The activities of office that require visual demand in the horizontal work is perceived less uncomfortable with the chair CB in comparison with the chair SB (p= 0, 03). While that the reading activity on the computer screen is less uncomfortable with the chair SB confronted with the CB ($p=0.002$).

The results of perception of low discomfort during writing in a chair CB are similar to those found by (Groenesteijn et al., 2012), the study of desktop tasks where the perception of discomfort was lower when a dynamic chair was used. This may be due to the ability to move according to visual requirement. However, the dynamic characteristic of the chair CB did not show the same effect for reading activity. So the results of some studies about the perception of discomfort or disorders in the lower back were revised, for instance, the change of posture are related to the work activity and not with the chair that is used (Gandavadi & Ramsay, 2005; van Dieen, Koppes, & Twisk, 2010), while in other study the work done had an impact on muscle activity. Also Ellegast et al. (2012) did not find differences in the posture in relation with the type of chair, but whether with the type of activity.

Nevertheless, the variability coefficient found for the slope of discomfort perception for the chair SB was 29%, this indicating that the reading and writing activities changed in the discomfort perception of initial with respect to the end of the prove. Whereas for chair CB was 4.9% variability, lower, thus indicating a similar increase of discomfort during the execution of the two activities. While the reading activity was perceived less uncomfortable during the use of chair SB, the variability of discomfort perception had a similar behavior during use of the chair CB. Therefore, the type of chair and the type of activity can affect the discomfort perception during prolonged sitting posture.

Additionally, in the initial report of discomfort considering the two activities, the results are similar for the chair SB and for the chair CB the discomfort perception obtained 0.5 points difference. This can be understood because the formal differences between the two chairs and therefore the influence of aesthetic factors in the initial perception of discomfort. It has been found that the aesthetic aspects of an object can affect the initial evaluation before use (Groenesteijn, Vink, Looze,

& Krause, 2009) (De Looze, Kuijt-Evers, & Van Dieen, 2003); and increase after of use for fatigue due to aspects physical as evidenced in Figures 1 and 2.

Although in this study the activities were analyzed individually, it should be noted that the office work consists in do several activities (Groenesteijn et al, 2012.). Therefore it must be considered that the perception of discomfort in working environments is the set of activities and not an activity considered in isolation. Additionally, it should include organizational and psychosocial factors at work that may affect physical inactivity in jobs and the occurrence of musculoskeletal disorders (Lis et al., 2007; Wahlström, 2005). Moreover, some authors have mentioned the importance of considering the type of work for define the design aspects of the chair (Dowell, Yuan, & Green, 2001; Denes & TAKÁCS, 2012; Groenesteijn et al, 2009) because the seated posture depends on the behavior of workers and the relation with reports of discomfort (Allread, Marras, & Fathallah, 1998).

In consideration of limitations of the study should be noted that the measure of perceived discomfort is not contrasted with another variable that would analyze the response of discomfort, for instance, the number of macro repositioning (Babski-Reeves & Stanfield, 2002; Fujimaki & Noro, 2005) or height, which decreases less when dynamic chairs are used. Also, the time in sitting posture in this study was 45 minutes and it can be considered insufficient according VanDien et al. (2010) but the rise in time will increase the discomfort perception. Nevertheless, in future studies with an approximation to the real work situation, it should be considered longer periods of time of prolonged sitting posture.

In conclusion, the study could determine that the functional characteristics (tilt) of the office chair may affect the perception of discomfort for activities with different visual demands. Therefore, a chair CB favors the execution of administrative tasks office where the visual requirements are constant and in a prolonged sitting posture. The impact of expressive-formal elements in office chairs should studied, where apparently identical chairs are compared and only the physical characteristics are assessed. The experimental environment and the situations of real work should be controlled. In addition, longer periods of time will be considered as impact of this on the perception of discomfort during sedentary work. Finally, it is important to have assessments of values electromyography, pressure sensors, measuring participant's height at the beginning and end of experimentation or questionnaires of self-report as contrast variables that explain, more precisely, the perception of discomfort.

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AN APPROACH TO ERGONOMIC DESIGN OF PACKAGING AND CONTAINERS FOR OLDER ADULTS IN MÉXICO.

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Resumen: Este artículo muestra una aproximación al problema de los adultos mayores al manipular envases de productos comerciales. Se observó a 32 adultos mayores mientras abrían envases de productos de consumo frecuente, como alimentos envasados, contenedores de productos de higiene personal y medicamentos. Los envases utilizados para la observación, se seleccionaron por ser los de mayor consumo entre la muestra de adultos mayores, además de considerar la inclusión de diferentes sistemas de cierres, sellos, tapas y fajillas. Durante la observación se tomó registro sobre el cumplimiento de la tarea, el tiempo que tomó la apertura del envase, los tipos de prensión, el uso de herramientas improvisadas y posibles riesgos de incidentes.

Los resultados muestran que para posibilitar la apertura de envases de productos comerciales a los adultos mayores es necesario considerar aspectos ergonómicos como el tipo de agarre, la fuerza en prensión de pinza y agarre y las dimensiones y texturas de las áreas de contacto.

Palabras clave: Adulto mayor, envase, diseño geriátrico.

Abstract: This article shows an approach to the problem of older adults when handling packaging of commercial products. 32 seniors interacted with packaging products frequently consumed like packaged food containers, personal hygiene products, and medicines. The selection of packages to carry out observation was based on the highest consumption between the sample of older adults, also considering the inclusion of different systems closures, seals and caps. The practical exercise is based on an analysis of task with a record of observation that includes: the realization of the activity, execution time, handheld types, using makeshift tools, and the main problems in the execution of the task.

The results show that to allow the opening of packaging of commercial products for the elderly is necessary to consider ergonomic aspects such as the type of grip force and palmar pincer grasp, dimensions and textures of the contact areas.

Keywords: Elderly, packaging, geriatric design.

Relevance to Ergonomics: The result of this study presents a series of qualitative observations that the discrepancy between the manual performance of older adults and the packaging design. This study highlights the need to develop ergonomic research in the field of geriatrics to promote functional independence through enablers a preventive and prosthetic products, which contribute to the safety and welfare of this population group in a scenario aimed at the home stay without permanent support.

1. Introduction

Aging is a continuous, universal, irreversible, and individual human lifetime process and is characterized by the progressive loss of the ability to adapt to the environment surrounding the older adults in this process the losing the ability to pick up a container has a direct effect in the functional independence in activities like feeding, grooming, personal care, medications, and communication of the elderly

During the aging process this capacity is diminished by various factors such as the loss of sensitivity, decrease in grip strength and reduced joint mobility (Staal & De Vries, 2011). This condition affects the autonomous performance of older adults and can be enhanced with the design of objects and geriatric products which proper to the ergonomic features of the elderly population.

This study presents an approach to the problem of the elderly when trying to open containers of commercial products through the observation of a practical exercise in a group of adults over 65 years, beginning with functional dependency.

2. Objectives

The purpose of the study is identify the problems that older adults have to open containers used in daily life such as food, medicine, and personal care items, and thereby establishing the ergonomic criteria to be considered in the design of packaging and containers of commercial products for older adults can open.

3. Methodology

The study includes the initial evaluation of 50 seniors with an age range of 65 to 92 years old which were excluded 18 because a condition that affects manual capacity as Parkinson's disease, fractures in joints elbow or wrist, herpes lesions and strokes. 20 participants are women and 12 men; 21 of them are between 76 to 85 years. They live in the urban area of the city of Aguascalientes and attend day stay "La Casa del Abuelo".

The 32 older adults have some degree of functional dependence caused by muscle degeneration associated with aging articulatory as osteo arthritis and sarcopenia.

The FALL PROOF (Rose, 2005) is a diagnostic evaluation of functional dependence that evaluates perform tasks more difficult in everyday life as well as the causes of this limitation. Participants presented a special difficulty in activities of cooking, sweeping and mopping, heavy lifting and perform personal hygiene. The main causes of its limitation are: lack of hand strength, wrist joint pain, and lack of flexibility in finger joints. The result of the diagnostic test identifies three problems in the manual performance: the force demanded by the task, the size and shape of the contact area and surface textures clamping area. The observation of the practical exercise of opening containers consider the problems detected in the diagnostic test.

The practical exercise is based on an analysis of task with a record of observation that includes: the realization of the activity, execution time, handheld types, using makeshift tools, and the main problems in the execution of the task as well as the facts and relevant findings presented. The containers used for the practical exercise are listed in Table 1.

Table 1. Packaging used and the type of opening

Containers with opening system by pincer grasp		
	Example of container	Type of opening
1.	Can of tuna	Metal container with easy open system
2.	Can of juice	Metallic container with aluminum seal
3.	Box of cereal	Cardboard packaging with removable belt
4.	Biscuit tube	Aluminum packaging with thermos seal
5.	Toothbrush	Plastic blister on cardboard base with removable seal
6.	Individual milk	Shrinkable dotted label with rotational opening
Container with opening system by palmar grasp		
7.	Marmalade container	Container with screw cap

The practical excercise was conducted in four sessions with groups of eight participants in which all of the participants tried to open the containers and the sequence was random. The sessions was held in a multipurpose room at the nursing home. There was support from one of the geriatric center nurses as a moderator of the practice and a physical therapist whom accompanied the adult care for their safety during the implementation it was agreed in the event that participants may have used a tool that would allow them to carry out the operation but will be taken into account as uncompleted task.

4. Results and discussion

The problems that older adults presented during the opening exercise packaging and containers are: the force required to open the package overcomes the force of pincer and palmar grasp the elderly, the shapes and dimensions opening systems offer insufficient contact area for the handgrip and the contact surfaces do not offer textures that favor greater hand grip. The synthesis results are shown in Table 2.

A relevant result was the increase of time it took them to older adults the opening of containers in all cases. The two containers less managed to open the elderly are the can with easy open system and glass container with lid metal thread the first one is manipulated by pincer grasp and the second one by palmar grasp. The carton of cereal was the only package that all participants opened easily.

Table 2: Synthesis of observation record

Type of container	Task completed		Average time	Max time	General Observations	Particular Discovery`s
	yes	No				
Easy open can	6	26	1 min 25 sec	4min 30 sec	6 participants managed to loosen the lid and 22 did it partially 4 participants did not want to try.	6 participants requested a fork or knife to use as a lever.
Aluminum sealed juice	23	9	42 sec	2 min 10 sec	12 participants were able to open the can of juice on the first try.	3 participants bowed the container and the contents spilled when opening.
Cereal carton container	32	0	11 sec	20 sec	4 cases opened the box by removable strip.28 cases preferred to lift the flaps.	
Metal cookies container	29	3	22 sec	48 sec	12 participants attempted to open the package with transversal seal. Package had little grip area which compromised the execution. 9 cases support the package against the body.	A participant declined activities due to articulation symptoms.
Toothbrush package	24	8	1 min 19 sec	3 min 20 sec	5 cases tried to removable strip. 14 older adults tried to separate the plastic from the cardboard from one side, using his fingernails.8 participants tried with both hands.	13 of them asked the therapist some scissors to try to perforate the plastic.
Milk container	27	5	47 sec	1 min 52 sec	No participant opened the container by rotating the cap. 18 cases attempted to open the shrink seal container with nails.	3 participants attempted to open the seal with clips and hair clips.
Marmalade container	3	29	2 min	2 min 35 sec	Participants attempted various actions in attempt to complete task: gentle tapping, grasp with cloth, and standing up to put weight on container.	Therapist suspended 4 operations for precaution of an injury.

The first problem in opening the containers is the force required to open. Pérez Bilbao (2011) found that the manual force decrease progressively with age, in a study with male population he estimated that the decrease of the maximum voluntary force in palmar grasp reduced approximately 45% from de 30 to 80 years old.

Figure 1 shows the evolution of the average strength in palmar grasp; the decrease starts at age 50 and the rate in force loss is approximately between 10% and 15% per decade, or even higher from 75 years of age. The mean values of muscular strength of women are usually 20% to 40% lower than those of men (Fontan Galvan & Uriel Martinez, 2010).

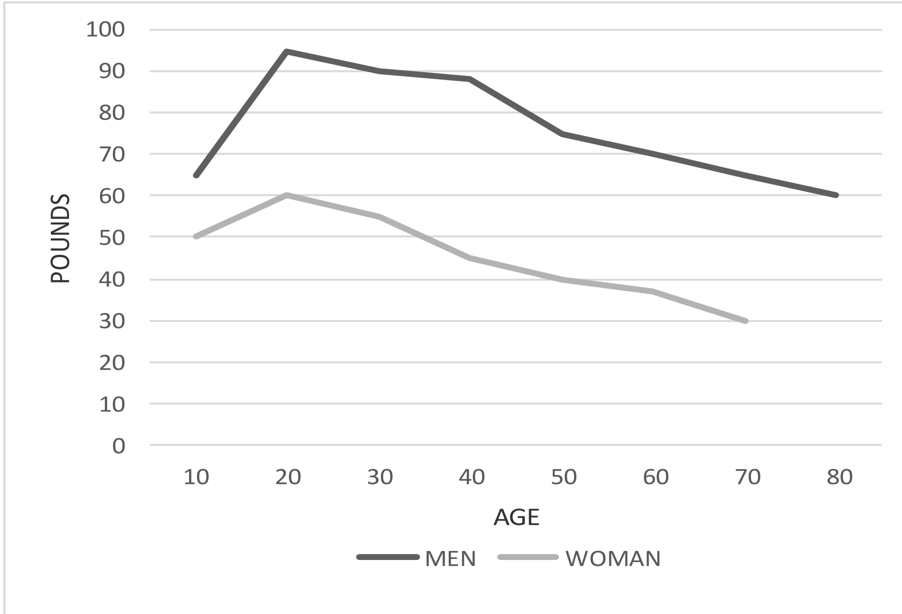

Figure 1: Average handgrip strength in pounds by sex and age
Note. Source: Fontan Galvan, M., & Uriel Martínez, S. (2010). *Fuerza Muscular* (p.78) Argentina,Vertice.

The Metrology Laboratory of the Center for Advanced Technology, CIATEQ Aguascalientes estimate the force required to open the glass container with metal screw cap. It is about 94.8 newtons equivalent to 21.3. The results should be considered the rotation of the wrist. Therefore we conclude that the force required for opening the package impossible in most cases the task.

Figure 2. Older adults manipulating two containers: screw cap system and easy open system

The second problem with older adults to open packaging refers to the shapes and dimensions of the areas of contact between the hand and the container like in the case of the container of aluminum sealed juice, cereal carton container and metal cookies container in which the dimensions of the tabs are very small for pincer grasp as it is shown in Figure 3. It is required increasing the size of contact and propose forms and textures that provide greater adherence in pincer grasp.

Figure 3. Older adults trying to open an aluminum seal and a removable strip.

The validation of this aspect was performed by an anthropometric assessment with the same older adults in which the contact distance between the index finger and thumb was measured.

Figure 4. Maximum width grip subterminal contact between finger and thumb.

Even when the anthropometric survey is not representative for the sample evaluated, estimating percentiles allow dimensional approach to the needs of older adults to hold a container. The percentile 5: 1.73 cm, percentile 50: 2.14cm, percentile 95: 2.56cm.

The third problem with older adults to open packaging refers to the contact surfaces do not offer textures that favor greater hand grip.In Figure 5 the case of the opening of the packing is shown with a heat shrinkable label where the elderly uses a pin to break the seal. The heat shrinkable plastic and metallic packaging slip through the fingers.

Figure 5. Older adults using makeshift tools to open container.

5. Conclusions

The autonomus performance of older adults can be enhanced with the design of ergonomic objects. The result of this work allows propose some criteria to be considered in the design of packaging and containers of commercial products.

It is important to consider that the maximum force required to open a package must be within the limits of normal force in pincer and palmar grasp even at older ages.

Packaging design for functional anthropometric dimensions should be applied as the maximum width of subterminal grip for caps and seals. Dimensions from lids, belts and wrapper lashes must be considered of a lateral grip to provide greater contact area It is also recommended implement the use of textures and bas-reliefs for better adherence to locking systems, seals, and caps.

The container design should give preference to the palmar grasp to use the strongest muscle groups for opening and reduce the articulatory movement to a minimum, mainly prone supination and inter phalangeal flexion.

If that is not possible own tools to facilitate the opening of containers so as not to risk the elderly with the use of improvised instruments must be developed.

The best indicator of the quality of life in older adults is their level of functional independence this could be possible if we focus on adapting products to the capabilities of the elderly through preventative products, enablers and prosthetists.

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MAP OF ERGONOMIC RISKS IN BUILDING MAINTENANCE PERSONNEL

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Resumen: El objetivo de este estudio es determinar un mapa de riesgos ergonómicos en el personal de mantenimiento reparación de edificios basados en las malas posturas y actividades con movimientos altamente repetitivos, para el análisis se utilizó el Método **RULA**, ya que permite evaluar la exposición de los trabajadores a los factores de riesgo que puedan causar lesiones musculo esqueléticas principalmente en las extremidades superiores por posturas, repetitividad de movimientos y fuerza aplicada al momento de realizar las tareas. Como resultados se obtuvo que en la mayoría de las actividades analizadas tanto para el lado derecho como para el izquierdo, dan riesgos **MUY ALTOS** y **ALTOS**, por lo que es necesario el implementar acciones inmediatas para evitar mayores daños a los trabajadores, las cuales van encaminadas a la utilización de equipo de protección personal y equipo neumático para agilizar el trabajo minimizar los riesgos de lesiones.

Palabras clave: Riesgos Laborales, Siniestralidad, Desordenes Musculo Esqueléticos.

Abstract: The aim of this study is to determine a map of ergonomic hazards in the maintenance staff repair bad posture based on buildings and activities with highly repetitive movements, for analyzing the **RULA** method was used because it allows to assess the exposure of workers to the risk factors that may cause musculoskeletal injuries mainly in upper limb postures, repetitiveness of movements and force applied when performing tasks. As a result it was found that in most of the activities discussed for both the right and to the left, they risk **VERY HIGH** and **HIGH**, so it is necessary to implement immediate action to prevent further damage to workers, which are aimed the use of personal protective equipment and pneumatic equipment to speed up work to minimize the risk of injury.

Keywords: Labor Risks, Accidents, Musculoskeletal Disorders.

Relevance to Ergonomics: Map of risks in the construction industry and building maintenance.

Introduction

While the dominant paradigm of occupational medicine, health-work relationship is approached from the perspective of a cause-effect relationship between exposure to known risk factors at work and damage to health, is not concerned only the quantification of occupational accidents and occupational diseases, but venturing into the study of living and working conditions. Industrial accidents and occupational diseases are factors that interfere with the normal development of construction activity and consequently in maintaining them, it is why one of the main concerns of an organization should be controlling risks threaten the health of their workers.

Maintenance and repairs as Tejera (2003, are the fundamental tasks that guarantee the extension of the useful life of the buildings, thereby preventing deterioration and eventually destruction. Its features are based on the typology of the building itself, also closely related to the time of construction and materials that were used in its execution.

It is noteworthy that the environment in which the building is immersed permanently influences its structure, its interior and exterior spaces, facilities and even its lifetime. According to Liberatore (2013) environmental impact studies are crucial to define and establish stages such as: project, broadcasting, construction, operation, maintenance and repair.

Construction, maintenance and its importance in economic activities are relevant to any country since it is considered as one of the main economic activities. The percentage of gross domestic product (GDP) that this activity contributes to the economy of a country is a variable which is generally linked to their level of development.

In Mexico the construction represents 7% of GDP (INEGI, 2009); between the states of the country, variations also occur, for example, in Nuevo Leon represents 3.9%, in the State of Mexico 3.1%, in Jalisco 3.9%, while in Yucatan 9, 0%.

It is estimated that globally, the construction workers and maintenance encompass 5 to 10% of the active population (Veen, 1999). In Mexico, workers in the construction, maintenance and repair represent 8.3% of the employed population (INEGI, 2009), which corresponds to 4.8 million workers, constituting the fourth source of work, after the trade (19, 5%), manufacturing (16.4%) and agriculture (14.5%).

Objective

To determine a map of ergonomic risk personnel Maintenance and repair of buildings based on poor posture and activities with highly repetitive movements.

Delimitation

This study is conducted on the premises of the Technological Institute of Nogales, where the building maintenance of Library and Industrial Engineering Laboratory will be analyzed.

Methodology

The **RULA** method allows assessing the exposure of workers to risk factors that can cause disorders in the upper limbs of the body: postures, repetitiveness of movements, applied forces and static activity of the musculoskeletal system. The application of the method begins with the observation of the worker's activity for several cycles. From this observation must be selected and postures most important tasks, its duration and to present a priori greater postural load.
This method should be applied to both the right and the left of the body separately. To assess these risk factors, the method uses body postures diagrams and tables of scores to evaluate the positions taken as:

- Repetition of movements.
- Static muscle work.
- Forces.
- Working positions.

Description of the method

The method evaluates the postural load all over the body, paying special attention to the neck, trunk, shoulders, arms and wrists. It also takes into account the time posture is maintained, the applied force and repetition of movement. That is why; this method is readily applicable to any workstation and provides general information about the task you want to study.

The method is based on **RULA** award marks to various parts of the body to assess the exposure of the same to the number of movements, postures applied force and certain work. The measures are essentially based on the angles formed by the different body segments analyzed for previously established references. The most common are the midline, dividing into right and left the body, or vertical. Measurements can be analyzed with the naked eye or with the aid of a suitable instrument for measuring angles. Each segment of the body is represented in the

sagittal plane (along the axis of symmetry). The evaluation is conveniently made from profile to provide more information to study awkward postures or overloads.
The **RULA** divides the body into two distinct groups is:
Group A: Formed by the upper limbs. They are broken down into arm, forearm and wrist. In the latter be taken into account also supination or pronation of it. The score depends on the angle of flexion or extension of the limbs.

Table 1: Evaluation of positions arms, forearms and wrists

Group A	Angles	Punctuation	Weighing
Arm	0°-20° the vertical flexion or extension	1	+1 if you lift your shoulders +1 if the arm is abducted or rotated -1 if the arm is supported
	20°-45° the vertical flexion or extension	2	
	45°-90° the vertical flexion or extension	3	
	>90° the vertical flexion or extension	4	
Forearm	60°-100° the vertical flexion or extension	1	+1 if it crosses the midline
	0°-60° o >100° the vertical flexion or extension	2	
Wrist	0° on Horizontal	1	+1 if radial or ulnar mind midline deviates
	0°-15 on Horizontal	2	
	>15° on Horizontal	3	

Group B: Formed by the neck, trunk and legs. The positions of the neck, trunk and legs are evaluated according what is shown in Table 2.

Table 2: Evaluation of neck, trunk and legs

Group B	Ángles	Punctuation	Weighing
Neck	0°-10° flexion on the vertical	1	+1 if the neck is rotated +1 if the neck is inclined laterally
	10°-20° flexion on the vertical	2	
	>20° flexion on the vertical	3	
	the vertical on extension	4	
Trunk	°0 the vertical and well on sitting	1	+1 if the trunk is rotating +1 if the trunk is tilted laterally
	0°-20° flexion on the vertical	2	
	20°-60° flexion on the vertical	3	
	>60° flexion on the vertical	4	
Legs		1	Sitting or balancing weight on both feet
		2	Weight rests on one foot or feet unsupported

It also takes into account the scores if the movement is repetitive or not or if any cargo handled manually. The values associated with the angles of members with reference and manipulated weights are attached in Table 3 and Table 4.

Table 3: Rating group A

		SCORING THE WRIST							
		1		2		3		4	
		TURN		TURN		TURN		TURN	
ARM	**FOREARM**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table 4: Rating group B

	SCORING POSITION OF TRUNK											
SCORING POSITION NECK	**LEGS**		**LEGS**		**LEGS**		**LEGS**		**LEGS**		**LEGS**	
	1	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

The two groups are evaluated separately, weighing at greater if cargo handling or repetitive work. There are certain situations that must be evaluated separately for static work and repetitive movements or handling of loads:

Static work and repetitive movements:

It is weighted with + 1 the score of A and B if:

- The position is largely static (held more than 1 minute.)
- The position is repeated more than 4 times per minute.

Application of forces

Added to certain amount the scores of A and B depending on the load handled following Table 5

Table 5: Evaluation of cargo handled

0	1	2	3
Non-resistance	2-10 kg load or intermittent force	2-10 kg static load	10 kg or more static load
Less than 2 kg load or intermittent force		2-10 kg loading or repeated force	10 kg or more of repeated load
		>10 kg load or intermittent force	Jerking or rapidly rising forces
Add the score to the scores A and B			

Adding weights due to posture, be maintained or repetitive, and cargo handled, the C values to members are obtained of Group A and the value D for members of Group B.

Final assessment

Once applied all weights and obtaining a final value for members of Group A and Group B, the score obtained in each case separately, is brought to another table where they combine both results give a final score for that position, which between 1 and 7, according to Table 6 obtaining the value D.

Table 6: Value D
SCORING (neck, trunk, legs)

SCORING C (upper limb)	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	5
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

SCORING A + C = Score muscle spindle and strength for group A
SCORING Score B + C = muscle use and force for group B

The **RULA** score classifies positions in 4 levels of action based on the value D obtained. At each level it is assigned a particular color depending on your risk:

Table 7: Classification of risk levels

Action level	Description
Level 1	Acceptable level. No short-term changes are required. The score is 1 or 2.
Level 2	They may need changes or additional analysis. The final score is 3 or 4.
Level 3	Are needed investigations or short-term changes. The final score is 5 or 6.
Level 4	Are needed investigations or immediate changes. The final score is 7.

Once obtained the action level, actions to consider redesigning the job or changes for improvement are prioritized. After making changes in a job, you should reevaluate the position to verify the ergonomic risk has disappeared or, at least, has been minimized to a tolerable risk.

Results

Some of the operations discussed below are presented graphically for analysis with postural **RULA**. (Figure 3 to Figure 6).

Figure 3: Detailed lamps

Figure 4: Fitting accessories

Figure 5: Detailed wall

 

Figure 6: Tirol

After the analysis, the risk to both the right and to the left, in each of the activities, result, according to as shown in Table 8, the risks are mostly **VERY HIGH** and in its **HIGH** minority, so the postures and highly repetitive movements, have severely damaging effects, so they are evaluated with the action category **VERY HIGH** immediate changes require both working methods and tools used, while activities were evaluated as **HIGH** risk is necessary for changes to be made at very short notice, so as to prevent musculoskeletal damage may be permanent worker.

Table 8: Result of analysis with RULA

N	TASK	SIDE	RULA		RESULTS	
			TABLE A	TABLE B	VALUE	RISK
1	DETAILED LAMPS	RIGHT	10	6	7	VERY HIGH
		LEFT	4	6	6	HIGH
2	FITTING ACCESSORIES	RIGHT	12	4	7	VERY HIGH
		LEFT	12	4	7	VERY HIGH
3	TIROL	RIGHT	7	5	7	VERY HIGH
		LEFT	7	5	7	VERY HIGH
4	DETAILED WALL	RIGHT	8	5	7	VERY HIGH
		LEFT	5	5	6	HIGH

Some of the solutions that can be given in task outlined above are:

In Task 1, the constantly grabs a tray can strain the hand, wrist and forearm, due to the weight, size and texture of the surface of the tray, so that the use of a glove easy grip recommended glued to the tray as it reduces the force needed to hold her hand, or a caulking gun motorized, which can be pneumatic with which reduces stress on the upper extremities.

In task 2 can promote the use of equipment such as extensions, lifts and elevators to reduce the need to lift the arms to do the work, in addition to implementing rules to limit time spent by workers performing tasks requiring movement above the head without rest.

In task 3 it is necessary to use a compressor, avoiding loading the container with the material and turn the handle to prevent hand stress also applying Tirol compressor can work much faster and less tiring to the worker.
In task 4, there are pneumatic systems for finishing drywall, with this manual finishing is avoided, still must perform movements and awkward positions but do not use as much force at the same time.
In addition to the analysis results with **RULA**, it observed that workers do not use safety equipment, such as:

- Masks to avoid breathing dust that vitiates the atmosphere.
- Gloves for handling the material with which maintenance is performed.
- Not all staff wears safety shoes to protect them against moisture, rough surfaces, falling objects, etc.
- Lenses to protect the eyes, because the work that is done is to release particles that can endanger the eyes of the workers.
- Seat belts for work in height to avoid possible falls worker.

Conclusions

Based on the above, it can be noted that ergonomics faces strong challenges in improving health (as) workers (as) particularly those dedicated to maintenance and repair of buildings in Mexico, especially under the following considerations:

- The training of professionals in ergonomics considering the trend of occupational health training to have competitive professionals in the study and transformation of work in this context.
- An action from the ergonomic point of view capable of contextualizing the analysis of work situations to impact prevention measures and health of construction workers and their subsequent activities and while permeating the formulation of a new health security model.
- The academic community of ergonomics in Mexico should channel their efforts to strengthen the most important in construction, where ergonomics can play a leading role.

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ERGONOMIC DESIGN, ENVIRONMENTAL FACTORS AND IDENTIFICATION OF RISK IN AREAS OF SEA AND LAND MAINTENANCE OF CONTAINERS

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Resumen: En el presente estudio se realizó en una empresa nacional dedicada a la reparación de contenedores marítimos o terrestres, de diferentes dimensiones y capacidades con el objetivo de identificar los riesgos a los que se expone un trabajador que se dedica a reparar contenedores marítimos y terrestres, realizando una evaluación ergonómica se alternan continuamente los factores ambientales lo que da lugar a las llamadas enfermedades del trabajo, entre las que se encuentran lesiones dorsos lumbares, traumatismos repetitivos, lesiones musculo esqueléticas además de trastornos de tipo psicológico. Se analizaron los factores de riesgo de lesiones por DTA´S (Desorden Traumático Acumulativo). El estudio permite determinar las afectaciones de DTA's por tipo de actividad y analizar factores de riesgo que existe dentro del área y desarrolla una propuesta de mejora. Para realizar este estudio se utilizaron los métodos de evaluación de puestos, de FCD, SUZANNE RODGER y PLIBEL. Asimismo las condiciones ambientales (iluminación, temperatura y ruido).

Palabras clave: Lesiones, riesgos potenciales, condiciones de trabajo.

Relevancia para la Ergonomía: El estudio contribuye a la difusión del conocimiento y la conciencia de la importancia de la ergonomía en el diseño de las estaciones de trabajo y los procesos de producción, destacando lo más importante es la salud y la vida de los trabajadores sin dejar de lado la parte productiva y funcional de la empresa

Abstract: The present study was conducted in a national company dedicated to the repair of sea or land containers of different sizes and capabilities with the objective of identifying the risks to which a worker who is dedicated to repairing sea and land containers exposed, making an ergonomic evaluation environmental factors are continuously alternate leading to calls occupational diseases, including lumbar backs are injuries, repetitive trauma, musculoskeletal injuries in addition to psychological disorders. risk factors of injuries DTA'S (Cumulative trauma disorder) were analyzed.

The study to determine the effects of DTA's by activity and analyze risk factors that exist in the area and develop a proposal for improvement. For this study the methods of job evaluation, FCD, SUZANNE RODGER and PLIBEL were used. Also environmental conditions (light, temperature and noise).

Keywords: *Injuries, potential risks, working conditions*

Relevance to Ergonomic: The study contributes to the spread of knowledge and awareness of the importance of ergonomics in the design of workstations and production processes, highlighting the most important thing is the health and lives of workers without neglecting the productive and functional part of the company.

1. INTRODUCTION

Tanks or containers are large near the main port areas areas in which, in addition to the storage of empty containers carried out a series of complementary activities such as inspection, repair and cleaning them in order to give a proper maintenance, and termination of the containers to be used for import and export sea or land.

In this work environmental factors leading to calls occupational diseases, including lumbar backs are injuries, repetitive trauma, musculoskeletal injuries and psychological disorders are continually altered.

Many of the diseases that occur in older people, are not due to aging of the body, but are the consequences of unnatural postures, repetitive movements or inadequate, exposure to noise, vibration, gas, lighting, etc., which in over time they affect the body. (Cañas 2012)

Physical risks are present include noise, heat and cold, radiation, vibration and barometric pressure. Often the construction work takes place in the presence of extreme heat or cold, with windy, rainy, snow, fog or night time. (Romero y Rescalvo s.f.)

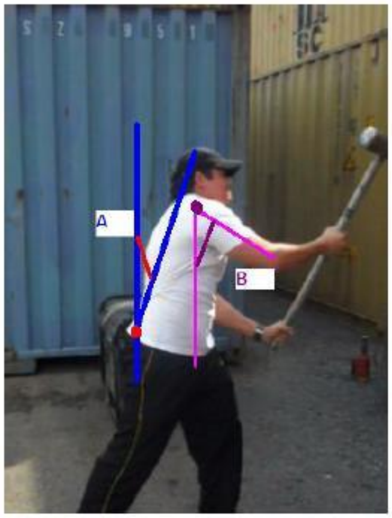
2. OBJECTIVES

1) Identify whether environmental conditions and procedure, favor the presence occupational diseases DTA'S (cumulative trauma disorder) in the operators.
2) To study the behavior of risk factors associated with poor posture, cargo handling and their interrelation to determine the effect of these environmental conditions in exposed workers.

3. METHODOLOGY

FCD

Fuerza de compresión del disco



M= 95kg
L= 1.7 m
W= 12.2 kg
A= 32°
B= 58°
C= 112°

X1=	0.09098714
X2=	0.28066519
X3=	0.61312376
X4=	0.78445791

X1= .1010* 1.7 sen 32°
X2= .2337*1.7 sen 32° +0.0827 * sen 58°
X3= .1010* 1.7 sen 32° + .1896*1.7*sen 58°+ .0820*1.7*sen 112°
X4= .1010* 1.7 sen 32° + .1896*1.7*sen 58°+ .1907*1.7*sen 112°

ENTONCES:

FME=	345.471
E=	0.52261
D=	27.592
FCD=	395.256

Figure 1: Method Compressive Strength disk

SUZANNE RODGER

Rango de valores para nivel de esfuerzo
1. ligero
2. moderado
3. pesado
4. muy pesado

Rango de valores para duración continúa del esfuerzo
1. menos de seis segundos
2. 6-20 segundos
3. 20-30 segundos
4. más de 30 segundos

Rango de valores para la frecuencia del esfuerzo
1. menos de 1/min
2. 1-5/min
3. 6-15/min
4. >15/min

Figure 2: Method Suzanne Rodgers.

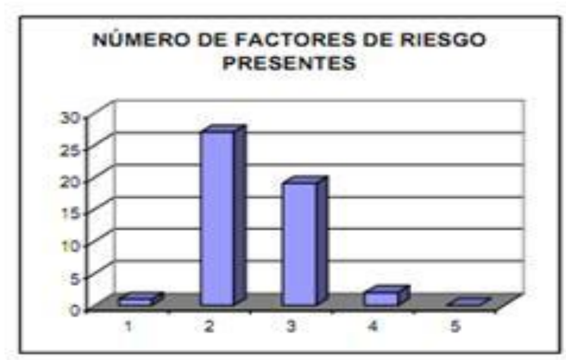


Figure 3: Results Plibel

4. RESULTS

Running of the worker's activity increased risk experiments with its main threat to the environment, which is confirmed by the study, which shows that they are exceeding the limits set by the Standard NIOSH. (De la Vega 2011).

5.CONCLUSIONS

Running of the worker's activity increased risk experiments with its main threat to the environment, which is confirmed by the study, which shows that they are exceeding the limits set by the Standard NIOSH. (STPS 2015)

Following NIOSH criteria for the classification of risk factors DTA for carpal tunnel syndrome is identified. a folding table and mobile operator was designed, in addition to preventing cervical injuries, excessive fatigue and bad posture is comfortable handling and fast with different working positions.

Figura 4: Propuesta de implementación

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AUTOETHNOGRAPHY AND ERGONOMICS AT HOME: A PARTICIPATIVE ASSESSMENT METHOD FOR ACTIVITY STATIONS.

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RESUMEN: Mientras que la ergonomía es una disciplina que surgió del sector industrial, existen áreas de oportunidad en la vida cotidiana en el hogar para mejorar el desempeño de los miembros de la familia.

En este trabajo, autoetnografía se aplica como una herramienta para evaluar estaciones de actividades en el hogar. De acuerdo con los métodos ergonómicos, donde se observan los trabajadores durante una tarea en un proceso dado, la auto-observación de la propia actividad sensibiliza al usuario para que él o ella puede identificar riesgos inmediatos o de mediano plazo de la lesión, en las tareas cotidianas. Por lo tanto, los métodos básicos de ergonomía como RULA pueden completar la evaluación.

Palabras clave: Autoetnografía, métodos de ergonomía, vivienda.

Relevancia para la Ergonomía: En este artículo, las técnicas de diferentes disciplinas se unen para reconocer las necesidades del usuario de la vivienda. En el marco de la ergonomía participativa, autoetnografía es una guía para localizar las situaciones de riesgo ergonómico de la experiencia de los residentes.

Autoetnografía se toma como herramienta de testimonio para el usuario en el hogar. Métodos ergonómicos tales como RULA completan el análisis ergonómico. El proceso de diseño arquitectónico, se actualiza de manera transdisciplinaria, mediante la integración de métodos antropológicos y ergonómicos, con el fin de mejorar la calidad del medio ambiente.

ABSTRACT: While ergonomics is a discipline that emerged from the industrial sector, there are opportunity areas in everyday life at home to improve the performance of family members.

In this paper, autoethnography is applied as a tool to evaluate activity stations at home. In accordance with ergonomic methods, where workers are observed during a task in a given process, self-observation of the activity itself sensitizes the user so that he or she can identify immediate or medium-term risks of injury, in everyday tasks. Hence, basic ergonomic methods such as RULA can complete the assessment.

Keywords: autoethnography, ergonomics methods, housing.

Relevance to Ergonomics: In this article, techniques from different disciplines come together to acknowledge housing user requirements. Within the framework of participatory ergonomics, autoethnography is a guide to locate ergonomic risk situations from the resident's experience.

Autoethnography is taken as testimonial tool for the user at home. Ergonomic methods such as RULA complete the ergonomic analysis.

The architectural design process, is updated in a transdisciplinary manner, by integrating anthropological and ergonomic methods, in order to improve the quality of the environment.

1. INTRODUCTION

The main objectives of ergonomics are to identify, analyze and reduce occupational risks. However, there are areas of opportunity in everyday life.

In the design of interior housing spaces, the user is also an essential factor. Therefore, people-centered tools are used. While ergonomics adapt the environment to bring comfort to the user and the right conditions to make tasks more efficient, humanist disciplines are incorporated into a comprehensive vision.

As a frame of reference, concepts and techniques of both ethnography and ergonomics are established. The aim is to identify opportunity areas in the stations of basic activity inside a home, from the resident's experience. For this, autoethnography is used to describe everyday experiences. When the user recognizes a task with a potential risk, RULA ergonomic methods are applied. Redesign requirements are obtained from the results.

1.1. Inhabiting a dwelling.

The Spanish term for inhabiting a dwelling comes from the Latin *habitāre*, which translates as *living*, *dwelling*. The usual way of inhabiting a space is a hallmark for each human being, hence marking with his or her own style, the conditions to which he or she responds in a given situation. According to this a habit is a special way of proceeding or conduct oneself, acquired by repetition of the same act of similar ones, or caused by instinctual tendencies

The Latin word *habitare*, is a frequentative term of the word *habere* (have). Frequentative means that the action is done repeatedly. Then it is understood that *habitare* means *having repeatedly*.

Inhabiting denotes action. A multiple and varied action. It is the movement of one being who is looking to stay satisfied with the means at his or her disposal in the surrounding area or in a shared territory.

Dwelling, as an action, movement and perception phenomenon, becomes experience in view of the possibilities of meeting between the dweller and the environment's components through sensory interaction. Through his or her own experience, the user certifies and assesses the satisfaction of dwelling firsthand.

The user's experience is the result of a phenomenon in which a multitude of factors play a part: individual, social, cultural, contextual, as well as some that are proper to the object with which there is an interaction. According to Hassan and Martin (2005), it is influenced by previous expectations and experiences, and therefore conditions future expectations and experiences. Special emphasis is placed on subjective factors in the interaction, such as the emotional behavior of the user and the importance of design attributes.

Forlizzi and Battarbee (2004) define *user experience*.

- *Experience* is the constant discursive current, which happens while one is conscious; it is how goals related to people, products and surroundings are assessed at a given time.

- Another definition is that of *experience as a story*. Stories are ways to organize and remember experiences, making it easy for people to communicate experiences in various specific situations.

In a process of architectural design, the designer is the one who makes decisions about space solutions. Their decisions are usually based on assumptions about reality, but aren't necessarily based on the users' experience and perception. Likewise, the user reports feeling comfortable at home even when the conditions in the ergonomic system denoting little to no effectiveness. Thus, opportunity areas for ergonomic interventions in activity stations can be found in many dwellings. See Figure 1.

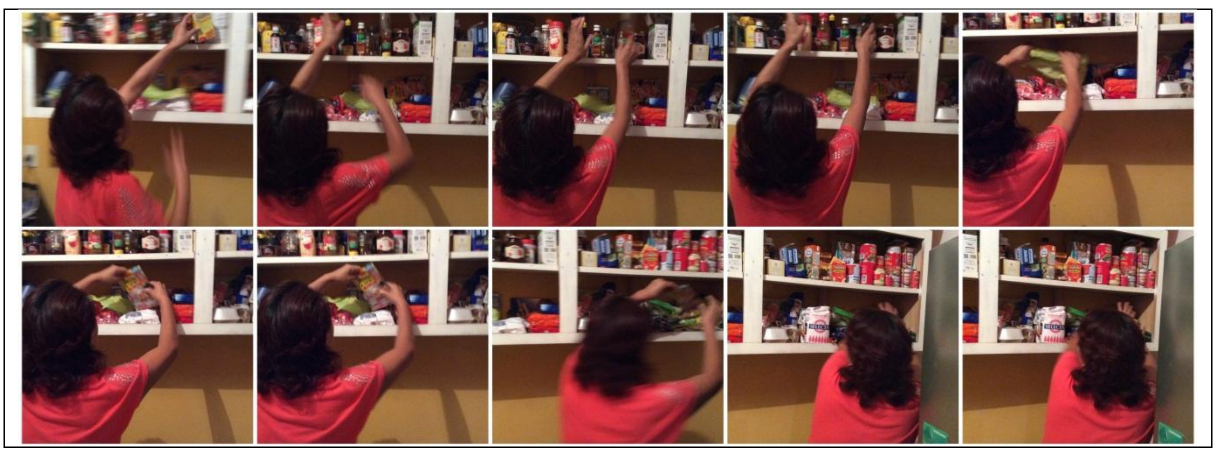

Fig. 1. Kitchen Station.

1.2. Autoethnography.

Ethnography is a method used by anthropologists to describe the customs of a human group. Ethnography consists of having the anthropologist perform a participant observation, for the duration of the direct interaction he or she has with the group that is being studied. The study can be complemented with interviews and other tools to find out data that is not in plain sight.

According to Citro (2009), regarding the practice of the ethnographer, participation in everyday life makes it possible to share different experiences, not just asking and observing. According to Jackson (1989), it is useful to break the habit of using a linear model of communication in order to understand the body praxis, "it is a methodological strategy of taking part without an ulterior motive and *literally* putting themselves in the position of another person: to inhabit their world. Participation thus becomes a purpose in itself, more than a means to gather information that is closely observed, which will be subject to interpretation elsewhere, after the event takes place. "(Jackson, 1989, 81)

Another aspect of qualitative research, and a form of writing and presentation of results, is the personal narrative called autoethnography, which maintains that an individual life may account for the contexts where that person has to live (Blanco, 2012). Here, the role of participant observer of a group gives way to the member of a social group.

Ethnography broadens its conception to give way to both personal and / or autobiographical accounts, as well as the ethnographer's experiences as researcher — whether separately or together— placed in a social and cultural context. The autoethnography is usually written in first person and the texts appear in a variety of formats. Autoethnographies are highly customized, revealing texts in which the authors give account of their own experience, linking the personal with the cultural (Richardson, 2003: 512). Said personal report gives account of life itself, exercise with which one realizes his or her own experience.

1.3. Ergonomic analysis methods for posture assessment.

Although regularly used in industrial fields, it is intended to apply these methods in both architecture and interior design environments, and thus improve habitat quality. The RULA method can be applied in conjunction with methods of task analysis.

RULA Method (Rapid Upper Limb Assessment)

- Determine work cycles and observe the worker for several of these cycles
- Select the positions to be evaluated
- Determine for each position, whether the left or the right side of the body will be evaluated (in case of doubt both will be evaluated)
- Determine the scores for each body part
- Get the method's final score and level of performance to determine the existence of risks
- Check the scores of the different body parts to determine where it is necessary to make corrections
- Redesign the station or make changes to improve posture if necessary

- If you have made changes, reevaluate the position with RULA to test the effectiveness of the improvement.

1.4. Participative Ergonomics.

Ergonomics should be applied differently to each specific situation, evaluating the effectiveness of the interventions and adapting to changes of the determining factors, through testing new actions (Garcia et al., 2009).

In this sense, it is important to implement interventions that will strengthen cooperation, information exchange and participation of all parties involved. As with participative ergonomics.

According to Haines and Wilson (1998), participative ergonomics is a strategy to get people involved in the planning and control of a significant part of their work, with enough knowledge and power to influence the processes and outcomes with the objective of achieving desirable goals.

It is an effective strategy to control work-related musculoskeletal disorders, with the participation of the different actors within the framework of a participatory ergonomics strategy (Vink et al., 2008).

The central and common element that all intervention experiences share in participative ergonomics, is the constitution of a work group within the company, with participation of the different actors, and which will be the main protagonist in the proposal of necessary preventive actions.

In the context of one of the main experiences of participative ergonomics available, supported by the *Institut de Recherche en Santé et Securité du Travail* in Canada, this work group is called ERGO Group.

2. DEVELOPMENT.

Inhabiting a home presents a series of opportunity areas for ergonomic intervention with the purpose of improving quality of life in the everyday environment. An inclusive approach to qualitative research with ergonomics offers an innovative analytical alternative to design processes.

2.1. OBJECTIVES.

2.1.1. Overall objectives;

To evaluate activity stations in housing:

2.1.2. Specific objectives:

To identify risk positions at activity stations in housing, from the perspective of the inhabitants.

To evaluate the level of ergonomic intervention.

Collect data for redesign.

2.2 DELIMITATION.

A sample of housing users is established at the researcher's convenience, among the researcher's acquaintances with the necessary availability to record personal narrative and photographs.

Development of the ethnographies is given priority; the assessment of activity and posture is carried out using the RULA ergonomic method. The outcomes of the assessment are presented in summary form.

2.3. METHODOLOGY.

2.3.1. Autoethnography inside the home.

The central axis is the employment of the autoethnography. Randomly selected housing users will be required to narrate their own inhabiting experience, detailing actions, postures and objects used. Activity stations where risk positions and actions are detected shall be located in the written accounts. Ergonomic postural assessment methods (RULA) will be applied.

2.3.1.1. A small guide, based on the following points, is given to the user for the development of his or her narrative:

- Location of your home.
- Description of the house.
- Description of the home. With whom does he or she live?
- What rooms are there? What are those rooms like? What furniture and objects are there?
- How do you experience your house?
- During which activities does your body experience uncomfortable positions?

2.3.1.2 It is required to make a photographic record of daily activity sequences.

2.3.1.3 Critical situations are analyzed alongside the user.

2.3.1.4 RULA method is applied.

2.3.1.5 With the results, recommendations are made.

2.4. RESULTS.

The sample was made up of five people, two of whom participated in a complete postural assessment. The autoethnography of a single user is presented.

User´s Autoethnography:

"Throughout my life I have lived in 5 houses, which has allowed me to get to know multiple variations of spaces and furniture, which helps me analyze more in depth the spaces and items that exist inside the house where I currently live."

"Most houses nowadays are designed for small families and small pieces of furniture. I live in a medium level, two-storey house, which means it has adequate ventilation and necessary areas (living room, dining room, kitchen, two bedrooms, one full bathroom, one half bath, service patio, a balcony and a one-car garage) but not with enough space for easy movement. "

"The space in the living / dining room is acceptable, because although my parents chose rustic and bulky furniture mostly, they fit perfectly in their designated areas, leaving enough space to move freely." See figure 2.

Figure 2. Dining Station.

The kitchen has just enough space for typical kitchen furniture, however it is not spacious enough to provide comfort when performing daily activities, since there can only be one person at a time, without running the risk of bumping into each other or tripping. "

Fig. 3. Cooking Station.

"The size of the half bath does not prevent it from fulfilling its function, however the size might turn out to be somewhat uncomfortable, given that from the toilet one is perfectly capable of washing his or her own hands, which is not very hygienic from the medical perspective, because every time the toilet is flushed, it has a "spray" effect, so bacteria can get to the soap or toothbrushes, which could be the cause of various diseases."

Fig. 4. Personal hygiene.

"About the stairs, the height of each single step is the ideal, but the actual staircase is very narrow which makes it impossible for two people to climb the stairs at the same time, besides they curve in a way that can cause accidents."

"The rooms are small, both are the same size, which can make it difficult to interact with the space, because when we talk about the master bedroom, there isn't enough space to furnish it with a commercial bedroom set with a double bed, because there is no space for opening drawers and having easy access. There's the same problem with the children's bedroom, especially because we know that families

nowadays are made up of the parents and two children, which means two beds, bedside tables and a space for homework, which cannot exist in said bedroom without it causing access and mobility conflicts."

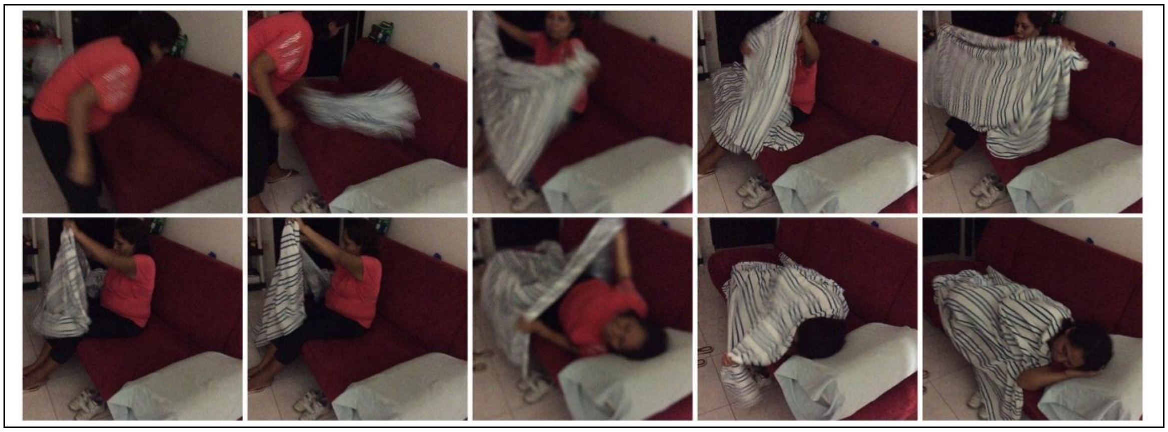

Fig. 5. Sleeping Station.

"In my opinion, several areas or spots in those areas of the house where I currently live do not fully comply with all aspects of convenience, which may be small or perhaps insignificant, but can lead to accidents or physical illnesses to any of the residents. For example, service areas like laundry."

Fig. 6. Laundry Station.

Through user's autoethnography, uncomfortable activity stations that cause fatigue can be located. Out of that group of stations, for practical reasons of the individual, the laundry station is analyzed using the RULA method. See Figure 2. The results are summarized in Table 1.

Table 1. RULA Work Sheet. Summary Laundry Station.

Group A:		Variation	
Upper Arm. Raised 45º - 90º	3		3
Lower Arm, Flexion, 60º y 100º	1	+1	2
Wrist position. Hasta 15º	1		
Wrist Twist.		+1	
Table A			3
Muscle Use: 4x per minute.		+1	1
Force/Load		0	
Total. Upper Arm, Lower Arm, Wrist.			4
Group B:			
Neck. Side bending 10º, twisted.	1	+1	2
Trunk. Flexion > 60º, twisted.	4	+1	5
Leg and feet. Supported.	1		1
Tabla B			6
Muscle Use. Static.	0		
Force/Load. < 2kgs.	0		
Total. Neck, Trunk, Leg.			6
Table C			6
Further investigation, change son, recommended.			

A more detailed analysis is required, as well as possibly modifying the task.

2.5. CONCLUSIONS.

The inhabitant's description of life, sustained on the autoethnographic approach, made it easy to understand the ergonomic framework for action at home. The user feels comfort where none existed.

Personal narrative allows to recognize activity stations where there's risk, for both the inhabitant and for the designer, who make up a sort of Ergo group, maybe Ergo design team, during the design process or housing redesign. In this case, several uncomfortable activities were identified. Other methods for human postures assessing during home activities, can be applied to complement the ergonomic analysis; for example, REBA, OWAS, NIOSH, if necessary.

Autoethnography is an anthropological tool that can be incorporated into the participative ergonomics paradigm, in the field of design of housing spaces.

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ENVIRONMENTAL FACTORS AND IDENTIFICATION OF RISKS IN IMPLEMENTING THE WORK OF PYROTECHNICS.

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Resumen: En el presente estudio se planteó identificar los riesgos a los que se expone una persona que se dedica a la pirotecnia, específicamente en la fabricación de cuetes, en este análisis se evaluó a un hombre adulto de 50 años de edad, de complexión media, cuya labor es ser pirotécnico artesanal. El método de análisis aplicado fue el de Suzanne Rodgers que estudia el esfuerzo, la duración y la frecuencia requerida por cada parte del cuerpo para realizar una determinada tarea. Este método evalúa lesiones o enfermedades por sobre esfuerzo, indicando que actividades pueden imponer demandas excesivas en los músculos, tendones y ligamentos articulares del personal operativo, a partir de estos parámetros se hace una predicción de la fatiga muscular. Los resultados arrojaron un Nivel 7, el cual es alta peligrosidad, además de las condiciones toxicas al respirar todo el turno los componentes químicos. Se propone equipo de protección, un rediseño de la estación y medidas de seguridad conforme a la Normatividad.

Palabras clave: Condiciones de trabajo, severidad toxica, daño lumbar.

Relevancia para la Ergonomía: El estudio contribuye a la difusión del conocimiento y la conciencia de la importancia de la ergonomía en el diseño de las estaciones de trabajo y los procesos de producción, destacando lo más importante es la salud y la vida de los trabajadores sin dejar de lado la parte de la empresa productiva y funcional.

Abstract: In the present study it raises identify risks that a person who is dedicated to the pyrotechnics, specifically in the manufacture of firecrackers, in this analysis an adult 50 years of age, medium build man was evaluated, exposed whose artisan work is to be pyrotechnic. The method of analysis of Suzanne Rodgers was studying the effort, duration and frequency required for each part of the body to perform a particular task. This method evaluates injuries or diseases overexertion, indicating that activities can impose excessive demands on the muscles, tendons and ligaments of the operating personnel from these parameters a prediction of muscle fatigue is. The results showed a level 7, which is highly dangerous, besides the whole breathing toxic chemical components shift conditions. protective equipment, a redesign of the station and safety measures under the proposed Regulations.

Keywords: Working conditions, toxic severity, lumbar damage.

Relevance to Ergonomic: The study contributes to the spread of knowledge and awareness of the importance of ergonomics in the design of workstations and production processes, highlighting the most important thing is the health and lives of workers without neglecting the part productive and functional enterprise.

1. INTRODUCTION

Every year in our country, public and private sectors related to the health sector especially, recommend a ban on fireworks, in order to prevent children / as may be affected .. The injuries related to fireworks most often occur on the hands and fingers, eyes, head and face. These cause burns, bruises and lacerations. Fire, burns, maiming, poisoning, poisoning, noise and environmental pollution are some of the risks to be expected when acquiring and handling fireworks.

Most lesions on the hands and face, by the approach of these body parts to turn artifacts. In the present study arose identify risks that a person who is dedicated to preparing firecrackers exposed. It also proposes an ergonomic design. This analysis evaluated a worker of 50 years whose work is artisanal pyrotechnics. It ergonomics to the workplace in order to identify risks in joint evaluation is performed.

2. OBJECTIVES

Mechanical identify ergonomic factors using quantitative methods or tools that can provide both passive information (passive surveillance) and active information (active surveillance). (Romero and Rescalvo S. F.)

3. METHODOLOGY

In this analysis we evaluate a man of 50 years whose work is being pyrotechnical craft, the 2000 white rockets made every hour. It ergonomics to the workplace in order to identify risks in the joint ligaments evaluation was performed. The analysis method Suzanne Rodgers studies the effort, duration and frequency required for each part of the body to perform a particular task. the interaction of level of effort, duration of effort before relaxation (or before moving to a lower level of effort), and frequency of muscle activation per minute for each muscle group is evaluated. From these parameters a prediction of muscle fatigue is. (Rexroth S. F.)

This method evaluates injuries or diseases overexertion, indicating that activities can impose excessive demands on the muscles, tendons and ligaments of the operating personnel. (De la Vega 2011).

Individual Features: Skill: High, Resistance: Media type: Weight: 70 kg, Height: 1.65 (Media), Age: 50, Gender: Male.

Figure 1. Activity Production process for the production of firecrackers.

4. RESULTS

In execution of the activity of the worker experiences a 43% fatigue, injuries 41% with an average risk, materials handling 83% with the highest risk being its main manual activity. Finally metabolic energy expenditure with 58%. So the same task may be more difficult for some people of small build. Environment: Thermal 25th C, 900 lux illumination level, noise 70 db. According to the established ranges in NOM`s (STPS 2015).

5. CONCLUSIONS

In this case the sum is HIGH (A) Severity 7 almost all cases this means that the operator has a high potential health risk in exercising this work.

The results have been decisive in the development of new procedures, restructuring jobs and protective equipment, in addition to the organization must maintain its facilities in a state of order, cleanliness and safety, in order to reduce occupational risks, without discrediting their productivity.

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ERGONOMIC SYSTEM TO REDUCE RISK FACTORS

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Resumen: Hoy en día, toda organización con estándares internacionales de calidad y metas de crecimiento integral, maneja el término de "ergonomía", ya que existe una preocupación genuina por la salud y seguridad de sus colaboradores. Por lo tanto, esta investigación se centra en la implementación de un sistema ergonómico en una empresa de manufactura de de balastras electrónicas, con el propósito de eliminar los factores de riesgo que afectan a los operadores en el área de segundas pruebas del departamento de producción. Dieciséis operadores participaron en esta investigación, por lo tanto, entrevistas y observación directa se aplicó para la recopilación de datos, la evaluación de esta se realizó con dos herramientas: Guía de evaluación para el Trabajo / lugar de trabajo (herramienta de empresa) y el método ergonómico de evaluación rápida de extremidades superiores (RULA) orientada hacia la revisión de posturas en las condiciones de trabajo.

Palabras clave: Factores de Riesgo, Ergonomía, posturas, método RULA

Relevancia para la Ergonomía: Esta investigación muestra cómo un diseño óptimo para el lugar de trabajo ayuda a reducir o eliminar los factores de riesgo, la mejora de las condiciones de salud y seguridad, la comodidad y la productividad del empleado en un entorno de manufactura.

Abstract: Nowadays, every organization with international quality standards and general growth goals, manages the term "ergonomics", since there is a real concern about the health and safety of its employees. Hence, this research focuses on the implementation of an ergonomic system at a manufacturing company producing electronic ballasts, for eliminating the risk factors that affect the operators in the second test area of the production department. Sixteen operators participated in this research, therefore interviews and direct observation were considered for the data collection, evaluating this with two tools: Evaluation Guide for Work/Workplace (company's tool) and the ergonomic Rapid Upper Limb Assessment (RULA) method oriented towards the revision of postures in working conditions.

Keywords: *Risk Factors, Ergonomics, Postures, RULA Method.*

Importance of this article: This research shows how an optimal design for workplace helps to reduce or eliminate risk factors, improving the health and safety conditions, comfort and productivity of the employee in a manufacturing environment.

Importance of this publication. Expose and publicize the results of the research conducted in the academic unit of Industrial Engineering of the Instituto Tecnológico de Tijuana focused on ergonomics.

1. INTRODUCTION

In the last decades, the concept of Ergonomics has been introduced in the industrial language. Considering Ergonomics represents opportunity areas for all organizations with objectives for economic, competitive and human growth. Economic growth considers payment avoidance of compensations and absenteeism caused by accidents; as well as, improving competitiveness through productivity due to right analysis of the motion economy.

Besides, the continuous evolution of work techniques, design innovation of equipment and machines, and the quality enhancement, Encourages companies´s competitiveness to improve; whilst, it is recognizing human growth from the importance than the organization gives to their human capital through motivation and attention of the workplace conditions (Niebel & Freivalds, 2009).

Therefore, ergonomics can be an issue that requires special attention in companies. In which is it not solely important to supply the necessary tools to the employees, analyze workplace conditions, and evaluate interactions with equipment and machines and the production areas environment. Also, factors like temperature, noise, vibrations, among other; skills to perform a task, postures and movements; labor relations, mental workload and economical and emotional situation must be considered Mondelo, Gregori, & Barrau, 1999).

The purpose of this research is to implement an ergonomics system that helps eliminate the current risk factors in the production department of a manufacturing plant dedicated to produce electronic ballasts; this company is located in the city of Tijuana; Baja California, México. This research is supported by the application of the RULA method and the evaluation guide for work and the workplace.

RULA method was developed to investigate the exposure of individual workers to risk factors associated with work and the evaluation of the postures adopted, forces required and muscle actions in a variety of manufacturing tasks where risk factors associated with upper limb disorders may be present the evaluation guide for work and the workplace (McAtamney & Corlett, 1993).

2. OBJECTIVES

Implement semiautomatic ergonomic system in second tests area, in order to eliminate risk factors at workstations, supporting the study with the application of the ergonomic RULA method and the evaluation guide for work and the workplace.

3. METHODOLOGY

This research applies the qualitative method with an exploratory approach. Quecedo and Castaño (2002), define the qualitative method as a research that produces descriptive data from people's words, spoken or written and / or direct observation. Therefore, the research is qualitative as surveys and direct observation were applied to analyze the positions and movements of the operators, in order to reflect information to identify the conditions of the workstations and the different positions of employees in both shifts morning and evening.

Likewise, the explanatory approach is focused in establishing the causes of events, incidents or phenomena being studied (Hernández, Fernández, & Baptista, 2006). This approach is used, once the risk factors are defined through an analysis before and after the implementation of the ergonomic system with the purpose of identifying improvements in workstations, and eliminate the risk factors. Therefore, this research requires the following steps:

Step 1. Identification of the work risks. It consists of studying working conditions, postures and movements of the operator; this step helps to identify each of the occupational risks faced in workstations. Implementing for this purpose the ergonomic method RULA and the evaluation guide for work and workplace, which include five elements to be evaluated.

Data collection for evaluation guide for work and workplace was based on interviews and direct observation of sixteen operators working in the area of second test. Results of this evaluation are shown in table # 1.

Table 1. Evaluation Guide for Work and Workplace

<table>
<tr><th>¿Repetitive movements involved?</th><th>¿Workplace designed Properly?</th><th>¿Fingers and wrists irregular movements?</th><th>¿Fatigue and / or physical workload?</th><th>¿Cycle Time?</th></tr>
<tr><td>Hip Turn</td><td rowspan="5">Space Reduced, causing interference between Operators
Wrong assembly, causing electrical discharges</td><td rowspan="4">No irregulars, but repetitive movements whenever the operations are performed</td><td rowspan="4">Depends on the producing model
Tiredness of back and neck</td><td rowspan="4">Varies depending on the model produce: from 4.5 to 7 Seconds</td></tr>
<tr><td>Arm Strech</td></tr>
<tr><td>Arm Flex</td></tr>
<tr><td rowspan="2">Moving Fingers</td></tr>
<tr><td colspan="3">¿Are there brackets or mounts for the operation?
The operation utilize test jigs with bronze connectors for connecting cables.</td></tr>
</table>

RULA evaluation was divided into three schemes: lower and upper limbs, muscular activity and load and strength; showing scores and performance level for each case. Evaluation shown in figure 1 muscular activity indicates that performance level is equal to four and based on the ergonomic method RULA urgent changes are required in the working area.

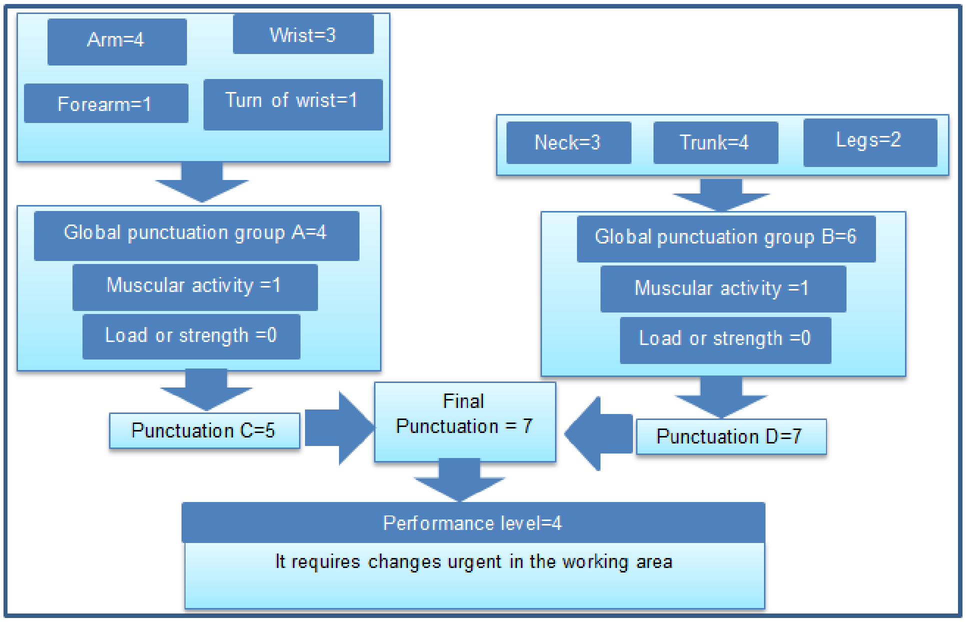

Figure 1. RULA Score for Muscular Activity

Step 2. Design of an ergonomic system. During this step, different ideas are proposed in order to reach the final design of a system that meets the required characteristics, integrating the following systems:

- Safe system for the operator
- Automatic Test System
- Continuous flow system
- Capable system to be manipulated in cycle times
- Flexible system to any type of ballast

Step 3. Supplier Bidding Process. Submit requirements for the new system to different suppliers to get their proposals. The supplier nomination is going to be based on quality, price and delivery times.

Step 4. Implementation of ergonomic system. Perform the implementation of the selected system, according to the requirements previously established in the analysis and diagnostic made. Figure 4 shows the Semiautomatic Ergonomic System that was implemented, which consist on a conveyor of automatic test constituted by a set of pallets for transporting ballast hauled by an electric motor and a system chain roller, aligning the amount of equipment and operators. This is divided in three processes: loading, and connection, testing and process packaging/ removal of parts not conforming, these processes are formed by elements electrical, mechanical, and pneumatic to carry out their function.

Figure 2. Semiautomatic Ergonomic System

Stage 5. System evaluation. Evaluate the new ergonomic system, perform pilot runs in order to determine if the system meets the requirements established or it requires modifications for the system validation purposes.

Step 6. System validation. During this last step, it is validated if the system meets the safety standards for employees; as a result of the adopted correcting actions.

4. RESULTS

It can be stated the purposes of this research were achieved, since the stablish objective of “Implementing a semiautomatic ergonomic system in the area of second tests, in order to eliminate risk factors at workstations, supporting the study with the application of the ergonomic method RULA and the evaluation guide for work and the workplace” was fulfilled. The results attained once the new system was implemented are described below:

1. Risk factors caused by the electric shock were eliminated, to accomplish this, the test is performed with a semiautomatic system and separated from the operator's activities
2. Significant improvements were achieved in the five elements of the evaluation guide for work and workplace, as shown in Table 2; also, the fixture test was eliminated and inspection is performed automatically.
3. Postures and movements were evaluated with the RULA method, it is concluded that the postures are acceptable, based on the new system RULA score for muscular activity, as show in the figure 3.

Table 2. Evaluation Guide for Work and Workplace with New System

¿Repetitive movements involved?	¿Workplace designed Properly?	¿Fingers and wrists irregular movements?	¿Fatigue and / or physical workload?	¿Cycle Time?
Stretch and flex arm	Enough space, no longer have contact with electrical test	No irregular movements	Normal tiredness for work	5 Seconds
The test jig was eliminated, no longer is the inspection performed by the operator, this is done automatically.				

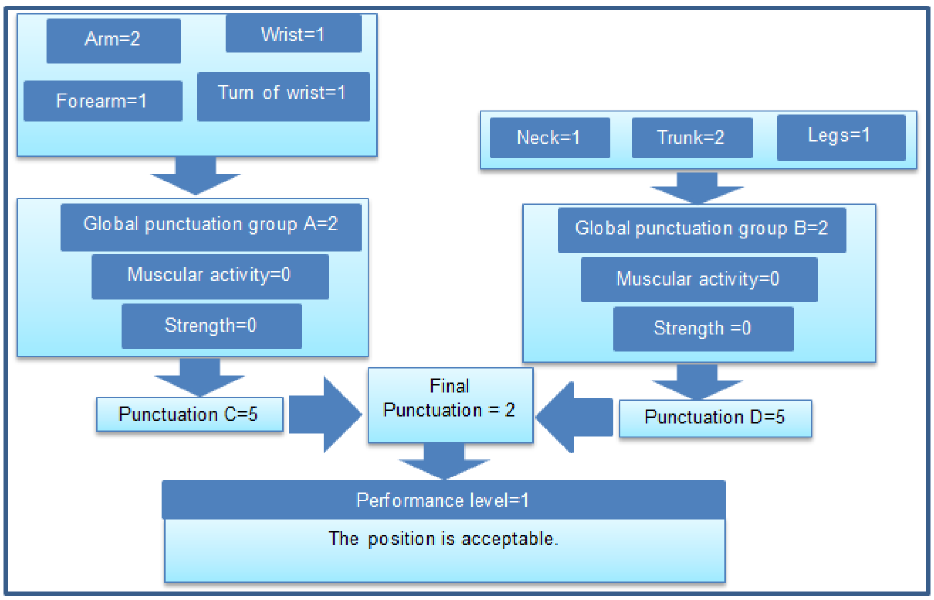

Figure 3. New System RULA Score for Muscular Activity

4. It was possible to reduce the number of incidents, given that in the past this process represented about 49% of the incidents record in the production area. Based on the last quarter evaluation, the proportion dropped to 7% of all incidents.

5. CONCLUSIONS

The conclusion of this research is that the system implementation helped minimize risk factors in the area of second tests. This allows duplicating the proposed actions, in order to analyze and reduce the risks that arise in other areas to improve the working conditions of the operators. Additionally, this implementation will be reflected with higher productivity and financial efficiency for the company, through the optimization of time, equipment and human resources.

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MEDICIÓN Y EVALUACIÓN DE FACTORES ERGONÓMICOS EN MICROEMPRESA DE PRODUCTOS PLASTICOS

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Resumen: En el presente trabajo se analizaron los factores de riesgo de lesiones por DTA´S (Desorden Traumático Acumulativo) en una estación de trabajo del departamento de Plásticos, específicamente en el proceso de moldeado; con el fin de identificar si las condiciones afectan la salud de los trabajadores, dando lugar a enfermedades profesionales. La investigación es tipo Transversal y de aplicación básica, por lo que los resultados muestran el diagnóstico y evaluación del estado actual del proceso de moldeado y específicamente en la producción de vajillas, el estudio permitió determinar las afectaciones en la salud de los operarios por tipo de actividad e identificó los factores de riesgo que existen en el área de moldeado. Se analizaron los factores de riesgo de lesiones por DTA´S (Desorden Traumático Acumulativo). El estudio permite determinar las afectaciones de DTA's por tipo de actividad y analizar factores de riesgo que existe dentro del área y desarrolla una propuesta de mejora.

Palabras clave: Riesgo, daño, estación de trabajo.

Relevancia para la Ergonomía: El estudio contribuye a la difusión del conocimiento y la conciencia de la importancia de la ergonomía en el diseño de las estaciones de trabajo y los procesos de producción, destacando lo más importante es la salud y la vida de los trabajadores sin dejar de lado la parte productiva y funcional de la empresa .

Abstract: In this paper the risk factors of injuries DTA'S (Cumulative trauma disorder) in a workstation Plastics department, specifically in the molding process are analyzed; in order to identify whether conditions affect the health of workers, resulting diseases. Research is Transversal and basic application type, so the results show the diagnosis and evaluation of the current state of the molding process and specifically in the production of tableware, the study allowed us to determine the effects on the health of workers by type activity and identified risk factors that exist in the molding area. risk factors of injuries DTA'S (Cumulative trauma disorder) were

analyzed. The study to determine the effects of DTA's by activity and analyze risk factors that exist in the area and develop a proposal for improvement.

Keywords: Risk, damage, workstation

Relevance to Ergonomic**:** The study contributes to the spread of knowledge and awareness of the importance of ergonomics in the design of workstations and production processes, highlighting the most important thing is the health and lives of workers without neglecting the productive and functional part of the company.

1. INTRODUCTION

Tanks or containers are large near the main port areas areas in which, in addition to the storage of empty containers carried out a series of complementary activities such as inspection, repair and cleaning them in order to give a proper maintenance, and termination of the containers to be used for import and export sea or land. In this work environmental factors leading to calls occupational diseases, including lumbar backs are injuries, repetitive trauma, musculoskeletal injuries and psychological disorders are continually altered.

2. OBJECTIVES

The aim was to identify through methods Ergonomic risk factors that may cause one or more cumulative trauma disorders by (DTA'S) on staff operating in shaping and improving workstation ..

3. METHODOLOGY

The ergonomic evaluation of jobs workers is especially directed to manual manufacturing activities of limes in the molding process, according to the handling of materials, and the use of tools, so as to allow a global vision performance of operators to design jobs and secure healthy and proactive tasks, leading track improvements and compare different jobs. The manufacturing process is carried out when melamine is combined with heat and pressure, forms this resin, and water containing released under pressure, becomes thermoset plastic which may be molded and pressed in several ways in the machine Chang Long double press, FBF series.

Tabla1. Areas evaluadas en el Método Plibel.

There are currently several methods for job evaluation; Metabolic expenditure, Rula and Plibel: In this study methods were used. Lighting, temperature and noise: and environmental conditions were evaluated. The software used was METRIXX VR. (De la Vega 2011).

Figure 2. The method of molding and cleaning.

4. RESULTS

Running of the worker's activity experience environmental conditions with intermittent noise level of 92 db, a temperature of 28 ° C, a level of vibration of 70 Hz and 500 lux. Rula method
result value obtained in Table 6, requires research and future changes.

Figura 3. Escalón fijo y Tapete ergonómico

5.CONCLUSIONS

En ejecución de la actividad el trabajador experimenta condiciones ambientales con un nivel de ruido intermitente de 92 db, una temperatura de 28 ºC, un nivel de vibración de 70 Hz y con 500 lux. Resultado del Metodo Rula Valor obtenido en tabla 6, requiere investigación y cambios a futuro.

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STATE OF THE ART OF THE PROPOSAL OF A COMPREHENSIVE MODEL OF ERGONOMIC ASSESSMENT IN MICRO-ENTERPRISES FOOD SECTOR FOR THE PLANNING OF HUMAN RESOURCES AND TECHNOLOGY.

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Resumen: Debido a que las Mipymes ocupan un lugar importante en la economía de muchos países y se observan características similares en cada uno de ellos, es de vital importancia la consolidación y crecimiento de cada uno de ellas, para lo cual se deben mejorar las condiciones internas de las empresas, con el fin de generar un ambiente que puedan superar los diferentes problemas que afectan el buen desempeño de los trabajadores e incrementar su crecimiento. Como la ergonomía centra su trabajo en el hombre, existe una relación muy estrecha con el desempeño de éste y la sociedad, por ello el desarrollar el binomio ergonomía-microempresa, debe de traer consecuencias favorables en primer lugar para el trabajador y por añadidura a la empresa con un crecimiento constante, debido a la mayor satisfacción del empleado y mejora continua en sus procesos de productos o servicios según sea el caso de la microempresa.

De ahí la importancia de desarrollar un modelo integral de evaluación ergonómica en micro-empresas del ramo alimenticio del Estado de Sonora, que permita la planeación de Recursos Humanos y Tecnología, buscando con ello evitar que los trabajadores estén expuestos a actividades que le puedan causar Trastornos Musculoesqueléticos, disminución en su productividad y una carga para la sociedad por sus incapacidades.

Abstract: Because Mipymes play an important role in the economy of many countries and similar characteristics in each of them, it is vital the consolidation and growth of each of them, are observed for which should improve internal conditions companies, in order to create an environment that can overcome the various problems affecting the good performance of workers and increase their growth. As ergonomics focuses its work in man, there is a very close relationship with the performance of state and society, so the development of the binomial ergonomics-

micro, should bring favorable consequences primarily company with steady growth, due to increased employee satisfaction and continuous improvement in its processes, products or services as the case of microenterprise.
Hence the importance of developing a comprehensive model of ergonomic assessment in micro-enterprises in the food sector in the State of Sonora, which allows the planning of Human Resources and Technology, seeking thereby to prevent workers from being exposed to activities that may cause disorders musculoskeletal, decreased productivity and a burden to society for their disabilities.

Keywords: Comprehensive model of ergonomic evaluation, Mipymes and Ergonomics.

Contribution to Ergonomics: Use this tool in order to increase productivity in the company, profitability, quality of service, human quality of its employees and families, which will result in increased income for both company-employed and better social stability. Since it is the state of the art research is very important publication for the impact it can have the comprehensive ergonomic evaluation model to be developed for small businesses in the food sector is known.

1. INTRODUCTION

At present there are studies internationally ergonomic applications in different types of companies and situations, as in the case of (Areeudomwong, et al., 2012) evaluating muscle fatigue trunk in sitting, handicrafts, where for thirty minutes they developed his work with legs crossed and found that muscle fatigue trunk craftsmanship is a potential risk for low back pain, in the same way (Bosch, et al. 2012) investigated the temporal changes in movement strategy and the fatigue performance during short work cycles, where it was found that participants gradually changed their strategy temporary movement to possibly alleviating the effects of fatigue. This suggests that in order to effectively counteract fatigue and maintain performance, industrial production should allow high spatial and temporal flexibility.

Similarly, (Keir and Brown, 2012) showed in their study that factors such as high repetition rates and the strength of high grip, play an important role in the development of related upper limb musculoskeletal disorders, the purpose of this study was to systematically examine the effects of pressure load and frequency in muscle activity with or without grip, finding the strength and frequency are important risk factors for disorders of the upper extremities. They also found that the upper extremity muscle activity in response to the workload frequency force in a complex shape that can be replaced if a grip is present.

Studies like these and many more that exist at the international and national levels, demonstrate the need to keep in mind in all companies regardless of their size using ergonomics. As mentioned (Cordova et al. 2011) comparing the perception of the weight of a load in the female workforce in the industry and the health sector, where it found that there is a difference in perception of effort between the two groups work that is less awareness in the health sector, demonstrating that it is desirable to have different considerations in the manual handling of loads where are handled the same level of weight or must be studied separately.

Same way it is important the relationship between human resources management, ergonomics and work dynamics (Charbel, 2011), because these three fields of knowledge who emphasize the human side of socially responsible organizations.

There are evaluation methods proposed by institutions in the United States or France which measure physical fatigue in terms of metabolic wear and others measure the risk of injuries Musculoskeletal, as the case of the new ergonomic method of postural evaluation called NERPA, proposed by (Sanchez-Lite, et al. 2013) which developed a three-dimensional model of the workstation and the assembly process, this method was used for the design of six production lines, with 240 manual assemblies, being improved 24 they. The previous study demonstrated the usefulness of the method, finding significant differences between the NERPA method and the method of Rapid Assessment of Upper Extremity RULA.

They must take action to preventing Musculoskeletal conditions caused by disorders of occupational origin because it has a growing statistical behavior and do not generate a high cost of implementation (Rodriguez and Guevara, 2011).

In the same way (Chiasson et al. 2012) presents a comparison of eleven different methods to determine the factors of risk of musculoskeletal disorders of occupational origin, where they are analyzed by video 224 workstations involving 567 jobs in various sectors industry, ranking risk categories low, moderate and high. The results determine that each of the variables measured by the method and type of intervention should be considered when choosing the method of observation.

There are some methods of evaluation, however there is a method that is comprehensive evaluation which take into account aspects of work execution, risk of injury, metabolic rate and biomechanics.

Because Mipymes occupy an important place in the economy of many countries of the European Union, Latin America and the Caribbean, similar features are observed in each, where 67% of workers belong to them, as said the United Nations Economic Commission for Latin America and the Caribbean, in the statement number 13/009.

Similarly it is considered that with the consolidation of micro, small and medium enterprises there is a possibility of improving the competitiveness of a country, which should improve the internal conditions of enterprises in order to create a political context and economic that can overcome the various problems affecting the good performance and growth levels. (Mora-Riapira, Vera-Hill and Melgarejo-Molina,2015).

According to data from INEGI, National Institute of Statistics, Geography and Informatics, the classification has micro-enterprises, are those that have a maximum of 10 workers and have a range of annual sales of 4 million pesos.

Similarly INEGI reports that there are approximately 4 million 15 thousand business units, of which 99.8% are SMEs that generate 52% of GDP and 72% of employment in the country in Mexico. In Sonora exist according to INEGI 107.723 economic units.

As ergonomics focuses its work in man, there is a very close relationship with the performance of this and society, as workers take care of the characteristics of the situation, which did not inform the organization of their work, the contribution they pose to production and the effects that may result from the difficulties encountered in doing so, both the company and themselves.

Therefore, the development of the binomial ergonomics-micro, should bring favorable consequences primarily for the worker and in addition to the company with steady growth, due increased employee satisfaction and continuous improvement in its processes, products or services as the case of microenterprise.

Despite the great importance of MSMEs, they present a number of complications that limit their development, such as: low innovation capacity, low use of information technology and communication, limit access to adequate financing problems marketing of its products and obtaining inputs, and limited participation in the public procurement market (Castillo and Girön, 2014). Another problem is that mostly MSMEs, do not take the right decisions for their financial strategies of growth, which can lead to bankruptcy (Alvarez and Abreu, 2008).

Hence the importance of investigating whether the micro-enterprises in the State of Sonora in the food sector there is the culture of the application of ergonomics in workstations and their environment, with the goal of creating an integrated model of ergonomic overall utilization for companies in the food sector, for planning human resources and technology, it is necessary to solve the following main question: ¿what are the causes that prevent micro enterprises Sonora the food sector do not apply a model of ergonomic evaluation workplaces and what effects that are causing this impediment they are?

Also to answer this key question, you must answer the following questions:

- ¿Are you facing the food sector MSMEs limitations to apply traditional models of ergonomic evaluation?
- ¿What are the traditional ergonomic assessment models available for MSMEs in the food sector?
- ¿What are the ergonomic evaluation models that are being used in the food?
- ¿Is there a record of diseases caused by exposure to the routine work in the food sector MSMEs?

The issue addressed in the proposed research is relevant, firstly because of the importance MSMEs have international, national and local level, since according to data from INEGI 2009, in almost every country in the world, over 90% of companies are micro, small and medium enterprises, generating more than half of employment and in many countries represent the most dynamic sector of the economy.

In Latin America microenterprises represent between 60 and 90% of all economic units. In Mexico, MSMEs are considered of great importance for development of the country (Lagunas, Olivares and Post, 2012) as the sector with the highest number of economic units.

Moreover, diseases repetitive work, musculoskeletal disorders or risk exposures of occupational origin have increased significantly as mentioned (Petit et al., 2015) in the study of risk factors for carpal tunnel syndrome related the organization of work, in this study it was observed that the damage increased linearly with age, women being the most affected. These alterations suffering body structure affect the muscles, joints, tendons, ligaments, nerves, bones and circulatory system of people.

According to the European Agency for Safety and Health at Work, MSDs affect a quarter of the European population where 25% of workers suffer backache and 23% complain of muscle aches, economic cost in Europe MSDs account for 1.6% of GDP is 205.107 million euros a year. (Fernandez, M. et al. 2014).

Due to regulations which came into force on 13 February 201 5 and was issued by the Presidency of the Mexican Republic and published in the Official Gazette on November 13, 2014 for the Federal Regulations on Safety and Health at Work, in its Article 3 paragraph XVI, which aims to ensure workers safe organizational and healthy environments, which requires companies to have an area of decent work to enable them to prevent risks and workers the right to develop their activities in a secure environment. (Official Gazette, November 13, 2014).

It is expected that the information produced by this research serve primarily to micro enterprises, in order to create a model of ergonomic evaluation that lead to greater productivity and performance in their work and thereby contribute in a major way in the local economy, state and national.

This work aims to help micro enterprises, which are the weakest sector for their shortcomings in those found to be more productive by decreasing the risks of work, the government sector to establish methodologies support for the implementation of this model in companies in the food sector of a home and the rest of the productive sectors as see the application and workers increasing safety at work for the elimination of Musculoskeletal disorders.

2. OBJECTIVES

2.1 General objective.

Develop a comprehensive model of ergonomic assessment in micro-enterprises in the food sector in the State of Sonora, which allows the planning of Human Resources and Technology, seeking thereby to prevent workers from being exposed to activities that may cause musculoskeletal disorders, decrease in productivity and a burden to society for their disabilities.

2.1 .1 Specific Objectives.

1. Evaluate the degree of application of ergonomics in micro companies in the food industry.
2. Identify that ergonomic assessment techniques for workstations micro food sector companies are using.
3. Identify what risk factors generate musculoskeletal disorders in micro-companies in the food industry.

4. Quantify Musculoskeletal Disorders in micro companies in the food industry.
5. Identify the main causes that prevent food sector micro enterprises have access to the use of ergonomic assessment techniques.

3. METHODOLOGY

3.1. Research Design.

It aims to develop research descriptive and correlational nature, where the model resulting from ergonomic assessment, establish a relationship between musculoskeletal disorders with productivity, commitment employer-employee and worker satisfaction in micro companies in the food industry.

3.2 Sample selection.

The population to be taken into account for research are micro companies in the food branch of the main cities of the State of Sonora as: Hermosillo, Obregon, Nogales, Navojoa and Caborca and also that are registered in the Ministry of Economy of Sonora. With the list of companies simple random sampling for selection of the sample was used.

3.3 Data Collection.

For data collection instruments of assessment for large companies such as the REBA, RULA, LEST, NIOSH, SUE RODGERS, among others will be used.

3.3.1 Selection of the instrument.

A questionnaire as an assessment tool, based on existing techniques will be developed, using the Likert scale, with the purpose of measuring the degree of risk of musculoskeletal disorders that exists in the workstations of micro-companies in the food industry.

3.3.1.1 Validity of the instrument.

To give confidence to the measuring instrument will run a pilot test, applying the survey to micro enterprises in the city of Caborca, Sonora.

3.3.2 Implementation of the instrument selection.

Randomly micro food industry companies will be selected from the list presented by the Ministry of Economy of the State of Sonora and depending on the sample that results.

Authorization for the application of the survey and interviews with the owners and employees of micro companies in the food sector is required.

3.3.3 Coding.

From the results, a statistical analysis using SPSS (Statistical Package for Social Science) will.

3.3.4 Data preparation.

Once applied the surveys will analyze them to eliminate those that are inconsistent and increase the reliability of the same.

3.4 Data Analysis.

With the results of the surveys will be established whether or not relationship between different Musculoskeletal Traumas and Productivity in micro companies in the food industry.

4. SCOPE AND LIMITATIONS

It will be investigated in the main cities of the State of Sonora where micro enterprises in the food sector, registered in the Ministry of Economy of the Government of the State of Sonora, which will be selected using techniques and statistical procedures are, thereby seeking to gather information occupational hazards and ergonomic assessment techniques that apply.

The information provided by employers and workers will determine the feasibility of building the model of ergonomic comprehensive evaluation.

Similarly, collaboration of municipal and state government agencies are expected to facilitate the development of research.

Some of the limitations you have is impossible to study all micro enterprises in the State of Sonora, lack of time and resources, equally unable to develop a longitudinal study to measure the effects of restructuring and methods execution of the tasks on the workstations of micro enterprises food sector, lack of time and availability of resources.

5. EXPECTED RESULTS

With this research we expect:

a) Establish a relationship between the integrated model of ergonomic assessment and productivity.

b) To inform employers of the food business model comprehensive ergonomic evaluation.

c) Raise awareness among entrepreneurs of micro companies in the food branch of the importance of the implementation of the comprehensive model of ergonomic evaluation.
d) To assist micro enterprises food sector to grow by decreasing absenteeism caused by Musculoskeletal Disorders.
e) Prevent injuries that can cause irreversible damage to people.
f) To assist the social welfare by decreasing Musculoskeletal disorders caused by poorly designed work stations.
g) To establish precedents that consider the importance of the application of ergonomics in micro enterprises, which can lead to generate new revenues and contribute to the economy of the countries.
h) That further research generated in the area of ergonomics in all MSMEs, seeking with this decreased the possibility of injury to workers and helping businesses to generate more wealth by applying this technique ergonomic comprehensive evaluation.

6. EXPECTED CONTRIBUTIONS

This research is expected to contribute to:
a) Make available to micro enterprises of food sector, information that contributes to the growth of the company.
b) Make available to those who require the comprehensive model of ergonomic evaluation.
c) To contribute to the reduction of musculoskeletal disorders caused by exposure in the daily work of micro companies in the food industry.
d) Increasing the productivity of micro companies in the food industry for the use of the comprehensive model of ergonomic evaluation.
e) Raise awareness among employers of the importance of the use of ergonomics in micro enterprises.
f) Reduce the economic sanctions applied to micro enterprises in the non-use of ergonomics in their companies.
g) To use this tool in order to increase productivity in the company, profitability, quality of service, human quality of its employees and families, which will result in increased income for both company-employed and better social stability.

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ERGONOMIC ASSESSMENT OF A WORK OF AN AUTOMOTIVE AND VULCANIZED WORKER.

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Resumen: El presente es un estudio sobre seguridad en el trabajo que realiza un mecánico automotriz, con el objetivo de establecer una evaluación para emitir un diagnóstico sobre riesgos potenciales de daños corporales o accidentes, donde puede verse afectada su salud debido a las condiciones de su puesto de trabajo. Aun cuando la base de la Ergonomía es adaptar el trabajo al trabajador y no a la inversa; en el caso particular de los talleres mecánicos es muy difícil de aplicar por la variedad de tamaños y diseños de vehículos que ingresan. presente estudio se planteó identificar los riesgos a los que se expone una persona que se dedica a reparar autos para tomar medidas preventivas y mejorar las condiciones. Se analizaron los factores de riesgo de lesiones por DTA´S (Desorden Traumático Acumulativo). El estudio permite determinar las afectaciones de DTA's por tipo de actividad y analizar factores de riesgo que existe dentro del área, desarrolla una propuesta de mejora. Para realizar este estudio se utilizaron los métodos de evaluación de puestos, de FCD, SUZANNE RODGER y PLIBEL. Asimismo las condiciones ambientales (iluminación, temperatura y ruido). Los sistemas a evaluar están realizados por medio del laboratorio virtual de ergonomía, METRIXX VR

Palabras clave: Nuevas tecnologías, riesgos potenciales, condiciones de trabajo.

Relevancia para la Ergonomía

: El estudio contribuye a la difusión del conocimiento y la conciencia de la importancia de la ergonomía en el diseño de las estaciones de trabajo y los procesos de producción, destacando lo más importante es la salud y la vida de los trabajadores sin dejar de lado la parte productiva y funcional de la empresa .

Abstract: This is a study on safety at work performing an auto mechanic, with the aim of establishing an evaluation to issue an assessment of potential risks of injury or accidents, which may be affected their health due to the conditions of his post job. Although the basis of ergonomics is to adapt the work to the worker and not the reverse; in the case of mechanical workshops it is very difficult to apply for the variety of sizes and designs of vehicles entering. This study was planned to identify the risks that a person who is dedicated to repairing cars to take preventive measures and improve conditions exposed. risk factors of injuries DTA'S (Cumulative trauma disorder) were analyzed. The study to determine the effects of DTA's by activity and analyze risk factors that exist within the area, develop a proposal for improvement. For this study the methods of job evaluation, FCD, SUZANNE RODGER and PLIBEL were used. Also environmental conditions (light, temperature and noise). Evaluate systems are made through the virtual laboratory ergonomics, METRIXX VR.

Keywords: Risk, DTA's, workstation.

Relevance to Ergonomic**:** The study contributes to the spread of knowledge and awareness of the importance of ergonomics in the design of workstations and production processes, highlighting the most important thing is the health and lives of workers without neglecting the productive and functional part of the company.

1. INTRODUCTION

The activities carried out in repair of vehicles are very different and functions that develop workers cause ergonomic hazards due to: The adoption of awkward postures and / or maintained: forced by lack of space in the pit or inside the vehicle positions , arms raised above shoulder (high vehicles), crouching or squatting, bending of the trunk, folded back (wheel alignment) Making efforts and application of forces, Manual manipulation of medium or heavy loads and performing short tasks repetitive cycles (in many cases with exposure to hand-arm vibration, applying pressure with the extremities and maintenance of heavy tools).

Field studies developed by OSHA (Occupational Safety and Health Administration) in the United States, have established the existence of five risks associated closely with the development of muscle-tendon injuries / musculoskeletal (L.M.E):

- Perform the same movement or movement pattern every few seconds for more than two hours without interruption.
- Keep body parts in fixed positions or dangerous positions for more than two hours during the shift.
- The use of tools that produce vibration for more than two hours.
- Make vigorous efforts for over two hours.
- Make frequent manual lifting or overexertion (MHL).

2. OBJECTIVES

To study the behavior of risk factors associated with poor posture, cargo handling and their interrelation to determine the effect of these environmental conditions in exposed workers.

3. METHODOLOGY

The methodology is based on identifying and quantifying the risk of each job, considering the areas in which each task and activity or job develops, through direct and questionnaires observation on working conditions, verifying compliance with Standards, (STPS 2015).

To do so, they are carried out four phases:

a) Collection of information.

b) Identification of potential risks (risk factors and agents), through Plibel Method and FCD.

c) Risk assessment found.

d) Development and establishment of preventive measures to leliminar or reduce risks and improve the safety and health of workers.

Workers do not have protective equipment such as goggles and gloves would be protective. Because the dimensions of the workshop are very small, the cars occupy the most space and hinder the transfer of materials and tools, as well as the displacement of workers with dismantled parts.

Another irrigation are the substances and products used and generated by the deterioration of the pieces in their work.

Figure 1a: Working with hands above the level of the heart

Figure 1b: Working with hands above the level of the heart

Figure 2: Working with Active flexion retained

4. RESULTS

With 14 si's result in Method Plibel us indicates that there is an increased risk of injury in the following parts: Elbows, forearms, hands. The result of FCD is a bit high but does not exceed NIOSH indicated. Susanne Rogers method, medium risk.

5.CONCLUSIONS

The results have been decisive in the development of new procedures, restructuring jobs and training courses. It is recommended: Avoid working behind the frontal plane. The optimum area work is between the knuckles and shoulders, avoid bending the neck, careful not to work with elbows above shoulder work lying Avoid using elevators or for that pit. If you do it with a platform with wheels and padded Regular lifting height and work equipment, Avoid finger gripping pincer is inevitable. If the activity requires it there are warm-up exercises / relaxation to reduce fatigue in the area and thus reduce the risk of injury.

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ERGONOMIC EVALUATION OF THE LABELING JOB POSITION IN A COMPANY DEDICATED TO THE PROCESSING OF FOOD PRESERVATION

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Resumen: Los riesgos de trabajo representan una de las principales amenazas a la solidez y permanencia en el mercado de cualquier empresa ya que interfieren en el desarrollo normal de las actividades e inciden negativamente en su productividad, por ello el control de los mismos debe ser una de las principales preocupaciones que cualquier empresa debe abordar. En la industria agroalimentaria, a pesar de los avances tecnológicos, se continúan realizando trabajos manuales que implican movimientos repetitivos, adopción de posturas forzadas, esfuerzo físico intenso y manipulación de cargas. El objetivo de este estudio es identificar y caracterizar los factores de riesgo del puesto de trabajo de etiquetado y su impacto en la salud de los trabajadores para generar propuestas que los reduzcan o eliminen, de forma que las actividades que se llevan a cabo en la empresa sean más eficientes, productivas y seguras. Se aplicaron el método propuesto por Suzanne Rodgers y el método RULA (Rapid Upper Limb Assessment) para detectar los riesgos ergonómicos en el área de etiquetado. Los resultados de ambos métodos reportan que existe riesgo moderado y alto de ocasionar DTA's principalmente en el cuello, hombros, espalda, mano y muñeca. Después de analizar los resultados arrojados por los métodos de evaluación ergonómica utilizados y se hicieron propuestas de rediseño y mejora de las condiciones de trabajo.

Palabras clave: Rodgers, RULA, preserves manufacturing, riesgos ergonómicos.

Relevancia para la Ergonomía: Es importante estudiar los factores de riesgo ergonómicos que pueden causar trastornos musculoesqueléticos (TME) en los operadores de producción y, posteriormente, proponer estrategias que minimicen o los eliminen, para mejorar la calidad del lugar de trabajo e incrementar la calidad.

Abstract: Work risks represent a major threat to the solidity and permanence in the market for any company because they interfere with the normal development of activities and adversely affect their productivity, thus controlling those risks should be one of the main concerns that any company must address. In the food industry, despite technological advances, they are still doing manual jobs that involve repetitive movements, adopting awkward postures, intense physical exertion and cargo handling. The aim of this study is to identify and characterize risk factors of the labeling job position and its impact on the health of workers in order to generate proposals that reduce or eliminate, so that the activities carried out in the company can be more efficient, productive and safe. The method proposed by Suzanne Rodgers and RULA (Rapid Upper Limb Assessment) were applied to detect ergonomic hazards in the labeling area. The results of both methods reported that there is a moderate to high risk of causing CTD's (Cumulative Trauma Disorders) mainly in the neck, shoulders, back, hand and wrist. After analyzing the results obtained by the ergonomic evaluation methods used redesign proposals and improving working conditions were made.

Keywords: Rodgers, RULA, preserves manufacturing & ergonomic risks.

Relevance to Ergonomics: It´s important to study the ergonomic risk factors that may cause the MSD (Musculoskeletal Disorders) in production operators and subsequently propose strategies that minimize or eliminate it, to improve the workplace and increase quality.

1. INTRODUCTION

The main economic activity in Sinaloa is agriculture (Meyer, 1997). It has 15,000 producers and 10 packing plants in the state. In the food industry (preserved vegetables and fish, meat, etc.) the work carried out involves repetitive movements, the adaptation of awkward postures, intense physical exertion and cargo handling as well. Despite the mechanical technology developed in these sectors, new risk factors have been added linked to the noise, vibration and thermal load as many of these stations lack of ergonomic principles (Martin, 2007).

In Mexico the number of risks and injuries in the agricultural sector has increased, resulting in labor problems in the process by the operator, according to the IMSS (2012), 768 cases of diseases caused by occupational hazards in the agricultural sector were recorded, which leads to subsidize 22, 240 disability days a year. At the Preservation Food plant where the study was conducted, there are 3 shifts of 8 hours leaving 1 hour free to rest and to eat, and at the labeling area 8,000 to 9,500 boxes with cans of food per shift are packed, with four operators per shift. Despite improvements that have been made in workstations operators continue to have musculoskeletal injuries, mainly in the labeling station where injuries to hands, fingers, neck and back are generated. In Mexico, there is insufficient ergonomic studies in food preservation plants that provide a proposal for improvement of work and increase productivity but especially the quality of life of all those involved in the process.

2. OBJECTIVE

To identify and characterize ergonomic risk factors of the job labeling position and its impact on the health of workers in order to generate proposals that reduces or eliminate, so that the activities carried out in the company can be more efficient, productive and safe.

3. METHODOLOGY

A tour was conducted in order to know in a visual way the study area and to identify the workstations with more ergonomic risk, and to select the appropriate methods for evaluating these stations. Each activity carried out by the operator in his/her work area and how it was carried out was recorded.

Subsequently, the 12 workstations of labeling job position located in the company were filmed, with the purpose of capturing in detail the movements carried out by operators in the different activities carried out by them. All stations were evaluated using the RULA (Rapid Upper Limb Assessment) and Suzanne Rodgers methods. The reason for using both methods was to compare the levels of risk and to have greater accuracy.

The Suzanne Rodgers method (1992) is a method of ergonomic analysis that studies three important factors: the level of effort, duration before relaxation (or before moving to a lower level of effort) and the frequency of muscles activation to perform the activity. With these parameters the level of muscle fatigue that occurs in the following body parts is estimated: neck, shoulders, back, arms-elbows, hands-wrists-fingers, legs-knees, ankles-feet-toes. Each factor has the ability to take values from 1 (low) and 3 (high). At the level of effort the appreciation is subjective, but not in the rest of the factors. The value obtained for each body segment is between (1-1-1) and (3-3-3). For comparison the worst result is used, comparing the obtained values against the reference values of the method.

The RULA method was developed by doctors McAtamney and Corlett, of the University of Nottingham in 1993 (Institute for Occupational Ergonomics), to assess the exposure of workers to risk factors that can cause disorders in the upper limbs. RULA uses body postures diagrams and score tables for assessing exposure to the following risk factors: posture, repetitive movements, applied forces and static activity of the musculoskeletal system.

4. RESULTS

The following operations on the workstation of the labeling job were identified: bending over and taking a cardboard box with the left hand, putting the cardboard box in front, taking from the conveyor belt two cans of product in each hand, rotating both wrists to place the cans in the carton box, the last operation is repeated until 24 cans are placed into the carton box.

In charts 1 and 2 risk levels resulting from the application of S. Rodgers and RULA methods are presented, indicating in which activities of the workstation is necessary to apply preventive and corrective measures to prevent injury to operators.

Chart 1. Result of the application of the S. Rodgers method.

Activity/Task	Body Part	Effort	Duration	Frequency	Risk
Taking a carton Box and placing it in front	Neck	3	1	2	Moderate
	Shoulders	2	1	2	Low
	Back	3	1	2	Moderate
	Arms/Elbows	2	1	2	Low
	Hands/Wrists/Fingers	2	1	2	Low
	Legs/Knees	2	1	2	Low
	Ankles/Feet/Toes	2	1	2	Low
Putting cans into a carton box	Neck	2	1	3	Moderate
	Shoulders	3	1	3	Alto
	Back	1	1	3	Low
	Arms/Elbows	1	1	3	Low
	Hands/Wrists/Fingers	2	1	3	Moderate
	Legs/Knees	1	1	3	Low
	Ankles/Feet/Toes	1	1	3	Low

According to the results of the S. Rodgers method, taking the carton box and placing it in front presents moderate risk of causing CTD's in neck and back. Placing the cans into the carton box generates moderate risk in neck and hands, wrists and fingers and high risk in shoulders. On the other hand, the results of RULA indicate the need to investigate and redesign the workstation.

Chart 2. Result of the application of the RULA method.

Activity/Task	Group	Score
Taking a carton Box and placing it in front	A (Arm/Wrist)	3
	B (Neck/Back/leg)	6
	C (Muscle use/Loading)	6
	Final	Investigate and redesign workstation
Putting cans into a carton box	A (Arm/Wrist)	4
	B (Neck/Back/leg)	3
	C (Muscle use/Loading)	5

	Final	Investigate and redesign workstation

5. CONCLUSIONS

6.

From the observation of the results obtained, it is clear that there are potential risks of musculoskeletal disorders (MSD's) in the job position. In order to reduce or minimize the risk, it is necessary:

- Redesign the workstation to anthropometric measures of the workers. It is recommended to increase the height of the boxes container to reduce the neck and back score and minimize the risk of injury to the operator.
- Redesign the method of work. (Avoid inadequate movements like wrist twist that produce injuries at workers).
- Establish periodic breaks and in order to decrease of fatigue in certain muscles, joints and tendons.
- Allow rotation of the staff during the work day.
- Introduce to the company the importance of health care and in this way also satisfy legal requirements.

The above recommendations may be useful to improve the operator's health and the work area in a more optimal way, and thus increase the company productivity and reduce the risk of injury at workers.

6. REFERENCES

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MANUAL FINAL INSPECTION

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Resumen: En este proyecto se busca la mejora de un puesto de trabajo dentro de una de las líneas de producción de ensamble final de Continental Automotive Guadalajara, Periférico.

Como metodología de análisis se uso el software propio de la empresa “BDS”, con el cual fue posible detectar factores de riesgo ergonómicos para los trabajadores, así como evaluar el impacto de las mejoras realizadas.

Por su parte este proyecto sirvió como base para detectar otras estaciones de trabajo con riesgos ergonómicos similares, y crear un estándar ergonómico para todos los equipos nuevos que se fabriquen o se compren de Inspección final Manual.

Abstract: This project seeks to improve a job within one of the production lines for final assembly of Continental Automotive Guadalajara Periferico.
As analysis methodology using the proprietary software of the company "BDS", with which it was possible to detect ergonomic risk factors for workers as well as assess the impact of improvements.

Meanwhile this project served as a basis for detecting other workstations with similar ergonomic risks, and creates an ergonomic standard for all new equipment manufactured or purchased of Manual Final Inspection.

Keyword: Ergonomic, BDS, Safe Launch, Final Quality Inspection

Relevance to Ergonomics: Ergonomic hazards detection on Safe Launch stations (final quality inspection) and risk evaluation identified based on the BDS software, to implement improvements in the workplace to eliminate ergonomic injuries.

1. INTRODUCTION

The following work shows us how to identify risks and exposures within a workplace and evaluate based on an internally developed software in conjunction with Continental ASER Institute (Institut für Arbeitsmedizin, Sicherheitstechnik und Ergonomie), called BDS (Exposure Documentation System. It is a tool which helps us analyze the ergonomic risks of different jobs, get an overview of it, the various characteristics can generate absenteeism or in the worst case a partial or permanent damage to the operators.

This software has the advantage, to perform physical assessments exhibitions, environmental conditions, work organization, occupational safety, legal requirements and prevention measures previously detected..

1.1 Objective

Ergonomic hazards detection on Safe Launch stations (final quality inspection) and risk evaluation identified based on the BDS software, to implement improvements in the workplace to eliminate ergonomic injuries.

2. ANTHROPOMETRICS

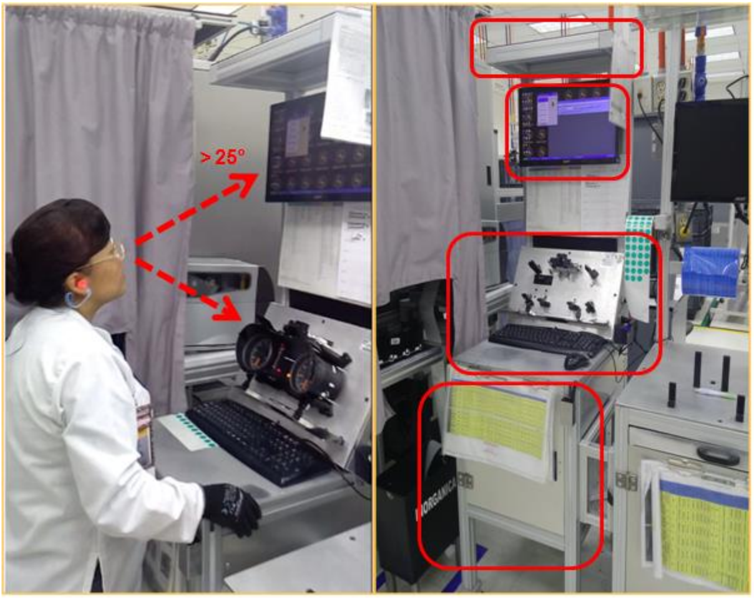
To evaluate workstation an internal anthropometric study must be done in order to define data from population inside location. The first step is to collect a sample from population for Commercial Vehicles division, and then our medical department collects measurements for different parts of the body.

With this data we are able to define height and size for different equipments to help operator to perform their job according to good practices on ergonomics.

Identification				Measurements (cm)							
Employee Number	Name	Age	Gender	Size	Eye height	Shoulder height	Elbow height	Flex Elbow height	Arm Front Range	Scope Lateral Arm	Vertical maximum range
32427141	SUSTAITA ROMERO MARIA DEL ROCIO	46	F	162	149	134	102	100	62	57	194
32429530	ESTRADA ESPARZA EDGAR ENRIQUE	40	M	168	148	136	97	94	65	78	194
32415195	ARELLANO ARGANDA MA CONCEPCION	52	F	146	132	118	82	84	47	67	162
32425043	REAL CARRANZA LUZ MARIA	45	F	168	151	138	104	102	62	61	200
32435262	RAMIREZ ADAME EZEQUIEL	19	M	178	162	147	112	110	64	63	220
32435294	WONG YERENA FRANCISCO JAVIER	40	M	178	168	162	117	118	68	84	220
32431796	RIVERA PRIETO ERENDIRA BERENICE	24	F	160	150	131	103	105	53	55	183
32422322	RODRIGUEZ CASTRO J JESUS	42	M	188	154	136	109	110	67	80	193
32426220	GARCIA PEREZ ANA ISABEL	44	F	154	144	131	102	106	62	73	188
32416861	GOMEZ CHAVEZ CARMEN ALICIA	42	F	185	169	140	108	112	64	71	193
32435277	GUTIERREZ CATAÑO DALILA ELIZABETH	49	F	155	145	131	104	108	61	73	187
32430040	GARCIA CRUZ FABIOLA	28	F	159	151	158	108	114	63	70	189
32422412	GUTIERREZ ORTEGA MARIA ISABEL	56	F	172	156	148	115	117	64	62	216
32419307	GONZALEZ ZEPULVEDA CLAUDIA BERENICE	38	F	160	148	134	103	101	53	79	192
32432910	JIMENEZ SANDOVAL MAYRA	34	F	166	153	138	105	103	60	57	188
32431796	RIVERA PRIETO ERENDIRA BERENICE	24	F	160	150	131	103	105	53	55	183
32434115	TAVARES LEAL CRISTOBAL NATANAEL	20	M	180	189	160	116	120	70	81	205
32417307	MORENO DIAZ MARTINA	41	F	160	148.5	133	108	104	62	67	185
32429581	RAMIREZ CARRANCO ROSALVA	30	F	183	151	131	106	104	61	71	188
32430997	HERNANDEZ ALVAREZ MARITZA ALEJANDRA	23	F	154	143	123	100	98	57	70	185
32425506	ECHEVERRIA PRECIADO MARIA DEL ROSARIO	41	F	150	140	132	90	92	49	62	172
32428810	FERNANDEZ MEDELLIN ESTER	30	F	168	152	137	104	107	62	74	194
32422872	MARTINEZ LOPEZ CARMEN	54	F	142	124	110	93	90	65	61	162
32427349	VILLEGAS CASTELLON ERIKA	31	F	184	176	166	118	101	75	70	200
32430567	SANTIAGO JUAREZ MARIA ICHEL	40	F	158	142	124	108	103	68	66	170
32432726	HERNANDEZ MORA MARIA DEL SOCORRO	34	F	152	132	119	106	102	71	64	163
32435296	JIMENEZ RAYGOZA NOEMI	35	F	158	146	132	102	100	70	58	197
32425158	CAMPA YADIRA NOEMI	29	F	184	176	166	105	102	74	79	196
32429561	MORALES ORNELAS ANGELICA	22	F	156	134	120	104	100	54	68	160
32432599	RIVAS CAMPOS DALIA	31	F	163	144	135	108	102	72	70	186
32429482	MARTINEZ LARIOS MARIA ELENA	37	F	162	146	136	105	106	72	65	164
32429738	HERNANDEZ ESTRIVERO BEHIRA	21	F	168	152	132	104	100	70	79	178
32419301	LEON SERRATOS HECTOR	47	M	170	128	126	116	112	75	74	200
32431858	LUQUIN BECERRA LAURA CRISTINA	36	F	159	138	122	109	106	75	62	163
32429581	RAMIREZ ROSALBA	30	F	183	151	131	106	104	61	71	188
			Min value	**142**	**124**	**110**	**82**	**84**	**47**	**55**	**160**
			Max value	**188**	**189**	**166**	**118**	**120**	**75**	**84**	**220**
			Average	**166**	**150**	**136**	**105**	**104**	**64**	**68**	**187**

3. RESULTS

According to analysis on BDS were found the following ergonomic risk points:



Workplace issues:

- Operator constantly have awkwark head position/movement due the display and fixtures height.
- There 's not enough ilumination even when is a quality check area (565 lux).
- The keyboard and mouse are outside of the ergonomic work area
- The operator is 91.7% of all shift is in standing position.
It is hardly possible to use a sit-stand-stool because there is no space for operator`s legs

There's just one operator working on this station in each shift (10.75 hours)

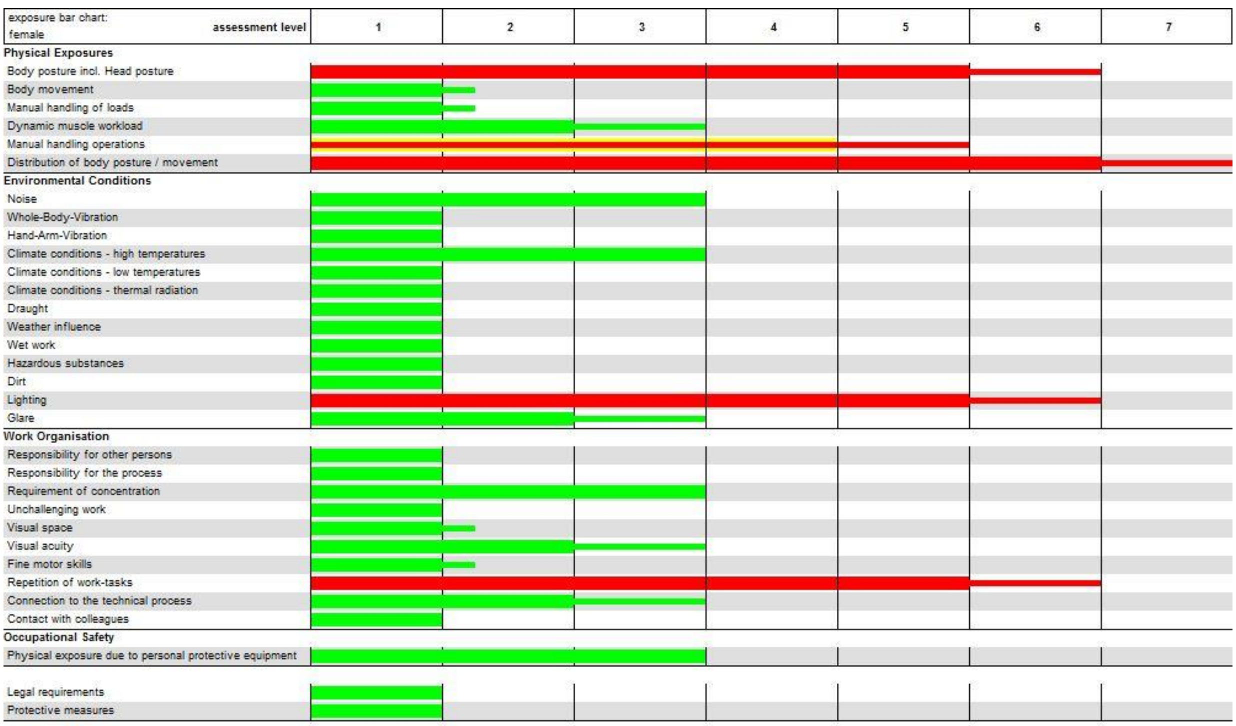


Figure 1 – BDS Assessment Work Place Evaluated

Improvement actions were as follows:

Workplace improvements:

- It was modified to add a sit-stand-stool to reduce the distribution of body posture exposure
- The Screen's height can be adjusted according to the standard operetators height
- The station roof was modified to add a lamp (accomplish the minimum brightness of a quality control area) and to eliminate the glare generate by the lights of the roof .
- The keyboard and mouse was changed with a keyboard with touchpad to prevent movements far from the ergonomic area of work
- Jobrotation concept was implemented. Now there´s 3 operators working on that station

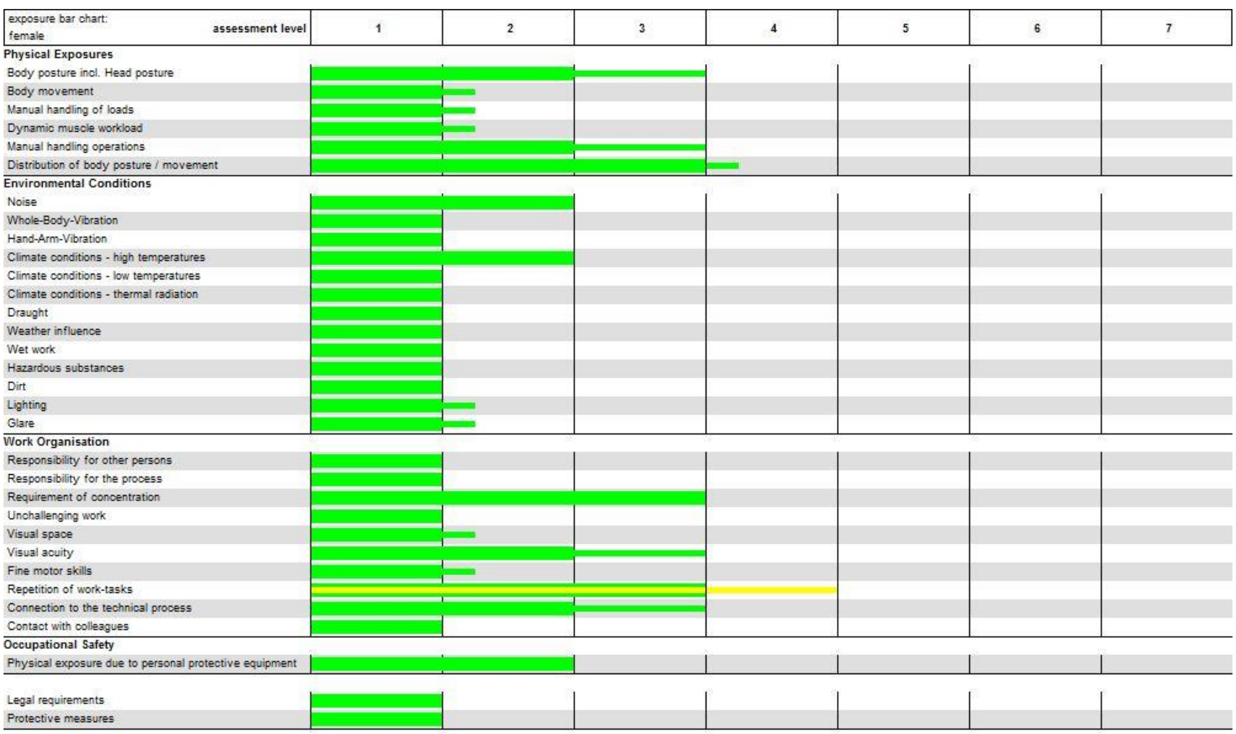


Figure 2 – BDS Assessment Improved

4. CONCLUSIONS

To avoid ergonomic risk in the workplace will be mandatory to follow the ergonomic standards and take into account the population of workers that may be in that workplace.
For each new workplace that is going to be manufactured by us (in our technical center) or purchased an evaluation with the BDS software will be mandatory too.

5. REFERENCES

BDS is design and develop by:
Institute of Occupational Health, Safety and Ergonomics
ASER Institute **http://www.institut-aser.de/**