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Prefacio

El 4 de enero del presente año, la Secretaria del Trabajo y Previsión Social (STPS) publicó en el Diario Oficial de la Federación el Proyecto de Norma Oficial Mexicana PROY-NOM-036-1-STPS-2017, Factores de riesgo ergonómico en el trabajo-Identificación, análisis, prevención y control. Parte 1-Manejo manual de cargas. SEMAC reviso dicho proyecto y presento en tiempo y forma ante la STPS las observaciones que creyo necesarias para un cambio en la redacción de la NOM-036 y que fuera mas accesible a todos los involucrados en el proceso ergonómico dentro de los centros de trabajo. Es deseable que esta norma sea publicada en el Diario Oficial de la Federacion lo antes posible.

La autoridad laboral cuenta con dos proyectos de norma que son punta de lanza en el mundo, pues no hay país que cuente con requerimientos legales en Factores de riesgo Ergonómicos y Factores de riesgo Psicosociales. Estamos seguros que en cuanto de aprueben estas dos normas se verá incrementada la calidad de vida de nuestros compañeros trabajadores, que con su esfuerzo generan la riqueza de nuestro País, México.

Este año reunimos un gran número de trabajos, tanto de investigaciones como aplicaciones en los puestos de trabajo que tienden a mejoran la calidad de vida de los trabajadores. Hemos seleccionado los mejores trabajos de las diversas áreas de la Ergonomía. En este libro encontrares colaboraciones de Instituciones de Educación Superior y Empresas con trabajos que se destacan tanto por su originalidad como por su pertinencia.

Los editores, árbitros y comité académico, a nombre de la Sociedad de Ergonomistas de México, A.C., agradecemos a los autores de los artículos aquí presentados su esfuerzo, e interés por participar y compartir su trabajo y conocimientos en este nuevo libro. También agradecemos a los autores provenientes de muy diversos lugares y formaciones 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”

Mexicali, Baja California, Abril de 2018

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ANTHROPOMETRIC MEASURES OF THE POPULATION THAT WORKS IN MAQUILADORA INDUSTRY OF AGUA PRIETA, SONORA.

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Resumen: Una de las principales fuentes laborales de la ciudad de Agua Prieta, Sonora es la Industria Maquiladora y Manufacturera de Exportación, quienes conforman de forma general procesos de fabricación con flujos en línea, lo que demanda una gran cantidad de estaciones de trabajo, las cuales son establecidas de manera empírica por las personas dedicadas al diseño de este tipo de estaciones.

En el cumplimiento de las directrices ergonómicas para el diseño de estaciones de trabajo debe ser referenciado principalmente por los sistemas de cartas antropométricas, las cuales deben de ser validadas científicamente a través de procesos estadísticos concretos y aceptados.

La presente investigación tiene como objetivo principal desarrollar un sistema de medidas antropométricas de los trabajadores de la Industria Maquiladora de Agua Prieta Sonora, ofreciendo primeramente un marco teórico referencial validado científica y estadísticamente, y posteriormente proporcionar el comportamiento de los percentiles antropométricos necesarios para el diseño de las estaciones de trabajo antes referidas.

Cabe mencionar que la presente investigación y toma de datos se limita únicamente a la población laboral de la ciudad de Agua Prieta, y ha sido aplicada a un total de 175 personas quienes laboran dentro de estas empresas, sujetos seleccionados a través de un procedimiento aleatorio para eliminar el sesgo en la inferencia de los datos muéstrales.

El equipo de recolección de datos ha sido capacitado por un experto en el tema y se realizó un conjunto de mediciones para mejorar su experiencia en el manejo de los instrumentos utilizados tales como: Antropómetro, Bascula digital, Flexómetro y Medidor de agarre.

Una vez concluida esta capacitación se realizó un estudio de repetitividad y confiabilidad para valorar las mediciones desarrolladas por el equipo de trabajo, las mediciones obtenidas han sido comparadas con las del experto obteniendo un .97 en los estudios de confiabilidad.

Durante un periodo de seis meses el equipo de recolección de datos se ha abocado a la obtención de las medidas dictadas por la antropometría estática, para la realización de tablas antropométricas, tales como: Estatura completa, Distancia Ojo – Piso, Acromion – piso, Dedo medio – Piso, por mencionar algunas, estos datos han sido capturados en una hoja de cálculo de Excel para procesar la información de una manera rápida y confiable. Cabe mencionar la relevancia que tendrá el presente estudio en cumplimiento de la elaboración de la carta antropométrica propuesta por la SEMAC.

Por último, se concluye que el desarrollo de una carta antropométrica, donde se presenten las principales medidas utilizadas en el diseño de estaciones de trabajo que contemplen las directrices ergonómicas, mantiene hoy una alta prioridad para la industria maquiladora, ya que con ello se está en la posibilidad de disminuir el impacto negativo del trabajo sobre el operador, mejorando la competitividad de la entidad productiva.

Abstract: One of the main sources of employment in the city of Agua Prieta, Sonora is the Maquiladora and Export Manufacturing Industry, which generally make up manufacturing processes with online flows, which demands a large number of work stations, which are established empirically by the people dedicated to the design of this type of station.

In compliance with ergonomic guidelines for the design of work stations should be referenced primarily by anthropometric chart systems, which must be validated scientifically through specific and accepted statistical processes.

The main objective of this research is to develop a system of anthropometric measures for the workers of the Agua Prieta Maquiladora Industry in Sonora, first providing a referential theoretical framework scientifically and statistically validated, and then provide the behavior of the anthropometric percentiles necessary for the design of the work stations referenced above.

It is worth mentioning that the present investigation and data collection is limited to the working population of the city of Agua Prieta, and has been applied to a total of 175 people who work within these companies, subjects selected through a random procedure to eliminate bias in the inference of the sample data.

The data collection team has been trained by an expert in the subject and a set of measurements was made to improve their expertise in handling the instruments used such as: Anthropometer, Digital Scale, Flexometer and Grip Meter, once completed This training was conducted a study of repeatability and reliability to assess the measurements developed by the work team, the measurements obtained have been compared with those of the expert obtaining a .97 in the reliability studies.

During a period of six months, the data collection team has focused on obtaining the measurements dictated by static anthropometry for the realization of anthropometric tables, such as: Full height, Eye - Floor distance, Acromion - floor, Middle finger - Floor, to mention a few, these data have been captured in an Excel spreadsheet to process information in a faster and more reliable way. It is worth mentioning the relevance of this study in compliance with the elaboration of the anthropometric chart proposed by the SEMAC.

Finally, it is concluded that the development of an anthropometric chart, which presents the main measures used in the design of work stations that contemplate the ergonomic guidelines, maintains today a high priority for the maquiladora industry, since it is in the possibility of diminishing the negative impact of work on the operator, improving the competitiveness of the productive entity.

Key Words: Anthropometry, maquiladora – industry

Contribution to ergonomics: The present investigation develops a system of validated and reliable anthropometric measurements. This maintains ergonomic relevance due to the information contained in the measurement system is of high priority in the design and redesign of work stations that are considered ergonomic. Added to this, in Mexico exists few systems of anthropometric measurements and this research will be part of the anthropometric chart that is currently developing by Sociedad de Ergonomistas de Mexico, A.C.

1. INTRODUCTION

The productive development generated in the Northwest State of Sonora, mainly in the region of Agua Prieta, is supported mostly by the maquiladora industry, which is why the adoption of a system of anthropometric measurements by this sector, in the design of work stations, where, from the planning to the operation of the productive plant, the guidelines for the scientific study of the adaptation of work to man, this would generate many benefits to the industrial sector and would be a factor of optimization in the methods and industrial processes, in addition to adjusting the work stations to the physical characteristics of the operators who work in these industries.

The anthropometric measurements are considered as the starting point for the design and redesign of work stations, where you want to apply the ergonomic guidelines and sustain a research work and applied with quantitative arguments. This implies a greater facility for the adequacy and modification of working conditions where the worker performs, thereby improving the productive performance and decreasing the possibility of generating a musculoskeletal disorder in the operators who work in the work stations of the maquiladora and manufacturing industry company in the city of Agua Prieta, Sonora.

1.1 General Objective:

Develop a system of anthropometric measurements of workers in Agua Prieta maquiladora industry, necessary in the design of ergonomic workstations.

1.2 Specific objectives:

1. Elaborate the theoretical framework of the research from the study of the main anthropometric measures that are necessary for the design of ergonomic workstations.

2. Develop the procedure to obtain the anthropometric chart of the workers of the Agua Prieta maquiladora industry.
3. Perform the lifting of the necessary data for the system of anthropometric measurements.

2. DELIMITATION

The research work was developed in the maquiladora manufacturing and export, located in the city of Agua Prieta, Sonora. Considering specifically the workers that work in the intermittent production lines with online flows and that as a consequence of the study could be viable of an ergonomic redesign.

3. METHODOLOGY

The structure of the guiding research of this project is established in two stages: The first consists in the conformation of tools and methodologies, required to carry out the research, establishing as a priority the need to stratify the population under study, in such a way that we can determine a classification according to physiological capacities related to sex, age and place of origin of the worker and the parents of the operator, in addition to the above, the research project contemplates retaking the measurements proposed by Sociedad Ergonomistas de México, A.C. to carry out the anthropometric study. Figure 1 shows the scheme by means of whereby the data that make up the system of anthropometric measurements of the population under study was carried out.

In the second part of the project, the planning and execution of the pilot sampling and the statistical inferences necessary to determine the optimum size of samples to be collected were carried out. To perform the fieldwork, the research team was trained in taking anthropometric measurements and a hypothesis test was established, where the effectiveness of the measurements of the research team was verified.

The reliability of the registered data is one of the main scientific aspects related to the present research project, mainly because these data are the starting point for the design and redesign of work stations where you want to apply the ergonomic science guidelines.

Subsequently, the field work was carried out over a period of 6 months, collecting a total of 175 samples, to establish a total of 8750 measurements for the five determined strata and the necessary statistics were calculated for the ergonomic design of jobs. Statistical inferences were made taking into account an experimental error of 1 centimeter and a reliability of 99%. With this information, the anthropometric charts for each of the determined strata were constructed, statistically validated and with the aim of being a useful tool for the design of jobs that have an ergonomic focus.

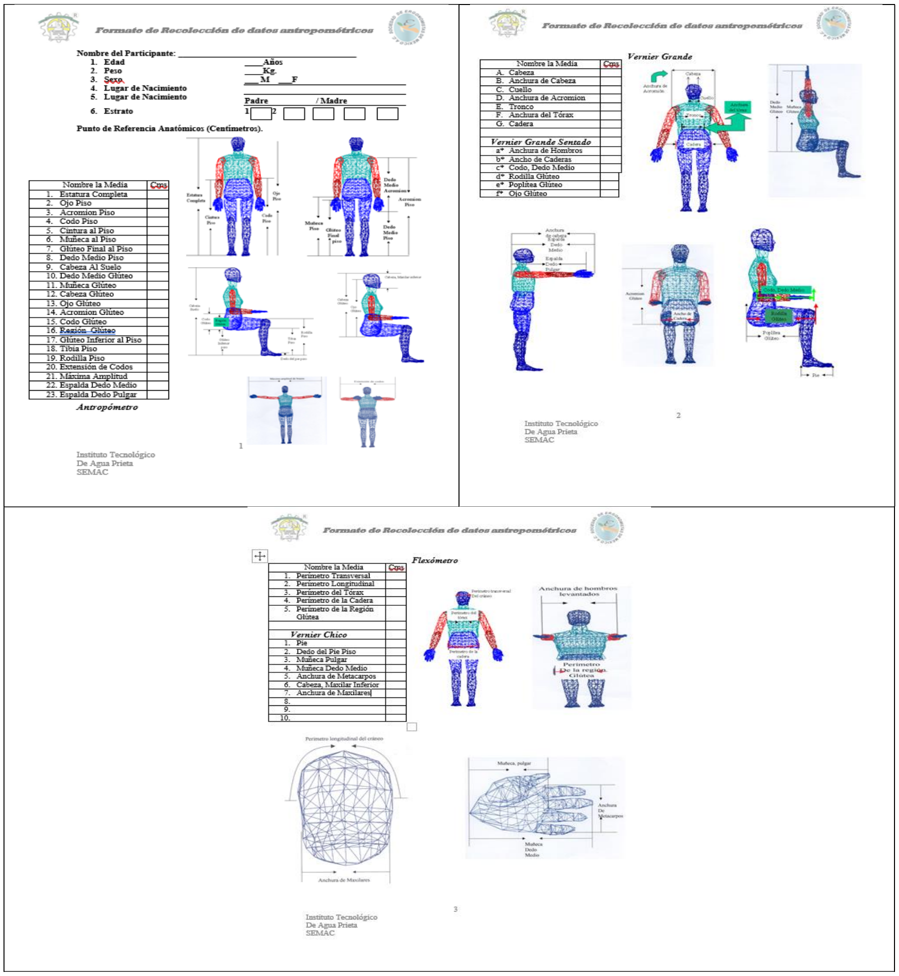

Figure1. Format of anthropometric data collection.

4. RESULTS

The research project has collected 175 measurements of workers who develop their activities in the work stations of the production lines, with intermittent flows in line, of the maquiladora and manufacturing industry located in the city of Agua Prieta, Sonora. In table 1 the results of the principal anthropometric measurements, object of study of the present investigation, are presented by strata and sex.

Table1. Results of strata and sex.

		Estrato 18 -19 Femenino							
		Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	920	33.64	42.33	46.86	54.55	71.43	79.11	83.64	92.34
ESTATURA	805	150.12	153.15	154.74	157.42	163.30	165.98	167.57	170.60
ALTURA AL OJO (PARADO)	328	137.39	141.51	143.67	147.31	155.33	158.97	161.13	165.25
ALTURA AL HOMBRO (PARADO)	23	123.93	126.47	127.80	130.04	134.98	137.23	138.56	141.10
ALTURA AL CODO (PARADO)	309	93.76	95.89	97.00	98.88	103.02	104.91	106.02	108.15
ALTURA A LA CINTURA (PARADO)	949	92.95	95.75	97.21	99.69	105.12	107.60	109.06	111.86
ALTURA A LA MUÑECA (PARADO)	973	69.25	71.92	73.32	75.68	80.86	83.22	84.61	87.28
ALTURA AL GLUTEO (PARADO)	398	61.61	64.36	65.79	68.22	73.54	75.97	77.40	80.15
ALTURA AL DEDO MEDIO (PARADO)	265	56.70	58.34	59.19	60.63	63.81	65.25	66.10	67.74
ALTURA DE LA CABEZA AL SUELO (SENTADO)	2FGM	117.96	119.96	121.00	122.78	126.66	128.44	129.48	131.48
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	914	112.00	115.67	117.58	120.83	127.95	131.19	133.10	136.77
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	912	83.79	92.54	97.10	104.83	121.82	129.55	134.11	142.86
ALTURA DEL ASIENTO A LA CABEZA	758	74.75	77.66	79.18	81.76	87.42	89.99	91.51	94.43
ALTURA DEL ASIENTO A LOS OJOS	330	61.23	64.95	66.90	70.19	77.41	80.70	82.65	86.37
ALTURA DEL ASIENTO AL HOMBRO	25	40.23	45.07	47.60	51.88	61.27	65.55	68.07	72.91
ALTURA DEL ASIENTO AL CODO 90"	312	14.66	17.92	19.62	22.50	28.82	31.70	33.40	36.66
ALTURA AL MUSLO (SENTADO)	856	10.50	11.91	12.64	13.89	16.63	17.88	18.61	20.02
ALTURA DEL SUELO AL ASIENTO	4FGM	33.74	35.52	36.44	38.01	41.47	43.04	43.96	45.74
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	678	37.35	39.08	39.99	41.53	44.90	46.44	47.34	49.08
ALTURA DEL SUELO A LA RODILLA (SENTADO)	529	32.53	38.05	40.93	45.80	56.52	61.39	64.27	69.79
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	798	70.08	73.24	74.88	77.67	83.81	86.60	88.24	91.40
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	797	149.55	152.38	153.86	156.36	161.86	164.37	165.85	168.68
*ESPALDA DEDO MEDIO	80	70.34	72.83	74.14	76.34	81.19	83.40	84.70	87.19
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	752	62.11	64.84	66.27	68.68	73.98	76.39	77.81	80.54
ANCHO DE LA CABEZA	427	13.94	14.27	14.45	14.74	15.39	15.69	15.86	16.19
LONGITUD DE LA CABEZA	441	15.62	16.46	16.90	17.64	19.26	20.00	20.43	21.27
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	165	11.02	11.40	11.60	11.95	12.69	13.04	13.24	13.62
ANCHO DE HOMBROS (PARADO)	122	26.30	29.22	30.74	33.31	38.97	41.54	43.06	45.98
ANCHO DE PECHO (PARADO)	223	23.11	24.84	25.74	27.27	30.62	32.15	33.05	34.78
ANCHO DE CADERA (PARADO)	457	26.49	28.42	29.44	31.15	34.92	36.63	37.64	39.58
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	507	30.53	32.85	34.06	36.10	40.60	42.65	43.86	46.18
ANCHO DE LA CADERA	459	19.79	24.71	27.28	31.62	41.18	45.52	48.09	53.01
LONGITUD DEL CODO AL DEDO MEDIO	381	38.11	39.47	40.19	41.39	44.05	45.25	45.97	47.33
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	194	49.06	51.03	52.05	53.79	57.62	59.36	60.39	62.36
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	200	37.41	39.76	40.98	43.05	47.61	49.69	50.91	53.26
f* OJO GLUTEO	328-398	65.10	69.50	71.79	75.67	84.21	88.09	90.38	94.78
CIRCUNFERENCIA DE LA CABEZA	430	52.74	53.51	53.91	54.59	56.09	56.77	57.17	57.94
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	144	32.03	33.40	34.11	35.32	37.97	39.18	39.90	41.27
CIRCUNFERENCIA DEL PECHO	230	73.60	78.89	81.65	86.33	96.61	101.28	104.05	109.34
CIRCUNFERENCIA DE LA CINTURA	931	59.67	65.26	68.18	73.12	83.98	88.93	91.84	97.43
CIRCUNFERENCIA DE LA CADERA	178	66.06	75.17	79.92	87.97	105.65	113.70	118.45	127.55
LARGO DEL PIE	775	20.63	21.46	21.89	22.62	24.23	24.96	25.40	26.22
ALTO DE EMPEINE	776	4.49	5.06	5.36	5.86	6.97	7.47	7.77	8.34
LONGITUD DE LA PALMA	656	8.22	8.56	8.74	9.04	9.70	10.00	10.17	10.51
LONGITUD DE LA MANO	420	15.55	15.99	16.21	16.60	17.44	17.83	18.05	18.49
ANCHO DE LA PALMA DE LA MANO	411	5.89	6.27	6.47	6.80	7.53	7.87	8.06	8.44
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	595	16.91	18.03	18.61	19.59	21.75	22.74	23.32	24.43
ANCHO DEL PIE	777	7.19	7.61	7.83	8.21	9.03	9.41	9.63	10.05
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	859	18.57	20.89	22.09	24.14	28.63	30.68	31.89	34.20
DIAMETRO DE AGARRE (INTERIOR)	402	41.78	43.03	43.68	44.79	47.21	48.32	48.97	50.22

	Estrato 20-21 Femenino							
	Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	32.82	41.14	45.48	52.83	68.98	76.33	80.67	88.99
ESTATURA	146.55	149.80	151.50	154.37	160.69	163.56	165.26	168.51
ALTURA AL OJO (PARADO)	136.97	140.07	141.69	144.43	150.45	153.19	154.81	157.91
ALTURA AL HOMBRO (PARADO)	120.94	123.77	125.25	127.75	133.24	135.75	137.22	140.05
ALTURA AL CODO (PARADO)	91.92	94.04	95.14	97.01	101.12	103.00	104.10	106.22
ALTURA A LA CINTURA (PARADO)	90.79	93.47	94.87	97.24	102.45	104.82	106.22	108.90
ALTURA A LA MUÑECA (PARADO)	70.84	72.91	73.99	75.81	79.83	81.66	82.73	84.80
ALTURA AL GLUTEO (PARADO)	64.36	66.41	67.48	69.29	73.26	75.07	76.14	78.19
ALTURA AL DEDO MEDIO (PARADO)	54.08	56.04	57.07	58.80	62.62	64.36	65.38	67.34
ALTURA DE LA CABEZA AL SUELO (SENTADO)	103.11	108.43	111.20	115.89	126.21	130.91	133.68	138.99
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	113.32	116.44	118.07	120.84	126.91	129.67	131.30	134.42
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	105.49	108.49	110.06	112.72	118.56	121.22	122.79	125.80
ALTURA DEL ASIENTO A LA CABEZA	66.72	72.43	75.40	80.45	91.54	96.59	99.57	105.28
ALTURA DEL ASIENTO A LOS OJOS	65.61	68.03	69.29	71.43	76.13	78.27	79.54	81.96
ALTURA DEL ASIENTO AL HOMBRO	52.01	53.71	54.60	56.10	59.40	60.91	61.79	63.49
ALTURA DEL ASIENTO AL CODO 90"	19.41	21.34	22.34	24.04	27.78	29.48	30.48	32.41
ALTURA AL MUSLO (SENTADO)	10.43	12.04	12.87	14.29	17.41	18.83	19.66	21.27
ALTURA DEL SUELO AL ASIENTO	31.58	33.67	34.77	36.62	40.68	42.53	43.63	45.72
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	34.65	36.89	38.06	40.04	44.39	46.37	47.54	49.78
ALTURA DEL SUELO A LA RODILLA (SENTADO)	43.31	44.80	45.58	46.90	49.81	51.13	51.91	53.41
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	70.79	73.54	74.97	77.40	82.74	85.17	86.60	89.35
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	86.04	104.82	114.62	131.23	167.71	184.32	194.12	212.90
*ESPALDA DEDO MEDIO	44.90	55.22	60.60	69.72	89.76	98.88	104.27	114.58
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	61.23	63.72	65.01	67.21	72.04	74.24	75.54	78.03
ANCHO DE LA CABEZA	12.63	13.29	13.64	14.22	15.51	16.09	16.43	17.09
LONGITUD DE LA CABEZA	15.16	16.08	16.56	17.37	19.15	19.96	20.43	21.35
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	10.55	11.20	11.55	12.12	13.39	13.97	14.31	14.96
ANCHO DE HOMBROS (PARADO)	15.26	22.38	26.09	32.38	46.19	52.48	56.20	63.31
ANCHO DE PECHO (PARADO)	21.97	23.88	24.87	26.55	30.24	31.92	32.92	34.82
ANCHO DE CADERA (PARADO)	19.53	23.22	25.14	28.40	35.56	38.82	40.74	44.43
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	32.97	34.81	35.76	37.39	40.95	42.58	43.54	45.37
ANCHO DE LA CADERA	31.30	33.48	34.61	36.53	40.76	42.68	43.82	45.99
LONGITUD DEL CODO AL DEDO MEDIO	37.88	39.14	39.80	40.92	43.36	44.48	45.13	46.40
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	49.88	51.62	52.53	54.07	57.46	59.00	59.91	61.65
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	39.63	41.34	42.24	43.75	47.07	48.58	49.48	51.19
f* OJO GLUTEO	69.28	71.21	72.22	73.92	77.67	79.37	80.38	82.31
CIRCUNFERENCIA DE LA CABEZA	50.28	51.76	52.52	53.82	56.68	57.98	58.74	60.22
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	31.48	32.84	33.55	34.75	37.39	38.59	39.30	40.65
CIRCUNFERENCIA DEL PECHO	70.72	77.06	80.37	85.98	98.30	103.91	107.21	113.56
CIRCUNFERENCIA DE LA CINTURA	52.12	60.35	64.64	71.91	87.88	95.15	99.44	107.66
CIRCUNFERENCIA DE LA CADERA	71.40	78.45	82.13	88.37	102.06	108.30	111.98	119.03
LARGO DEL PIE	20.86	21.48	21.80	22.34	23.54	24.09	24.41	25.03
ALTO DE EMPEINE	4.20	4.83	5.16	5.72	6.95	7.51	7.84	8.47
LONGITUD DE LA PALMA	7.80	8.24	8.46	8.84	9.68	10.07	10.29	10.72
LONGITUD DE LA MANO	14.72	15.31	15.63	16.15	17.32	17.85	18.16	18.76
ANCHO DE LA PALMA DE LA MANO	6.44	6.69	6.81	7.03	7.52	7.74	7.86	8.11
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	17.56	18.49	18.97	19.79	21.58	22.40	22.89	23.81
ANCHO DEL PIE	7.10	7.53	7.76	8.15	8.99	9.38	9.60	10.04
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	16.82	20.65	22.65	26.03	33.47	36.85	38.85	42.68
DIAMETRO DE AGARRE (INTERIOR)	36.73	39.17	40.44	42.60	47.33	49.49	50.76	53.20

	Estrato 22-23 Femenino							
	Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	36.70	45.49	50.07	57.85	74.91	82.68	87.27	96.06
ESTATURA	145.90	150.02	152.16	155.80	163.79	167.43	169.57	173.69
ALTURA AL OJO (PARADO)	136.27	140.13	142.15	145.56	153.06	156.47	158.49	162.35
ALTURA AL HOMBRO (PARADO)	120.18	123.78	125.66	128.84	135.83	139.01	140.89	144.48
ALTURA AL CODO (PARADO)	92.44	95.03	96.38	98.67	103.69	105.97	107.32	109.91
ALTURA A LA CINTURA (PARADO)	92.60	95.30	96.71	99.10	104.34	106.72	108.13	110.83
ALTURA A LA MUÑECA (PARADO)	68.29	71.21	72.74	75.32	81.00	83.59	85.11	88.04
ALTURA AL GLUTEO (PARADO)	61.96	64.96	66.52	69.18	75.00	77.66	79.22	82.22
ALTURA AL DEDO MEDIO (PARADO)	55.35	57.42	58.50	60.33	64.35	66.18	67.26	69.32
ALTURA DE LA CABEZA AL SUELO (SENTADO)	114.86	117.10	118.27	120.25	124.60	126.58	127.75	129.99
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	116.34	119.10	120.54	122.98	128.33	130.77	132.21	134.97
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	108.56	110.94	112.18	114.28	118.89	121.00	122.24	124.61
ALTURA DEL ASIENTO A LA CABEZA	80.30	81.86	82.67	84.05	87.08	88.46	89.27	90.83
ALTURA DEL ASIENTO A LOS OJOS	69.52	71.33	72.27	73.86	77.37	78.97	79.91	81.72
ALTURA DEL ASIENTO AL HOMBRO	53.73	55.02	55.69	56.83	59.33	60.47	61.15	62.44
ALTURA DEL ASIENTO AL CODO 90"	11.86	16.31	18.64	22.58	31.24	35.19	37.51	41.97
ALTURA AL MUSLO (SENTADO)	10.78	12.32	13.12	14.47	17.45	18.81	19.61	21.15
ALTURA DEL SUELO AL ASIENTO	26.98	29.80	31.27	33.76	39.23	41.72	43.20	46.01
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	37.16	38.62	39.38	40.66	43.48	44.77	45.53	46.98
ALTURA DEL SUELO A LA RODILLA (SENTADO)	44.22	45.78	46.60	47.98	51.01	52.40	53.21	54.77
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	72.83	75.57	76.99	79.41	84.71	87.13	88.55	91.28
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	113.90	126.49	133.07	144.20	168.67	179.81	186.38	198.98
*ESPALDA DEDO MEDIO	41.96	53.99	60.27	70.91	94.28	104.91	111.19	123.22
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	61.05	64.14	65.76	68.49	74.50	77.23	78.85	81.94
ANCHO DE LA CABEZA	-8.56	-0.81	3.23	10.08	25.13	31.99	36.03	43.78
LONGITUD DE LA CABEZA	14.83	16.04	16.68	17.75	20.11	21.19	21.82	23.04
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	9.57	10.61	11.15	12.07	14.08	15.00	15.54	16.57
ANCHO DE HOMBROS (PARADO)	21.28	25.93	28.36	32.46	41.49	45.60	48.02	52.67
ANCHO DE PECHO (PARADO)	22.33	24.75	26.02	28.17	32.88	35.03	36.29	38.72
ANCHO DE CADERA (PARADO)	28.03	30.13	31.23	33.10	37.19	39.06	40.16	42.26
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	29.66	32.42	33.86	36.31	41.67	44.12	45.56	48.32
ANCHO DE LA CADERA	32.63	34.98	36.20	38.28	42.83	44.91	46.13	48.48
LONGITUD DEL CODO AL DEDO MEDIO	38.31	39.77	40.54	41.83	44.68	45.97	46.74	48.20
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	50.15	52.26	53.36	55.22	59.32	61.18	62.28	64.39
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	38.86	41.12	42.30	44.30	48.69	50.69	51.87	54.13
f* OJO GLUTEO	69.60	71.82	72.97	74.93	79.24	81.20	82.36	84.57
CIRCUNFERENCIA DE LA CABEZA	50.53	51.99	52.75	54.04	56.86	58.15	58.91	60.37
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	31.66	33.03	33.74	34.95	37.62	38.83	39.55	40.92
CIRCUNFERENCIA DEL PECHO	75.74	80.90	83.60	88.16	98.19	102.76	105.45	110.61
CIRCUNFERENCIA DE LA CINTURA	60.72	68.83	73.07	80.24	95.99	103.16	107.39	115.51
CIRCUNFERENCIA DE LA CADERA	75.53	82.95	86.82	93.38	107.79	114.35	118.22	125.64
LARGO DEL PIE	20.89	21.67	22.08	22.78	24.30	24.99	25.40	26.18
ALTO DE EMPEINE	3.10	3.98	4.44	5.22	6.93	7.70	8.16	9.04
LONGITUD DE LA PALMA	7.72	8.32	8.64	9.17	10.34	10.87	11.19	11.79
LONGITUD DE LA MANO	14.82	15.44	15.76	16.31	17.50	18.05	18.37	18.99
ANCHO DE LA PALMA DE LA MANO	6.35	6.65	6.80	7.06	7.63	7.89	8.04	8.34
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	17.16	18.16	18.68	19.56	21.50	22.38	22.91	23.90
ANCHO DEL PIE	7.29	7.63	7.81	8.12	8.78	9.09	9.27	9.61
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	19.26	23.20	25.25	28.73	36.38	39.86	41.92	45.86
DIAMETRO DE AGARRE (INTERIOR)	37.92	40.26	41.48	43.55	48.09	50.16	51.38	53.72

Table1. Results of strata and sex (continuation).

		Estrato 24 -25 Femenino								Estrato 29 -47 Femenino							
		Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99	Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	920	14.00	30.34	38.86	53.30	85.03	99.47	108.00	124.33	57.48	59.87	61.12	63.23	67.87	69.98	71.23	73.62
ESTATURA	805	149.25	152.04	153.49	155.96	161.37	163.84	165.29	168.08	147.59	152.91	155.68	160.39	170.71	175.42	178.19	183.51
ALTURA AL OJO (PARADO)	328	141.12	143.21	144.30	146.14	150.19	152.04	153.13	155.21	137.38	142.74	145.54	150.29	160.71	165.46	168.26	173.62
ALTURA AL HOMBRO (PARADO)	23	124.39	126.89	128.19	130.40	135.26	137.47	138.78	141.28	122.24	127.07	129.59	133.86	143.24	147.51	150.03	154.86
ALTURA AL CODO (PARADO)	309	87.16	91.09	93.14	96.62	104.25	107.73	109.78	113.71	94.85	98.32	100.12	103.19	109.91	112.98	114.78	118.25
ALTURA A LA CINTURA (PARADO)	949	96.33	97.72	98.45	99.68	102.39	103.62	104.35	105.74	89.62	94.50	97.05	101.36	110.84	115.15	117.70	122.58
ALTURA A LA MUÑECA (PARADO)	973	67.93	71.22	72.95	75.86	82.27	85.19	86.91	90.21	73.80	76.44	77.81	80.14	85.26	87.59	88.96	91.60
ALTURA AL GLUTEO (PARADO)	398	63.76	65.93	67.07	68.99	73.21	75.13	76.27	78.44	57.87	62.60	65.07	69.25	78.45	82.63	85.10	89.83
ALTURA AL DEDO MEDIO (PARADO)	265	52.78	55.56	57.01	59.47	64.87	67.32	68.77	71.55	61.78	62.51	62.89	63.54	64.96	65.61	65.99	66.72
ALTURA DE LA CABEZA AL SUELO (SENTADO)	2FGM	110.04	113.99	116.04	119.53	127.20	130.69	132.75	136.70	114.92	119.16	121.38	125.13	133.37	137.12	139.34	143.58
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	914	117.28	120.19	121.71	124.28	129.92	132.49	134.01	136.92	117.75	121.89	124.06	127.72	135.78	139.44	141.61	145.75
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	912	108.65	111.83	113.48	116.29	122.45	125.25	126.91	130.08	108.89	113.23	115.49	119.33	127.77	131.61	133.87	138.21
ALTURA DEL ASIENTO A LA CABEZA	758	75.96	78.85	80.35	82.90	88.50	91.05	92.55	95.44	87.45	87.94	88.19	88.63	89.57	90.01	90.26	90.75
ALTURA DEL ASIENTO A LOS OJOS	330	66.59	69.05	70.33	72.51	77.29	79.47	80.75	83.21	71.64	73.49	74.46	76.10	79.70	81.34	82.31	84.16
ALTURA DEL ASIENTO AL HOMBRO	25	49.85	52.86	54.43	57.08	62.92	65.57	67.14	70.15	57.47	58.89	59.63	60.88	63.62	64.87	65.61	67.03
ALTURA DEL ASIENTO AL CODO 90"	312	13.50	16.98	18.80	21.88	28.65	31.73	33.55	37.03	24.88	25.95	26.51	27.46	29.54	30.49	31.05	32.12
ALTURA AL MUSLO (SENTADO)	856	13.27	14.73	15.49	16.78	19.62	20.91	21.67	23.13	11.06	12.18	12.77	13.76	15.94	16.93	17.52	18.64
ALTURA DEL SUELO AL ASIENTO	4FGM	34.82	35.69	36.15	36.92	38.62	39.39	39.84	40.72	31.46	34.24	35.69	38.15	43.55	46.01	47.46	50.24
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	678	40.98	41.58	41.89	42.42	43.58	44.11	44.42	45.02	19.08	25.42	28.73	34.34	46.66	52.27	55.58	61.92
ALTURA DEL SUELO A LA RODILLA (SENTADO)	529	46.88	47.71	48.15	48.89	50.51	51.25	51.69	52.52	40.41	44.02	45.90	49.09	56.11	59.30	61.18	64.79
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	798	78.55	79.46	79.93	80.72	82.48	83.27	83.74	84.65	74.39	78.05	79.96	83.20	90.30	93.54	95.45	99.11
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	797	154.30	155.54	156.19	157.29	159.71	160.81	161.46	162.70	146.95	153.39	156.75	162.45	174.95	180.65	184.01	190.45
*ESPALDA DEDO MEDIO	80	74.27	75.65	76.37	77.59	80.28	81.50	82.22	83.60	60.38	65.74	68.54	73.29	83.71	88.46	91.26	96.62
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	752	66.17	67.62	68.38	69.66	72.47	73.76	74.51	75.96	55.25	60.04	62.53	66.76	76.04	80.27	82.76	87.55
ANCHO DE LA CABEZA	427	12.29	12.87	13.17	13.68	14.79	15.30	15.60	16.17	12.16	12.94	13.35	14.04	15.56	16.25	16.66	17.44
LONGITUD DE LA CABEZA	441	14.78	15.82	16.37	17.29	19.31	20.23	20.78	21.82	17.57	17.67	17.72	17.81	17.99	18.08	18.13	18.23
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	165	12.18	12.37	12.46	12.62	12.98	13.14	13.23	13.42	10.17	10.61	10.84	11.22	12.08	12.46	12.69	13.13
ANCHO DE HOMBROS (PARADO)	122	25.02	28.30	30.01	32.91	39.29	42.19	43.90	47.18	36.29	37.65	38.37	39.57	42.23	43.43	44.15	45.51
ANCHO DE PECHO (PARADO)	223	21.48	23.84	25.07	27.15	31.72	33.80	35.03	37.38	25.84	26.37	26.65	27.13	28.17	28.65	28.93	29.46
ANCHO DE CADERA (PARADO)	457	21.35	25.31	27.38	30.88	38.58	42.09	44.16	48.12	30.42	31.68	32.35	33.47	35.93	37.05	37.72	38.98
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	507	33.33	34.96	35.81	37.25	40.42	41.86	42.71	44.34	37.02	38.28	38.95	40.07	42.53	43.65	44.32	45.58
ANCHO DE LA CADERA	459	20.83	26.73	29.81	35.03	46.50	51.72	54.80	60.71	35.44	36.96	37.74	39.08	42.02	43.36	44.14	45.66
LONGITUD DEL CODO AL DEDO MEDIO	381	36.67	38.62	39.64	41.37	45.16	46.89	47.91	49.86	42.12	43.38	44.05	45.17	47.63	48.75	49.42	50.68
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	194	50.97	53.48	54.80	57.02	61.91	64.14	65.45	67.97	52.73	53.95	54.59	55.67	58.03	59.11	59.75	60.97
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	200	40.72	43.52	44.99	47.47	52.93	55.41	56.88	59.68	39.80	41.80	42.84	44.61	48.49	50.26	51.30	53.30
f* OJO GLUTEO	328-398	63.06	67.04	69.12	72.64	80.36	83.88	85.96	89.94	77.70	78.68	79.19	80.05	81.95	82.81	83.32	84.30
CIRCUNFERENCIA DE LA CABEZA	430	50.28	51.56	52.23	53.36	55.84	56.97	57.64	58.92	53.57	54.01	54.24	54.62	55.48	55.86	56.09	56.53
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	144	31.34	32.72	33.44	34.66	37.34	38.56	39.28	40.66	34.38	35.11	35.49	36.14	37.56	38.21	38.59	39.32
CIRCUNFERENCIA DEL PECHO	230	72.81	78.97	82.19	87.64	99.62	105.08	108.29	114.46	82.92	84.83	85.82	87.50	91.20	92.88	93.87	95.78
CIRCUNFERENCIA DE LA CINTURA	931	47.62	57.87	63.22	72.28	92.19	101.25	106.60	116.84	63.97	67.38	69.16	72.18	78.82	81.84	83.62	87.03
CIRCUNFERENCIA DE LA CADERA	178	55.08	69.08	76.39	88.77	115.96	128.34	135.65	149.65	82.47	86.86	89.15	93.04	101.56	105.45	107.74	112.13
LARGO DEL PIE	775	19.98	20.77	21.19	21.89	23.44	24.14	24.56	25.36	23.35	23.84	24.09	24.53	25.47	25.91	26.16	26.65
ALTO DE EMPEINE	776	3.37	4.20	4.63	5.36	6.97	7.70	8.14	8.97	4.06	4.84	5.25	5.94	7.46	8.15	8.56	9.34
LONGITUD DE LA PALMA	656	6.58	7.16	7.46	7.97	9.10	9.61	9.91	10.49	9.93	10.17	10.30	10.51	10.99	11.20	11.33	11.57
LONGITUD DE LA MANO	420	14.37	14.82	15.06	15.46	16.34	16.74	16.98	17.43	16.19	16.88	17.23	17.84	19.16	19.77	20.12	20.81
ANCHO DE LA PALMA DE LA MANO	411	6.12	6.46	6.64	6.94	7.60	7.90	8.08	8.42	7.03	7.27	7.40	7.61	8.09	8.30	8.43	8.67
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	595	16.67	17.98	18.67	19.83	22.37	23.53	24.22	25.53	19.68	20.07	20.28	20.62	21.38	21.72	21.93	22.32
ANCHO DEL PIE	777	7.28	7.70	7.92	8.29	9.11	9.48	9.70	10.12	8.43	8.67	8.80	9.01	9.49	9.70	9.83	10.07
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	859	21.01	24.37	26.13	29.10	35.63	38.61	40.36	43.72	21.91	23.52	24.36	25.79	28.91	30.34	31.18	32.79
DIAMETRO DE AGARRE (INTERIOR)	402	38.29	39.88	40.71	42.12	45.21	46.62	47.45	49.05	36.67	41.06	43.35	47.24	55.76	59.65	61.94	66.33

Table1. Results of strata and sex (continuation).

		Estrato 16-19 Masculino							
		Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	920	38.40	48.37	53.57	62.39	81.76	90.57	95.77	105.74
ESTATURA	805	157.53	161.71	163.89	167.58	175.69	179.39	181.57	185.75
ALTURA AL OJO (PARADO)	328	146.82	150.85	152.95	156.51	164.34	167.90	170.00	174.03
ALTURA AL HOMBRO (PARADO)	23	93.25	106.92	114.05	126.14	152.69	164.77	171.91	185.58
ALTURA AL CODO (PARADO)	309	97.09	100.14	101.73	104.43	110.35	113.05	114.64	117.69
ALTURA A LA CINTURA (PARADO)	949	94.72	98.52	100.50	103.86	111.24	114.60	116.58	120.38
ALTURA A LA MUÑECA (PARADO)	973	76.03	78.11	79.20	81.05	85.10	86.94	88.03	90.12
ALTURA AL GLUTEO (PARADO)	398	68.47	71.48	73.05	75.71	81.55	84.21	85.78	88.79
ALTURA AL DEDO MEDIO (PARADO)	265	56.17	58.84	60.24	62.60	67.78	70.14	71.54	74.21
ALTURA DE LA CABEZA AL SUELO (SENTADO)	2FGM	100.74	108.87	113.11	120.29	136.07	143.25	147.49	155.61
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	914	112.76	119.83	123.51	129.76	143.49	149.74	153.43	160.50
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	912	105.02	111.81	115.35	121.34	134.52	140.52	144.06	150.84
ALTURA DEL ASIENTO A LA CABEZA	758	82.31	84.52	85.68	87.64	91.96	93.92	95.08	97.29
ALTURA DEL ASIENTO A LOS OJOS	330	56.36	62.55	65.78	71.24	83.25	88.72	91.95	98.13
ALTURA DEL ASIENTO AL HOMBRO	25	50.72	54.08	55.84	58.81	65.34	68.32	70.07	73.44
ALTURA DEL ASIENTO AL CODO 90¨	312	17.03	19.29	20.47	22.46	26.85	28.84	30.02	32.28
ALTURA AL MUSLO (SENTADO)	856	11.30	12.60	13.28	14.43	16.96	18.11	18.79	20.09
ALTURA DEL SUELO AL ASIENTO	4FGM	33.81	36.01	37.15	39.09	43.36	45.30	46.44	48.64
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	678	38.45	40.97	42.29	44.52	49.43	51.66	52.98	55.50
ALTURA DEL SUELO A LA RODILLA (SENTADO)	529	47.14	49.23	50.32	52.16	56.22	58.07	59.16	61.25
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	798	80.17	83.09	84.62	87.21	92.89	95.48	97.00	99.93
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	797	150.75	157.63	161.22	167.30	180.66	186.74	190.33	197.21
*ESPALDA DEDO MEDIO	80	74.05	77.49	79.28	82.32	89.00	92.04	93.84	97.28
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	752	66.23	69.69	71.49	74.55	81.27	84.33	86.13	89.59
ANCHO DE LA CABEZA	427	13.21	13.71	13.97	14.41	15.37	15.81	16.07	16.57
LONGITUD DE LA CABEZA	441	16.57	17.30	17.68	18.32	19.74	20.38	20.76	21.49
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	165	11.17	11.79	12.11	12.66	13.85	14.40	14.72	15.34
ANCHO DE HOMBROS (PARADO)	122	28.89	32.72	34.72	38.10	45.54	48.93	50.92	54.75
ANCHO DE PECHO (PARADO)	223	24.49	26.62	27.74	29.62	33.77	35.66	36.77	38.90
ANCHO DE CADERA (PARADO)	457	27.82	29.55	30.45	31.98	35.34	36.86	37.77	39.49
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	507	33.51	36.29	37.74	40.19	45.59	48.05	49.50	52.28
ANCHO DE LA CADERA	459	28.62	31.10	32.40	34.59	39.42	41.61	42.91	45.39
LONGITUD DEL CODO AL DEDO MEDIO	381	41.81	43.44	44.29	45.73	48.89	50.33	51.18	52.81
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	194	46.50	50.01	51.84	54.95	61.77	64.87	66.71	70.22
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	200	35.41	38.89	40.70	43.78	50.53	53.61	55.42	58.90
f* OJO GLUTEO	328-398	72.31	75.01	76.42	78.81	84.05	86.44	87.85	90.55
CIRCUNFERENCIA DE LA CABEZA	430	52.64	53.91	54.57	55.69	58.14	59.26	59.92	61.18
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	144	32.67	34.11	34.86	36.13	38.93	40.20	40.95	42.39
CIRCUNFERENCIA DEL PECHO	230	72.98	79.75	83.28	89.27	102.41	108.39	111.93	118.70
CIRCUNFERENCIA DE LA CINTURA	931	60.71	67.72	71.38	77.57	91.18	97.38	101.03	108.04
CIRCUNFERENCIA DE LA CADERA	178	79.82	85.06	87.79	92.42	102.58	107.21	109.94	115.18
LARGO DEL PIE	775	22.88	23.79	24.26	25.06	26.82	27.62	28.09	29.00
ALTO DE EMPEINE	776	3.12	4.20	4.76	5.71	7.81	8.76	9.33	10.41
LONGITUD DE LA PALMA	656	8.35	8.92	9.21	9.72	10.82	11.33	11.62	12.19
LONGITUD DE LA MANO	420	16.13	16.79	17.14	17.73	19.01	19.60	19.94	20.61
ANCHO DE LA PALMA DE LA MANO	411	7.33	7.59	7.72	7.95	8.45	8.68	8.81	9.07
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	595	19.05	20.11	20.66	21.59	23.65	24.58	25.13	26.19
ANCHO DEL PIE	777	5.47	6.54	7.09	8.04	10.12	11.06	11.62	12.69
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	859	21.05	22.78	23.68	25.21	28.57	30.10	31.00	32.73
DIAMETRO DE AGARRE (INTERIOR)	402	42.60	44.71	45.81	47.68	51.77	53.64	54.74	56.85

		Estrato 20-22 Masculino							
		Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	920	34.84	47.10	53.50	64.34	88.14	98.98	105.38	117.64
ESTATURA	805	152.51	157.73	160.45	165.06	175.19	179.81	182.53	187.75
ALTURA AL OJO (PARADO)	328	141.87	147.18	149.95	154.65	164.96	169.66	172.43	177.74
ALTURA AL HOMBRO (PARADO)	23	125.51	130.00	132.34	136.31	145.03	149.00	151.34	155.83
ALTURA AL CODO (PARADO)	309	94.43	98.00	99.87	103.03	109.97	113.13	114.99	118.57
ALTURA A LA CINTURA (PARADO)	949	92.49	96.37	98.40	101.83	109.38	112.81	114.84	118.72
ALTURA A LA MUÑECA (PARADO)	973	71.72	74.98	76.68	79.56	85.89	88.77	90.47	93.73
ALTURA AL GLUTEO (PARADO)	398	66.39	69.32	70.85	73.43	79.12	81.70	83.23	86.15
ALTURA AL DEDO MEDIO (PARADO)	265	55.33	57.80	59.09	61.27	66.07	68.25	69.54	72.01
ALTURA DE LA CABEZA AL SUELO (SENTADO)	2FGM	115.53	119.48	121.54	125.04	132.72	136.21	138.28	142.23
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	914	117.49	122.46	125.05	129.43	139.07	143.46	146.05	151.02
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	912	87.94	98.41	103.88	113.14	133.49	142.75	148.21	158.69
ALTURA DEL ASIENTO A LA CABEZA	758	70.39	75.83	78.68	83.49	94.07	98.88	101.72	107.17
ALTURA DEL ASIENTO A LOS OJOS	330	70.22	72.84	74.21	76.52	81.61	83.92	85.29	87.91
ALTURA DEL ASIENTO AL HOMBRO	25	27.75	38.09	43.49	52.64	72.74	81.89	87.29	97.64
ALTURA DEL ASIENTO AL CODO 90¨	312	17.04	19.29	20.47	22.46	26.84	28.83	30.00	32.26
ALTURA AL MUSLO (SENTADO)	856	11.39	12.95	13.76	15.13	18.16	19.53	20.34	21.90
ALTURA DEL SUELO AL ASIENTO	4FGM	33.15	35.22	36.30	38.12	42.13	43.96	45.04	47.10
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	678	38.78	40.94	42.06	43.97	48.16	50.07	51.20	53.36
ALTURA DEL SUELO A LA RODILLA (SENTADO)	529	46.75	48.66	49.66	51.35	55.07	56.76	57.76	59.68
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	798	77.49	80.74	82.43	85.29	91.59	94.46	96.15	99.40
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	797	155.50	161.06	163.95	168.86	179.64	184.55	187.45	193.00
*ESPALDA DEDO MEDIO	80	74.27	77.73	79.53	82.59	89.30	92.36	94.17	97.63
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	752	65.51	68.99	70.80	73.88	80.64	83.72	85.54	89.02
ANCHO DE LA CABEZA	427	13.30	13.85	14.13	14.62	15.68	16.16	16.45	16.99
LONGITUD DE LA CABEZA	441	16.21	17.09	17.55	18.33	20.04	20.82	21.28	22.16
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	165	11.61	12.30	12.65	13.26	14.59	15.19	15.55	16.24
ANCHO DE HOMBROS (PARADO)	122	30.88	34.78	36.81	40.25	47.80	51.25	53.28	57.17
ANCHO DE PECHO (PARADO)	223	22.74	25.64	27.15	29.71	35.33	37.89	39.40	42.30
ANCHO DE CADERA (PARADO)	457	23.69	26.44	27.88	30.31	35.64	38.07	39.51	42.26
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	507	33.80	36.77	38.32	40.94	46.71	49.34	50.89	53.86
ANCHO DE LA CADERA	459	29.24	31.96	33.37	35.78	41.06	43.47	44.88	47.60
LONGITUD DEL CODO AL DEDO MEDIO	381	41.59	43.13	43.94	45.30	48.30	49.66	50.47	52.01
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	194	51.08	53.55	54.84	57.02	61.82	64.01	65.30	67.77
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	200	39.13	41.51	42.75	44.85	49.45	51.55	52.79	55.17
f* OJO GLUTEO	328-398	70.76	74.46	76.39	79.67	86.86	90.13	92.06	95.77
CIRCUNFERENCIA DE LA CABEZA	430	42.35	46.51	48.68	52.36	60.44	64.12	66.30	70.46
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	144	30.69	32.97	34.15	36.17	40.59	42.60	43.79	46.07
CIRCUNFERENCIA DEL PECHO	230	74.85	82.08	85.85	92.25	106.30	112.69	116.47	123.70
CIRCUNFERENCIA DE LA CINTURA	931	61.83	69.90	74.11	81.24	96.91	104.05	108.26	116.33
CIRCUNFERENCIA DE LA CADERA	178	71.04	78.87	82.96	89.89	105.11	112.04	116.13	123.97
LARGO DEL PIE	775	22.94	23.79	24.24	24.99	26.63	27.38	27.83	28.68
ALTO DE EMPEINE	776	3.04	4.01	4.52	5.38	7.27	8.12	8.63	9.60
LONGITUD DE LA PALMA	656	8.30	8.90	9.22	9.75	10.93	11.46	11.78	12.38
LONGITUD DE LA MANO	420	16.05	16.70	17.05	17.63	18.91	19.49	19.84	20.49
ANCHO DE LA PALMA DE LA MANO	411	6.80	7.17	7.36	7.69	8.41	8.74	8.93	9.30
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	595	19.19	20.20	20.73	21.63	23.60	24.50	25.03	26.04
ANCHO DEL PIE	777	6.22	7.12	7.59	8.39	10.15	10.95	11.43	12.33
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	859	19.03	22.53	24.35	27.45	34.24	37.34	39.16	42.66
DIAMETRO DE AGARRE (INTERIOR)	402	42.18	44.65	45.93	48.11	52.89	55.07	56.35	58.82

		Estrato 23-25 Masculino							
		Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	920	52.96	61.92	66.60	74.52	91.93	99.85	104.52	113.49
ESTATURA	805	151.68	157.74	160.90	166.26	178.03	183.39	186.55	192.62
ALTURA AL OJO (PARADO)	328	140.93	146.80	149.86	155.05	166.45	171.65	174.71	180.58
ALTURA AL HOMBRO (PARADO)	23	124.93	130.21	132.97	137.63	147.89	152.56	155.31	160.59
ALTURA AL CODO (PARADO)	309	94.17	98.40	100.60	104.34	112.54	116.28	118.48	122.70
ALTURA A LA CINTURA (PARADO)	949	94.46	98.35	100.38	103.82	111.38	114.82	116.85	120.74
ALTURA A LA MUÑECA (PARADO)	973	74.26	77.26	78.82	81.47	87.28	89.93	91.49	94.49
ALTURA AL GLUTEO (PARADO)	398	64.96	68.82	70.84	74.25	81.75	85.16	87.18	91.04
ALTURA AL DEDO MEDIO (PARADO)	265	57.11	59.84	61.27	63.68	68.99	71.41	72.84	75.57
ALTURA DE LA CABEZA AL SUELO (SENTADO)	2FGM	60.21	78.68	88.32	104.65	140.52	156.85	166.49	184.96
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	914	96.06	106.50	111.95	121.18	141.45	150.69	156.13	166.57
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	912	108.13	113.07	115.65	120.01	129.60	133.97	136.55	141.49
ALTURA DEL ASIENTO A LA CABEZA	758	82.48	84.87	86.12	88.23	92.86	94.98	96.22	98.61
ALTURA DEL ASIENTO A LOS OJOS	330	67.19	71.22	73.33	76.89	84.72	88.29	90.39	94.43
ALTURA DEL ASIENTO AL HOMBRO	25	56.09	57.68	58.52	59.93	63.03	64.44	65.27	66.87
ALTURA DEL ASIENTO AL CODO 90¨	312	18.21	20.18	21.22	22.96	26.81	28.55	29.59	31.56
ALTURA AL MUSLO (SENTADO)	856	10.82	12.47	13.32	14.78	17.97	19.43	20.29	21.93
ALTURA DEL SUELO AL ASIENTO	4FGM	31.44	34.01	35.35	37.62	42.61	44.88	46.22	48.79
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	678	37.27	40.01	41.44	43.86	49.19	51.61	53.04	55.78
ALTURA DEL SUELO A LA RODILLA (SENTADO)	529	46.22	48.66	49.93	52.08	56.82	58.98	60.25	62.69
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	798	79.55	82.94	84.71	87.71	94.29	97.29	99.06	102.45
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	797	154.26	160.48	163.72	169.22	181.30	186.80	190.04	196.26
*ESPALDA DEDO MEDIO	80	76.11	79.36	81.05	83.91	90.21	93.08	94.77	98.01
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	752	68.91	71.50	72.85	75.14	80.17	82.46	83.81	86.39
ANCHO DE LA CABEZA	427	13.50	14.01	14.28	14.73	15.73	16.18	16.45	16.96
LONGITUD DE LA CABEZA	441	16.31	17.26	17.76	18.59	20.44	21.27	21.77	22.72
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	165	12.15	12.72	13.01	13.51	14.61	15.11	15.40	15.97
ANCHO DE HOMBROS (PARADO)	122	31.01	35.13	37.28	40.92	48.91	52.55	54.70	58.82
ANCHO DE PECHO (PARADO)	223	28.45	29.97	30.77	32.11	35.07	36.42	37.21	38.73
ANCHO DE CADERA (PARADO)	457	28.18	29.85	30.72	32.19	35.44	36.91	37.78	39.45
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	507	36.83	39.35	40.66	42.89	47.78	50.00	51.32	53.83
ANCHO DE LA CADERA	459	33.32	35.05	35.95	37.47	40.82	42.34	43.24	44.97
LONGITUD DEL CODO AL DEDO MEDIO	381	40.86	42.82	43.85	45.58	49.39	51.12	52.15	54.11
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	194	47.53	50.80	52.51	55.40	61.75	64.65	66.36	69.63
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	200	38.05	40.67	42.04	44.35	49.45	51.76	53.13	55.75
f* OJO GLUTEO	328-398	74.41	76.81	78.07	80.20	84.87	86.99	88.25	90.65
CIRCUNFERENCIA DE LA CABEZA	430	38.64	43.56	46.13	50.48	60.03	64.38	66.95	71.87
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	144	24.61	28.86	31.08	34.84	43.10	46.86	49.08	53.33
CIRCUNFERENCIA DEL PECHO	230	84.06	89.89	92.93	98.09	109.42	114.57	117.62	123.45
CIRCUNFERENCIA DE LA CINTURA	931	62.24	72.09	77.24	85.95	105.08	113.80	118.94	128.79
CIRCUNFERENCIA DE LA CADERA	178	34.00	51.45	60.55	75.97	109.85	125.27	134.37	151.81
LARGO DEL PIE	775	22.02	23.32	23.99	25.13	27.64	28.78	29.45	30.75
ALTO DE EMPEINE	776	3.52	4.62	5.19	6.16	8.29	9.26	9.83	10.92
LONGITUD DE LA PALMA	656	8.30	8.92	9.25	9.81	11.02	11.58	11.91	12.53
LONGITUD DE LA MANO	420	16.11	16.84	17.22	17.86	19.27	19.91	20.28	21.01
ANCHO DE LA PALMA DE LA MANO	411	7.26	7.63	7.82	8.14	8.85	9.17	9.36	9.72
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	595	19.05	19.95	20.42	21.22	22.98	23.78	24.25	25.15
ANCHO DEL PIE	777	7.56	8.14	8.44	8.94	10.06	10.56	10.86	11.44
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	859	21.96	24.93	26.48	29.10	34.87	37.49	39.04	42.01
DIAMETRO DE AGARRE (INTERIOR)	402	40.14	43.22	44.82	47.55	53.53	56.25	57.86	60.94

Table1. Results of strata and sex (continuation).

		Estrato 26-34 Masculino								Estrato 36-46 Masculino							
		Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99	Perc. 1	Perc. 5	Perc. 10	Perc. 25	Perc. 75	Perc. 90	Perc. 95	Perc. 99
PESO	920	39.61	49.72	55.00	63.93	83.57	92.50	97.78	107.89	58.88	65.37	68.76	74.51	87.12	92.87	96.26	102.75
ESTATURA	805	147.57	152.57	155.18	159.60	169.30	173.72	176.33	181.33	148.25	153.70	156.54	161.35	171.93	176.75	179.59	185.03
ALTURA AL OJO (PARADO)	328	137.49	142.21	144.67	148.84	158.00	162.16	164.62	169.34	137.90	143.17	145.92	150.58	160.82	165.48	168.23	173.50
ALTURA AL HOMBRO (PARADO)	23	119.98	124.75	127.23	131.44	140.69	144.90	147.39	152.15	122.29	127.15	129.68	133.97	143.40	147.69	150.22	155.08
ALTURA AL CODO (PARADO)	309	93.73	96.42	97.82	100.20	105.43	107.81	109.21	111.91	91.27	95.25	97.33	100.85	108.58	112.10	114.17	118.15
ALTURA A LA CINTURA (PARADO)	949	88.95	92.81	94.83	98.25	105.75	109.17	111.19	115.05	94.93	98.24	99.97	102.90	109.33	112.26	113.99	117.30
ALTURA A LA MUÑECA (PARADO)	973	68.02	71.69	73.60	76.85	83.98	87.23	89.15	92.82	67.07	71.45	73.74	77.62	86.13	90.00	92.29	96.67
ALTURA AL GLUTEO (PARADO)	398	64.98	67.79	69.25	71.73	77.17	79.65	81.11	83.92	65.81	68.96	70.60	73.38	79.50	82.29	83.93	87.08
ALTURA AL DEDO MEDIO (PARADO)	265	52.66	55.25	56.60	58.89	63.91	66.20	67.55	70.14	48.91	53.19	55.42	59.19	67.49	71.27	73.50	77.77
ALTURA DE LA CABEZA AL SUELO (SENTADO)	2FGM	112.26	115.56	117.29	120.21	126.62	129.55	131.27	134.57	111.83	116.29	118.62	122.57	131.23	135.18	137.51	141.97
ALTURA DEL ASIENTO AL DEDO MEDIO CON LOS BRAZOS HACIA ARRIBA	914	115.26	119.49	121.69	125.43	133.64	137.37	139.58	143.81	117.56	121.86	124.10	127.89	136.22	140.02	142.26	146.55
ALTURA DEL CENTRO DEL PUÑO CON LOS BRAZOS HACIA ARRIBA	912	108.16	112.03	114.06	117.48	125.02	128.44	130.47	134.34	108.82	113.02	115.21	118.92	127.08	130.79	132.98	137.18
ALTURA DEL ASIENTO A LA CABEZA	758	79.06	81.35	82.54	84.56	89.00	91.02	92.22	94.50	76.97	80.20	81.88	84.74	91.01	93.86	95.54	98.77
ALTURA DEL ASIENTO A LOS OJOS	330	65.71	68.50	69.96	72.42	77.84	80.31	81.76	84.55	67.49	69.98	71.29	73.49	78.34	80.54	81.84	84.34
ALTURA DEL ASIENTO AL HOMBRO	25	52.62	54.28	55.14	56.61	59.83	61.29	62.15	63.81	52.12	54.51	55.75	57.87	62.51	64.62	65.86	68.25
ALTURA DEL ASIENTO AL CODO 90¨	312	21.32	22.64	23.33	24.50	27.07	28.23	28.92	30.24	18.22	20.02	20.96	22.55	26.05	27.64	28.58	30.38
ALTURA AL MUSLO (SENTADO)	856	12.83	13.84	14.36	15.25	17.21	18.10	18.63	19.64	13.54	14.18	14.51	15.07	16.30	16.86	17.20	17.83
ALTURA DEL SUELO AL ASIENTO	4FGM	33.51	34.82	35.50	36.66	39.21	40.37	41.05	42.36	33.33	35.33	36.38	38.15	42.05	43.82	44.87	46.87
ALTURA DEL SUELO A LA PARTE POSTERIOR DE A RODILLA (SENTADO)	678	37.54	39.24	40.13	41.63	44.93	46.44	47.32	49.02	39.75	41.29	42.10	43.46	46.45	47.82	48.62	50.17
ALTURA DEL SUELO A LA RODILLA (SENTADO)	529	45.14	46.96	47.90	49.51	53.03	54.63	55.58	57.39	42.59	45.09	46.40	48.61	53.47	55.69	57.00	59.50
ANCHO DE CODOS CON LAS MANOS AL CENTRO DEL PECHO (PARADO)	798	70.65	74.81	76.98	80.66	88.74	92.42	94.59	98.75	75.55	79.30	81.25	84.56	91.84	95.15	97.10	100.85
ANCHO DE LOS BRAZOS EXTENDIDOS LATERALMENTE (PARADO)	797	152.00	156.92	159.48	163.83	173.37	177.72	180.28	185.20	155.68	160.54	163.07	167.37	176.80	181.10	183.64	188.49
*ESPALDA DEDO MEDIO	80	72.01	75.21	76.88	79.71	85.92	88.75	90.42	93.62	78.32	80.40	81.49	83.33	87.38	89.22	90.31	92.39
DISTANCIA DE LA PARED AL CENTRO DEL PUÑO (PARADO)	752	65.44	68.03	69.37	71.66	76.68	78.96	80.31	82.89	45.56	54.13	58.60	66.17	82.80	90.38	94.84	103.41
ANCHO DE LA CABEZA	427	14.04	14.44	14.64	15.00	15.77	16.12	16.33	16.73	13.70	14.07	14.26	14.58	15.30	15.63	15.82	16.19
LONGITUD DE LA CABEZA	441	16.22	16.85	17.17	17.73	18.94	19.49	19.82	20.45	16.06	16.90	17.35	18.09	19.74	20.48	20.92	21.77
ANCHO DE LA CARA A LA ALTURA DE LAS PATILLAS	165	12.83	13.26	13.48	13.87	14.70	15.08	15.31	15.74	12.92	13.22	13.39	13.66	14.26	14.53	14.69	15.00
ANCHO DE HOMBROS (PARADO)	122	36.21	38.91	40.32	42.70	47.93	50.32	51.72	54.42	36.09	38.78	40.19	42.57	47.80	50.18	51.59	54.28
ANCHO DE PECHO (PARADO)	223	26.42	28.08	28.95	30.42	33.65	35.12	35.98	37.64	28.66	30.20	31.00	32.35	35.33	36.69	37.49	39.02
ANCHO DE CADERA (PARADO)	457	24.22	26.53	27.73	29.77	34.26	36.30	37.51	39.81	30.52	31.70	32.32	33.37	35.66	36.71	37.33	38.51
ANCHO DE LA ESPALDA CON LOS BRAZOS EXTENDIDOS HACIA AL FRENTE	507	33.28	36.16	37.67	40.22	45.82	48.37	49.87	52.75	38.87	40.68	41.63	43.23	46.74	48.35	49.29	51.10
ANCHO DE LA CADERA	459	31.92	33.61	34.49	35.99	39.28	40.77	41.66	43.35	34.14	35.58	36.33	37.60	40.40	41.67	42.42	43.86
LONGITUD DEL CODO AL DEDO MEDIO	381	39.35	41.23	42.21	43.87	47.53	49.19	50.17	52.05	44.30	44.89	45.20	45.72	46.88	47.40	47.71	48.30
LONGITUD DE LA RODILLA AL RESPALDO DE LA SILLA	194	49.43	51.75	52.96	55.01	59.52	61.57	62.78	65.10	52.29	53.94	54.80	56.27	59.48	60.94	61.80	63.45
LONGITUD DE LA PARTE POSTERIOR DE LA RODILLA AL RESPALDO DE LA SILLA	200	41.11	42.40	43.08	44.21	46.72	47.86	48.53	49.82	42.03	43.28	43.93	45.03	47.45	48.56	49.21	50.46
f* OJO GLUTEO	328-398	70.61	72.96	74.18	76.25	80.81	82.89	84.11	86.46	67.16	70.60	72.39	75.43	82.11	85.15	86.94	90.38
CIRCUNFERENCIA DE LA CABEZA	430	54.09	54.78	55.13	55.74	57.06	57.67	58.02	58.71	53.49	54.24	54.63	55.30	56.76	57.42	57.82	58.57
DISTANCIA DE OIDO A OIDO SOBRE LA CABEZA	144	35.09	35.99	36.46	37.26	39.01	39.80	40.27	41.17	34.05	35.18	35.77	36.76	38.95	39.95	40.53	41.66
CIRCUNFERENCIA DEL PECHO	230	75.93	82.77	86.34	92.38	105.65	111.70	115.26	122.10	94.72	97.57	99.06	101.59	107.13	109.65	111.14	113.99
CIRCUNFERENCIA DE LA CINTURA	931	68.80	75.00	78.24	83.73	95.77	101.26	104.50	110.70	77.08	82.97	86.03	91.23	102.65	107.85	110.92	116.80
CIRCUNFERENCIA DE LA CADERA	178	76.41	81.82	84.65	89.43	99.94	104.72	107.54	112.95	90.09	93.13	94.71	97.39	103.29	105.98	107.56	110.60
LARGO DEL PIE	775	22.63	23.46	23.90	24.64	26.26	27.00	27.44	28.27	23.79	24.29	24.55	24.99	25.95	26.39	26.65	27.15
ALTO DE EMPEINE	776	4.94	5.47	5.75	6.22	7.25	7.72	8.00	8.53	4.56	5.41	5.85	6.59	8.23	8.98	9.42	10.27
LONGITUD DE LA PALMA	656	8.44	8.97	9.25	9.72	10.75	11.22	11.50	12.03	9.79	9.94	10.02	10.16	10.47	10.60	10.69	10.84
LONGITUD DE LA MANO	420	14.98	15.80	16.23	16.95	18.55	19.27	19.70	20.52	16.43	16.89	17.13	17.53	18.41	18.82	19.05	19.51
ANCHO DE LA PALMA DE LA MANO	411	6.21	6.83	7.16	7.71	8.92	9.47	9.80	10.42	7.62	7.80	7.89	8.05	8.40	8.56	8.66	8.84
ALTURA DE LA BARBILLA A LA PARTE SUPERIOR A LA CABEZA	595	19.12	20.24	20.82	21.81	23.99	24.98	25.56	26.68	20.56	21.28	21.66	22.30	23.70	24.34	24.72	25.44
ANCHO DEL PIE	777	7.51	7.98	8.23	8.65	9.58	10.00	10.25	10.73	8.67	8.91	9.03	9.23	9.68	9.89	10.01	10.24
ANCHO DE LOS MUSLOS CON LAS RODILLAS JUNTAS	859	21.87	24.43	25.76	28.02	32.98	35.24	36.57	39.13	25.02	26.05	26.59	27.50	29.50	30.41	30.95	31.98
DIAMETRO DE AGARRE (INTERIOR)	402	40.17	42.54	43.78	45.87	50.46	52.56	53.79	56.16	38.63	41.06	42.34	44.49	49.22	51.38	52.65	55.09

5. CONCLUSIONS

The development of an anthropometric chart, which presents the main measures used in the design of work stations that address the ergonomics directives, remains today a priority for the maquiladora industry, which can be used to work on the worker and improve the productivity of the productive entity.

The results presented in the present investigation are validated from the studies of hypothesis tests, which leads us to a use of the data presented in the system of anthropometric measurements with high reliability.

The use of presented data in the system of anthropometric measurements allows the design and redesign managers of work stations in the production lines with intermittent Flow of maquiladora and manufacturing industry in Agua Prieta Sonora, sustain the designs in validated and reliable data.

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STUDY OF THE LEVEL OF EFFORT IN THE HANDS OF UNIVERSITY STUDENTS.

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Abstrac: En la actualidad, debido a la constante presentación de los Desórdenes musculo esqueléticos (DME) en los sitios de trabajo, se ha vuelto una necesidad contar con información de referencia para la mejora o diseño de instrumentos de trabajo acordes a los usuarios de un proceso o sector en particular. Las dimensiones y el nivel de esfuerzo de la mano son de gran relevancia para lo antes descrito siendo este último parámetro el de principal interés para el presente estudio. Para su desarrollo se realizaron las mediciones del nivel de esfuerzo de 94 hombres y 73 mujeres entre los 18 y 28 años de edad en tres posiciones diferentes empleando un guante y sin usar guante. Como resultados se obtuvieron los registros del nivel de esfuerzo para cada posición descrita, su valor mínimo, máximo y el promedio. Se observa que la fuerza promedio tanto en hombres como mujeres utilizando guantes es ligeramente mayor quizás a que existe un mejor agarre del dinamómetro. Se aprecia una pequeña diferencia de 1kgf en los promedios entre mano dominante y no dominante, sin embargo, este diferencia se incrementa en alrededor de 6kgf al tratarse de los valores máximo y mínimos entre ambas manos. Al comparar el nivel de esfuerzo entre mujeres y hombres se aprecia una mayor fuerza en estos últimos. Con respecto a los percentiles se analizaron los percentiles de 5, 50 y 95 lo que permitirá tener datos precisos al momento de plantear una nueva herramienta. En conclusión replicar este tipo de estudio atraerá una disminución en los riesgos laborales y los DME asociados al uso del equipo. Es recomendable explorar la correlación entre las variables nivel de esfuerzo, dimensiones de la mano, la estatura e índice de masa corporal del sujeto de muestreo.

Abstrac: Currently, due to the constant presentation of Musculoskeletal Disorders (MSD) in workplaces, it has become a necessity to have reference information for the improvement or design of work tools according to the users of a particular process or sector. The dimensions and the level of effort of the hand are of great relevance for what was previously described, this last parameter being the main interest in this study. For its development, measurements of the effort level of 94 men and 73 women between 18 and 28 years of age were made in three different positions using a glove and without wearing a glove. As a result, records of the effort level were obtained for each position described, its minimum, maximum and average values. It is observed that the average strength in men and women using gloves is slightly higher perhaps because there is a better grip of the dynamometer. A small difference of 1 kgf is observed in the averages between dominant and non-dominant hand, nevertheless, this difference increases by around 6kgf since it is the maximum and minimum values between both hands. When comparing the level of effort between women and men, greater strength is seen in the latter. With respect to the percentages, those of 5, 50 and 95 were analyzed, which will allow having precise data when proposing a new tool. In conclusion, replicating this type of study will attract a decrease in occupational risks and MSD associated with the use of equipment. It is advisable to explore the statistical correlation between the variables effort level, hand dimensions, height and body mass index of the sampling subject.

Key words: Ergonomics, anthropometry, factors and risk.

Relevance to Ergonomics: Reduce occupational risks and musculoskeletal disorders associated with the use of equipment and tools.

1. INTRODUCTION

University education is a public good that also produces private benefits, which manifest themselves in a variety of circumstances, including higher incomes and higher job satisfaction. More collectively transcendent are the public benefits. A more and better educated population means a more informed, participatory and critical citizenship. Additionally, university education has important multiplier effects on economic and social development and is a crucial component in building a more prosperous and socially inclusive nation (Fuentes, 2013).

In Mexico only 3 out of 10 young people have the opportunity to go to university. According with data of the SEP, there are 2.93 million young people enrolled in any of the 4,894 public and private universities in the country; and of the university student total, the projections indicate that only 4% will be able to advance towards postgraduate studies. In Sonora there are different private and public educational institutions that offer university and higher education careers. Universidad de Sonora, Universidad de Navojoa o Universidad de la Sierra are some of those institutions in which students can pursue different university careers from online degrees to technical careers, through masters and doctorates.

Institutions of higher education include, as part of the ability or competence of Industrial Engineering, the subject of Ergonomics either as such or as a starting line and / or specialization being relevant “Detect problematic situations of ergonomic type in the workplace, and thus propose alternative solutions to achieve an efficient relationship between the worker and his environment” as is the case of work accidents and Musculoskeletal Disorders (MSD) (Castellano, 2014).

According to statistics of Secretaría del Trabajo y Previsión Social (2017), in Sonora 88% of occupational risks occur in companies related to building the manufacture and provision of purchase-sale services. It is also established that 66% of occupational diseases and 63% of permanent disabilities are caused by ergonomic risk factors. Related to accidents it is observed that, 518, 718 cases presented to date, 86% occurs in upper extremities and 84% in jobs related to the production, construction and operation of machinery. On the other hand according

with Gil y Sandoval (2013) mention that Guaymas is positioned in the second place of numbers about certified cases of MSD with 48 cases.
Currently it has been observed that most of the equipment that is used such as work tools, are acquired without previous analysis of design, functionality or manipulation, which in most of the time is uncomfortable for the worker, thus causing a low performance in the operation. Given this, there is a need to contribute to avoid the presentation of occupational risks and musculoskeletal injuries resulting from effort and design by the use of work tooling.

2. OBJETIVE

Develop a study of effort in dominant and non dominant hand in students of higher education to contribute in the design of work tooling, in avoiding the appearance of MSD´s in various parts of the body and develop the Ergonomics competence in students of the Industrial engineer career of a University.

3. METHODOLOGY

The method used rescues aspects of proposed by Mohammad (2005) and the study was conducted at a university localized in Guaymas Sonora, focusing on students with current enrollment. For the application a representative sample of 167 was used of a total of 508 students being the total population. The characteristics and values of the sample can be seen in figure 1.

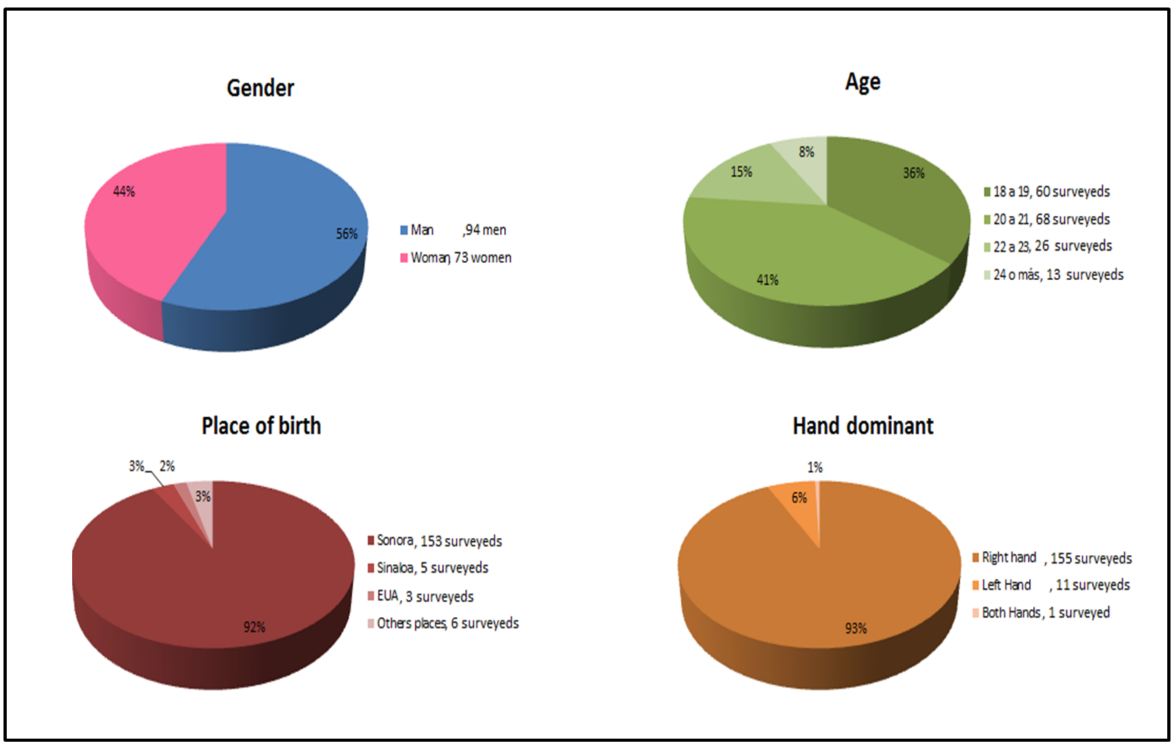

Figure 1. Characterization of the sampling subjects

Of the 167 subjects studied 94 are men and 73 women, corresponding to 56 and 44 percent respectively. Regarding age, it is observed that 60 are in the range between 18 and 19 years (36 percent); 68 range from 20 to 21 years (41 percent); 26 are between 22 and 23 years old (15 percent); and 13 are 24 years old or older (8 percent). In relation to the place of birth 153 are born in the State of Sonora (92 percent), 5 in Sinaloa (3 percent), 3 in the United States (2 percent) and the rest in other places (3 percent). Finally 155 students have the right hand as dominant (93 percent) and 11 with the left hand (6 percent) and one person claimed use both hands (right and left) (1 percent). It is worth mentioning that at the moment of making the measurements to the sample, they were provided with information related to the measurement technique, it was observed that they were in good health and that none lacked any limb or hand.

To obtain data, the JAMAR manual hand dynamometer was used, which has handle adjustable to the size of the hand and measures muscle strength between 0 and 90kgf in intervals of 2kgf. The format to be used contemplates maximum strength values without gloves and maximum strength with gloves, each one being made in three different positions for dominant hand and non-dominant hand, the above is observed in figure 2.

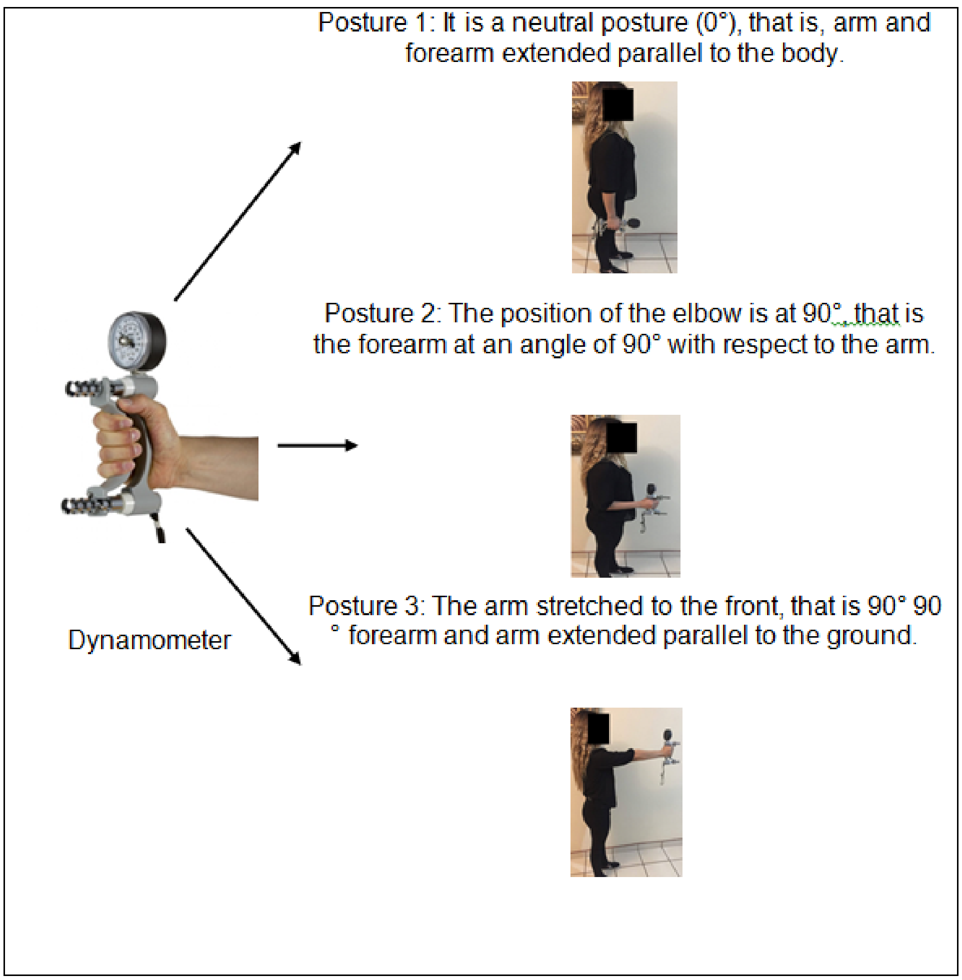

Figure 2: JAMAR manual dynamometer and effort postures

After the training of the use of the dynamometer, the team and work space were prepared, an area was assigned to perform measurements within campus facilities and it began with the recording of data according to the postures of effort indicated above. Next step proceeded to perform the calculations to obtain the variables of interest among which is the average, standard deviation, the minimum value, the maximum value and the determination and interpretation of the percentiles of 5, 50 y 95.

4. RESULTS

Once the data collection of the 167 individuals was made, the information was ordered by gender (male or female), listing the variables of interest in each row and in each column the postures and the hand under study. Results are shown in tables 1 and 2.

Table 1. Results of the effort level in men

A. Effort of men without gloves

	Maximum strength without gloves					
	P1		P2		P3	
	DH	NDH	DH	NDH	DH	NDH
Average	32	32	32	31	32	31
D.E.	10	11	10	10	10	10
Max	57	61	63	65	53	55
Min	12	11	13	13	13	13
P5	17	17	18	19	18	18
P50	32	29	30	29	29	29
P95	50	52	48	47	50	48

B. Effort of men with gloves

	Maximum strength with gloves					
	P1		P2		P3	
	DH	NDH	DH	NDH	DH	NDH
Average	33	32	32	31	33	32
D.E.	10	10	10	9	9	9
Max	66	61	67	60	61	52
Min	15	15	13	12	15	13
P5	19	19	19	17	19	18
P50	31	30	30	29	32	31
P95	50	50	47	48	49	47

In tables 1, it shows the level of effort generated in the hands of man. First shown maximum strength without gloves (A), the highest average was 32 in all positions and 31 in the position two and three in non-dominant hand. On the other hand, the standard deviation was 10 in most of the postures, while the highest was 11 in position 1 in non-dominant hand, the maximum was 65 in the position 2 in non-dominant hand and the minimum was 11 in position 1 in non-dominant hand.

Average values of maximum strength with gloves range from 31 to 33. The smallest value of standard deviation was obtained in position 3 and in position 2 in non-dominant hand with 9. The maximum value was in position two in dominant hand with 67kgf and the minimum value was in position 2 in non-dominant hand with 12kgf. The results of the effort level in women are shown below.

Table 2. Results of the level of effort in women

C. Effort of women without gloves

	Maximum strength without gloves					
	P1		**P2**		**P3**	
	MD	**MND**	**MD**	**MND**	**MD**	**MND**
Average	21	20	21	19	21	20
D.E.	5	5	6	5	6	5
Max	39	38	41	35	40	35
Min	12	11	7	8	5	8
P5	13	12	12	12	11	11
P50	21	19	21	20	22	20
P95	28	28	27	27	29	29

D. Effort of women with gloves

	Maximum strength with gloves					
	P1		**P2**		**P3**	
	DH	**NDH**	**DH**	**NDH**	**DH**	**NDH**
Average	22	21	22	21	22	20
D.E.	5	6	6	6	6	6
Max	39	38	36	40	43	41
Min	9	9	9	7	9	7
P5	12	13	13	13	11	12
P50	22	21	22	20	22	20
P95	31	30	30	29	30	30

In relation to the level of effort in women, first appears the maximum strength without glove (C) obtaining an average of 19 to 21 in the three positions in both hands. The standard deviation varies from 5 to 6 in the same way in the three positions in dominant hand and non-dominant hand, being the dominant hand in the position 1 with the least deviation. In the three position was obtained the highest standard deviation in dominant hand. The maximum that was obtained was 41 kgf in position 2 in dominant hand, and the minimum was 5 in position 3 in the dominant hand. The data obtained in the maximum strength with glove (D) the average of the three positions are from 20 to 22. The minor deviation was in position 1 in dominant hand with 5, the rest of the positions obtained a deviation of 6. The maximum value was 43 in the position 3 in dominant hand and the minimum was 7 in position 2 and 3 in non-dominant hand.

With the results obtained, it can be seen that the average strength in men and women using gloves is a little higher, since there is a better grip, with respect to the percentages, those of 5, 50 and 95 were analyzed, which allows to have information of great relevance in tooling design.

5. DISCUSSION/ CONCLUSIONS

Regarding the effort, the charts showed averages in which it can be observed that in men as in women the dominant hand is the strongest, Analyzing the strength of the man without a glove, it was noted that in the three positions the average was 32kgf, while with glove the strength is greater since it has better grip with a total of 33kgf but only in position 1 and 3. The women obtained on average that the dominant hand is also the strongest one obtaining without glove 21kgf in the three positions and in the same way increase of minimum with glove with a total of 22kgf in the three positions.

Which leads to conclude that the use of gloves gives a better grip to increase strength, but this increase can be noted that in both cases it was minimal, 1jgf for men and women. The charts obtained, contribute greatly in the design and construction of material or tools such as tweezers, scissors and everything related to this body limb. This will reduce the costs associated with diseases due to the presentation of musculoskeletal disorders and occupational diseases.

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ANTHROPOMETRIC CHARACTERISTICS AND ITS RELATIONSHIP WITH THE ACCIDENTABILITY IN THE WORKPLACE OF METALMECHANICAL COMPANY.

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Resumen: La investigación se lleva a cabo en una empresa metalmecánica en la zona oriente del Estado de México, donde se percataron que los accidentes y ausentismo se habían incrementado. En Memorias del IMSS, 2016, se reporta que en el Estado de México, existen aproximadamente 39848 empresas, con 53,414 casos de riesgos de trabajo, ocupando el 2° lugar a nivel nacional, implicando 26,520 incapacidades y de ellas 14,790 son incapacidades permanentes por accidente de trabajo, anteriormente en 2013, se tenían 12,000, en 2014, creció a 12,579 y en 2015, 12,881, con un pronóstico para 2020 de 15,024 incapacidades permanentes por accidente de trabajo. Con base en lo anterior, se realizó esta investigación descriptiva, transversal, con el objetivo de identificar las secciones con alto riesgo mecánico y su relación con las características antropométricas de los trabajadores. Se evaluaron los puestos de trabajo a través del método RULA, se entrevistó a los operarios y se recopilo información de la accidentalidad en la empresa, así como la evaluación de riesgos a través del método LEST y diagnóstico de cada máquina. Posteriormente se llevaron a cabo mediciones antropométricas a través del método de siete puntos, para la generación de la base de datos, finalizando con la evaluación de condiciones ambientales de acuerdo a la normatividad vigente. Los resultados del análisis mostraron una correlación de 0.89 entre la accidentabilidad y las dimensiones antropométricas de los operarios. La propuesta fue optimizar el proceso de forma integral, con la implementación de métodos ergonómicos y la readecuación de la estación de trabajo. La oportuna intervención de la Ergonomía es de vital importancia, en preservación de la integridad del factor humano, además del cumplimiento con la Normatividad vigente.

Palabras clave: *Riesgo, accidentabilidad, incapacidad.*

Abstract: The investigation is carried out in a metalworking company in the eastern area of the State of Mexico, where they realized that accidents and absenteeism had increased. In Memories of the IMSS, 2016, it is reported that in the State of Mexico, there are approximately 39,848 companies, with 53,414 cases of occupational hazards, occupying the 2nd place nationally, involving 26,520 disabilities and of these 14,790 are permanent disabilities by accident of work, previously in 2013, there were 12,000, in 2014, it grew to 12,579 and in 2015, 12,881, with a prognosis for 2020 of 15,024 permanent disabilities due to work accidents. Based on the foregoing, this descriptive, cross-sectional investigation was carried out with the objective of identifying the sections with high mechanical risk and their relationship with the anthropometric characteristics of the workers. The work stations were evaluated through the RULA method, the operators were interviewed and information was collected on the accident rate in the company, as well as the risk assessment through the LEST method and diagnosis of each machine. Subsequently, anthropometric measurements were carried out through the seven-point method, for the generation of the database, ending with the evaluation of environmental conditions according to the current regulations. The results of the analysis showed a correlation of 0.89 between the accident rate and the anthropometric dimensions of the workers. The proposal was to optimize the process in an integral way, with the implementation of ergonomic methods and the readjustment of the work station. The timely intervention of the Ergonomics is of vital importance, in preservation of the integrity of the human factor, in addition to the compliance with the current Regulations.

Key words: *Risk, accident, disability.*

Relevance to Ergonomics: The study contributes to the dissemination of knowledge and awareness of the importance of Ergonomics in the design of work stations and production processes, highlighting the most important thing is the health and life of operators without neglecting the productivity and functionality part of the company.

1. INTRODUCTION

In recent years, the number of companies worldwide has increased in both the manufacturing and services sectors. The International Labor Organization (ILO, 2013) reports that more than 317 million accidents occur at work each year and 6,300 people die each day due to work-related accidents or illnesses. The cost of this daily adversity is enormous and the economic burden of poor safety and health practices is estimated at 4 percent of the Gross Domestic Product (GDP), global each year, implying in addition to human losses, financial losses. In 2008, the ILO adopted the Occupational Health and Safety and Environment Program, which aims to create global awareness of the magnitude and consequences of accidents, injuries and work-related illnesses and disergonomic risks.

The International Ergonomics Association (IEA, 2016), defines ergonomics as the scientific discipline that deals with the understanding of the interaction between human beings and the other elements of a system, among the objectives of ergonomics is the achievement of the satisfaction at work, considering the responsibilities, attitudes, beliefs and values for personal development as well as individual and cultural differences. Ergonomics as a scientific discipline, is related to the development of knowledge about the capabilities and limitations of human beings in the process and performance of their activities in the context of interface between people, machines, systems and their environment. For Organizational Ergonomics the approach is to optimize the functioning of work systems through the interface of organizational design, with technology, the environment and people. (Aguayo & Lama, 2016).

In the present work, the approach is oriented towards the Organizational Ergonomics, and for this investigation the definition of Hendrick is considered: "The organizational ergonomics or macro ergonomics is the approach of the socio-technical systems for the organizational design and finally of the systems of work and the design of the related interfaces: man-machine, man-environment and user ". (Hendrick, 1991a, p.77). Occupational safety and health conditions differ enormously among countries, economic sectors and social groups, including between types of work and professions. In the case of Mexico, the Ministry of Labor and Social Security (STPS) establishes the mechanisms (Laws, Regulations, Standards, among others), through which the Labor and Health and Safety and Health relations are governed, as well as keeping them updated according to society's own needs and monitoring compliance with them.

With respect to the modifications, the most recent was carried out on November 13, 2014, when the Federal Regulation of Safety and Health at Work was published in the Official Gazette of the Federation (DOF, 2014), which It came into force on February 13, 2015. The International Ergonomics Association (IEA, 2016), defines ergonomics as the scientific discipline that deals with the understanding of the interaction between human beings and the other elements of a system, among the objectives of ergonomics is the achievement of the satisfaction at work, considering the responsibilities, attitudes, beliefs and values for personal development as well as individual and cultural differences.

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With which the Federal Regulation of Occupational Safety, Hygiene and Environment was repealed on January 21, 1997. With the objective of establishing the provisions on Occupational Safety and Health to be observed in the Work Centers, effect of having the conditions that allow to prevent risks and in this way, guarantee workers the right to carry out their activities in environments that ensure their life and health, based on what is stated in the Federal Labor Law.

On the other hand, also on January 4, 2018, the Official Mexican Standard NOM-036-STPS was published, which states that ergonomic risk factors can lead to physical effort, repetitive movements or forced postures in the work carried out, with the consequent fatigue, errors, accidents and work diseases derived from the design of the facilities, machinery, equipment, tools or work station.

One of the biggest problems for ergonomics is that it is not part of the work culture, and there is no follow-up to the real figures of injuries, accidents, and occupational diseases caused by disergonomic factors in the work centers, because not all companies have their employees insured or is not documented. The importance and importance, of the Ergonomics and Psychosocial Factors, lies in the Prevention of Work Risks, promoting its application and disclosure in companies and educational institutions to minimize the accident rate, deterioration of health and underutilization of machinery.

In Memories of the IMSS, 2016, it is reported that in the State of Mexico, there are approximately 39,848 companies, with 53,414 cases of occupational hazards, occupying after Coahuila, the 2nd place nationwide, involving 26,520 disabilities and of these 14,790 are permanent disabilities due to work accidents, previously in 2013, there were 12,000, in 2014, it grew to 12,579 and in 2015, 12,881, with a prognosis for 2020 of 15,024 permanent disabilities due to work accidents.

In this information, it is inferred that there is little or no knowledge about ergonomics and occupational health, causing discomfort in workers, back pain, neck pain, wrists, lumbago and work accidents; resulting in absenteeism and disabilities, having an impact on productivity. Regarding Anthropometry, the dimensional characteristics of a human being are determined by the influence of several factors. In the ergonomic perspective, the most important factors are age, sex, ethnicity, nutritional status and, in the case of a working population, the occupation itself; However, although there is information from other countries, there is currently very little information regarding anthropometric charts of the Mexican population, whose results are reliable due to ethnic differences and variability of dimensional features, limit the usefulness of the information stored in such databases. Of data for its scientific validation.

In the researchers reported by the University of Guadalajara, in the book Anthropometric Dimensions: Latin American Population (Ávila, Prado, & González, 2007), anthropometric results of the population of the Federal District, Guadalajara, Jalisco and León, Guanajuato, cities are shown. They are from the center of Mexico, however, these anthropometric data cannot be generalized for the whole country. The book by Ávila et al (2007) also contains a small sample of working women from the Mexican border with the United States of America. The works of Bustillos and Hernández (1999) and Liu, Sánchez-Monroy and Parga (1999), do not consider the entire community.

Based on the foregoing in this project, the anthropometric profiles of the northern area of the State of Mexico will be investigated, in order to prepare an analysis to determine if there is a relationship between the accident rate and the anthropometric characteristics of the workers and to document the results to generate a database and with it the construction of Anthropometric Charts of said region for its publication as base of the Anthropometric Atlas of Mexico, due to the fact that none is currently available.

This study is generated from the need to know the causes of the recurrence of complaints by workers with regard to joint pain, back and frequent disabilities for the same reasons in the area of molding a production plant of glass bottles located in the municipality of Tultitlán in the State of Mexico. One of the factors that were identified from the beginning was that, due to its origin, the dimensions and design of the machines tend to be very different from the morphological characteristics of the users and this has resulted in the operators having to adapt to their station. I work on equipment and machinery, with the risk of acquiring cumulative trauma dysfunction (DTA).

That is why this study aims to make measurements of the anthropometric dimensions to workers in the glass bottle production plant located in the municipality of Tultitlán in the State of Mexico, for future ergonomic evaluations. Anthropometry allows the creation of a suitable working environment for the design of the equipment and its correct distribution, allowing to configure the geometric characteristics of the position, a good furniture design, manual tools, individual protection equipment, among other applications.

2. OBJECTIVES

1. Identify the sections with high risk and their relationship with the anthropometric characteristics of the workers.
2. To evaluate the relationship between the anthropometric characteristics of the workers and the accident rate.

3. METHODOLOGY

The study will be quantitative, observational, descriptive and cross-sectional, it will be carried out to determine the anthropometric profile of the working population of the state of Mexico, northern zone (municipalities of Tultitlán, Coacalco, and Ecatepec). The population will be divided by age group, gender and sex (it should be noted that the concept of sex refers to the differences and biological, anatomical and physiological characteristics of human beings that define them as men or women; it is born, universal and unmodifiable and gender is the set of ideas, behaviors and attributions that a given society considers appropriate for each sex), of which samples will be taken by groups of 18 to 24 years and 18 to 65 years. For each sample, 37 of the anthropometric dimensions will be taken, to then capture and analyze the data and finally generate anthropometric tables.

The work stations were evaluated through the RULA method, the operators were interviewed and information was collected on the accident rate in the company, as well as the risk assessment through the LEST method and diagnosis of each machine. Subsequently, anthropometric measurements were carried out through the seven-point method, for the generation of the database, ending with the evaluation of environmental conditions according to the current regulations. Materials and Equipment, is measurement and analysis module of anthropometric and biomechanical measurements Asia Tech.

Figure 1. Materials and Equipment.

The samples will be at convenience and consist of voluntary participants, before making the measurements will be read and explained to the participants an informed consent sheet that will include information about the purpose of the project and those responsible for it, as well as the necessary information on the procedure, the risks, benefits, their rights and the confidentiality of the study, finally the document will be signed by the volunteer, the person in charge and a witness.

The first activity to be carried out as part of the project will be a certification in Isak Level I anthropometry, to ensure the correct measurement and data collection. After this, an information acquisition will be carried out on the basic economic area in the INEGI to select the companies to be sampled. Once the companies have been selected, the corresponding authorizations of each institution must be obtained. At the same time, the recruitment of members of anthropometric teams will be carried out, and these will be trained in anthropometry to take measurements.

A literature review will be carried out with the objective of knowing which anthropometric dimensions are the most used by the designers, books and articles related to anthropometry will be reviewed for the design of furniture, tools and work stations, once these dimensions are known a format will be created to record the data of each volunteer. Once the above is done, it will begin with the taking of samples. Anthropometric measurements of the population will be taken for each age group and sex (18 to 24 years and 18 to 55 years).

To take the samples will assist the work places with the necessary equipment, an anthropometric and a person in charge of recording the data. The informed consent form will be reviewed with each volunteer, these will include information about the project, the people in charge of it, risks, benefits, rights, obligations and confidentiality, after signing the volunteer, the person in charge of the project and a witness will proceed to the taking of the measurements, using the anthropometric technique of Hertzberg (1968).

At the end of the measurements, the capture, revision, correction and processing of the data will be performed, these will be analyzed in SPSS for Windows in version 15.0, in order to perform the analysis of the variables in said program and in the software Amos 16.0 ., first an analysis matrix will be elaborated to carry out the statistical analysis, normality tests will be carried out, as well as generating measures of central tendency, dispersion, percentiles (5, 50 and 95) and finally, anthropometric charts will be generated for each age group and sex.

4. RESULTS

The results of the analysis showed a correlation of 0.89 between the accident rate and the anthropometric dimensions of the workers. The proposal was to optimize the process in an integral way, with the implementation of ergonomic methods and the readjustment of the work station. The timely intervention of the Ergonomics is of vital importance, in preservation of the integrity of the human factor, in addition to the compliance with the current Regulations.

When analyzing the work station it was found that the weight of the molds is between 70 and 90 kg. With which it exceeds the 25 Kg. That marks the Official Mexican NOM-006-STPS-2014 for Management and storage of materials-Health and safety conditions at work for an operator, without the help of another loading tool.

It is suggested the authorization of technologies, processes, equipment, procedures, mechanisms, test methods or alternative materials to those provided in the standards. The category of older workers varies according to their functional condition, which in turn is influenced by their previous work history. It also depends on the job they occupy and the social, cultural and economic situation of the place where they live.

Thus, those workers who perform a purely physical job are often the ones with the lowest level of schooling and professional preparation. They are subject to stress caused by strenuous work, which can be a cause of illness, and exposed to the risk of work accidents. In this context, it is more than probable that their physical capacity will decline at the end of their active life, a fact that makes them more vulnerable workers. It is clear that the benefits of ergonomics can be reflected in many different ways: in productivity and quality, in safety and health, in reliability, in job satisfaction and in personal development.

The basic objective of ergonomics is to achieve efficiency in any activity carried out for the purpose of achieving the desired result without wasting resources, without errors and without damage to the person involved or to others. It is not efficient to waste energy or time due to poor design of work, work space, environment or working conditions and ensure that the work environment is in harmony with the activities performed by the worker.

Various parts of the body were measured, but only the most relevant for the use of tools and machinery is shown.

Table 1. The phalanges of the human right hand.

Average lengths of sector of the phalanges of the human right hand expressed in mm.									
Age	L	W	T	L	W	T	L	W	T
18-19	25.2+-3.43	30.4+-4.38	20.1+-0.99	22.9+-3.479	22.3+-2.452	37.3+-4.69	19+-1.56	23.1+-3.18	26.8+-2.7
20-24	27.5+-3.11	31.1+-4.49	20.7+-2.63	24+-2.775	21.29+-3.258	40.2+-3.75	19.5+-1.75	25.3+-2.41	26.7+-3.81
25-29	30+-7.07	30+-2.83	21.5+-0.71	27.5+-6.364	24.5+-3.536	42+-8.49	20+-1.41	27.5+-6.36	38+-18.4
30-34	27.3+-4.62	34+-5.57	21.7+-0.58	25.33+-0.577	22.67+-1.155	41.3+-2.08	21+-1	25.7+-0.58	28.3+-1.53
35-39	30+-1	34+-6.08	22.3+-0.58	23.67+-1.528	22.67+-4.041	39.7+-0.58	19.3+-1.15	26+-1	27.3+-3.06
40-44	30.3+-1.53	36.3+-4.51	24+-6.93	27+-5	30+-9.165	35.7+-3.51	23.3+-7.57	28+-4	28.3+-4.04
45-49	28+-2.83	27+-1.41	20.5+-0.71	25+-4.243	27.5+-4.95	40+-0	21+-1.41	25.5+-0.71	27+-1.41
50-54	30+-1.73	33.3+-3.21	22.3+-1.53	26.33+-0.577	23.67+-3.786	40+-2.65	20.3+-1.53	25.3+-0.58	29+-1
55-59	25.7+-1.53	31.7+-4.62	21+-2	22.33+-4.041	21.67+-2.082	39+-1	20.7+-1.15	24.7+-3.21	24.7+-5.03
60-64	24.3+-3.79	27.3+-2.08	21+-1	23.33+-0.577	22+-1.732	34.3+-8.62	20.7+-0.58	23+-2.65	22.7+-1.15
65-69	28+-4.36	33+-3	21+-1	25.33+-2.082	23.33+-2.082	40.7+-5.51	20+-1.73	26.3+-2.31	30+-4

5. CONCLUSIONS

The anthropometric variables are mainly linear measures, such as height or distance in relation to the reference point, with the subject sitting or standing in a typified posture; widths, such as distances between bilateral reference points; lengths, such as the distance between two different reference points; curved measurements, or arcs, such as the distance on the body surface between two reference points, and perimeters, as measurements of closed curves around body surfaces, generally referred to at least one reference point or at a defined height. Individual differences can be very large, such as those of physical constitution and strength, are evident, but there are others, such as cultural differences, of style of skills that are more difficult to identify.

In view of the complexity of the situation, it might seem that the solution is to provide a flexible environment, in which the operator can optimize a specifically suitable form of procedures. Unfortunately, the most efficient way is not always obvious and, as a result, the worker can continue to do his job for years in an inadequate way or in unacceptable conditions. It is concluded that the best ergonomic approach is a comprehensive, long-term study, a restructuring of the workplace in the medium term and the training of supervisors and workers to raise awareness of the risks and the importance of taking care of work risks, in the short term; that is, it is necessary to adopt a systemic approach.

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ANTHROPOMETRIC STUDY AS SUPPORT TO THE PROCESS OF TENDERING AND PURCHASE OF OFFICE EQUIPMENT AND CLASSROOMS IN A UNIVERSITY

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Resumen: Las diferencias físicas y antropométricas son evidentes entre etnias, países y hasta entre regiones. Estas diferencias representan un factor importante a considerar en la adquisición de mobiliario educativo que corresponda a las necesidades y características físicas de los estudiantes. Por ello, el objetivo de la presente investigación fue determinar las características antropométricas de los estudiantes del Instituto Tecnologico de Sonora con la finalidad de establecer en un futuro próximo parámetros que garanticen la adquisición de mobiliriario y equipo a través de los procesos de licitación institucional que cumpla con aspectos de funcionalidad, comodidad, seguridad y salud de los estudiantes de Nivel Superior. En la primera etapa del estudio, se reclutaron a los participantes para registrar su lugar de nacimiento, así como del padre y madre, género y edad. Posteriormente, se realizaron las distintas medidas antropométricas en posición de pie y sentado. Por último, se procesaron estadísticamente los datos para obtener los percentiles 5, 50 y 95 de la muestra de estudiantes participantes. El principal resultado del estudio es la obtención de cartas antropométricas de los estudiantes del Instituto Tecnológico de Sonora que servirán de base para generar un catálogo con las medidas del mobiliario que el departamento de compras de la institución podría utilizar como referencia en la compra de mobiliario para las aulas de clase.

Palabras clave: Ergonomía, Antropometría, cartas antropométricas

Abstrac: The physical and anthropometric differences are evident between ethnic groups, countries and even between regions. These differences represent an important factor to consider in the acquisition of educational furniture that corresponds to the needs and physical characteristics of the students. Therefore, the objective of the investigation was to determine the anthropometric characteristics of the students at Instituto Tecnológico de Sonora with the objetive of establishing parameters in the near future that guarantee the acquisition of furniture and equipment through the institutional bidding processes that comply with aspects of functionality, comfort, safety and health of students of university education. In the first phase of the study, participants were recruited to register their place of birth, as well as their father, mother, gender and age. Subsequently, the different anthropometric measurements were made in standing and sitting position. Finally, the data were statistically processed to obtain the 5, 50 and 95 percentage of the sample of participating students. The main result of the study is the obtaining of anthropometric charts of the students of the Instituto Tecnológico de Sonora that will serve as base to generate a catalog with the measures of the furniture that the department of purchases of the institution could use like reference in the purchase of furniture for the classrooms.

Keywords: Ergonomics, Anthropometry, Anthropometric charts

Relevance to Ergonomics: Having the characterization of a sector of the population through anthropometric charts is of the utmost importance, since with this information future designs can be made, such as: furniture, equipment, work stations and hand tools, with the objetive of eradicating possible musculoskeletal disorders or even fatigue and that these in turn can be used in the region or even in the state with the sole purpose of favoring our society.

1. INTRODUCTION

University education in the world has repercussions at the economic, social, political and cultural levels. Many countries are reforming their education systems because they anticipate that what happens in the classroom today will mark the path of their future. That is why the evolution of enrollment and higher education coverage is undoubtedly one of the most important issues for the present and future of our country.

According to Rodolfo Tuirán, Subsecretary of Secretaría de Educación Pública (SEP) the 2006-2007 cycle, the number of university level students (without considering the master degree) it was slightly higher than 2.5 million students, for the 2010-2011 cycle, according to preliminary estimates, the enrollment is already above 3 million and, of that total, the school modality represents around 91 percent. Six years later for the 2016- 2017 school cycle the registration of students enrolled in university in school modality assists amounts to a total 3,523,807 of which 50.66% are male gender and 49.34% are female gender, data provided by the Asociación Nacional de Universidades e Instituciones de Educación Superior (ANUIES).

Derived from the above, it is essential to pay special attention to the spaces and equipment of the educational infrastructure, which respond to a physical, cognitive, socio-affective and perhaps even aesthetic need for the group of students. The equipment and its organization play a facilitating role in the educational units. To have furniture that is ergonomic, that benefits the physical health of the students, must be a priority for educational institutions at all levels (Lugo G., Stincer D. y Campos R., 2013). Nevertheless, Musa (2001) establishes that the seats of university students are of low comfort level, starting from the fact that the anthropometric data are not considered from the design of the same. The anthropometric dimensions provided they are considered for the design will allow the students to reach the comfort level (Adu, 2014), reduce musculoskeletal disorders

(MSD) (Sepehri, 2013), improving student performance in terms of attention while teachers and instructors teach them (Musa, 2001 y Mokdad, 2009).

The fundamental ergonomic principle that must govern in every intervention is that of adapting the activity to the capacities and limitations of the users, and not vice versa. The best job design is the one that gives the person the greatest freedom to change their position whenever they want without abandoning or damaging the task they are doing and if they leave it to rest and recover, doing another task (active or rest), or at rest. Anthropometry is the science that studies the dimensions of the human body (Mondelo P., Joan E. y Barrau P., 1999), physical geometry, volume properties and resistance capabilities of the human body (Roebuck, 1995), be it with anthropological, medical, sports objectives, as well as for the design of systems of which the person is a part: objects, tools, furniture, spaces and jobs. The difference lies precisely in the objectives with which it is used (Mondelo P., Joan E. y Barrau P., 1999).

However, anthropometric differences become more evident between ethnic groups, countries and even between regions. All this population located in different regions of the country have anthropometric discrepancies which can be attributed to: The genetic mixture among indigenous, European and African that was produced in Mexico from the XVI century formed a mestizo population with varied physical characteristics. The social perception of these anthropological profiles has led to the creation of regional human stereotypes as a basis for a national identity (Serrano, 2003).

According Panero y Zelnik (1996), socioeconomic factors constitute an essential impact on the body's medications. The feeding influences the time of development of the body, to the exemption of childhood diseases. This is important from the anthropometric and design point of view, since Mexico is considered worldwide as one of the countries with high rates of overweight and obesity. Encuesta Nacional de Salud y Nutrición (2012) reported that 35% of adolescents were overweight and obese, being the prevalence for the female gender of 35.8% and 34.1% for the male gender (Ensanut, 2012).

These aspects that influence the design of furniture and equipment for educational use that meet and respond to the needs and physical capabilities of students and administrative staff of the school, reason for the need to provide support to the Acquisitions Department of the Instituto Tecnologico de Sonora for being the entity responsible for managing the acquisition of goods and services in their phases of advice, information of quotation proposals and selection of the right good to the requirements of the client. Well-being, health, productivity, quality, satisfaction in the workplace and other aspects, it is provided, to a great extent, by the harmonic dimensional relations between man and his area of activity.

In process of Acquisition - Bidding is very important to define the technical aspects or criteria, in which it is clearly stipulated for example the type, size, quantity, physical characteristics and functionality, quality, safety and comfort of the furniture that is acquired.

That is why the need arises on the part of the Department of Acquisitions to have parameters that facilitate the adequate selection of furniture for the university community y evitar continuar con el hábito de adquirir muebles prefabricados sin prestar atención a las medidas antropométricas de los estudiantes que puede resultar en incomodidad (Hafezi, 2010), musculoskeletal disorders (John, 2015), and can also reduce the performance of students who use such furniture for more hours per day while sitting (Bendak, K. Al-saleh, A. & Al-khalidi, 2010 y Pinto, S. De Medici, C. Van Sant, A. Bianchi, A. Zlotnicki, C. 2000).

2. OBJETIVE

Determine the anthropometric characteristics of the students of the Instituto Tecnologico de Sonora with the purpose of establishing in the near future parameters that guarantee the acquisition of furniture and equipment through the processes of institutional bidding that meets aspects of functionality, comfort, safety and health of university students.

3. METHODOLOGY

In the first phase of the study, participants were recruited to register their place of birth, as well as their father, mother, gender and age. Subsequently, the different anthropometric measurements were made in standing and sitting position. Finally, the data were statistically processed to obtain the 5, 50 and 95 percentage of the sample of participating students.

Subjects: This research involved 377 women and 421 men, both healthy university students, with ages of 18 to 21. They were selected at random, considering 50% of the sample foreign students.

The data of the students were recorded in a database by gender, age and place of birth of the subjects and their parents; as follows:

1) Stratification by gender
    - Female
    - Male

2) Stratification by Age
    - From 15 to 20 years old
    - From 21 to 30 years old

3) Stratification by place of birth of participants and their mother and father.
    - North zone: Integrated by Chihuahua, Coahuila, Durango, Nuevo León y Zacatecas.
    - Center zone: Integrated by Aguascalientes, Ciudad de México, Guanajuato, Hidalgo, Morelos, Puebla, Querétaro, San Luis Potosí and México state.
    - South zone: Considering Yucatan, Campeche and Quintana Roo.
    - Golfo zone: Considering Tamaulipas, Tabasco and Veracruz.
    - North Pacific Zone: Considering Sonora, Sinaloa, Nayarit, Baja California Norte and Baja California Sur.
    - Center Pacific Zone: Integrated by Jalisco, Michoacan and Colima.

- South Pacific Zone: Considering Guerrero, Oaxaca and Chiapas.
- United States of America: states of this country.

For these categories, characteristics and recommendations made by De la Vega and Lopez (1996) and Mungarro (2002) were considered.

4. Materials

The instruments used to carry out the investigation were the following:

Anthropometer folding type altimeter 210 cm, with a sliding blade used to indicate the part of the body to be measured, which is shown below in figure 1:

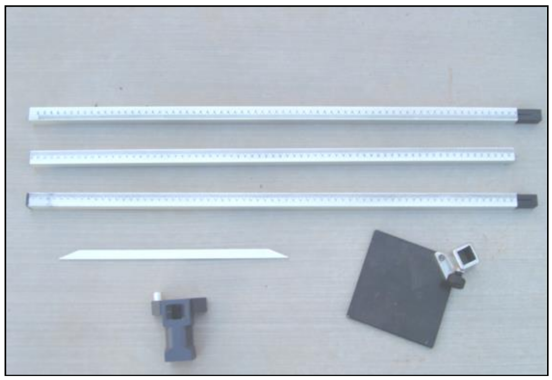

Figure 1. Anthropometer type altimeter.

Anthropometric stool to perform anthropometric measurements in a sitting position. Standard size 50x40x30cm Length x Height x Width. Observe figure 2:

Figure 2. Anthropometric Bank

Medical type scale to measure the body weight of the participants. Observe figure 3:

Figure 3. Nuevo León Scale, 160 kg capacity.

Format for registration of anthropometric measurements proposed by De la Vega y López (1996) (observe figure 4):

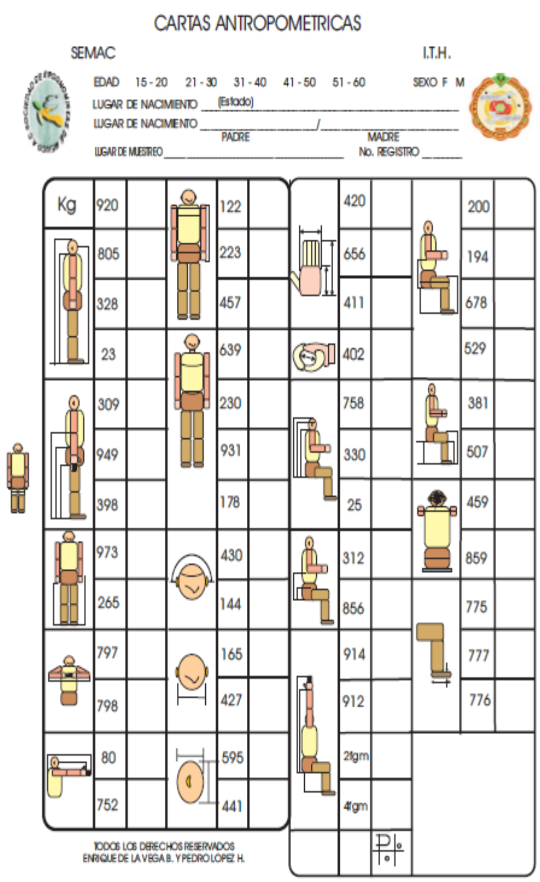

Figure 4. Schedule for the capture of anthropometric measurements

4. RESULTS

In this section it is present the main results obtained in the investigation.

1.- Stratification by sex

In this section was consider the sex of participants in order to start de data classification, since it is desired to elaborate anthropometric mesurements by sex, was consider the sex of participants .As the figure 5 shows, 52.76% of parcipants are male and just only 47.24%a are female.

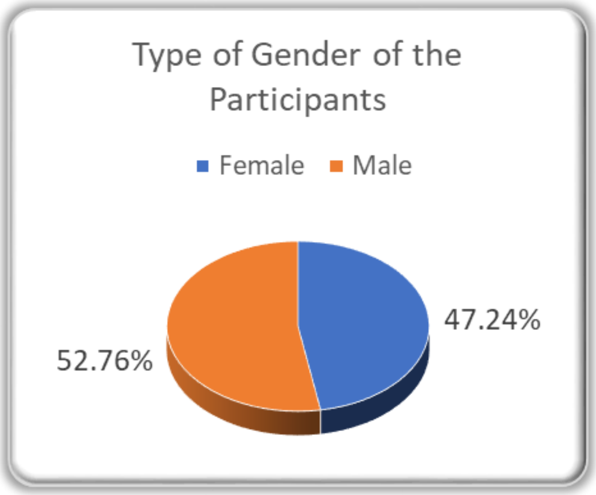

Figure 5. Stratification by Type of Sex

2.- Stratification by age

Was stablished two range of age for both sex: 1) 15 - 20 years and 2) 21 - 30 years. For female sex 50.13% of participants belong to range 1 while 49.87% to range 2. In the male sex the majority of participants (61.28%) correspond to range 1 and the 38.72% are between the 15 to 20 years. The results are shown in figure 6.

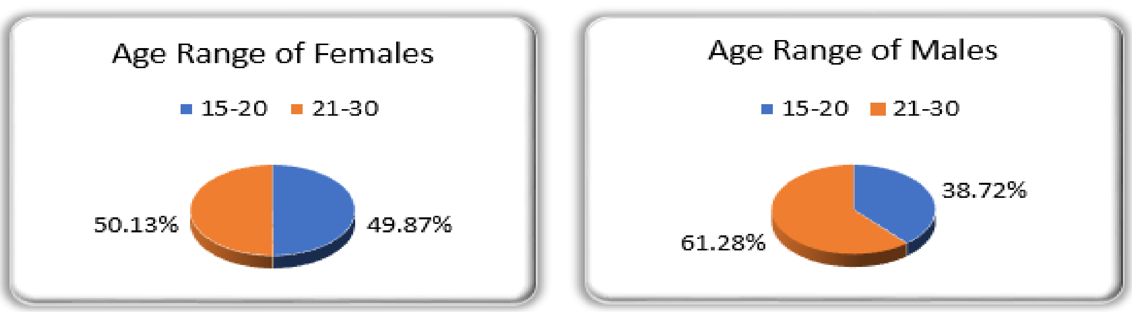

Figure 6. Stratification by age of the participants

3.- Stratification by birthplace of the participants

This aspect is important for anthropometry, since, depending on the zone of the country where the participant was born and also considering the birthplace of their parents, different physical or ethnic characteristics are presented.

For the female sex case most of participants were born in the Northern pacific zone, representing 96.82%, From central zone only 3 women were mesured (8%). For the pacific central just 2 participants were identified, representing the 0.53%. In the Northern region exist 3 participants with 0.8%. Finally, we have the 1.06% that were born in the United States, from these, 3 women have mexincan father and just 1 have Mexican mother. The results of this stratification are shown below

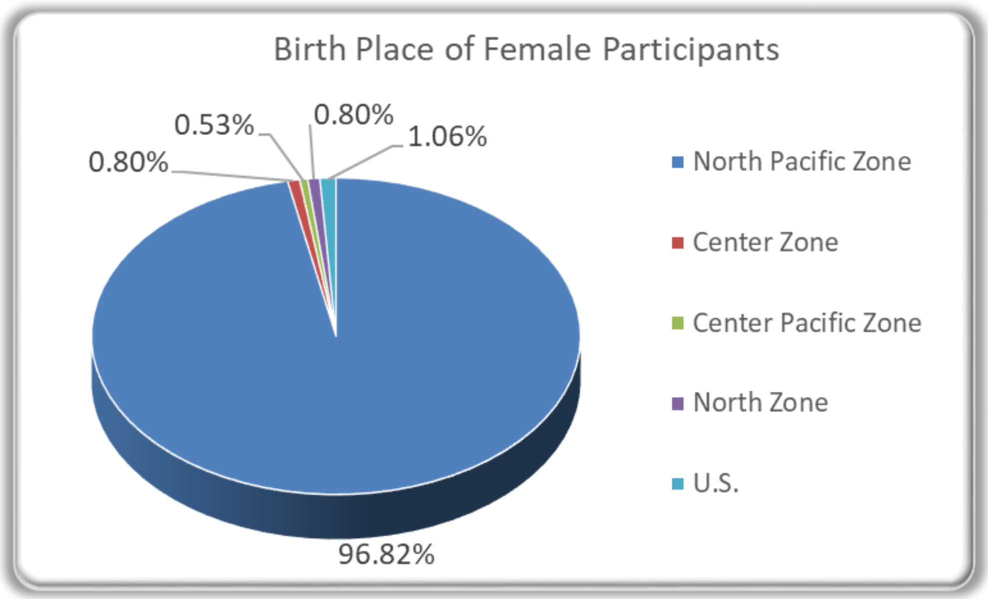

Figure 7. Stratification by Place of Birth of the Participants

Like in the female case, the Northern Pacific was the zone where the majority of male participants were born with 411, representing 97.62% of the sample. The central zone has 2 participants from Guanajuato (0.48%), just one from Jalisco State who belongs to the Central pacific zone (0.24%). In the Northern Zone we have 2 who were born in Chihuahua (0.48%), same result for the Gulf Zone in Veracruz, Yucatan state have 1 student (0.24%). Finally, 2 births to place in the United States of America (0.48%) and It is important to highlight that their parents come from the Northern Pacific Zone. The results are shown in figure 8

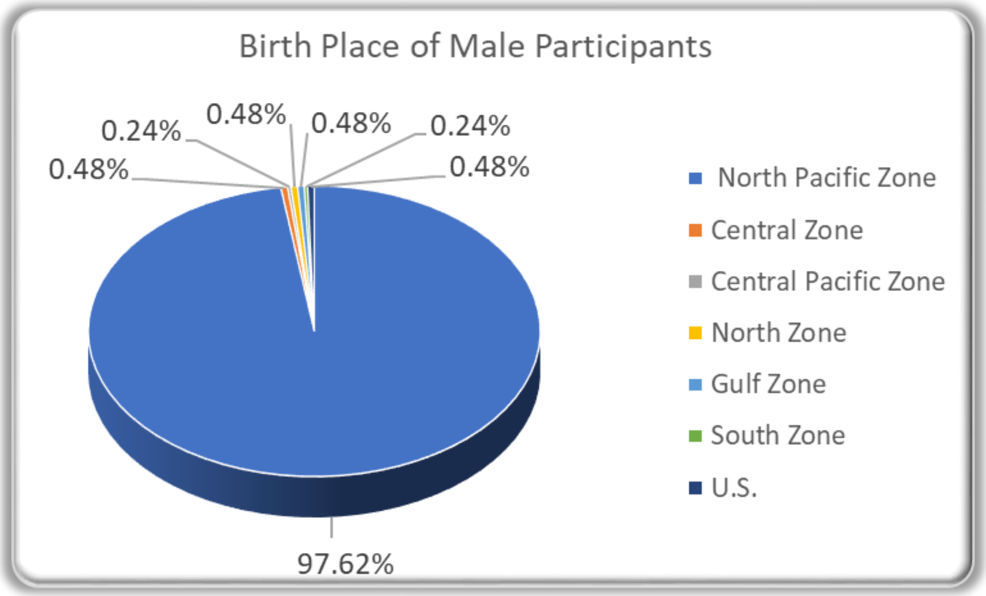

Figure 8. Stratification by Place of Birth of the Participants

These data show that only in one case for the female sex could exist some physical alteration since the mother was born in the United States and we do not have any information from her grandparents to stablish physical similitudes or differences

4.- Stratification by Birthplace of Father and Mother of the female participants From the data analysis we obtain for the female case that 93.90% belong to the pacific Northern zone from country, Sonora State predomin with 254 borns and Sinaloa with 88. We found that 1.86% of the fathers was born in the Central zone, the same is for the Northern Zone, While the pacific zone and Gulf zone contribute each one with the 1.06%. This data are shown in figure 9

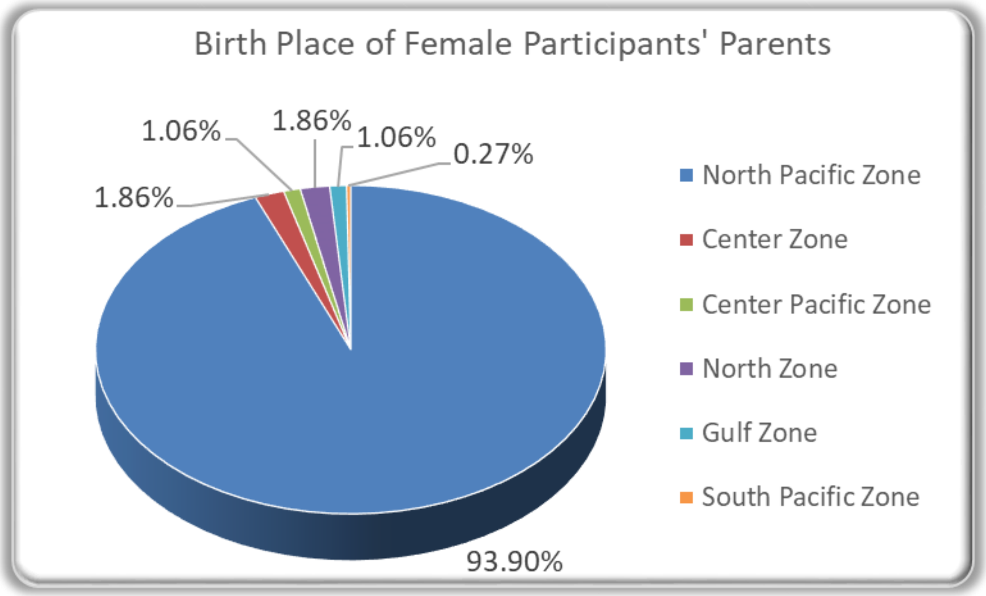

Figure 9. Stratification by Place of Birth of the Parent of the Participants

The figure 10 shows the results for mother brithplace of the participants.

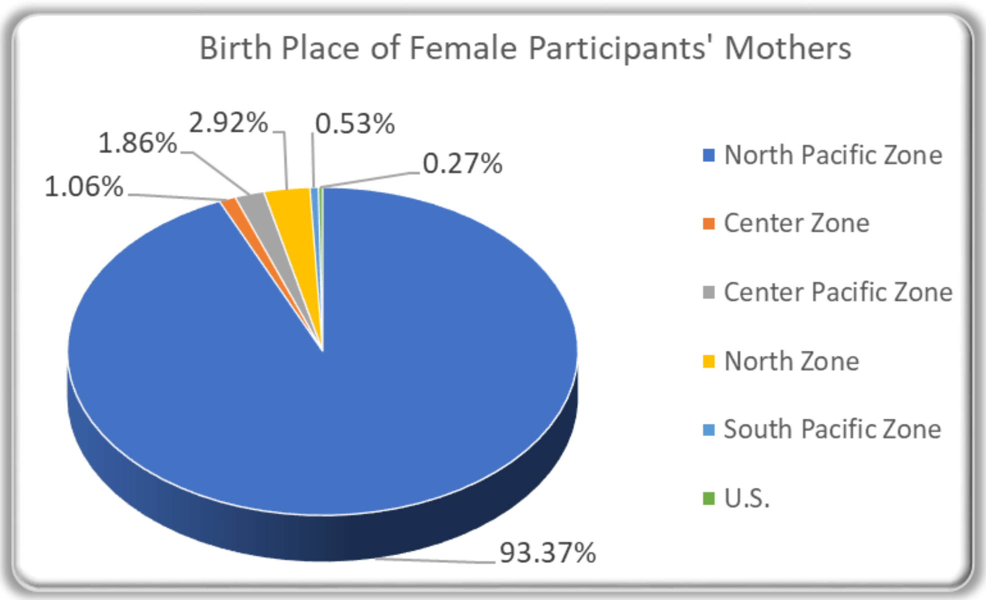

Figure 10. Stratification by Place of Birth of the Mother of the Participants

It was observed, from the previous graph that most mothers birthplace are in the Northern pacific zone with the 93.37%. The 2.92% of the mothers was born in Northern zone of the country, being Chihuahua the state who concentrate the birthplace. Also, the central pacific has the 2.92% while the 1.86% and 1.06% corresponds to the Central pacific and central zone respectively. Only 0.2% of the mothers are born in the united states.

The data show that do not exist a significant mix of races or even of physical traits in the sample of female students, we can also confirm that in both cases (parents and mothers) represents at least 93.7% of the sample and are from the Northern Pacific Zone and we can say that it is homogeneus

5.- Stratification by Birthplace of Father and Mother of the male participants
Figure 11 show the results of the parent birthplace for the male students case.

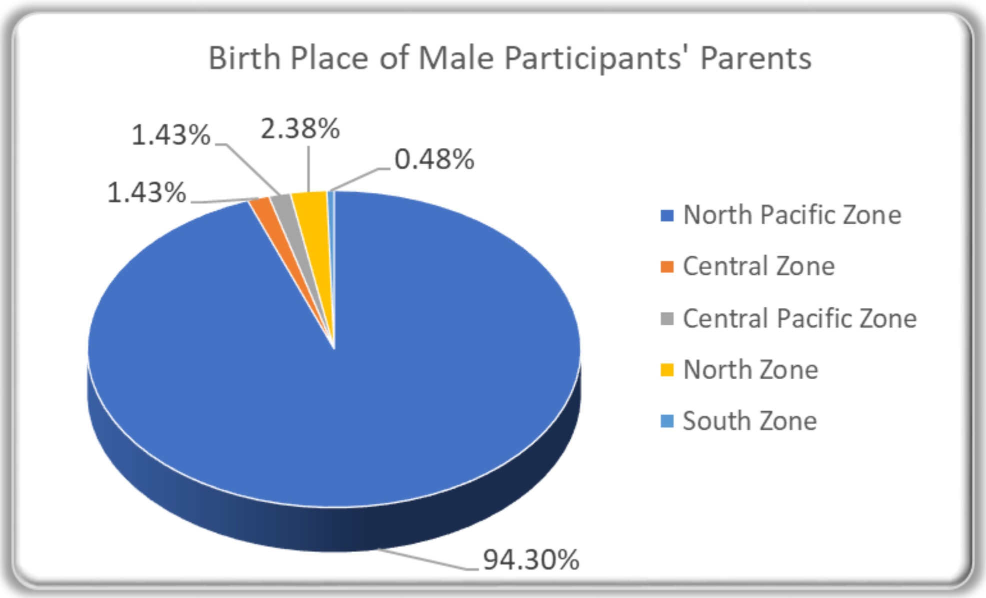

Figure 11. Stratification by Place of Birth of the Parent of the Participants

As we can see in the previous figure, the majority of the fathers were born in Northern Pacific Zone representing the 94.30%, The fathers who were born in the Norther Zone of the country are the 2.38%, while the 1.43% belong to the Central Zone, is the same for the Central Pacific Zone . For the Southern Zone 2 fathers were born in Yucatan representing the 0.48%

Regarding mother's birthplace of participants we obtained the follow results: For the Northern Pacific Zone 95.01% were born in this zone, being this the largest proportion of the sample while 2.14% and 1.43% of the mothers were born in the Northern and central pacific zone respectively. The Gulf Zone and Central Zone both register just 0.48%. The results are shown in figure 12.

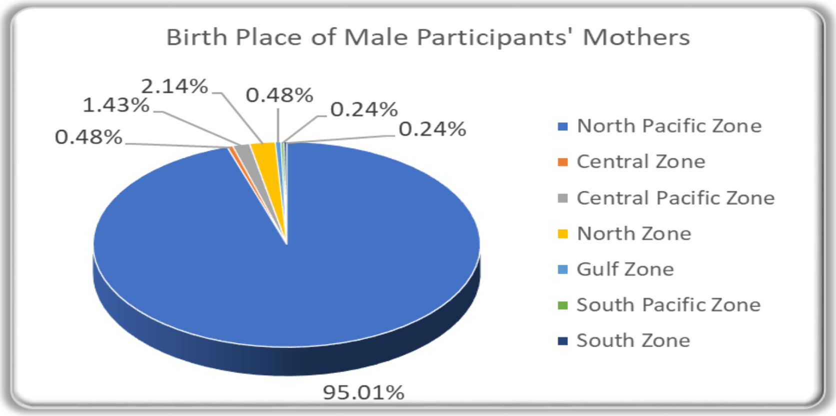

Figure 12. Stratification by Place of Birth of the Mother of the Participants

With this information we can conclude that do not exist a significant mix of races or even of physical traits in the sample of male students. We can also confirm that both fathers and mothers are from northern Pacific Zone and represent at least 94.30% of the sample, so we can say that it is homogeneous.

Once the information was stratified was calculate the percentils for each measurament. The results are shown in the table 1.

Table 1 summarizes the anthropometrics data compiled after statistical analysis. Mean, standard deviation, 5th, 50th and 95th percentile are summarized for each dimension and gender.

5. DISCUSSION/ CONCLUSIONS

With this investigation the answer to the first stage of the Project is given. We obtained the anthropometric charts for both sex and it can be confirmed that there are differences in both male and female, these differences influence the design of the furniture since it is in common use and must be meet the students needs.

It is very important to consider the requirements of the students for classroom furniture design instead of supplying furniture without direct or indirect participation of users (students) throughout the entire process of acquisition.

The implementation of these parameters will help the purchasing department to select the most appropriate furniture to provide greater comfort, safety, welfare, fitness, reduce musculoskeletal disorders and improve student performance in terms of attention. It is strongly recommended to take in count the needs of the students in the classrooms furniture designing, also conduct seminars and workshops to educate students about the negative impact of adopting poor posture in prolonged use of classroom furniture.

Table 1. Student Anthropometric Letters

No.		Anthropometric measures	WOMENS					MENS				
			Average	Stand. Dev..	PERCENTILE			Average	Stand. Dev.	PERCENTILE		
					5°	50°	95°			5°	50°	95°
1	920	Weight	60.20	12.12	40.26	60.20	80.14	77.00	15.61	51.33	77.00	102.67
2	805	Stature	162.30	8.62	148.12	162.30	176.48	175.20	7.36	163.09	175.20	187.31
3	328	Height to eye	152.00	7.35	139.92	152.00	164.08	164.70	9.92	148.38	164.70	181.02
4	23	Acromial (shoulder) height	135.65	6.51	124.93	135.65	146.37	146.50	9.37	131.09	146.50	161.91
5	309	Elbow height	105.00	8.28	91.39	105.00	118.61	112.00	9.61	96.18	112.00	127.82
6	949	Waist height	102.45	13.08	80.94	102.45	123.96	106.30	10.38	89.22	106.30	123.38
7	398	Altura al glúteo	77.00	8.16	63.58	77.00	90.42	82.00	8.07	68.72	82.00	95.28
8	973	Wrist height	80.00	10.55	62.64	80.00	97.36	85.30	7.02	73.75	85.30	96.85
9	265	Height to the middle finger in normal position	63.65	11.71	44.39	63.65	82.91	68.50	6.87	57.19	68.50	79.81
10	797	Width of arms extended laterally	160.20	19.73	127.74	160.20	192.66	137.30	22.86	99.69	137.30	174.91
11	798	Width of the elbows with the hands to the center of the chest	82.20	14.42	58.48	82.20	105.92	92.00	9.98	75.58	92.00	108.42
12	80	Middle finger tip reach	77.90	7.31	65.87	77.90	89.93	86.00	8.50	72.02	86.00	99.98
13	752	Distance from the wall to the center of the fist	68.40	7.11	56.70	68.40	80.10	76.50	7.49	64.18	76.50	88.82
14	122	Shoulder width	39.60	8.34	25.88	39.60	53.32	45.00	7.11	33.30	45.00	56.70
15	223	Chest breadth	29.00	6.09	18.98	29.00	39.02	32.00	9.95	15.64	32.00	48.36
16	457	Hip width, standing	34.10	6.66	23.14	34.10	45.06	34.20	5.45	25.24	34.20	43.16
17	639	Neck Circumference	32.50	4.08	25.79	32.50	39.21	38.00	4.17	31.14	38.00	44.86
18	230	Chest circumference	89.45	10.69	71.87	89.45	107.03	97.00	13.12	75.42	97.00	118.58
19	931	Waist circumference	74.65	10.89	56.74	74.65	92.56	89.00	14.39	65.32	89.00	112.68
20	178	Buttock circumference	96.50	11.15	78.15	96.50	114.85	100.00	13.04	78.56	100.00	121.44
21	430	Head circumference	55.00	5.11	46.60	55.00	63.40	57.00	5.41	48.10	57.00	65.90
22	144	Distance from ear to ear over head	35.95	6.78	24.80	35.95	47.10	37.00	8.98	22.23	37.00	51.77
23	165	Bizgomatic (face) breadth	13.60	2.33	9.77	13.60	17.43	14.50	3.84	8.19	14.50	20.81
24	427	Head breadth	15.00	1.78	12.08	15.00	17.92	16.00	2.86	11.30	16.00	20.70
25	595	Chin height to the top of the head	20.90	1.98	17.65	20.90	24.15	22.50	2.02	19.18	22.50	25.82
26	441	Head length	18.20	9.08	3.26	18.20	33.14	19.30	2.26	15.58	19.30	23.02
27	420	Hand lenght	17.35	1.23	15.33	17.35	19.37	19.00	2.21	15.36	19.00	22.64
28	656	Palm lenght	9.70	1.14	7.82	9.70	11.58	10.70	1.32	8.54	10.70	12.86
29	411	Hand breadth	7.50	0.85	6.10	7.50	8.90	8.50	1.20	6.53	8.50	10.47
30	402	Inner grip diameter	4.61	1.55	2.06	4.61	7.16	5.00	1.55	2.45	5.00	7.55
31	758	Sitting height	84.45	8.37	70.67	84.45	98.23	89.25	8.95	74.52	89.25	103.98
32	330	Eye height, sitting	74.00	8.47	60.07	74.00	87.93	78.00	8.50	64.01	78.00	91.99
33	25	Shoulder height sitting	57.30	8.42	43.44	57.30	71.16	60.20	10.59	42.78	60.20	77.62
34	312	Elbow rest height, sitting	24.60	9.19	9.48	24.60	39.72	25.00	5.81	15.44	25.00	34.56
35	856	Thigh clearance	14.00	13.13	-7.59	14.00	35.59	14.95	3.12	9.81	14.95	20.09
36	914	Vertical reach height sitting	123.00	9.95	106.63	123.00	139.37	134.00	9.81	117.86	134.00	150.14
37	912	Height to the fist with arms up	114.00	11.22	95.54	114.00	132.46	125.00	8.37	111.24	125.00	138.76
38	2FGM	Sitting Height	127.00	7.42	114.79	127.00	139.21	132.00	12.79	110.96	132.00	153.04
39	4FGM	Height floor - seat	44.00	7.65	31.42	44.00	56.58	44.80	14.18	21.48	44.80	68.12
40	200	Buttock-popliteal length	47.20	5.18	38.67	47.20	55.73	49.00	8.55	34.93	49.00	63.07
41	194	Buttock-knee length	57.00	6.32	46.61	57.00	67.39	60.10	7.33	48.04	60.10	72.16
42	678	Popliteal height	43.20	4.96	35.05	43.20	51.35	47.10	6.22	36.88	47.10	57.32
43	529	Knee height, sitting	51.20	4.01	44.60	51.20	57.80	56.00	6.20	45.79	56.00	66.21
44	381	Forearm hand length	43.00	5.01	34.76	43.00	51.24	47.40	7.43	35.18	47.40	59.62
45	507	Width of the back with arms extended towards the front	39.12	5.51	30.06	39.12	48.18	44.00	7.15	32.24	44.00	55.76
46	459	Hip breadth, sitting	38.00	5.63	28.73	38.00	47.27	37.00	8.44	23.11	37.00	50.89
47	859	Thighs breadth con los muslos juntos	34.00	5.87	24.35	34.00	43.65	33.15	8.60	19.00	33.15	47.30
48	775	Foot lenght	24.00	1.65	21.28	24.00	26.72	26.60	3.25	21.25	26.60	31.95
49	777	Foot width	8.50	1.99	5.23	8.50	11.77	9.50	2.15	5.97	9.50	13.03
50	776	Instep height	7.10	1.45	4.71	7.10	9.49	8.79	1.20	6.82	8.79	10.76

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ERGONOMIC MOUSE PROTOTYPE "ERGOMOUSE"

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Resumen: El diseño ergonómico de los productos de uso cotidiano es una alternativa confiable para prevenir las lesiones musculo esqueléticas, es por esto que en las áreas de trabajo donde se realizan actividades repetitivas y por largos periodos de tiempo es importante identificar cuáles son las herramientas de que por consecuencia de su diseño pueden ocasionar alguna lesión que afecte a la productividad del colaborador.

En la presente investigación se identifico que en varias actividades de trabajo, principalmente en las de tipo secretarial se utiliza constantemente el mouse, el cual por su diseño convencional ocasiona una postura forzada en la muñeca del usuario lo cual puede perjudicar su desempeño si se mantiene así por largos periodos de tiempo siendo el síndrome del túnel del carpo una de las principales consecuencias negativas que una posición incorrecta de la muñeca puede ocasionar.

Se realizó un prototipo de mouse con un diseño donde la palma de la mano se encuentre de manera vertical provocando una posición más natural en la muñeca y menos forzada en comparación con un mouse convencional, para su realización se utilizaron materiales reciclados así como partes de un mouse óptico el cual sirvió para el ensamble final y su correcto funcionamiento, dicho prototipo lleva por nombre "Ergomouse".

Palabras clave: Diseño ergonómico, síndrome del túnel del carpo, mouse.

Abstract: The ergonomic design of many products is a reliable alternative to prevent musculoskeletal injuries, which is why in the areas of work where repetitive activities are performed for long periods of time it is important to identify which tools are available as a consequence of their design they can cause some injury that affects the productivity of the employee.

In the present investigation it was identified that in several work activities, mainly in those of a secretarial type, the mouse is constantly used, which due to its conventional design causes a forced posture on the wrist of the user which can harm its performance if it is maintained for long periods of time being carpal tunnel syndrome one of the main negative consequences that an incorrect position of the wrist can cause.

A mouse prototype was developed with a design where the palm of the hand is vertically causing a natural position on the wrist and less forced compared to a conventional mouse, for its realization recycled materials were used as well as parts of a optical mouse which served for the final assembly and its proper functioning, said prototype is called "Ergomouse".

Keywords: ergonomic design, carpal tunnel syndrome, mouse.

Relevance to Ergonomics: An ergonomic product perfectly fits the needs of the user within a work environment and that the action for which it is intended can be performed efficiently, Villareal (s/f) say that a product with an ergonomic design is one that meets or gives solutions to the following concepts:

- Physical operations
- Biological requirements
- Adjustment to work
- Resolve the needs of the user and producer

The ergonomic design of the ergomouse can reduce the risk of suffering CTS or any musculoskeletal injuries on the wrist caused by the repeated and forced use of flexion movement's wrist and fingers. When a product is correctly ergonomic it is considered made with better quality, so for this reason it is important to raise awareness and sensitize the people of benefits that ergonomic products can generate in their physical and emotional health

1. INTRODUCTION

The evolution of industrial society in recent centuries has been demanding from ergonomics and production engineering a joint and continuous effort towards the supply of solutions through concepts, methods, techniques and tools, in order to satisfy the needs of Modern societies (Gomes, 2014).

Nowadays, the accelerated progress of new technologies and their updating, allow man to have a variety of electronic control and manipulation devices that facilitate the various activities of daily life also in different tasks of the job. In this context, the electronic control and manipulation device known as "mouse" is essential to command the actions performed on a computer.

This device whose size and shape can vary, however the principle of its operation is the same for all. His work consists of interpreting the movement made by the hand, manipulating the mouse on a surface to be processed by the computer, being the result of this process the movement of the cursor through the computer screen. In addition, through different buttons the instruction is sent to select and execute various actions of interest to the user.

When the user uses a conventional mouse for prolonged periods of time, there is a risk of suffering carpal tunnel syndrome caused by increased pressure on the median nerve at the wrist, generating venous stasis, increased vascular permeability, edema and fibrosis followed nerve, continuing degeneration of the myelin sheath to the interruption of nerve conduction occur (López, 2014). That is why the ergonomic design can reduce the chances of an injury of this type and thus prevent the effects that the CTS causes to the population.

An ergonomic mouse is designed to maintain the natural position of the hand during work, which causes a decrease in the tension in its lower part of the hand, thus avoiding the pressure that the median nerve can suffer during prolonged time when remaining in a forced position caused by the use of a mouse designed in a conventional way.

This article shows the procedure to develop an ergonomic mouse prototype that is suitable to preserve the natural position of the wrist, conserving its wireless functionality for the comfort of the user. It is intended that the prototype developed the first stage for the impact it can have on society for its future evaluation in various work activities.

2. OBJECTIVES

GENERAL OBJECTIVE:
Design an ergonomic mouse prototype that tries to maintain the natural position of the wrist and that is functional in any computer equipment.
SPECIFIC OBJECTIVES

- Identify the different types of ergonomic mouse that exist.
- Adapt the functions of a conventional mouse to the proposed design.
- Promote the natural posture of the wrist through the proposed design.

3. METHODOLOGY

For the design prototype of "ergo mouse" it was decided to use a PET bottleneck which turned out to be suitable for its shape, the upper part of the hand and the fingers adjust to its handling. Subsequently, a conventional mouse was dismantled to reuse its useful parts such as the optical sensor and the buttons, ensuring that these can be functional for the prototype. For this it was necessary to soldering new wires so that the conventional mouse's electrical system was compatible with the new design of the prototype and the base of the conventional mouse was retained in order to maintain the mouse type design with optical sensor, this being comfortable for the user because that a wireless mouse does not use any wire that could interfere in the physical working space.

Finally, the left button was adapted to the upper part to be operated by the thumb and the right button by the index finger as shown in the following images.

Image 1. Conventional optical mouse dismantled.

Image 2. PET bottleneck assembly with optical mouse base to integrate the Ergo mouse prototype.

4. RESULTS

Once the electronic components were integrated in the prototype, it was proceeded to give a vertical design, thanks to this the wrist is in its natural position, thus avoiding the pressure of the middle nerve that can cause carpal tunnel syndrome. The optical sensor of the ergo mouse works on any surface where it can slide properly. In addition, the wireless functionality that allows you to work without problems and in a comfortable way to the user was preserved.

The left button is located at the top of the prototype to be activated with the thumb and the right button was adapted to the front at the height of the index finger for manipulation when required. The functionality of the ergo mouse is in its entirety similar to that of a conventional mouse, which makes it useful for any type of use that is required.

Image 3. Top view

Image 4. Side view.

Image 5. Lower view.

To verify its functionality, various tests were performed for indefinite periods of time only to check the operation of the ergomouse. These tests were carried out by students and teachers of ITSCC where the mouse was manipulated in a normal way simulating an activity of daily work. The results were liked by the users since they felt greater freedom of movement when handling it during the movement on the work surface feeling more comfort in their wrist to not be under the tension of the median nerve that originates from the position of the hand to the use a conventional mouse.

Image 6. Usability test.

Image 7. Usability test.

5. CONCLUSIONS

The preventive and effective ergonomic education is a measure to avoid situations that put at risk the health of the user, that is why it was considered to make a prototype of ergonomic design in an electronic tool of daily use in secretarial and office work, that for its nature, the manipulation of said tool known as mouse can be prolonged for long periods and repeatedly causing the described injuries.

This prototype was made with the available resources so it can be improved aesthetically but retaining its main characteristic of vertical design that helps maintain the natural posture of the hand, which avoids the pressure of the middle nerve that can generate discomfort and carpal tunnel.

The design was well accepted by the users who had the opportunity to manipulate the ergomause, however it is important to point out that it is intended to perform more specific tests to know if the prototype has the total acceptance of the users and also if its design is really beneficial in the realization of work activities, therefore we intend to continue investigating the possible benefits and opportunities of ergomouse.

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PROTOTYPE OF TAMPER FOR BARISTS WITH ERGONOMIC APPROACH

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Resumen: El análisis ergonómico de un sinfín de herramientas, estaciones de trabajo y procesos, contribuye en la actualidad a proteger al trabajador de lesiones o riesgos ergonómicos que son causan baja productividad y menores ganancias en las empresas. Mediante la creación de un diseño y elaboración de un prototipo se podrá generar más productividad y menos lesiones. Debido a que el actual diseño tiende a generar mucho peso para la compactación del café, lo cual conlleva a utilizar esa fuerza en posturas muy descuidadas. Por lo que se observó la actividad de elaboración de espressos en una sucursal de venta de bebidas a base de café, generando de esta manera un diseño con agarre más ergonómico. Lo ideal es que se hicieran las mediciones en cada uno de los puntos de venta para que sea más cercano a la realidad. El diseño del prototipo del tamper con características específicas en cuanto al agarre, principal problema detectado, se propuso un mango recto con una guarda en la parte final de la empuñadura, sin comprometer la integridad del proceso (aplastar café molido) de la actual herramienta. El diseño del tamper para distribuir la fuerza, aunado con la técnica adecuada, de manera uniforme por toda la mano, evitará dolencias ocupacionales y otros DTA's que la tarea de elaborar espressos conlleva.

Palabras clave: Barista, compactador, expreso, salud ocupacional

Abstract: The ergonomic analysis of endless tools, work stations and processes, currently contributes to protect the worker from injuries or ergonomic risks that are causing low productivity and lower profits in companies. Through the creation of a design and development of a prototype can generate more productivity and fewer injuries. Because the current design tends to generate a lot of weight for the compaction of coffee, which leads to using that force in very neglected postures. Therefore, the preparation of espressos was observed in a coffee-based beverage sales branch, thus generating a more ergonomic design. Ideally, measurements should be made in each of the points of sale to be closer to reality. The design of the tamper prototype with specific characteristics in terms of grip, main problem detected, was proposed a straight handle with a guard in the final part of the grip, without compromising the integrity of the process (crush ground coffee) of the current tool. The design of the tamper to distribute the force, combined with the appropriate technique, uniformly throughout the hand, will avoid occupational ailments and other DTA's that the task of producing espressos entails.

1. INTRODUCTION

The tamper is composed of a weight (aluminum or any other light metal) designed to fit in the filter cavity and manually press the coffee, this technique allows to prepare a coffee of optimum quality.
"Tamping is definitely a point in the preparation of drinks where baristas can hurt themselves," says Gimme! the regional manager Devorah Freudiger on the company's blog. "It's hard to tamp down in a way that is not stressful to your body unless you're quite tall because keeping the shoulder blades on your back is difficult with a tamping counter that is too high for your body." The best thing that has been found is to keep the wrists straight and make sure that the power of the tamping comes from the nucleus of our body, never from our fingers or palms. In the study prepared by Dainty et al. (2014) "Prevalence of pain related to occupation among baristas and an examination of the demand for lower back and shoulder during the preparation of espresso-based beverages" found that, of the respondents, at least half of the baristas suffer from back pain or shoulder attributed this pain to their work. In addition, these individuals, in general, have higher loads in the lower back and higher moments in the shoulders.

1.1 Ergonomics for design

Ergonomics can be defined for industrial design as the discipline that studies the relationships that are established reciprocally between the user and the objects of use when performing any activity in a defined environment. Cecilia Flores (2001) proposes the trinomial user-object-environment, since each of these elements is essential to maintain the ergonomic relationship and, therefore, ergonomics.

1.2 Coffee Compactor (Tamper)

One of the tools that characterizes baristas is the coffee compactor (see image 1) or also known as Tamper, this tool allows to press, press and compact the ground coffee in the filter of the machine during the preparation of the espresso coffee. The tamper is composed of a weight (aluminum or any other light metal) designed to fit in the filter cavity and manually press the coffee, this technique allows to prepare a coffee of optimum quality.

Image 1. Traditional design of the Coffee compactor

While automatic and semi-automatic tamping machines are likely to reduce the risk of injury, an alternate design hand rammer can offer the ergonomic benefits of a tamping machine while allowing baristas to control the tamping style and the application of force.

1.3 Ergonomic Adjustments

These can be of different types, such as anatomical, biomechanical, psychological, psychosocial and obviously anthropometric adaptations. All these are important, but the anthropometric measures are of particular relevance, since they are the basis for achieving physiological and biomechanical adaptations. (Prado, Ávila and Herrera, 2005)

The adjustments in the designs of a great variety of tools are necessary due to the frequent incidence of the rudimentary designs that are found in the tools that are currently in the market, neglecting the health of workers in all areas of the industries.

1.4 Anthropometry

It is the application to the human being of physio-scientific methods for the development of design standards for specific requirements and for the evaluation of engineering designs, scale models and manufactured products, in order to ensure the adequacy of all of them to the characteristics of the user. (Llaneza Álvarez, 2006).

1.5 Musculoskeletal disorders

One of the most common diseases in the family, work and personal are the tendinitis, the most diagnosed in recent years. It is a very common pathology due to the varied forms that usually occur, such as excessive efforts, repetitive movements and direct trauma. Repetitive movement is characterized by being actions that are carried out in the same way numerous times throughout the workday.

2. GENERAL OBJECTIVE

Through the design and development of a Tamper prototype that contributes to improving the health of operators, avoid injuries due to repetitive and non-ergonomic movements, increasing the productivity of barista operators.

3. METHODOLOGY

The espressos elaboration activity was observed and inadequate posture and movements were identified that compromised the health of the operator, for which a more ergonomic grip was designed through software.

3.1 Background of the Tamper

The vertical handle used with traditional tampers and, subsequently, how the barista must sustain and apply force through these traditional tampers, is what gives rise to awkward and non-neutral postures of the spine (Dainty et al., 2014)

3.2 Hand (measurements)

This study was carried out with the cooperation of the operators of a branch of the preparation of coffee-based drinks in the city of Los Mochis.
We proceeded to record the measures (see table 1) of the hands of all the operators that work in both shifts.

Table 1. Measures of the hands of the operators that cooperated with the investigation

Operator	grip	width
Valeria	55	8.3
María	43	7.5
Karely	42	7
Rubén	42	7
Denisse	54	9
Zulma	51	8
Faustina	54	8.2
PERCENTILES	**51**	**8.79**

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4. Results of the Redesign

A prototype of tamper was designed with specific characteristics in terms of grip, this being the main problem detected, a straight handle with a guard was proposed in the final part of the handle, without compromising the integrity of its functionality (crush ground coffee) of the original design.

Although the calculations resulting from the design are only for a specific branch, it is only presented as a recommended prototype.
It was identified that the measurements are very close to the traditional design, so to standardize the size of the handle of the tamper we use for the width of palm the 95th percentile of 8.79 cm so that any person can hold it without discomfort, and the grip on the contrary we use the 50 percentile of 51 cm, because if the smallest one can grasp it with more reason the biggest person.

4. CONCLUSIONS

The design of the tamper to distribute the force, combined with the appropriate technique, uniformly throughout the hand, will avoid occupational ailments and other dta's that the task of producing espressos entails.

If for the moment the implementation of a design that addresses the conditions that baristas suffer is not submitted to consideration, it is necessary to introduce improvements in the process of coffee compaction, perfecting the movements to delay the effects that the constant repetition of said task generates, as well as reducing the impact and ailments that would arise from not changing or paying attention in the process.

Ideally, these measurements should be made in each of the points of sale to be closer to reality, as well as it is advisable to make fatigue assessments to all operators of the other points.

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ERGONOMIC GLOVES TO REMOVE SHRIMP'S HEADS.

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Resumen: El guante de látex ha sido utilizado en el proceso de descabezaedo de camarón históricamente con resultados parcialmente deseables, debido a que si bien aisla la piel del operador de los ácidos del camarón y de la humedad, lo frágil del material del guante hace posible que el el tórax del crustáceo el guante, generando el estado de malestar, dolor y heridas en la mano del operador.

Por lo tanto se propone implementar una mejora al guante de látex, la cual consiste en diseñar una uña resistente para el dedo pulgar y adaptar un antideslizante en el costado del dedo índice, además se le agregara una plantilla de silicón en frio, a la parte central interna del guante (palmar), esto con la finalidad de crear un mecanismo de protección al momento de alcanzar, tomar y mover el crustáceo, por parte del camarón.

Palabras Clave: guantes ergonómicos, diseño, protección.

Abstract: The latex glove has been used in this process historically with partially desirable results, because this product isolate the operator's skin of the shrimp's acids and humidity, because the brittleness of the material causes that the shrimp's torax breaks the glove, generating a state of discomfort pain and injury on the operator's hands.

Given this, is proposed to implement an improvement to the latex glove, this consist of the design of a resistan nail on the thumb and to adapt an non-slip on the side of the index finger and we'll add cold silicon to the central part of the glove(internally), all this with the purpose of to create a protection mechanism when we have the shrimp on our hands.

Keywords: ergonomic glove, design, protection

Relevance to Ergonomics: Through this article, in the area of ergonomics, a tool proposal for shrimp headings is offered, which offers aquaculture workers a better quality of work and personal life. An ergonomic glove design is proposed that provides protection, hygiene and ease of handling. It is important to publish it since it is a way to publicize and share a proposal for a new work tool aimed at improving and preserving the worker's health.

1. INTRODUCTION

According to an article made by Ma. Asunción Mirón Hernández, of Centro Nacional de Medios de Protección (INSHT) Sevilla España, “Enfermedades por agentes biológicos en El Sector De La Pesca” , 04 de julio del 2011, “Fishing workers are exposed to risk factors: psychosocial, physical, chemical and biological, that can produce diseases (mental, infectious, allergic, muscular-skeletal), this shows the pathologies that can be suffered the worker of the fishing sector, as a result of exposure to biological agents during his work. Some of these pathologies are considered as professional diseases.

A lot of the diseases caused by biological agents on the work environment can to become a public health problem”. Based on this, the document presents a proposal for improvement the tool to remove heads of shrimp (activity that causes deep wounds on the hands), with this it is intended that the workers have a better quality of life, to improve security conditions and hygiene, it is a team designed to partially protect the hand, it’s ergonomic, their characteristics are: carcase that covers the thumb for force application, non-slip material on the index finger to sustain it on the process, the glove is flexible with a resistant material that protects nails and skin.

1.1. JUSTIFICATION.

A publication made by “Instituto Nacional de Seguridad e Higiene en el Trabajo y el Ministerio de Empleo y Seguridad Social al Sector Pesquero de España” on the 2014, found that dermatological conditions on the fisher’s skin is exposed during the long working day, to environmental factors like solar light, temperatura and humidity. A survey was made to 100 fisherman asking them about their risk factors on the working environment and their health. 23 % of workers had a dermatological problem. The review of the literature of Matheson, 2001 collects the results on dermatological conditions in the study of Casson, 1998 the objective was to relate the work of the fishermen with chronic diseases in Italy.

For the above, a flexible ergonomic glove prototype proposal is created to give movement to the wrist and fingers, with a resistant material that covers of acid substances that secrete the shrimp.

1.2. GENERAL OBJECTIVE

Design an ergonomic glove for the purpose of create a barrier between the worker and the shrimp by the wear of the operator's hands when handling by friction and receive the characteristic substances of the crustacean.

1.2.1. SPECIFIC OBJECTIVES

Identify the most functional and comfortable protection model.
Verify and do a survey to see the need for this type of glove.
Improve the operator’s occupational health using the ergonomic glove.

1.3 DELIMITATION:

This study is aimed at working people in the aquaculture sector in northern of Sinaloa, specialized on removing shrimp heads with an age range between 18 and 50 years old.

2. METHODOLOGY

The author John Elliot says the next concept: "Action-Research is a solution to the question of the relation between theory and practice" (ELLIOT, 2002). By the characteristics of the study that was developed the inductive method was used generating actions focused on the proposal to implement this type of glove on the freezers that do this activity.

For the creation of ergonomic glove design field research was used doing a descriptive study, this study was carried out with workers of a freezer company of products derived from the sea, where their main activity is processing, storage and distribution of marine products. This company is located on the common " Ricardo Flores Magón" of the municipality of Ahome, Sinaloa, 20 workers from this area were surveyed for the study, the age of respondents is in the range of 18 to 50 years. At the time of the survey, everybody had a damaged on their hands.

2.1 PROCESS DESCRIPTION.

The operator that do operations of this activity do repetitive movements (remove the shrimp's head). This procedure is done in the following way:

The shrimp is taken with both hands with your thumb you look for the joint between the head and the body the nail is pushed hard, applying pressure and force for separation, then the shrimp body is placed in a container and the head is discarded. This process is repeated as often as necessary during the working day reaching up to 124800 moves in 8 hours on each hand.

Fig. 1 Results of the question 1.

The figure 1 shows that of 20 people surveyed, 100% suffers from discomfort in the hands with the gloves they currently use in their operations. Why?, because the material is thin, this causes the shrimp thorax to snap and peel the skin off the sides of the fingers, because the shrimp is slipping, the material of the glove causes me hives on the skin, the material takes away my performance at work.

Fig. 2 Results on the question 2

The figure 2 shows that of 20 persons, 3 mention that the glove material they use are plastic, 1 latex, and 16 didn't respond.

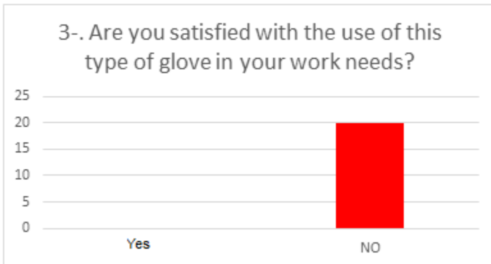

Fig. 3 Results of the question 3

The figure 3 shows that of 20 people surveyed, 100% agree that the glove used does not satisfy the characteristics necessary to do the process.

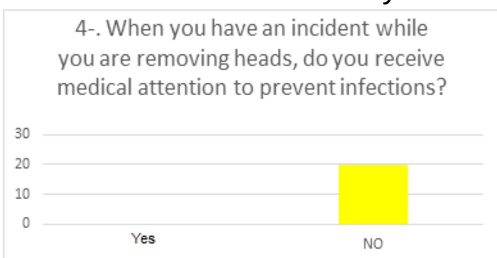

Fig. 4 Results of question 4

The figure 4 shows that of 20 people surveyed, 100% says that they do not receive medical attention to prevent infections.

Fig. 5 Results of question 5

The figure 5 shows that of the 20 people surveyed mention that the gloves used in the process are provided by the company.

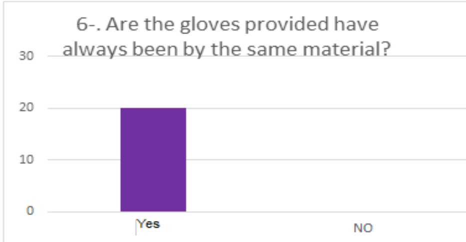

Fig. 6 Results of question 6

The figure 6 shows that of the 20 people surveyed, 100% says that they always receive gloves of the same material.

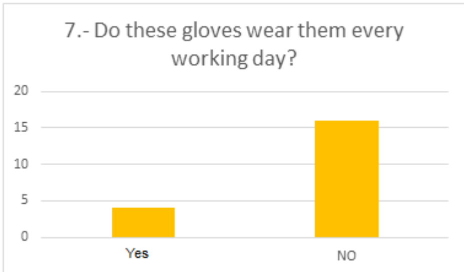

Fig. 7 Results of question 7

The figure 7 shows that of the 20 people surveyed, 4 use gloves every day, 16 do not use them.

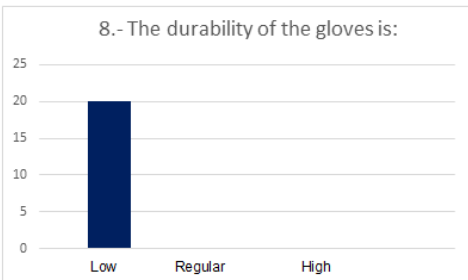

Fig. 8 Results of question 8

The figure 8 shows that of the 20 people surveyed, 100% says that the durability of gloves is low.

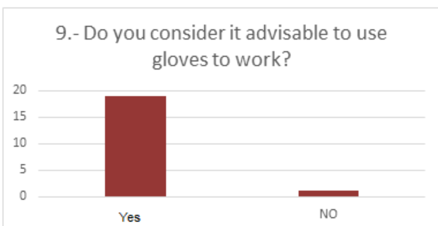

Fig. 9 Results of question 9

The figure 9 shows that of the 20 people surveyed, 19 say that it is advisable to use gloves to carry out the process of removing heads of shrimp and only 1 thinks that no

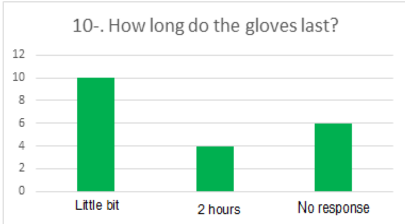

Fig. 10 Results of question 10

The figure 10 shows that of the 20 people surveyed, 10 say that the glove lasts a short time, 4 that the glove lasts 2 hours and 6 did not respond.

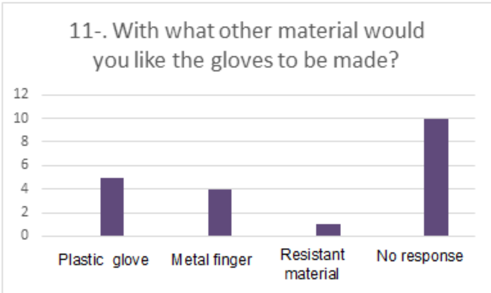

Fig. 11 Results of question 11

The figure 11 shows that of the 20 people surveyed, 5 think that the glove could be made of plastic, 4 that the glove must have a metal finger, 2 that it must be made of resistant material and 10 did not respond.

With the information from the survey, an ergonomic glove design is proposed, therefore according to the results of the survey, there is a need to propose a tool design to remove shrimp heads, which meets the characteristics demanded by users. Resistance and flexibility at the same time, with a fingernail on the thumb that offers a barrier that prevents damage to the skin of the fingers and allows you to continue your work without diminishing its performance.

3. RESULTS

Due to the process of removing shrimp heads, it is imperative that the operator uses a glove that adheres completely to his skin but at the same time protects his index and thumb fingers from the acid that comes off the shrimp when the head comes off, this with the purpose of avoiding wounds, pain and loss of skin in these areas.

The latex glove has been used in the process of removing shrimp heads historically with partially desirable results, because it isolates the operator's skin from shrimp acids and from moisture, the fragile material of the glove makes it possible for the thorax of the crustacean breaks the glove, generating the state of discomfort, pain and wounds on the operator's hand.

Therefore it is proposed to implement an improvement to the latex glove, which consists of designing a resistant nail for the thumb and adapting a non-slip on the side of the index finger, and adding a cold silicone template, to the internal center of the glove, this with the purpose of creating a mechanism of protection when reaching, taking and moving the crustacean

For the design of the nail the anthropometric measurements of 30 workers of the study area were taken, considering the following: Width and depth of the thumb and even the angle of the nail. The 95 percentile was taken as a reference, to propose the final design, because it should be used by most of the population. In this section we propose a prototype tool to remove shrimp heads that offers aquaculture workers a better quality of work and personal life. An ergonomic glove design is proposed that provides protection, hygiene and ease of handling, which also increases the performance of your work.

According to the above, a random sample of 30 operators was taken, which were taken the measures of depth and width of the thumb, to determine the appropriate percentile for the design of the ergonomic nail, the instrument used was a vernier and a personal computer to carry out the registration of the data. The results are shown in table No. 1.

For development of coverage of a thumb and anti-slip on an index finger on a glove, the standard measurements of the latex glove (you see the table 2) were used and taking that as a basis, the complete prototype was elaborated, the material used was silicone.

3.1 IMAGES OF THE PROTOTYPE OF GLOVE

Next are the images of the glove prototype from different perspectives. In figure 12, you can see the design and prototype of the nail made with hard polymer material, the width of the nail is 17.2 mm, measured corresponding to the 95th percentile of the sample studied

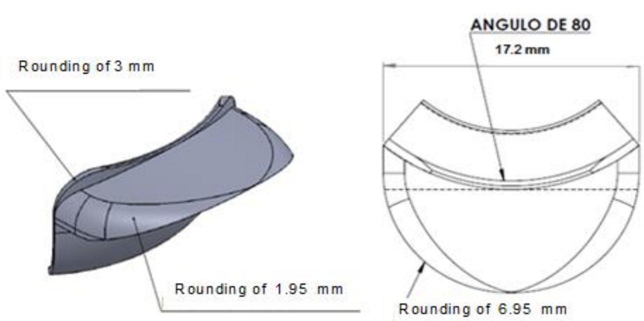

Fig. 12. Nail design, with top view and front view.

Table No. 1 Sampling results, for depth and width of the thumb

<table>
<tr><th>Number</th><th>Depth (mm)</th><th>Width (mm)</th><th>Number</th><th>Depth (mm)</th><th>Width (mm)</th></tr>
<tr><td>1</td><td>6</td><td>14</td><td>16</td><td>7</td><td>16</td></tr>
<tr><td>2</td><td>9</td><td>15</td><td>17</td><td>10</td><td>15</td></tr>
<tr><td>3</td><td>9</td><td>16</td><td>18</td><td>11</td><td>14</td></tr>
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<tr><td>5</td><td>6</td><td>14</td><td>20</td><td>5</td><td>11</td></tr>
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<tr><td>9</td><td>4</td><td>11</td><td>24</td><td>8</td><td>14</td></tr>
<tr><td>10</td><td>6</td><td>11</td><td>25</td><td>4</td><td>11</td></tr>
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<tr><td>12</td><td>7</td><td>12</td><td>27</td><td>4</td><td>7</td></tr>
<tr><td>13</td><td>6</td><td>11</td><td>28</td><td>7</td><td>12</td></tr>
<tr><td>14</td><td>6</td><td>13</td><td>29</td><td>6</td><td>11</td></tr>
<tr><td>15</td><td>9</td><td>12</td><td>30</td><td>6</td><td>13</td></tr>
<tr><td>Percentil 95</td><td>11.8</td><td>17.2</td><td colspan="3" rowspan="3">The 95th percentile of the total sample for the depth of the thumb is 11.8 mm and the width of the thumb is 17.2 mm, this being the most adequate to develop the prototype of the nail, because with this measure it could be used by 95% of the sample.</td></tr>
<tr><td>Percentil 50</td><td>7</td><td>13</td></tr>
<tr><td>Percentil 5</td><td>4</td><td>4</td></tr>
</table>

Table No.2 Technical measures of latex gloves already established.

Size	Length mm	Width mm	Fist mm	Width Finger mm	Palm mm
S	≥ 240	85±2	0.07±0.02	0.11±0.02	0.14±0.02
M	≥ 240	95±2			
L	≥ 240	105±2			
XL	≥ 240	110±2			

In figure 13, you can see the design and prototype of the nail, the width of the nail is 11.8 mm, measured corresponding to the 95th percentile of the sample studied. In figure 16, you can see the side view of the length of the anti-skid on the glove (70mm).

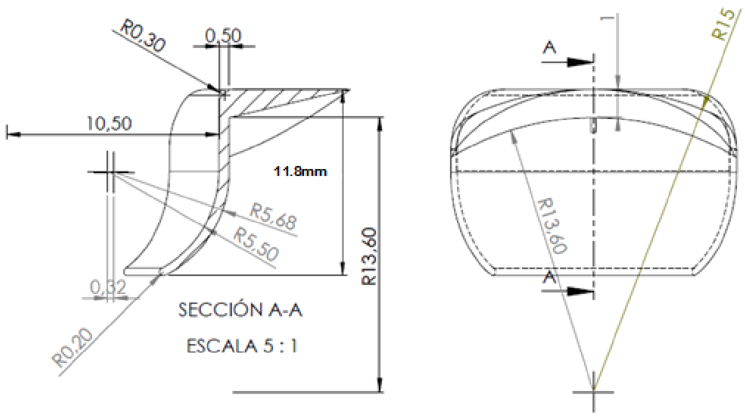

Fig. 13 Nail design, with an angle view and depth (11.8mm).

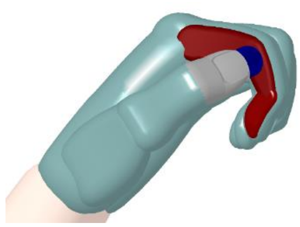

Fig. 14 Side view of anti-skid.

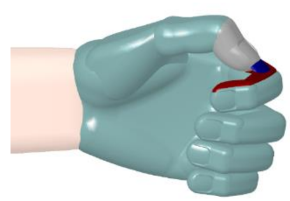

Fig. 15 Side view of the nail.

In figure 14 and 15, you can see the side view of anti-skid.

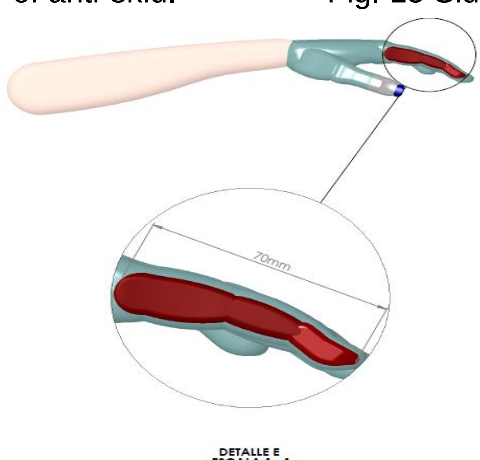

Fig.16 Side view of the length of the anti-skid on the glove

4. CONCLUSION

With the results obtained we provide the design of a tool that helps to protect the hands of the worker avoiding wounds, as blisters and painful infections. Therefore it has been innovated in a tool that helps to carry out in a safe and hygienic way this work. It is considered to be of much support to the fishing sector in the northern region of the state of Sinaloa.

For the design of the glove, anthropometric measures of 20 workers were taken, all of them lives on the common "Ricardo Flores Magon" located on the municipality of Ahome, Sinaloa. In addition a survey will be applied to this same population to know in a reliable way the current position of the worker (do the operations without ergonomic glove).

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PROTOTYPE OF FORK FOR PEOPLE WITHOUT UPPER LIMBS

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Resumen: En este proyecto se pretende presentar un rediseño de un cubierto, específicamente un tenedor, que sirva para aquellas personas que padecen de discapacidad en la parte superior del cuerpo. Esto incluye personas con malformaciones parciales de brazos, ausencia parcial de brazos, ausencia total de brazos y amputaciones parciales o totales de brazos. Ayudará en la manipulación de los alimentos, en la destreza del manejo de los utensilios, la fuerza de agarre de los pies y en el movimiento de los mismos.

La idea surge de haber observado la dificultad que representa, para estas personas impedidas, realizar una de las actividades necesarias y más comunes en el ser humano, alimentarse. Se notó que estas personas tenían una postura muy incómoda o tenían que recurrir a la ayuda de alguien más para poder ingerir sus alimentos.

El funcionamiento de este producto es básicamente mediante el uso de los pies del individuo, utilizando principalmente sus dedos. Contará con un mango más largo y el cual tendrá un accesorio que se trasladará a lo largo de este, disminuyendo principalmente la postura encorvada de la persona impedida. Por otra parte, aunque el tenedor está concebido como ayuda técnica y la función del mismo es lo que predomina, no se descuida la estética del producto.

Como resultado se tiene que el tenedor cuenta con una base convencional de 4 dientes en uno de los extremos del mango para pinchar los alimentos. Cuenta con un mango más largo, de aproximadamente 30 cm, y un diámetro de 0.7 cm. Tiene un accesorio que mantiene el tenedor firme entre el dedo gordo y los demás dedos del pie, el cual consiste en una media argolla para el dedo gordo y un soporte para los demás dedos cuya función es posicionar el tenedor y deslizarse a lo largo del mango.

Palabras clave: Discapacidad física, discapacidades de las extremidades superiores, cubiertos especiales, dificultad para comer, rediseño ergonómico

Abstract: The objective of this project is to present the redesign of a piece of cutlery, particularly a fork, for it to be useful to those people who suffer disability on the upper half of their body. This includes people with partial malformations, partial absence and partial or total amputations of arms. It will help with the manoeuvre of the utensils, the grip strength on the feet and the movement.

The idea came out observing the difficulty that it presents, for this handicapped people, carry out one the most necessary and common activities the human being has, feeding. It was noted that this people had a very uncomfortable posture o had to ask for someone else's help so they could eat.

This product works basically through the use of the individual's feet, using mainly the toes. It will have a longer handle and this will have an accessory that will move on the length of it, decreasing mostly the hunch posture of the person. On the other hand, although the fork is made up as a technical help and the functionality of it is fundamental, the aesthetic of the product is not neglected.

As a result, there is a fork has a base with four points on one of the ends of the handle to pinch the food. This fork has a longer handle of approximately 30 cm, and diameter of 0.7 cm, so the person could eat more comfortably without having to bend their body too much. On the other end of the handle, above the base, it has an accessory that keeps the fork firm between the first toe and the other ones, which is made up of a half ring for the first toe and a holder for the other toes, which function is positioning the fork and sliding it across the handle.

Key words: Physical disability, upper extremities disability, special cutlery, difficulty to eat, ergonomic redesign.

Relevance to ergonomics: This is a proposal of redesign an every-day tool. This will include people with disability in the upper part of their body so they would feel more integrated in society, and it will avoid possible injuries in other parts of the body like back, neck and legs.

1. INTRODUCTION

The purpose of this project is the design and manufacture of an item (fork) which could change the lives of the people that do not have their upper limbs, when they take the food to their mouths, having a result a more comfortable and normal way to eat.

It is observed that this people take very uncomfortable positions when they eat, since they do it with their feet o they need someone to help them with that very basic action such as feeding yourself. Assuming they do feed themselves, they sit on the edge of a chair, cross their legs too much and lower their head applying pressure on the neck, which can cause pain and injuries. Besides using utensils made for people who have no problem using them for most of them are made of stainless steel or others materials that can become very heavy to hold with the toes, apart from having a design with a very thick handle which makes grabbing more difficult if it is not grabbed with the hands. Moreover, there exists another kind of utensils made for people with other kinds of physical or mental impairments, meaning they do have their upper limbs, excluding the ones that do not have them.

Since the product is of common use, the only alternative that people without their upper limbs can take is limited to the selection of the ones that already exist and, afterwards, alter them to their needs, without having the chance of acquire them in a simple way like any other person who acquires items that satisfy their needs.

Furthermore, it is necessary to stress that its design is meant to made the use easier to the person given its shape, it also has to be light and flexible, having the proper materials and manufacturing process so the product fits the user and not the user to the product, providing autonomy and comfort.

1.1 General objective

Devise a tool that makes eating easier to people with limited or no use of their upper extremities.

1.2 Specific objectives

- Redesign a fork that is gripped with the toes through an accessory and a longer handle.
- Reduce uncomfortable postures that could cause some kind of injury.
- Improve the quality of life of people with special needs.

1.3 Delimitation

This project is limited to the population that suffers the deficiency of their upper extremities, making a simple activity such as eating very difficult.
Based on 2010 population estimates – 6.9 billion with 5.04 billion of 15 years and over and 1.86 billion under 15 years – and 2004 disability prevalence estimates, there are around 785 (15.6%) to 975 (19.4%) million persons of 15 years and older living with disability. Of these, around 110 (2.2%) to 190 (3.8%) million experienced significant difficulties while carrying out a function. Including children, over a billion people (or about 15% of the world's population) are estimated to be living with disability. (World Health Organization, 2011)

Mexico has 119,530,753 people, according to the latest INEGI inquiry, of which 5,739,270 people has some kind of disability. Of the population of people with disabilities, 5.5% has difficulty attending their personal care, which include being able to feed themselves. The aim of this tool is to make eating easier for 315,659 people, approximately. (INEGI, 2010)

2. METHODOLOGY

The original idea was to build a set of cutlery for people in this particular condition. After that, it was decided to focus on one piece and it was selected that a spoon would be easier to ingest food. The plan was that the spoon would have more depth in order to not spill liquids, because this people have to handle cutlery with their feet. It was also planned that the handle of the spoon would have an accessory to help maintain the spoon between the first toe and second toe, to avoid spilling food and keep the spoon in place.

Following a detailed analysis of the functionality of said tool, the result was that it had a high level of difficulty, because it needed certain measurements, tests and calculations, for which there is not enough knowledge.

Finally, it was decided that the best utensil that could be redesigned, for people with this kind of condition, was the fork, since it does not represent many complications according to the authors.
The tool is designed for people with limited o no use of their upper limb, as a result they have to use their lower limbs. This includes people with partial deformities of arms, partial absence of arms, total absence of arms and partial and total surgical amputations of arms.
Making a wider analysis, the fork is meant for people of any age with one of the former conditions, which provoke physical disability affecting the manipulation of food, the skill on handling utensils, on the feet's grip strength and on their movement.

The function is that when they eat, the user puts the first and second toe in the respective rings. When they pinch the food, the fork will stay in its place because the lock will stop the movement. When they take the food to the mouth, the user could deactivate the lock and the handle will slid by gravity in the accessory. The handle will become larger automatically, providing more grasp while avoiding bending over.

On the other hand, the fork fits in the products for individual use category. The aesthetics are fundamental for this kind of products. Although, the fork to design is meant as a technical help, and thus the practical function is prominent, the aesthetics should not be overlooked as a product of individual use. As said before, it must be considered that, if it should be practical but not aesthetically attractive, it would not satisfy the user's need completely and, as a result, the chances of sales would decrease significantly. (Rodríguez, 2013)

As the product to be designed belongs in the kitchen utensils category, these must have the approval for feeding uses. Besides, the manufacturing materials for the product must be neither porous nor absorbent, and it must be impact or scratch-resistant, in order to prevent bacterial development.

The materials that are most used on cutlery, and which could be used to manufacture the fork are: stainless steel, silver, solid silver, silver metal, gilded silver and plastic.
The final product must be resistant and that, in case of drops, the different elements that make up the fork do not separate.

3. RESULTS

The fork has a base with four points on one of the ends of the handle to pinch the food as seen in figure 1. This fork has a longer handle of approximately 30 cm, and diameter of 0.7 cm as seen in figure 2, so the person could eat more comfortably without having to bend their body too much. On the other end of the handle, above the base, it has an accessory, as seen in figure 3, that keeps the fork firm between the first toe and the other ones, which is made up of a half ring for the first toe and a holder for the other toes, as seen in figure 4, which function is positioning the fork and sliding it across the handle, as well as manoeuvre the fork from one side to the other and from the plate to the mouth.
Its elements have to be flexible and light materials like plastic or sponge, and the base could be made of silver or stainless steel.

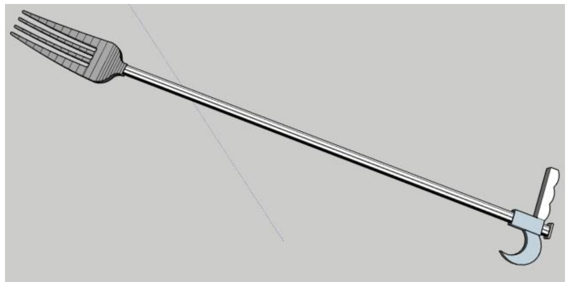

Figure 1. Top view of the fork.

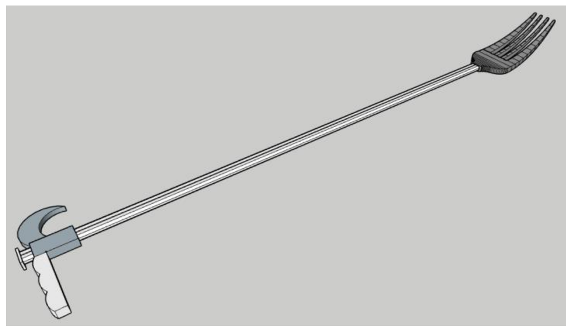

Figure 2. Lateral view of the fork.

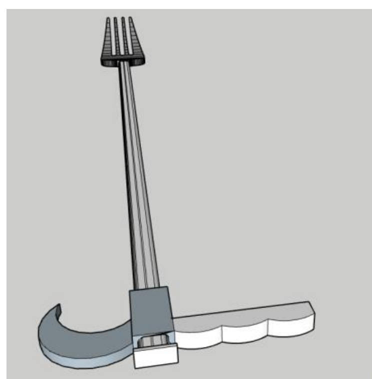

Figure 3. Back view of the fork.

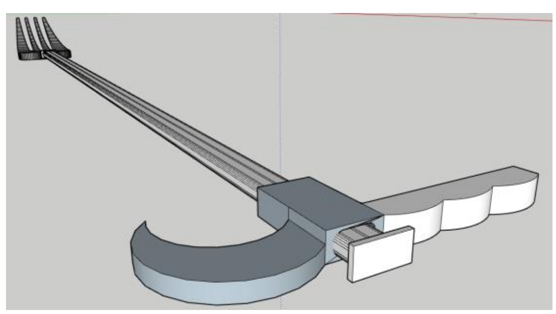

Figure 4. View of the accessory.

4. CONCLUSIONS

To sum up, to design an ergonomic tool, common sense must be used, since the function it wishes to provide is an easy use and that the people with this life condition do not feel excluded. Beyond an extensive analysis, the senses must be sharpen to understand the logic of the process and in that way find all the ramifications that could result from it, employing creativity as well.

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CONTRIBUTIONS OF THE EMOTIONAL DESIGN TO THE CONCEPTUALIZATION OF ERGONOMIC PRODUCTS

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Resumen: El diseño emocional como propuesta metodológica conceptualiza el diseño de productos a partir de emociones predefinidas. Dicho acercamiento puede ser utilizado para: 1) definir efectos emocionales apropiados, 2) obtener información relevante de los usuarios para que dicho efecto pueda ser alcanzado, 3) conceptualizar conceptos evocadores, o bien, 4) establecer la medida en que un concepto evoca la emoción pretendida. Investigadores como Donald Norman (2002), y Pieter Desmet (2003) han discutido la influencia de las emociones en el proceso cognitivo, el cual afecta de manera directa la interacción y usabilidad de los productos. Esta investigación analiza el potencial del diseño emocional -usualmente concentrado a estimular la compra- para contribuir al proceso de conceptualización de productos ergonómicos, tanto en el ambito físico como en el cognitivo.

Palabras Clave: Diseño emocional, Ergonomia, producto

Abstract: The emotional design as a methodological proposal conceptualizes the design of products based on predefined emotions. This approach can be used to: 1) define appropriate emotional effects, 2) obtain relevant information from users so that this effect can be achieved, 3) conceptualize evocative concepts, or 4) establish the extent to which a concept evokes the pretended emotion. Researchers such as Donald Norman and Andrew Ortony (2014), and Pieter Desmet (2012) have discussed the influence of emotions in the cognitive process, which directly affects the interaction and usability of products. This research analyzes the potential of emotional design -usually concentrated to stimulate the purchase- to contribute to the process of conceptualization of ergonomic products, both in the physical and cognitive fields.

Keywords: emotional design, ergonomics, product.

Relevance to ergonomics: Contributing to the teaching of ergonomics by incorporating - from conceptualization to evaluation - the process of developing new products. Disseminating and analyzing the new design approaches, developed and concentrated mainly in Europe and the United States, will allow to expand and enrich the ergonomic field.

1. INTRODUCTION

The development of ergonomics in the last decades has allowed to expand the field of knowledge, mainly, from the evaluation and optimization of workspaces. The concept of ergonomics accepted by the International Ergonomics Association, considers the understanding of the interactions between humans and the elements of the system as its central concern and the optimization of the well-being of people and the performance of the system, as the main purpose; achieving the above implies applying theory, principles, data and methods to design.

Designing, on the other hand, is a process that generally requires following a series of steps to define a problem, generate alternative solutions, evaluate them and select the most appropriate one. At first sight, both ergonomics and design pursue the same objectives: optimization of human well-being and system performance, however, the scope of the term well-being can vary and, with it, change the meaning of the problem to be solved, especially, when dealing with it from the cognitive side.

Traditionally, ergonomics recognizes three areas of specialization: physical, cognitive and organizational ergonomics. Cognitive ergonomics recognizes the concern for mental processes, such as perception, memory, reasoning and motor response as the main elements that intervene in the interaction of humans with the elements of a system. The relevant topics for this field of action are the mental workload, decision making, performance, human-computer interaction, human reliability, work stress and training, all of the above depending on the relationship that has between the human and the system (IEA, 2018).

In a work environment, cognitive ergonomics focuses on the adjustment between human cognitive abilities (abilities and limitations) and machines, tasks and environments (Budnick & Michael, 2001). Although cognitive ergonomics has been applied to improve the human-system interaction (Velazquez & Díaz, 2005), the complexity of the new technological systems and the change of epistemological paradigms (Mattelmäki, Vaajakallio, & Koskinen, 2014), demand to consider the human beyond the merely rational and take into account subjective factors such as affective and emotion, to understand the interaction in a much more complete way (CIEHF, 2016).

Industrial design has not been oblivious to this paradigm shift, with a shift of traditional methods predominantly linked to cognitive models, which consider design as the solution (exit) to specific problems, and in which the user is one of the inputs of information to define the problem, until the link - at the end of the 20th century - of feelings and moods with design solutions. Then, methodological approaches arise with topics such as experience, meaningful daily practices and emotions (Mattelmäki, Vaajakallio, & Koskinen, 2014), the latter being approached within a particular focus of projective exercise: emotional design.

2. OBJECTIVES

1. Determine if design can contribute to the design of ergonomic products.
2. Describe the effects that emotions have on cognitive processes.
3. Explain the main approaches of emotional design, its scope and limitations.
4. Identity areas of emotional design intervention in the conceptualization of ergonomic products.

3. METHODOLOGY

The developed research takes up the proposal of Donald Norman (2002), from the cognitive sciences and Pieter Desmet (2004), which argues that the emotional response evoked by a product can determine the usability and effectiveness of it. The scope and limitations of this proposal analyze its relationship with mental processes studied by cognitive ergonomics, such as perception, memory, reasoning and motor response.

4. THEORETICAL DISCUSSION

The theoretical discussion is divided into two sections: 1) the conceptualization of emotions and their effects on the cognitive processes considered, and 2) the main proposals of emotional design, its scope and limitations.

4.1 Emotions and cognitive effects

Emotions are defined from psychology as "a multidimensional experience with at least three response systems: cognitive / subjective; behavioral / expressive and physiological / adaptive "(Choliz, 2005, p.3). These three dimensions are linked and are manifested in virtually all human activity at different levels and respond to three basic functions: adaptive, social and motivational. The adaptive function of emotions is one of the most important, since it prepares the response of the organism to particular environmental conditions. Social functions facilitate the appearance of "appropriate behaviors" that favor interpersonal relationship processes. Finally, the motivational directs and intensifies the behavior to achieve some goal, an emotionally charged behavior will be performed more vigorously (Choliz, 2005).

Each emotion can be provoked, and its intensity stimulated, by external factors triggering physiological and cognitive changes in individuals, for purposes of this work we will only consider the latter. (Table 1).

Table 1. Dimensional analysis of basic emotions. Choliz (2005)

Emotion	Instigators	Cognitive process
Happiness	-Successful achievement of objectives. -Congruence between what is desired and what is possessed.	-Increase in the ability to enjoy. - Positive attitude. -Favors cognitive and learning processes, curiosity and mental flexibility. -Sense of vigor and competence, transcendence and freedom.
Anger	-Aversive stimulation: physical, sensory and / or cognitive. -Conditions that generate frustration: interruption of motivated behavior, immobility, physical or psychological restraint.	-Focus of attention on external obstacles that impede the achievement of the objective or are responsible for frustration. -Inability or difficulty for the efficient execution of cognitive processes.
Fear	-Potentially dangerous situations. -New and mysterious situations. -Height and depth. -Pain and anticipation of pain.	-Reduction of the effectiveness of cognitive processes. -Obsession. -Focalization of perception to the feared stimulus.
Sadness	-Physical or psychological separation. -Loss or failure. -Disappointment -Situations of helplessness, lack of prediction and control.	-Focus of attention on the consequences internally. -Cognitive process characteristic of depression. -Errors in information processing.
Surprise	-Novel stimuli weak or moderately intense. -Unexpected events. -Sudden increase of stimulation.	-Attention and memory dedicated to processing novel information. -Increment in general cognitive activity.
Disgust	-Unpleasant stimuli (olfactory or gustatory).	There are not considered cognitive implications.

On the other hand, Mihaly Csikszentmihalyi (1997), in his study on optimal experiences, proposed a relationship between the abilities (physical and cognitive) of people and the level of demand required, identifying the emotions generated. The central idea is that negative emotions produce "physical entropy" in the mind, which means that it is not possible to pay attention in an affective way until the internal subjective order is restored; on the contrary, positive emotions produce "negentropia", facilitating the development of other activities.

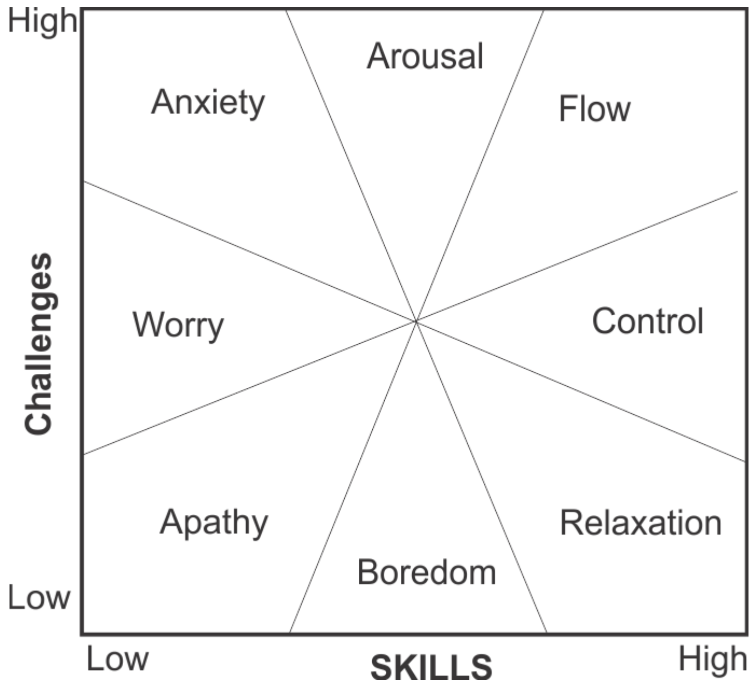

Figure 1. Model proposed by Csikszentmihalyi (1997)

If the level of demand is too high, the person will feel frustrated, worried and anxious. If the challenge is too easy compared to the capabilities of the person, it will feel relaxed and after a while, boring. On the other hand, if the challenge and capabilities are minimal, the person will experience apathy. When challenges are difficult and combined with adequate capacities, the level of attention and involvement increases, which for Csikszentmihalyi represents the ideal state or “Flow”.

4.2 Approaches to Emotional Design

For the field of ergonomics and human factors, the emotional dimension and experience were relegated issues until, at the beginning of the 21st century, they began to be taken into account as key factors to evaluate and conceptualize products. Emotional Design as an informed theoretical perspective has as main exponents Donald Norman (2004) and Pieter Desmet (2012), whose proposals will be described below.

Norman, generates a proposal of neurobiological character to analyze, from the level of cognitive processing, the emotional responses provoked by the products in different stages of the interaction, identifying three levels. The first level, called visceral, is directly related to the sensitive experience: smell, sight, hearing, touch and taste, which together define the appearance of the perceived product. The second level is determined by the evaluation of the function in relation to what the product has to do, its performance (as it does) and its usability (how easy it is). At this level, the user's response may be frustration or satisfaction regardless of what has previously been experienced. The third level, reflective, implies a much longer period of experience, which can lead to a more objective opinion about what the product represents for the user, since it can link it to their culture, identity, education and his memories.

Derived from years of experience and study, Norman states that "attractive things work better", arguing that affectivity (or emotional state) changes the parameters in which cognition operates: positive affectivity improves creativity and broadens thinking, while the negative centers or improves attention, minimizing distractions. Therefore, the products that will be used under the stress level must follow a good human-centered design, since in these conditions people will have less capacity to face difficulties and their ability to solve problems will be less flexible. The products conceptualized to cause pleasure improve their usability through an aesthetic and pleasant design (Norman, 2002).

On the other hand, Pieter Desmet (2003) considers emotion as an instrumental element in the product design process, establishing a model with four parameters: evaluation, concern, product and emotion. All these parameters are interconnected and determine if a product generates an emotion, in which case, it is also important to identify its type. The emotion, from the cognitive theory, always involves an evaluation, of how an activity / product can harm or benefit a person.

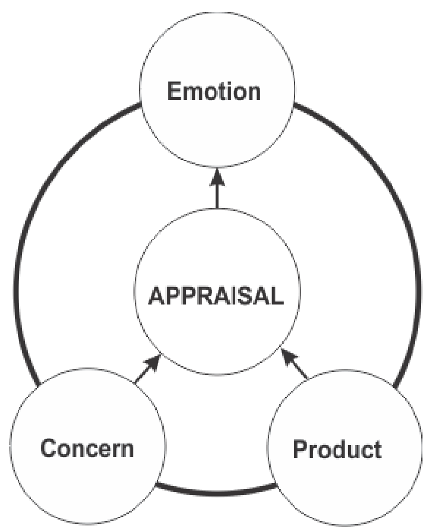

Figure 2. Model proposed for Pieter Desmet (2004).

The concern, also understood as needs, impulses, instincts, motives, goals and values, is the point of reference in the evaluation process. The products that match our concerns are evaluated as beneficial, and those that do not are considered harmful (this relationship can be linked to efficiency.) The products in turn can trigger emotions in two senses: by directly sensing experience with the object, or, by experiences attached to these.

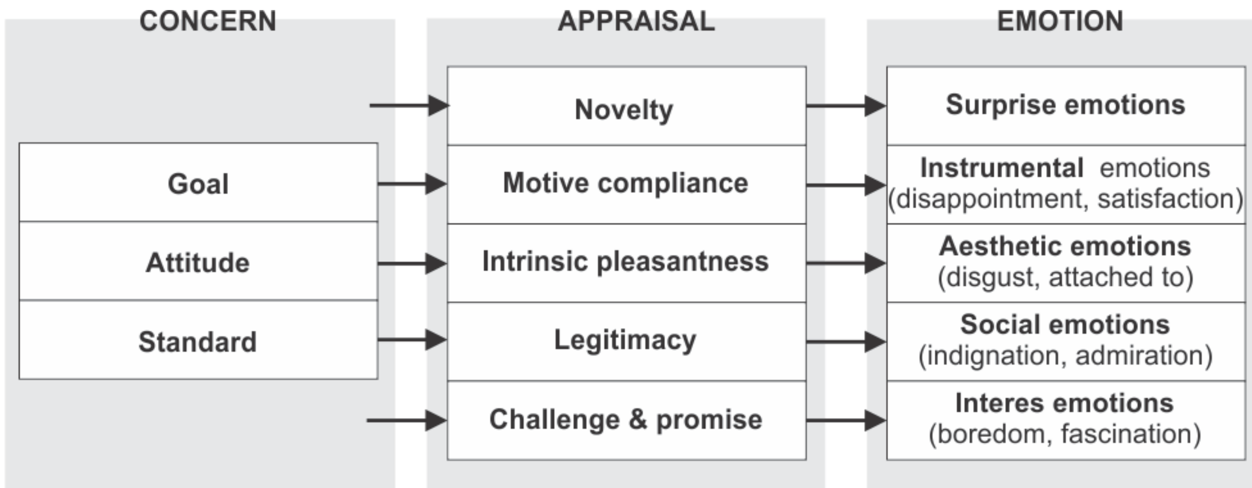

Figure 3. Classification of emotions linked to products (Desmet,2004).

Moreover, emotional design as a method is considered a systematic approach to design products with predefined emotional intentions. This approach can be used to: 1) define an appropriate emotional effect, 2) collect relevant information so that the defined emotion can be generated, 3) imagine concepts that can evoke the defined emotion, and 4) identify to what extent the concept is able to evoke the emotion defined (van Boeijen, et al., 2013).

One of the project proposals, derived from emotional design, is the so-called Hedonomics, defined as the "branch of science and design dedicated to the human-technological promotion of pleasure" (Hancock, et al., 2005, p.8), that it differs from traditional ergonomics - which is called ergonomics of negation - that seeks to eliminate the negative, look for the pleasant aspects of interaction. In this sense, recognition of motivation, quality of life, enjoyment and pleasure are incorporated into design recommendations. The methodological proposal consists in linking positive attributes to the conceptualization of experience, also allowing the individualization of it.

The principles of personalization are: 1) aesthetic longevity, design principle that maintains a classic form combined with optional functional elements that can be modified; maintaining in this way the norm and the novelty; 2) Fluid interaction, this principle seeks to facilitate the "transparency" of the tool, allowing the operator to concentrate on the task and not on the tool (with which it becomes an extension of the body of the person).

The Hedonomics perspective establishes that designing for pleasure must be an explicit objective from the beginning of the design project, although, subordinating compliance with security, functionality and usability conditions. Applying this proposal therefore requires establishing evaluation criteria to "measure pleasure".

In all the design perspectives analyzed, as well as in the ergonomics itself (both physical and cognitive), the concept of usability is referred to as one of the operative qualities of any object or system. Specifically, Demir & Erbug (2008) in their study on the determinants of product satisfaction, found that usability is one of the most important factors that influence not only the purchase but also the acceptance of the products. In their analysis they define it from the following dimensions: effectiveness (extent in which the goal of using a product is achieved), efficiency (effort required to reach the goal) and satisfaction (ease of use).

Based on the perspectives analyzed and the factors considered by each of them, the following model was developed in which the relationship they have in the design process is considered, both in the initial conceptualization and in the evaluation of interactions in spaces of work or with products

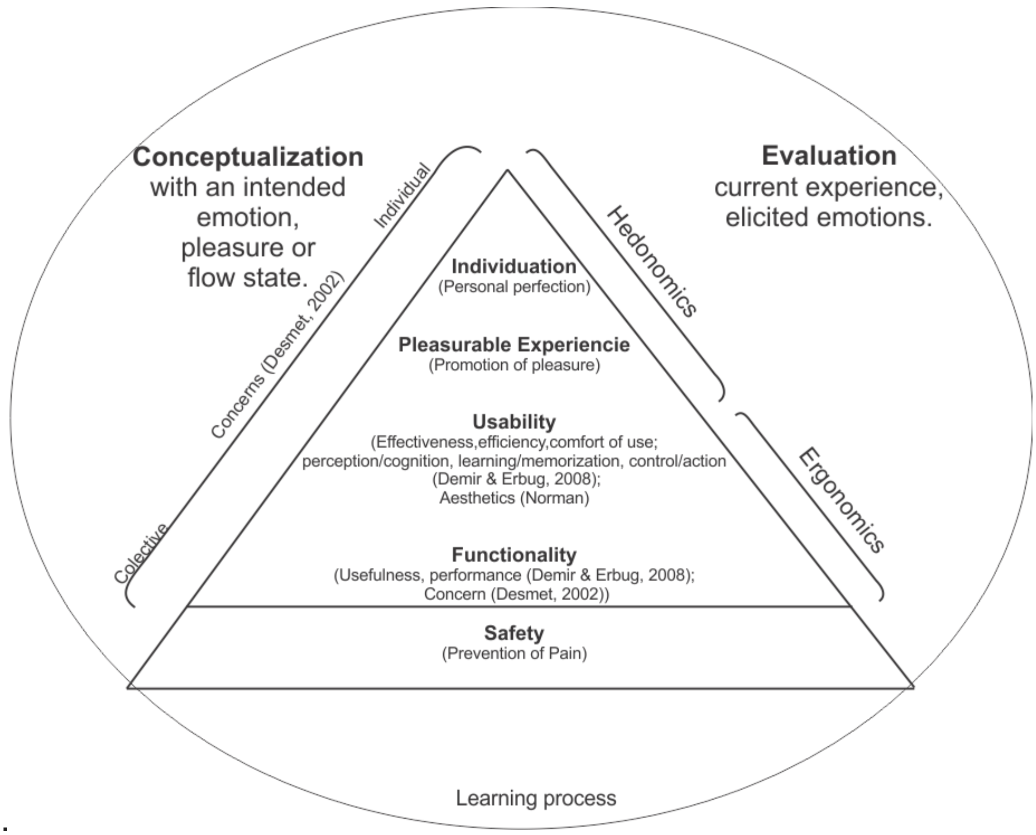

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Figure 4. Relationship model of emotional design and ergonomics. Based on Hancock (2005), Demir (2008) and Desmet (2003).

5. CONCLUSIONS

While human factors and ergonomics work with negative aspects -which must be avoided or corrected- the emotional design works with the positive aspects, which generates a substantial difference in the way of approaching the projects (this category also includes the design of experiences). The practice of industrial design - under the approach of Human Centered Design and with methodologies such as Design Thinking - has incorporated its process the analysis of the experience of people in the use or interaction of products, in addition to to take into account the psychological, cultural and social aspects of the individuals for whom it is intended to design. Although it has been theoretically advanced, it is necessary to carry out specific investigations that allow measuring the impact of emotions as the axis of the ergonomic design process.

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INNOCUOUS DIDACTIC PLASTICINE (SAFE OF TOXIC, APT TO CELIACS), TO IMPROVE THE SAFETY AND HYGIENE OF THE EDUCATORS AND CHILDREN.

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Resumen: La plastilina por generaciones se ha considerado como un material sumamente especial, pues tiene color y volumen, características invaluables para llevar a cabo el ejercicio de crear. Este material, debido a sus características flexibles y polivalentes permite: Modelar, esculpir, animar; y ha acompañado de manera activa gran parte de manifestaciones culturales, de manera que forma parte de la historia del cine, la animación, la caricatura, entre otros.

Por lo tanto se propone implementar una mejora al material didáctico (plastilina), la cual consiste en crear una plastilina 100% inocua y apta para toda la población infantil y docente (Celiacos y no celiacos), con una fórmula 100% libre de tóxicos, en su mayoría casera, de fácil y agradable olor y manipulación, totalmente higiénica y amigable con el medio ambiente, que cubra las variables de la salud, seguridad y bienestar del infante y su educador.

Palabras Clave: Higiene, Seguridad, Salud, Didáctica.

Summary: Plasticine for generations has been considered as a very special material, because it has color and volume, invaluable characteristics to carry out the exercise of creating. This material, due to its flexible and versatile characteristics allows: Modeling, sculpting, animating; and has actively accompanied many cultural events, so that it is part of the history of cinema, animation, caricature, among others.

Therefore it is proposed to implement an improvement to the didactic material (plasticine), which consists of creating a plasticine 100% innocuous and suitable for all the child and teaching population (Celiac and non-celiac), with a 100% free of toxic formula, mostly homemade, easy and pleasant smell and handling, totally hygienic and friendly to the environment, which covers the variables of health, safety and welfare of the infant and his educator.

Key words: Hygiene, Security, Health, Didactic.

Relevance to Ergonomic: Through this article, in the area of occupational health and hygiene, a tool proposal is offered for the didactic area of preschool children, which offers to children teaching workers a better quality of working life and personal and the infant greater security when interacting with these materials at the time of the classroom. A totally innocuous design of didactic materials is proposed that provides protection, hygiene and ease of handling. It is important to publish it since it is a way to publicize and share a proposal for a new tool (material) to work to improve and preserve the health of the infant and teacher.

1. INTRODUCTION.

Celiac disease (CD) or autoimmune response to gluten consumption affects a world average of one in every 150 births; it is estimated that only 9% are diagnosed, with an approximate volume of 2.6 million potential celiacs in Mexico, according to figures provided by the National Institute of Medical Sciences and Nutrition Salvador Zubirán (INCMNSZ), the EC causes the atrophy of the intestinal villi, which in turn leads to poor absorption of the nutrients that make up the daily diet. Gluten, the basic protein in cereals such as wheat, barley, rye and oats, is part of 80% of the food, either directly or as a thickener, support of aromas and binder. From which it follows that 90% of the manufactured products that we find in the market are not suitable for celiacs. Based on this, this document presents a proposal for tool improvement for the manipulation of didactic materials (plasticine), with this it is intended that infants and educators (celiac and non-celiac) achieve a better quality of life in the environment of their pedagogical and motor training and the relationship they have with these materials, improve safety and occupational hygiene conditions in such work, the prototype alternative material is a mass destined to be suitable for handling people (celiac and non-celiac) for so protect them at the time of intake and interaction with the material, it is hygienic, its characteristics are: 100% gluten-free dough, home ingredients for its composition, hardness and conservation.

1.1 Justification.

One of the most popular trademarks currently manages a mass composed of flour, water, boric acid and silicone oil, however, this clay is not toxic, you must take special care not to use it in case of having children and teaching celiacs, since being made of wheat flour it contains gluten, which for them would be harmful because they could accidentally ingest it or remain traces between the fingers that could contaminate what they consume.

It was found that in an evaluation study created for this brand published in 2007 in The Lancet, a British medical journal, it suggests that children who ingested artificial dyes were more likely to show decreased attention and hyperactive behavior. In some children, artificial colors have been associated with allergic reactions and other adverse effects. Also in December of 2015, a web page dedicated to food information published a note, explaining how risky the consumption of this product could be, and its repercussions, specifically on children. The report of the page explained, that it was common in children, to ingest by accident or curiosity a little of this plasticine. Although it is emphasized that the plasticine is not edible, likewise, it could affect consumers with allergies to any of the ingredients, however the page, explained that the product had an incredible risk to health, due to its high content of salt, which could seriously affect the health, of children, even adults. Later, on July, 2017, more ingredients that made up the product were released, in this report it was explained that for a child, a little less than half an ounce of salt could be toxic, a portion that could be achieved with plasticine.

Acording to an article found in the newspaper “El Debate” of Los Mochis, Sinaloa 28 of February of 20128 we’ve found the next note: .- The Maria Montessori kindergarten in the Nueva Revolución neighborhood will not be the same again. In their corridors and their classrooms will lack the smiles, the quick steps and the innocent mischief of the small Jesus Tadeo, who lost his life in a tragic way after suffocating with the piece of a crayon. In a press conference in the teaching area of the General Hospital, Román Messina stated that the child died of irreversible brain damage due to lack of oxygenation and ruled out that medical malpractice had occurred, as the specialists acted immediately from the first minute, without even stop to ask if the infant was entitled or not. For his part, the head of the SEPyC explained that the child had shown his teacher some difficulty breathing and went to the bathroom. He returned and it was when the same problem was detected but more acute. Robles, Blanca. 5 "Between applause and tears, teachers and children say goodbye to Tadeo".

For the above, a prototype proposal of didactic material (plasticine) suitable for celiacs and non-celiacs is created, 100% safe, homemade and dissolvable in contact with the saliva of those who ingest it, since the infant is in frequent contact with said material and educator.

1.2. General Objective:

To create a didactic plasticine with the porpoise of increasing safety and comfort between the infant, educator, and the material, eliminating the manipulation of materials with comon components, harmful to the infant and the same educator (celiacs).

1.2.1. Specific Objectives:

To Identify the most functional, hygienic and safe model of teaching material for the infant and educator.

Define the functional control techniques that meet the objectives of the standards established for this type of materials.

Make and verify a survey to see the need for this type of material in society and its acceptance by it.

Improve the occupational health of the teacher and the student, by using the didactic material (Hygiene, protection, ease of handling, health in the intake).

1.3. Delimitation:

This test is aimed to the infants, teachers and parents of sane children and with celiac, with a range of age that is a round 2 – 60 years.

2. METODOLOGY:

The author John Elliot conceptualizes the following: action research constitutes a solution to the question of the relationship between theory and practice "(ELLIOT, 2002).

For the creation of the design of 100% innocuous ergonomic didactic material, the field research will be used, carried out with a descriptive study, for the characteristics of the study will be developed for the inductive method, by proposing a design of ergonomic didactic material for the area of education, the project will be developed as a practical investigation, generating actions focused on the proposal of implementation of this type of material in the institution.

For the elaboration of the material, an interaction evaluation will be made to the preschool students. Full-time children's garden: Margarita Maza de Juárez. Password: 25DJN0878V. Location: street: ejido nine of Dicember and ejido Mochis, Sinaloa. Colonia: Roberto Pérez Jacobo, all of them inhabitants of the city Los Mochis, located in the municipality of Ahome, Sinaloa, Mexico. In addition, a survey will be applied to educators and parents, with the aim of knowing in a reliable way the current position of the infant and the educator regarding the condition in which they interact with these teaching materials. Subsequently the proposal of the prototype of the material for this group of people will be presented.

2.1. DESCRIPTION OF THE PROCES.

The teacher of the preschool area is the one who is dedicated to attend the area of initial training of infants, who directs and coordinates activities to stimulate their intellectual and physical development, as well as emotional growth, must conceive this stage of didactic planning as a fundamental methodological process, therefore when in contact with plasticine toxic for celiacs, should avoid its use, seeking health, safety and welfare of students.

For the above, a prototype proposal of didactic materials (plasticine) 100% innocuous and suitable for the entire child and teaching population (Celiac and non-celiac), with a formula 100% free of toxins, mostly homemade, is created. and pleasant smell and manipulation, totally hygienic and friendly with the environment, covering the variables of health, safety and well-being of the infant and his educator.

Below is the graphs of the survey applied in the present investigation which had the objective of obtaining information about the repercussion of the use of didactic materials (suitable for celiac and non-celiac) or absence of them in the work of pedagogy.

Figure 1 shows that of 12 people (teachers) surveyed, 80% do not carry out activities with this material due to the prevention of accidents and the components of said material. Why? Because the safety of the students is sought and there have been cases of accidents due to poisoning of these materials even recently due to their consistency and chemical composition.

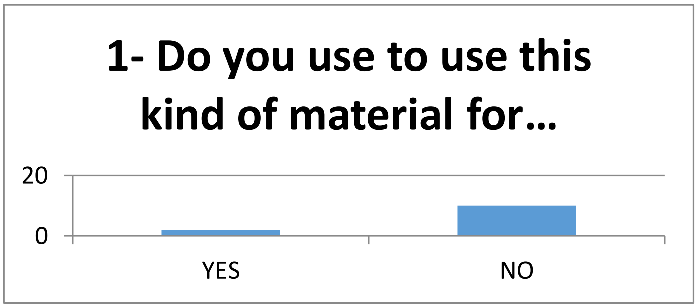

Fig. 1 Results of the question 1.

The figure 2 shows that of the 12 people (teachers) surveyed, 100% do not carry out activities with this material because they do not feel safe when implementing the activity.

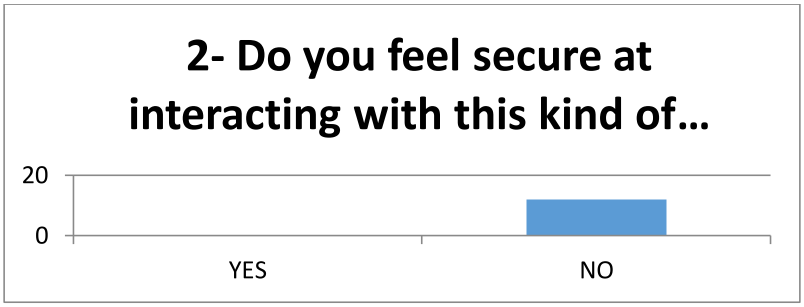

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Fig. 2 Results of the question 2.

The figure 3 shows that of the 12 people surveyed, 5 think it would be perfect, 7 would be a good option, and 0 would not like it.

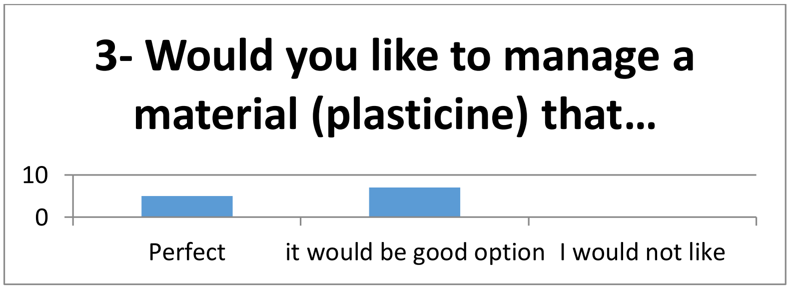

Fig. 3 Results of the question 3.

The figure 4 shows that of the 12 surveys, 40% knows about the existence of ingestible didactic material and 60% doesn't know about it.

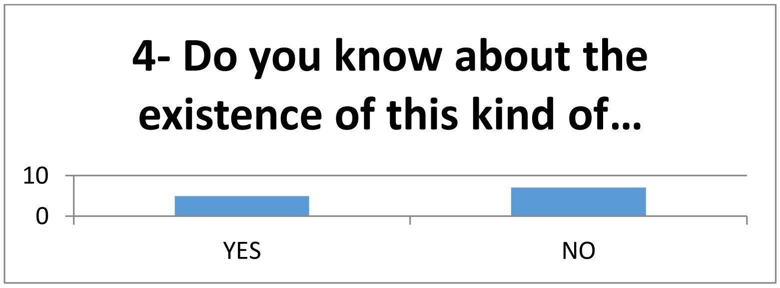

Fig. 4 Results of the question 4.

The figure 5 shows that of the 12 people surveyed, 100% liked the activity with the prototype proposal of teaching material

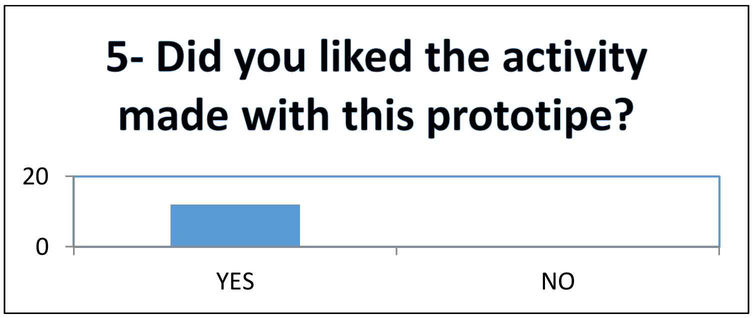

Fig. 5 Results of the question 5.

Derived from the information gathered through the survey, a 100% innocuous didactic material design is proposed and suitable for all types of population (celiac and non-celiac) for its same benefit, therefore according to the results of the survey, inferred the need to propose a tooling design for pedagogical use, which meets the characteristics that users demand: Healthy, Easy Handling, Hygienic, with a composition of completely healthy and friendly ingredients for this type, easily digested and that comply with all the requirements that this type of materials must cover and this way allow their free and safe interaction both the infant and the educator.

2.2 FIGURES OF ELABORATION OF THE PROTOTYPE MATERIAL

The figures 6, 7 and 8 show the elaboration process that is carried out to create the prototype of didactic material (plasticine).

Fig.6: Mix of the ingredients to the prototype.

Fig.7: Final mix for the prototype.

Fig.8: Observation of the final paste for the prototype.

3. RESULTS.

Due to the importance of early childhood education due to the need of stimulation in their intellectual and physical development, as well as their emotional growth, it is imperative that the preschool teacher use teaching materials which facilitate their work and so that he can achieve his goals as a child trainer, this in order to provide the infant with all the possible stimulation tools for his personal development.

Plasticine has been used in the process of education and training of the child historically with partially desirable results, because although it meets the expectations of helping the teacher in his work to stimulate the infant in their intellectual and physical development, as well as their emotional growth, the components with which this material is made up to the present time, causes that when the educator imparts his class with this material he does it with extreme care and concern about how the interaction of the infant with the material is carried out , generating the work and psychological stress of the teacher.

Therefore it is proposed to implement an improvement to the current didactic material (plasticine), which consists of creating a composition of ingredients for the preparation of such material and adapt the formula to be suitable for celiac people, looking for these ingredients are in their all homemade, to convert this modeling dough into a 100% eatable and easily digested modeling clay with the purpose of creating a protection mechanism for the infant and educator when interacting with said material.

For the creation of the composition of the formula, numerous investigations were carried out on the components of the different current varieties of this material and their acceptance by society. At the same time, investigations of the diet governed by celiac people were also carried out and elaborated the composition for this prototype of didactic material (plasticine).

In this section we propose a prototype of didactic material (plasticine) 100% safe and suitable for all children and teachers (Celiac and non-celiac), with a 100% free of toxic formula, mostly homemade, easy and pleasant smell and manipulation, totally hygienic and friendly with the environment, that covers the variables of health, safety and well-being of the infant and his educator what offers the worker of pedagogical branch a better quality of work and personal life. A design of didactic material is proposed that offers protection, hygiene and ease of handling, and that also increases the performance in your work.

According to the above, a test of this material prototype was made to a total of 18 infants, students of the before mentioned institution to observe their interaction and acceptance of said material. The results are shown in figures No. 4, 5, 6 and 7.

3.1 FIGURES OF THE TESTS WITH THE PROTOTYPE OF THE DIDACTIC MATERIAL (PLASTICINE)

The figures 9, 10, 11 and 12 are the samples of the test that was done in the institution mentioned earlier in this article, to confirm that this teaching material does meet its objectives.

Fig.9: Interaction of infants with the prototype.

Fig.10: It is observed that this material does not adhere or leave a trace on the tables.

Fig.11: It is observed that this material does not leave a trace on the hands of the infants

Fig.12: It is observed that this prototype is pleasant for the management of infants.

4. CONCLUSION:

After obtaining the information and evaluation of the didactic material of the institution that was visited, it was observed that during this activity, both the infant and the educator interact with said material with great care due to the design of the material seen, they tended to adopt a behavior where safety and hygiene are losses, and without being a professional in the field we can appreciate that surely in the future this causes, an inefficient safety for infants and the teacher as well as work stress for the same. This way rectifying the low efficiency of these materials for the preschool now reveals more of a problem.

With the results obtained, we provide the redesign of a material that helps a better interaction of infants and teachers (celiacs and non-celiacs), therefore it has been innovated in a material that helps them perform this work safely and hygienically. It is considered that it will be of great support to the pedagogical sector of the country.

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BIOMECHANICAL DESIGN CONSIDERATIONS FOR AN ERGONOMIC HOME SEWING PRACTICE

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Resumen: Las mujeres son un sector de la población, que se ha dedicado a actividades no profesionales, como son la costura en el ámbito de sus hogares, que como sabemos es una actividad esencialmente femenina, siendo para muchas de ellas una actividad no profesional remunerativa, debido a esto, existen pocos estudios que refieran a los problemas de tipo biomecánico en particular en segmentos como el cuello y los hombros, sin embargo, en el sector industrial si existen estudios que revelan la incidencia de trastornos músculo-esqueléticos debidos a tareas repetitivas y posiciones incómodas. En esta investigación, se han estudiado bajo un modelo biomecánico los momentos de fuerza generados durante la actividad de costura en las condiciones habituales, es decir en la posición sedente, a fin de comparar el resultado con la evaluación de los momentos de fuerza generados respecto del centro de rotación de la espalda baja en la misma posición, después de que se han realizado recomendaciones para modificar la postura original, a través de un dispositivo que se inserta en la base de la máquina de coser, el cual modifica el ángulo de rotación del cuello y espalda. De acuerdo, a los resultados obtenidos, el momento de fuerza generado respecto al centro de rotación de espalda baja, revela que los momentos de fuerza son menores después de colocar el dispositivo, el cual es un soporte fijo fabricado en acrílico, que tiene una pendiente fija respecto de la horizontal de 26 grados.

Palabras Clave: Costura, Biomecánica, Análisis

Relevancia para la Ergonomía: Este estudio ofrece una información invaluable en relación con algunos aspectos ergonómicos a considerar en las tareas de las mujeres que realizan labores de costura en máquina, en el ámbito de sus hogares y que tienen actividad remunerativa, las cuales no se encuentran documentadas, debido a que la mayoría de ellas no cuentan con servicios médicos sociales. Se proponen modificaciones a la postura, a través del uso de un dispositivo que ha de colocarse bajo la máquina de coser.

Abstract: Women are a sector of the population, who has devoted itself to non professional activities, such home sewers, which we know it is an essentially feminine activity and in most cases a non remunerative activity, due to this, there exist few studies regarding to this activity, however, in the industrial sector, there are several studies that reveals the prevalence of muscle skeletal disorders, especially in body segments, like neck and shoulder, and specifically in tasks where there are repetitive movements and awkward positions. In this research, there have been studied under a biomechanical model the moments of force generated during the activity of home sewers at the seat position in the habitual condition, then a new evaluation of force moments is done, in order to compare both conditions, after a given number of recommendations is done and a device is positioned under the sewing machine in order to modify the neck and low back rotation angles. The results reveal that moments of force are lower than the moments of force before inserting the device under the sewing machine, which has been made of acrylic with a fixed slope respect to the horizontal axis and has a slope of 26 degrees.

Key Words: Sewing, biomechanical, analysis

Relevance to Ergonomics: This study offers a valuable information in regards to ergonomic aspects in the home sewers with remunerative activity, which normally are poorly documented, and also, because most of them are not under medical social services. Recommendations are done to improve posture, and a proposed design is presented to reduce strengths.

1. INTRODUCTION

Women are a population sector that has been dedicated to non professional sector activities such home sewing, that is feminine in nature, due that home sewing is a non professional activity, there are few studies related to the research of Biomechanical problems associated with neck and shoulders in this population sector, however, international studies (Brar et al, 2004) have shown the incidence¨of Musculoskeletal Disorders in the manufacturing industries, where a combination of repetitive tasks and awkward postures exists. Home sewers are subject to the same physical problems, due to that the garment manufacture, takes on average, an exposition to the same posture for about 46 minutes and for a total time of ten hours, and also because they perform unvaried tasks for long periods; all of these characteristics have been observed in the home sewers that have a remunerative activity.

Studies have shown that operators of sewing machines, experience pain in the shoulders, wrists and hands and pain in the neck and shoulders (Delleman and Dull, 2002). Pain in neck and shoulders relates to long working hours in the same working posture. Also, some research papers report that sewing operators presents pain in the head and lower back .

This study is dedicated to formulate the biomechanical analysis of neck and shoulder strengths, and propose the biomechanical considerations to reduce them.

2. OBJECTIVES

Three objectives has been established in this work:
To perform a biomechanical analysis of neck and shoulder of home sewers, while they are doing the sewing tasks.
To establish the biomechanical considerations to be taken in order to reduce strengths in neck and shoulders.
To design a gadget for home sewers, that help to reduce strengths in shoulders and neck.

1. METHODOLOGY

3.1 Subjects of study

This study has been focused to perform a biomechanical analysis of 46 women dedicated to home sewing tasks with remunerative activity in the city of Hermosillo, Sonora, México. A stratified sampling was used in order to select the sample from the defined subgroups of the given population corresponding to the diverse neighborhoods in the city which were stratified according to the 113 postal zones defined for the city. All subjects in the sample were healthy women from 23 to 54 years.

3.2 Materials and Equipment

Two basic anthropometric measures were performed: corporal weight and stature, using a weight scale and anthropometer set. The measurements of rotation angles were taken with a calibrated goniometer and a repeatability and reproducibility study was performed over the measurement system in order to verify that the system error, equipment error and inspector error were aleatory. A 2.3 m by 3 m white screen with a blue grill was placed behind the sewer, and used as a support measurement device when was not possible to have free access to measurement.

A Nikkon camera with a twenty pixels of resolution was used in some cases to take a photograph of a position that was difficult to verify and measure with goniometer. When the camera was used, a laser level was used to align it.

3.3 Procedure

A Corlett and Bishop's body part discomfort subjective symptom survey was applied to evaluate the direct experience of discomfort at the different body parts in home sewers that perform a remunerative activity.

A biomechanical model was developed to study the static loads over the body, according to results obtained from Corlett and Bishop's survey.

Static loads were estimated in regards to the stature and weight of each individual, which correspond to head, trunk, arm and forearm weights. Also, were estimated the neck, arm, forearm and trunk segment lengths and segment rotation centers, where, the center of rotation of low body back segment, is the basis point to perform the calculation of force moments generated by the static loads from body segments. The force moment was obtained through an excel spreadsheet template developed by the author.

A set of recommendations for posture changes were established and a new biomechanical analysis was performed in order to compare force moments after changes in posture.

A proposed gadget was designed in order to reduce force moments over the entire upper body. The proposed gadget allows home sewers to take a posture which promotes a better corporal posture, avoiding rotate the neck at a rotational angle higher than 35° from vertical in the sagittal body plane; and also, letting the sewer, to maintain a straight back posture.

4. RESULTS

4.1 Corlett and Bishop's Body Part Discomfort Scale

The forty six women were asked to answer theCorlett and Bishop's Body Part Discomfort Scale, and results helped us bypass our biases and judgments and expectations that affect responses, because it anchors users to their specific physical sensations. The results of that survey are presented in figure No. 1:

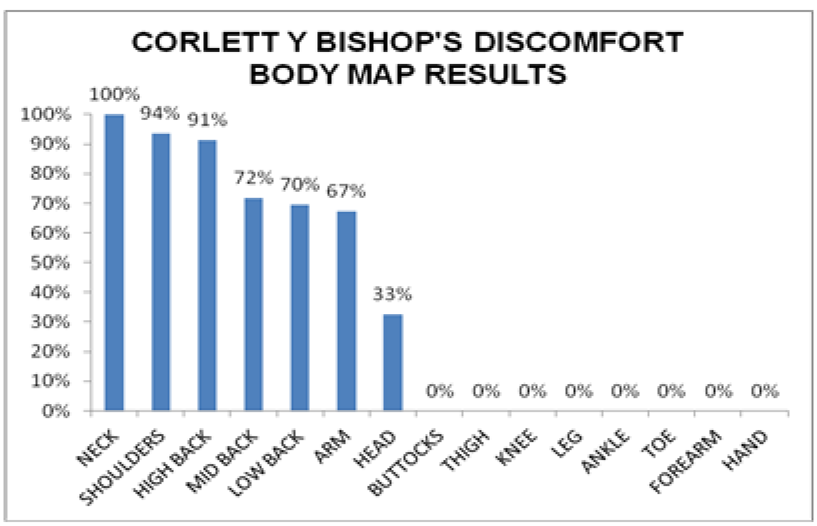

Figure No. 1 Corlett and Bishop's body Map Results

According to Figure No. 1 the three most important discomfort sensations experienced by women are in the neck, shoulders and high back, and this resultant lead us to think that an upper body biomechanical model will let us to have an understanding of the forces acting during home sewers tasks.

4.2 Biomechanical Model for the Home Sewer

The resulting biomechanical model reflects the upper body segments which are related to the tasks developed by a home sewer, and it was used to calculate force moments at the static body sustentation point, which is located in the back segment. The biomechanical model comprehends five variables: body segment weight, body segment mass center, body segment length, location of body rotation centers, which are the joint points between two adjacent body segments, and rotation angles of body segments measured counterclockwise from horizontal to vertical at the sagittal plane of the body.

The body segments comprised in the model are the head, neck, back, forearm and arm. They were assigned the following letters and numbers for the model variables: CR for the rotation center, CM for the center of mass, mg for the mass of body segment and L for length of body segments, which are shown in figure No. 1:

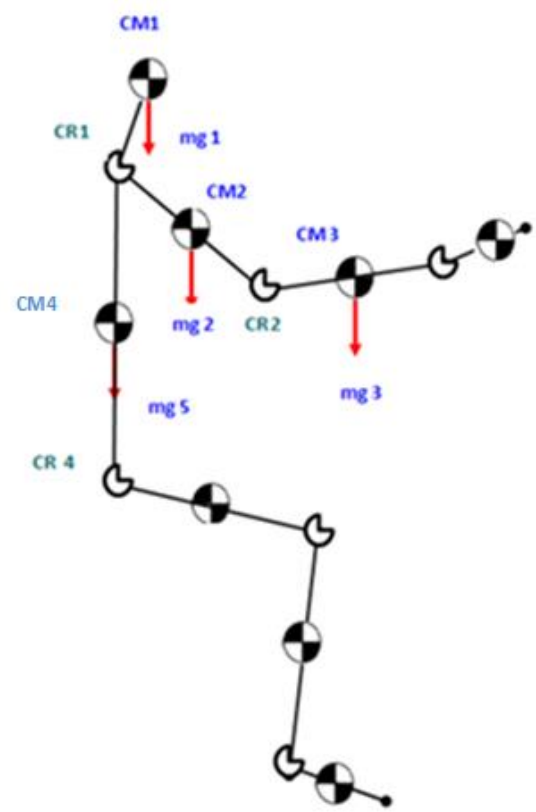

Figure No. 2 Biomechanical Model for the Home Sewer

4.3 Force Moments Before and After recommendations

In order to calculate moments of force in regards to the rotation center (CR4) located at the lowest point on back, they were estimated the following variables: mass center, body segment mass and body segment length of the measured stature and weight, and also the rotation angles of body segments for every woman. The force moments were calculated under the normal conditions observed for every woman, using an excel spreadsheet designed by the author and other force moments were calculated after the addition of the device proposed and the recommendations in postures.

They were established the following recommendations in order to improve posture of home sewer: angles of rotation for neck and back segment were modified adding a device positioned under the sewing machine as shown in figure No. 3:

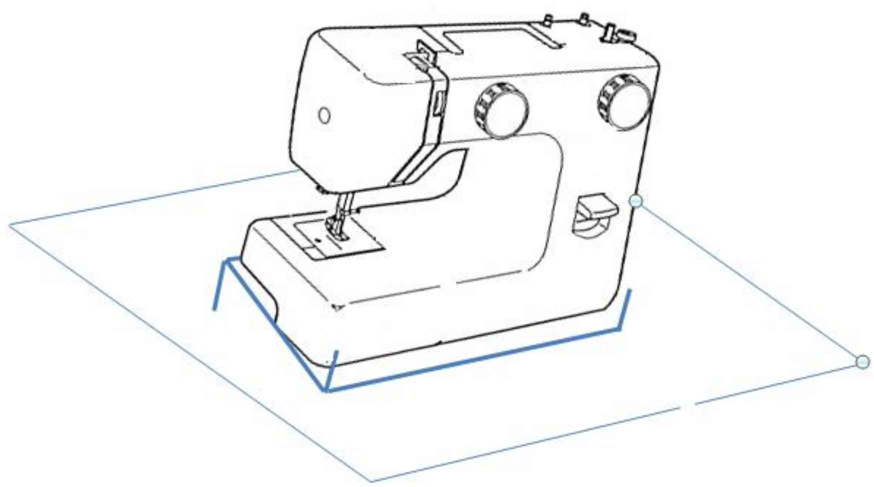

Figure No. 3 Sewing Machine Slope Angle

The addition of the device under the sewing machine promotes the reduction of neck and back rotation angles which provides a comfort during sewing tasks. The Slope in regards to horizontal plane for device is 26 degrees.

A reduction of 56% of force moments was noticed in the average moments calculated after the changes were implemented.

5. CONCLUSIONS

According to results from Corlett and Bishop's Comfort Map, there were three important body areas where women experience discomfort: neck, shoulders and back, 100% of women reported neck discomfort, and the most important areas reported where the corresponding to the upper body.

The proposed biomechanical model was developed for the upper body, in agreement with results found from Corlett and Bishop's Comfort Map. The model lets us perform the mechanical analysis of force moments generated in the actual postures held by women during the execution of sewing tasks and also make a second analysis after making changes in the posture due a device to modify rotation angles was placed under the sewing machine. It is important to say, that the slope of the device against the horizontal was 26 degrees, and for this angle, it was found a reduction of 56% in the force moments average in the total population.

There were performed twenty calculations of moments changing the angles of rotation of two segments: back and neck, in order to find out the reduction of 56% in the generated force moments. We cannot say that slope obtained is the optimum value. Optimum value could be got thru the development of a linear programmation model, that minimize a moment of force subject to certain restrictions that comprehend the maximum and minimum rotation angles for every segment considered.

It is important to mention the limitations that surround this study. The results of Corlett and Bishop's Map were obtained thru the self reported discomfort by women. The cross sectional nature of data conduces to think that it is not possible to define causal inferences regarding the nature of the work itself.

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REDESIGN OF AN ERGONOMIC BUCKET TO AVOID CTD´s

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Resumen: Una cubeta es un recipiente en forma cilíndrica que puede retener sustancias fluidas. Para facilitar su uso y el transporte dispone de un asa semicircular que está sujeta por sus extremos al borde superior. Esta herramienta se utiliza en diferentes trabajos como la agricultura, pintores, albañilería o amas de casa. En este documento se presentan las muestras de 20 personas que se dedican a estos trabajos, con el fin de conocer los percentiles necesarios para el rediseño de la cubeta como herramienta manual.

Palabras clave: Percentil, Herramienta, lesiones.

Abstract: A bucket is a cylindrical container that can hold fluid substances. To facilitate its use and transport it has a semicircular handle that is attached at its ends to the upper edge. This tool is used in different jobs such as agriculture, painters, masonry or housewives. This document presents the samples of 20 people who are dedicated to these works, in order to know the percentiles needed for the redesign of the bucket as a manual tool.

Keywords: Percentile, Tool, injuries.

Contributions to Ergonomics: Provide a proposal to redesign a bucket to prevent injuries to workers and improve their quality of life. The study of hand tools to improve the quality of life of people is a very important part within the field of action of ergonomics.

1. INTRODUCTION:

Our ancestors built their tools from their own needs and discoveries, as the human being was developed, it was transformed and applied for different uses. Nowadays the use of manual tools is very common in many work environments. The problem is that this type of media does not adapt to the workers and the task to be carried out, thus generating risk during its handling.
The design of the tools is of the utmost importance since it facilitates their use and helps to avoid diseases of the operator's work, which can generate expenses for the company or industry and decrease the worker's performance.

The bucket is a container or vessel in the shape of an inverted truncated cone so that its concavity can retain fluid substances. To facilitate its use and transport it has a semicircular handle that is attached at its ends to the upper edge.

In most cases, the tool must be in the hand preferred by the user. The right is preferred by approximately 90% of the population, a percentage that seems to be similar in all cultures and in both sexes.

The main benefit of a tool that can be used with any hand favors the remaining 10% of the population. (Konz, 2005).

2. OBJETIVES:

Achieve a satisfactory adaptation of the characteristics of the bucket as a working tool to safeguard the health and welfare of the operator while improving the efficiency and safety of the same.

- Optimize the use of the bucket.
- Find a suitable design for the best use of the bucket.
- Minimize injuries in operators who use buckets.

3. METHODOLOGY:

In order to improve the ergonomic characteristics of the bucket, tasks were carried out with this tool, identifying the parts that needed improvement.

It was observed that it did not have an optimal grip in the upper part and that in the lower part it needed another to be able to improve the emptying of the same one. In addition, the width of the arch that this tool has is very thin and it was decided to add wider grips for better operator comfort.

3.1. Delimitation

According to the NOM-006-STPS-2014 the research focuses on men between 18 and 50 years.

3.2. Determination of the sample

According to the National Institute of Statistics and Geography (NISG), Mexico has a territory of 198 million hectares, of which 30 are agricultural lands.

Mexico has 5.5 million people engaged in agricultural activities as of December 2015, of these, 56% are farmers and 44% support agricultural workers (peon or laborers), this gives a total of about 2,420,000 support workers of which Sinaloa has the amount of 266,200.

In Mexico, according to the NSOE, in the fourth quarter of 2016 the population with this occupation amounts to about 190 thousand people of whom Sinaloa has around 5,470 people dedicated to the work of painters of fat brush.

According to the National Survey of Occupation and Employment (NSOE), in the year of 2013 the population employed as a bricklayer in Mexico, amounts to two million 419 thousand people. Of which Sinaloa has around 55,600 masons.

Measures were taken of 20 people of different ages between 18 and 50 years old. 5 people who work in the fields, 5 painters, 5 masons and 5 housewives in the city of Los Mochis, Ahome, Sinaloa, who use a bucket as a work tool.

In the case of manufacturing the tool, this study would have to be done on a larger scale so that the measures include most people.

4. RESULTS

Table 1. Average percentage.

Dimensions In cm.		PERCENTIL	
		Mens	
		5 %	100 %
1	Pinky width in the palm of the hand	1,6	1,8
2	Width of the little finger close to the bud	1,5	1,7
3	Width of the ring finger in the palm of the hand	1,8	2,1
4	Width of the ring dew close to the yolk	1,5	1,9
5	Width of the big toe in the palm of the hand	1,9	2,3
6	Width of the big toe close to the bud	1,7	2,0
7	Width of the index finger in the palm of the hand	1,9	2,3
8	Width of the index finger close to the bud	1,7	2,0
9	Length of the little finger	5,6	7,0
10	Ring finger length	6,9	8,6
11	Length of the big toe	7,5	9,2
12	Length of the index finger	6,8	8,3
13	Thumb length	6,0	7,6
14	Length of the palm of the hand	10,2	11,7
15	Total length of the hand	17,0	20,1
16	Thumb width	2,0	2,5
17	Thickness of the hand	2,4	3,2
18	Width of the hand including the thumb	9,8	11,6
19	Width of the hand excluding the thumb	7,8	9,3
20	Hand grip diameter	7,5	8,5
21	Hand perimeter	19,5	22,9
22	Perimeter of the joint of the duster	16,1	18,9

There must be enough space for the four fingers to fit. The width of the hand along the metacarpals varies between 2.8 inches (7.1 cm) for the 5th percentile of women and 3.8 inches (9.7 cm) for the 95th. Percentile for men. (Garrett, 1971).

This tool was designed with a grip on both sides so that both right-handed and left-handed can use it, as stated "the tools are designed to be used with one hand (...) if it is designed to be used with the hand that the user prefers, that for the 90% of the population is right, the rest, or 10%, would be dissatisfied "(Miller & Freivalds, 2009)

Based on these studies, a lower part of the tray was first removed and a plastic tube was placed to facilitate the emptying of the tray since there is no part with which to hold it, using a 5 percentile for its width and a 100 percentile for the length of the tube so that the grip is suitable for small and large hands. This was done for the reason that it causes injuries to fingers, hands and wrists at the time of emptying.

On the other hand the grip of the upper part is not adequate and it was decided to put a grip on both sides to be able to eliminate the arch that caused great damage in joints and ligaments mainly in the wrist and that covers up the back, column, legs and arms. These grabs were made with a 5 percentile for the tube width and 100 percentile for the length.

The grabs were made with a depth of 100 percentile so that the grip is comfortable and easy for any measurement of the hands depending on the width of the fingers of the same. In addition all the grips have an inclination which allows the correct position of the hand and wrist when lifting or emptying the contents of the bucket.

5. CONCLUSIONS

With the passage of time, people have sought an improvement in the area where they develop their work activities, that is why the concept of ergonomics emerged. The study of risk factors in the workplace is a very important part in the field of ergonomics.

In a large number of work activities, manual tools are those work tools usually used individually and which only require human force to activate them. It is therefore important that these tools have a good design so that users do not suffer injuries or accidents.

The bucket is a tool that coexists daily and is used by a large percentage of people in different activities especially in the field, home, by painters and masons, so the fact that it has a bad design makes that many people are at risk.

The redesign of the bucket as a manual work tool allows many people to improve their quality of life.

The manual handling of loads includes the synchronized action of legs, column and arms with the grip of the hands or other parts of the body, such as the back or shoulder, this makes the position of these parts have to be adequate for operators do not suffer injuries.

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WOOD CHISEL REDESIGN FOR THE WORKERS´ SECURITY

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Resumen: Las herramientas manuales son utensilios que se utilizan cotidianamente y por ello es importante que estén diseñadas con un enfoque ergonómico. En el presente documento se realiza el rediseño de la herramienta formón, que es utilizada por los carpinteros para la realización de algunas de sus actividades. En base a un estudio de medición antropométrico de carpinteros mayores de edad en las ciudades de Los Mochis y Guasave Sinaloa, se propone un rediseño del formón agregándole una guarda formando un mango en T, que ayudará a disminuir los riesgos por deslizamiento en su utilización, brindando la seguridad necesaria para la realización de las actividades.

Palabras clave: Antropometría, guarda, carpinteros.

Abstract: Hand tools are dispositives that are used on a daily basis and it is therefore important that are designed with an ergonomic approach. In the present document is the redesign of the wood chisel tool, which is used by carpenters for the realization of some of its activities. Based on an anthropometric measurement study of adults carpenters in the cities of Los Mochis and Guasave Sinaloa, proposed a redesign of the wood chisel by adding a guard forming a handle on T, which will help reduce the risks by using sliding, providing the security needed for the realization of activities.

Keywords: Anthropometry, guard**,** carpenters

Contribution to ergonomics: Mayor security of the workers, the productivity and get better the products of daily use in the occupation.
Increase the safety of the worker, the productivity and improve the products of daily use in the office.

1. INTRODUCTION

Throughout history, human beings have acquired different skills: wit and survival. As they were discovering your environment, they analyzed it to know their qualities and discover how to use the resources it provided them in nature to meet one of the most basic needs of humans, feeding to survive. That was how, someone take a stone and sharpen to cut something, and thus, to create tools that facilitate them work, they were not the most efficient tools, but they fulfilled their purpose.

"Hand tools enhance the ability of the hands" (Konz, 2005), can be used at any time and, to be more compact, they are easier and lighter to carry.

A definition of hand tool would be: utensil that is conceived as an extension of the human hand and requires for its operation of the human driving force, alone or in combination with any type of auxiliary mechanical energy; being the most common electric power.

On the other hand, "it is necessary that the tools comply with design conditions from the ergonomic point of view, which implies that the instruments must be adapted to the characteristics and needs of workers to reduce the exertion by its" "use and avoid uncomfortable hand postures or wrist, especially, which reduces fatigue". (Sibaja, 2002)

A hand tool used by carpenters is the wood chisel, its design has remained equal for a long time, however, does not provide sufficient protection to the worker during use, a slip of the hand may occur, and in case of having a barrier, this is not suitable since the risk persists.

With this research pretend to reduce the risk by slip of the hand, adding a guard. Guards in the hands can improve accuracy during use and prevent accidents, helping to make a safe activity and preserve the physical health of the worker.

2. OBJETIVE

The main objective of this investigation is redesign the wood chisel adding a guard on the handle to improve accuracy during use and decrease the severity of accidents in the use of the same by reason of slide due to the manipulation of the tool.

Delimitation: The study only includes the use of the tool by adults carpenters (male gender).

3. METODOLOGHY

For the present project is necessary to carry out the following sequence of activities:

1. Scan tool and determine the necessary dimensions for your redesign
2. Measure the dimensions of the hand needed to redesign the wood chisel.
3. Guard design for the improvement of the wood chisel design.
4. Redesign the wood chisel adjusting the guard on the handle grip.
5. Check the operation of the tool and its efficiency.
6. Finished tool.

Two measuring instruments were used to collect the necessary information on the redesign of the guard, anthropometric tape and cone for grip diameter.

The tool of greater relevance to use was the cone for the measurement of grip, because it offers more accurate and reliable measurements relating to the dimensions of the diameter of the grip, which were subsequently needed to redesign both the handle of the tool, as the guard.

3.1. Determination of the necessary dimensions for your redesign.

Was initially designed an anthropometric identification for data collection to carpenters of the male sex. The dimensions required for the preparation of the prototype were the following:

a) Long hand

b) Long Palm

c) Length of thumb

d) Length of the index finger

e) Palm width

f) Grip perimeter

g) Width of the index finger

3.2. Determination of anthropometric measures required

Once determined the necessary dimensions of anthropometric identification, 20 carpenters' data was taken in the city of Los Mochis and Guasave, Sinaloa, 10 and 10 workers respectively (see table 1).

The number of samples is small due to the fact that the elaboration of a prototype is being approached to measure its efficiency in a certain segment of the population.

Table 1. Samples taken to carpenters in the region.
Source: Own elaboration

	Measures in centimeters						
No. samples	a)	b)	c)	d)	e)	f)	g)
1	20	9.5	8	9	10	5	2.9
2	21.5	10.4	9.2	10.3	11.1	5.9	3.2
3	19.8	8.1	7.5	8.4	8.9	4.3	2.8
4	20.6	10	8.5	9.4	10.6	5.5	2.9
5	22.6	11.1	9.8	10.5	11.3	5.9	3.2
6	19.5	9.1	7.3	8.4	9.5	4.2	2.7
7	20.5	11.5	7	8	10	5.5	3.1
8	22.3	10.9	8.7	9.1	9.8	5.8	3.1
9	20.5	11.8	6.8	8.2	9	5.2	3
10	16.8	9	6.5	7	9	4.8	2.6
11	19.5	9	7.5	8	9.6	4.8	3.1

12	22.7	11.5	8.9	9.3	10	5.7	3.5
13	17.7	10	6	7.1	7.8	5	2.9
14	20	9.2	7.8	8.9	10	5.4	3
15	21.5	12	8	9	10.6	6.2	2.8
16	19.6	8.8	7.6	7.9	9.4	5	2.9
17	17.3	10.1	6.7	7.1	8.5	4.9	2.8
18	21.6	10.9	8.4	9.1	10.5	6	2.9
19	19	10.5	7.5	7.5	8	5.4	2.7
20	20.6	11.1	7	8.1	10.2	5.7	2.8

Once collected the data collected in table 1, was to determine the 5, 50 and 95 percentiles concerning to measures by formulas 1 and 2, relating to the average and standard deviation.

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad (1)$$

$$S = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{n}}$$
(2)

The data in each of the dimensions shows in table 2.

Table 2. Result in the use of the formulas for each dimension
Source: Own elaboration

Dimension	a)	b)	c)	d)	e)	f)	g)
Media	20.18	10.225	7.735	8.515	9.69	5.2894	2.945
Standard deviation	1.6462	1.1224	0.9680	0.9831	0.9486	0.5616	0.2111

On the basis of the table of areas under the standard normal curve, from scratch to z, were determined for 5° and 95° percentile values.
-1.645 = 5 °. Percentile = $-Z_{.05}$
1.645 = 95^{avo}. Percentile = $Z_{.05}$ (Niebel & Andris, 2009)

According to the data in the use of both formulas (1) y (2), calculated the percentiles for each dimension using the normal distribution in each dimensions.

Table 3. Necessary measures for the redesign.
Source: Own elaboration.

	Percentiles		
Dimensions	**5º**	**50º**	**95º**
(a) Long hand	17.4719	20.18	22.8880
(b) Long Palm	8.3785	10.225	12.0714

(c) Length of thumb	6.1425	7.735	9.3274
(d) Length of the index finger	6.8977	8.515	10.1322
(e) Palm width	8.1295	9.69	11.2504
(f) Grip perimeter	4.3655	5.2894	6.2133
(g) The index finger's width	2.5971	2.945	3.2928

3.3 Design of the guard for the improvement of the wood chisel

The guard design is based on the measure concerning the subparagraph f) (see table 3) where the diameter of the grip is reflected in percentiles.
Initially, the width of the handle of the wood chisel was designed for 5°, measure that was also used for the diameter of the guard, and 95° was used for the length of the guard. The width of the guard was determined by a ratio between long wood chisel and the length of the guard.

It should be noted that when designing the prototype, we round up to the nearest integer measures in order to be more inclusive.

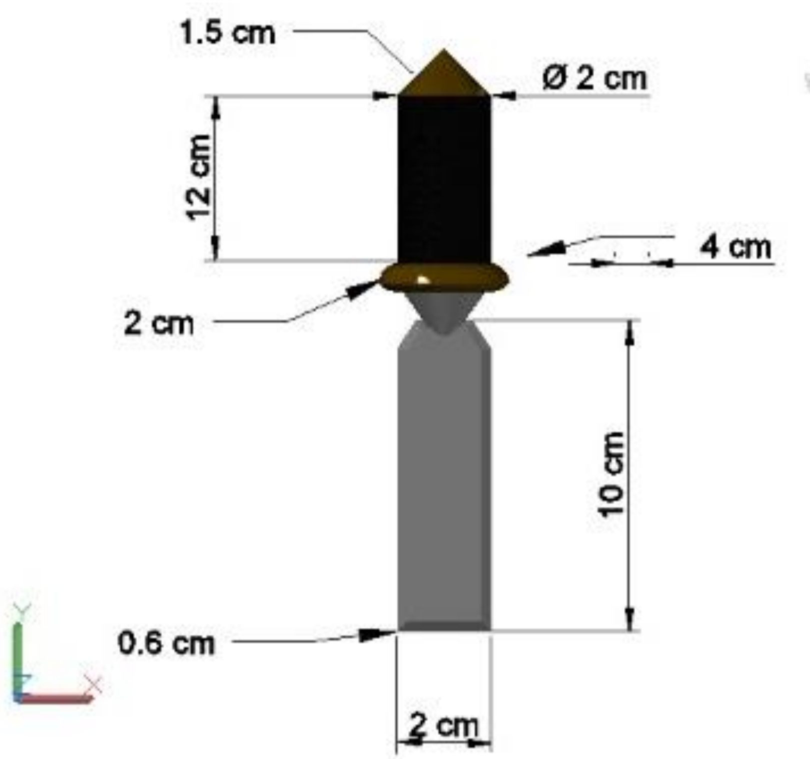

Figure 1. Guard and wood chisel design in AutoCaD (with measures).

Table 4. Determination of the dimensions of the prototype
Source: Own elaboration

Dimension of the prototype	Dimension used (based on table 2)	Percentile	Measured in cm.	Rounded
Length of the handle	Palm width	95º	11.2504	12
Width of the handle Perimeter guard	Grip diameter	5º	1.5915	2
Length of guard		95º	6.2133	
Saves bandwidth	Width of the index finger	95º	3.2928	4

4. RESULTS

With this improvement of the wood chisel (see Figure 1) it managed to get greater protection to the worker, already that guard that was added as a T-handle, causing that more force along the axis of the tool, causes the muscles of the forearm and shoulder are not limited by the strength of the fingers grip with the surface of the handle.

4.1. Redesign of the chisel adjusting the guard on the handle

Once placed the guard, managed to observe a significant change (see Figure 2) which served to give more protection to workers and security to carry out its activities

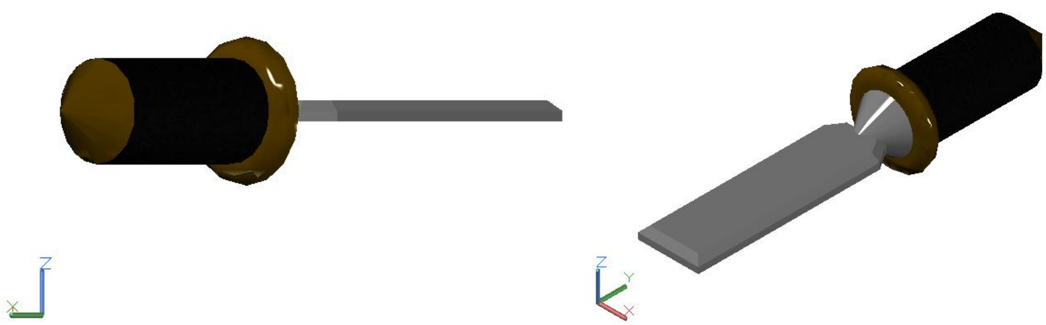

Figure 2. Prototype view

5. CONCLUSIONS

Currently, there are a myriad of tools, so many that we can almost say that everything is invented, however, while they are created for the man and play a role, most of the cases are not suitable for use.
With the redesign of the present tool called "wood chisel" is intended to reduce the risks of work associated with the activity of carpenters for the own use of this tool, the above, putting into practice the anthropometric measurements of the hand to give an ergonomic twist.

6. RECOMMENDATIONS

Helped to reduce risks by slide and was a very efficient tool for workers. However, the carpenters have not only a wood chisel of if not, in the majority of the times 4 different. A future proposal would be designing a guard which is adaptable to each of the wood chisel with which they have the possibility of having protection regardless of the thickness being used.

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SEARCH AND DETERMINATION OF ERGONOMIC AND ANTHROPOMETRIC REQUIREMENTS IN THE DESIGN OF PRODUCTS TO MAKE AEROBIC EXERCISE: A REVIEW OF LITERATURE.

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Resumen Diseñar se ha convertido en una actividad que ha evolucionado en las últimas décadas. Esta evolución ha cambiado con el paradigma de solo crear y diseñar contra diseñar y crear para satisfacer las necesidades del usuario, integrando responsabilidad social, compatibilidad con el medio ambiente, sustentabilidad, funcionalidad y economía. Ante esta serie de restricciones, surge la necesidad de contar con información fidedigna de las consideraciones mínimas para un diseño exitoso. En este tenor, la creación de diseños dirigidos al uso directo por parte de seres humanos, hace necesario que estos integren principios ergonómicos por su funcionalidad y adaptabilidad. Ante la necesidad de determinar cuáles son las características con las que debe contar el diseño de aparatos para hacer ejercicio, primero se realizó el despliegue de la función de calidad (por sus siglas en ingles QFD) para definir cuáles son las necesidades del cliente. A partir de los resultados obtenidos del QFD, se desarrolló la revisión de literatura asociada, bajo la operación de búsqueda sistemática en la que el objetivo fue identificar información relevante para el diseño de este tipo de productos. Debido a que el diseño depende de la subjetividad del diseñador, se complementó la investigación asociando la técnica de diseño axiomático, la cual es una metodología compleja y recientemente empleada para hacer objetivas las necesidades de los usuarios finales. Se identificaron 18 artículos que exponen la integración del diseño axiomático, la ergonomía y la antropometría como principios para el diseño de productos. Estos provenientes de una revisión de 108 artículos encontrados en 5 bases de datos, publicados en el periodo 2010-2018.

Palabras clave: *Ergonomía, antropometría, diseño, diseño de producto, diseño axiomático.*

Relevancia para la Ergonomía: La información obtenida presenta una fuente de información sintética, que puede ser considerada por los diseñadores de productos para ejercicios, con la certeza de que se declaran implícitamente los principios de ergonomía y antropometría.

Abstract Design is an activity that has been changed in the last decades. This evolution has changed the paradigm of only create and design versus design and create to satisfy the user necessities, integrating social responsibility, environment, sustainability, functionality, and economy. With these restrictions, there is a need to have reliable information on the minimum considerations for a successful design. In this regard, the creation of designs aimed at direct use by human beings makes it necessary the integration of ergonomic principles for their functionality and adaptability. The present work arises from the need to determine what are the characteristics with the design of exercise equipment should count, for this, the information obtained from the of the quality function deployment (QFD) was considered to define the client's needs. With these results, a literature review was developed using systematic research technique with the aim to identify relevant information for the design of exercise products. Due that the design depends on the subjectivity of the designer, the research was complemented considering the axiomatic design methodology. 18 articles were identified, those articles expose the integration of axiomatic design, ergonomics, and anthropometrics as a principle for the product's design. Those papers come from a review of 108 documents founded in 5 databases, published in a period from 2010 to 2018.

Keywords: Ergonomics, anthropometry, design, product design, axiomatic design.

Relevance to Ergonomics. The information generated is a resource of synthetic information that could be considered by exercise product designers, with the certainty that the principles of ergonomics and anthropometry are implicitly declared.

1. INTRODUCTION

Designing exercise products for a population with a diffuse range of characteristics, represents a challenge for market analysts, designers, manufacturers also, for the participant as a user’s of future products. The design of a product for exercising must be a subject to different restrictions. In this way, the inclusion of social responsibility, sustainability, environment and, functionality, have become the trigger for the inspiration of the designers and creators to establish rules and protocols for the development of their products. Given these considerations, this research describes information associated with obesity and overweight as part of the social element, the use of ergonomics and anthropometry as part of sustainability and finally the use of axiomatic design as a critical element of functionality.

1.1 Obesity and overweight versus physic activity.

On this subject, it is essential to define the concepts carefully. Overweight and obesity are defined as an abnormal or excessive accumulation of fat that can be detrimental to health. Both are global health indicators. The determination of those indicators is based on the percentage of the total population that has a body mass index (BMI). Where 25 to 30 is the BMI for overweight and, higher than 30 is for obesity – The BMI is calculated by dividing the weight in kilograms by the square of the height in meters (kg / m2) –
(Organización Mundial de la Salud, 2017).

At present, many of the countries have integrated education plans, health plans, security plans, etc., into their policies. It is not a coincidence that within the health plans there is concern about the rates of overweight and obesity. According to, World Health Organization (WHO), (2017), 57% of the world population lives in countries where overweight and obesity cause more deaths than weighted insufficiency (insufficiency generated by being below the weight that is considered healthy).

According to the WHO and the Food and Agriculture Organization of the United Nations (FAO, 2017), obesity is a disease that affects a large part of the population of the countries of the world and presents a trend that is increasing. In many cases, it is a risk factor for developing other diseases such as diabetes, ischemic heart disease and certain cancers that are attributable to overweight and obesity.

On the other hand, the World Health Organization (WHO) has declared that the two leading causes to generate overweight are eating habits and the level of sedentary lifestyle, coupled with the malfunction of some parts of the body(Organización Mundial de la Salud & Organización Panamericana de la Salud, 2016).

In Mexico, the prevalence of overweight and obesity among women aged 15 and over-represents a percentage between 71.0 and 77.2 percent. Which means that 3 out of 4 women have a problem with overweight and obesity (Romero, 2013). These records represent a significant change in the epidemiological profile.

In the past, the main problems were infectious diseases and malnutrition. Nowadays, overweight and obesity represent a factor that generates other diseases. Those affect the female population such as cancer (breast, endometrium, vesicle and biliary tract), cholelithiasis and hepatic steatosis (fatty liver), psychological problems (depression and anxiety), peripheral venous insufficiency (varicose veins, edema and trophic changes in the lower extremities) and problems of the locomotor system (osteoarthritis of the spine and knee) (Sánchez-castillo, Pichardo-ontiveros, & López-r, 2004).

Finally, it is important to highlight that in Mexico efforts are being made to reduce the percentage of the female population that suffers from overweight or obesity through health activation programs. The national statistics show that of 56% of the physically active people, only 45.8% corresponds to the female population. Of which, 58% corresponds to women over 25 years. This numbers suggests that the realization of physical activities is essential for this population and are usually a function of the timely disposition of those who perform them. Due to the schedule preference, 41.9% of the population that performs physical activities, prefers a morning schedule, which is opposed to the period of activities conducted by this population.

Of the physical activities in which the woman has participation, the exercises or routines considered as aerobics, have a preference of 1.6% of the active female population. Which represents the percentage of interest for the present investigation due to the variety of elements of exercise that are used in this discipline as complements to increase the degree of difficulty and the demand of effort on the part of the users.

1.2 Axiomatic Design

The methodology and theory of Axiomatic Design (AD) is one of the most cited works in engineering design publications. The state of the AD is the best solution for the design based on two axioms:

1. Maximum independence of functional elements.
2. The minimum information content.

The first axiom ensures that the designs will be adjustable, controllable and avoid unintended consequences. The second axiom guarantees that the design will be robust with a maximum probability of success. The success of the AD consists of three elements each of two parts. The parts of the first element are the axioms, by applying the axioms systematically through the design of the structure where the design of the components is required. The structure is the second element, and its two parts are the horizontal decomposition into client, functional, physical and process domains. And the vertical disintegration into hierarchies from general aspects to specific aspects of the design. The third element is the process. This is a zigzag decomposition to create hierarchies in top-down domains by first performing the functional requirements (FRs) for the client attributes (CAs) in the client domains and then selecting the Design Parameters (DPs) in domains physical to satisfy the FRs and correspond to the Process Variables (PVs) in the process domain to create PDs. The zigzag decomposition continues up and down through the hierarchy of the most specific level of simple design features where the solution is obvious (Suh, 1990, 1995, 2001; Tomiyama et al., 2009).

2. METHODOLOGY

A methodology for a systematic search was developed, Figure 1 presents the flow diagram of the method. The following phases integrate this methodology:

- Phase 1. Formulation of the search question from the results of the QFD. In this phase, the core question of the investigation is declared. Because the objective of this project is to present a literature review associated with the design of exercise devices, specifically aerobics. It was established as a restriction that the question should integrate the words: design, ergonomics, anthropometry, products for exercise, aerobics, product design and axiomatic design.

- Phase 2: Literature Review. During this stage, a database of the Universidad Autónoma de Ciudad Juárez was used as a resource. The database used was: Springer Link, Scopus, Science Direct, Emerald y EBSCOHost. The search syntax as built using the following words: design, ergonomics, anthropometry, exercise products, aerobics, product design and axiomatic design. Search constraint subject to the parentheses functions for different search combined with combinations of them linked to the "and" connector. Search for the concordance in the title of the publication, summary, and keywords. Search restriction by period subject to the interval of years from 2010 to 2018. Spanish and English as a restriction on the language of publication. Consider only scientific articles.

- Phase 3: Reading of information. The process of reading the information lies in the rapid sweep of the information, which consists in first identifying the restrictions considered in Phase 2. With the articles obtained from the discrimination process, the aim is to identify the type of product developed, the author, the design methodology, the tools used, and the design considerations. Typically, we seek to identify the following elements for the first table: Adaptability to human dimensions, design considerations based on posture, use of the client's voice for design, anthropometric considerations, type of grip, weight considerations, considerations of form, Easy to use. For the construction of the second table, we look for information related to the axiomatic design, where the author is identified, the type of product, the axiom used, the complementary methodologies, economic attributes and anthropometric attributes.

- Phase 4: Data extraction. The extraction phase consists of identifying the elements mentioned in stage 3 and proceeding to the identification of the information pertinent to the search.

- Phase 5: Classification of information. The classification phase of the information is developed in two aspects, the first in the allocation of the information obtained to table number 1 called "Product Designs" or to table 2 called "Axiomatic Design."

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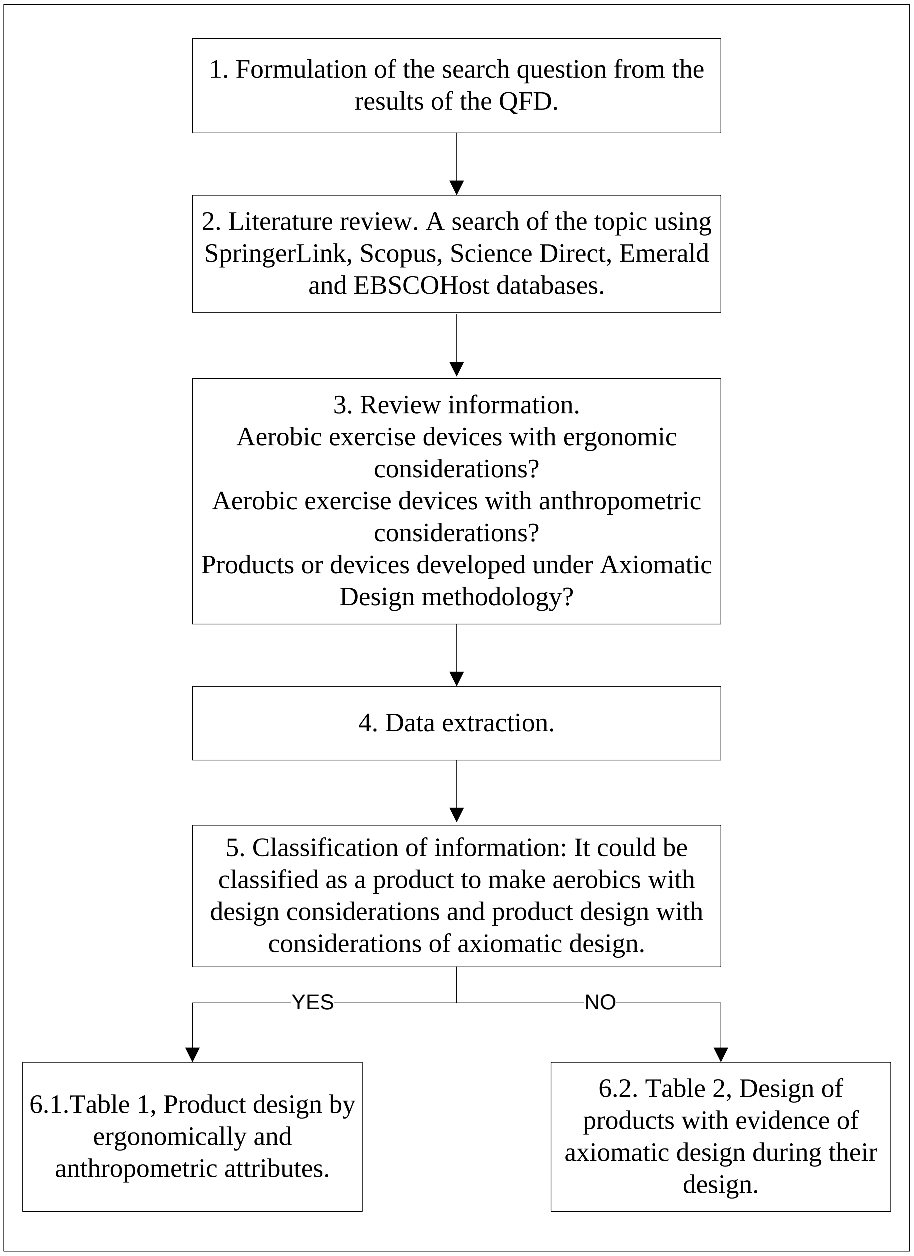

Figure 1. Flow chart of systematic search.

3. RESULTS

The results generated by the systematic search, it was possible to build two tables. Table 1, exposes the information made under the restriction of product design of exercise devices ad, table 2 presents the insertion of axiomatic design as a pure or hybrid methodology for product design. Both tables synthetize the information with the aim to show only the most relevant information.

Table 1. Product design by ergonomically and anthropometric attributes.

Author	Journal	Methodology	Ergonomically attributes	Anthropometric attributes
Castellucci, Arezes, & Viviani, (2010)	Applied Ergonomics	Anthropometric measures for design	Students of 8th grade	6 anthropometric measures: Stature, Popliteal height, Buttock-popliteal length, Elbow height while sitting, Hip width, Thigh thickness and Subscapular height
Castellucci et al., (2010)	International Journal of Industrial Ergonomics	Design of ergonomic-oriented	Students of 1st grade in the elementary school	Anthropometric measures such as stature, weight, body mass index (BMI), popliteal height, buttock-popliteal length, and hip breadth shows that stature and body mass index
Castellucci et al., (2010)	Applied Ergonomics	Anthropometric measures for design	High school students	Anthropometric measurements (stature, sitting height, sitting shoulder height, popliteal height, hip breadth, elbow seat height, buttock popliteal length, buttock knee length and thigh

				clearance) and five dimensions from the existing classroom furniture.
(Castellucci et al., 2010)	International Journal of Industrial Ergonomics	Anthropometric measures for design by mismatch computed through a set of equations	Students of basic and secondary school	Stature, sitting shoulder height, elbow seat height, Thigh thickness, Buttock-popliteal length, subscapular height, and Hip width.
Castellucci et al., (2014)	Applied Ergonomics	Anthropometric measures for design by mismatch computed through a set of equations	Students of basic and secondary school	Stature, sitting shoulder height, elbow seat height, Thigh thickness, Buttock-popliteal length, subscapular height, and Hip width.
Butlewski, Misztal, & Belu, (2016)	ModTech	Design by modeling	Cognitive techniques, ergonomic modeling	Anthropometric measures.
Münster, Schäffer, Kopp, Kopp, & Friedrich, (2016)	Transportation research procedia	Lightweight design automotive	Geometric design phase begins with the positioning of the occupants in the passenger compartment and the ergonomic layout	Anthropometric measures for passenger.
Xin, (2017)	Physical Education	Fitness Equipment design	Function, weight, posture.	Anthropometric measures for users.
W. Lee et al., (2018)	Computers & Industrial Engineering	Sizing analysis system	Complex body dimensions.	Anthropometric dimensions based on the

				CAESAR head measures.
Da Silva, Gordon, & Halpern, (2018)	International Journal of Industrial Ergonomics	Design by anthropometric data base	Workplace, systems, persona protective devices.	Anthropometric measure by six dimensions.
Zitkus, Langdon, & Clarkson, (2018)	Applied Ergonomics	Design evaluation tools	Ergonomic task demands	Anthropometric data.

Table 2 exposes the synthesis of information gained under the search synthases. Due the size of the table, the columns that use number that describes the next information: column with number 1, presence of axiomatic design, column with number 2, presence of information axiom, column with number 3, application area of product design, column with number 4, axiomatic design application, column with number 5, method integrated by more than two design mythologies and, column with number 6, theoretical development.

Table 2. Design of products with evidence of axiomatic design during their design.

Author	1	2	3	4	5	6	Product	Attributes
Yang, Yu, & Sekhari, (2011)	X		X	X	X	X	Refrigerator	+Electronic and electric product. +Product integrated by many components +Recycled.
Cheng, Zhang, Liu, Gu, & Cai, (2011)	X		X	X	X	X	Motherboard of personal computer in a quadrate integrated circuit	+ Keep CPU and equipment in a collaborative environment work. .
Kremer et al., (2012)	X			X	X	X	Ballast arrangement locomotive	+ Lack of standardization + Cost + Complicated process
Lee & Park, (2014)	X			X	X	X	Ceiling type air conditioning system	+ Air flow + Capacity of air cool + Capacity of exchange from heat to cool
Song & Zhang, (2013)	X		X	X			Microchanel	+ Size of microspheres. + Consistency of the microspheres + Flow

Hong & Park, (2014)	X		X	X	X	X	Water faucet Stering column, ceiling type air conditioner	P1 + Control of water flow + Control of water temperature. P2 + Movement restrictions during assemble. + Movement control to high and low position of a assemble tube. + Tube assemble adjust. P3 + Minimize the space used by the air conditioned. + Generate the adequate quantity of air in the area, + Generate enough cold air, + Minimize vibration and noise. + Purify the air in the area. + Keep temperature programed on equipment and, + Assure the accessibility to the equipment for maintenance and system fix.
Kumar & Tandon, (2016)	X		X	X	X	X	Hair dryer	+ Capacity to dryer. + Portability. + Ability to concentrate cold air. + Security during operation. + Life length. + Economy.

4. CONCLUSIONS

The results express the impact in ergonomics and anthropometrics as a principal actor in general process design. Those considerations are logical due to the products nature that is developed for human use or to perform in a controlled environment for people. The results presented in Table 1 refer to the development environment that implies considerations ergonomically in a work area, factors that generate fatigue, environment, among others. Other concern is restricted by anthropometric attributes, which are a restriction for the design of elements that need to be adjusted to a specific population. Is essential mention that the variability is a predominant factor in many people, which tries to be explained and measured by anthropometric studies that must continuously be updated. Due to the characteristics of the template, only the most meaningful articles are exposed, those cover the conditions of ergonomic and anthropometric attributes. Table 2 present a group of information more critical due to the shortage of existing data in the use of the axiomatic design as a pure or hybrid methodology for the design of products in general. In this way the results obtained in search of these syntaxes is restricted by "product to do exercise," reduces the number of articles published. This represents an area of opportunity for futures searches in the field of exercise products design.

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PRESS PROTOTYPE TO OPEN CLAMS WITH ERGONOMIC APPROACH

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Resumen: La ergonomía es indispensable para complementar el diseño propuesto que se centra al usurario final. Esto indica tomar en cuenta las necesidades expuestas para la solución de problemas causados por insuficiencia de características implementadas en diseños convencionales. El uso de herramientas no adecuadas para realizar la actividad de abrir almejas, con el paso del tiempo originan lesiones en piel, manos, brazos, hombros y columna, es por eso que el prototipo de prensa para abrir almejas con enfoque ergonómico se diseñó gracias a esos problemas, con la finalidad de lograr reducir esas lesiones causadas por las posturas forzadas que el usuario realiza con los cuchillos y herramientas de cocina convencionales. Se realizaron investigaciones de prensas y utensilios de cocina que normalmente se utilizan en la actualidad, para observar las bases existentes de estos. Como resultado obtenemos este prototipo de prensa abre almejas con enfoque ergonómico para promover la salud, satisfacción laboral, y lo más importante que es la calidad de vida de los usuarios y sus familias.

Palabras clave: Rediseño Ergonómico; Trastornos Musculo Esqueléticos; Salud Ocupacional.

Abstract: Ergonomics is essential to complement the proposed design that focuses on the final usury. This indicates taking into account the needs exposed for the solution of problems caused by insufficient characteristics implemented in conventional designs. The use of unsuitable tools to perform the activity of opening clams, with the passage of time originate injuries in skin, hands, arms, shoulders and spine, that is why the prototype press to open clams with ergonomic focus was designed thanks to those problems, in order to reduce those injuries caused by the forced positions that the user makes with conventional knives and kitchen tools. Investigations of presses and kitchen utensils that normally are currently used were conducted to observe the existing bases of these. As a result, we obtain this press prototype that opens clams with an ergonomic approach to promote health, job satisfaction, and the most important thing is the quality of life of users and their families.

Keywords: Ergonomic Redesign; Musculoskeletal Disorders; Occupational Health.

Relevance to ergonomics: Proposal of a tool designed to reduce occupational risks, diseases and diseases, as well as to increase the quality of life of the user.

1. INTRODUCTION

Fishermen and seafood workers of the Port of Topolobampo Sinaloa,they usually use kitchen knives to open clams, which generates exposure to occupational risks. Over time these tools cause injuries due to the excessive force applied to the handle of the knife and fragile handling due to the viscous consistency produced by the residues of the maritime product, These risks are reflected in the arm, hand and back, that's why the prototype tool to open clamshell with ergonomic focus was designed based on those problems taking into account injuries caused by forced postures that the user performs with conventional tools and inadequate for their function. The author Guillet, in 2007 it reported that the most cited risks are the risks that refer to safety: physical risks/Work accidents (51,12%) – especially the risks of cuts(10,98%), the risks of falls (17,22%), the risks related to the work rhythms (7,42%), the risks to the functional unit(fishing boat) (5,87%).

After carrying out bibliographic research on tools to open oysters and clams that exist today, As a result, a prototype of the clamshell press is proposed with an ergonomic approach to promote health, job satisfaction, and the most important thing is the quality of life of the users, as well as being a multifunctional tool.

1.1 DELIMITATION

The research was developed in the port of Topolobampo, Ahome, Sinaloa, to shower workers region.

1.2 GENERAL OBJECTIVE

Design a prototype of a multifunctional tool that solves the problems of users who practice the activity of opening sea products such as clams, mussels and oysters, caused by the use of conventional cutting tools.

1.3 ERGONOMICS

Scientific discipline is interested in understanding the interaction between human beings and the elements of a system; And the profession that applies theory, principles, data and methods to design in order to optimize human welfare and the overall performance of the system. (Ruiz, Ochoa, De la Vega, Villarreal 2009).

1.4 GRIPPING POWER

A strength grip: used to hold a hammer, for example, that uses relatively strong muscles in the forearm. Your whole hand is wrapped around the handle. (Pheasant, 1998)

2. METHODOLOGY

The elaboration of this prototype arose through the considerations that were reflected in seafood workers and fishermen when observing how they opened clams and oysters with a kitchen knife in a restaurant in the Port of Topolobampo. The worker placed the clam on a table where he struck with the right hand the upper edge of the knife exerting pressure and with the left hand he held the handle of the utensil in order to open the clam. It was observed that the person presented redness in the proximal dorsal part of the right hand caused by the blow exerted on the edge of the knife, and symptoms of discomfort in the wrist by the grip of the handle.

The author Frantzeskou in 2012, found that Muscle Skeletal Disorders affected 71% of the sample. When analyzing the results according to the age variable, it was observed that 77% of fishermen surveyed under 50 years of age suffered from this disorder, while among those aged 50 or older this percentage was 68%.

According to the author Novalbos, in 2008, in the Andalusian fishing sector, a cross-sectional study was carried out through a questionnaire to find out the health status, working conditions and lifestyle of workers in that sector. The sample consisted of 247 workers, with an average age of 40.3 years and an average seniority of 24.4 years. In 32% of the cases, fishing was the second job after agriculture and construction. The results presented as one of the main problems of the fishermen the TME, in particular, 29% of the respondents (n = 72) reported having suffered them.

On the other hand, given the high physical workload, the continuous tension to which they are exposed, undefined work and rest regimes and long working hours, it is very common for fishermen to experience fatigue. Due to the above points it is very likely that fatigue is one of the health damages that is most frequently mentioned in the literature related to the risks of sea workers.

The author Smith in 2007, argued that to address the fatigue of the sea workers it is necessary to verify various points such as: the rest of the work hours as well as organize information campaigns and fatigue management, as well as the development of a tool that facilitates the tasks. On many occasions, fatigue and stress are analyzed together. Security risks have a fundamental role in fishermen and seafood workers in the port of Topolobampo Sinaloa, since activities that can generate exposure to occupational risks are carried out. The reason for these problems is related to the ability to use their tools, which do not fulfill the necessary function required by the fisherman to perform their work efficiently and safely because of the negative factors that affect the user.

2.1 DESIGN OF THE PRESS OPENS CLAMS

Currently there is not much information about presses to open clams, the results of the research are based on kitchen tools such as knives and press to mold tortillas. That is why we saw the need to complement articles and tools related to design, and the function of a press opens clams.

Most of the presses use a handle that makes handling difficult, this design will help to be handled by people with different hand anthropometric measurements, allowing a comfortable grip and a safe drive.

2.2 FORMULATION OF PRESS DESIGN

The press is a manually operated tool, made of silicone material, stainless steel, steel and rubber. The importance of providing security and comfort required by fishermen and shellfish workers has become an indispensable element in any trade that handles this type of activities such as clams and molluscs.

2.3 STATE OF THE ART

The first tools used to open clams, were made by hand with materials such as wood and blacksmithing, around the eighteenth century. The following tool has dimensions of 25 x 8 x 7 cm, consisting of a blade that is made in forge, unique piece, its function is to place the oyster or clam in the groove of the base of the tool, then pull the blade to exert pressure on the mollusk and thus be able to open it, as can be seen in the following figure:

Figure 1. Wooden press to open clams
Source: (All collection, 2000)

A publication of a research developed in the católic university of chile was found, which aimed to design a tool to facilitate the work of the working area of said nation. The difficulty to open bivalve shellfish was chosen as a design opportunity. According to the Office of Agricultural Studies and Policies (ODEPA), during 2013 the total landfall in the country of aquaculture products was around three million tons, 50% of which was of an artisanal nature.

Based on the results obtained in this research, they developed the following prototype: a circlip pliers, to which the ideated tips are exchanged (Figure 2). This first prototype was tested with different users, such as fenadores and owners of the house. The purpose of this was to receive feedback from potential users. As suggested by experts in the field, a tool to open seafood "should be hygienic, fast and safe."

Figure 2. Knife opens oysters, Victorinox black nylon handle
Source: (Camps, 2013)

The next prototype is that the handles were coated in a waterproof, non-slip and not retain odors or moisture, in addition to several anticorrosive layers. In this way, a fast, safe and hygienic prototype with a more aesthetic finish was achieved.

Figure 3. Pliers with interchangeable tips to open seafood
Source: (Camps, 2013)

One of the first tools that have been used to open oysters or clams is a knife dyer, which has a round tip ideal for the process is thin and is 7.5 cm (3 inches) long.

Figure 4. Pliers with universal tips to open seafood
Source: (VICTORINOX, 2018)

3. RESULTS

After the investigation focused on the occupational risks suffered by fishers and seafood workers in the port of Topolobampo Sinaloa, and the health problems that are most commonly presented, based on this, a decision was made to elaborate a proposal design of a press opens clams, and to be able to carry out the design, identified certain factors that generate them.

The decision was made to cover and resolve all the aspects that affect in some way the productivity and health of the worker, through the following components captured in the design (figure 7, 8): Handle of yellow color, this striking color is chosen because it is the color that is best appreciated by people with color blindness, likewise consists of a handle with ergonomic grip of 40 mm (1.5 inches) in diameter, with a range of 30-50 mm (1.25 to 2 inches), as well same with an inclination of 19 ° based on the study carried out by Knowlton and Gilbert in 1983. These authors described the muscular load that was needed when hammering. They observed that with a hilt with a curvature the muscular load was reduced due to the lower grip force that was exerted. They studied the effort that was made when nailing 20 nails with different hammers: one with a handle with an inclination of 19 ° and a straight one of 0 °.

It consists of removable components for complete cleaning, stainless steel material to avoid contact of physical wounds with ferrous contaminants, lever with stainless steel punch to easily open the clam, base with rough surface in "V" shape where the product, a base was added to rest the handle and prevent damage to the punch, the main base is composed of four rubber plugs to prevent unforeseen movements when handling the press.

Next in figure 5, the design of the press prototype to open clams is shown, prepared with the results of the investigation to solve all the risks and accidents in which seafood workers of the Port of Topolobampo, Ahome, are exposed , Sinaloa.

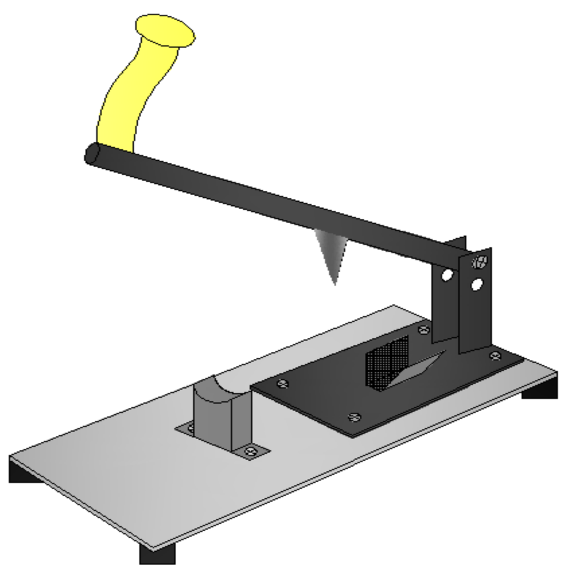

Figure 5. Enhanced pliers with coated, non-slip handles.
Source: (Own elaboration)

The exploded drawing that can be seen below in figure 6, indicates the components that make possible the operation of the press.

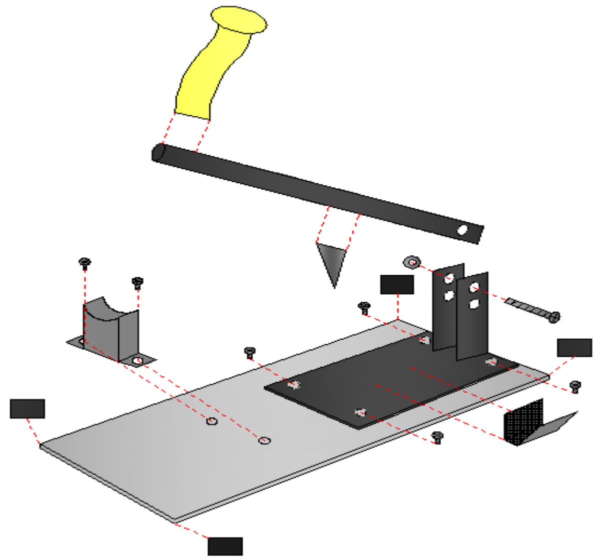

Figure 6. Drawing in press explosion to open clams.
Source: (Own elaboration)

4. CONCLUSIONS

In order to offer a better quality of life to the user through an ergonomic redesign, it is essential to know the main risks that are generated in this type of activities in order to identify the area in which solutions can be provided to seafood workers. and fishing through the innovation of the press tool opens clams with an ergonomic approach that facilitates clam preparation activities in seafood restaurants and homes.

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DESIGN OF A SCHOOL SEAT, WITH STRUCTURAL, FUNCTIONAL AND ERGONOMIC IMPROVEMENT

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Resumen: Actualmente, el mobiliario escolar que tienen las instalaciones educativas no es adecuado para la postura del alumno, ya que no tiene un diseño ergonómico. En esta investigación, el objetivo fue diseñar una silla de la escuela con mejora estructural, funcional y ergonómica, utilizando un diseño experimental DOE 23, con dos estudiantes, 1 hombre y 1 mujer como modelo. Luego de analizar los resultados obtenidos, se presentó una propuesta de mejoras y diseño de un asiento escolar.

Palabras clave: Confort, ergonomía, funcional.

Summary: Currently the school furniture that educational facilities have is not suitable for the posture of the student, because they do not have an ergonomic design. In this research, the objective was to design a school chair with structural, functional and ergonomic improvement, using an experimental design DOE 2^3, with two students 1 man and 1 woman as a model. After analyzing the results obtained, a proposal of improvements and design of a school seat was presented.

Key words: Comfort, ergonomic, functional.

Relevance to ergonomics: The design of an ergonomic and functional school seat, which is able to self-adjust and to adapt to the students' physical needs, is of great importance. In this way discomfort and injuries will be avoidable in the future, as well as increasing the quality in the educational service, offered by academic institutions.

1. INTRODUCTION

This research emerges from a problem detected within the institution; the school furniture that is currently in use is unsuitable for the students, the development of an ergonomic school seat and its functional design, aims to the basis for the acquirement of new seats, to enhance the teaching-learning process quality and the academic services.

When a user sits, then looks for a stable body position, this action ensures a greater control of the movements and increases visual capacity, which is necessary to determine tasks. Additionally muscle activity and the inner tensions are reduced, which provides a greater body comfort. (Anderson 1986).

The furniture must have adjustable dimensions that allow different adaptations and activities for the users, such as height of the seat, lumbar support and a great angle of the backrest. Oborne (1992), Mondelo (2002 and 2003).

In this present project a prototype of a school chair was designed and constructed distinguished from the rest because of its ergonomic and functional model, adding a system of self-adjusting height. Taking into account that the physiological conditions which affects the curvature of the spine is the deflection of the hip, but also the exemption from the knee, makes it to a lesser extent. (Keegan 1953, Braunschweig 1984, Eklund and Liew 1991).

In this manner the seat will allow the student to hold a correct sitting position, providing safety and comfort, as well as ease their performance within the classroom, integrating elements such as a palette for left-handed and right-handed people, including a self-adjusting height seat.

2. OBJECTIVE

Designing a school Chair, with an improved, functional and ergonomic structure, it provides a greater comfort in students considering the quality on their teaching-learning process.

- → Review and analyze based on an experimental design (DOE) 2^3 using 2 students (1 man and 1 woman) as a model, to carry out the runs at different levels and factors.
- → Compare different models of school chairs, to determine particularities of the new design and problems that may generate the current designs.
- → Designing a school Chair with feasible features for suitable comfort of the students.

3. INVESTIGATION METHODOLOGY

The development of this method was carried out with 2 students in the seventh semester of Industrial Engineering at the Instituto Tecnológico Superior de Guasave. The students were selected randomly by choosing a male and a female gender. The students participated in a 3 week period experiment, which consisted of a factorial design 2^3 currently taken from (Gutierrez Pulido, 2009).

1. Select randomly 2 students to participate in the experiment.
2. Adjusts suitable measures for each experimental run.
3. Carry out a survey to grade the level of comfort of the prototype.
4. Obtain the statistical data analysis.

4. RESULTS OBTAINED

Results: Through the first objective, based on the experimental design DOE factorial 2^3 allowed the research to study and analyze a man and a woman, with different factors and parameters.

FACTORIAL DESIGN MATRIX		
FACTORS	LEVELS	
	Low	High
Time of Exposure	2 hrs.	5 hrs.
School Chair Height	43 cm.	47 cm.
Level of Cushioning	5 cm.	7.5 cm.

WOMAN				
Run Sequence	Blocks	Exposure Time	Seat Height	Level of Cushioning
1	1	2	43	5
2	1	5	43	5
3	1	2	47	5
4	1	5	47	5
5	1	2	43	7.5
6	1	5	43	7.5
7	1	2	47	7.5
8	1	5	47	7.5

MAN				
Run Sequence	Blocks	Exposure Time	Seat Height	Level of Cushioning
1	1	2	40	5
2	1	5	40	5
3	1	2	42	5
4	1	5	42	5
5	1	2	40	7.5
6	1	5	20	7.5
7	1	2	42	7.5
8	1	5	42	7.5

Figure 1: The matrix experiment

Based on the second objective different designs of school chairs were analysed and compared from different authors, which helped to determine the features of the new design and problems that emanate the current designs. This was highly useful to determine the new design of the school chair.

Subsequently the investigations were decisive to design the school chair with feasible features for an adequate comfort of students, which was the most variable response in this experiment

5. CONCLUSIONS

It is determined in order to obtain the best quality according to Genichi Taguchi, you must have a 5 hours' time exposure, a 47 cm height and a level of 7.5 cushioning, considering these factors the school chair will have the best convenience and it will provide greater comfort in the experimentation using a woman as a model.

It is determined in order to obtain the best quality according to Genichi Taguchi, you must have a 2 hours' time exposure, a 40 cm height and a level of 7.5 cushioning, considering these factors the school chair will have the best convenience and it will provide greater comfort in the experimentation using a man as a model.

Figure 2: Design of the School chair

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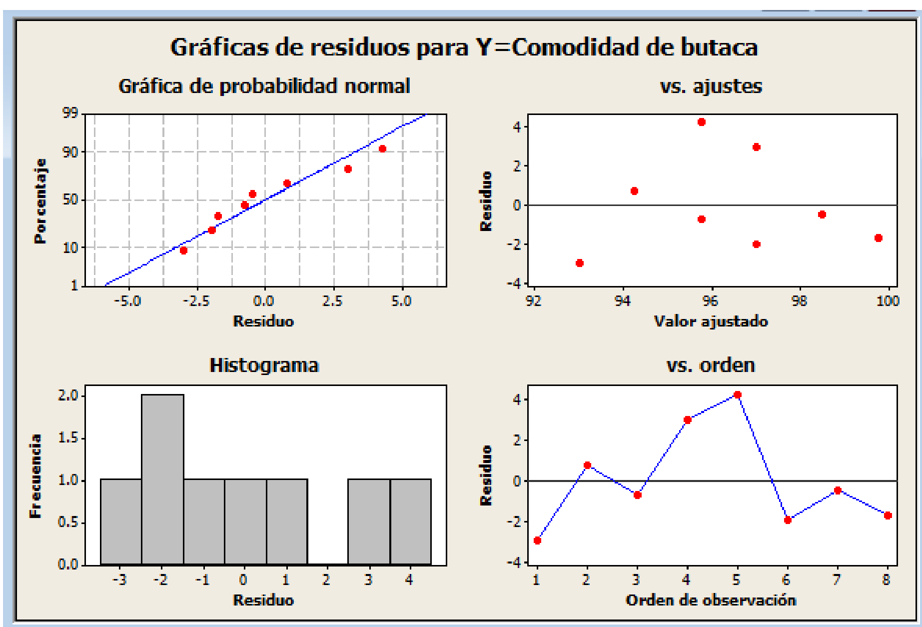

Figure 3: Residual Graphics

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ERGONOMIC DESIGN OF CUTLERY FOR PEOPLE WITH DISABILITIES

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Resumen: La ergonomía es una rama de la ciencia que abarca desde fisiología, ingeniería y estudios de psicología. Se trata de armonizar la funcionalidad de las tareas con las necesidades humanas.

El diseño ergonómico se centra en la compatibilidad de los objetos, sus entornos con los humanos que los usan. Los principios de diseño ergonómico se pueden aplicar a objetos cotidianos y espacios de trabajo. La palabra ergonómica significa: ingeniería humana.

El diseño ergonómico que se dice que es el diseño centrado en el hombre se centra en la usabilidad. Su objetivo es garantizar que se cumplan las restricciones y las capacidades humanas y el respaldo de las opciones de diseño. En un entorno ergonómico, los equipos y las tareas se alinearán.

Palabras clave:Ergonomia, usabilidad, cuchillería, discapacidad

Contribución a la ergonomía: una propuesta de un nuevo rediseño de los cubiertos a partir del mango ergonómico inclusivo; mejorar la calidad de vida de las personas que tienen esta discapacidad en el momento de la comida y el rediseño que brindamos puede mejorarse en otras investigaciones

Summary: Ergonomics is a branch of science ranging from Physiology, engineering and psychology studies. It is harmonizing the functionality of tasks with human needs to be conducted.

Ergonomic design focuses on the compatibility of the objects, their environments with humans who use them. The ergonomic design principles can be applied to everyday objects and workspaces. The word ergonomic means: human engineering.

The ergonomic design that is said to be the male-centered design focuses on usability. Its objective is to ensure that the restrictions and human capacities are met and the support of design options. In an ergonomic environment, teams and tasks will align.

Keyword: Ergonomics, usability, cutlery, disabilities

Contribution to ergonomics: A proposal of a new redesign of the flatware from the inclusive ergonomic handle; improve the quality of life of people who have this disability at the time of their food and the redesign that we provide can be improved in other investigations.

1. Introduction

This project is carried out in order to make life easier for the disabled who have deformities in his hands caused by arthritis or that have amputated les one of his fingers, and that common feeding activity is just as easy for them as for us. In other words, that they feel have no disability, and that they can do things without complications only with a small but significant redesign in the handle of the cutlery material.

Objectives: redesign the cutlery to eat more ergonomic way for people with disabilities caused by arthritis or amputation of one of his fingers, so that can improve the quality life.

2. Methodology:

Apply the principles of inclusive ergonomics and improving the quality of life of the disabled.

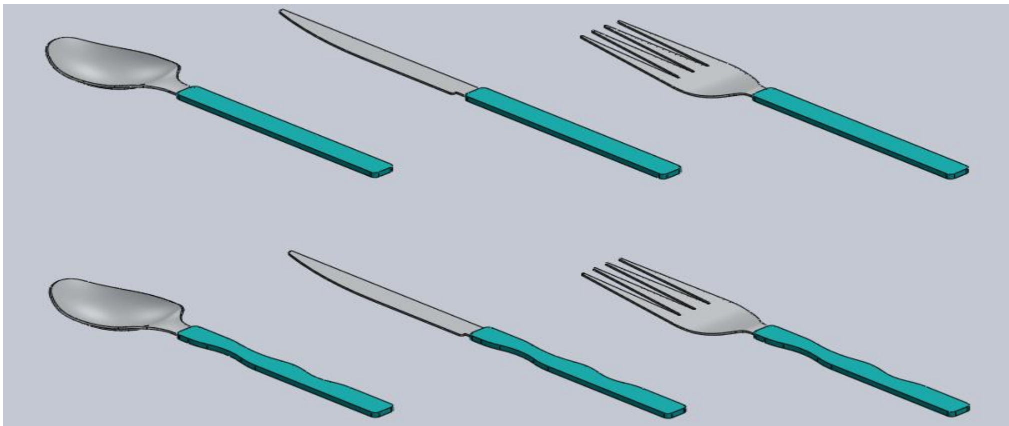
3. Results:

As we can observe, these utensiles fulfill their function but they are not suitable for people with disabilities as they do not have an inclusive desing, only for a percentage of the population.

So with my new redesing we want to be inclusive in a general way, people with disabilities and without disabilities can use it and contribute a new redesign to brings better quality of life and self esteem to ergonomics and be able to help future research to improve its fuction.

Redesign:

We have three types of utensil ergonomic (spoon, fork and knife) that mold to the fingers of people. The idea is to design it gel, so that the utensil not be heavy and be easily moldeable to the disability.



Delimitation:

This design is made for the disabled people whose hands have been deformed by arthritis or who have amputated any of their fingers. The redesign is applied to the handle of the utensils that they use to bring the food to their mouth: spoon, fork and knife. Each utensil has its weight and measure. The weight of the spoon is 65 grams and has 17 centimeters long. The weight of the knife is 60 grams and has 20 centimeters long. The weight of the fork is 55 grams and has 19 centimeters long. The redesign applied only to the handle of the utensils with a gel material, so that the handle can be grasped and molded according to the disability presented.

4. **Conclutions**:

This project aim to improve the quality of life of disabled people when they eat their food, and that once people use these three types of utensils, not be an impediment and not be difficult for them.

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THIMBLE PROPOSAL FOR NAIL SCULPTORS

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Resumen: el trabajo de las escultoras de uñas puede ocasionar lesiones cutáneas como lo son las callosidades, lo cual hace que su trabajo se torne un poco más complicado, debido a que su oficio implica mucho el trabajo de herramientas como pinceles, brochas y algunas pinzas las cuales requieren que la trabajadora este aplicando presión, que es lo que ocasiona dichas lesiones en sus manos.

Debido a eso, en el presente estudio se propone un accesorio especialmente diseñado para que a las escultoras de uñas no se les formen las lesiones anteriormente mencionadas, específicamente, se trata de un dedal, que tiene como objetivo proteger los dedos de la trabajadora, así como también, hacer que su labor sea más fácil y cómoda de realizar.

Palabras clave: dedal, escultoras de uñas, antropometría, callosidades

Abstract: the work of the nail sculptors can cause skin lesions such as calluses, which makes their work a bit more complicated, because their job involves a lot of work tools such as brushes, brushes and some tweezers which they require that the worker is applying pressure, which is what causes these injuries on her hands.

Due to this, in the present study we propose an accessory specially designed so that the nail sculptors do not have the aforementioned injuries, specifically, it is a thimble, which aims to protect the fingers of the worker, as well as well as making their work easier and more comfortable to perform.

Key words: thimble, nail sculptors, anthropometry, callosities

Relevance to ergonomics: thimble design proposal for nail sculptors that makes the work offered more comfortable.

1. INTRODUCTION

Calluses are thickened skin layers caused by repetitive pressure or friction at the point where the callus or callus occurs, this thickening of the skin is the way in which the body reacts as a measure of protection to certain pressures, although, In most cases they are not a serious condition, the comfort of the manicurists can be affected when performing their services, therefore, the design of a thimble that can fulfill the function of protecting the supporting finger used by the manicurists, in order to make your work more enjoyable and prevent the appearance of blisters and future calluses.

2. OBJECTIVES

2.1 General objective

Design a thimble for women between the ages of 18 and 60, from the city of Los Mochis, without. And nail sculptors in order to avoid apparitions of blisters and calluses.

2.2 Specific objectives

- Conduct an ergonomic study applying anthropometry to the design of the thimble.
- Improve the experience of nail sculptors by providing their services to their clients.
- Avoid that the calluses reach a state of seriousness that can result in a skin infection.

3. JUSTIFICATION

This investigation was carried out because when analyzing the work performed by a nail sculptor, it was possible to see a "callus" on the support finger used by the worker, which visibly distorted said finger and caused discomfort. took as reference the thimbles used by people who have calluses on the toes, however these thimbles are usually made of rubber or cloth, and the proposed design is a cloth thimble with a small cushion cushion to serve as support for perform these works and in this way protect the finger avoiding the appearance of more calluses or blisters.

4. DELIMITATION

The study was carried out on a group of five nail sculptors taken as samples in the city of Los Mochis, Sinaloa.

5. THEORETICAL FRAME

Calluses: Calluses, also called helomas or tilomas, are hyperkeratotic surface areas of the skin, the size of a pea or even something larger, that occur in areas that suffer small bumps or scratches repeatedly. The thickness of the callus is not uniform and its edges are ill-defined, although the skin maintains the characteristic stretch marks or "traces". It is a defensive mechanism of the skin before a mild but repeated trauma. Its location depends on where the trauma occurs, and can appear on the palms (farmers, mechanics, and athletes) or the fingers (people holding the pen strongly), on the elbows, knees, or even in the left jaw, in the case of violinists. However, most often they appear on the feet.

Calluses, calluses and nails affect to a greater or lesser extent practically all the population, although they tend to be more common, and of greater thickness and extension, in adults. The incidence of helomas is greater in the elderly, in which, in addition, the thickness of the fatty tissue of the skin is smaller, which prevents it from exercising its protective pad work. The calluses are usually produced in the hands and feet, although they can be observed in other locations; in fact, lesions of this type can appear in almost any place of the organism that is subjected to pressure or friction, especially if there is some bony prominence. It is very common that the origin of corns is professional. In this sense, there are curious locations, such as the fingers of the hand in people who manually write a lot (and squeezing intensely) with pen or pencil, the elbows of some students, the jawbone or the clavicle of some violinists, the palm of hands on rowers (athletes or sailors). However, most of the cases are related to the pressure externally supported by the feet, due to tight shoes, defects in the way of walking and long walks.

Ergonomics: Ergonomics (or study of human factors) is the scientific discipline that deals with the interactions between human beings and other elements of a system, as well as, the profession that applies theory, principles, data and methods to design in order to optimize the well-being of the human being and the overall result of the system. (International Ergonomics Association, 2000).

Anthropometry: Anthropometry is the treatise on the proportions and measurements of the human body. (Panero and Zelnik, 2000)

Thimble: From lat. digitāle, from digĭtus 'finger'.

1. m. Small utensil, slightly conical and hollow, with the surface full of whorls and sometimes closed by a spherical cap to protect the alcoser toe.
2. m. finger (‖ cover to protect the finger). (RAE)

6. METHODOLOGY

In 2015, a professional thesis called Identificación de Fatiga y de Posibles DTA’s en Escultora De Uñas De Los Mochis Sinaloa (Guadalupe S.R., Osmara C.O.,2015)was carried out, in this thesis the work carried out was analyzed. Five young Mochitans women whose ages are between 17 and 22 years old and their work schedules exceed 8 hours a day for six days per week; to determine if there was any DTA in these workers.

- The well-known "tianguis de uñas" was visited, located at Plaza Alexandra, Miguel Hidalgo and Costilla 231, Col. Centro, 81200 Ahome Los Mochis, Sin., Mexico.
- In this visit, taking as a reference the thesis "Identification of Fatigue and Possible DTA's in Sculpture of Uñas De Los Mochis Sinaloa" (2015), the work done by five manicurists was observed and subsequently analyzed, in order to obtain a Complete information about the beauty service they provided.
- Once all the steps and all the tools used were known in detail, it was concluded that the five manicurists that were observed to handle the same tools and used them in the same way.
- The thesis "Identification of Fatigue and Possible DTA's in the Nail Sculptor of Los Mochis Sinaloa" (2015) was reviewed again to obtain data of the most common complaints presented in the manicurists, since the most

common ailments are known, it was followed up and the use of a thimble was proposed.
• An anthropometric chart was suggested, which could be used to collect the required data about the measurements of the fingers of the manicurists, as well as the user profile.

7. RESULTS

A design proposal of a thimble for manicurists was obtained, with which it is intended to reduce the skin lesions (callosities) that are noticed after being exposed for a long time to certain hand tools.

Table 1. User profile

User profile			
Name of the anthropometrist:			
Name of the user: hannia gomez			
Gender : f	Occupation : estudiante		
Age: 20	Place of birth : Los Mochis, Sin.		
Place of birth of the parents: Los Mochis, Sin.			
Children	yes ☐	How many?	No ☒
Do you exercise?	Sí ☒	No ☐	
¿what type of exercise?? cardio			
How many hours do you dedicate to work? 8			
How many years have you been working on this? 3			

Source: self mad

Table 2. Anthropometric table proposal

Anthropometric table				
Anthropometry for 20-year-old Mexican adults				
User	Dimensions			
	Long middle finger	Long ring finger	Diameter middle finger	Diameter Ring finger
5%	3.14 In	2.87 In	2.00 In	1.77 In
95%				
Data obtained from the author				

Source: self mad

8. RECOMMENDATIONS

- Avoid working for long periods of time in a row.
- Perform stretching exercises consciously for hands, wrists, arms and fingers.
- Use a body moisturizer in the area affected by calluses.
- Use a thimble or in its absence a bandage, trying to leave the padded part in the affected area.

9. CONCLUSION

The use of this thimble will not eliminate the ailments that the mochitenses sculptors may present at the time of performing their services, however, if it reduces them and pretends that they are not formed in the future.

The most important task is to educate and sensitize the workers dedicated to the work of carving artificial nails so that they maintain correct habits in their work area and to use the prototype in an appropriate way, since the task can be done without this accessory, but, using it can be more pleasant to do the job.

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DEPOSIT HARNESS IN THE BLUEBERRIES COLLECTION

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Resumen: Un recolector es una persona dedicada a la colecta en este caso de la frutilla (Real Academia Española, 2001). El siguiente documento presenta la realización del diseño de un arnés para el depósito en la recolección de arándanos tomando como referencia las herramientas que ellos utilizan para llevar a cabo su labor. Se calcularon datos estadísticos con el fin de conocer las dimensiones corporales para el diseño del prototipo con el fin de evitar un posible daño físico en los trabajadores del campo mediante la mejora de su postura, así como permitir un mejor desempeño de la recolección mediante la libre manipulación de sus extremidades superiores, logrando una mayor eficiencia en su actividad.

Palabras clave: Postura, daño físico, antropometría

Abstract: Collector is a person who works collecting, in this case blueberries. (Spanish Real Academic, 2001). This paper presents the design of a deposit harness for the blueberries collection taking by reference the tools that they use to carry out their work. Statistical information was calculated in order to know the body measurements for the prototype with the purpose to prevent a possible physical damage on field workers by improving their posture, in addition to allow them a better performance in the collection by the free manipulation of the upper extremities, making a greater efficiency in their activity.

Key words: Posture, physical damage, anthropometry

RELEVANCE TO ERGONOMIC: Increase security of the employees of the blueberries collection enabling to preserve their physical health on the own tasks of the work. The aforementioned using the anthropometric measurements in the design of the device.

1. INTRODUCTION

The blueberries collection has been taking relevance in the past years because of it´s large demand, this have impact in a positive way the economy of Sinaloa state, the commercialization of this fruit is increasing the income obtained in the agricultural area through the production of these. The planting area has been strengthened by more than 500 percent and there are already 7 thousands jobs in the harvest, which positively impact the inhabitants of rural communities (Vega, 2016).

Likewise, people have been hired to perform this job as collectors, demanding a desired productivity without having adequate equipment or material to perform the job correctly, and this may cause some physical damage.

Normally the harvesting of the blueberry is done with the container loaded on the worker's arm, causing the weight of it to concentrate on one side of the person, in addition to making it difficult to manipulate both hands freely. The above can generate difficulties in the execution of their work, which can cause fatigue and injuries, as well as a decrease in the efficiency of the work, due to the obstruction of the handling of the arm that loads the container.

2. OBJETIVE

Design a harness for the loading of a basket for the harvest of blueberries, that improves productivity, reduce the fatigue and injuries that are prone to suffer the workers who perform this work, by the homogeneous distribution of weight and the release of both extremities superior for the collection.

3. METHODOLOGY

For the design of the tool that will help the field workers dedicated to harvest blueberries, the following steps were realized:

3.1 Delimitation

It is designed for both genres adults older than 18 years old.

3.2 Analysis of the work and instruments used for the harvest of blueberries.

A visual analysis was made of the activities carried out by the workers as well as the tools they use to collect, during this activity it was possible to observe how the workers looked for a way to facilitate their work, how to position themselves the deposit that they use in a way that hurts them less and allows them to perform their work more efficiently**.**

3.3 Design a tool that improves performance and safeguards the physical health of the person.

A prototype was realized, which consists of a harness that contains a base to insert the deposit that workers use for their collection, this device avoids the holding with one hand, as well as the decrease of the fatigue in the back and arms by the activity before mentioned.

3.4 Analyze the anthropometric dimensions required for the device.

According to the design, the anthropometric measures that are required for the optimal development of the prototype are shown in Table 1.

Table 1. Requiered Anthropometric Measures

MEASURES
SHOULDER WIDTH
CHEST WIDTH
WAIST CIRCUMFERENCE
HEIGHT FROM DE SEAT TO THE SHOULDER

3.5 Measure the workers

A survey was conducted of 50 workers who showed interest in cooperating with the present investigation. The measurement of each of them was taken to obtain the required base measurements, it is sought that the present model is adjustable for all workers in the field.

3.6 Perform the prototype according to the percentiles obtained from the measurements.

The prototype was created with the measurements of the workers taking the percentiles from 5 to 95, covering the majority of the population that is dedicated to the collection of blueberries, making it adjustable and easy to handle for employees. Using the kavo percentile formula (Niebel W. Benjamin, 2009).

$$\mu \pm z\sigma \quad (1)$$

Table 2: Anthropometric Percentiles

MEASURES	AVERAGE	STANDARD DEVIATION	PERCENTILES		
			5	50	95
SHOULDER WIDTH	42.6755556	4.771609008	34.8262587	42.6755556	50.5248524
CHEST WIDTH	31.5333333	9.994384787	15.0925704	31.5333333	47.9740963
WAIST CIRCUMFERENCE	78.2377778	15.57383133	52.6188252	78.2377778	103.85673
HEIGHT FROM DE SEAT TO THE SHOULDER	83	6.379592198	72.5055708	83	93.4944292

4. RESULTS

Prototype of harness that adjusts to the different physical structures of the workers in the harvesting of blueberries, more specifically to the upper part of the corporal trunk, which allows the equitable distribution of the load and grants freedom manipulation of both upper extremities.

This collector was designed for 5% and 95% percentile of the measurements. Taking into account the majority of possible people, making it more versatile for its use and performance. Trying to eliminate overstresses and bad postures.
Figure 1 shows the harness that is composed of 3 parts:

- Belt that provides support to the waist (adjustable).
- Straps that extend from the back to the chest (adjustable).
- Support for the bucket or container they need for harvesting.

Figure 1: Harness Prototype

Percentiles that were used for the design and elaboration:

- Waist support was used: 5° and 95° percentile of the measurements.
- Straps (Back) was used: 5° and 95° percentile of the measurements.
- Braces (Chest) was used: 5° and 95° percentile of the measurements.

This collector consists of a thick elastic that provides support to the back (height of the waist), accompanied by two straps that cross in the part of the high back making a better support (figure 2).

The measures that were used are:

- Waist support: 104 cm
- Adjustable: 52.096 cm - 104 cm

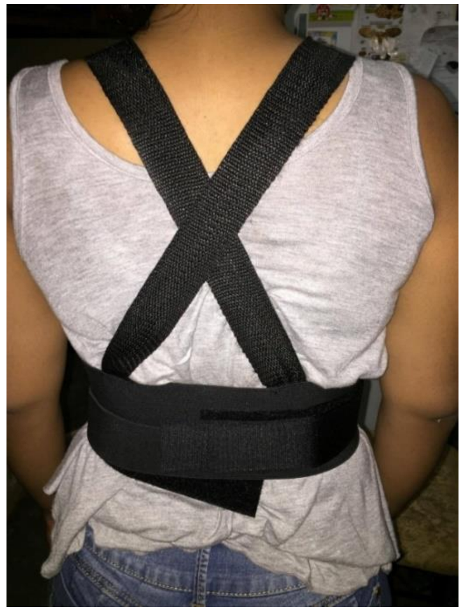

Figure 2: Back of the prototype

These same ones are connected in the part of the chest of the worker to a container where the bucket is inserted in which they collect the blueberry (figure 3).

On the front the connectors are adjustable depending on the height that the worker is most comfortable.

- Braces (Total measurement): 43 cm
- Adjustable (Chest): 0 cm - 19 cm

Figure 3: Front of the prototype

5. CONCLUSIONS

With this new tool created for workers who are dedicated to the collection of blueberries, it is intended to achieve an improvement in productivity and efficiency in the work done by staff, as well as safeguarding the health of employees in order to avoid injuries.

Through the use of this device the preservation of workers' health is sought by equally distributing the weight of the container of blueberries in the trunk of the human body, preventing physical injuries caused by an inadequate load of the container used for the harvest, together with the release of both upper extremities for the efficient harvesting of this, generating with this a greater productivity in the employees.

The present project is designed for both adults genres, being adaptable to the complexion of each one, and will be of great help in the blueberry harvests.

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CLASSROOM TELEVISION SCREEN ERGONOMIC HEIGHT PLACEMENT CONSIDERATIONS AS A MEAN TO AVOID NECK INJURIES

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Resumen: Los desórdenes musculo esqueléticos del cuello, han sido asociados a diferentes tipos de tareas ocupacionales, y la mayoría de ellos, de manera particular a los esfuerzos sostenidos no neutrales, sin embargo, existe una población con tareas no ocupacionales que potencialmente está sujeta a las mismas condiciones. Sabemos que, en las escuelas públicas, es cada vez más frecuente el uso de pantallas planas de televisión como una manera de mejorar la experiencia del aprendizaje, sin embargo, a pesar de los beneficios de esa tecnología, existe un riesgo potencial en el uso de la televisión, y en particular con la altura en la cual es instalada en las paredes del aula.
Esta investigación presenta una evaluación del los síntomas de no confort percibidos en el cuello de 329 estudiantes de una escuela pública, en donde el 30% del tiempo de clases, se emplea una pantalla de televisión montada en la pared del aula. Durante la investigación se observe que la altura a la cual es colocada la televisión, conduce a los estudiantes a realizar una esfuerzo capital sobre el cuello que podría asociarse con la sensación de no confort y posiblemente con desórdenes músculo esqueléticos en esa área. Se desarrolló un modelo biomecánico del cuello a fin de realizar un análisis mecánico para calcular los momentos de fuerza generados en la condición actual descrita, así como también se realiza otro análisis mecánico después de modificar la altura de colocación de la pantalla. Se observa una reducción del 83% en la magnitud de los momentos de fuerza generados después de modificar la altura de colocación de la pantalla.

Palabras Clave: Cuello, Ergonómico, Pantalla

Relevancia para la Ergonomía:. Este estudio provee de información en relación a los aspectos ergonómicos a ser tomados en cuenta al integrar una nueva tecnología como es la pantalla de televisión en un aula de clases. Sabemos que en el diseño del mobiliario de un aula, se han realizado consideraciones ergonómicas, como es el caso de los pupitres, que además están acordes a ciertos estándares comerciales, sin embargo, en la colocación de la pantalla no siempre se considera la altura de la misma en la pared, en función de variables ergonómicas y antropométricas.

Abstract: Neck musculoskeletal disorders have been associated with various occupational tasks, most of them related to non-neutral sustained exertions, however, there is a population with no occupational tasks, who potentially is subject to the same conditions. Increasingly, public school class is integrating flat television screens as a way to improve learning experience among students, however, despite of the benefits of that technology, there is a potential risk in the use of the television screen, and the risk is related to the height in which it is installed in the classroom wall.

This investigation presents an evaluation of the perceived discomfort symptoms in the neck of a stratified sample from a population of 329 students from a public school, where a 30% of the time they are using a television screen located in a wall, as a means to improve the academic experience. It was observed that the wall height placement of this device leads to a student's capital exertion that could be associated to neck discomfort or possible neck musculoskeletal disorders. A Neck biomechanical model was developed to perform a mechanical analysis to calculate the force moments generated in the explained condition, another analysis was made after implementing changes in television screen height placement, in order to know the magnitude of force moments in neck and define the appropriate television screen height placement. It was found a reduction of 83% in force moments generated after the screen placement height changed.
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Key Words: Neck, ergonomic, screen

Relevance to Ergonomics: This study offers information in regards to ergonomic aspects to be taken in account when a classroom is integrated with a new technology as a flat television screen.

Ergonomic considerations are taken in the selection of chairs, that normally are according to the commercial standards, however, the television screen hight placement is defined without taking in account ergonomic and anthropometric considerations.

1. INTRODUCTION

Students from public schools are a population that is growing in a fast way, so with this increase of pupils, and the new technology available, there are many changes in a classroom, one of them is the introduction of the television screen, which is a gadget that helps professor to have a more closer experience to certain activities that improve the academic experience, however, despite of the benefits of that technology, there is a potential risk in the use of the tv screen, and the risk is related to the height in which the tv is installed in walls.

It is known that occupational exposures, such as prolonged sedentary practices, awkward postures, repetitive arm and neck movements, and forceful neck exertions are risk factors associated with certain discomfort symptoms in the neck (Cote et al, 2008). There are also, some other risk factors associated to prolonged non-neutral neck posture that are prevalent not only in the work environment but also leisure time and know in the classroom due to the use of flat tv screens. According to Aaras et al (1997), There is evidence that neck and shoulder posture are possible risk factors in work-related neck and upper limb disorders, there is also, evidence that suggests that prolonged static posture with increased muscle loading increased risk of developing symptoms in the upper body.

This investigation presents an evaluation of the perceived discomfort symptoms in the neck of a stratified sample of 55 subjects from a population of 329 students from public school, where a 30% of the time they are using a flat television screen placed in a wall as a means to improve the academic experience, the placement of screen can be seen in figure No. 1, which shows the placement of the screen in the classroom, from image we can notice the screen is over the blackboard and this lead the student to have a capital exertion which causes discomfort in the neck.

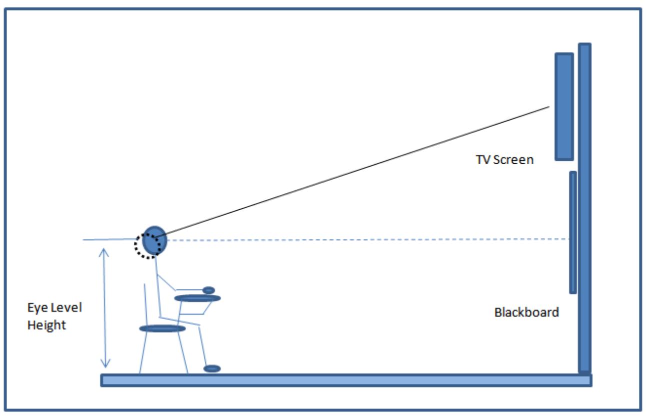

Figure No. 1 Television Screen Placement in Classroom

As we know, the neck has three main functions: to support the head, to allow it moves three dimensionally and to conduct nerve signals to and from the brain through the spinal cord and also the neck muscles provide the flexion movements. Flat television screen placement influences head posture and neck symptoms, however the effects are not well known, this study will lead us to evaluate force moments before and after making changes in height placements of the television screen in a classroom.

A study of load moments in the neck segment was performed in order to calculate strengths when students sew the screen at the usual position in wall, and another study was performed after changes in screen height placement.

There is a hypothesis that suggest that neck strength will be reduced after a height change be made.

2. OBJECTIVES

There are two objectives in this work:

To perform the analysis of mechanical strengths in neck from students from a school were a television screen is used as a part of class practice.

To propose a change in placement of the television screen to reduce the level of strength of neck in students from a superior level school.

3. METHODOLOGY

3.1 Subjects of study

A stratified sampling was used in order to determine the number of subjects in this study, the defined subgroups of the given population, correspond to the groups of period from August to December 2017 in a public school from the city of Hermosillo, Sonora, México. The total population of students is 329 and eleven strata were identified, stratified sample is 55. Twenty eight females and twenty seven male subjects were recruited for this field investigation with an age range of nineteen to twenty one years and a mean age of 19.8 years. The inclusion criteria were that the subjects had to perform a minimum of four daily continuous class sessions daily. Prior to participating, the students were asked a series of questions to gather information about their general health as well as any neck specific discomfort history not related with class activity; also they were asked for general data: name, age, gender.

3.2 Materials and Equipment

Two basic anthropometric measures were performed: corporal weight and stature, using a weight scale and anthropometer set. The measurements of rotation angles of neck segment were taken with a calibrated goniometer and a repeatability and reproducibility study was performed over the measurement system in order to verify that the system error, equipment error and inspector error were aleatory. A 2.3 m by 3 m white screen with a blue grill was placed behind the student, and used as a support measurement device when was not possible to have free access to measurement.

A Nikkon camera with a twenty pixels of resolution was used in some cases to take a photograph of a position that was difficult to verify and measure with goniometer. When the camera was used, a laser level was used to align it.

3.3 Procedure

A Corlett and Bishop’s body part discomfort subjective symptom survey was applied to evaluate the direct experience of discomfort at the different body parts in students.

A biomechanical model was developed to study the force moments generated with respect to the static body sustentation point, located in the low back, the model was developed for the sagittal profile of the upper body. Static loads were calculated over every individual from the sample.

It was made a change of screen height placement besides the blackboard in classroom wall. After changes were done, a new mechanical analysis was done in order to calculate the force moments generated.

4. RESULTS

4.1 Corlett and Bishop's Body Part Discomfort Scale

According to Corlett and Bishop's body part discomfort subjective symptom survey, applied to evaluate the direct experience of discomfort at the different body parts, in students from a public school, it was found that 67% of the students report discomfort and pain in the shoulders and neck, these results lead to think that the height at which the television screen has been placed, is one of the factors that leads to report discomfort at the neck segment.

4.2 Biomechanical Model and Analysis

The biomechanical model comprenhend the upper body segments, which are considered due that there are a high variability in stature and weights between students and because of that, there are several variables that have influence in the perceived symptoms. There was used a point located in the low back which is the static body sustentation, and from this point, all force moments were calculated. The biomechanical model comprehends five variables: body segment weight, body segment mass center, body segment length, location of body rotation centers, which are the joint points between two adjacent body segments, and rotation angles of body segments measured counterclockwise from horizontal to vertical at the sagittal plane of the body.

The body segments comprised in the model are the head, neck, back, forearm and arm. They were assigned the following letters and numbers for the model variables: CR for the rotation center, CM for the center of mass, mg for the mass of body segment and L for length of body segments, which are shown in figure No. 2:

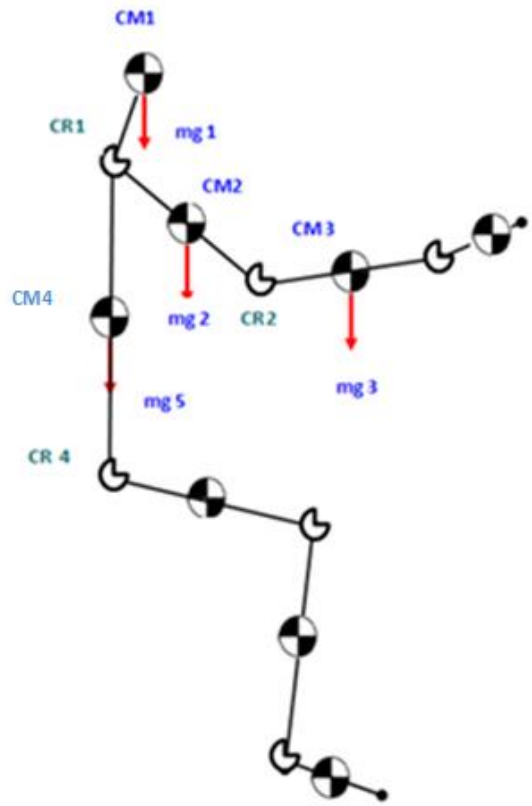

Figure No. 2. Biomechanical Model for Student

4.3 Calculation of Force Moments Before and After recommendations

In order to calculate moments of force in regards to the rotation center (CR4) located at the lowest point on back, they were estimated the following variables: mass center, body segment mass and body segment length of the measured stature and weight, and also the rotation angles of body segments for every student in stratified sample, were measured.

The force moments were calculated under the conditions observed in classroom for every student, using an excel spreadsheet designed by the author. The height of placement of the screen was reduced locating it besides the blackboard. Force moments were calculated after this change, and the new force moments in average were reduced by 83%, which means that the screen needs to be placed at the same height of blackboard, in Figure No. 4 are shown the force moments values before and after the change in height placement.

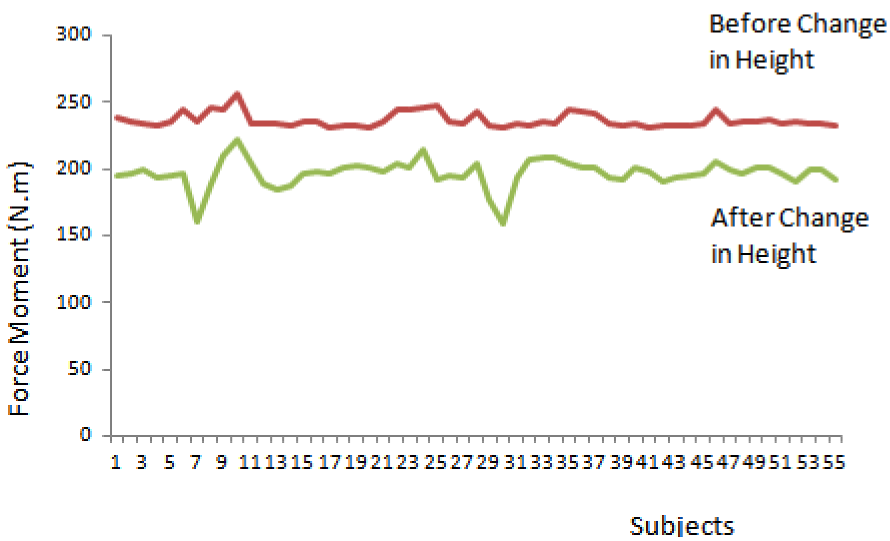

Figure No. 4 Force Moments Before and After Change is Height

7. CONCLUSIONS

It was found that there are several ergonomic considerations that must be taken into account in a classroom design, one of them is the related to the placement of the television screen, which is normally located in a way that demands from viewers a capital extension that could be the cause of musculoskeletal discomfort of the neck and shoulders.

The changes proposed in the location of the television screen, must be related to a specific and precise calculus of moments, and study reveals there is a strong relation between the risk of musculoskeletal disorders and the high values of load moments in the neck segment. After making a change in height placement and perform a new evaluation of force moments, it was found a reduction of 83% of generated force moments

We can say that this investigation has some limitations in regards to the found results, one of them is related to the time of observation, that was from ten to twenty minutes, due that measurements were done during the class session; another situation to take in account is that in a realistic class situation, the students changes continuously the posture and movement patterns in the neck and shoulder region and probably the cumulative effects can be see after the complete class routine time for six continuous hours, this situation could be related to the development of musculoskeletal discomfort. This study has been made based on measurements of static resting posture and therefore cannot be generalized to postures held during the total periods of class sessions.

This study aimed to better understand that force moment is changing continuously because of the changes in body posture during the all class sessions and the static approximation at the sagittal plane has a limited chance of evaluating the whole situation.

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VISUAL AUDIO BOARD FOR PARKING AREAS INTENDED FOR DISABLED PEOPLE

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Resumen: Las personas con capacidades diferentes son aquellas que tienen una o más deficiencias físicas, mentales, intelectuales o sensoriales y que, al interactuar con diferentes factores del entorno social, no pueden lograr su participación plena y efectiva en condiciones de igualdad con otros individuos. Este documento contiene una propuesta para facilitar la gestión del estacionamiento que corresponde a estas personas, con la ayuda de un tablero auditivo visual.

Palabras clave: tablero auditivo visual, estacionamiento, personas con capacidades diferentes.

Summary: Disabled people are those who have one or more physical, mental, intellectual or sensory deficiencies and who, when interacting with different factors of the social environment, cannot achieve their full and effective participation in equal conditions with other individuals. This document contains a proposal to facilitate the management of the parking place that corresponds to these people, with the help of a visual audio board.

Keywords: visual audio board, parking, disabled people.

Contribution to Ergonomics: The study of boards and controls that improve the quality of life is a very important part of the field of Ergonomics.

In many activities of daily life there are possibilities for improvement because people do not perform activities properly and other times because things were not created in the best way.

The board and control mechanisms are useful in the improvement of some tasks and, in this particular case, it seeks to improve the parking process of places, shops and supermarkets. For its part, the boards are the only means by which the machine can communicate information to the operator about its internal state through one of the five sensory human senses.

1. INTRODUCTION

Today, the focus on disability is considered a human rights-related issue. People are disabled by society, not just by their bodies. These obstacles can be overcome if governments, non-governmental organizations, professionals, people with disabilities and their families work collaboratively.

One of the main purposes of Ergonomics is to seek safety, efficiency and comfort by connecting the demands of the "machine" to the operator's capabilities.

If the operator adapts to the requirements of his/her machine, a relationship between them will be established, in such a way that this machine will give information to the operator through the sensory apparatus.

In this way, the information will pass from the machine to the worker and vice versa, in a closed human-machine circuit.

In the case of closed circuit (continuous) systems, the feedback about the process conditions consists in the transmission of information to the sensor in order to be used in the necessary corrections during control activities of the system.

The best board is chosen by means of the criteria of speed, precision and sensitivity to continue the flow of important information. Because communication is a factor that requires the receiver to interpret the originating message in the transmitter in a correct way, it is necessary to take into account the amount of work of both the operator and the machine. Therefore, it is important to explain the needs of both operator and the assigned task, because in some cases one of the criteria may be more important than the other two.

1.1 General objective

To provide adequate tools for the human operator in order to perceive the information in a better way, and also this represents an adequate way to respect the parking areas of the disabled people and, in turn, to make good use of it, helping those people who due to health problems cannot travel long distances between parking zones and destination.

1.2 Specific objectives

To provide a visual, audio and sensor-inclusive tool.
To make proper use of parking with the help of distinctive sensors.
To Increase the quality of life of people.

1.3 Delimitation

Vehicle parking areas.

2. METHODOLOGY

The main problem was determined to be that within the parking lots areas, the place that is considered for the disabled people is occupied by individuals who are not in this condition, therefore not leaving parking areas for those people who really need it. An efficient solution has not been reached since it is not enough to see the sign, it is also necessary to ensure that its instructions are followed.

In order to improve this situation, a research was conducted about visual and audio boards that could be useful to this problem, in which it was concluded the importance of creating a detecting device that comes included in the parking area sign destined to disabled people, so that when the vehicle reaches the specific area (the vehicle has a chip or bar code) a scanning occurs, causing the vehicle that does not have any identification mechanism, the detector begins to make a warning noise and turn a red light on, the person in charge of the parking lot is aware of this action and orders to remove the vehicle from the place that does not correspond to.

With this design it is possible to take care of disabled people's parking areas in a much better way, since they are often not respected and therefore, they are forced to park at a distance not favorable for reaching the desired place with less time and effort.

2.1 Determination of the sample

According to the National Institute of Statistics and Geography (INEGI), by 2010 people who have some type of disability in Mexico are 5, 739, 207 individuals, which represents 5.1 % of the total population. The state of Sinaloa includes the 2.7 %, this percentage is equivalent to around 154,900 people.

The study is focused in parking areas for people with disabilities in the city of Los Mochis, Sinaloa. However, it can be replicated all over the country, therefore the sample previously mentioned.

3. RESULTS

After analyzing the parking areas of Los Mochis, Sinaloa, it was possible to observe the misuse of the areas destined for people with disabilities, which is an alarming situation.

According to the study carried out, it was proposed the installment of a sensor on the sign, this sensor turns red and makes an alert sound when a not authorized vehicle has parked there, that is, it does not have its identification required, and alerts the guards and / or owners of the parking lot for assistance and ask the drivers to take another parking lot suitable for their needs, or that this sound and light warn the driver himself that he should not park on that site.

How to identify the fact that a person suffers from a disability? Well, new stickers are required to be created that are granted to people with disabilities, but now including a chip that the sensor previously mentioned is able to detect and therefore it deactivates the alarm, allowing to use their parking area with no restrictions.

On the other hand, it could also work with cards including bar codes and some other types of code that represent different options for identification.

4. CONCLUSIONS

Over the years, people have sought an improvement in many aspects of life, which is why the concept of Ergonomics emerged. The study of board and control systems that improve the quality of life is a very important part within this field.

In many daily life situations there is a wide range of possibilities for improvement because either people do not perform activities in an adequate way or some tools and machines were not created in the best way.

The board and control systems is useful in the improvement of some tasks and, in this case, the improvement corresponds to the parking process of different places, shops and supermarkets.

For its part, boards are the only mean by which the machine can communicate information to the operator about its internal state through one of the five sensory human systems.

Ergonomics rely on the primary importance on people and information regarding their safety. It is mandatory to identify the factors and situations of risk to which users are exposed in different situations in order to develop preventive measures and means of improvement regarding life quality and safety issues.

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PROTOTYPE OF PRECISION ERGONOMIC FORCEPS

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Resumen: No pocas veces ha ocurrido que personal médico se ve afectado por el uso de herramientas de mano pobremente diseñadas, sin los requerimientos ergonómicos necesarios para evitar daños en los usuarios; y tomando en cuenta las largas jornadas de trabajo con tales instrumentos, y la repetitividad de movimientos de las tareas en el área médica, no es extraño que se desarrollen enfermedades tales como síndrome del túnel carpiano y cubital, epicondilitis lateral o en general cualquier trastorno en extremidades superiores. Y no solamente la salud del usuario se ve afectada por estas herramientas manuales, sino por consecuencia directa, también los pacientes que se someten a cirugía bajo la utilización de malas herramientas que fatigan al cirujano y se ve propenso a cometer errores.

En éste caso se estudiarán las pinzas convencionales de precisión (spring forceps ó dissection forceps), púes se ha comprobado que el diseño actual de éste instrumental carece de criterios ergonómicos necesarios para el buen desempeño del cirujano. El prototipo creado busca principalmente facilitar la labor del usuario evitando fatiga y cansancio a corto plazo, y previniendo enfermedades más graves a largo plazo, siempre manteniendo un buen desempeño durante su utilización, brindando el nivel de precisión deseado durante su uso.

Palabras clave: Diseño ergonómico, herramienta de mano, antropometría.

Abstract : More than a few times, the medical workforce seems to be affected by the use of poorly designed hand tools, without the ergonomic requirements that are needed to prevent injuries on the user; and plus the long and tiring hours of workdays whit this instruments and the repeatability of the movements in the medical area, is not uncommon that diseases develops such as carpal tunnel syndrome and cubital tunnel syndrome, lateral epicondylitis or in general any disorder in the upper extremities. And not only the health of the user it's affected by this hand tools, but as a direct consequence, patients who undergo surgery whit the utilization of wrongly design tools that cause fatigue on the surgeon and gets prone to make mistakes.

In this case conventional precision forceps will be studied ("spring forceps" or "dissection forceps"), due to the fact that it's been proved the actual design of this instrumental lacks of ergonomic criteria for a well performance of the surgeon. The prototype mainly looks for facilitate the labor of the user preventing fatigue and tiredness as a short term, and preventing more serious diseases as a long term,

always providing a well performance , and the level of precision looked for while its use.

Key words: Ergonomic design, hand tool, anthropometry.

Relevance to Ergonomics: Prototype of a hand tool that counts with the needed requests to realize its work and add to it doesn't cause negative consequences on the user's health, just like fatigue or tiredness.

1. INTRODUCTION

The human being, from the beginning of times, has been developing technics and tools that help him to perform tasks that, otherwise, wouldn´t be able to do. Nevertheless, and even when the hand it's a perfect engineering machine, there are some works that for its nature are impossible to realize without the help of a tool specifically designed for the job, as is the case of precision tweezers. Although those have been very useful for the propose which they were designed for (based on previous research) the fact that can cause negative consequences on the user (like Carpal Tunnel Syndrome and Cubital Tunnel Syndrome) as while performing, has been studied. In the present project, a hand tool prototype which gives precision and the same quality level as the conventional tool, providing a design that avoids negative effects of itself, it's presented.

2. OBJECTIVES

Present a tweezers design's prototype, based on previous research about the actual state of instrumental, which avoids injuries on the user and that provides a better performance during its use.

Specific objectives:

- Identify the main inconveniences that the actual model causes on the user's health, in order that the resulting redesign avoids them.
- Research the tool's functions to improve the design.
- This document aims to be a tool that increases the incorporation of Ergonomics on the surgical instrument's design.

3. DELIMITATION

The potential users contemplated on the hand tool prototype can be mainly surgeons, biologists, chemists, forensic doctors; in general, any profession that needs the use of precision tweezers, which have a big application range, from helping at conducting clinical analysis studies, to be on microsurgery procedures (due to the nature of the material which it is proposed to be made), and wants to avoid injuries to health thanks to the ergonomic design that it offers.

4. METHODOLGY

The next investigation exposes the risks and injuries to which users are subjected to excessive use of poorly designed precision tweezers, or with a none practical design, during an excessive period of time, like it is required on medical areas, and at the time a redesign of the tweezers is created, based on and the use of anthropometry. The article "ANÁLISIS ERGONÓMICO DEL DISEÑO ACTUAL DEL INSTRUMENTAL EMPLEADO EN CIRUGÍA LAPAROSCÓPICA Y PROPUESTAS DEL REDISEÑO PARA UN DISEÑO OPTIMIZADO", by A. Gonzales; D. Rodríguez; L. García (2009) was studied and taken as a reference for this investigation, as well as "Guidelines for hand tool design", (Smith, Calum), for the purpouse of a better understanding of the subject, the most relevants for the research, are included to follow.

Tool weight: Tools that are too heavy will make you tired very quickly and will be difficult to control. There is no single weight limit that can be recommended for hand tools. An acceptable weight for a sledgehammer would be completely unsuitable for a pair of pliers! It should usually be possible to carry a tool in one hand without strain.

Material: The material of the handle should be a poor conductor of heat and electricity, and should be non-porous so that it will not soak up and retain oil or other liquids. Materials should be strong enough not to chip or crack and injure your hand.

Triggers: Your thumb is the most suitable digit for strong, repeated activation of push buttons or triggers located on the handle or main body of a hand tool. This is because your thumb is operated by strong short muscles located within your palm and does not tire quickly. Your index finger has an additional muscle that is best suited for actions involving extension of your finger - repetitive pointing. It is not so good for repetitive bending because the muscle that makes it bend works against the muscle that makes it extend. This means that the thumb is best suited for triggers despite the common practice of using the index finger. However, the weight and shape of the tool must allow your thumb to be moved to operate a trigger without the tool slipping from your grasp.

Gloves: If you wear gloves, your hand effectively becomes bigger, so the handle size should be correspondingly bigger, by about 10mm.

Workstations: Poor working postures are still possible even when using well-designed hand tools because the workstation affects the way that they are used. If a job requires precise and intricate work but the workstation is too low, for example, you might have to bend forward and work in an uncomfortable posture.
There are two main issues in body posture - what your eyes need to see and what your hand needs to grip. If the job involves applying force, the work piece should be just below elbow height. If it is more precise, the work piece may need to be nearer to your eyes. If possible, it is a good idea to secure the work piece on the workstation, so that one hand is not used just to support the object. This reduces the overall effort.

Van Veelen (Goosens and Van Veelen, 2006) proupose three points for this study, which are:

• Solve the physical ergonomy of the equipment.
• Improve the information during surgery.
• Focus on the realization of procedures based on human factors.

As well as Goosens proupose the ergonomic design aspects related to human functions:

• Physical ergonomycs
• Sensory ergonomics
• Cognitive ergonomics

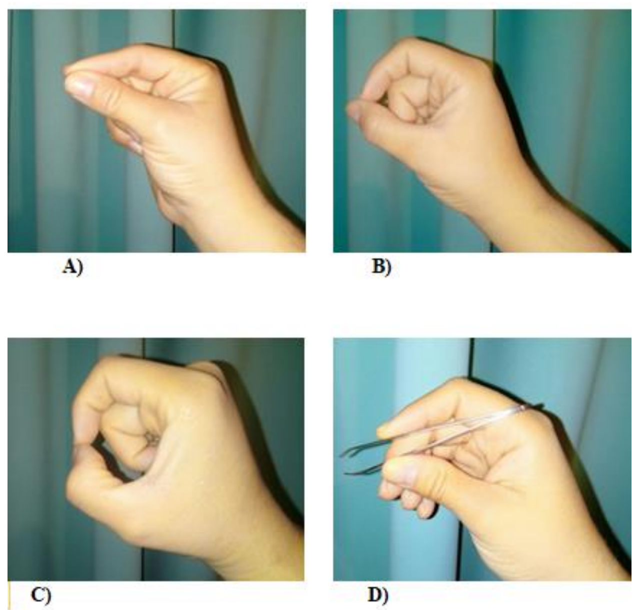


Fig. 1.0*Tipes of precision grip.*

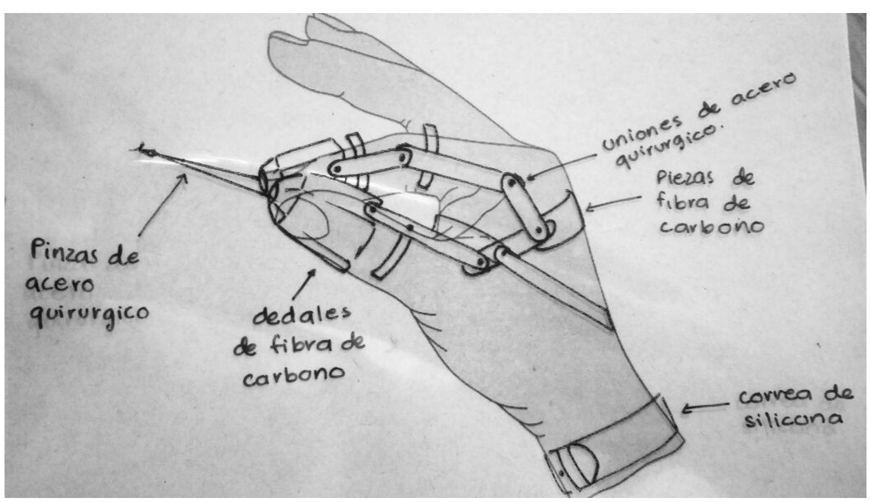
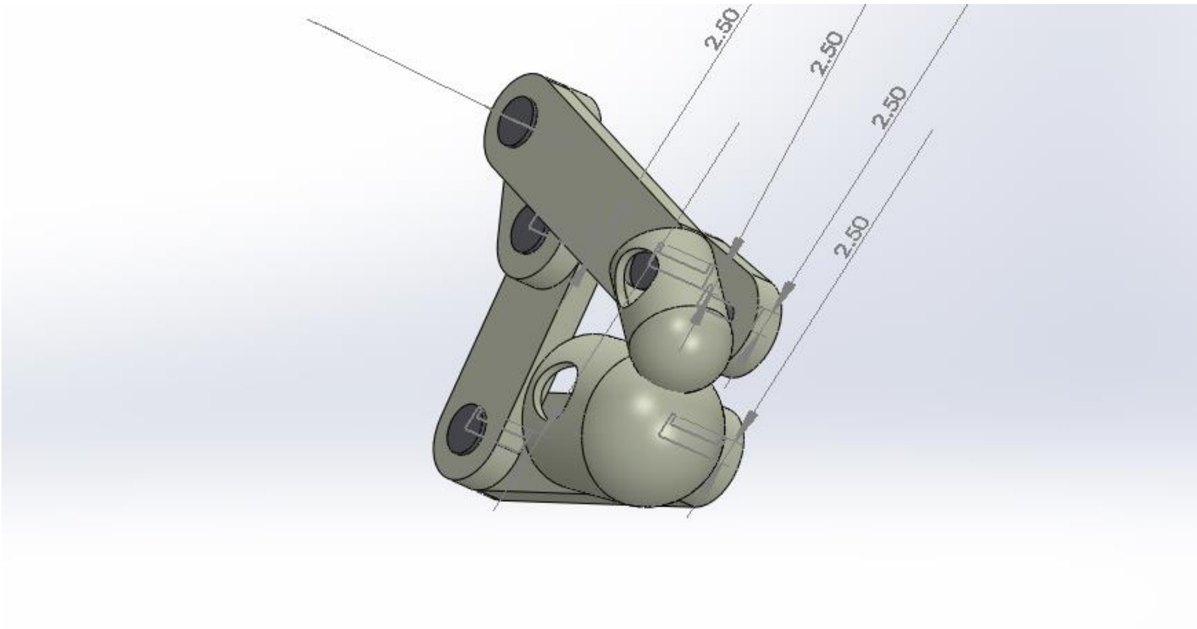


Fig. 2.0 Sketch guide for the design of the prototype of precision forceps. Shirley Navarro.



3.0 *Model 3D of the main mechanism of the prototype, using a CAD (Solidworks)*.Shirley Navarro.

A sketch of the precision forceps it's presented, which it's based on the natural precision grip of the hand, this is used even by monkeys to take away parasites from each other.

- For the exoskeleton anthropometry must be applied due to the fact that the adjustment changes depending of the user.
- In order to avoid unwanted displacement, the plates are subjects to each finger phalanx
- The adjustable belt runs down to the forearm for avoiding Carpal Tunnel Syndrome, and it is united
- The prototype has unchangeable points and this way it can be better used the mechanism without avoiding the natural movement of the hand.

The anthropometry must be applied at 100 because of the nature of the job, every measurement depends on the user's dimensions of the hand.

4.0 *Proposed prototype.* Shirley Navarro

6. DISCUSSION/CONCLUSIONS

By carefully studying the majority of the variables involved in the design of surgical instruments we realize that this directly affects the performance of the instrument, and due to the absence of ergonomic criteria in the current instruments it is necessary to establish a cause-effect relationship for correct the physical and mental problems that cause to professionals during and after their employment, which ultimately are those who suffer from the deficiencies in the design of these instruments, as well as reduce the risk to which patients are subjected. Perhaps the problem lies in the lack of ergonomic studies that generate design guidelines to take into account in the development of such instruments; something that is of great importance in the design of a tool that must be in addition to precise, comfortable enough so that, without generating injuries, it can be used for long periods of time.

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PROPOSAL FOR ERGONOMICS SUBJECT. INDUSTRIAL DESIGN PROGRAM. FES Aragón. UNAM

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Resumen: Este artículo presenta la propuesta para definir los contenidos de Ergonomía que deben incluirse en el Plan de Estudios de Diseño Industrial con el objetivo de formar diseñadores que propongan soluciones innovadoras, basadas en conocimientos especializados sobre la materia, que consideren al usuario en el centro del proceso de diseño y que puedan aplicarse a diferentes campos de la práctica profesional: diseño de muebles, la museografía, diseño de interiores, diseño automotriz, por ejemplo.

Así mismo es importante formar investigadores en Ergonomía desde la licenciatura, con el objetivo de obtener datos de la población mexicana que puedan aplicarse a la práctica profesional y ayudar a los estudiantes y profesores a prever las circunstancias en donde los usuarios puedan desempeñar sus actividades con productos nuevos en un contexto totalmente diferente.

Palabras clave: Diseño industrial, Ergonomía, Investigación, Enseñanza

Abstract: This article presents the proposition to define a balanced portfolio of specialized issues related to Ergonomics that should be included in Industrial Design Program with the purpose of creating innovative design proposals, considering user in the center of design process and developing skills and knowledge in students, in different areas as furniture, automotive, interior and museum design as a part of design practice.

It is also important to encourage undergraduates in ergonomic research with the aim of gathering data of Mexican population that is so necessary for design practitioners; on the other hand research may help students and teachers understand the world where users might find new products that would change their lives.

Keywords: Industrial Design, Ergonomics, Research, Teaching.

Relevance to Ergonomics: This proposition is relevant to Ergonomics because it will be analyzed and assessed by academic experts who will recognize the importance of these topics and the advantages of including them in Industrial Design courses. In addition, students and designers will be able to develop skills and knowledge in order to support creative and innovative products and services applying Ergonomics in their practice. Encouraging design educators and students to get involved in ergonomic research would enhance useful and necessary contributions of Mexican database for academic and professional requirements.

The annual edition of this Book provides an important contribution to the literature on ergonomic research, accessible on the SEMAC website, that stimulates different specialists and academics to publish their findings.

1. INTRODUCTION

Ergonomics is a scientific discipline that contributes to industrial designer's practice with knowledge and expertise that helps creating innovative design projects. Ergonomics applied to industrial design practice links different areas to help develop products and systems that optimize function, value and appearance for the benefit of user.

Designers ought to be creative and innovative. What knowledge and skills of Ergonomics do industrial designers need in their training to achieve this profile?

Industrial Design Academic program must include a balanced portfolio of subjects to prepare professionals with applied knowledge, skills and attitudes during nine or ten semesters. The theoretical pedagogical support that encourages meaningful learning must be emphasized in such a way that the contents are linked with designers' practice; that is, students should be able to understand and relate relevant ergonomic concepts with their design projects.

Figures 1 and 2 express in few words what expectancies designers must fulfill, first as successful students and afterwards as recognized practitioners. Therefore, trying to achieve these ambitious goals, universities must be able to prepare designers the future will require.

Subsequently, Ergonomics is a scientific discipline that might benefit teaching, learning and research experience, because its importance is "concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance". (IEA, http://www.iea.cc/whats/).

Design distinguishes itself from other disciplines in that it combines a number of activities, such as visualizing, creative thinking, empathizing with the intended users and reasoning from values via functions to forms. In essence, designing is an activity that has intended to lead to new possibilities and an embodiment of those possibilities. Designing requires you to cope with uncertainty and to play with possibilities, leading to new insights that can result in innovations. (Boeijen, A., Daalhuizen, J. Zijlstra, J. y Shoor, R. (2016).

Figure 1. Design discipline

Nowadays designers must fulfill a “systematic and structured activity, purposeful and goal-oriented. Due to its complexity, designing requires a structured and systematic approach, as well as moments of heightened creativity”. (Delft Design Guide, 2016).

Figure 2. Design Approach

2. OBJECTIVE

Suggest contents and location of the learning units of the Ergonomics Area in the curriculum, as well as the planning of the Ergonomics Laboratory that complements the learning units and design workshops to evaluate and verify design proposals, in order to be considered in Industrial Design Program.

3. DELIMITATION

This is an academic research within the process of reviewing Industrial Design Program of FES Aragon. UNAM Legislation and Development Plan 2017-2020 regulate procedures and timing.

4. METHODOLOGY

- Analyze information on how many students apply each year, academic achievements, and subjects with high failure rate, terminal and degree efficiency.
- Analyze information about Professional Practice and Social Service.
- Define income, intermediate and exit profiles.
- Analyze and propose pre-specialization courses in bachelor degree of industrial designer.
- Develop the contents for each learning unit and module.

The five themes mentioned above describe the rules that should be followed to prepare a new curriculum in Universidad Nacional Autónoma de México - UNAM.

Besides these topics, design and ergonomic methods must be included for the purpose of preparing students with the field of knowledge of both disciplines, helping understand different roles of methods to be able to choose the appropriate.

Teach undergraduates to plan and write the results of a study, prepare an article or a dissertation.

The present Theoretical Model is included in this paper.

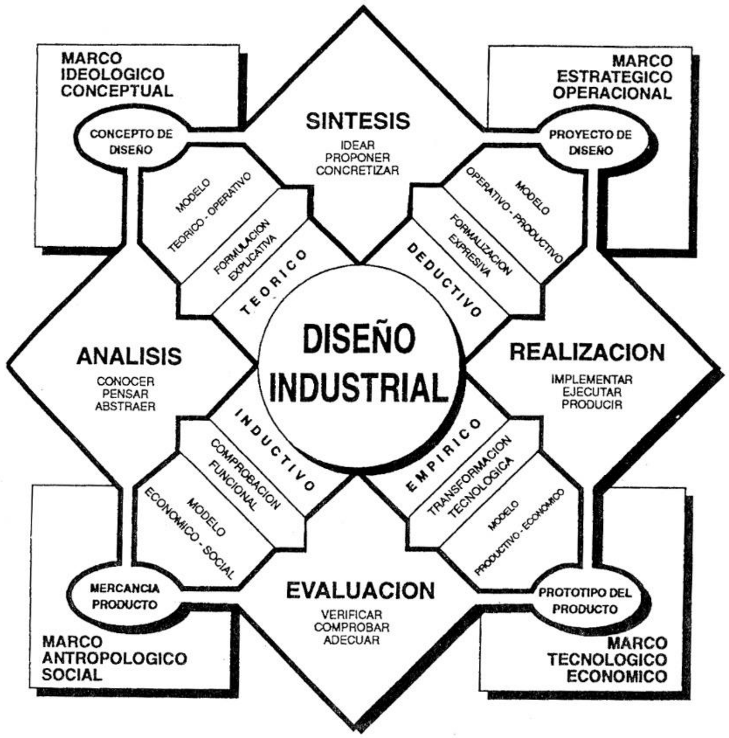

Figure 3.
Industrial Design Theoretical Model. FES Aragón, UNAM, 2002.

On the other hand, some subjects are suggested:

Table 1. Methods and design methods.

Research Design: Qualitative and Quantitative approaches	Interviews Questionnaires Focus groups
Reasoning in Design	Design Thinking Design drawing by hand Basic design cycle Design Methods

Table 2. Design methods.

Problem investigation and solving methods	User Centered Design Cradle to cradle design Trend analysis Mind and Perceptual maps List of requirements Product concept evaluation Cost price estimation Technical documentation Storyboard Eco design

Table 3. Ergonomic Methods and Techniques

Ergonomic Models, Methods and Techniques	• User observations • Anthropometry for designers • Understanding Statistics • Product usability evaluation • Personas • NIOSH National Institute for Occupational Safety and Health • RULA Rapid Upper Limb Assessment

5. RESULTS

The Study Plan suggested is divided into three modules: Basic, Disciplinary and Pre- specialization.

The Basic Module is intended to prepare students to be able to understand Design basics. For example: Geometry, Design History, Mathematics and Physics. It is important to mention that “Design workshops” are the core of the curriculum, from the beginning in first semester up to ninth or tenth semester. In this collaborative learning academic group of subjects, Ergonomics would develop in students a combination of skills and experiences to explore innovative and creative solutions to a project.

The Disciplinary Module, in fourth semester *Introduction to Ergonomics* can offer the essentials of anatomy, physiology, anthropometrics, biomechanics and perceptive basics, for example, to be able to know the user from physical and cognitive viewpoints. All these knowledge could be applied in the students' projects.

After studying six semesters the University can offer the students a Technical Diploma to enable the students to work at design studios or wherever it is possible.

The most important and attractive module is known as Pre-Specialization in these three semesters students can find what interests them. The curriculum allows them to choose the subjects according to what is relevant to the project brief they are working on:

- Automobile design
- Designing for special populations
- Eco Design
- Exhibition Design
- Fashion Design
- Furniture design
- Interactive design
- Interior Design
- Jewelry Design
- Product design
- Workstations design

In all these options, Ergonomics theory must be completed with exercises, models and different techniques to permit the students and teachers explore different solutions to the problems.

An Ergonomics Laboratory with different apparatus must satisfy the theoretical requirements completing the models and prototypes made to assess the design solutions.

Ergonomic research must be developed to discuss contemporary issues and generate the basics to innovative design solutions, with the user-human as the center of the new objects.

6. CONCLUSIONS

The possibility of covering more subjects related to Ergonomics will surely favor the complete training of industrial designers and will benefit the students, since it will allow them to develop knowledge and skills they require according to their interests and needs.

A flexible structure is proposed to achieve the purposes described reinforced with the Ergonomics Laboratory and unquestionably with Ergonomics Research.

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ERGONOMIC EVALUATION OF JOBS FOR WOMEN IN A GESTATION PERIOD

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Resumen: Aquellas tareas que puedan requerir esfuerzo físico, posturas forzadas o movimientos repetitivos y que tengan como consecuencia fatiga, accidentes y enfermedades de trabajo, esto causado por el diseño del puesto de trabajo, equipo, instalaciones, maquinaria o herramientas, se conoce como factores de riesgo ergonómico. El objetivo del estudio es identificar y evaluar los factores de riesgo ergonómicos relacionados con el trabajo repetitivo y postura forzada o prolongada que se encuentren asociados con la aparición de trastornos musculo-esqueléticos en las trabajadoras embarazadas. Para esta identificación y evaluación se llevó acabo la recolección de datos por medio de cuestionarios y finalmente la evaluación fue realizada por medio del software ErgoMater que es una herramienta que permite evaluar y detectar factores de riesgo ergonómico para la trabajadora embarazada o para el futuro hijo, que combina conocimientos que provienen de la biomecánica y la ergonomía. Este estudio fue enfocado específicamente a una empresa de Tijuana de giro metal-mecánica a su población total de trabajadoras embarazadas, dicha población fue de cinco trabajadoras embarazadas. Los resultados obtenidos mostraron una asociación positiva entre factores de riesgo ergonómicos y la aparición de trastornos musculo esqueléticos. El trastorno con mayor prevalencia presentado por las trabajadoras embarazadas fue dolor de espalda baja, teniendo en común posturas forzadas o prolongadas por al menos 40 horas por jornada semanal.

Palabras clave: Trabajo y embarazo, Trastornos musculo-esqueléticos, Factor de riesgo, Ergonomía.

Summary: Those tasks that may require physical effort, forced postures or repetitive movements and that have as a consequence fatigue, accidents and work illnesses, this caused by the design of the job, equipment, facilities, machinery or tools, are known as factors of ergonomic risk. The aim of the study is to identify and evaluate the ergonomic risk factors related to repetitive work and forced or prolonged posture that are associated with the appearance of musculoskeletal disorders in pregnant workers. For this identification and evaluation the data collection was carried out by means of questionnaires and finally the evaluation was carried out through the ErgoMater software, which is a tool that allows to evaluate and detect ergonomic risk factors for the pregnant worker or for the future child, that combines knowledge that comes from biomechanics and ergonomics. This study was specifically focused on a Tijuana company with a metal-mechanic turnaround to its total population of pregnant workers, this population was five pregnant workers. The results obtained showed a positive association between ergonomic risk factors and the appearance of musculoskeletal disorders. The most prevalent disorder presented by the pregnant workers was low back pain, having in common forced or prolonged postures for at least 40 hours per week.

Key words: Work and pregnancy, Musculoskeletal disorders, Risk factor, Ergonomics.

Relevance for ergonomics: The aim is to provide useful information on the ergonomic risk factors identified, as well as the effects they have on the health of pregnant workers who, if not treated in some cases, could have fatal consequences. It could also be a guideline to deal with this problem more thoroughly as it seeks to be a contribution to other research work. It is important to publish it since a review on the subject warns that in Mexico there is very little research that addresses this type of problem. This study is the first of its kind in the state of Baja California.

1. INTRODUCTION

The ergonomic risk factors to which women may probably be exposed in pregnancy could cause a series of consequences on the health of women workers, due to changes in body dimensions such as the increase in mass and volume influence their function [1] and are exposed to a large number of hazards in the workplace that pose risks to the health and safety of pregnant workers [2]. But what ergonomic risk factors are exposed? What musculoskeletal disorders do they exhibit by being exposed to ergonomic risk factors? What is the prevalence of musculoskeletal disorders exposed to these risk factors? What are the effects of these musculoskeletal disorders on your health? Which tasks represent a possible risk for them? and What preventive measures should be implemented in the company?

The participation of women in the labor force has been increasing in recent years as can be seen in statistics from the National Institute of Statistics and Geography (INEGI), the increase from the year 2014 to 2017 was 1,154,877 women [3]. According to statistics from the Mexican Institute of Social Security (IMSS) of 2011 in Mexico, musculoskeletal pathology is one of the main causes of morbidity, where it was reported that the total number of work risks was 536,322 reported cases [4]. Musculoskeletal disorders (MSD) are closely related to ergonomics. Because ergonomics is the investigation of the interaction between the physical environment and the human being, which aims to optimize human well-being and general performance [5]. The IMSS in 2016 determined that annually 273 thousand workers request the maternity disability benefit [6]. The protection of maternity is established in the Federal Labor Law [7], as well as in NOM-006-STPS-2014, which establishes that cargo handling should not be carried out in the particular case of pregnant women or during the first 10 weeks after delivery [8], but there may be the possibility that some companies do not respect this rule.

The INEGI also announced in August 2017 that the Manufacturing, Maquiladora and Export Services (IMMEX) industry nationwide there are a total of 5,064 companies, of which 18.3% are in Baja California occupying the first place of number of companies per state [9]. The Ministry of Labor and Social Security (STPS) provides information that in Baja California to the second quarter of 2017 the total population in the state was 3,578,442, the economically active population was 1,636,098 of which 375,728 were active in the industry manufacturing obtaining that 59.5% of the participation are men and 40.5% are women [10].

The objective of the study is to identify and evaluate the ergonomic risk factors that are related to the appearance of MSD when developing repetitive tasks, manual handling of load (if any), activities involving prolonged and / or forced postures, as well as the identification of the effects caused on the health of pregnant women. And establish preventive and / or corrective measures. This is supported by the need for the protection of motherhood that promotes equity, health and well-being of mothers and their children, secondly safeguard employment and income of women, during pregnancy and after childbirth. As well as avoiding a negative economic impact on companies by way of compensation, disability, fines and various sanctions imposed by federal agencies. Most studies have focused on the most dangerous jobs and in which the predominant labor forces are men, [11]. In the country there are few studies carried out addressing this problem. The hypothesis is that the ergonomic risk factors such as prolonged and / or forced posture, the repetitiveness of the task performed and the distribution of working hours are related to the appearance of musculoskeletal disorders predominantly of the lower back.

2. OBJETIVES

Apply an instrument with which you can achieve an identification and analysis of ergonomic risk factors that are related to the development of repetitive tasks, activities involving prolonged and / or forced postures, identification of the effects caused on the health of pregnant women. And establish preventive and / or corrective measures.

2.1 Specific objectives

1. Identify cases of pregnant workers who have musculoskeletal complaints.
2. Apply questionnaires to identify ergonomic risk factors.
3. Measure the time of the activity performed, seated and standing exposure.
4. Measure the amount of repetitive movements.
5. Analyze postures, load handling and repetitive work.
6. Analyze musculoskeletal disorders and ergonomic risk factors.
7. Evaluate the risk factor: application of the ErgoMater instrument.

8. Establish the ergonomic recommendation for the correction, prevention and / or adaptation of the task or job.

3. METHODOLOGY

The methodology developed is aimed at the protection of motherhood. This procedure allows to analyze and in turn to detect ergonomic risk factors of strength, posture and repetitiveness for the pregnant worker or for her child, it also allows to provide preventive measures for the risks encountered. It is applicable in healthy women, who do not present obstetric medical complications to avoid confusion of the origin of the presented disorder. It is not applicable to women with obstetric complications because it could require a more detailed assessment of the work situation, and the application of measures or additional restrictions that are not included in this method. These cases must be analyzed in a personalized way by the appropriate professionals. From the beginning of pregnancy, it is advisable to avoid any exposure to risk factors, but it is very important to avoid them starting at week 20 of pregnancy [12].

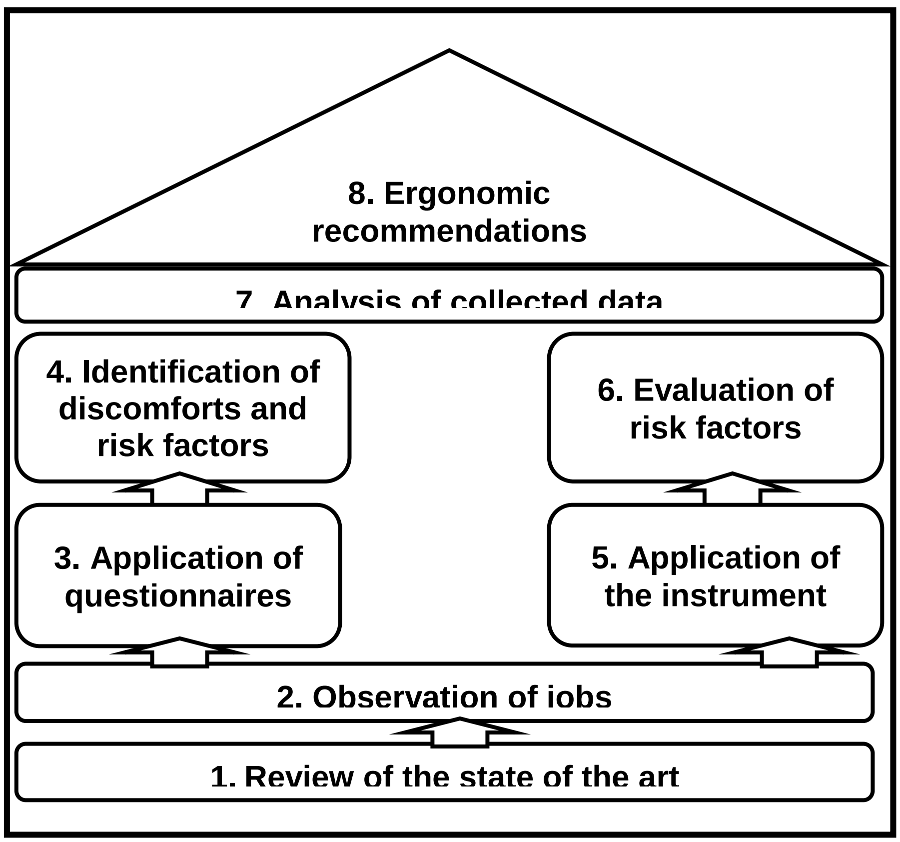

Figure 1. Scheme of the methodology

3.1 Observation

This methodology begins with the observation and analysis of working conditions of the work station, environment and organizational type in which the pregnant worker is found that may cause risks to the health of the worker and the child.

3.2 Application of questionnaires

The information collected based on the observation and analysis of working conditions is recorded through questionnaires that include questions related to the measurement of the force exerted by the activity, measurement of seated or standing exposure time, measurement of the time of the activity carried out, presence of musculoskeletal discomfort. The questionnaire is made up of the following:

Instructions. Recommendations are made on the application of the questionnaire, to whom it is addressed, as well as the objective of this questionnaire is briefly mentioned.

Case identification. The date of the evaluation was recorded and specific data that identify the worker and the work performed. In which are included general information of the worker as name, age, number of weeks of pregnancy, social security number, job position, tasks performed. The company includes name, address and money order.

3.3 Evaluation of risk factors

The evaluation contains questions that are related to: postures and movements, cargo handling, environmental conditions, work organization, acceptable weight and suggestions on improvements in the work area. This can be determined by observing the task and the interview applied to the worker, regarding the acceptable weight should be made comparing the actual weight of the load handled with the point weight acceptable and the corresponding calculations.

3.4 Identification of pregnant workers with musculoskeletal complaints

Consult the company's medical service about cases of pregnant workers who have presented with musculoskeletal discomfort. The questionnaires applied to pregnant workers are reviewed to identify the existence of current cases.

3.5 Application of the instrument

This instrument was adapted according to the provisions of Mexican legislation that indicate that manual manipulation of loads by women during pregnancy is not allowed [8]. The ErgoMater software is a procedure that allows to evaluate and detect ergonomic risk factors for the pregnant worker or for the future child, and incorporates suggestions to help prevent or control the detected risks; It combines knowledge from biomechanics and ergonomics developed by the Institute of Biomechanics of Valencia (IBV) with the support and collaboration of Muvale and

Unión de Mutuas [12], arises from the need for maternity protection and the fulfillment of the Spanish, European and international legislation such as the Convention (C183) [13] and Recommendation (R191) [14] on the protection of maternity.

The IBV is a technological center that studies the behavior of the human body and its relationship with the products, environments and services used by people. The start of the activity of the center dates back to 1976 and now the institute is a concerted center between the Valencian Institute of Business Competitiveness (IVACE) and the Polytechnic University of Valencia (UPV). [15] The main objective of ErgoMater is to be a tool for ergonomic intervention for the analysis and control of the risks associated with the exposure of physical load in the case of women in pregnancy, of the working conditions of the pregnant woman in activities with physical load, the development of very repetitive tasks or the performance of activities that imply forced and / or prolonged postures. As well as providing the description of measures aimed at adapting the workplace. [12]

3.6 Analysis of collected data

An analysis of the information is made based on the information thrown by the software used. Which exposes the consequences to which the pregnant worker and / or the child of a certain risk factor presented in the workplace is prone.

4. RESULTS

The study was conducted in a mechanical metal manufacturing industry in the city of Tijuana, in which pregnant women between the ages of 22 and 36 participated, on average the age of the participants was 29.4 years. The weeks of pregnancy in which they were found were between 18 and 28 weeks. The average amount of movements made by the assembly workers per piece was an average of 38, with an average time of 7'83 "per task. Prevalence of low back pain was observed in pregnant workers with a weekly workday of at least 40 hours. regardless of the activity they performed. Some of the corrective recommendations for this discomfort were: allowing to alternate standing and sitting posture while performing the task, using adjustable work chairs, avoiding sitting for more than two hours without changing position, avoiding unnecessary displacements, avoiding standing more than four hours in a row.

Table 1. Time and number of activities

Worker	Load handling	Repetitive work	Time of the activity performed per piece	Number of movements made per piece
1. Administrative	Don't	Don't	Doesn't apply	Doesn't apply
2. Operator	Don't	Yes	10´20´´	47
3. Operator	Don't	Yes	5´15´´	25
4. Administrative	Don't	Don't	Doesn't apply	Doesn't apply
5. Operator	Don't	Yes	8´15´´	42

Table 2. Disorders presented by pregnant workers

Worker	Age	Weeks of pregnancy	Exposure time	Risk factor	Disorder presented
1. Administrative	22	18	<40 hrs.	Prolonged sitting posture	Low back pain
2. Operator	31	28	<40 hrs.	Prolonged standing posture and forced posture	Low back pain
3. Operator	36	21	<40 hrs.	Prolonged standing posture and forced posture.	Low back pain, hips and / or thighs
4. Administrative	27	27	<40 hrs.	Prolonged sitting posture and forced posture.	Low back pain, ankles and / or feet
5. Operator	31	15	<40 hrs.	Prolonged standing posture and forced posture.	Low back pain

Table 3. Ergonomic recommendations

Worker	Age	Weeks of pregnancy	Disorder presented	Ergonomic recommendations
1. Administrative	22	18	Low back pain	*Allow alternating standing and sitting posture when performing the task. * Use adjustable work chairs. * Avoid sitting for more than two hours without changing position.
2. Operator	31	28	Low back pain	* Avoid standing more than four hours in a fixed or combined position. * Allow alternating standing and sitting posture when performing the task. * Avoid unnecessary travel.
3. Operator	36	21	Low back pain, hips and / or thighs	* Avoid standing more than four hours in a fixed or combined position. * Allow alternating standing and sitting posture when performing the task. *Avoid unnecessary travel.
4. Administrative	27	27	Low back pain, ankles and / or feet	* Allow alternating standing and sitting posture when performing the task. * Use adjustable work chairs. * Avoid sitting for more than two hours without changing position.
5. Operator	31	15	Low back pain	* Avoid standing more than four hours in a fixed or combined position. * Allow alternating standing and sitting posture when performing the task. * Avoid unnecessary travel.

5. DISCUSSION / CONCLUSIONS

In this study it was found that the prevalence of ergonomic risk factors identified in the participants were repetitive tasks and prolonged or forced postures. It was found that when performing the activity exposed to these factors for at least 40 hours per week, regardless of the week of gestation in which they were found or the activity performed by the pregnant workers, they commonly presented with low back pain. With the results obtained, it was possible to meet the objectives set. Failure to perform assembly tasks does not guarantee not having some TME as observed in administrative workers. With these results we found the existence of positive association between the appearance of MSD, repetitive tasks, prolonged or forced postures and the distribution of time of the working day. The most similar study related to pregnant women found in the review aimed to identify the main occupational factors that were mostly related to back pain in pregnant women who worked in higher education, health care and health care areas. service, they also yielded positive results regarding back pain related to remaining in a confined area and having restricted space [16]. No other similar studies were found that allow any relevant comparison with our data. Research, surveillance and attention to exposures to risk factors of this type is necessary since musculoskeletal disorders affect the development of pregnancy and can cause fatal consequences

The participants stated that at the beginning of pregnancy they did not know the procedure to follow in the company when they knew they were pregnant. No records were found in the company about these conditions as the workers did not consider it important to notify the company's medical service. The limitation of the study was the participation of a greater number of companies due to their refusal to participate in said study. They stated that they did not consider that pregnant workers in their company were exposed to any risk factor. Of which they did not show any evidence to support this assertion. It is suggested that pregnant workers have the possibility to take breaks, be provided with adequate furniture and be allowed to alternate postures to minimize low back pain, as well as an occupational health program in the companies, the use of a guide to be used by them for the prevention and improvement of working conditions. It is important to point out that it is not possible to prevent what we do not see, and it is necessary to standardize the evaluation of risk factors since each person assesses the risk factor in a different way depending on the perception.

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IDENTIFICATION OF ERGONOMIC RISK FACTORS USING THE PLIBEL CHECKLIST IN 20 BUTCHER SHOPS IN THE CITY OF HERMOSILLO, SONORA, MEXICO.

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Resumen: En el presente trabajo se analizó el sistema de producción de 20 carnicerías de la ciudad de Hermosillo, Sonora, México para identificar los factores de riesgo ergonómico en donde se utilizó la lista de verificación PLIBEL. Los factores de riesgo más comunes que se encontraron fueron: los trabajadores permanecen de pie durante períodos prolongados de tiempo y realizan movimientos tanto de largo alcance y de torsión de la espalda, así como también movimientos de torsión de las muñecas debido al mal diseño de las estaciones de trabajo. En la lista de verificación el 55% de las observaciones manifiestan que las herramientas y equipos son inadecuadamente diseñados, mientras que un alto porcentaje, el 78%, respondió que se manipulan cargas manualmente de manera repetitiva, 67% revela que la carga es elevada y el 61% que el agarre de la carga es incómodo. Con respecto a los movimientos del antebrazo y la mano, 60% indican que se realizan con torsión, 85% con fuerza y 60% en posiciones incómodas. Se deben optimizar los procesos para que no haya movimientos repetitivos, implementar acciones para evitar el levantamiento manual de cargas y para finalizar se debe de proporcionar herramientas y equipo de trabajo que se adapte a las necesidades de los carniceros. El método PLIBEL es una herramienta útil para cumplir con la identificación de factores de riesgo ergonómicos en los centros de trabajo así como también con los requerimientos de la Secretaría del Trabajo y Previsión Social en el Proyecto de Norma Oficial Mexicana PROY-NOM-036-1-STPS-2017, Factores de riesgo ergonómico en el trabajo en donde señala la obligación de la identificación, análisis, prevención y control de los mismos.

Palabras clave: carniceros, ergonomía, PLIBEL.

Relevancia para la ergonomía: Este estudio es importante porque puede ser útil como información que contribuya al emprendimiento de gestiones tendientes a mejorar las condiciones laborales de los carniceros.

Abstract: In paper aims to identify possible ergonomic risk factors in production systems of 20 butcher shops in the city of Hermosillo, Sonora, Mexico. The PLIBEL checklist was used to investigate ergonomic hazards with a focused approach in different body regions. PLIBEL allowed knowing that the most common risk factors are the over extended periods the workers had to remain standing, and also work movements with awkward hand's reach, repeated work with hand performing twisting movements due to poorly designed work stations. Results: 55% of the observations state that the tools and equipment are inadequately designed; while a high percentage, 78%, responded that loads are handled manually in periods of repetive work, 67% answered they handle heavy loads and 61% said that the grip of the load is uncomfortable. Repeated work is performed with forearm and hand, 60% responded with twisting movements, 85% said with forceful movements and 60% reported with uncomfortable hand positions. The processes must be optimized in order to avoid both, repetitive movements in unacceptable positions and manual lifting of heavy loads and finally work equipment must be provided for handling heavy loads manually. The PLIBEL method is a useful tool to comply with the identification of ergonomic risks factors in work centers and to meet all standards of the Secretaria del Trabajo y Previsión Social (Department of Labor and Social Security) on the Project of Norma Oficial Mexicana (Official Mexican Standard) PROY-NOM-036-1-STPS-2017, Factors of ergonomic risk in the work where it indicates the obligation of the identification, analysis, prevention and control of manual load handling.

Keywords: butchers, ergonomics, PLIBEL.

Importance for ergonomy: This study is important because it can help as information that contributes to the undertaking of actions tending to improve the working conditions of the butchers.

1. INTRODUCTION

Given the great competitiveness of markets, designing ergonomic workstations is essential for employers to obtain the highest performance and at the same to take care of the physical and mental well-being of the workers, in other words productivity and quality of the products and services are present with the health, safety and comfort of workers. The literature reports butchers face several health and safety risks factors in different countries (Vogel et al., 2013, Mukhopadhyay and Amaltas, 2015). In the United States of America, the Occupational Safety and Health Administration, OSHA, has recognized the packaging of meat as one of the highly risky jobs and as a form of protection for workers, they published in August 1993 the Ergonomics Program Management Guidelines for Meatpacking Plants. These guides provide solutions that have been implemented in the poultry industry, which may also be useful in other industries (OSHA, 2014). The current work is carried out in the production system of butcher shops where butchers handle loads, perform scopes and activities that force them to adopt non-neutral and sometimes highly repetitive postures. For this, the PLIBEL method is applied to identify the ergonomic risk factors in the production processes of 20 butcher shops in the city of Hermosillo, Sonora, Mexico, and from the results obtained, general proposals for their control are developed. The PLIBEL method is a useful tool to diagnose possible occupational musculoskeletal disorders and from this information allows to take actions to comply with the general ergonomic principles of jobs and the draft of the Norma Oficial Mexicana (Official Mexican Standard) PROY-NOM-036-1 -STPS-2017, ergonomic risk factors in work where it indicates the obligation of identification, analysis, prevention and control of them.

1.2 Problem statement

It is necessary to know the skeletal muscle risk factors of the butchers, because during their work they use machines, hand tools and processes that can cause injuries. For example, they use machines to cut and grind meat, hand tools such as knives, manipulate loads, perform repetitive work, they can suffer from slips and falls, they work in cold rooms, etc. On the other hand, the results obtained can contribute to the undertaking of actions aimed at improving the working conditions of this sector of workers.

1.3 Objectives

1.3.1 General objective

Identify ergonomic risk factors using the PLIBEL method in 20 butcher shops in the city of Hermosillo, Sonora, Mexico.

1.3.2 Specific Objectives

- Identify ergonomic risk factors.
- Know the impact on the skeletal muscle system of the tasks carried out by the butchers.
- Suggest alternatives to eliminate or reduce risk factors.

1.4 Justification

The work of the butchers is considered heavy physical work. The continuous use of meat cutting tools, handling large pieces of meat of very heavy weight with uncomfortable positions, among other activities, enables the development of musculoskeletal injuries. The health of the butchers is also affected by injuries with cutting tools, slips from working on wet floors, improper use of equipment, etc. Therefore, it is necessary to know the ergonomic risk factors of the processes of butcher shops in Hermosillo, Sonora, Mexico in order to make recommendations of the adoption of actions to improve the health and safety of workers.

1.5 Delimitation

The PLIBEL checklist was applied to 20 butcher shops located in the city of Hermosillo, Sonora, Mexico.

2. METHODOLOGY

2.1 Subjects

In this research participate butchers of the city of Hermosillo, Sonora, who have worked for a year or more.

2.2 Sample

The sample consists of workers from a total of 20 butcher shops who agreed to participate in the study.

2.3 Instrument

The PLIBEL checklist will be used to identify possible ergonomic risk factors of the whole body regions.

2.4 Methodology

From the telephone directory, specifically from the yellow section, butcher shops were located. These shops were visited and permission from the owner or manager was requested to allow butcher shop workers to participate by responding to the survey. Once the proposed sample size is achieved, the data is captured in Microsoft Office Excel and descriptive statistics are applied.

Among the activities developed by the butchers we can find the following: take orders both in site and by telephone, package cuts to display in showcase, charge, make cuts of meat, roast meat, clean the establishment, review product inventory and label merchandise.

Process description

In the process of the butcher shops, various activities are carried out for the aim of the present study, only the service activity of the customer's order was analyzed.

Working areas of butcher shops process allow workers sufficient space to perform their tasks comfortably and is not necessarily designed to minimize time.

There are several butchery tools and equipment required, such as: tables, knives, saws, refrigerators, cold rooms, laundry, slicers, scales, packaging machines, cutting boards, etc.

The butchers have showcases that can have the dimension of 1.15 meters high, 1.16 meters wide and 2.54 meters in length and also internally there are long tables that together measure 3.4 meters long, 1.06 meters wide and 0.93 meter high. These work areas are shown in figures 1 to 5.

Figure 1. Showcases.

Figure 2. Showcases.

Figure 3. Cutting table

Figure 4. Cutting table.

Figure 5. Cutting table.

Below are the main equipment and tools used in butcher shops.

Figure 6. Slicing machine.

Figure 7. Meat Saw.

Figure 8. Meat grinder.

The slicer (figure 6) is mainly used in cold meats and cheeses. Its construction is in reinforced aluminum, has chrome steel blades. It is extremely fast when slicing.

The saws of meat (figure 7) are widely used in butcher shops because of their properties of providing enough force to cut even the hardest bones with ease, tendons and other elements found in meat pieces.

Figure 9. Scale. Figure 10. Packaging machine.

The meat grinder (figure 8) is one of the most used equipment since it allows to grind meat.

The scale (figure 9) is an important instrument because it allows to know the exact weight of products clients request and also its price.

The packaging machine (figure 10) is used to package / seal the amount of meat desired by the customer.

The tools and utensils that they use can be knives, machetes, tweezers, and those useful for cleaning the butchers shops.

Figure 11.Cutting table. Figure 12. Knifes.

In the cutting board (figure 11) the worker leans to make meat cuts and have a clean area.

The knives of a butcher are essential, they must be of the best quality, always sharp and very clean. They can be handles of different shapes and material, for specific use such as skinning knives, sharp point knives, round-tipped knives, breaking knives.

Working area

The working day of the process is from 8 to 10 hours a day, where 80% of the time the operators are standing, taking short and continuous walks. Arm stretches are observed to reach or leave the meat and/or the tools from the table to the showcases and equipment and viceversa. When using the equipment as the slicer, grinder and cutter non-neutral postures in neck, shoulder, elbow, wrist are maintained. When using knives for cutting meat, non-neutral postures of neck, shoulder, elbow, and wrist are observed which force workers to make uncomfortable and dangerous movements.

Of the main activities carried out in these work centers are the following:

Activity 1. Vacuum packing, to pack the meat, in this case the ground meat. The product to be packaged are placed in the feeding system of the packing machine, the plastic is stretched until the product is packed, wrapped and the knife is taken with the right hand to cut it, while the left holds the product (figure 13).

Activity 2. Save/ remove meat from the showcase. Under the butcher counter, the freezer is found and to remove the meat from the freezer it is necessary to bend down his back, here a risk factor is observed since it is necessary to force trunk to bend, which can lead to a possible injury in the low back region (figure 14).

Activity 3. Cutting cold meats in machine.
The ham bar that the client wants sliced is taken, then it is opened at one end and placed it to the ham holder. The operator turns on the machine and with one hand slides the support horizontally to obtain slices of ham. With the other hand, the operator receives the slice of ham and deposits it in a unicel tray. The operator turns off the machine and proceeds to weigh the final product to take it to the vacuum packing area. (Fig. 15)

Activity 4. Grind meat with a grinder. To grind the meat first the amount of meat the customer wants is taken. Then it is weighed on the scale to get the specified amount, the meat is put in the upper tray of the electric grinder, the machine is turn on with the switch and immediately the meat is absorbed and ground by internal blades of the machine, then the meat is ground into strips in the lower tray, so it is served in a unicel tray (figure 16).

Activity 5. Meat is cut with knife on a board. In this activity two tools are needed, the butcher knife and the table where the meat is placed. The butcher places the meat on the board and proceeds to remove the fat for later packaging (figure 17).


Figure 13. Vacuum packing.


Figure 14. Save/remove meat from the showcase


Figure 15. Cutting cold meats in machine


Figura 16. Grind meat with a grinder.


Figura17. Meat cut with knife and board.

3. RESULTS

The PLIBEL checklist was applied to 20 butcher shops and descriptive statistics was obtained with Microsoft Office Excel, as it is shown in figure 18.

PLIBEL Checklist	YES	NO	Total	% YES	% No
1. Is the walking surface uneven, sloping, slippery or nonresilient?	4	16	20	20%	80%
2. Is the space too limited for work movements or work materials?	5	15	20	25%	75%
3. Are tools and equipment unsuitably designed for the worker or the task?	11	9	20	55%	45%
4. Is the working height incorrectly adjusted?	15	5	20	75%	25%
5. Is the working chair poorly designed or incorrectly adjusted?	2	3	5	40%	60%
6. If work performed standing, is there no possibility to sit and rest?	3	15	18	17%	83%
7. Is fatiguing foot pedal work performed?	0	3	3	0%	100%
8. Is fatiguing leg work performed? e.g. ...					
a) repeated stepping up on stool, step etc.	13	7	20	65%	35%
b) repeated jumps, prolonged squatting or kneeling	1	19	20	5%	95%
c) one leg being used more often in supporting the body.	11	9	20	55%	45%
9. Is repeated or sustained work performed when the back is:					
a) mildly flexed forward	19	1	20	95%	5%
b) severely flexed forward	8	12	20	40%	60%
c) bent sideways or mildly twisted	11	9	20	55%	45%
d) severely twisted	3	17	20	15%	85%
10. Is repeated/sustained work performed with neck:					
a) flexed forward	16	4	20	80%	20%
b) bent sideways or mildly twisted	12	8	20	60%	40%
c) severely twisted	4	16	20	20%	80%
d) extended backwards	3	17	20	15%	85%
11. Are loads lifted manually? Note important factors:					
a) periods of repetitive lifting	14	4	18	78%	22%
b) weight of load.	12	6	18	67%	33%
c) awkward grasping of load	11	7	18	61%	39%
d) awkward location of load at onset or end of lifting	9	9	18	50%	50%
e) handling beyond forearm length	7	11	18	39%	61%
f) handling below knee length	4	14	18	22%	78%
g) handling above shoulder height	6	12	18	33%	67%
12. Is repeated, sustained or uncomfortable carrying, pushing or pulling of loads performed?	12	8	20	60%	40%
13. Is sustained work performed when one arm reaches forward or to the side without support	9	11	20	45%	55%

14. Is there a repetition of:	Yes	No	Total	% YES	% No
a) similar work movements	16	4	20	80%	20%
b) similar work movements beyond comfortable reaching distance?	6	14	20	30%	70%
15 Is repeated or sustained manual work performed? Notice factors of importance as:					
a) weight of working materials or tools	9	11	20	45%	55%
b) awkward grasping of working materials or tools	7	13	20	35%	65%
16. Are there high demands on visual capacity	8	12	20	40%	60%
17. Is repeated work, with forearm and hand, performed with:					
a) twisting movements	12	8	20	60%	40%
b) forceful movements	17	3	20	85%	15%
c) uncomfortable hand positions	12	8	20	60%	40%
d) switches or keyboards	2	18	20	10%	90%
	Yes	NO		% Yes	% NO
A. Is job performed under time demands or psychological stress?	8	12	20	40%	60%
B. Can job have unusual or unexpected situations?	9	11	20	45%	55%
C. Is it possible to take breaks and pauses?	20	0	20	100%	0%
D. Is it possible to choose order and type of work tasks or pace of work?	6	14	20	30%	70%

Figure 18. Results of PLIBEL Checklist applied to 20 Butcher shops in the city of Hermosillo, Sonora, Mexico.

The ergonomics risk hazards reported at the butcher's workplace are the following: 55% of the respondents indicated that the tools and equipment are inadequately designed, while a high percentage, 78%, pointed out that heavy loads are handled manually in long periods of repetitive work, 67% answered they handle heavy loads and 61% said that the grip of the load is uncomfortable. Repeated work is performed with forearm and hand, 60% responded with twisting movements, 85% said with forceful movements and 60% in uncomfortable hand positions of the hands. The processes must be optimized in order to avoid both, repetitive movements in unacceptable positions and manual lifting of heavy loads, finally work equipment must be provided for handling heavy loads manually.

4. CONCLUSIONS

The PLIBEL checklist was applied to 20 butcher shops in the city of Hermosillo, Sonora, Mexico and it can be concluded that the tasks the worker and the observer found particularly stressful to the musculoskeletal system are: over extended periods of fatiguing leg work, repeated or sustained work is performed when the neck and the back are flexed forward, loads are handled manually in periods of repetitive work, repeated work with forearm and hand is carried out with twisting and forceful movements and with awkward hand positions.

The PLIBEL method is a method of identification of musculoskeletal stress factors, used as a screening tool in order to take possible changes in redesigning ergonomic workstations. It also allows to fulfill standards of the Secretaria de Trabajo y Previsión Social (Department of Labor and Social Security) on the Project of Norma Oficial Mexicana (Official Mexican Standard) PROY-NOM-036-1-STPS-2017, Factors of ergonomic risk in the work where it indicates the obligation of the identification, analysis, prevention and control of manual load handling.

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ASSESSMENT OF THE ECONOMIC – PRODUCTIVE IMPACT OF ERGONOMIC REDESIGN OF BUFFER SHELVES IN PRE-ASSEMBLY OPERATIONS.

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Resumen: Las fuertes demandas de productividad, calidad y competitividad de los modernos procesos productivos llevan consigo una alta exigencia operativa del recurso humano, que desempeña su labor en este tipo de procesos. Situación que compromete la relación sinérgica entre el operador y la estación de trabajo donde se realiza la actividad. Las tareas implicadas en estos trabajos mantienen un conjunto de acciones repetitivas, tiempos de ciclo cortos, estrés por contacto, posturas inadecuadas y manejo manual de cargas que no contempla las directrices enmarcadas en la ergonomía y la biomecánica ocupacional.

En el caso específico de las estaciones operativas de pre-ensamble para productos de arneses (sistema de formado para cables y componentes electrónicos utilizados en camiones de carga), objeto de estudio de la presente investigación, se ha presentado un importante incremento en el impacto negativo del trabajo sobre el operador, debido principalmente a los cinco factores complejos definidos anteriormente. Esta situación ha generado las condiciones necesarias para que se presenten los denominados Desordenes Músculo Esqueléticos (DME´s), específicamente referenciados en la columna vertebral y los miembros superiores.

La situación problémica que se presenta hizo necesario desarrollar un rediseño biomecánico ocupacional de los estantes buffer, con el objetivo de reducir el impacto negativo del trabajo y mejorar los resultados operativos establecidos en las tareas de pre-ensamble, pertenecientes a las líneas de producción de una empresa manufacturera.

Una vez contemplado el diseño ergonómico y biomecánico de los estantes buffer, se realizó un análisis valorativo de las diferencias productivas de la estación de trabajo rediseñada en cuanto al diferencial en: tiempos de ciclo, tiempos estándar y nivel de producción. Obteniendo con ello los comparativos productivos de la estación de trabajo, antes y después del rediseño. Aunado a lo anterior, se hace el análisis de los costos incurridos en el rediseño y se compara con benéfico productivo obtenido, esto se define como un procedimiento competente para valorar el impacto económico del rediseño realizado a la estación de trabajo en operaciones de pre – ensamble.

Palabras calve: Ergonomía, Rediseño, Productivo – Económico

Abstract: The strong demands of productivity, quality and competitiveness of modern production processes carry a high operational demand of human resources, which performs its work in this type of process. Situation that compromises the synergistic relationship between the operator and the work station where the activity is carried out. The tasks involved in these jobs maintain a set of repetitive actions, short cycle times, contact stress, inadequate postures and manual handling of loads that does not contemplate the guidelines framed in ergonomics and occupational biomechanics.

In the specific case of the pre-assembly operating stations for harness products (forming system for cables and electronic components used in cargo trucks), object of study of the present investigation, there has been a significant increase in the negative impact of work on the operator, mainly due to the five complex factors defined above. This situation has generated the necessary conditions for the occurrence of the so-called Musculoskeletal Disorders (SMDs), specifically referenced in the spine and upper limbs.

The problematic situation that was presented made it necessary to develop an occupational biomechanical redesign of the buffer shelves, with the objective of reducing the negative impact of the work and improving the operating results established in the pre-assembly operations, belonging to the production lines of a Manufacturing company.

Once the ergonomic and biomechanical design of the buffer shelves was contemplated, an evaluative analysis of the productive differences of the redesigned work station was made regarding the differential in: cycle times, standard times and production level. Getting with it the productive comparisons of the work station, before and after the redesign. In addition to the above, an analysis of the costs incurred in the redesign is made and compared with the productive benefit obtained, this is defined as a competent procedure to assess the economic impact of the redesign made to the workstation in pre-assembly operations.

Key Words: Ergonomics, Redesign, Productive – Economic.

Contribution to Ergonomics: This research assesses the productive and economic impact of the ergonomic redesign of a pre-assembly work station. This maintains ergonomic relevance because the assessment allows establishing in a quantitative way the importance of establishing the guidelines of ergonomics in the redesign of work stations, providing management with data on the increase in production, cost reduction and improvement of the quality of life of workers. A comparison is established between the costs associated with the ergonomic redesign and the operational results of the work station.

1. INTRODUCTION

In the maquiladora and manufacturing industry of the Northeast of the State of Sonora, it has been observed that the high demand of production and its wide variety of products has generated an increment in the operational load on the worker. This situation develops a negative impact of the work on the operator who performs such functions, which in an upward perspective carries with it the possibility of presenting a Musculoskeletal Disorder (DME), affecting the quality life of the worker and the productivity of the business exercise. This situation has been observed mainly due to the increase in reports of incidents, staff turnover, discomfort expressed by the worker and an absolute increase in visits to the doctor by the personnel who perform their duties in these areas.

The present work carries with it the assessment of the productive and economic impact of the application of the main guidelines of occupational biomechanics and ergonomics for the redesign of buffer shelves in pre-assembly operations, a situation that in its global perspective will present a substantial improvement in the intrinsic machine-man relationship and will reduce the negative impact of the exogenous variable environment (Vázquez, 2012). With the actions described above, support is generated for improvements that positively impact productivity, efficiency, business economy and improvement in the quality of life of the workers

1.1 General purpose:

Quantitatively assess the economic and productive impact of the ergonomic redesign of buffer shelves, in pre-assembly operations in the production lines of a manufacturing company located in the Northeast of Sonora.

1.2 Specific objectives:

1. Assess the scientific theoretical aspects related to the work carried out in the pre-assembly operations.
2. Redesign the pre-assembly operation applying the ergonomic guidelines and principles of occupational biomechanics.
3. Validate the increase in the economic and productive performance of the work station, based on the procedure designed.

2. DELIMITATION

The research was developed in the maquiladora and manufacturing export industry, located in the Northeast of the State of Sonora, specifically in those intermittent production lines with online flows, which due to their own requirements, pre-assembly is necessary.

3. METHODOLOGY

The present investigative work carries with it a set of methodologically pragmatic actions that are divided into three main points:

1. As a first action, an ergonomic diagnosis is made that indicates the degree of risk in which the workstation is encounter. To carry out the diagnosis, the RULA

method was applied through direct observation and video recording. At this point it is very important that the research team is qualified in the usability and application of the RULA method, to obtain the highest reliability in the results of the diagnosis. In addition to the above, the flowchart of operation and bimanual diagram are made, as a support to the evaluation of the ergonomic method. The quantitative evaluation of the work station is done by obtaining the cycle time of the operation and the volume of production realized by the work station

2. The second part of the methodology consists in developing the redesign of the pre-assembly station, applying the guidelines of occupational biomechanics and ergonomic principles. It is very important to maintain the minimum distance between the neutral position of the worker and the position in which it performs its activity, this consideration implies a significant decrease in the possibility that the operator presents a Musculoskeletal Disorder, in performing its function.

3. As a third point, a comparison is made of the two main variables involved in the research, the reduction of the risk of work from the comparison of the results of the application of RULA method; and the comparison of cycle times, production volumes and the costs associated with the performance of the redesigned workstation.

4. RESULTS

To evaluate the occupational risk conditions to which pre-assembly workers are exposed, an ergonomic evaluation of the said work station was developed with the application of the RULA method (Takala, 2010). After that, the main movements that the operator performs when carrying out the assigned task were identified; this was carried out from the application of the bimanual diagram for the evaluation of the productive performance of the worker.

The analyzed work station develops a series of activities by means of which a harness is configured, being necessary to place a set of cables in electronic connection devices, according to a succession of priorities established in the work instructions. Figure 1 shows a graphic representation of the harness pre-assembly station.

In order to fulfill with the first point established in the methodology used in the present investigation, the application of the RULA method was carried out. The main considerations that were maintained during the application of the method were the following: The position with the greatest negative impact for the worker is taken as reference, during the assignment of the RULA quantification; the application of the method is developed in direct observation and verified with the support of video recording (Takala, 2010).

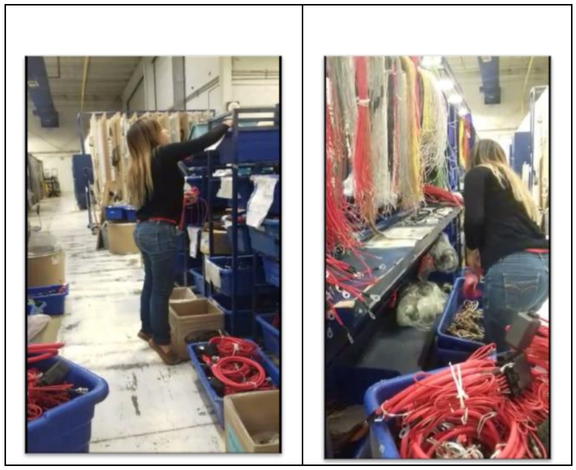
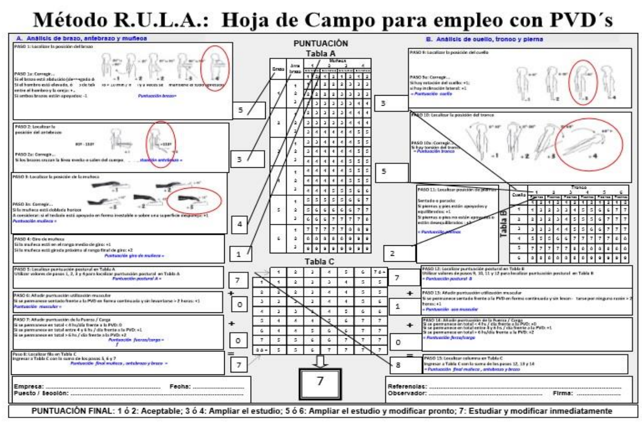


Figure 1. Harness pre-ensambly station.

In figure 2 the results of the application of RULA method in the work station before the ergonomic guidelines and biomechanical principles.



Método R.U.L.A.: Hoja de Campo para empleo con PVD´s

A. Análisis de brazo, antebrazo y muñecas

PUNTUACIÓN

Tabla A

B. Análisis de cuello, tronco y pierna

Tabla B

Tabla C

7

PUNTUACIÓN FINAL: 1 ó 2: Aceptable; 3 ó 4: Ampliar el estudio; 5 ó 6: Ampliar el estudio y modificar pronto; 7: Estudiar y modificar inmediatamente

Figure 2. RULA Method Evaluation of before the application of ergonomic guidelines in the work station.

See in Figure 2 that the qualification obtained by the RULA method was 7, this qualification being considered a high risk for the worker who performs his activity and it is recommended to study and modify immediately.

In addition to the above, the bimanual diagram shows the actions and activities that the worker develops with each of his two upper extremities. It is important to note that as a set there is a large number of movements and repetitive actions that do not add value to the sub-assembly that is developed.

Figure 3 shows the bimanual diagram of the operation of the harness sub-assembly (for the original extension of the original diagram only one tablet of this is presented, showing part of the beginning and end of the elaborated diagram).

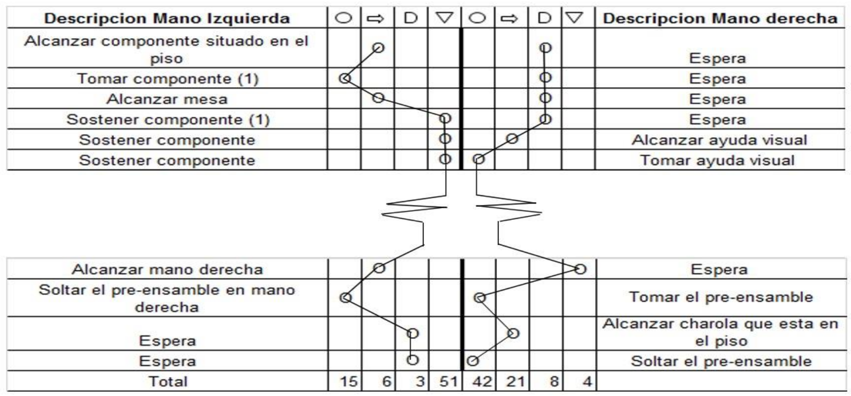


Figure 3. Bimanual diagram of the harness sub-assembly operation before the application of biomechanical principles and ergonomic guidelines.

The diagram shows an unbalance in the number of operations carried out by the upper extremities of the operator, being for the left hand a total of 15, while for the right hand they contemplate a total of 42; the previous situation sees the compromised delays in storage activities for both hands, which is reflected that for the left hand there is a total of 51, while for the right hand there is a total of 4. As a whole the diagram shows an excessive unbalance in the activities developed by both hands, which leads to an unequal increase in fatigue and a negative impact on the health and quality of life of the operator.

Once the problematic of the current design of the pre-assembly workstation has been analyzed, established and quantified, from the ergonomic perspective, a set of proposals for the redesign of the work station is structured, based on the principles of occupational biomechanics and ergonomic guidelines (Scott, 2010), with the fundamental objective of reducing the negative impact of work on the operator who performs his activity in pre-assembly workstations. Table 1 presents the principles of occupational biomechanics and the ergonomic guidelines that supported the redesign of the pre-assembly workstation.

With the application of the principles and guidelines mentioned before, the redesign of the work station is carried out, thereby showing a substantial improvement in the synergistic relationship between the work station and the operator that performs its activities in the said station. Figure 4 shows the redesigned workstation from the application of the principles described above.

Table 1. Biomechanical principles and ergonomic guidelines applied for the redesign of the pre-assembly workstation.

Biomechanical principles	Ergonomic guidelines
Reduce the distance between the worker's neutral posture and the posture in which the task is performed.	Adapt the work to the areas of worker’s comfort, according to the anthropometric measurements at the ninetieth percentile.
Decrease the static charge.	Decrease the repetitiveness of movements

Decrease manual load lifting.	Decrease the amplitude of the angles of movement to conserve the comfort angles.
Use a footrest if the working height is fixed.	Reduce the visual impact of inventory at the work station.
Avoid excessive stretching.	Minimize unnecessary movements
Select working surfaces with inclination.	The seat and backrest heights of the chair should be adjustable.
Provide enough space for the legs.	The specific characteristics of the chair are determined by the task.
Do not use platforms.	Limit the number of possible settings.
Offer variation in tasks and activities.	The working height depends on the task to be performed.
Introduce sitting / standing work stations.	Avoid developing tasks above the height of the shoulders.
Select the appropriate work tool.	Avoid working with your hands behind the body.
	Avoid loading objects with one hand.

Figure 4. Redesigned work station based on the application of biomechanical principles and ergonomic guidelines.

To validate the quantitative results in the redesign of the work station, the same procedures were applied as in the diagnosis, in order to compare the different parameters obtained and assess the improvement.

To do this, RULA method is applied in the redesign. Figure 5 shows RULA method after applying the biomechanical principles and ergonomic guidelines in the work station. A value of 3 is contemplated in the evaluation result.

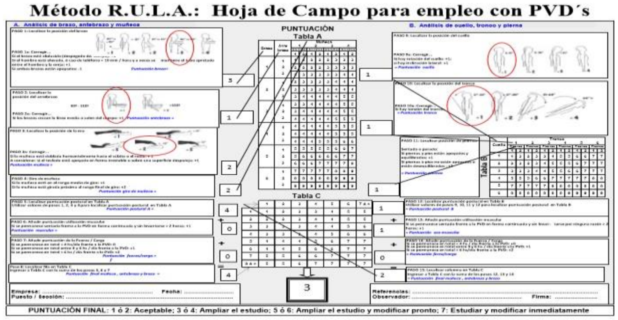


Figure 5. Result of the RULA method applied to the redesigned workstation.

Again, the bimanual diagram of the harness sub-assembly operation is obtained, after the application of the biomechanical principles and the ergonomic guidelines.

Figure 6 shows the bimanual diagram obtained, in this diagram you can see a balance in the set of activities and operations performed by the upper extremities of the operator: the total operations performed by the left hand are 38, while for the right hand are 34.

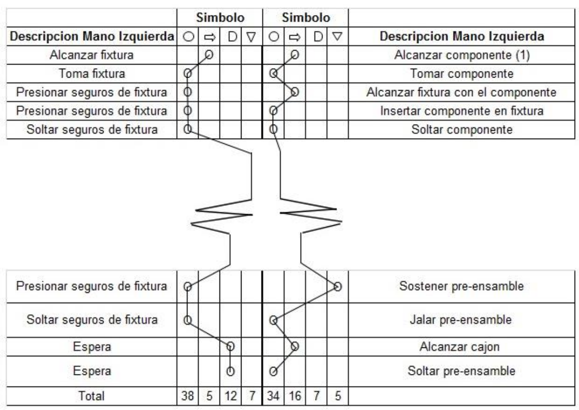


Figure 6. Bimanual diagram of the redesigned pre-assembly workstation.

The comparative variation of the results obtained is presented in table 2. In addition to the previous assessment, a graph of the equilibrium point of the work station is developed before and after the redesign, comparing in it the costs associated with the new work station, observing the decrease of the equilibrium point, this situation indicates that the business result of the redesign is successful. Figure 7 shows the graphs of equilibrium points before and after the redesign.[1]

[1] Author's note: Due to the confidentiality agreement the data is not presented in the graphs.

Table 2: Comparative chart of the results obtained in the redesign of the pre-assembly workstation.

Comparative procedures	Before the application of biomechanical principles and ergonomic guidelines.	Redesigned work station
Work risk, valued through the RULA method.	Score reached 7 (study and modify immediately).	Score reached 3 (expand study).
Bimanual diagram	Notorious imbalance in the activities of the upper extremities.	Noticeable balance in the activities of the upper extremities.
Cycle time of the operation.	76 seconds.	46 seconds.
Daily pieces production.	426 pieces.	704 pieces.

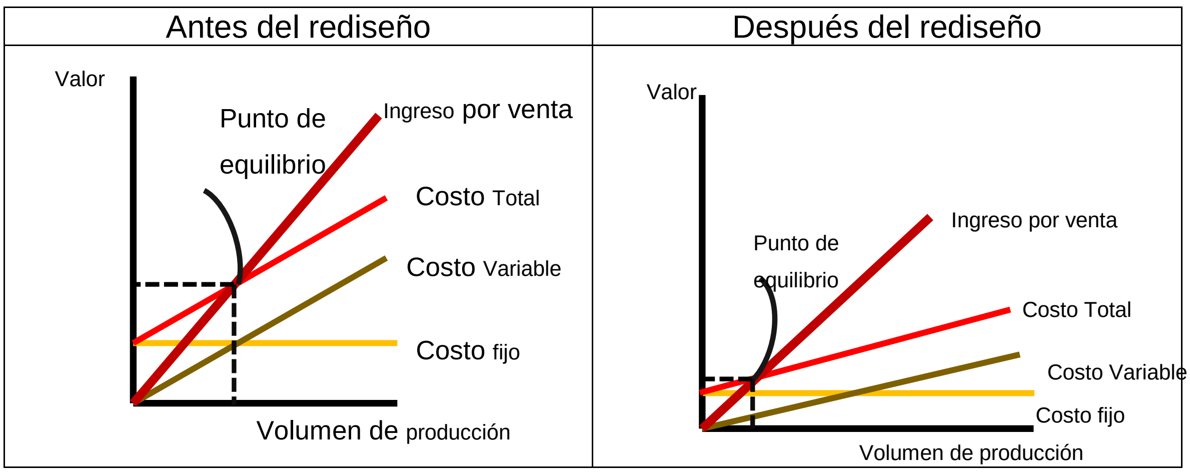


Figure 7: Comparative graphs of the equilibrium point.

5. CONCLUSIONS

The pre-assembly operations maintain a set of sequentially operational activities that bring with them a great demand for energy, work and concentration by the operator. The main demands of these work stations are concentrated in the inadequate postures in which the task is developed, the short cycle times, the manual handling of the loads and the contact stress. These demands as a whole increase the possibility that the worker develops in Skeletal Muscle Disorder and, in turn, have been affected by the productive performance of the work station.

The comparative results of the work stations before and after the redesign show a substantial improvement, both in the reduction of the risk of the work station and in the operative results of this. The quantitative values of risk reduction from the application of the RULA method show a decrease of 7 to 3 in its final result. In the bimanual diagram a balance is shown between the activities developed by both hands. The productive results of the workstation are improved with the 40%

decrease in the cycle time of the operation, which is indexed with a 65% increase in the volume of production obtained by the work station.

With the results described above, there is a considerable decrease in the possibility that the worker has a Skeletal Muscle Disorder, while the operative results of the work station maintain a considerably high percentage of improvement. With all of the above, it is possible to sustain that by framing the principles of occupational biomechanics and ergonomic guidelines in the redesign of buffer shelves in pre-assembly operations, the negative impact of work on the operator is reduced and the operational results of the work station, improving the quality of life of the operator and the business results of the production lines in the maquiladora and manufacturing industry located in the Northeast of the State of Sonora.

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ERGONOMIC ASSESSMENT OF THE PACKING STATION IN A MANUFACTURING COMPANY

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Resumen: De acuerdo con la literatura, existen diversos factores de riesgo ergonómico, entre los cuales se encuentran los movimientos repetitivos, el incorrecto manejo manual de cargas, y las posturas de los diferentes segmentos corporales al realizar un trabajo. A pesar de los múltiples métodos de evaluación y de diseño ergonómico, hoy en día, se siguen presentando estos factores de riesgo ergonómico dentro de las empresas de manufactura en México. Tal es el caso de una empresa ubicada en la ciudad de Tijuana. En esta empresa, específicamente en la estación de empaque, se detectó que una trabajadora adoptaba posturas incómodas al realizar su trabajo. Es por ello que en esta investigación se pretende conocer el nivel de riesgo laboral causado por las posturas. Se evaluaron sólo dos posturas del lado izquierdo. Para ello se aplicó el método RULA utilizando el software online de la plataforma de Ergonautas. Además, se aplicó un cuestionario de dolor ocupacional. Los resultados indicaron que la persona ha sufrido de dolor en los codos, y que el actual diseño de la estación de trabajo, así como la tarea representan un riesgo para el trabajador, por lo que es necesario rediseñar la estación, así como el método de trabajo.

Palabras clave: Riesgo postural, evaluación ergonómica, RULA, estación de empaque

Relevancia para la Ergonomía: Este proyecto aporta a la Ergonomía ocupacional por el hecho de que promueve el análisis y diseño ergonómico dentro de una empresa de manufactura antes de que se ponga en marcha la norma NOM-036-STPS-2015 de la Secretaría del Trabajo y Previsión Social (STPS), la cual se ocupa de auditar los factores de riesgo ergonómico.

Abstract: According to literature, there are several ergonomic risk factors, such as repetitive movements, the wrong manual material handling, and the postures of different body segments when a task is performed. Although there are different ergonomic evaluation and design methods, nowadays, these risks factors still exist in the manufacturing companies in Mexico. Such is the case of a company located in Tijuana. In this company, specifically in the packing station, a female employee was farced to adopt uncomfortable postures when performing a task. Due to this, this research aims to know the occupational risk level caused by the body postures. Two body postures were evaluated from the left side. As method, the RULA was applied by means of the online software available in Ergonautas. In addition, an occupational pain survey was applied. Results indicated that the employee has suffered of pain in her elbows. Also, results indicated that the current design of workstation and the work method are a risk factor to the employee. Then, it is necessary to redesign the workstation and the work method.

Keywords: Postural risk, ergonomic assessment, RULA, packing station

Relevance to Ergonomics: This project contributes to occupational Ergonomics in the fact that it promotes the ergonomic analysis and design in a manufacturing company before the norm NOM-036-STPS-2015 of the Ministry of Labor and Social Security (Secretaría del Trabajo y Previsión Social) goes into effect.

1. INTRODUCTION

According to the International Ergonomics Association (IEA), Ergonomics is defined as the scientific discipline that deals with the understanding of interactions of human being with other elements of a system, and the profession that applies theories, principles, data and methods to the design in order to optimize human wellbeing and the general performance of the system (International Ergonomics Association (IEA), 2016). More specifically, the objective of Ergonomics is to preserve the employee's health, comfort and safety conditions (Tirado, 2016), since, according to literature, a healthy, comfortable and safe environment helps improve the occupational performance (Dul & Neumann, 2009). On one hand, there are several factors that may affect employee' health, safety and comfort. These factors include environmental elements, such as lighting (Nava, Castro, Rojas, & Gómez, 2015; Omidiandost, Sohrabi, Poursadeghiyan, Yarmohammadi, & Mosavi, 2015), noise (Lee, Lee, Jeon, Zhang, & Kang, 2016; Nava et al., 2015), temperature (Califano, Naddeo, & Vink, 2017; Nava et al., 2015), etc.; awkward and uncomfortable postures adopted by employees for each one of the different body segments (neck, trunk, arms, legs) in order to perform a specific task (Nava et al., 2015; Shirzaei, Mirzaei, Khaje-Alizade, & Mohammadi, 2015); psychosocial factors, such as mental workload, and work demands (Pereira, 2014); among others. On the other hand, there are several methods to perform ergonomic assessments. These methods allow determining if a workstation offers a healthy, comfortable and safe environment for the employees. Specifically, there are several methods that allow perform ergonomic assessments of body postures. Such methods include the Rapid Entire Body Assessment (REBA) (Hignett & McAtamney, 2000), the Ovako Working Posture Analysis System, (OWAS) (Esen, Hatipoglu, & Figlali, 2016), and the Rapid Upper Limbs Assessment (RULA) (Dockrell et al., 2012; McAtamney & Nigel Corlett, 1993), among others.

In Mexico, different studies on the ergonomic evaluation in manufacturing companies have shown that there is a lack in the application of ergonomic improvements, since different risk factors have been found (awkward postures, manual material handling, and work load) (Hernández, Brunette, Ibarra, & García-Alcaraz, 2012; Hernández, Castillo, Serratos J., & García-Alcaraz, 2015;

Maldonado-Macías, Alvarado, García, & Balderrama, 2013; Maldonado-Macías, Realyvásquez, Hernández, & García-Alcaraz, 2015). For instance, in a company that manufacture computer equipment, it was found that in the employee in the repairing task was exposed to postures that represented a high risk level and that favors the appearance of musculoskeletal disorders (MSDs) (Maldonado-Macías et al., 2015). In addition, it has been detected that employees are exposed to physical demands due to manual handling of materials whose weight ranges from 3 kg to 14 kg. This leads a decrease in energy and an increase in fatigue of employees, which in turn causes a decrease in their occupational performance (Hernández et al., 2015). Also, it has been noted that activities required to manipulate advanced manufacturing technology (AMT), demand physical and mental efforts in a combined way, which causes premature fatigue in employees (Hernández et al., 2012). These backgrounds served as the basis to the case of a female employee in the packing station in a manufacturing company located in Tijuana, Mexico. To perform her work, this employee is forced to adopt uncomfortable postures for the different body segments, which can favor the appearance of MSDs.

2. OBJECTIVES

Backgrounds stated above highlight the need to perform different ergonomic assessment interventions in manufacturing companies. Therefore, the objective of this research is to perform an ergonomic evaluation of the postural risk level in the packing station.

3. LITERATURE REVIEW

3.1 Occupational Risk

Occupational risk is defined as any aspect of work that has the potential to cause harm (Parra, 2003). There are diverse types of occupational risks caused by different activities and the environment where these are performed. Occupational risks can be classified in risks caused by safety conditions, risks of physical environment, risks of biological and chemical contamination, work organization, and workload (Parra, 2003). In the case of the last type of occupational risk, workload, there are several factors that may cause it and generate fatigue and MSDs in employees. Such factors include repetitive movements, requirements of excessive force, and body postures adopted by employees and the time these postures are kept (Parra, 2003). It is in this last risk factor on which this research focuses.

3.2 The RULA Method

The RULA method assesses concrete postures adopted by employees. Such assessment is performed by direct observation while employees perform their activities (Singh, Lal, & Kocher, 2012). Moreover, RULA also evaluates the number of movements performed, static muscle work, and the use of force (Escalante, 2009), what can favor the appearance of MSDs (Rodríguez-Ruíz & Guevara-Velasco, 2011). To perform this evaluation, RULA divides the body into two groups of segments : A) arm, forearm, and wrist; and B) neck, trunk and legs (Escalante, 2009; McAtamney & Nigel Corlett, 1993). Each body side, left and right, is evaluated in an independent way (Diego-Mas, 2015; Escalante, 2009). RULA uses an evaluation format that includes figures of the positions adopted by the worker for each of the different body segments. The final score provided by the RULA method ranges from 1 to 7, and it is proportional to the risk involved in the task, so that higher values indicate greater possibilities of injuries at musculoskeletal level, guiding the evaluator on the decisions to be taken after perform the analysis (Escalante, 2009). Table 1 presents the risk levels and the actions required to reduce such risk (Escalante, 2009).

For the lower risk level, level 1, the RULA score is 1-2. At this case, the posture is acceptable, and changes are not required; whereas for the higher risk level, level 4, the RULA score is 7, and changes must be implemented immediately to decrease such risk level.

Table 1. Risk and action levels in RULA

Risk level	RULA score	Action level
1	1-2	Posture is acceptable, and changes are not required
2	3-4	In-depth research is required, it is possible to make changes.
3	5-6	It is required to redesign the task; it is necessary to carry out research activities.
4	7	Immediate changes are required.

When results are obtained, the evaluator will have a clearer vision about potential occupational risks that can be caused by the analyzed task. This will allow applying ergonomic interventions to improve postures adopted by employees to decrease the risk level to suffer MSDs. At long term, this will benefit both employee and company.

4. METHODOLOGY

Methodology proposed in this research is cross-sectional and non-experimental type. Materials used in this research, data of the worker and the task analyzed, as well as the procedure applied to determine the level of occupational risk in the packing station, are mentioned below.

4.1 Materials

Materials used to carry out this research were the following:

- Computer laptop HP.
- Photo/Video camera in cell phone Samsung Galaxy J7.
- Occupational pain survey

- Online software of RULA (Diego-Mas, 2015).

4.2 Employee

The ergonomic assessment includes a single employee of the above-mentioned task. This is due to limitations imposed by the company. The participant employee is a person of the female gender, who has an age of 50 years, and 8 years of experience in the task analyzed. As for the working day, the employee is in the packing station for 9 hours, six days for week.

4.3 Procedure

In this research, methodology is composed by six stages, which are described below.

Stage 1. Contact with the manufacturing company: The contact with the company is performed by means of a student of the Master's in Industrial Engineering in the Postgraduate Mode with Industry of the Technological Institute of Tijuana (Instituto Tecnológico de Tijuana), since the student works in the mentioned company.

Stage 2. Presentation of the project: Once the company is contacted, authors present the project, its objectives and the benefits it will bring to the company.

Stage 3. Selection of the task to be evaluated: To select the tasks to be evaluated, authors observe the body postures adopted by the employee when performing the different tasks. In a first visual analysis, the task of packing was selected. Due to impositions of the company, only this task is analyzed. Figure 1 shows the body postures adopted by the worker when performing this task.

Figure. 1. Task of packing

Stage 4. Analysis and evaluation of the selected task: Once the task is selected, a camera is placed to record the movements performed by the employee (postures and time of exposure) to avoid disturbing her at the time of evaluation. Subsequently, the recording is analyzed to detect the most critical postures at the time of carrying out the task. Then, the RULA method is applied by means of the Ergonautas.upv.es platform to obtain an overall assessment of the level of risk associated with the task analyzed. To obtain the angles of displacement of the body segments, we use the tool of RULER, which allows to measure the angles between different members of the body on photographs. Figure 2 shows the postures to be analyzed (posture A and posture B) and some of the angles adopted during the execution of the task of packing. It is necessary to mention that only the left side was evaluated, then, results section will exclude the right side.

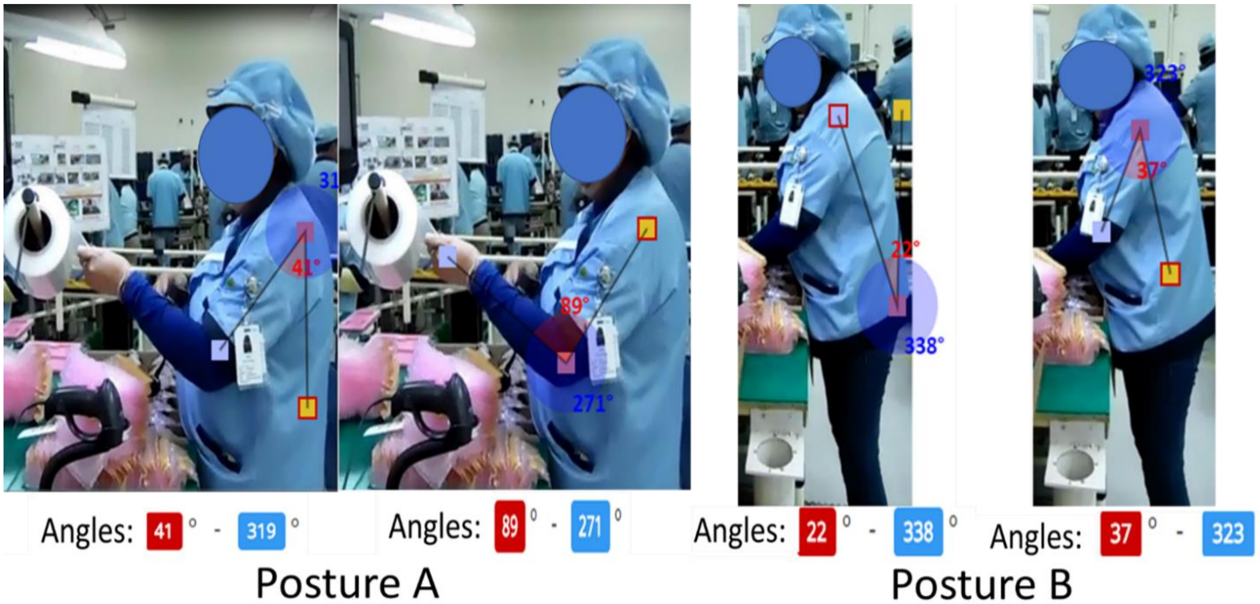

Figure 2. Postures selected to be analyzed and some angles

Stage 5. Analysis of results: Results obtained are analyzed taken as reference the risk levels showed in Table 1. Based on this analysis, postures with elevated risk level are determined. Lately, proposals for ergonomic improvement are developed.

Stage 6. Proposal for ergonomic improvement: Ergonomic proposals are made according to relation between the stature of the operator and the high of the workstation. A meeting is called to propose ideas regarding improvements in the design of the technology used and the workstation.

5. RESULTS

Results obtained from the occupational pain survey indicated that the employee of the packing station had experienced pain in her elbows. Respect the results of the postural risk level, Table 2 shows the results of the ergonomic assessment for each posture.

Table 2. Results of ergonomic assessment for posture A and posture B

Posture A		Posture B	
Body segment	RULA score	Body Segment	RULA score
Upper arm	2	Upper arm	2
Upper arm abducted	+1	Upper arm abducted	+1
Lower arm	1	Lower arm	2
Wrist	2	Wrist	2
Wrist bent	+1	Wrist bent	+1
Wrist twist	1	Wrist twist	2
Neck	1	Neck	1

Trunk	2	Trunk	3
Legs	2	Legs	2

In addition to information showed in Table 2, it is necessary to mention that in both postures, the activity is repetitive (arms) or static (legs) for more than one minute, which added +1 to each group (group A: Upper arm, lower arm, and wrist; group B: neck, trunk and legs) for each posture analyzed. In the case of force/load, a force/load lower than 2 kg exerted in an intermittently, which did not add any point. Figure 3 shows the final RULA score for posture A and posture B. As can be seen, in both assessments the result is to redesign the task or work station.

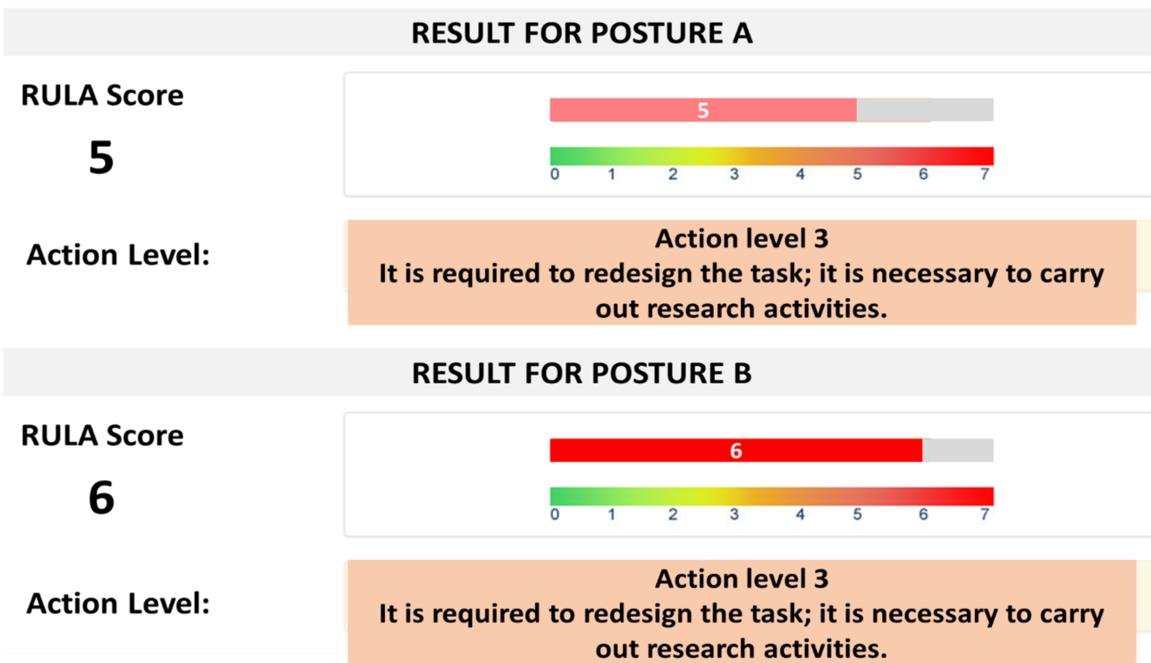

Figure 3. RULA score and action level for postures A and B

6. CONCLUSIONS AND RECOMMENDATIONS

The general objective of this project was achieved, since a result about the postural risk and action level in packing station was done. In addition, the workstation and work method need to be redesigning to decrease the postural risk level. Redesign actions must be focused on those body segments with higher scores, such as upper and lower arm, wrist, trunk, and legs.

As recommendations, authors proposed the following:

a) Perform an anthropometric study and redesign the work station according to anthropometric principles. After this, it is suggested to hiring only employees that meet the anthropometric requirements.

b) Add a high chair that allow the employee to change of posture (standing and

sitting).
c) In the redesign of the workstation, include armrest.
d) Include a collaborative robot.

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INDUSTRIAL ALARM: VISUAL, AUDITORY AND ODORIFIC.

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RESUMEN: Existen muchas alarmas industriales para el sentido de la vista y del oído, pero ninguna para el sentido del olfato, en este trabajo trataremos sobre las alarmas industriales odoríficas, para cuando se tiene alguna discapacidad en la vista o en el oído que tan frecuentemente se dañan a nivel trabajo industrial por el constante nivel de ruido y por el cansancio visual de los empleados en tareas rutinarias y la podemos sustituir con otro sentido, el sentido del olfato, que reaccionarán inmediatamente a un olor desagradable y los pondrá de nuevo en alerta para atender una emergencia en donde se pone en peligro la vida del operario o la integridad del mismo o daño a la línea de producción o los equipos industriales. Utilizamos los principios de la Ergonomía y el diseño de puestos de trabajo para elaborar el prototipo (Mondelo, 2009; Ramírez, 1991; Oborne, 1987) y también atendiendo a las personas con capacidades diferentes en el ámbito laboral como lo dictan las leyes promulgadas por los expresidentes (Calderón, 2011; Fox, 2005).

Palabras claves: Sentidos de la vista, oído y olfato.

Abstract: There exist several industrial alarms for the sense of sight and hearing, but none for the sense of smell. In this work we will attend with the odorific industrial alarms, for when there is a disability in sight or hearing, senses that are frequently damaged at the industrial level due to the constant noise level and the visual fatigue of the employees in routine tasks, and we can substitute the danger measure with another sense, the sense of smell, which will make an immediate react to an unpleasant odor and put them back on alert to attend an emergency where the life of the operator or its integrity is at risk or damage to the production line or the industrial equipment.

We must also include people with different abilities to work systems as published by the federal government, first with President Vicente Fox Quezada in 2005 General Law on Persons with Disabilities text in force New Law published in the Official Gazette of the Federation June 10, 2005 and later with President Felipe Calderon Hinojosa in 2011 in the General Law for the inclusion of people with disabilities New Law DOF 30-05-2011 the Chamber of Deputies of the H. Congress

of the Union that in its Chapter II of Labor and Employment in its Article 11. The Ministry of Labor and Social Welfare promote the right to work and employment of persons with disabilities in equal opportunities and equity, which gives them a personal, social and work development.

Key words: Senses: sight, hearing and olfaction.

Contribution to Ergonomics: If we take into account the meaning of ergonomics we have: Ergonomics is the discipline that is responsible for designing workplaces, tools and tasks, so that they match the physiological, anatomical, psychological and capabilities of an employee. It seeks the optimization of the three elements of the system (human-machine-environment), for which it creates methods of study of the person, the technique and the organization. The present article links perfectly with ergonomics. Our contribution would be to include the sense of smell in the work area.

1. OBJECTIVES:

Design an industrial alarm: visual, auditory and odorific.

2. DELIMITATION:

Industrial area, but it could have applications in: supermarkets or consumer stores, cinemas, in transport or even in households. A prototype will be designed for an industrial plant.

3. METHODOLOGY:

Firstly, focusing on the human being, in our sensory system, we have the 5 senses: sight, hearing, taste, smell, and touch. See Fig. 1

Fig. 1 The five senses in the human body.

Smell is the sense in charge of detecting and processing odors. It is a chemoreceptor in which the aromatic or odoriferous particles detached from the volatile bodies act as stimulants, entering through the olfactory epithelium located in the nose, and are processed by the olfactory system.

The human nose distinguishes between more than 10,000 different smells. Odorous substances are volatile chemical compounds transported by air. Odorous objects release molecules into the atmosphere that is perceived by inhalation. These molecules reach the olfactory mucosa, that consists of three characteristic types of cells: the sensory olfactory cells, the glial cells and the basal cells, which divide approximately once a month and replace the moribund olfactory cells. The 20 or 30 million human olfactory cells contain, at their anterior end, a small head with about 20 small sensory filaments (cilia). The aqueous nasal mucus transports the smell molecules to the cilia with the help of fixative proteins; the cilia transform the chemical signals of the different smells into electrical responses.

Second in the design of the prototype we have to refer to the man-machine interface.

Geometrical ergonomics makes it possible to act in the design of spaces, machines and tools that shape the person's environment, which is nothing more than the means it uses to communicate or meet their needs at work or at leisure. The set of tools and mechanisms, their environment and the user form a unit that we can define and analyze as a P-M system, considering, not only the values of interaction of variables, but also the synergistic relationships.

We can classify these systems according to the degree of interaction quality between the user and the elements of the environment; using a commonly accepted classification, we would obtain three basic types of interaction systems:

1. Manual.
2. Mechanic.
3. Automatic.

We will take the design of an industrial alarm according to the anthropometry of the population that will use said alarm and obtain an adequate and functional ergonomic design.

In order to design an alarm, we must first know what an alarm is, they are:
Devices that transmit urgent information quickly and clearly, are handled with a bit of information (yes-no) without other alternatives, their meaning must be known by all operators in the workplace, they are used to be related to sound alarms to get attention and must have a certain flicker.

The interrelation between the alarm (informative devices) that will send you information through the sensory receptors in this case: visual, auditory and odorific, with the human being that will process the information and make the decision to issue the execution order for operate the controls within your reach to execute the order by means of devices and attend the alarm triggered by the automatic device, which closes the control feedback cycle. See Fig. 2.

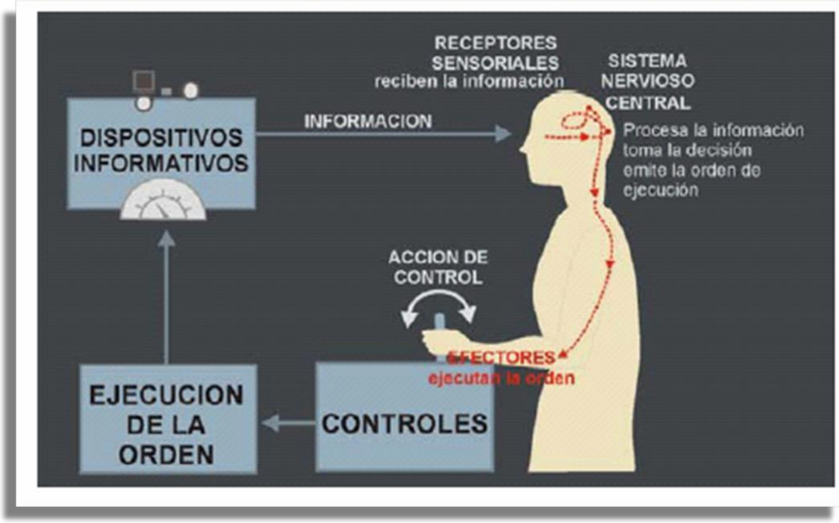

Fig. 2 Interrelations between the man-machine system.

An example of the visual and auditory alarms currently in the industry. See Fig. 3.


Fig. 3 Current industrial alarms.

Third Implementation of the prototype in the industry.

According to several authors, there are seven basic odors that, mixed together, result in the whole range of smells that human beings can perceive. See Table I.

TABLE I.- THE SEVEN PRIMARY ODORS.

Tipo de olor	Ejemplo
1. Éter	Líquido de limpieza en seco
2. Floral	Olor a rosas
3. Menta	Olor a hierbabuena
4. Acre	Vinagre
5. Alcanforado	Protección contra la polilla
6. Almizclado	Algunos perfumes
7. Pútrido	Huevos podridos

We use two basic smells putrid and floral sprays in glass containers by means of a linear actuator will activate atomizers with a fan and take the scent to the workers. See Fig. 4

Fig. 4 Atomizer, linear actuator and fan.

Prototype general view. See Fig. 5.

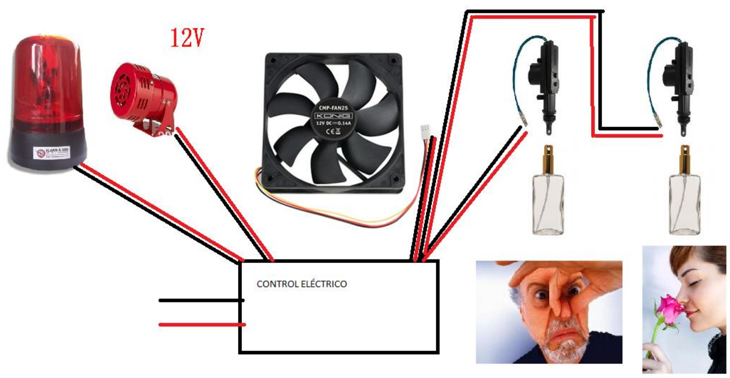

Fig. 5 General view of the prototype.

And finally, we get an industrial alarm with the 3 senses: sight, hearing and smell within a single device that can be placed on top of a machine that the worker is operating or on a wall like any other alarm of an adequate size to an industrial environment. See Fig.6

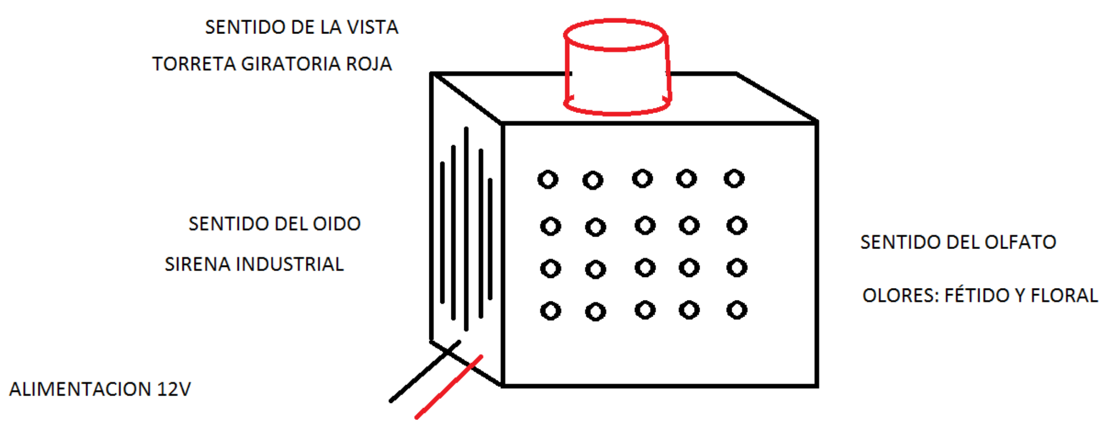

Fig. 6 Industrial alarm: visual, auditory and odorificial.

4. RESULTS

There were accomplished very good results, and were tested in a pilot plant in the industry, it is an affordable solution.

5. CONCLUSIONS

This alarm can be created in any industry, in small modules for each operator or in large modules that involve a whole area of work of several people or in the entire industry at the plant level.

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ERGONOMIC ASSESSMENT IN THE DEPARTMENT OF IGNITIONS (SUB – ASSEMBLY) IN AN ASSEMBLY PLANT FROM LOS MOCHIS

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Resumen: Cada día son más evidentes las consecuencias negativas que produce un puesto de trabajo mal diseñado para la salud de los trabajadores y para la propia productividad de la empresa. Ante esta situación, en los últimos años, algunas empresas han empezado a prestar atención a la ergonomía para proteger la salud de los trabajadores y para aumentar la calidad y productividad. En el estudio realizado, se determinó el nivel de fatiga física (disminución de la capacidad física) que se presenta en los trabajadores al tener una semana de trabajo comprimida, así como también el riesgo de DTA's (desórdenes de trauma acumulativo). Para obtener los resultados, se utilizaron los métodos de evaluación ergonómica Yoshitake, 4 puntos de Luke, Corlett y Bishop y ART tool. Los resultados de método Yoshitake, indican que la principal causa de fatiga es la monotonía, el análisis se realizó durante tres semanas y hay una variación significativo en los resultados de la primera semana y la tercera semana. En el método de 4 puntos de Luke la mayoría de los operadores reportan que inician el turno sin cansancio y finalizan su jornada cansados. Con el método Corlett & Bishop se constató que existe riesgo de que los trabajadores sufran desórdenes de Trauma Acumulativo (DTA's) en los pies, cabeza, piernas y hombros. Los resultados del método ART tool nos indicaron que los movimientos y posturas que realizan los operadores al hacer sus tareas son riesgosos por lo cual es necesario rediseñar la estación de trabajo.

Palabras clave: Fatiga, DTA's, Planta de ensamble

Abstract: Each day, the negatives consequences that a bad design of a workplace produces are more evident because they affect the worker's health and the enterprise productivity. Faced this situation, recently, some companies have begun pay attention to ergonomics in order to protect the workers´ health and increase the quality and productivity. Into the research realized, the result established the level of physical exhaustion (diminution of physical ability) that workers present after a compressed workweek, as well as the risk of cumulative trauma disorders (DTA's).To obtain the results, they were used the ergonomic assessment methods like Yoshitake, 4 points of Luke, Corlett & Bishop and ART tool. The results from Yoshitake method indicates that the main cause of fatigue is the monotony; the analysis was make for three weeks with a significant variation in the results from the first week and the third week. In the 4 points of Luke method, the majority of the operators report that they commence the shift without tiredness and conclude the day tired. With the Corlett & Bishop method, they confirm the risk existent to suffer cumulative trauma disorders (DTA's) in feet, head, legs and shoulders. The results of ART tool method indicates that the movements and postures on doing the work are dangerous for the operators, therefore is necessary to redesign the workplace.

Keywords: Fatigue, DTA's, Assembly Plant

1. INTRODUCTION

In recent years, Mexico has been increase the number of assembly companies and the personnel that works in them. In the majority of this work centers the work schedule is under the diagram of compressed workweek, which consist to work the same hours during the week but in fewer days, therefore they work more hours per day. A way of work with this diagram is working 12 hours shifts, where the workers go from Monday to Thursday and then rest from Friday to Sunday. The benefits to operators from this schedule are that work 4 days, one after the other, it left enough time to rest and recovery, also the days of rest are during the weekend. Nevertheless, work 12 hours continuous in a day, during 4 days one after the other may lead to tiredness or fatigue.

At present, there is not datum from private or governmental organisms about the application in Mexico of the diagram of compressed workweek. In addition, it wasn´t found information about fatigue behavior, DTA's, quality and productivity in 12 hours shifts inside this type of companies.

The enterprise where the research was carrying through is an assembly plant where the operators work under the diagram of compressed workweek with a physical overloading. Therefore, is very important to determine by means of an ergonomic assessment, if the plant workers get tired after work 12 hours for 4 days a week, and establish, if they present compound trauma disorders because of carry out repeated activities and over exertion.

In the department of ignitions (sub – assembly) from Assembly Company, the product is reprocess continuously because the mistakes or inattention from workers. The operators from this area complain about suffering ache in some parts of the body and argue that the mistakes they make are because of the tiredness caused of carry out repeated activities during continuous hours without rest. The present study will help to personnel from the ergonomics area to identify their growth opportunity to improve the workstations into this department.

2. OBJECTIVE

Carry out the ergonomic assessment from the positions into the department of ignitions (sub – assembly) from Assembly Company with the purpose to suggest improves.

2.1 Specific objectives

Evaluate the fatigue by means of the Yoshitake survey and the scale of 4 points of Luke. Identify the ergonomic risk factors that generate compound trauma disorders with the mapping of Corlett & Bishop and the ART tool method.
Suggest improves based on the ergonomic principles for the workplaces design.

3. METHODOLOGY

3.1 Subjects

In the research, the operators collaborated (seven women and three men) who integrate the department of ignitions (sub – assembly) of the company, which make repeated activities using the upper limbs. The operators who work the diurnal shift of 12 hours from Monday to Thursday, related to be healthy and accept voluntarily to participate in the study. It applied to all the participants each one of the ergonomic assessment methods (Yoshitake, 4 points of Luke, Corlett & Bishop and ART tool).

3.2 Procedures

The study was make during a period of 21 days, of which only were evaluated 12 workdays. Considering that the company works 4 days and rests 3 days, it completed three work cycles (3 weeks).

At the beginning of the study the movements, positions and ranges made by operators were observed during the working day. In the 12 hours shift, the assessments of fatigue and compound trauma disorders risks made at the beginning and at the end.

Were used four different ergonomic methods. To determine the fatigue it was applied the Yoshikate and 4 points of Luke methods, while the compound trauma disorders risk evaluated with the Corlett & Bishop and ART tool methods.

3.3 Methods

3.3.1 Yoshitake questionnaire

The Yoshitake fatigue subjective symptom test is a questionnaire that measures the types and magnitudes of fatigue that workers present. It measures three dimensions of the subjective perception of work fatigue by asking ten questions for mixed symptoms (psychic and physical), ten questions for the mental requirement at work (psychic) and finally ten for the physical manifestations of fatigue (Yoshitake, 1978).

The questions are designed in such a way that they require a dichotomous response (YES / NO), those who respond affirmatively to 6 or more symptoms in the case of men and 7 or more in the case of women are considered fatigued. This tool was applied successfully in different Latin American countries, such as Mexico, Cuba, Argentina, Venezuela, Brazil and others.

3.3.2 Luke’s 4 points scale

Luke et al. (1999), used a scale to determine the level of fatigue. On this scale, called Luke's 4 points, fatigue levels are cataloged after a normal work day, where the scale of measurement is as follows: "Nothing tired" 1 point, "tired" 2 points, "very tired "3 points and" extremely tired "4 points.

3.3.3 Corlett and Bishop Map

The mapping of Corlett and Bishop (1976), is a subjective tool that assesses the direct experience of the interviewee of suffering pain or discomfort in one or several parts of the body. This method of ergonomic evaluation helps to determine the presence of cumulative trauma disorders.

3.3.4 Art tool

The ART tool uses a numerical score and a traffic light approach to indicate the level of risk for twelve factors: frequency and repetition of movements, force, working posture, duration of exposure, working environment, psychosocial factors and others factors. These factors are grouped into four stages:
A: Frequency and repetition of movements
B: Force
C: Awkward postures of the neck, back, arm, wrist and hand
D: Additional factors, including breaks and duration

The factors are presented on a flow chart, which leads you, step-by-step, to evaluate and grade the degree of risk. The tool is supported by an assessment guide, providing instruction to help you to score the repetitive task you are observing. There is also a worksheet to record your assessment.

4. RESULTS

4.1 Yoshitake questionnaire

Tables 1 and 2 show the result of the Yoshitake questionnaire at the time of arrival and departure respectively.

Table 1. Yoshitake Questionnaire (arrival)

No.	WEEK 1			WEEK 2			WEEK 3		
	Drowsiness and dullness	Difficulty of concentration	Physical impairment	Drowsiness and dullness	Difficulty of concentration	Physical impairment	Drowsiness and dullness	Difficulty of concentration	Physical impairment
1	7	0	1	13	4	9	12	0	5
2	12	3	7	15	5	10	10	8	2
3	14	3	6	18	1	3	19	3	5
4	18	2	5	19	3	5	14	0	4
5	8	1	3	12	2	6	15	2	14
6	5	0	2	5	3	5	15	4	6
7	5	1	7	20	8	10	15	5	13
8	18	2	9	8	2	5	16	0	11
9	4	2	5	20	3	12	9	2	7
10	8	1	2	10	3	4	6	2	4
TOTAL	**99**	**15**	**47**	**140**	**34**	**69**	**131**	**26**	**71**

Table 2. Yoshitake Questionnaire (departure)

No.	WEEK 1			WEEK 2			WEEK 3		
	Drowsiness and dullness	Difficulty of concentration	Physical impairment	Drowsiness and dullness	Difficulty of concentration	Physical impairment	Drowsiness and dullness	Difficulty of concentration	Physical impairment
1	15	3	15	17	0	10	6	0	0
2	15	0	8	21	2	13	10	3	5
3	25	5	15	20	5	11	20	2	6
4	25	4	9	21	2	6	25	2	10
5	15	3	7	18	0	7	18	4	10
6	15	5	5	12	3	12	21	9	16
7	15	3	6	28	7	20	25	4	15
8	12	4	8	10	2	11	20	2	5
9	15	5	17	20	5	22	8	2	9
10	10	3	4	12	0	8	10	1	4
TOTAL	**162**	**35**	**94**	**179**	**26**	**120**	**163**	**29**	**80**

4.2 Luke’s 4 points scale

Table 3 presents the results of the ergonomic evaluation performed with Luke's 4-point scale.

Table 3. Luke's 4 points results

	WEEK 1		WEEK 2		WEEK 3	
	ARRIVAL	DEPARTURE	ARRIVAL	DEPARTURE	ARRIVAL	DEPARTURE
NOTHING TIRED	27	7	16	5	15	4
TIRED	8	22	19	31	18	26
VERY TIRED	4	9	4	3	6	9
EXTREMELY TIRED	1	2	1	1	1	1
TOTAL	40	40	40	40	40	40

4.3 Corlett and Bishop map

Table 4 contains the data of the Corlett and Bishop's method application at the arrival (A) and departure time (D).

Table 4. Corlett and Bishop map results

	WEEK 1				WEEK 2				WEEK 3			
	PAIN		DISCOMFORT		PAIN		DISCOMFORT		PAIN		DISCOMFORT	
	A	D	A	D	A	D	A	D	A	D	A	D
Head	11	6	6	6	6	2	6	7	10	12	3	2
Neck	0	0	8	4	0	0	2	6	0	0	2	3
Shoulder	0	3	9	6	2	1	3	10	0	2	6	8
Upper arm	1	2	1	0	0	0	1	4	0	1	2	1
Lower arm	0	0	2	1	0	0	1	5	0	0	2	1
Wrist/Hand	0	3	1	1	0	0	1	5	1	3	2	2
Upper back	0	3	4	9	2	4	2	7	2	4	4	5
Mid back	1	2	5	5	3	5	4	8	0	4	5	7
Lower back	0	2	4	7	3	4	4	8	0	4	4	7
Buttocks	0	0	1	0	0	0	1	5	0	0	3	2
Thighs	0	0	1	0	0	0	2	7	0	0	2	1
Knees	0	0	1	0	0	1	2	5	0	0	2	1
Legs	7	11	3	5	4	9	6	10	2	14	6	7
Ankles	0	0	1	1	0	2	1	5	0	2	2	1
Feet	5	10	4	10	7	12	6	12	5	17	4	6
TOTAL	**25**	**42**	**51**	**55**	**27**	**40**	**42**	**104**	**20**	**63**	**49**	**54**

4.4 Art tool

Table 5 and 6 show the results of art tool method. According to the table of interpretation of results proposed by the method, when the exposure score is greater than 22 it is urgent to make a redesign. For the evaluation carried out in the ignitions department of the company, the exposure score was 61.5, therefore it is urgent to do a redesign.

Table 5. Task description form

Assessor name	Mayra Pérez	**Date** 10/06/17
Company name	x	**Location** LM
Name of task	Ensamble de Módulos de Ignición	
Task description Ver diagrama de proceso		
What is the weight of any items handled?	Ligero	
If items weigh more than 8 kg and the task involves manual handling consider using the MAC		

Which side of the body is primarily involved?	Left		Right		Both	☆

What hand tools are used?	Ninguna
Production rate (if available)	unidades por turno, hora o minuto círculo según corresponda
How often is the task repeated?	Cada 30 segundos

Breaks in the shift
Begin

6:30					12-13		18				

How long does a worker perform the task?	…Without a break	5:30 horas
	…In a typical day of shift	10:30 horas
How often does an individual perform the task? (eg daily, weekly, etc)		De Lunes a Jueves
How often is the task carried out within the organisation? (eg daily, etc)		Diario
Do workers rotate to other tasks? If so, what tasks? No		

Tabla 6. Score sheet

Risk factors	Left arm		Right arm	
	Color	Score	Color	Score
A1 Arm movements	Red	6	Red	6
A2 Repetition	Red	6	Red	6
B Force	Red	12	Red	12
C1 Head/Neck posture	Yellow	1	Yellow	1
C2 Back posture	Green	0	Green	0
C3 Arm posture	Yellow	2	Yellow	2
C4 Wrist posture	Red	2	Red	2
C5 Hand/Finger grip	Red	2	Red	2
D1 Breaks	Red	8	Red	8
D2 Work pase	Green	0	Green	0
D3 Other factors	Red	2	Red	2
Task score		41		41
D4 Duration multiplier		* 1.5		* 1.5
Exposure score		61.5		61.5
Psychosocial factors				

5. CONCLUSION AND RECOMENDATIONS

According with the results of Yoshitake method, can been conclude that the operators present fatigue mainly for the somnolence symptoms and monotony, following the physical damage and last concentration difficulties. The fatigue increases at the same time the workweeks increases and, at the beginning of the day, they feel less tired than the leaving hour.

The scale of 4 points of Luke indicates that the majority of the operators answered to feel not tired at the beginning of the workday during the first week and at the end, they commented feel tired. During the second week, the number of operators who reported feel tiredness to the beginning of the workday increases and at the end they feel exhausted.

According with the mapping of Corlett & Bishop, operators present risks of suffering cumulative trauma disorders mainly in the head, shoulders, legs and feet.

During week 1, in comparison with week 2, the pain indicator is very similar with a slight increase variation in the week 3. In the following indicator is observe that the discomforts are numerous during the 3 weeks, having more discomfort in week 2, following the week 3 and lastly the week 1.

Based on the ART tool method results, the risks factors about which must implement actions of improvement are arm movement, repetition, strength, wrist posture, fingers grip and rests.

Is very important that the company takes precautions with intent to protect the workers' health, therefore is suggest:

- Redesign the workstation.
- Reduce the frequency and repetition of movements.
- Reduce the uncomfortable and forced postures.
- Use ergonomic equipment like appropriate carpets and shoes to avoid discomfort and pain, mainly in feet.
- Reduce the work hours or assign two daily rests at least, for workers body relaxation.
- Improve the enterprise environment (appropriate temperature).

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ERGONOMIC-COGNITIVE ANALYSIS THROUGH PATTERN RECOGNITION, APPLYING INTELLIGENT COMPUTATION

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Resumen: Este documento presenta la propuesta de implementación de un sistema de reconocimiento de emociones mediante cámaras, con la finalidad de relacionarlas a estados anímicos de un ambiente de trabajo. Se presenta la hipótesis de que es las condiciones laborales pueden afectar directamente el estado cognitivo del trabajador, como se presenta en la teoría de la ergonomía cognitiva y que, al realizar un análisis continuo del trabajador, podríamos tomar las consideraciones necesarias para mejorar la calidad del ambiente del trabajador. Se implementan estrategias de reconocimiento de patrones ampliamente verificadas, como las redes neuronales.

Palabras clave: Ergonomía, Cognitiva, tecnologías de la información.

Abstract : This document presents the proposal for the implementation of a system of recognition of emotions through cameras, in order to relate them to mood states of a work environment. The hypothesis is presented that working conditions can directly affect the cognitive status of the worker, as presented in the theory of cognitive ergonomics and that when carrying out a continuous analysis of the worker, we could take the necessary considerations to improve the quality of the environment of the worker. Strategies for recognizing widely verified patterns, such as neural networks, are implemented.

Keywords: ergonomics, cognitive, information technologies

Contribution to Ergonomics. That ergonomic regulations and regulations are assisted by ergonomic analysis strategies supported by intelligent computing and specialized applications. Achieve a broader technology penetration in the sector, through cutting-edge computing strategies and artificial intelligences.

Mexico is the most profitable country in terms of lower costs to do business, emerging as the most competitive country compared to nine developed economies evaluated in the 2016 edition of the Competitive Alternatives guide (Georgi Popov,

2016) (Vidakovic & Mueller, 1991)(Wiebe, 2016), situation that we can interpret as a growing demand for labor in the coming years, so it is essential to pay attention to the quality of working conditions in which these activities will be developed.

Generation of knowledge and the development of support tools to assist in cognitive and anthropometric ergonomic evaluation processes. When implementing pattern recognition technologies, it is intended to carry out exhaustive studies and for long periods of time, a situation that could not be carried out by a person. That the traditional studies of ergonomics are carried out by techniques of analysis by surveys, measurements by sensors, specialized software, just to mention a few (J. J. Cañas, 2004) (Maestre, 2006) .

1. INTRODUCTION

The problem of ergonomics has traditionally been treated from the physiological perspective, through the implementation of anthropometric analysis strategies and design of work spaces. It was only until the 70s, when the interest and need to address the psychological aspects of the worker arises. However, for more than two decades, all efforts focused on the implementation of traditional techniques of analysis and data collection such as questionnaires, surveys or reports, produced mainly by the industrial engineer and / or health personnel, so that the results are subject to the interpretation of the subject that performs the evaluation, its technical and / or physiological limitations.

This proposal on the other hand raises the implementation of intelligent computing strategies, for the attention of industrial engineering problems and analyze human behaviors in industrial activities and thus obtain characteristics of work behaviors that can only be extracted through comprehensive analysis strategies. Expecting to find information that helps to reinforce the knowledge of the area of space design and interaction between the worker and his activities.

It is intended to take advantage of the fact that computers are in all environments of our life and that several disciplines are concerned with their design. Among them, psychology can help us better understand how we interact with our environment in an effective way. Within psychology is cognitive ergonomics, a discipline that studies the behavioral and cognitive aspects that develop in the individual in the human-machine relationship. Intelligent computing can help us in the analysis and interpretation of data and to understand behaviors of this kind of interactions. Particularly the recognition of patterns, focusing on the analysis of human behavior and its application in the detection of biometric parameters with the purpose of alerting about somatic and / or psychosomatic states.

All this indicates us, the need to look for interaction strategies between both techniques and their application in real environments. Therefore, it is sought to apply a software platform specialized in the recognition of biometric patterns, particularly the implementation of video cameras with depth sensors for the identification of facial features associated with cognitive behaviors (moods) and use this information in the investigation of situations of cognitive ergonomics, through the study of complicated analysis scenarios to achieve under traditional analysis techniques.

1.1 Objectives

- ● Develop a coordination strategy between cognitive ergonomics and intelligent computing.
- ● Implement data analysis strategies using intelligent processing techniques, with the purpose of obtaining unobservable patterns at a glance.
- ● Implement the specialized software system in real work environments.
- ● Propose response scenarios, based on the information obtained by the platform.
- ● Improve the quality of the work environment, by attending to the cognitive needs of the worker.

1.2 Delimitation

The present project will be carried out in the manufacturing economic activity in the industrial sector that participates in the region, counting this with 6.52 million employed persons, representing 13.2% of the total employed population of the country (Durazo, 2015); this research will not only concentrate on obtaining data through the recognition of patterns, but also a proposal to take into account ergonomic improvements in the work area.

2. Methodology

The ergonomics of traditional work focuses on methodologically defining the application of corrections in the work environment in an organization. Ergonomics is understood as a multidisciplinary activity that studies the behavior and activities of people with the purpose of adapting jobs. Nowadays systems are able to interpret natural language, such as the identification of emotions. The identification of emotions can be detected through the recognition of patterns through the implementation of depth sensors. The aim is to implement affective computing strategies to meet the needs of cognitive ergonomics, such as pattern recognition, whose function is to describe and classify objects, signals, traits, to name a few.

Pattern recognition works based on a previously established set of all possible individual patterns to be recognized. The range of applications of pattern recognition is very wide, however, the most important are related to vision and hearing by a machine, analogous to human beings. As can be seen, pattern recognition is the most important theoretical basis of biometrics, since a biometric system is essentially a pattern recognition system. (Durazo, 2015).

Cognitive ergonomics. It is the study of human capabilities and limitations, related to the knowledge and processing of information. It focuses on specifying and giving recommendations for adapting the design of information supports to certain user characteristics such as: cognitive processing, central processes, perceptual and perceptive-motor (J. J. W. Cañas, 2001) (Maestre, 2006) (Medina, 2006).

Affective computing. Is the study and development of systems and devices that interact more naturally with humans by an interdisciplinary effort that covers areas as diverse as psychology and computing, just to mention a few. While the origins of the field can be traced back to the philosophical study of emotion was Rosalind Picard (Picard & Healey, 1997) who defines the term affective computing, who proposes it as a strategy to simulate empathy or provide a machine with the ability to interpret the emotional state, adapt its behavior, and provide an adequate response for these emotions. Affective computing technologies perceive the emotional state of a user (through sensors, a microphone, cameras and software logic) and respond through predefined services or products functions (Banafa, 2016).

2.1. Stages of recognition

An input neural network was used by the retro propagation algorithm, in the Python development tool and the Tensorflow library (Martín Abadi, Ashish Agarwal, Paul Barham, Eugene Brevdo et al., 2015), with the following characteristics:

- Neural network of retropropagation, to two layers and eighteen neurons per layer.
- 1000 iterations.
- Cross validation- 10kfold.
- Distribution 70/15/15. Training, testing and validation.
- Mean square error objective a 0.05.

The recognition is done by training with images from CASME databases (Yan et al., 2014), which is a widely used standard for identifying emotions and is composed of a large number of previously labeled images with an emotional state.

Once the classifier was obtained, it was implemented on the OpenCV platform (Bradski, 2000), which is a library that allows you to use the camera of a device, it is not necessary for the camera to be of special characteristics, since you can use a camera type "webcam" and if you use a better resolution camera you will only win image quality, but we will not gain in the recognition rate, because the algorithm detects aspects of the image itself and these only become redundant when the quality increases. The image is displayed on the computer screen, to which tags and points of interest are superimposed as shown in Figure 1.

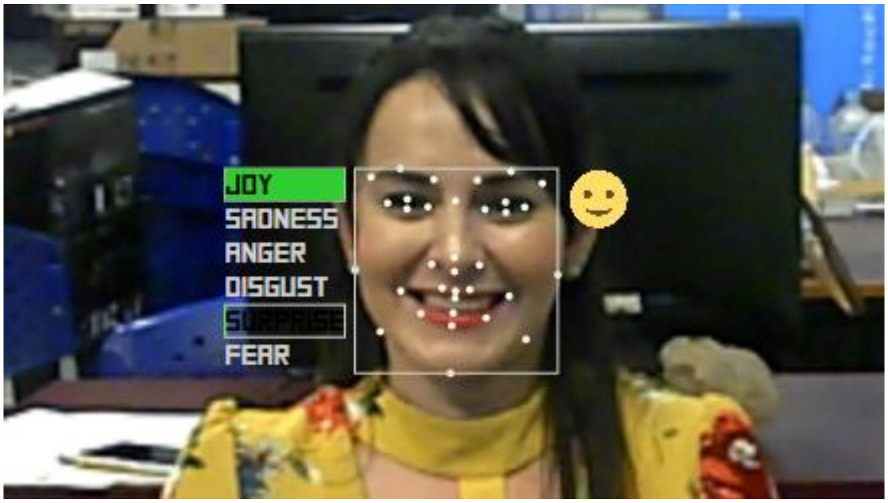

Figure 1. Active recognition of emotional states, through a neural network and OpenCV.

2. 2. Interaction of affective computing and ergonomics.

Because the recognition process will provide us with real-time user psychic information, it is important to create an action plan based on this information, which is why two base states are established: desirable and undesirable states, the former refer to those related to happiness and relaxation or neutral while the seconds to states related to anger and sadness. It is in the unwanted states, in which the intervention of a health professional or of ergonomics will be necessary. However, this system in its first version will only provide reports and notifications of the need to attend to the problems identified, since there is not enough information to create a predictive type system.

3. Results

The acquisition platform is fully developed and tested with the CASME and CASME 2 database(Yan et al., 2014), which allows us to validate recognition scenarios. The recognition rate is stable at 82% and, as already mentioned, the recognition of live emotions through video in real time is one of the most important key points in human-machine interaction. It should be considered that it is estimated that interpretation of basic emotions (fear, anger, joy, sadness, surprise and disgust), reaches 70% in different cultures among their same individuals (Ekman & Friesen, 1971).

The simple question, what is an emotion?, can lead us to a large number of interpretations, which is why it is important to define a model that helps us to interpret the results and thus be able to implement them. Therefore, the emotions and ergonomics interaction model was developed, with which we can establish well-defined parameters that could help in decision-making. This model contemplates four main states, in which two of them are defined as desirable, while two others are treated as opportunity points. That is to say, when the system interprets that the worker's psychic conditions are of low excitement or valence (sadness or anger), the system can warn the personnel in charge to take the measures that are pertinent to them, which is shown in Figure 2 .

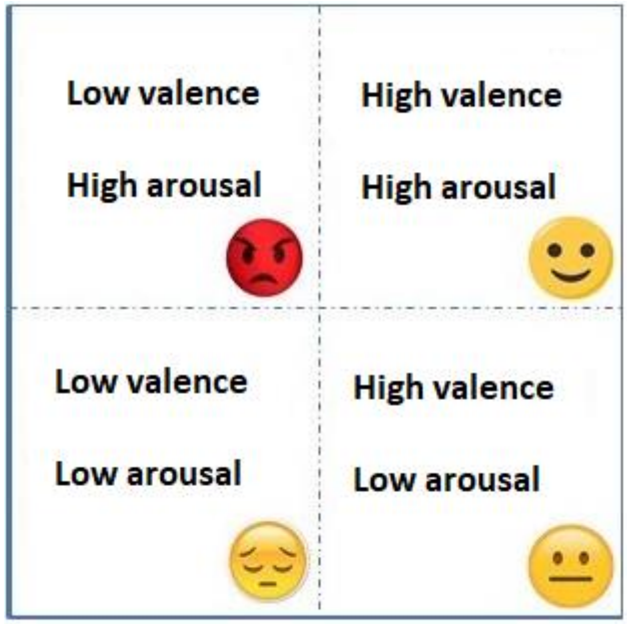

Figure 2. Scheme of distribution of emotional states, according to the Ekman and Russell models (Ekman et al., 1987) (Russell, 1980).

4. CONCLUSIONS

With this study you can see the importance that ergonomic working conditions not only bring benefits to the health of the worker but that it improves the performance in his position. Ergonomics is part of today and it is essential to pay attention to the quality of working conditions in which this activity is developed. The ergonomics can not only be applied in those processes of an industrial work, but in any space or activity, thus achieving a better performance and avoiding possible errors.

Several methods have been used to collect data, human movements or detection of gestures through sensors that detect and capture the movements of the worker. However, these technologies have not focused on the detection of postures through the recognition of patterns and not enough information is obtained from the worker for the analysis and thus be able to perform ergonomic evaluations that in many cases are cases of invasive and high cost methods. In addition to that many of these are obsolete technologies like the Microsoft Kinect ™.

An ergonomic analysis based on intelligent computing and specialized applications was carried out using state-of-the-art computing strategies and artificial intelligences. This project focused on the detection of gestures by means of patterns, the different impacts of emotions were considered; the study of these emotions is important for this investigation since these can affect the way we interact and work, this detection of gestures is an improvement process in which information is obtained from the worker for the analysis and conduct of ergonomic evaluations. This is of benefit to the industry since the monitoring is in real time, it is not invasive, it obtains data in movement, and it stores the information for long periods of time besides being low cost sensors.

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ERGONOMIC FACTORS IN SLEEPING ACTIVITY AND NON-TRAUMATIC NECK PAIN

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Resumen: El Dormir otorga beneficios fisiológicos y espinales; el Sistema de Dormir (SD) debe ser adecuado a cada sujeto especialmente si se padece cervicalgia. Existen muchas propuestas en el mercado, pero con evidencia cuestionable.

Objetivos: 1) analizar la evidencia disponible para saber si factores como la postura, soporte cefálico y la antropometría, fueron considerados; y 2) determinar si esos estudios aportan evidencia para su uso en personas con cervicalgia no traumática.

Material y métodos: Análisis de la literatura publicada en Pub-Med con 5 criterios de búsqueda distintos.

Resultados: De 678 artículos, sólo 28 resultaron útiles, se observaron debilidades como: a) objetivos no enfocados a las variables del SD, predominan enfoques comerciales. b) no se consideran todos los grupos de edad, c) un 39% trabajaron con participantes sanos, d) la clasificación de la cervicalgia fue muy distinta en los diferentes tipos de estudio, e) Los instrumentos utilizados para medir las variables, fueron subjetivos f) sólo 50% de los estudios tienen antigüedad menor a 5 años. Conclusiones: 1) No hay elementos para sugerir el uso de algún implemento para dormir que brinde soporte cefálico adecuado en población sana o en población con cervicalgia, 2) no es posible emitir recomendaciones para el uso o no de implementos para soporte cefálico en personas sanas ni en personas con cervicalgia no traumática.

PALABRAS CLAVE: Neck pain, sleep, pillow

Abstract: Sleeping provides physiologic and spinal benefits; the sleeping system (SS) must be suitable to each individual, specially if that individual suffers neck pain. There are many proposals in the market, but their evidence is questionable. Aims: 1) To analize the available evidence to know if factors such as posture, cephalic support and anthropometry, were considered; and 2) to determine if such studies provide evidence for the use of SS cephalic support by people suffering non-traumatic neck pain. Method: Analysis of Pub-Med published literature, under 5 different searching criteria. Results: Only 28 out of 678 articles were useful, some biases such as the following were found: a) objectives not focused on the variables of the SS, comercial approaches were predominant, b) not all age-groups were considered, c) 39% of issues worked with healthy participants, d) neck-pain classification was different for several types of studies, e)instruments used to measure variables were subjective, f) only 50% of the studies were less than 5 years old. Conclusions: there are no elements to suggest the use of a sleeping implement that gives appropriate cephalic support to healthy population nor to population suffering neck pain, 2) it is not possible to issue recommendations for people to use o avoid the use of implements for cephalic support in healthy populations nor for people with non-traumatic neck pain.

KEYWORDS: Neck pain, sleep, pillow.

CONTRIBUTION TO ERGONOMICS: the sleeping activity has been studied by ergonomics althought not in a thoroughtful way, it has focused on the lumbar region of the spine but not on the cervical region. It has not been considered how this activity can contribute to the worsening of non-traumatic neck pain, by using inadecuate SS or postures. The present document shows a revisión of the state of the art with regards to this issue.

1.-INTRODUCTION

Sleeping is a natural, periodic suspension of consciousness that must ease rest and resstoration (Haex, 2005), (cognitive, muscular, hormonal, etcetera), essentials for health keeping. It provides spinal-disc re-hydration, sleeping in an inadequate way could cause the opposite (Haex, 2005).

Sleeping requires a series of elements, which together make a system. In this study we would call it “sleeping system” (SS) as it was described by Haex (Haex, 2005). This SS encompasses a combination of a matress, box spring, cephalic support (pillow), sheets and blanket.

There are physical, psychological and physiological factors that disturb the sleeping activity; nevertheless, the anthropometric, postural and relative to the SS (cephalic support specifically) are the most important to this research.

There is a great amout of published research, not all has scientific basis, some has medical goals and still other has comercial aims (Dengchuan 2016). Although some SS manufacturers promote having appropriate cervical spine support, not all of them meet the need (Haex 2005).

Optimal SS must ease the natural, horizontal posture, so that the direction of the gravitational vector does not coincide with the diurnal craneo-caudal axis (Haex, 2005) allowing for the rehydration of intervertebral discs.

Existing literatura has focused on low back pain (Ariëns, 2001) (Bendix, 1984) (Straker, 1997), and little on neck pain; during daytime activity, the cervical region is the second most affected spine segment, which can could cause even more severe effects compared to low back pain and in a shorter time period.

The term “Neck pain” is used when any subject has pain for longer than 12 weeks, caused by leaning, extending or flexing the neck (CENETEC 2013). In Mexico, there is no epidemiological research, but in the United States the incidence of cervicalgia is about 28 to 58% (CENETEC 2012). In some alien populations, only 30% of the population report has never suffered neck pain (Cote, 1998).

Neck pain could be of either traumatic or non-traumatic origin. Non-trumatic neck pain could have its origin in daytime activity ergonomic factors (Horton 2010; Cote, 2008). Currently, there is a big offer of cephalic support implements that assure to be a solution, but it is unknown if they really fulfill such sales promotion.

Daytime postures have already been described and the individual can refer to them and help with their correction; but sleeping (activity lasting 6 hours or longer daily) with inadequate SS could cause sleep to be a factor of neck pain worsening instead of generating restoration.

2.-OBJECTIVES

The aims of this study are 1) to analyse the available scientific evidence that allows the description of how the interaction between the human being and the SS has been researched, mainly with regards to craneo-cervical support; in order to know if factors such as posture, type of cephalic support, and anthropometry were considered; and 2) to determine, based on elements of published research (participants, variable measuring instruments, ages and medical condition of participants and finally the age of the publisehd article at interest) if it is feasible to provide proven scientific knowledge to aenable the issue of recommendations with regards to the use of sleeping cephalic support for patients with non-traumatic neck pain.

3.- METHODS

A search was made on PUBMED database using the keywords “neck pain”, “sleep”, “pillow” under five different searching criteria, separately and with joint advanced search, only selecting studies with relationship to the ergonomic analysis of SS, factors relative to posture, implemets of cephalaic support or the anthropometry of participants.

4.-RESULTS

Under the five serching criteria, a total of 678 articles were unfolded, out of which, 628 were not related to the issue of interest, 28 were useful and 22 were duplicated. On tables 1 and 2 we are going to show the results.

Table 1 shows a summary of the articles found regarding each of the searching pattern. It was found that this issue is dealt with from different approaches: a) analysis of people; these studies focus on anthropometric measurements to design novel implements, analysis on how the spine deforms while sleeping; b) analysis of postures; among which outstand: healthy population sleeping postures, sleeping postures in adolescents, (there are studies in couples and in the elderly, although they were not found under this searching criteria); c) analysis of used sleeping implements, these predominate in literatura, but they center on the comparison between existing pillows, testing confortability; analysis of matresses, highlighting their features; d) analysis of diurnal postures and athropometric measurements of the head and neck in patients with neck pain; e) ergonomic factors that originate neck pain; f) neck pain incidence and prevalence studies of so differing populations as people suffering fibromyalgia.

Table 1.- Searching pattern on Pub-Med and their results

Search	1	2	3	4	5	
Keywords	*sleep* / *neck pain* / *pillow*	*neck pain* / *sleep*	*neck pain* / *pillow*	*neck pain* / *pillow*	*neck pain* / *sleep*	Total
Location at paper	*any field*	*title*	*title*	*any field*	*any field*	
Number of papers	8	5	3	30	632	678
Related to issue	7	3	2	3	13	28
Not related		1		18	609	628
Duplicated	1	1	1	9	10	22

According to the aims of the studies, the following was found (number of studies reported in parenthesis): tests on experimental pillows (4), comparison betwen pillows (4), effects of certain interventions over neck pain (4), cervical musculature studies (4), relationship between pain and sleep disturbance (5), long standing consequences of neck pain and other ailments (3), incidence and prevalence studies (2), others (1).

With regards to the analysis of participants, table 2 shows the found data about their age, medical conditions reported on the analized paper. Table 2 will show an description of the population analysed on this issues according to the search criteria mentioned in the Table 1.

Table 2.- Participants and their medical conditions

	Number of participants
Adult	19,401
Teenagers	2,599
	Numer of papers
Healthy	11
With any medical condition	17

Reported Medical conditions	Number of issues
Neck pain (all)	5
Benign Neck Pain	1
Cronic Neck Pain	3
Not traumatic Neck Pain	1
Neck and Low Back Pain	4
Neck/arm/shoulder pain	1

Regarding the instruments used to quantify the variables, it was found that self report was used in 7 studies, 4 used questionnaires, 3 used interviews, 5 physical exploration, 5 standarized measuring instruments, 2 used electromyography, and 2 studies were longitudinal with serial measurements using standarized instruments.

With respect to the age of the studies that the search showed, it was found that 14 (50%) are less than 5 year-old, there are 6 between 6 and 10 years of published (21%), 3 (11%) between 11 and 15 years, and 5 (18%) are older than 15 years, therefore, evidence is not updated.

Analysing 28 useful articles, to our judgement the following biases were found: 1) a total of 11 out of the 28 useful articles (39%) were carried on healthy individual, 2) half of them were undertaken using questionnaires or subjectively testing participants (14 out of 28), 3) some of the participants were paid, 4) some of the studies were paid by one or several of the implements manufacturers, 5) anthropometric measurements did not consider anatomic changes due to age, 6) non of them considered head weight as a variable, 7) only 50% of the studies is less than 5 years old, 8) neck pain was not classified according to international guidelines, therefore it is unclear which type of neck pain was considered for each study.

5.-DISCUSSION

Participants selection is a fundamental part of scientific studies design, so that this allows for the feasibility of extrapolating results to other populations, when a study includes only healthy individual, it can be concluded that the results will not be applicable to non-healthy population. If one study collects data regarding sleeping postures using questionnaires, it is very likely that the results will be inadequate, because sleeping is an unconscious activity, the subject does not control nor knows how many times he moves, nor the postures he adopts, since he will only know the initial sleeping and final waking postures.

If participants are filmed during sleep in laboratories under alien environmental conditions which are different to their sleeping habitual conditions, the results cannot be extrapolated to other populations since conditions such as environmental temperatura and SS consistency are different, and can all be determinant over how many times an individual changes postures during sleep.

If participants are paid for colaborating, it is likely that they will try to please whoever hired them, resulting in a clonflict of interests. When participants were paid by one or several of the cephalic support (pillow) manufacturers there could also be a conflict of interests in the results, even if this was stated in the same study. Since there are studies that manifest that such product advertisement is misleading and states properties of their products even though it has been scientifically proven that they do not comply with those properties (Haex, 2005).

It cannot be considered that a cephalic support can be used by all people if the study based such conclusions on participants with normal anthropometric features.

Not considering the head weight among anthropometric variables is a generalized oversight. This is fundamental data together with the deformity degree of the cephalic support in order to find out if such SS is able to aid with the appropriate cervical support.

If a study was not carried on mexican population, then it cannot be stated with certainty that a cephalic support can be used by our population for cutural diferences.

Lacking adequate anthropometric variations, cephalic support features or postures adopted to sleep in populations in which it is pretended to recommend certain implements imply a great likelihood of risking that such implement would turn inadequate.

The set of evidence, not in isolated studies, but in a single integral one, would be a fundamental piece to consider if a sleeping implement could provide adequate cephalic support to a healthy person or to somenone who suffers neck pain, therefore, it is deduced that if a manufacturer offers these benefits in the advertisement of such implements, this advertisement will be inadequate since it has not been proven with the suitable means and populations, and it would be misleading as already suggested (Gordon, 2009).

Confusing advertisement with regards to an implement that would be used daily can be harmful since it it would cause constant damage. The lack of trustable recommendations would leave individuals in a state of vulnerability by not knowing if an implement is adequate or it is not.

6.-CONCLUSIONS

With regards to the first objective of the study, at this moment, and based on the reviewed scientific literature found on PUBMED database, we can conclude that there are no elements to suggest that any implement to sleep provides cephalic support that can be recommended for healthy population or for population with neck pain since not all of the elements of a SS were taken into account in an integral fashion, anthropometric variations in different populations, nor the study of sleeping postures, therefore the use of such implements could even worsen the ailment during the sleeping activity.

Regarding the second objective and based on the design of existing studies over this topic, it is not possible to issue recommendations for the use or not of the cephalic support implements for healthy people nor for people with non-traumatic neck pain.

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ANALYSIS OF HUMAN ERROR IN THE TASK OF CHANGING A PC POWER SUPPLY

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Resumen: Al irse extendiendo el uso de los equipos de cómputo, es cada vez más común el encontrar tanto en empresas, como en escuelas, hospitales, entre otros, áreas de soporte para la reparación de estos equipos. Estos centros han ido ampliándose gradualmente, por lo que su proceso de trabajo carece del suficiente estudio, registro y documentación, por lo que es posible que se requiera de tareas complejas y laboriosas para los técnicos, que generen errores y ocasionen daños al equipo y pérdidas económicas. En este trabajo, se presenta la evaluación cognitiva de una tarea de cambio de una fuente de reparación de un equipo de cómputo de un centro de soporte de una institución de educación superior. El estudio inicia con un análisis jerárquico de tareas (HTA) que fue realizado para la operación genérica del centro y para el estudio específico de la tarea. Posteriormente, se analizó el error humano de la tarea por medio del método TAFEI (Task Analysis for Error Identification).
Por medio de los diagramas estado-espacio se pudieron identificar 6 posibles estados en los cuales el equipo analizado puede estar en la ejecución de la tarea seleccionada. Haciendo uso de la matriz de transición se identificaron 3 posibles causas de error. Se encontró que el error humano se da principalmente por la mala identificación del estado de los equipos en el área de reparación.

Palabras Claves: Ergonomía cognitiva, error humano, análisis jerárquico de tareas, TAFEI.

Abstract: With the increasing use of computer equipment, it is becoming more and more common to find in companies as well as in schools, hospitals, among others, support areas for this equipment. These centers have been gradually expanded, so that their work process does not have enough work study, registration and documentation, so it is possible that requires complex and laborious tasks for technicians, which generate errors and cause damage to equipment and economic losses. In this paper, the cognitive assessment of a change task from a computer repair source at a support center of a college is presented. The study starts with a hierarchical task analysis (HTA) that was performed for the generic operation of the center and for the specific study of the task. Subsequently, the human error of the task was analyzed using the TAFEI (Task Analysis for Error Identification) method.

With the help of the state-space diagrams, it was possible to identify 6 possible states in which the analyzed equipment can be in the execution of the task under analysis. Three possible causes of error were identified through the transition matrix. It was found that human error is mainly due to poor identification of the condition of the equipment in the repair area.

Keywords: Cognitive ergonomics, human error, hierarchical task analysis, HTA, TAFEI.

Relevance to Ergonomics: This paper presents a case study using the Hierarchical task analysis (HTA) that precedes the application of the human error identification technique (TAFEI).

Despite human error identification is being important for human-artifact systems, there has been very little applied in the field. In this manner this paper contributes to increase the application of cognitive ergonomics methods for analyzing tasks and for all those who need to implement TAFEI in their workplaces.

1. INTRODUCTION

Nowadays, the use of computers is a growing activity. It is more and more common to find that in most of the work places, or even in the houses, the use of computers is becoming an important activity, so the development of different support facilities for the repair of computers has become necessary. Within these facilities, damage to the equipment they are servicing may occur due to errors resulting from their activities. This causes damage to the equipment and economic losses.

In the field of cognitive ergonomics, it's recognized that the cause of human error is often found in the design of machines, computer signals or the media among people. Cognitive ergonomists have started from the basic idea that a good design is the one on which the person who is interacting with the machine presents cognitive characteristics that impose limitations on their ability to process information and make decisions. Explaining, predicting and avoiding human error is the principal theme of investigation of the cognitive ergonomics (Cañas & Waerns, 2001).

1.1 Human Error

The Human error is a complex construct that has received constant attention among ergonomics experts and it has been consistently identified as a contributing factor in a high proportion of incidents in dynamic and complex systems (Stanton, Salmon, & Rafferty, 2013). It occurs on all those occasions when a planned sequence of physical or mental activities fails to achieve their intended outcome and when these failures cannot be attributed only to the intervention of causal agents (Reason, 1990). Human Error Identification (HEI) or error prediction methods are used to identify potential errors that may result from human-machine interactions in complex systems.

1.1.2 Task Analysis for Error Identification.

The TAFEI method allows people to predict errors with the use of a device (artifact) by modeling the interaction between the user and the device under analysis (Stanton & Baber, 2005). People are supposed to use devices in a certain way, so that interaction can be described as a "cooperative effort," and it is through this cooperative process that problems emerge. This technique assumes that actions are limited by product status at any point in the interaction and that the device provides information to the user about its functionality. Therefore, the interaction between users and devices progresses through a sequence of states. In each state, the user selects the most relevant action for his target, based on the system image. The advantages of the use of TAFEI are (Stanton et al., 2013):

1. Structured and thorough procedure.
2. Sound theoretical underpinning.
3. Flexible, generic, methodology.
4. TAFEI can include error reduction proposals.
5. TAFEI appears to be relatively simple to apply.
6. TAFEI represents a flexible, generic method for identifying human errors which can be used for the design of anything from kettles to computer systems

The TAFEI method consists of 3 steps:

- Develop a Hierarchical Task Analysis.
- Create a State-space diagram.
- Develop the transition matrix.

1.1.2.1 HTA

Hierarchical Task Analysis (HTA) is a powerful tool that gives the analyst a broad overview of how a given process works (Stanton, 2006). HTA is the analytical description of a process or activity and includes performing a hierarchy of objectives, sub-objectives, operations and task plans. The HTA, according with Stanton (2006), is a basic ergonomic approach with over 30 years of continuous use and originally was developed as a method of determining training requirements. On the other side, Annett (2004) mentions that the HTA process is to decompose the tasks into subtasks at any desired level of detail. HTA is the oldest and best known task analysis technique, which is still valid, even if new methodologies have appeared (Lorés & Granollers, 2017).

1.1.2.2 State-space diagrams

Space-state Diagrams (SSDs) are constructions that represent the behavior of the device or product. Each of them represents one of the possible task states, listing the initial and final status, this is based on the HTA (Mohammadian, Choobineh, Mostafavi Nave, & Hashemi Nejad, 2012).

1.1.2.3 Transition matrix

The transition matrix is an important step in the TAFEI technique (Mohammadian et al., 2012). All possible states are inserted in this matrix. The transition states of the SSDs are placed in the cells of the table.

1.2 Objective

The objective of this work is: analyzes the causes of human error in the task of repairing computer equipment that is carried out in a technical support center to analyze the possible causes of damage to humans who performed difficult and complex tasks and the equipment being repaired and may serve as a reference for future work.

1.3 Scope and Delimitation

In terms of scope, this research includes analysis of the human error when performing the repair task. An HTA was necessary to describe this task. Regarding the delimitation of this research, only 7 participants were observed performing this task during different days and hours.

2. METHODOLOGY

2.1 Materials

The materials used in this work are:

1. Several PCs pending repair in the support center used in the analysis of the task.
2. PCs power supplies from different brands and specs used in the execution of the task.
3. PC with the office suite MS Office© used for the elaboration of this paper.

2.2 Method

The following methodology was followed in the elaboration of this paper:

2.2.1 Selection of the task to analyze.

For the selection of the task to be analyzed, a survey was carried out among the personnel of the support center to determine the task whose consequences would have a greater impact and which, due to its poor execution, would cause irreparable damage to the equipment under reparation.

2.2.2 Elaboration of HTA.

In the elaboration of the HTA, the task analysis was realized by interviews with the personnel to establish the main purpose of the task, validating each step with the different participants. For the development of HTA, according by Stanton et al. (2013), the following steps must be observed:

1. Define the task for the analysis: The first step in carrying out an HTA is set the task to be analyzed. In addition to identifying the task to be analyzed, the purpose of the task analysis effort must also be defined.
2. Data collection process: Once the task to be analyzed is defined, specific data on the task must be collected. The data collected during this process are used to the development of HTA. Data should be collected on the steps of the task, the technology used, the interaction between man/machine and team members, decision-making and task constraints.
3. Determine the general objective of the task: The general objective of the analyzed task should be specified first at the top of the hierarchy.
4. Determining sub-objectives of the task: Once the overall objective of the task has been specified, the next step is to divide this overall objective into significant sub-objectives (usually four or five), which together form the tasks required to achieve the overall objective.
5. Decomposition of sub-objectives: The analyst should then break down the sub-objectives identified during the fourth step into other sub-objectives and operations, according to the number of steps of the task in question. This process must continue until a proper operation is reached. The lower level of any branch in an HTA must always be an operation. While everything above an operation specifies goals, operations really say what needs to be done. Therefore, operations are actions that must be performed by an agent to achieve the associated objective.
6. Plan analysis: Once all sub-objectives and operations have been fully described, plans need to be added. Plans dictate how goals are achieved. A simple plan would be: Do 1, then 2 and then 3. Plans do not have to be linear and exist in many forms, some examples are shown in Table 1.

Table 1 Types of plans for the HTA.

Plan	Example
Linear	Do 1, then 2, then 3
Nonlinear	Do 1, 2 and 3 in any order
Simultaneously	Do 1, then 2 and 3 at the same time
Bifurcation	Do 1, if X is present make 2, then 3, if X is not present Exit
Cyclic	Do 1, then 2 and then 3 and repeat until X
Select	Do 1, then 2 or 3

2.2.3 Analysis of human error through TAFEI

With the HTA carried for the previous stage, the SSDs were completed considering the different states in which the computer equipment was at the time of completing the task and then the transition matrix was filled. Three approaches are adopted to complete the matrix:

- If the given transition is impossible, a dash is placed in the respective cell.
- If a given transition is possible and desirable (I. e., the user is moving towards the target), it's a legal transition represented by L in the table.
- If a given transition is possible, but undesirable (deviation from the desired act), it's an illegal transition shown in the table, it's represented by an I.

When all possible intersections have been analyzed, the situations in which an illegal transition occurs (I) are analyzed.

3. RESULTS

4.1 Selection of the task to analyze.

Based on the interviews carried out with the personnel working in the technical support center, it was decided to analyze the task of changing the power supply (PS) of the computer, since it is in the responsibility of providing the adequate electric power supply current to all the elements of the computer equipment, so in case of an error this affects the whole equipment. Based on the interviewees' comments, power supply failures are uncommon, accounting for 16% of the electrical failures of the reviewed computer equipment.

4.2 HTA Results

For the realization of this paper, was decided to realize two HTAs, one general that describes in large ranges the activity of the technical support area for computer equipment, shown in Figure 1, and one that describes in detail the task "change of power supply", shown in Figure 2. In the case of Figure 1, two types of plans were followed, they are: linear and non-linear. In the case of Figure 2, which indicates by means of (*) its position in the general HTA, a linear plan was followed.

4.3 Human Error Analysis Results

Using the HTA from the previous stage, the SSDs was developed, this is shown in Figure 3, and the transfer matrix was developed, shown in Table 2. A total of 6 state-space diagrams were obtained. Changes between states are indicated by a blue line. They show the possible state of the equipment under repair at different times during the execution of the task.

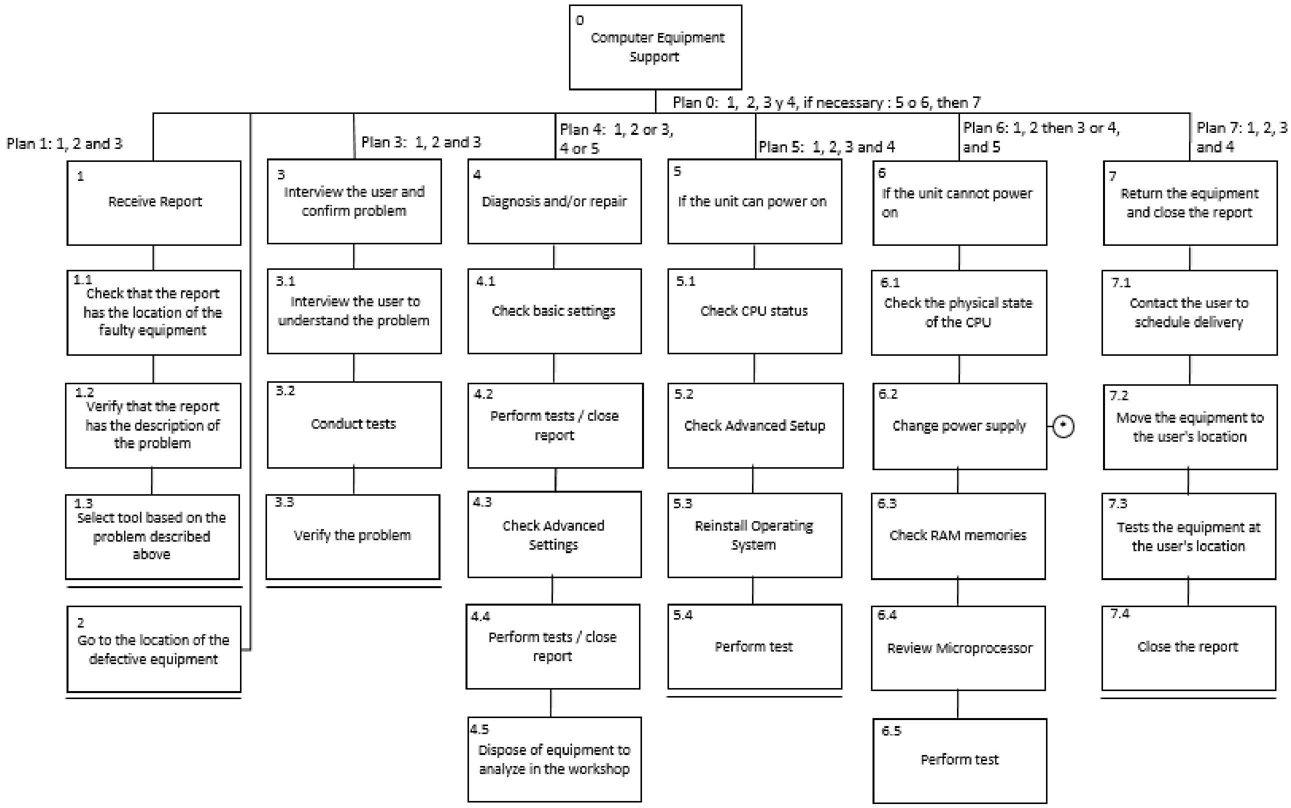

Figure 1 General HTA.

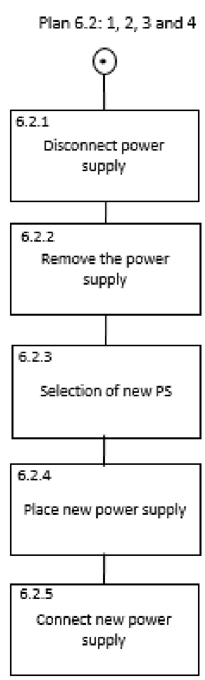

Figure 2 HTA of the subtask.

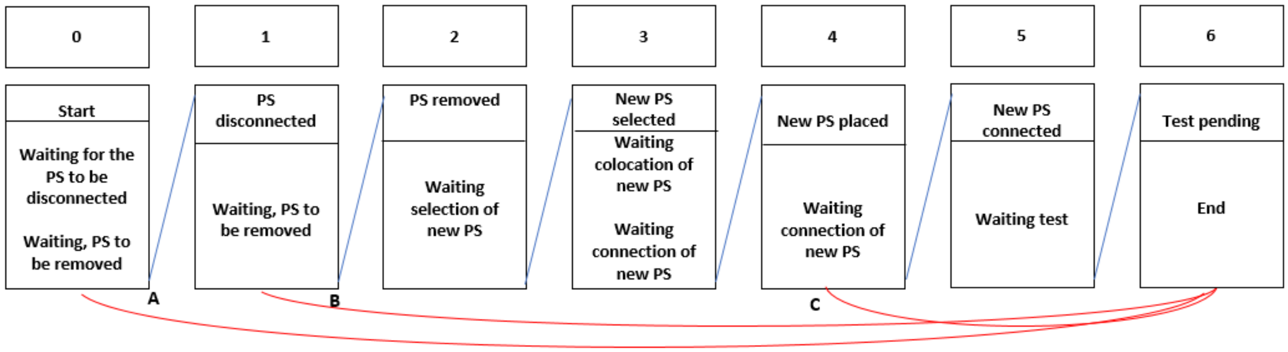

Figure 3. SSDs develop from the HTA.

Table 2 Transition matrix

		To state						
		0	1	2	3	4	5	6
From state	0	-	L	-	-	-	-	I (A)
	1	-	-	L	-	-	-	I (B)
	2	-	-	-	L	L	-	-
	3	-	-	-	-	L	-	-
	4	-	-	-	-	-	L	I (C)
	5	-	-	-	-	-	-	L
	6	-	-	-	-	-	-	-

Based on the transition matrix, the following illegal conditions, red lines in the SSDs, were detected:

1. Go from status 0 to 6.
2. Go from state 1 to 6.
3. Go from state 4 to state 6.

These errors occur when the equipment to be checked, as it is not identified, the repair status is confused, and it is sent to the next process without having finished the task.

No false alarms (transitions detected as errors when they are not) are detected in this paper, this is one of the advantages of using TAFEI, because is that even in the hands of a beginner the technique seems to prevent the individual from generating too many false alarms (Stanton et al., 2013).

4. CONCLUSIONS AND RECOMMENDATIONS.

In this work it was possible to prove the utility of the use of analysis tools to identify human error, specifically TAFEI. In this paper, the possible causes of error were analyzed by using TAFEI, but this does not mean that TAFEI is limited to this type of task since it can be used to analyze all types of tasks and situations, for example in the use of X-ray machines (Alferez-Padron, Maldonado-Macías, García-Alcaraz, Avelar-Sosa, & Realyvasquez-Vargas, 2017), in the use of meat grinders (Mohammadian et al., 2012), orthopaedic robots (Kuang, Hu, Zhang, & Gao, 2009), etc.

Through the two methodologies used in this work (HTA, TAFEI), a few elements can be identified that could cause errors. For example, three possible situations where the error is tangible were detected and is possible to reduce them if a system of identification of the state in which the equipment is at that time is implemented. With the implementation of a series of stickers that show the status of the equipment these problems should be reduced.

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REDESIGN WORK STATION "RAYÓN"

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Resumen: En este artículo se presenta un sistema de evaluación ergonómico, que permite establecer los principales problemas relacionados con la interacción hombre – medio ambiente de trabajo y propone acciones que ayuden a disminuir la problemática, que se ha diagnosticado en un entorno industrial denominado maquiladora, específicamente en el Noreste del estado de Sonora en México. El trabajo se fundamenta, en la aplicación de la jerarquización multivariante de las posiciones que se presentan en las estaciones de trabajo con ensamble manual y su relación con la disminución de la capacidad productiva del trabajador.

Palabras clave: Traslado, hombro, material.

Abstract : In this article an ergonomic evaluation system is presented, which allows to establish the main problems related to the human - work environment interaction and proposes actions that help to diminish the problem, which has been diagnosed in an industrial environment called maquiladora, specifically in the Northeast of the State of Sonora in Mexico. The work is based on the application of the multivariate hierarchy of the positions that are presented in the work stations with manual assembly and its relation with the decrease of the productive capacity of the worker.

Key words: Move, shoulder, material.

Relevance to Ergonomics: With this project, an ergonomic improvement was achieved, of upper limb posture and simplification of the process of transfer for the operator. Therefore, in the few months of installation has benefit the company, in terms of SCRAP and productivity, denoting that the application and support of this kind of projects can affect in all departments and open the doors to continues implementing ergonomic improvements, this reached the goal of creating a comfortable work station, safe and healthy.

1. INTRODUCTION

In recent years, the rules of industrial competitiveness have evolved. They have gone from a regional competition, with a strategy bases on the mass production to a global competition, where the new philosophies of world-class manufacturing reign. Therefore, the competitive companies need a solid organization structure, which allows them to develop highly flexible production systems, to adapt to the new demands of global markets. The productivity is a related event exclusively with the worker and efficiency is a function of the environment of work, when this interaction is structured in a way that reach repeated exposure to activities with high physical demand, monotony, vibrations, uncomfortable positions, mechanical and contact stress, they show cumulative- trauma disorder (DTA's) on the workers. These problems affect to the musculoskeletal system, the tendons, nerves, joints and the neuro-vascular system. The workstation with manual assembly, in production processes in line, develop they own conditions to manifestation of the DTA's in a relatively short time, which results in a decrease in the quality of life of the operator and a reduction of the competitive capacity of the company.

Work area:

- Containers
- Work review
- Manual handling of materials

2. Objectives

General: The project aims to involve the organization in ergonomic risk reduction projects, analyzing those characteristics or activities in which the risk to the operators in the workstation of Rayon hoppers in production is affected. We will propose the implementation of preventing actions in the detected opportunity areas in order to optimize the processes benefiting the operator.

Specific objectives:

- Do a diagnostic evaluation in order to identify areas of opportunity
- Analyze the results of the diagnostic evaluation to structure a possible proposal and / or ergonomic alternative.
- Indicate which is the critical ergonomically operation in production.
- Relate the results of the ergonomics evaluations with risk reduction projects.
- Classify possible solutions to the critical activity in production.
- Observe and attend safety standards in the installation of the project.
- Design the hopper model according to the optimal height, considering safety, quality and maintenance.
- Reminding the benefit of the implementation of prevention projects and risks correction.

Delimitation: In the workstation "Rayon", is pretend to reduce scopes both vertical and horizontal, so it can amend the improper positions in the workstation. In the area the materialist is exposed to traumas and injuries due to the ranges and weights of the material, they need to handle.

3. Methodology

The selected method used allows the joint analysis of the positions taken by the upper body members (arm, forearm, wrist), trunk, neck and legs.

It is a method of postural analysis that is especially sensitive task that involve unexpected changes in posture, as a consequence of the manipulation of unstable or unpredictable loads. Its application prevents the evaluator on the risk of injuries associated with a posture, mainly of musculoskeletal type, indicating in each case the urgency with which corrective actions should be applied. Evaluates individual positions and not joint or sequences of positions, therefore, it is necessary to select those positions that will be evaluated from among those adopted by the worker in the position. Those that, in priority, suppose a greater postural load either because of their duration, because of their frequency or because they present greater deviation from the neutral position will be selected.

It is the reason why first we use method REBA in the evaluation of before made by the doctor of the plant because REBA assesses the degree of exposure of the worker to risk by the adoption of inappropriate postures. It was basic for the elaboration of the angular ranges of the positions of the different parts of the body, reason why there is great similarity between both methods. In addition to the posture itself, other influential aspects in the physical load are valued, such as the load or force handled, the type of grip or the type of muscular activity developed by the worker (both static and dynamic postures). Another novelty regarding the Rula method is the consideration of the existence of sudden changes in posture or unstable postures, and if the posture of the arms is maintained in favor of gravity.

Therefore, the use of this method for the installation, verification and accreditation of the project was define in the following phases that are presented chronologically, which are from the analysis of theories, the application and validation of the system in the industry.

Firstly, the departments involved measured the cost of the lost material level and SCRAP with the current process, since in the metrics of the company is in matter of SCRAP reduction.

The engineering department and Operational Excellence proposed the change since in the packing area has produce less waste of material due the hoppers that facilitate supplying material at a lower height and to the operator to obtain the material easily.

The department of Safety, hygiene and environment, relate the results of waste with the inadequate workstation and the pasta ergonomic evaluation to the production area, where rayon and the materialist were at the top of highly impact. Based on the model of packaging was design, improving these at adding a front window to supply the material at a lower height. Model shown in figure 1.

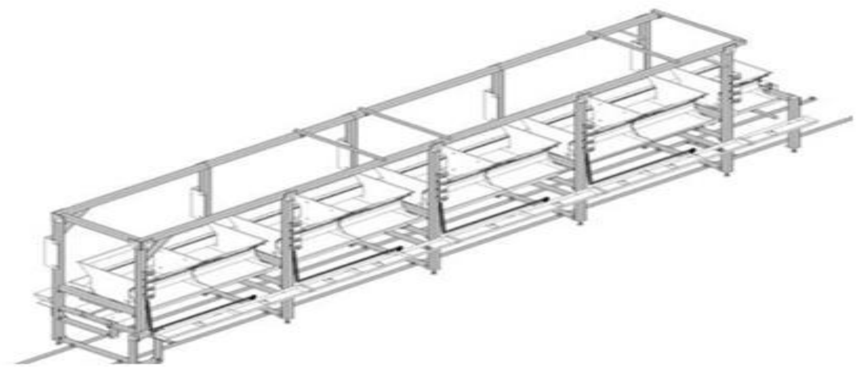


Figure 1. Change propose by the company departments

After the acceptance of management, and all departments involved, it was commanded to install and replace both hoppers and the air suction devices of each operator, so that it works by pedals and there is no high and continuous noise level point out in figure 2. Height, distances, weight were evaluated. In the installation a limitation was detected, since the production line has emergency stops which could not be removed, so the hoppers were a little higher than expected.

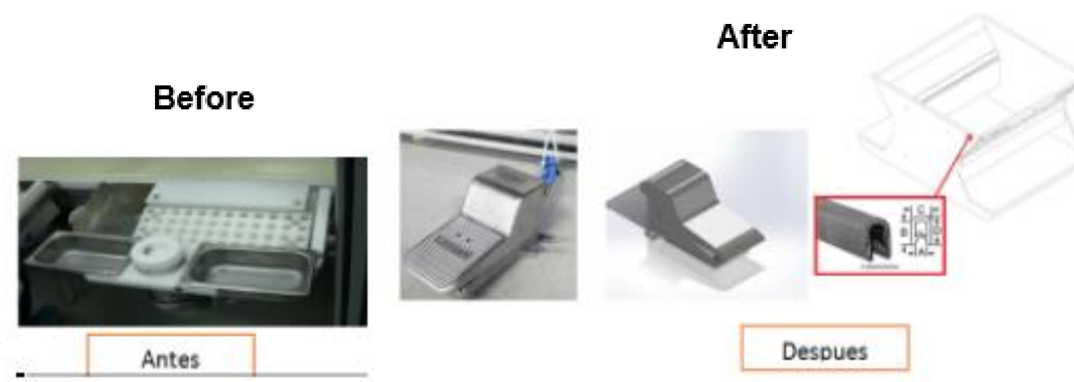


Figure 2. Change proposal in the area of noise reduction and material handling.

At the end the qualification of the installation of the new platforms and funnel pedals was carried out on the NS07 line since the distribution of the assembly lines makes easier to install new projects on a single isolated line and all the auxiliary support systems necessary in the plant.

The departments that were involved are the following:

Functional area
Quality manager
Operation manager
Engineering manager
Quality engineering manager
Facilities engineering manager
Quality management consultant
Project coordinator

All the staff involved in the execution was trained in the technical operation, besides that the training was documented. During the training there wasn't manufactured any product in this assembly line. It verified that what is electronically congruence with physically installed. In the installation, the primary and auxiliary equipment of the system was listed with identification number, model, producer, serial number, location and general specification of each product, using the information of the identification plate. Below are the dates of the phases of the project and various stages of installation, in table 1:

- Verification and results of the provider documents.
- Validation and determination of the software
- Verification and results of the preventive maintenance program.
- Verification and results of the work instruction.
- Standard operating Procedures
- Ergonomic evaluation to the change in the station.
- Calibration instruments and results.
- Results of the instrument calibration

Finally, it is evaluated with the RULA ergonomic method because it evaluates 4 risk factors (number of movements, static muscle requirement, strength and postures); but it does not consider other relevant ergonomic risk factors such as speed, precision of movements, frequency and duration of breaks. This work does not require critical precision, is performed by about 5 employees for 7 production lines and the entire day of 12 hours have rest of about 15 minutes every hour. In addition, the RULA method is particularly useful for assessing the impact of interventions (before and after comparison). It was developed as a method of identifying exposure to a probable risk of work-related upper extremity disorders and gives results that could be incorporated in a wider ergonomic evaluation. A single posture is analyzed, which may be the one that is maintained for the longest or the most demanding one.

Installation and verification of results

Activity	End Date
NS07 Construction package	Nov/02/2017
NS07 Engineering verification guides	Nov/02/2017
Detailed security report	Nov/02/2017

Table 1. End dates of each phase of the project.

The REBA and RULA methods are for exposures with 8 hours of working time, since our workday is 12 hours, these methods were used since the exposure of the operators when performing this operation is around 6:30 to 7:30 of the 12 hours already mentioned, since they carry out other operations besides the filling of the hopper, it is taken into account since in the technical note of REBA published in 1999 it refers that this method is only used for 8-hour working days, just like the RULA method.

4. RESULTS.

The results show that after the change of container application, it reduces the risk of handling material, because the use of stairs in process was eliminated as the figure 3 shows. It can be appreciated the position that is made when downloading material.

Previously, ergonomic studies carried out by medical recommended to establish a method of handling loads and adapting the height to avoid bad postures and work above the shoulders. As an additive to the change of the container, a visual aid was added that applies to all those personnel that operate any type of manual loading and exercise to rest the limbs at least twice per turn. It would have been possible to reduce the exposure of the operator more by lowering the container further, but process and sensor issues made it impossible to achieve optimum height, leaving the operator working over his shoulder, as shown in Figure 4..

The project managed to significantly reduce the level of waste material, that the containers do not use sensors. Likewise, it avoids the occurrence of downtime due to the decomposition of equipment and even the level of noise in the room decreased with the use of pedals that control the suction air of the plastics.

Fig.3 Proceso de alimentación de material sin tolvas propuestas.

Fig.4 Proceso de alimentación de material con tolvas instaladas.

EVALUATION BEFORE

OPERACIÓN 12 LLENADO DE TOLVA

Operación de llenado de la tolva con material, se realiza sobre una escalera
La cual se coloca frente al equipo

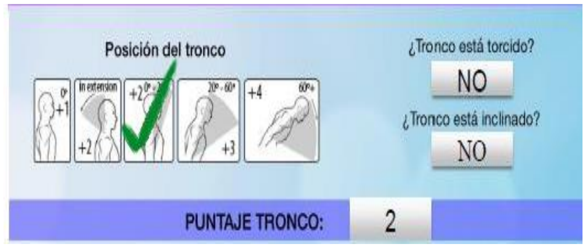
-Se toma una bolsa con material del rack,
-se traslada manualmente por arriba de los hombros hasta llegar a la plataforma final de la escalera,
-se vacía la bolsa en la tolva

*algunos operadores no tienen el suficiente alcance por lo que deben elevar el material a por arriba de su tórax para poder realizar esta operación

Se analiza esta operación utilizando el método REBA

APLICACIÓN DEL METODO REBA

TABLA A

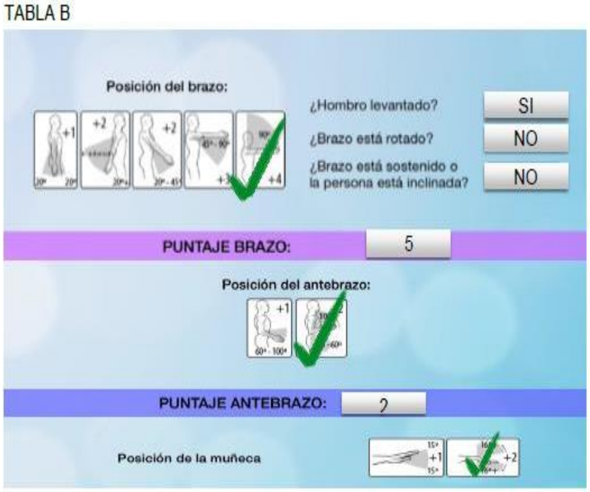


La Fuerza NO se aplica Bruscamente

CARGA MAYOR A 5 KG

PUNTAJE DE LA TABLA A: 7

TABLA B



¿Hay torsión o desviación lateral? SI

PUNTUACION DE LA MUÑECA 3

AGARRE : ACEPTABLE

PUNTAJE DE LA TABLA B: 9

TABLA C

Puntuación A	Puntuación B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	8	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Puntuación del tipo de actividad muscular	
Puntos	**Actividad**
+1	Una o más partes del cuerpo permanecen estáticas, por ejemplo soportadas durante más de 1 minuto.
+1	Se producen movimientos repetitivos, por ejemplo 1repetidos más de 4 veces por minuto (excluyendo caminar).
+1	Se producen cambios de postura importantes o se adoptan posturas inestables.

PUNTUACION TOTAL: 10
SE OBTUVO UN RESULTADO EN EL MÉTODO DE REBA DE 10 SIENDO ESTE CONSIDERADO COMO RIESGO ALTO. SIENDO LA MAYOR PUNTUACION PARA CUELLO Y MIEMBROS SUPERIORES, HOMBRO, COLUMNA, RODILLAS. POR LO QUE LA ACCIÓN ES NECESARIA CUANTO ANTES PARA CORREGIR ESTAS POSTURAS. EXISTIENDO PROBABILIDADES DE PRESENTAR SUS TRABAJADORES TRANSTORNOS MÚSCULO ESQUELÉTICOS.

EVALUATION AFTER

Departmento (Area):	Ensamble		Hoja de Resumen de Estudio
Operacion:	Llenado de tolvas		
Maquinaria/ Herramientas:			
Metodo Usado	RULA	Estudio No:	1
		No. De Hoja:	1 of 3
Participantes:		Termino:	
		Comienzo:	
		Duracion:	
		Fecha:	
		Evaluado por:	
		Verificado por:	Comité de Ergonomia

Factores de Riesgo
Caracteristicas de la carga: Bulto a granel el peso de la bolsa mas ligera es de 10 kg.
Esfuerzo fisico necesario: Levantamiento por encima de los hombros.
Caracteristicas del medio de trabajo : Espacio reducido y con personas alrededor
Exigencias de la actividad: Llenado de alrededor 3 bolsas si que rebase el tope de tolva
Factores individuales de riesgo: Peso,genero, fuerza de los trabajadores
Esta colocada la tolva de manera que debe sostenerse o manipularse a distancia de tronco con inclinacion del mismo.
la situación o el medio de trabajo no permite al trabajador la manipulación manual de cargas a una altura segura y en una postura correcta.
La carga es demasiado voluminosa para el area de trabajo y pesada, dificil de sujetar
Descripcion del area
Es manejo manual de carga
No cuenta con un espacio fijo de trabajo
Operacion
El operador camina desde la linea trabajada hasta la ventana del cuarto 3 a tomar
Lo coloca en el carro transportador si aplica
Lo dirige a la linea
Toma el material
Deja caer la bolsa

Resultado:	**Ampliar el estudio**		
Control de prioridad:	Alto	Bajo	Moderado
Recomendaciones:			
Riesgo para espalda			
Accion	Posible rediseño de tolva, disminucion de carga		
	Reducir el nivel de esfuerzo de la espalda mediante la disminucion de cargado de bolsa		

5. Conclusions

It's possible to conclude that there is a big relation between the workstations and the productivity of the operators since even comments of the same coincide in that it is more comfortable, practical and easy to work with these changes in the station, and only in a few months of implementation. It is expected over the years and with the annual reduction results it can be applied to the rest of the assembly lines of the company.

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EXPLORATORY STUDY OF THE ABILITY FOR THE WORK OF ADULTS OVER 40 YEARS OF THE MANUFACTURING EXPORT INDUSTRY

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RESUMEN: Introducción: La capacidad para el trabajo es un constructo multifacético y multideterminado no solo asociado con la salud física y el bienestar psicológico, sino además con las competencias profesionales de los sujetos, sus valores, el ambiente de trabajo y la organización laboral, así como con otros factores que rebasan el entorno laboral como son las condiciones generales de vida. Por lo anterior se hace necesario identificar los factores de la organización del trabajo que contribuyen a generar fatiga, percepción de envejecimiento y/o baja capacidad para el trabajo; incluyendo las diferencias de género para afrontar las exigencias de trabajo en la maquiladora. Objetivo: Esta investigación se realizó con el fin es explorar la habilidad para el trabajo de obreros de 40 años de edad o mayores de la industria de manufactura de exportación, quienes ya son o dentro de poco tiempo alcanzaran la edad de trabajadores mayores (> 45 años) y, pudiera ser que la disminución en la capacidad de trabajo indicara una posible jubilación anticipada y, por otra parte, la información generada pudiera utilizarse para estimular las condiciones de trabajo o los recursos relacionados con el trabajo y así las empresa promovería extender las carreras laborales. Delimitaciones: el estudio fue exploratorio tomando una muestra no probabilística por conveniencia de 29 obreros de dos empresas manufactureras en dos ciudades de la frontera norte de México en el Estado de Sonora, en otoño-invierno de 2017. Métodos: No se tiene una definición universal que resuma la esencia de lo que es capacidad de o para el trabajo, y, por tanto, se carece de un método uniforme a través del cual medirla, en este caso se evaluó la capacidad de trabajo utilizando el instrumento Finlandes, Work ability index (WAI) de Ilmarinen y Tuomi traducido al español. Veintinueve trabajadores participaron en este estudio de los cuales 17 fueron hombres y 12 mujeres, de estos 72.5% fueron trabajadores de piso en las áreas de producción, control de calidad, materiales y diseño. Resultados: El puntaje WAI promedio fue de 41.93 con desviación estándar 4.044, $V_{mín}$ = 31; $V_{máx}$ = 49), el 37.9% de los participantes tuvieron una capacidad de trabajo excelente, 55.2% buena, 6.9% moderada no se presentaron casos de capacidad de trabajo pobre. El 100% de las mujeres se clasificaron, de acuerdo al instrumento habilidad para el trabajo, entre buena y excelente capacidad. En relaciona enfermedades diagnosticadas por el medico el 58.3% de las mujeres reporto dos o más enfermedades mientras que en 23.5% de los hombres el reporto igual forma. Conclusiones La evaluación de la capacidad de trabajo es fundamental para construir entornos de trabajo más amigables con el obrero y, el instrumento de evaluación Work ability Index (WAI), realiza una buena aproximación a la capacidad del mismo y, con los resultados, pudieran identificarse situaciones donde los obreros están buscando la forma de realizar sus trabajos conforme a los requerimientos laborales buscando su propia satisfacción personal e implementarse apoyos para lograrlo y de esa forma permitir al obrero continuar laborando más allá de la edad de jubilación

Palabras Clave: Habilidad, Capacidad, Trabajo, Maquiladora, Indice de capacidad para el trabajo

APORTACIÓN A LA ERGONOMÍA: Dentro de las mejoras para apoyar al obrero a lograr su propia satisfacción tienen prioridad las intervenciones ergonómicas dedicadas a mejorar las condiciones de trabajo en áreas como demanda, organización y ambiente de trabajo, así como apoyos en el área de salud y capacidad funcional, competencias profesionales como resultado del desarrollo de tecnología de la información, globalización y redes.
Por otra parte, es importante publicar este trabajo para difundir el método, Índice de capacidad para el trabajo (WAI), como un instrumento sencillo para evaluar la situación de cada uno de los obreros que son el recurso más importante para las empresas y las familias.

ABSTRACT: Introduction: The capacity for work is a multifaceted and multidetermined construct not only associated with physical health and psychological well-being, but also with the professional competencies of the subjects, their values, the work environment and the work organization, as well as with other factors that go beyond the work environment such as the general conditions of life. Therefore, it is necessary to identify the factors of work organization that contribute to generating fatigue, perception of aging and / or low capacity for work; including gender differences to face the demands of work in the maquiladora. Objective: This research was carried out in order to explore the ability to work of workers 40 years of age or older of the export manufacturing industry, who are or will soon reach the age of older workers (> 45 years) and, it could be that the decrease in work capacity indicated a possible early retirement and, on the other hand, the information generated could be used to stimulate working conditions or resources related to work and thus the company would promote extending the career careers. Delimitations: the study was exploratory taking a non-probabilistic sample for convenience of 29 workers of two manufacturing companies in two cities of the northern border of México in the State of Sonora, in autumn-winter of 2017. Methods: There is no universal definition that summarizes the essence of what is capacity of or for work, and therefore, lacks a uniform method through which to measure it, in this case the work capacity was evaluated using the Finnish instrument, Work ability index (WAI) of Ilmarinen et al translated into Spanish. Twenty-nine workers participated in this study of which 17 were men and 12 women, of these 72.5% were floor workers in the areas of production, quality control, materials and design. Results: The average WAI score was 41.93 with standard deviation 4.044, (V_{min} = 31; V_{max} = 49), 37.9% of the participants had an excellent work capacity, 55.2% good, 6.9% moderate, there were no cases of poor work capacity. 100% of women were classified, according to the skill instrument for work, between good and excellent ability. In relation to diseases diagnosed by the doctor 58.3% of women reported two or more diseases while in 23.5% of men reported the same way. Conclusions: The evaluation of the work capacity is fundamental to build work environments more friendly with the worker and, the evaluation tool Work ability Index (WAI), makes a good approximation to the capacity of the same and, with the results, could be identified situations where the workers are looking for the way to perform their jobs according to the labor requirements, seeking their own personal satisfaction and implementing support to achieve it and in this way allow the worker to continue working beyond the retirement age.

Contribution to ergonomics: Within the improvements to support the worker to achieve their own satisfaction have priority ergonomic interventions dedicated to improving working conditions in areas such as demand, organization and work environment, as well as support in the area of health and ability functional, professional skills as a result of the development of information technology, globalization and networks. On the other hand it is important to publish this work to disseminate the method, Index of capacity for work (WAI), as a simple instrument to assess the situation of each of the workers that are the most important resource for companies and families.

Keywords: Ability, Capacity, Work, Maquiladora, Work Ability Index, WAI

1. INTRODUCTION

The ability to work is of great importance for the companies and the workers and even for the economies of the countries. Ilmarinen et al (2004) described the concept of work capacity, such as' how good the worker is at present, in the near future, and how he is able to do his job with respect to the demands of work and his health and mental resources. Due to the above, the work capacity is the result of the interaction of the worker and his work and describes the balance between the worker's resources and the demands of work. In this relationship, the worker contributes knowledge, skills, attitudes and motivation, which depend on their health and functional abilities. The demand for work influences the ability to work through the pre-established organization of work, especially in terms of leadership, management, workload, environment and work shifts. In addition to the above, there are factors that influence the ability to work, but exceed the working environment such as the microenvironment (family, relatives, friends) and the macro environment (infrastructure, services and other social dimensions) Ilmarinen (2006). On the other hand, the labor skill index shows a general decreasing trend throughout the person's life years, but changes according to working conditions and personal health status. In jobs with greater mental involvement and autonomy, but lower physical demand, remains fairly constant and high over the years, while decreasing significantly with a steeper trend the greater the physical workload and the lower labor autonomy Costa et al (2007). In the environment of the export manufacturing industry (IME), the work capacity is influenced by additional factors such as the requirements of work, especially due to the constant increase in the workloads of flexible production models, which leads workers to develop coping strategies to guarantee permanence in their jobs in an environment designed for young workers Hansson et al (2001).

2. OBJECTIVE

This research was carried out in order to explore the ability to work of workers of 40 years of age or older of the export manufacturing industry, who are or will soon reach the age of older workers (>45 years), quantify the level of fatigue, perception of aging and/or low capacity for work, collecting data for a diagnosis of the system on factors that affect the decrease in work capacity and eventually use the Work Capacity Index (WAI) as a tool complementary to the periodic monitoring of workers' health.

3. METODOLGY

3.1. DELIMITATION

The study was of exploratory nature taking a non-probabilistic sample for convenience of 29 workers of two manufacturing companies in two cities of the northern border of Mexico, in autumn-winter of 2017. The instrument used to determine the capacity of work was the self-administered questionnaire Work hability index by Tuomi et al (1998)

3.2. FRAMEWORK

According to López et. al., (2011) the study of work capacity and the changes that it undergoes throughout life, has been at the center of the attention of researchers dedicated to occupational health. The current panorama of the population aging that affects almost all the countries of the world and that includes the one of the productive forces, has imposed the need of having instruments that allow a valid and reliable qualification of the capacity for work, and the same time sensitive to the variations that this one is suffering with the advance of the age and the deterioration that the demands and the conditions of work impose.

There is no agreed universal definition that summarizes the essence of what is the capacity of or for work, and, therefore, lacks a uniform method through which to measure it. The ability to work is a multifaceted and multidetermined construct not only associated with physical health and psychological well-being, but also with the professional competencies of the subjects and their values López et al (2011).

Nygård et al (1991) validated the relationship between physical and mental functional capacity objectively measured and work capacity, observed a satisfactory relationship between subjective results of the capacity for work and the results of more objective measurements of physical and mental functional capacity.

Noone et al (2014) mentions that a primary source of articles, in relation to skills for work, was the Australian research study (Redesign of work for an aging society), which was the basis for the first attempt to measure concepts that were directly related to the holistic model of work capacity. This study resulted in the labor skill items of the instruments: Work ability index (WAI Tuomi et al 1998), the Fourth

European Survey of Working Conditions (European Foundation, 2007), the Copenhagen Psychosocial Questionnaire (COPSOQ, Pejtersen et al, 2010), the Survey of Domiciles, Income and Work Dynamics in Australia (HILDA, Watson and Wooden, 2002) and SF-36 (Ware et al, 1993), among others. According to Costa et al (2011), between 1997 and 2008, the Work ability index (WAI) is the most widely disseminated instrument in the world. It has been used in studies in more than 14 countries, mainly in Europe, the US and Brazil, participating industry workers, teachers, administrative employees, doctors, nurses, firemen, drivers, construction workers, textile workers. After this period, publications from Argentina, Cuba, Italy, Japan, Holland, Poland, were found in different occupations and investigations.

3.3. MATERIALS AND METHODS

3.3.1. RELIABILITY OF THE INSTRUMENT WORK ABILITY INDEX

Zwart et al (2002), using a test-retest design with an interval of 4 weeks between measurements, involving construction workers over 40 years of age, performed a verification process of the instrument and the results provided evidence of an acceptable reliability giving support for the applicability of the questionnaire in investigations and in the daily practice in occupational health care.

The concept of "work capacity" and its measurement are increasingly becoming the basis for the design of interventions in the workplace and also for comparison and cooperation in occupational safety and health, Hans et al (2008) and citing Ilmarinen (2006) states that it was shown that WAI predicts retirement due to disability, mortality and quality of life. The ability to work also related to sick leave and productivity, the most important, for companies, the ability to work is an indicator of the productivity of their own human resources.

3.3.2. DESCRIPTION OF THE INSTRUMENT WORK ABILITY INDEX

The instrument is structured in seven dimensions which display a self-applied questionnaire of ten items and a list of different diseases organized into 14 groups. Each item has its score by which the dimension shown in table 1 is evaluated.

Table 1 Dimentions of the WAI

Dimension	points
1. Current work capacity in relation to the best	0 - 10
2. Current work capacity in relation to the demands	2 - 10
3. Number of diseases diagnosed by the doctor	1 -7
4. Work impairment due to diseases	1 -6
5. Absence due to illness	1- 5
6. Estimated working capacity in 2 years	1, 4, 7
7. Mental resources	1 - 4

The answers to the questions on the instrument result in a WAI score that range from 7 to 49. A score between 7 and 27 is classified as poor, from 28 to 36 moderate, from 37 to 43 good and from 44 to 49 excellent work capacity, where "Poor work capacity" means that the demand for work and the worker's resources do not correspond to each other; this may be due to adverse work conditions, worker limitations, or both.

3.3.3. PARTICIPANTS

Twenty-nine workers participated in this study, the average age was 45.97 years with a minimum age of 40 and a maximum age of 59. There were 12 women and 17 men, of whom 72.5% were floor workers. 27.6% declared that the type of work was psychologically demanding, 58.6% physically demanding and 13.8% both requirements, information that influences the calculation of the score.

4. RESULTS

4.1. Dimension 1

"Current work capacity with respect to the highest level in life", scale from 0 to 10, table 2 shows the resulting statistics and in table 3 the results of the hypothesis test for equality between women and man.

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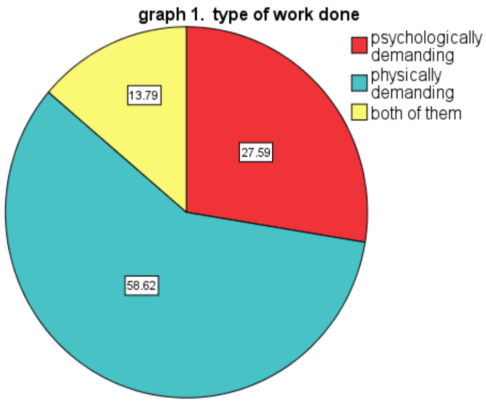
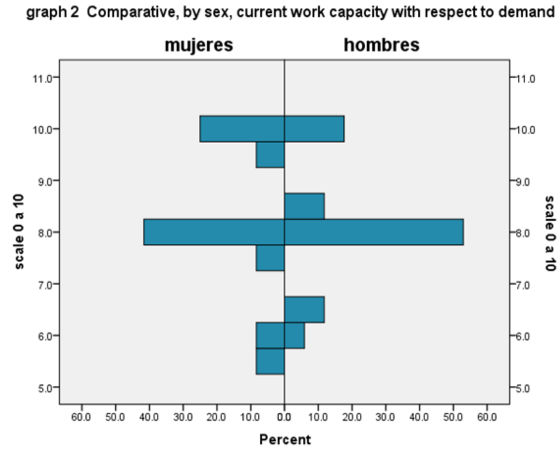
Table 3 Hypothesis test, Dimension 1, independent samples				
T test for equality of averages between women and men				
		Significance (bilateral) 95%	Confidence interval for the difference	
	f.d.		Lower	upper
Equal variances have been assumed (p = 0.068)	27	0.459	-0.781	1.683

It is estimated that the self-perception of current work capacity with respect to the highest in life is equal between women and men (p = 0.459).

4.2. Dimension 2

"Capacity for current work with respect to demands", scale 0 to 10. Figure 1 shows the percentage of workers in relation to the type of requirement in their work and according to this information and the response of the participant, the dimension is evaluated and the results are shown in graph 2 where it can be seen that the perceived capacity has a very similar distribution between men and women, most of the participants fall in value 8 few in value 10 and less in values less than 6.





4.3 Dimension 3

"Diseases diagnosed by doctors". In Table 3 it can be seen that the percentage of the total without disease is 41.3% where the difference between men and women is statistically equal (p = 0.489) however, 58.7% of the total of participants have one or more diseases. These diseases, 21.8% refer to cardiovascular diseases such as hypertension or coronary and/or endocrine or metabolic diseases such as diabetes, severe obesity or gout, alike.

Table 3.- percentage of workers with diseases diagnosed by the doctor, by sex

number of diseases	sexo		Total
	woman	man	
without disease	0.172	0.241	0.413
1 disease	0.069	0.207	0.276
2 diseases	0.069	0.103	0.172
3 diseases	0.069	0.035	0.069
5 or more diseases	0.035	0	0.035
Total	0.414	0.586	1

4.4. Dimension 4

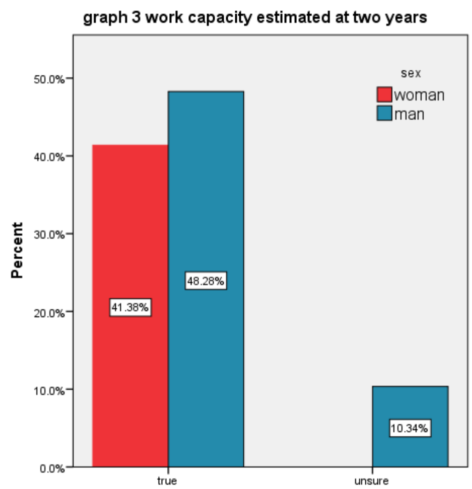
"Impairment of work due to illness, it was found that 69% have no disease that impairs their performance, 24.1% affirm that they can do their job but cause some symptoms and 6.9% affirm that they have to modify their work rhythm or methods.

4.5. Dimension 5

"Absence from work due to illness in the last 12 months", it was found that 51.8% did not have absences due to illness and 41.4% had between 1 and 9 days and statistically there is no difference in absenteeism due to illness between men and women (p = 0.471).

4.6. Dimension 6

"Do you believe, according to the current state of health, that you will be able to do your current job within two years? The results are shown in graph 3 and it can be seen that only 10% of the total is not sure if it can be done and this group is only men.

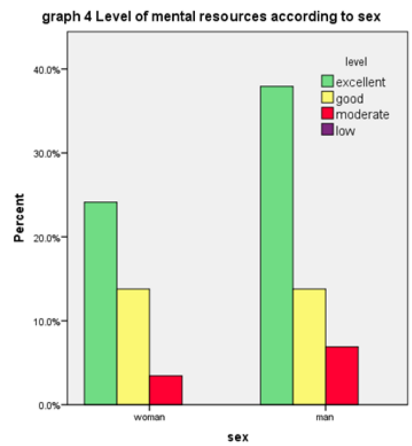


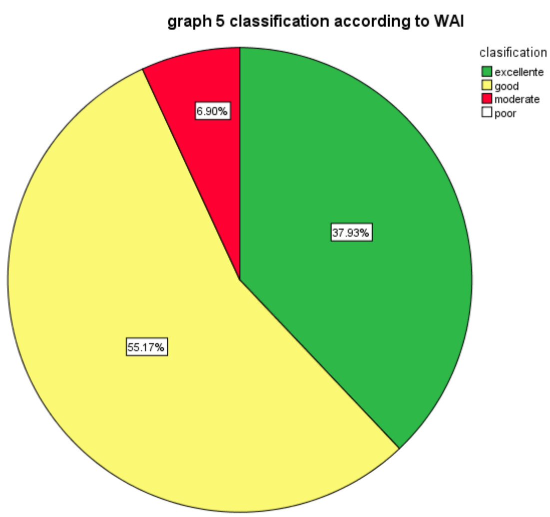
4.7. Dimension 7

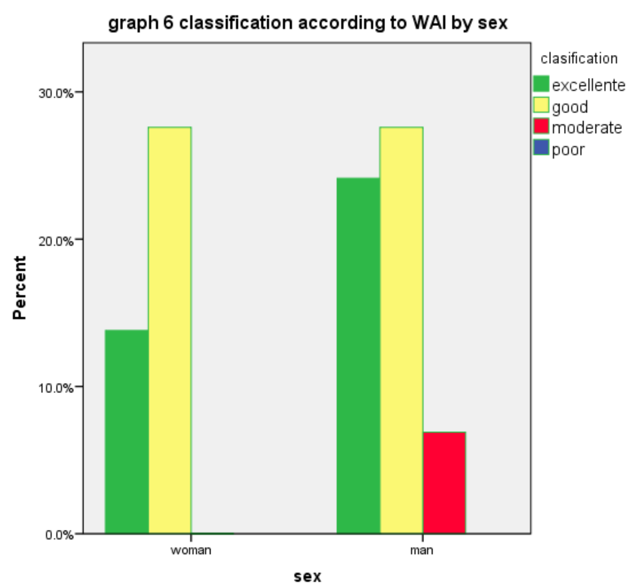
This refers to mental resources and consists of three items, namely:
Lately have you been able to enjoy your regular daily activities?
Lately have you felt active and willing?
Lately you have felt hopeful and encouraged for the future?

The combined results of the three items are shown in graph 4 and when performing the statistical analysis it was found that there is no significant difference of mental resources between women and men (p = 0.912)

Finally, combining the values obtained in each dimension, the classification of the skill for the work is obtained as shown in the graph 5 and the classification according to WAI by sex in graph 6







5. DISCUSSION AND CONCLUSIONS

The evaluation of the work capacity is fundamental to build work environments more friendly with the worker and the evaluation tool Work ability Index (WAI), makes a good approximation to the worker's capacity. Each of the seven dimensions of the instrument indicate something important that is happening with the worker, perceived from himself. Some situations could be identified, where the workers are looking for the way to perform their jobs according to labor requirements, looking for their own personal satisfaction and implement by the companies, support to achieve it and in this way allow the worker to continue working with high quality of life. In this case, with 95% confidence, it is estimated that between 6.3 and 38.0% of the population from which the sample was taken are self-perceived with a moderate work capacity in relation to demand, this could indicate a lack of correspondence between the capacity of workers or working conditions or both. Likewise, in the capacity index for work (WAI) with 95% confidence, it was estimate that between 1.45 and 36.4 of the population from which the sample was extract, they self-perceive with a moderate work capacity that is close to the poor level. This indicator is very important and urgent where companies should implement improvements and have priority ergonomic interventions to improve working conditions in areas such as production, organization and work environment, as well as support in the area of health and functional capacity, to treat to reverse this situation and/or avoid increasing this percentage

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ERGONOMIC ASSESSMENT OF ELECTRIC COMPONENT FORMING OPERATION

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Resumen: La ergonomía busca el mejor diseño de la tarea y estación de trabajo, para que quien efectúe la tarea tenga una mejor eficiencia. Este caso de estudio presenta una evaluación de riesgos por disergonomía, realizada a una operación de preformado de cable. Se desarrolla el análisis del trabajo en base a video-grabación de la tarea, se identifican riesgos y se recomiendan cambios para un rediseño de la estación de trabajo. La metodología utilizada consta de cuatro etapas: la recolección de información, el análisis del trabajo, la evaluación de riesgos y análisis de las sub-operaciones seleccionadas, y la identificación de riesgos y recomendaciones. Como resultados se obtiene información del trabajador, la estación de trabajo, la operación y las condiciones de la empresa ante las propuestas. Se detecta una sub-operación como la más riesgosa en base a la frecuencia y se evalúan los riesgos en esta operación. Al término de este caso de estudio, se encuentran un alto nivel de estrés en manos, muñecas y hombros de acuerdo con JSI, además de un nivel de riesgo alto en un método que evalúa cargas según REBA, por esto se considera necesario un rediseño tanto de la estación como de la operación.

Palabras clave: Evaluación Ergonómica, Job Strain Index, REBA.

Abstract: Ergonomics seeks the best design of the task and workstation so that whoever performs the task has a better efficiency. This case study presents a risk assessment for disergonomy, performed on a pre-formed cable operation. The analysis of the work is developed based on video-recording of the task, risks are identified, and changes are recommended for a redesign of the workstation. The methodology used consists of four stages: the collection of information, the analysis of the work, the evaluation of risks and analysis of the selected sub-operations, and the identification of risks and recommendations. As results, information is obtained from the worker, the workstation, the operation and the conditions of the company before the proposals. Likewise, a sub-operation is detected as the riskiest based on frequency and the risks in this operation are evaluated. At the end of this case study, there is a high level of stress in the hands, wrists, and shoulders according to JSI, in addition to a high level of risk in a method that evaluates loads according to REBA, therefore a redesign is considered necessary of the station as of the operation.

Keywords: Ergonomic Evaluation, Job Strain Index, REBA.

Relevance to Ergonomics: An analysis is provided to a workstation with a combination of effective tools to assess the risk of the operation using two methods. Recommendations are offered to reduce the risk.

1. INTRODUCTION

Ergonomics seeks the best design of the task and workstation so that whoever performs the task has a better efficiency. Thus, ergonomics is divided into different branches and in this work, two sections are required; section 1 is for work analysis and section 2 is for ergonomic risk assessment.

This work presents a risk assessment for disergonomy, made to a pre-formed operation of copper cable lined with plastic for its assembly in the interiors of certain vehicles. In the station in which this operation is performed, high repetitiveness in the task and musculoskeletal discomfort in the operator have been observed. For this reason, an ergonomic risk assessment was carried out.

The risk factors that are evaluated in this case study are the repetitiveness of the work, uncomfortable postures, and energetic efforts. The concept "repetitive work" refers to similar work tasks performed repeatedly. By necessity, the repetitive work of the upper limb implies a motor component, which can be defined in terms of time and force. Repetitive work of the upper limb is considered one of several physical workload factors, associated with symptoms and injuries of the musculoskeletal system (Kilbom, 1994). Other important factors are the static charges, the postures and the effort of external forces. They occur simultaneously or during alternate tasks within the same occupational work, and their effects concur and interact. In general, the harmful effects on the musculoskeletal system cannot be separately identified for each factor. It is also important to mention that shoulder pain is frequently observed in populations of industrial workers. Dul (1988), says that working with raised arms involves high static loads in the muscles and joints of the shoulders. Musculoskeletal disorders in the shoulders are one of the most common in the working population. Some of the causes that cause it are repetitive movements, demands of high forces and strange or extreme positions (Søgaard, 2007).

The present case study is applied to the electrical copper component forming station and methods of task analysis and postural evaluation were applied to evaluate the risk due to lack of ergonomics.

2. OBJECTIVES

The general objective of this work is: apply methods of ergonomic work analysis and evaluation to propose changes in the workstation that contributes to reducing the risk of the operation for musculoskeletal injuries.

The particular objectives are:

- Develop the Analysis of the Work based on video-recording of the task.
- Evaluate ergonomic risks in a station forming an electronic component using ergonomic evaluation methods such as REBA and JOIN STRAIN INDEX.
- Recommend changes for a redesign of the workstation.

3. METHODOLOGY

To present the methodology of this case study will be mentioned the materials used as well as all the stages carried out for an execution that is clearly understood by the reader.

3.1 Materials

The materials used in this project were a computer team for the writing of this document, risk assessment through software and research activities, a Dell Inspiron 2010 laptop was used; and a video-recording camera, to capture the activities, carried out by the worker, using a Sony DSC-H300 recording camera. A tape measure was used to measure the workstation. In this way, Microsoft Word programs were also used as a word processor, GOM PLAYER to obtain frames, Microsoft Excel to perform task analysis.

3.2 Methodology

The methodology used in this risk assessment work is in line with that of Fernández and Marley (2011). The stages to follow during the risk assessment in the workplace when performing a task are described.

3.2.1 Stage 1

The collection of worker information and data analysis is performed. Within the information collection stage, the first step is both the observation and the route of the task and the workstation (Fernandez and Marley, 2011). Then it is important to establish a conversation with the operator to obtain his opinion regarding the execution of the operations (National Institute of Safety and Hygiene at Work, INSHT, nd), the duration of the shift, the breaks, whether or not there are other turns, if you make extra time and other important points to start in the analysis of the task.

The video-recording activities require special attention since the product will be the material with which the entire analysis process will be carried out. There are recommendations for video capture by Karwowski and Marras (2003), which suggest determining the basic cycle of the task and recording at least one continuous cycle without stopping the camera; record far enough away to be able to see the entire body and the layout of the workplace and then focus on recording the area of concern longer; among others. Marley and Kumar (1996), mention that the worker must be recorded in at least 3-5 cycles, or 10 minutes, in whatever way the recording is longer. If the cycle time is short, taking between 10 and 20 cycles is optimal.

The worker measurements collected are weight, eye height, shoulder height, elbow height, flexed elbow height and front arm reach. The weight will be obtained through a survey of general data and the other measures will be obtained from the anthropometric tables of the book by Ávila, Prado, and González (2007), according to the characteristics of the worker. In the same way, measurements of the workstation should be collected. All measurements must have reference to the floor or front view of the worker, as appropriate.

It can also be useful to interview management to understand the budget, design and other limitations. This will help the evaluator to know what modifications have been tried in the past, what is the approximate budget for the changes and will provide other useful information that will help with the development of recommendations or follow-up.

3.2.2 Stage 2

The task analysis is done through video recording and work analysis. From the video recording obtained from the station and work cycle, an amount of 200 frames is obtained through the GOM PLAYER software. From this number of frames, 100 are selected randomly. Each of the selected frames is classified within a specific sub-operation. The same sub-operation can obtain more than 1 frame. Once all the frames are organized, a table is created to analyze the work. In this table appears the name of the sub-operation followed by a representative image, the number of frames that were identified as part of this sub-operation, its frequency and its accumulated frequency.

The selection of the operation to be analyzed is based on the frequency of the sub-operations. This frequency must be equal to or greater than 10%. However, there are risky operations that should be considered despite having a frequency of less than 10%. When the analyze sub-operations have been selected, proceed to stage 3.

3.2.3 Stage 3

In this stage, the evaluation and analysis of the selected sub-operations are carried out in the analysis of the task. The complete cycle (recorded in stage 1) must be carefully observed for the input of adequate information in the required evaluation methods.

- Job Strain Index (JSI): JSI is a semi-quantitative work analysis methodology that results in a numerical score that correlates with the risk of developing distal disorders of the upper extremities (mainly hand, wrist and elbow). The JSI is the product of six factors: intensity of effort, duration of effort, efforts per minute, the posture of the hand/wrist, speed of work, and the duration of the task per day. A JSI greater than five indicates an increased risk of distal disorders of the upper extremities (Moore and Garg, 1995).

• Rapid Entire Body Assesment (REBA): REBA was developed to generally assess loads of the entire body. A score of REBA between 1 and 3 is considered acceptable; between 4 and 7 indicates a medium risk with necessary actions. A score of 8 to 10 indicates high risk with prompt actions, and a score of 11 to 15 indicates very high risk with immediate actions (Hignett and McAtammey, 2000).

Both evaluation methods will be applied through the software found in Ergonautas (2017).

3.2.4 Stage 4

The identification of risks and recommendations must be made in this last stage. The risks must be classified in order of potential severity and/or cost. After the risk factors have been identified and prioritized, recommendations and controls must be developed to reduce each risk.

4. RESULTS

In this section, the results are presented according to the previously established methodology.

4.1 Stage 1

In the first stage, 20 work cycles were recorded, 7 anthropometric dimensions of the worker were measured, and the workstation was sized. In addition, the worker and the administration were interviewed.

We went to the workstation where the task to be studied was carried out and it was observed that the user makes continuous movements of abduction, flexion, and extension of his upper extremities. The duration of the cycles is very short, so the operator is exposed to a high degree of repetitiveness and remains standing throughout the entire cycle of the operation, which he performs during the entire shift. After speaking with the operator, it was obtained that only the first shift is worked, where he is the only one who performs the task, it is the only operation he performs, and he does not go to overtime, besides two breaks for breakfast and lunch of 20 and 30 minutes, respectively. The operator had no suggestions regarding the order of operations.

As a result of the video-recording activities, we had a video of 6:29 minutes containing the execution of 20 cycles (in the frontal view of the upper extremities), plus 6 cycles in the sagittal view of the whole body. In addition, the capture of the other views was obtained with less duration.

To show the measurements of the assembled worker, we have the Table 1. The measurements shown in the table correspond to a 52-year-old woman with a height of 153.3 cm. The value of the weight of the survey answered by the person carrying out the operation was taken, and the other values were obtained by means of tables of anthropometric dimensions for industrial workers in the standing position of the female sex from 18 to 65 years of age. The measurements of the workstation are presented in Table 2. The measurements in this table were made with a tape measure in centimeters and the reference indicated in the column with that name was taken.

The results of this stage include the Employee Survey (Marley and Kumar, 1996), which was answered by the worker. In the body discomfort map, the worker has discomfort in the entire back (upper, middle and lower) and neck, right shoulder, right knee and left wrist. It is important to mention that the worker is older than 50 years old, which means that their ability to recover diminishes and is more affected by the poor design of the work and the workstation. With respect to the interview with the administration, important information was obtained since there is a budget to make modifications to the station of approximately $ 5,000 dollars; besides that, no previous analysis or redesign has been done.

Table 1. Results of worker's body measurements

Dimension	Mean
Weight	77 kilograms
Height to the eye	1449 mm
Height to the shoulder	1291 mm
Height to the elbow	1004 mm
Height to the flexed elbow	969 mm
Front reach of the arm	686 mm

Table 2. Results of workstation measurements

Dimension	Measure	Reference
Height of the table	94 cm	Floor
Height of the sensors	96 cm	Floor
Distance to the sensors	28 cm	Front view of worker
Height of the fixture	113 cm	Floor
Distance to the fixture	10 cm	Front view of worker
Distance to the pieces	20 cm	Front view of worker
Distance between sensors	46 cm	Between them
Deposit of pieces	23 cm	Front view of worker
Distance to the table	28 cm	Front view of worker
Distance to the table	10 cm	Tiptoe

4.2 Stage 2

For the second stage, work analysis was done by video recording 7 sub-tasks. For this analysis, 200 frames were obtained that correspond to the activities carried out during the operation cycle and include only movements of the upper extremities. The analysis of the task can be seen in Table 3. With the frames obtained from the video recording (corresponding to the front view), the previous table could be made showing four frequent operations, but the shaded operation is subject to evaluation by REBA and JSI.

In the analysis of the work, the most frequently significant sub-tasks could be observed, which are: Press sensors, Go piece by piece, Go through sensors, and Part arrangement (in descending order of frequency).

4.3 Stage 3

In the third stage, the evaluation generates high risk with the JSI and REBA method for the task of pressing sensors.

Table 3. Analysis of the task.

Subtask	Frame	Frequency	Frequency percentage	Accumulated frequency
Reach sensors		40	20%	20%
Arrange piece		36	18%	38%
Grasp material		4	2%	40%
Reach piece		54	27%	67%
Push sensors		60	30%	97%
Hold material		4	2%	99%

Empty material		2	1%	100%
	Total	200	100%	100%

• JSI: It was obtained by means of software on the page Ergonautas (2017), the worker presents a JSI of 12.00, this can be seen in Figure 1. This index to be greater than 5 indicates an increased risk of distal disorders of the extremities superior, and being greater than or equal to 7, represents a high-risk task for the worker's health. Similarly, the same software shows some recommendations such as decreasing the speed with which the worker performs the task, bringing the position of the wrist to its neutral position, among others.

• REBA: For this evaluation, the software was also used on the Ergonautas page (2017). The results can be seen in Figures 2 and 3. In Figure 2, a high risk is shown with an index of 8 for the right side. The above suggests a level of action 3 (as soon as possible). On the other hand, in Figure 3, a different result is shown: medium risk with an index of 7 for the left side. This suggests a level of action 2, which in the aforementioned methodology, is considered with necessary but not immediate actions. Unlike the results shown for the JSI, recommendations are not shown here.

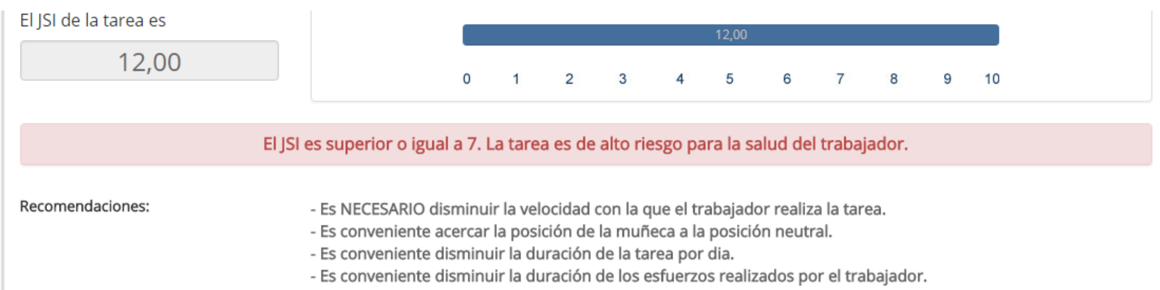

Figure 1. Result of JSI. Obtaining by means of software in Ergonautas (2017)

Figure 2. Result of REBA (right side). Obtaining by means of software in Ergonautas (2017)

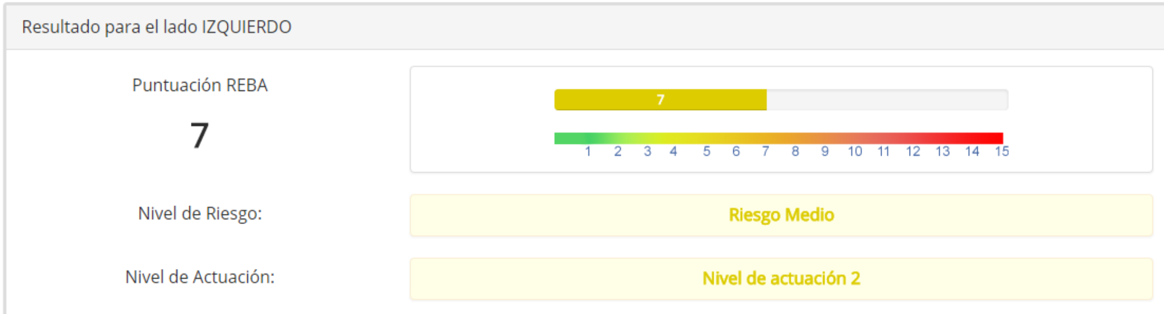

Figure 3. Result of REBA (left side). Obtaining by means of software in Ergonautas (2017)

The JSI provides an index of stress and risk of distal disorders high for hands, wrists, and shoulders, and the REBA also indicates medium and high risk with necessary and immediate actions.

4.4 Stage 4

In the last stage, it is recommended to reduce the static load on the legs of the worker by means of a variation in his standing posture and/or rotation to another seated workstation. They are offered as recommendations, to avoid static work, since this is inefficient and causes load on the legs of the worker since despite moving with high repetitiveness their upper extremities, their legs all the time remaining in the same place. In this sense, an anti-fatigue mat would be useful because, being in standing position for prolonged periods in very hard floors, it causes a decrease in the blood flow of the upper extremities, which increases fatigue in the feet and legs. Another recommendation is to modify the height of the table since in the analysis of the video you can clearly see how it performs an abduction movement to free your hands. For this, the table for the flexed elbow height of the 5th percentile of industrial workers in the standing position of women between 18 and 65 years old should be designed. This is also since the worker is very close to the work table, and this causes him to perform shoulder extension and elbow flexion movements (Smith, Kotajarvi, Padgett, and Eischen, 2002; Dvir, 2016). In addition, a redesign is suggested within the same station with respect to containers, scantlings and raw materials, given that the scope is not appropriate for the worker is not adequate. It is recommended to place them at a lower distance from the worker and closer to the edge of the table that gives view to the worker. Similarly, it is suggested that the sensors be repositioned, and their position changed, so that the worker does not perform supination movements to activate them with the thumb.

5. CONCLUSIONS

At the end of this case study, there is a high level of stress in the hands, wrists, and shoulders according to the JSI, in addition to a high-risk level according to REBA, which is a method that evaluates loads, and for this reason it is considered A redesign of both the station and the operation is necessary.

The methodology of the analysis of the task became clearer after this evaluation. Three sub-tasks were pending a risk assessment, and after carrying out these evaluations it is expected to proceed with the redesign of the workstation.

Both sides of the body were evaluated with REBA. On the right side, a value of 8 and an action level of 3 are shown. On the other hand, on the left side, a different result is shown: medium risk with an index of 7. This suggests a level of performance 2. In addition, in conjunction with all the sub-tasks performed, it is recommended to redesign the station with modifying the horizontal reaches, reduce repetitive efforts and allow the worker to rest from the standing posture with a rests-thighs.

It was obtained that in the areas of the body where there is more movement, it is where a higher stress index was found, besides that in conjunction with all the sub-tasks carried out, it is necessary to redesign the station.

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ANALYSIS OF RISK FACTORS RESULTING FROM THE USE OF SMARTPHONES

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Resumen: En el presente trabajo se exponen principalmente los resultados obtenidos en la investigación bibliográfica sobre el uso de los teléfono inteligentes, posibles desordenes de trauma acumulados a los que los usuarios se exponen, para complementar el estudio se realizó una investigación de campo a través de la cual se obtuvieron datos al aplicar encuestas, tomar medidas antropométricas de las manos y fotografías de los usuarios para su posterior análisis. Los resultados obtenidos reflejan que a pesar de que el 38% de los encuestados usan el teléfono celular 5 horas o más manifestaron que no tienen problema alguno al momento de sujetar el aparato además de que lo encuentran fácil de manipular y operar. El estudio también muestra que los usuarios sufren de malestares como: de dolor de muñeca, cuello, pulgares y otras dolencias, las cuales aún no se ha podido concluir si las causas son por el uso del teléfono celular ya que está en proceso de estudio.

Palabras clave: Telefonía Inteligente, Factores de Riesgo, Enfermedades Tecnológicas.

Abstract: This study centers mainly on the results obtained from bibliographical research made on smartphone usage and the possible accumulative trauma disorders that users are exposed to. To complement the study, field research was performed using surveys, anthropometrics measurements were taken of the hands and photographs of users hands were taken. The obtained results reflect that even though 38% of surveyed users state they use a smartphone for 5 or more hours per day, they state not having issues holding the device and they find it easy to use and operate. The study also revealed that users suffer from discomfort such as: pain in the wrist, neck thumbs and others ailments, of which it has been concluded that the cause of such pain and ailment is smartphone usage as the study is still in process.

Keywords: Smartphones, risk factors, technological diseases.

Relevance to Ergonomics: The study relevance to ergonomics resides in that risk factors related to smartphone usage and how this in itself related to acumulative trauma disorders is analyzed.

1. INTRODUCTION

Mobile telephony has revolutionized the way millions communicate around the world; the ubiquity of mobile devices, ease of access to them and the infinite number of applications developed in numerous platforms have allowed this device to become a fundamental part of modern life. Nevertheless, we have empirically identified that use and abuse of these devices can have an impact on many aspects of user health.

Technology evolution and ease of access to smartphones allows a greater number of people the ability to possess one and the dependency on such devices is greater. The adoption rate varies depending on the age group. A study conducted in Spain in 2012 (Urritia, 2012) finds that 96% of youngsters use the internet daily for information gathering and 85% use it to access social media platforms; this in sharp contrast to adults, of which 21% use the internet to find and collect information. This indicates that the millennial generation made up of people born between the middle 90’s and early 2000’s has grown using digital communications: internet, smartphones, social media and they use technology differently and more exhaustively (Ferrer, 2010).

1.1 Smartphone use impact on other countries.

According to figures published by INEC in Ecuador (2014), smartphone usage has increased 141% from 2011 to 2014 as shown by the latest Information Technologies & Communications survey. Of people that use a smartphone most often are those between the ages of 25 to 34 years old making up 76.6% of users; followed by people between the ages of 35 to 44.

En España, las estadisticas muestran que el 76.2% de españoles usa internet, de los cuales el 77.1% acceden a internet mediante el uso de su telefono inteligente o telefono móvil. (Penguin,2017)

In Spain, statistics show that 76.2% of their population use the internet and 77.1% log in using a smartphone. (Penguin, 2017)

In Mexico, according to INEGI (INEGI, 2017), a study found that 81 million persons use a cell phone, this represents 73.6% of the overall population older than 6 years. This is a 2.1% increase with regard to 2015. Additionally, 3 out of 4 people (75%) users of a cell phone have a smartphone. According to the same study, only 89% of survey respondents declared that they use a smartphone to access the internet via cellular service or wifi.

1.2 Problems identified in other countries caused by smartphone usage

In a Canadian study, observations were performed on how users held their phones and it found that they do in one of two ways: Single handed or double handed. Whenever a single hand is used to hold a phone, the thumb finger is subject to repetitive motion; in contrast to using both hands to hold the unit where effort is distributed between both thumbs improving overall performance (Trudeau, 2012).

In India research showed some of the possible effects of smartphone usage such as: pain in the thumbs and forearms, numbing, tingling sensations, wrist and hand rigidity and tendinitis. The study also proved that device size directly affects the thumbs while writing in a smartphone leading to esqueleto-muscular disorders. The author states that he only performed tests in 27 persons and recommends increasing sample size in order to get more reliable results and have tests using different brands made to understand proper design and smartphone usage according to anthropometric measurements; as well as identifying future patogens of this disorders so that proper recommendations can be formulated (Deepak, 2012).

1.3Disorders related to smartphone usage and bad postures

In 2014 the first case of smartphone induced tendinitis was identified as revealed by Lancet, a specialized magazine. As explained in this publication, a 34 year old woman used her smartphone for approximately 6 hours straight; this caused a strong pain in the wrist and numbing of the thumb finger; her doctor diagnosed a tendinitis. The article author added that treatment included anti inflammatory medication, rest and smartphone usage prohibition. (Fernandez, 2014).

In 2010 it was determined that the more frequent symptoms related to smartphone usage are: pain, fatigue, rigidity and weakness of the hands and in some cases, difficulty writing and holding small objects. It was also identified that within a 20 to 29 year old students universe, 18.5% of them had cumulative traumatic disorders in their upper limbs, smartphone usage was identified as the main cause of these symptoms. (Eapen, Kumar, Bhat, 2010)

A Guadalajara researcher and surgeon specialized in hand ortopedia, Misael Caballero, explained that carpal tunnel syndrome is repetitive trauma caused by abnormal position in technological devices. The researcher further stated that his patient suffered from paresthesia, his little and index fingers would become numb in both hands after 5 to 6 hours of straight smartphone use. Surgery was required to remove a cyst that was formed in the palm of the patient’s hand. It is worth mentioning that even though surgery got rid of the problem, if the patient would to continue the same habits, the issue would recur.

Other studies found a relationship between the number of text messages sent and the amount of thumb pain; it was also identified that the speed at which writing is performed and keyboard design are related to pain and weakness at the base of the thumbs and wrist. A positive result for De Quervain’s tendinitis was diagnosed. (Ali,M., Asim,M., Danish,SH., Ahmad, F.,Iqbal, A., Hasan, SD., 2014)

Other disorders related to the use of smartphones is the unnatural exposure to light emitted from these devices. The fact that these devices can be used in partial or total darkness has made it a common habit for users to used them in this way; which, according to a study by the Mayo Clinic (2013) represents yet another risk associated to sleep cycles alterations. A different research paper has demonstrated that even two hours of exposure to the light from these devices significantly reduces the levels of melatonin in the brain, a condition that can cause sleep disorders. (B.Rea,2013)

According to research (Wood, 2013), another symptom associated with smartphone usage is a condition named “Text Neck” which is chronic pain and neck pain as a result of the tension needed to maintain prolonged neck inclination while using a smartphone. In 2014, Hansraj determined that inadequate posture will dramatically increase neck tension from the normal 4.5 to 5.4 kgs to 27.22 kgs. (Hansraj, 2014).

With the objective of eliminating or minimizing the possible effects of smartphone usage on the human body, a number of strategies have been developed; nevertheless, they have been discarded by most users as they consider them expensive or unnecessary. (Stawarz, 2013).

Related to these strategies, the Environmental Health and Safety Department published a set of practices and guidelines geared towards preventing musculoskeletal injuries caused by mobile device usage as well promote ergonomics in office environments. (DEHS, 2013)

Other organizations such as the European Commission have evaluated the impact of mobile device usage in the workplace, considering both the physical and psychological effects; the objective of these evaluations being promoting ergonomics and the creation and implementation of norms that regulate the use of these devices if the workplace (DGESAAI, 2010).

In 2014, The Wall Street Journal, published an article based on the work of Hedge and Greiner where the ideal screen size selection method for a smartphone was recommended, with the goal of reducing uncomfortness and prevent injuries. By this method, two separate measurements are required, the length of the user’s thumb and the length of separation between the thumb and the index finger.

2. OBJETIVE

To determine if postures and/or excessive smartphone usage poses a risk to a person’s health

3. METHODOLOGY

With the stated purpose this research is being performed as observatory-descriptive in nature as said variable will be analyzed to reach a result. For this, surveys have been made to students at Instituto Tecnologico de Nogales to determine health risk factors result of smartphone usage and postures while using them. At the same time, a number of anthropometric physical measurements were taken of the survey participants hands to determine the relationship between size of the device, pain caused, hand sizes, usage times and manner of use, especially during the writing process; numerous photographs were taken to document the facts and further analysis.

3.1 SAMPLE

For this research practical purposes, sample is students currently enrolled at Instituto Tecnólogico de Nogales between the ages of 18 to 35; this is the age range inferred to be the amongst the most heavy users of smartphones.

3.2 TECHNIQUE AND DATA COLLECTION INSTRUMENTS

A six question questionnaire was applied; the questions centered around the following: Smartphone selection criteria, time spent using the device, is device easy or hard to use and operate, is pain experienced during extended usage periods and where is the pain experienced.

A specific template was used to collect anthropometric physical measurements of the hands. A Digital Caliper was used to take measurements of the following: Hand length, palm width, palm length, thumb length. During measurement taking it was also recorded which was the users dominant hand, their physical activity levels, the kind of work they performed and if this work involved the repetitive use of their hands. A chronometer was also used to measure how many characters a user types in 10 and 15 seconds intervals.

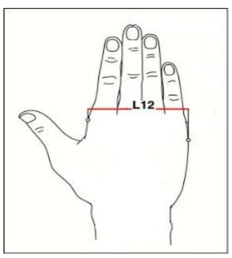

Fig. 1. Length of the hand.

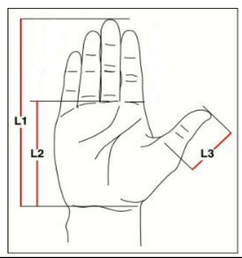

Fig. 2. Width and length of the Palm.

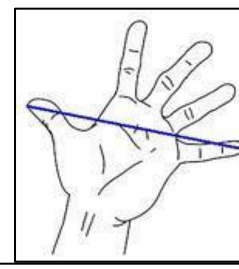

Fig. 3.Length of the palm and length of Thumb.

4. RESULTS

The obtained results in this part of the investigation are mainly the percentiles of the anthropometric measures that were taken into account, this were describen before in figure 1,2 & 3 as shown below:
The percentile results for figure 1 were:
95= 3.7”, 50= 3.3” y 05= 2.8”
The percentile results for figure 2 were:
95= 5.5”, 50= 4.7” y 05= 4.0”
The percentile results for fiere 2 were:
95= 5.5”, 50= 4.7” y 05= 4.0”

Once the obtained data of the surveys was analyzed it was observed that 50% of respondents chose their smartphones based on brand followed by other determining factors as shown in Figure 4.

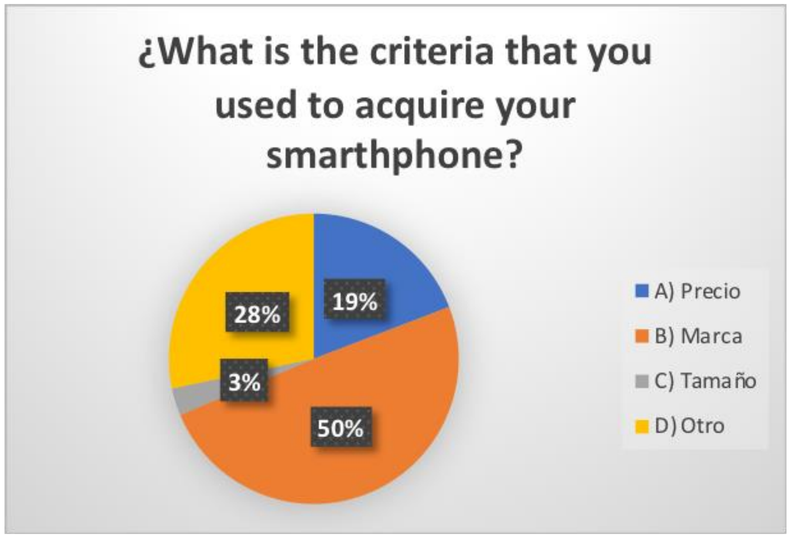

Fig. 4

It was also determined that 38% of survey respondents use their smartphones 5 hours or more a day; see Figure 5.

As shown in Table 1, 76% of respondents said the device was easy to hold and 99% stated the device is easy to use and operate; nevertheless, Figure 6 shows 60% of respondents said they have experienced pain or discomfort resulting from smartphone use.

The main health issues mentioned from the respondents were wrist pain, neck pain, thumb pain, followed by other ailments as shown in table 2.

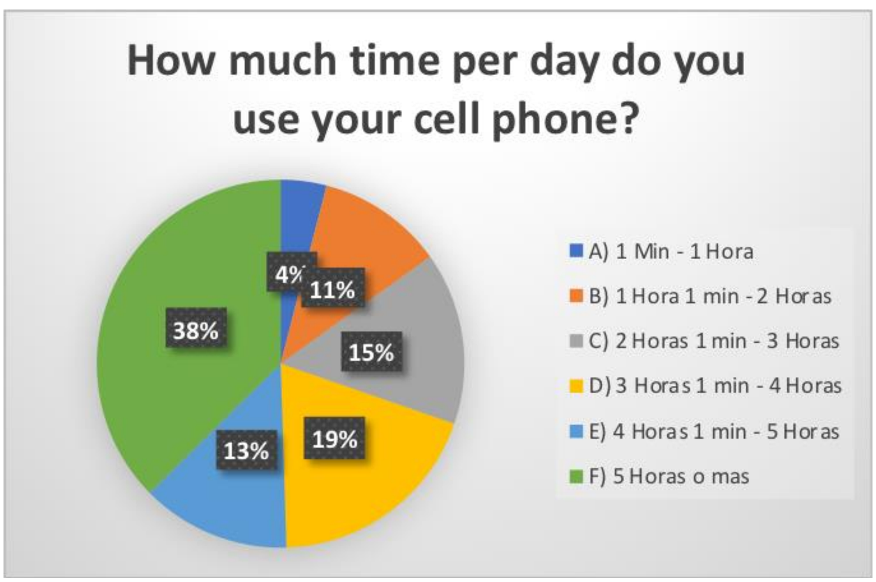

Figure 5.

Table 1. Handling of the device

Easy to hold		Easy to operate	
YES	NO	YES	NO
76	23	98	1

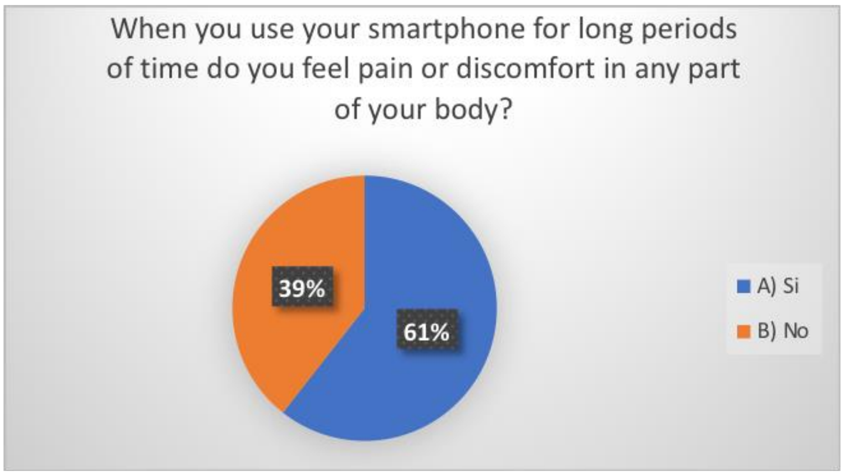

Figure 6.

Table 2. Discomforts presented

Pain in the neck	10
Pain in the wrist	17
Pain in the arms	3
Pain in the thumbs	11
Pain in wrist arm and thumb	1
Pain in wrist and thumb	1
Pain in neck and wrist	1
Pain in wrist and thumb	1
Pain in wrist and thumb	1
Other	14

Based on the photographs taken during the last part of the research work, it was determined that 50% of the study participants held a posture where the head inclination would create tension of 18.14 kgs in the neck area as shown in table 3.

Lastly, looking to determine the body parts involved while using the mobile device specially during text message writing, a number of photographs of the users were taken for further analysis.

Tabla 3. Proporción de la inclinación,el peso y actividad.
Table 3. Rates of inclination, weight and activity.

	Angulo de inclinación	Peso ejercido en la columna vertebral	texteando
Neutral	0° - 14°	4.54-5.44	9
A	15° - 29°	12.25	15
B	30° - 44°	18.14	38
C	45° - 59°	22.23	37
D	60° - 89°	27.22	0

5. DISCUSSION AND CONCLUSIONS

Through the data obtained from the study, it can be concluded that acording to antropometrics measurements taken, users in the 95 and 5 percentil don't have any issues regarding the hold of the device as the dimensions of said device range between 2.32 and 3.07 inches wide.

The study also revealed that users suffer from discomfort such as: pain in the wrist, neck thumbs and other ailments, of which it has been concluded that the cause of such pain and ailment is smartphone usage as the study is still in process.

On the other hand, it can be concluded that users adopt risky positions when using their smartphones, it was shown that when they write text messages they are subjected to muscle-skeletal lesions such as neck pain. For this, the last phase of the study will determine the DTAs generated by bad postures on the upper parts of the body.

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PARTICULARITIES OF OCCUPATIONAL ACCIDENTS OF SPORT ORIGIN OCCURRING IN COLOMBIA BETWEEN 2010 AND 2015

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Resumen: La accidentalidad laboral tiene una importante repercusión en la salud de los trabajadores, así como en su entorno social y familiar, por esta razón es muy importante caracterizar todas las fuentes de peligro para establecer las líneas de acción adecuadas a contexto en el que se desarrollan.

En el presente estudio se aborda el accidente laboral de origen deportivo; caracterizar sus particularidades y hacerlo visible propone la línea base para su intervención y prevención. Es una Fuente de peligro latente en el entorno laboral colombiano, presente en todos los sectores económicos, además en él han sido protagonistas trabajadores de ambos géneros, de todas las edades y practicando una variabilidad interesante de deportes.

Fomentar la práctica de deportes en el entorno laboral se debe realizar de manera responsable, planeada y con el apoyo de las áreas respectivas, esto con el fin de que la actividad no genere un riesgo para la salud del trabajador.

Palabras clave: Accidente Laboral, Seguridad industrial, Riesgos Laborales

Abstract: Occupational accidents have an important impact on the health of workers, as well as on their social and family environment, for this reason it is very important to characterize all the sources of danger in order to establish the lines of action appropriate to the context in which develop

In the present study the occupational accident of sporting origin is addressed; characterize its particularities and make it visible proposes the baseline for its intervention and prevention. It is a source of latent danger in the Colombian work environment, present in all economic sectors, and in it have been protagonists workers of both genders, of all ages and practicing an interesting variability of sports.

Encourage the practice of sports in the workplace must be carried out in a responsible, planned and with the support of the respective areas, this in order that the activity does not create a risk to the health of the worker.

Keywords: Occupational Accident, Industrial Safety, Occupational Hazards

Relevance to Ergonomics: Ergonomics professionals are the experts that should guide the necessary actions for the promotion of workers' health and the prevention of the occurrence of injuries caused by sporting accidents in workplaces, the characterization presented is a basic input for the formulation of said intervention measures and raises a baseline of the importance of acting on them.

1. INTRODUCTION

The characterization of Accidents in the workplace is one of the fundamental axes in the Prevention of Occupational Risks, the previous premise motivated the interest to study the events that have as origin the execution of recreational or sports activities when the employee acts on behalf of or on behalf of the employer.

In the popular imagination it is found that practicing a sport is synonymous with a healthy action that does not represent a risk to health, which is why, in some occasions, the development of this type of activities is not planned in a judicious and responsible manner. the work environment Through the presentation of the particularities found from a descriptive analysis, it is intended to demonstrate the importance of including this type of activities within the prevention work plan.

2. OBJECTIVE

Characterize work accidents of sport origin occurring in Colombia during the years 2010 to 2015

3. EXTENT OF STUDY

3.1 Spacial:
Colombian workers affiliated to the General System of Occupational Risks linked to the Occupational Hazard Administrator who have been notified of a work accident.

3.2 Conceptual:
Origin of the accident classified as sporting under the criteria defined in article 4 of law 1562 of the year 2012: "It is an accident at work any sudden event that occurs due to cause or occasion of work, and that produces an organic injury in the worker, a functional or psychiatric disturbance, a disability or death. [...] In the same way, work accidents are those that occur due to the execution of recreational, sports or cultural activities, when acting for or on behalf of the employer or the user company in the case of workers of service companies. that are on mission." (Congress of Colombia, 2012)

3.3 Temporary:
Report of qualification of accidents of work of sport origin between the year 2010 and the year 2015.

4. METHODOLOGY

As the main purpose of the study was to specify the properties, characteristics and important features of occupational accidents of qualified sporting origin between 2010 and 2015, it was decided to approach the problem from a descriptive study.

Initially, a database was received by the Technical Management of the Occupational Risk Manager, which reported 11,569 claims. Subsequently, the information was revised to be purified in terms of the scope defined normatively in Colombia as a Labor Accident of sporting origin during the period from January 1, 2010 to December 31, 2015, as well as the opportunity to have all the necessary information to be subjected to analysis. . At the end of this exercise, it was determined that 10,532 cases met all the criteria. With this refined data base, the descriptive statistics are analyzed using the following variables, under the precept of confidentiality specified in resolution 8430 of 1993 (Ministry of Health, 1993).

Table 1. Study Variables

Variable	**Type of variable**
Gender	Categorical - Nominal
Age	Quantitative - discrete
Socioeconomic Sector	Categorical - Nominal
Risk level	Numeric
Type of sport activity	Qualitative
Department or Region	Categorical - Nominal
Clinical diagnosis	Qualitative

5. RESULTS

When reviewing the trend of the number of cases classified as occupational accidents of sporting origin from year to year, the trend shown in figure 1 is observed. The increase can be analyzed based on two main reasons, in the first instance due to the increase in coverage in the affiliation of workers to the Occupational Risk System, as well as to the increase in the culture of the accident report, fundamental strategies of the respective Directorate of the Ministry of Labor.

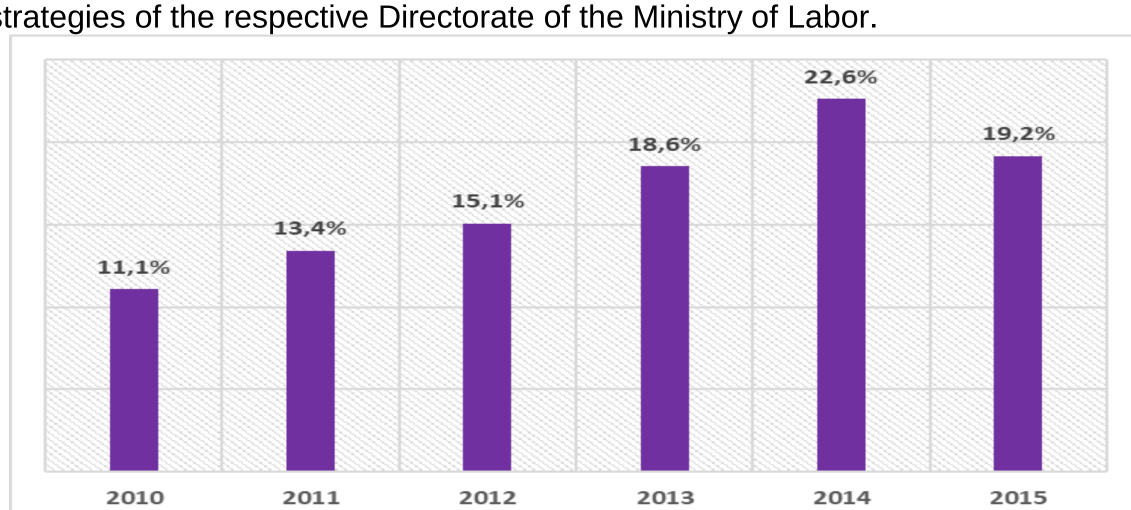

Figure 1. Annual distribution of occupational accidents of sporting origin

Regarding the gender of the worker who suffered the accident, it was established that in the period studied the greatest participation was in men, this is reflected in Figure 2.

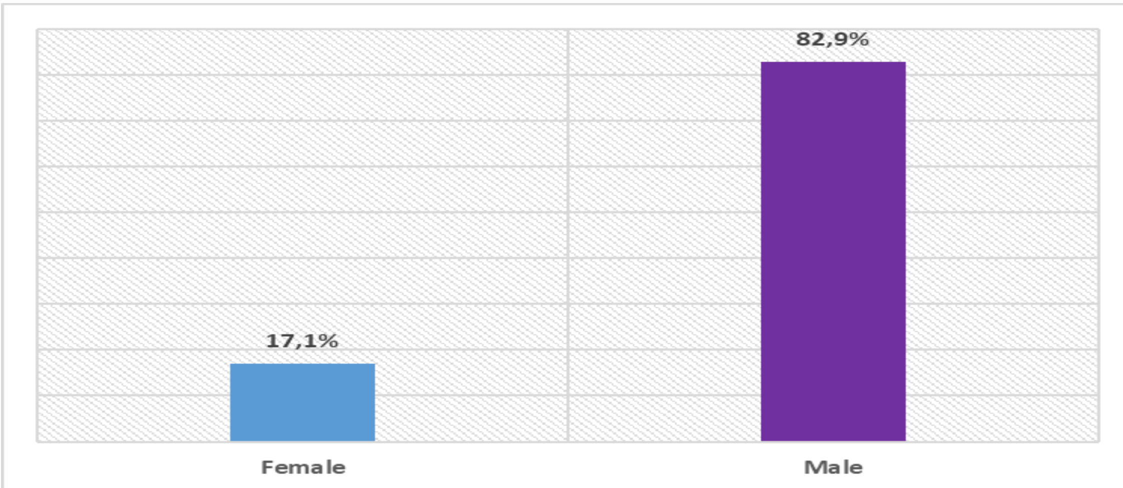

Figure 2 Distribution of the population by gender.

When characterizing the age of the skilled workers with the work accident it is observed that the greater proportion of the affected population is between 26 and 35 years old.

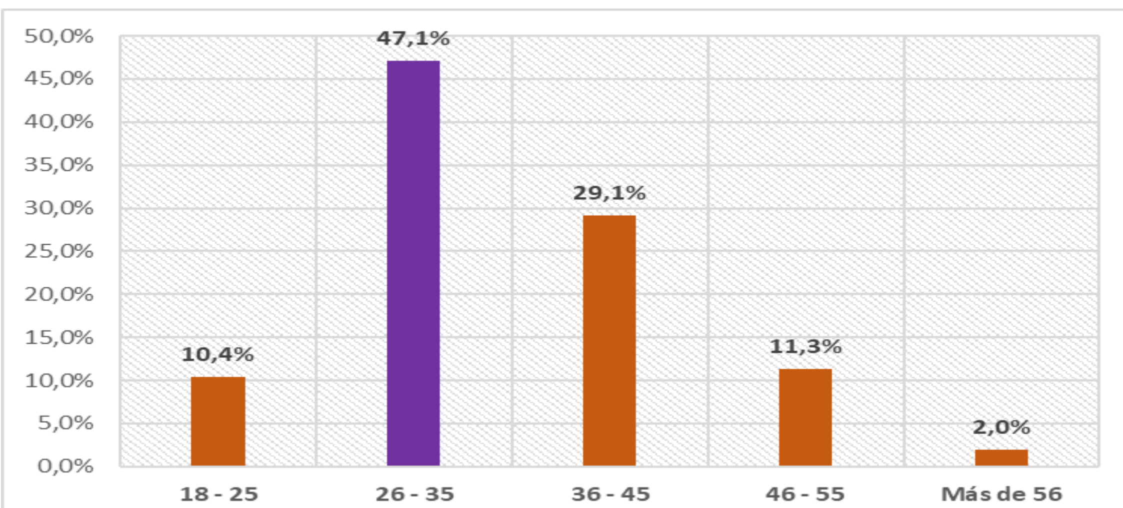

Figure 3 Distribution by age of the population

The sectors with the highest accident rates are the following General Services with 16.9%, then Commerce with 15% and thirdly Manufacture with 8.4%. The complete distribution is shown in Table 2.

Table 2. Accident distribution by socioeconomic sector

Sector	Frequency	Percentage
General Services	1781	16.9
Commerce	1580	15,1
Manufacture	889	8.4
Temporary Services	708	6.8
Education	702	6.7
Food, beverages and tobacco	595	5.6
Health and social assistance	556	5.3
Metalworking	531	5,1
Transport	488	4.6
Floriculturist	417	4,1
Electricity, gas and water	402	3.8
Financial	387	3.7
Petrochemical industry	379	3.6
Public administration	282	2.7
Costruction	276	2.6
Security	208	2,1
Hotels and restaurants	190	1.8
Agriculture, Fishing, Hunting and Forestry	103	1,1
Mining	58	0.6

Companies in Colombia are classified in 5 levels of risk depending on the type of economic activity and the dangerousness of the activities carried out by the workers in them, this is normatively contemplated in Decree 1607 of 2002. Faced with this classification, it is observed that levels 1 and 3, with 32% and 30% respectively, are those that have the highest participation of workers, the complete distribution is presented in Figure 4.

One of the referents of the reality of occupational accidents of sport origin in Colombia is the type of sport that was practicing the worker at the time of the event, in this aspect it is evident that football (soccer 11, football 8, soccer 5) is the most representative because it meets 67.6% of the cases. The total distribution of cases against this variable is presented in Table 3.

When geographically characterizing the location of the work accidents studied, it is observed that the largest proportion is concentrated in the main cities of the country: Bogotá, Medellín and Cali. This is because in these areas there are the majority of workers affiliated to the General System of Labor Irrigation. Table 4 shows the distribution of accidents by department organized alphabetically.

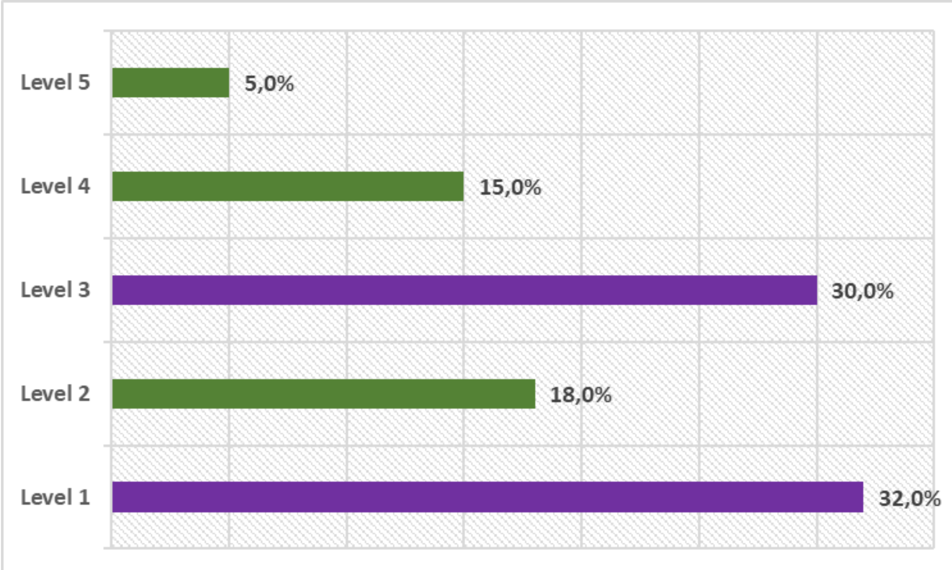

Figure 4 Distribution of the population by level of risk

Table 3. Distribution of the population by type of sport

Sport	Frequency	Percentage	Sport	Frequenc y	Percentag e
Football	7116	67.6	Recreational activity	9	0.1
No information	2557	24.3	Tennis	6	0.1
Basketball	366	3.5	Fitness center	2	0,0
Microfutbol	215	2,0	*Tejo*	2	0,0
Volleyball	168	1.6	Table tennis	2	0,0
Bowling	26	0.2	Dance	1	0,0
Softball	25	0.2	*Minitejo*	1	0,0
Athletics	13	0.1	Swimming	1	0,0
Kick ball	11	0.1	Other	1	0,0
Cycling	10	0.1			

Table 4. Distribution of accident frequencies by department

Department	Frecuency	Percentaje	Department	Frecuency	Percentaje
Amazonas	1	0,0	Guaviare	1	0,0
Antioquia	2331	22.1	Huila	33	0.3
Arauca	4	0,0	Magdalena	98	0.9
Atlántico	650	6.2	Meta	84	0.8

Bogotá	3055	29,0	Nariño	40	0.4
Bolívar	350	3.3	Norte De Santander	93	0.9
Boyacá	106	1,0	Putumayo	6	0.1
Caldas	229	2.2	Quindío	63	0.6
Caquetá	1	0,0	Risaralda	301	2.9
Casanare	11	0.1	San Andrés y Providencia	3	0,0
Cauca	64	0.6	Santander	446	4.2
Cesar	84	0.8	Sucre	28	0.3
Choco	7	0.1	Tolima	166	1.6
Córdoba	66	0.6	Valle Del Cauca	1291	12.3
Cundinamarca	915	8.7	Vaupés	1	0,0
Guajira	4	0,0			

When characterizing the type of injury suffered by the worker in the accident, the main ones are foot, ankle and knee contusions, information consistent with the type of sport practiced by the largest affected population, soccer. Figure 5 shows the lesions reported in the database analyzed.

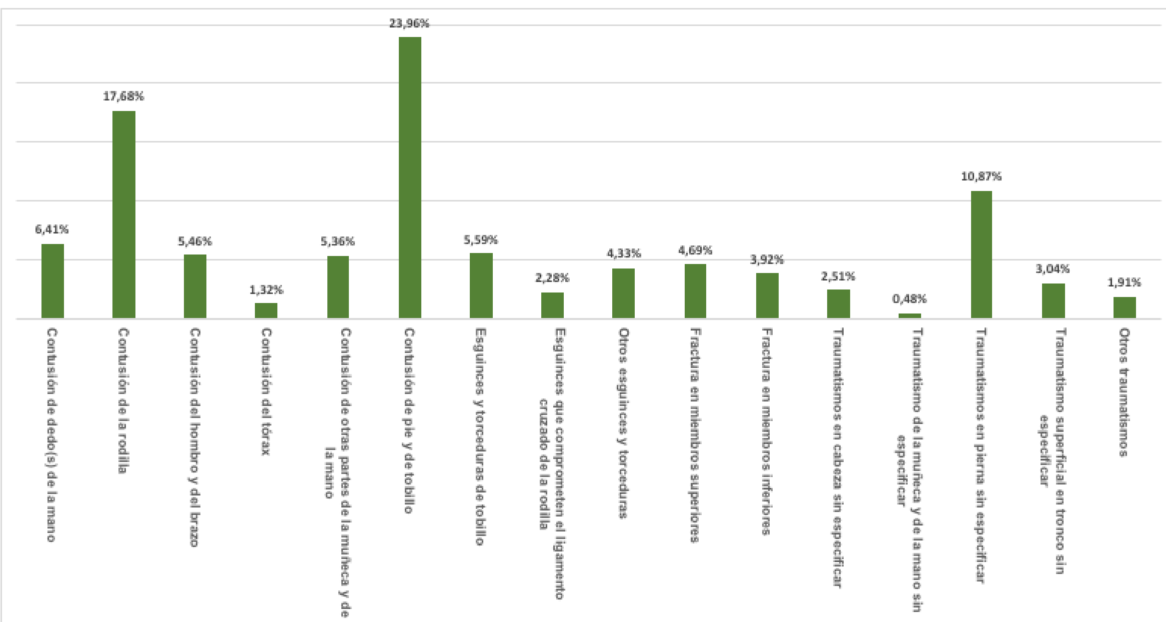

Figure 5. Percentage distribution of the most frequent diagnoses in occupational accidents of sport origin

In order to have an image of the effect of the origin of the studied accident against the general accident rate in the same period, a comparison of both accident rates was made, based on the number of workers affiliated to the Occupational Risk Manager that provided the information. Faced with this aspect, Table 5 shows that the participation of the type of accident studied is not high.

Table 5. Ratio of occupational accidents to accidents of sporting origin

Year	Qualified accident rate	Accident rate of sporting origin
2010	9.63	0.08
2011	9.87	0.08
2012	10.1	0.09
2013	9.85	0.1
2014	8.65	0.1
2015	7.57	0.08

6. DISCUSSION/CONCLUSIONS

As we observe the accident rate of the studied type has been presented in all economic sectors and by type at all levels of risk of work activity, have been protagonists in the different events workers of both genders, of all ages and practicing a great variety of sports, that is, occupational accidents of sporting origin must have its own line of prevention and attention in the Colombian labor context, its impact is transversal geographically and not negligible economically.

Within the framework of occupational risk prevention in Colombia, physical activity is one of the main strategies promoted by lifestyle programs, whose main objective is to improve the health of workers and therefore the their quality of life, however, as evidenced throughout the study, the number of accidents and the consequences that these can have on the particular environment of the workers and on the productivity of the companies, the participation of employees in the practice of sports, it must be done in a responsible, planned manner and with the support of the respective areas, in order that the activity does not generate a risk for the health of the worker.

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COMPARISON OF THE TECHNIQUES TO MEASURE THE BURNOUT IN THE MEDIUM AND HIGHER CONTROLS OF THE MANUFACTURING INDUSTRY

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Resumen: Se realiza una comparación de tres instrumentos utilizados para medir el burnout que son el Maslach Burnout Inventory (MBI), el Burnout Measure (BM) y la escala de desgaste ocupacional (EDO); con el fin de seleccionar el más adecuado para la toma de muestras en personal que ocupa puestos medios y superiores de la industria manufacturera en el zona fronteriza del país. Como resultado se obtiene que el más adecuado para el sector específico de análisis es el MBI por las ventajas que ofrece sobre otros instrumentos y un tiempo de aplicación menor a 5 minutos conveniente para el sector al que va dirigido en específico. Considerando el MBI como aceptable se realizó una validación de consistencia interna del instrumento con 121 muestras que pertenecen a trabajadores de la industria manufacturera de las ciudades de Tijuana y Mexicali, los valores de alfa de cronbach obtenidos fueron los siguientes: 0.892 para agotamiento emocional, 0.816 para eficacia profesional, 0.847 para cinismo y un valor de 0.814 para el instrumento completo. Considerando el MBI adecuado para el sector de interés con un valor alfa mayor a 0.8 de consistencia interna.

Palabras clave: Burnout, sector industrial, comparación de técnicas.

Abstract: A comparison is made of three instruments used to measure burnout, which are the Maslach Burnout Inventory (MBI), the Burnout Measure (BM) and the occupational wear scale (EDO); in order to select the most suitable for sampling in personnel occupying middle and top positions of the manufacturing industry in the border area of the country. As a result, it is obtained that the most suitable for the specific sector of analysis is the MBI because of the advantages that offers over other instruments and a shorter application time of 5 minutes for the sector to which it is specifically addressed. Considering the MBI as acceptable, a validation of internal consistency of the instrument was made with 121 samples belonging to workers in the manufacturing industry of the cities of Tijuana and Mexicali, the values of cronbach´s alpha obtained were the following: 0.892 for emotional exhaustion, 0.816 for professional efficacy, 0.847 for cynicism and a value of 0.814 to the complete instrument. Considering the MBI suitable for the sector of interest with an alpha value greater than 0.8 of internal consistency.

Keywords: Burnout, industrial sector, comparison of techniques

Relevance to Ergonomics: Ergonomics contribution to determine a reliable instrument for measuring chronic job stress workers in middle and senior management of the industrial sector in order to measure their level of chronic job stress and employ measures to improve their occupational health.

1. INTRODUCTION

Work-related stress can be defined as the harmful physical and emotional responses that occur when work requirements do not match the capabilities, resources or needs of the worker (ILO, 2016). The problem shows alarming statistics in Mexico with respect to other countries, maintains the first position in work stress with 75% of workers who suffer it, above countries such as China (73%) and the United States (59%), both largest economies in the world, according to figures from the World Health Organization (Forbes, 2017).

One of the consequences that can occur in a worker who suffers from work stress is the appearance of occupational wear or also known as "Burnout"; that can sometimes be explained by personality traits such as social support, self-esteem and self-efficacy. There are explanatory models that suggest that this condition leads to psychosomatic discomforts such as poor sleep quality, headaches, among others (González & Landero, 2008); emotional symptoms such as irritability, anxiety, depression, frustration, boredom and job dissatisfaction (Wulfften & Janssen, 2016); as well as behavioral symptoms such as cynicism and apathy (Apiquian, 2007).

One of the most representative studies was developed in the 70s approximately, with the research of the psychiatrist Herbert Freudenberger who analyzed the behavior of volunteers in a clinic for drug addicts in New York. In a period of one to three years, most of the volunteers showed loss of energy, lack of motivation, lack of interest in work accompanied by symptoms of anxiety and depression. The term "Burnout" was used by the psychiatrist Herbert Freudenberger (1974) to describe the behavior of individuals and defines it as "a state of fatigue or frustration that is produced by dedication to a cause, way of life or relationship that does not produce the expected result ". For the year of 1978 the study of the concept extends to other professions not considered previously (Garden, 1987).

Since its inception, the concept of Burnout has been evolving by the proposal of various authors who propose theoretical models from which they seek their explanation and delimitation as clinical syndrome associated with work. At present, there is no single and universally accepted definition of Burnout, although there tends to be a consensus with the definition proposed by Maslach, in which burnout is defined as a psychological disorder that appears when there is a prolonged response to interpersonal stressors in the work (Maslach & Leiter, 2016). Regardless of the particular definition of the different studies in the field, the truth is that burnout is a condition that comes to "burn" completely to the person who suffers.

We began by evaluating the syndrome through systematic observations, structured interviews, exploratory and qualitative studies conducted in the field, case studies and personal experiences (Liter & Maslach, 2016); later on authors present improvements, giving emphasis to the evaluation by means of questionnaires or self-reports that have become the most used for the measurement and remained until now with great acceptance. The diversity of instruments has varied according to the theoretical concept and approach given that each author considers about the Burnout construct.

At present it is possible to find studies that investigate Burnout in various groups of professionals that include, managers, housewives, workers in social environments, volunteers from organizations of the Third Sector and athletes (Tutte & Garcés, 2010), to mention a few. . On the other hand, service-oriented professions, such as education and health care (Gil-Monte, 2002), have been considered for years as vulnerable for the development of the syndrome because the relationships they develop with recipients require a continuous and intense level of personal emotions. The individual begins to generate stress with self-assessment within a social context and the valuation of the relationships that he establishes with the people around him; Although such relationships can be rewarding, they can also be quite stressful. Recent research has shown that, regardless of occupation, Burnout occurs as a consequence of successive efficacy crises (Llorens et al., 2005) and anyone can suffer it (Aranda et al., 2004).

Mexico presents a lack of studies related to Burnout, especially if the situation is analyzed from the context of the manufacturing industry (Maldonado et al., 2015); for this reason the present investigation analyzes the presence of the syndrome from the industrial context. Currently, it is necessary to consider aspects of occupational health and well-being when evaluating the effectiveness of a specific organization, as there will be repercussions on the quality of working life and the state of physical health if something is wrong.

The customer-oriented approach that more and more companies adopt (Maslach & Leiter, 2016) is characterized by great changes with accelerated rhythms of life, competition, greater demand for specialization, permanent reformulation of objectives, goals and strategies, as well as a dynamic of constant decision-making that affects middle and higher management. As a consequence, some conditions may arise that harm the workers' performance, creating negative health behaviors, such as the loss of interest in work, a decrease in the efficiency of work (Wulfften & Janssen, 2016), an increase in absenteeism (Marrau, 2004); As far as physical discomforts are concerned, it can develop cardiovascular, muscular, mental and, in some cases, cancer (Seward, 1990). Due to the above, the interest of this phenomenon has become relevant in the industrial sector (Martínez, 2010).

The present investigation has the objective as the analysis of the main instruments to diagnose the syndrome burnout in personnel that occupies average and superior commanders, because they are these positions those that demand greater autonomy, flexibility, initiative, security in themselves and capacity to be molded in different situations.

2. OBJECTIVE

The objective of this study is to compare the three main instruments used to measure the Burnout syndrome, in order to find the most suitable instrument for its application in workers who belong to middle and upper management of the industrial sector.

3. METHODOLOGY

The methodology of the present investigation is developed in four stages; each of them described below:

3.1 Literature consultation related to Burnout measurement instruments

The first step was to identify relevant studies for the analysis, the search included articles and books published from January 2015 to date. It is important to mention that despite emphasizing recent research, most authors still respect some concepts and theories defined at the beginning of the Burnout study. The selected documents fulfilled the following characteristics: Described the instrument used to measure the Burnout, applied to a particular sector or group of people and it was validated for the selected sample.

3.2 Selection of the three main instruments to measure the Burnout

The instruments selected for analysis are: The Maslach Burnout Inventory; proposed by Maslach and Jackson in 1981, the Burnout Measure, proposed by Pines and Aronson in 1981, and the Occupational Wear Scale proposed by Uribe Prado in 2008.

3.3 Detailed analysis of each instrument and fields of application

3.3.1 Maslach Burnout Inventory (MBI)

It was the first instrument to analyze the Burnout syndrome, considered as the standard tool for research on this subject, for its construction was based on a comprehensive psychometric research program (Maslach & Leiter, 2016). This instrument was applied to health professionals and was validated in 2002 by Gil Monte, obtaining high reliability and validity. It has three versions:

The first version was the MBI Human Services Survey (HSS) aimed at health professionals, composed of 22 Lickert-type items, whose division consists of the three dimensions most commonly used to define burnout (Martínez, 2010);

emotional exhaustion, depersonalization and low personal fulfillment, with results on a low-medium-high scale.

The second version of the instrument is the so-called MBI Educators Survey (ES); It is structured in the same way as the MBI Human Services Survey, the difference is that it is applied specifically to teachers (Schwab, 1986) and in the writing of the instrument only the word patients is replaced by students (Grajales, 2000).

In 1996, the third version of this instrument was published, transforming the MBI-General Survey (MBI-GS) with a more generic vision to include more professions outside the scope of human services; It was developed in conjunction with Leiter and Schaufeli.

Among the main advantages of the instrument are:

International acceptance, since countries in Latin America, the European Union and the United States have implemented this instrument in their research (Golembiewski et al., 1996, Maslach et al., 2001), in addition to having been translated and validated in different languages (Maslach et al., 2009), this allows comparisons to be made between analyzes of different countries, which will be valid for using the same instrument.

The acceptance of the three dimensions by several authors as a result of various analyzes carried out; by orthogonal rotation (Söderfeldt et al., 1996), oblique rotation (Abu-Hilal, 1995), confirmatory factor analysis (Boles et al., 2000, Hansung & Juye 2009) or by means of qualitative data analysis (Bakker et al. al., 2002, Shirom & Melamed, 2006, Rubio, 2003).

Recurrent validity in various investigations such as Beckstead (2002), Le Roux and Mostert (2004), Camacho et al. (2014), Maldonado et al. (2015) To mention a few, they have shown the validity of the instrument. Validity for different sectors with the study of the syndrome in various professions with high significant correlations as results, analysis is found in personnel dedicated to social assistance (Barria, 2002), in police (Briones, 2007), in professors (Miño, 2003, Parra 2005, Valdivia et al., 2003), to mention a few.

3.3.2 Burnout Measure (BM)

It has its origins in the Tedium Measure (TM) instrument, the Tedium construct is more complete because it not only addresses burnout but also includes other syndromes. It consists of 21 items, the description of the syndrome occurs in physical exhaustion with 7 items characterized by fatigue and feeling of despondency; emotional exhaustion with 7 items consisting of feeling of depression and burnout; and finally the mental exhaustion with 7 items that includes sensations of unhappiness, uselessness and rejection.

Some of the advantages of the instrument are the following:

It was developed for application in any occupational group or people who do not present a particular job with high degrees of validity and reliability (Pines, 1993, Pines & Aronson, 1988, Schaufeli & Van Dierendonck, 1993, Schaufeli & Enzmann, 1998).

It has the support of various investigations such as the one carried out by the authors Fernández and others (1994) in a study in which they analyze the effects of teaching stress on health habits, claiming that it offers guarantees for its use given its internal consistency and its proven usefulness as a measure of stress; another example is the research developed by Takai et al. (2009) in which they make a comparison of how the syndrome influences the quality of life and depression in people dedicated to the care of patients with dementia. On the other hand, Pines and Aronson (1988) mention that it has high levels of stability when obtaining values above 0.90 in the coefficient of internal consistency.

Wide global coverage due to its application in several countries such as France, Holland, Japan, Mexico, Portugal, Spain, Israel, Germany, Hungary, to name a few (Malach, 2005).

There is a short version consisting of 10 questions that considerably reduce space and time of application facilitating this activity; The selection of questions is based on a theoretical analysis. The validity and reliability of the instrument has been demonstrated with a coefficient of internal consistency that exceeds 0.85 (Malach, 2005).

It has its own response scale established to validate the degree of affectation that a person has regarding Burnout syndrome; Diagnoses range from "a low level" to "require immediate professional help" (Malach, 2005).

Short application time of 5 to 7 minutes from the original version.

3.3.3 Occupational Wear Scale (EDO)

EDO is created in order to cover the measurement needs of the burnout syndrome with formal and reliable psychometric standards, as well as to provide those evaluated with an ethical measurement of their health status (Uribe Prado, 2007).

Among the advantages are the following:

It was prepared by and for Mexicans, so it considers aspects such as culture, language, interpretations and the psychosocial environment for this particular population. The author (Uribe, 2007) substitutes the term Burnout for Occupational Wear, because, through the technique of semantic networks, he discovered that this term is more appropriate in the Mexican context.

Some authors recommend the use of this instrument when approaching burnout study (Littlewood et al., 2013) despite being a relatively recent instrument.

It has satisfactory psychometric properties in addition to measuring psychosomatic symptoms not considered by the MBI. Using an exploratory factorial analysis, it obtained satisfactory indices of reliability and construct validity (0.85 in Exhaustion, 0.76 in Depersonalization and 0.86 in Dissatisfaction) in the research by Littlewood et al. (2013).

One of the most outstanding advantages of this method is that 30 of the 110 total reagents, theoretically and significantly reproduce the proposal of the concept of burnout proposed by Maslach and Jackson (1981, 1986), that is, the theory most accepted in the investigations. Consider the three fundamental aspects of the syndrome: depersonalization, personal fulfillment and emotional exhaustion;

proposed by Maslach and Jackson (1981) and recognized as the best instrument for the assessment of the syndrome according to Oliver and others (1990).

The answers of the EDO instrument can be interpreted by means of two methods depending on the case that is convenient, the first is considering the area under the curve (Normal distribution) whose output variables have 6 levels: Very high, High, High middle term, Below term Medium, Low and Very low. The Leiter model is the second method and it is a quick and less precise procedure that does not require the use of areas under the curve and is used only for the interpretation of occupational wear values, in this case it considers 4 levels: Healthy, Normal, Endangered and Burned (Uribe, 2007).

3.4 Selection of the appropriate method for the specific field of application

According to the characteristics and literature analyzed, the selected instrument is the Maslach Burnout Inventory (MBI), table 1 shows the most outstanding characteristics of each instrument analyzed.

Table 1. Characteristics of the instruments

Instrument	MASLACH BURNOUT INVENTORY (MBI-GS)	BURNOUT MEASURE (BM)	SCALE OF OCCUPATIONAL WEAR (EDO)
Reliability level	0.90	0.91-0.93	0.89
Number of ítems	16	21	30
Dimensions	Emotional wear, professional efficiency and cynicism	Demoralization, tiredness and Low motivation	Exhaustion, depersonalization and achievement dissatisfaction
Application sector	Without approach to a determined sector	Without approach to a determined sector	Without approach to a determined sector

4. RESULTS

Regarding the Maslach Burnout Inventory in the nineties, it is considered as the main one, since it appeared in 90% of the investigations (Scheufeli & Enzmann, 1998) and is currently considered the most used instrument (Littlewood et al. , 2013, Díaz & Gómez, 2016). It has 3 official versions and the internal consistency for the 1986 version was 0.80 (Maslach & Jackson, 1986).

On the other hand the instrument Burnout Measure, is considered as the second most used in literature, developed by Pines and Aronson in 1988 and defines burnout as a state of physical, emotional and mental fatigue (Malach, 2005). Despite not having three dimensions, this instrument has a strong correlation with the emotional exhaustion sub-scale of the MBI, this is important because it has been shown that this dimension is the most dominant and significant when describing the burnout syndrome (eg, Burke & Richardsen, 1993; Koeske & Koeske, 1989).

While the Occupational Wear Scale (EDO), is created in order to meet the needs of measurement of burnout syndrome with formal and reliable psychometric standards for the specific Mexican population. This instrument is the most recent of the three compared, was prepared by researchers from the Faculty of Psychology at the Autonomous University of Mexico and has been validated with an acceptable cronbach alpha of general reliability of 0.8910.

According to the information analyzed, it is proposed that the most appropriate instrument to evaluate the burnout syndrome in the Industrial sector aimed at personnel who hold medium and higher positions is the MBI.

After selecting the instrument, it was subjected to the internal consistency test by means of the cronbach alpha, considering a total of 121 samples taken and 6 discarded; in personnel that belongs to middle and upper management of companies in the industrial sector of the cities of Tijuana and Mexicali with the following alpha values: 0.892 for emotional exhaustion, 0.816 for professional efficiency, 0.847 for cynicism and a value of 0.814 for the complete instrument.

5. CONCLUSIONS

The psychological, behavioral and physiological responses of the stress process can become over time in more or less permanent consequences that significantly affect the pace of life of people in terms of decreased work performance, accompanied by emotional exhaustion and feelings of disability, which combine with a series of physical and somatic discomforts in a downward spiral of deterioration (Littlewood et al., 2013). Burnout is a consequence of presenting chronic stress, it depends on the social environment in which people develop professionally; If, for example, there are internal problems, disorganization, strong competition among peers or lack of tools to deal with activities (Aranda et al., 2004), the worker can develop it at a high level. When the workplace does not recognize that there must be a human side, mismatches begin to arise between the nature of the work and the nature of the people, and that is when there will be a greater risk of suffering burnout (Maslach, 2009).

It is necessary to identify people who suffer from this syndrome in companies, both to alleviate their own discomfort, and to prevent the harmful effects that this may have on the clients they serve or the people with whom they interact and avoid job instability in the organizations.

The present investigation analyzed three of the most important and well-known instruments to measure burnout; The importance of having an adequate instrument at the beginning of any project lies in the reliability of the results obtained with the taking of samples. The instrument selected was the MBI. In addition to the multiple advantages described above, the brief duration is emphasized to answer it compared with other instruments that can last up to 40 minutes. The approximate duration to answer it in its entirety is 5 minutes maximum, which makes its application viable in companies because there is a limited time to perform activities in this context (application of surveys, guided tours, etc.) and even more considering that it is aimed at middle and upper management; who are in charge of formulating, articulating and executing the strategic movements of the organization and who get to spend more than 48 hours a week working in most cases.

After selecting the instrument, the internal consistency is calculated for each dimension that makes up the MBI and a value of 0.814 is obtained for the complete instrument; considered good for having a value greater than 0.8 (George & Mallery, 2003).

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DESIGN AND ERGONOMIC EVALUATION OF AVOCADO HARVEST

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RESUMEN: Actualmente, muchas de las actividades de trabajo agrícola se llevan a cabo en condiciones ergonómicas desfavorables. Los trabajadores de este sector manejan cargas de más de 25 kg en posiciones incómodas, alejadas del cuerpo y terreno inestable, lo que probablemente constituya un riesgo en sí mismo. La investigación se lleva a cabo en el análisis de la actividad de cosecha de aguacate con un palo en una plantación de 20,000 m^2 en el municipio de Uruapan, Michoacán. La actividad de recolección se lleva a cabo regularmente en grupos de 3 personas por árbol y hay una fuerza de trabajo de 30 trabajadores en horas efectivas de trabajo de 9.5 horas, 6 días a la semana. El universo de muestra consistió en 15 trabajadores. Los riesgos con un palo se identificaron usando la Evaluación Rápida de la Parte Superior (RULA), la Evaluación Rápida del Cuerpo Completo (REBA), el Sistema de Análisis de Trabajo Ovako (OWAS) y se complementó con el índice de esfuerzo laboral (JSI). Los resultados muestran que la cosecha de aguacate con un palo genera riesgos en la salud del trabajador. Las medidas correctivas inmediatas son el diseño ergonómico de una cosechadora de fruta que utiliza la metodología Blitz QFD. Los criterios de diseño del mecanismo incluyen: manejo de carga por persona hasta 25 kg, cubierta superior o toldo que reduce la exposición del operador, radiación solar y condiciones de lluvia, contenedores con agarre fácil, sujetadores para transporte seguro, y una altura máxima de 80 cm que permite visibilidad al trabajador en el manejo del volumen total de carga. En conjunto, existe una contribución ergonómica al aplicar métodos de evaluación ergonómica en el análisis ocupacional en el sector agroindustrial.

Palabras clave: cosechadora de frutas, REBA, OWAS, JSI y salud ocupacional.

ABSTRACT: Currently, many of the agricultural work activities are carried out under unfavorable ergonomic conditions. Workers in this sector handle loads greater than 25kg in awkward positions, away from the body and unstable ground, which most likely constitute a risk in themselves. The research is carried out in the analysis of the harvest activity of avocado with a pole in a plantation of 20,000 m^2 in the municipality of Uruapan, Michoacán. The harvesting activity is carried out regularly in groups of 3 people per tree and there is a workforce of 30 workers in effective working hours of 9.5 hours, 6 days a week. The sample universe consisted of 15 workers. The risks in pole-vaulting were identified using Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Ovako Working Analysis System (OWAS) and supplemented with the Job Strain Index (JSI). The results show that the harvest of avocado with a pole generates risks in the worker's health. The immediate corrective measures are the ergonomic design of a fruit harvester using the Blitz QFD methodology. The design criteria of the mechanism includes: cargo handling per person up to 25 kg, top cover or awning that reduces operator exposure, solar radiation and rain conditions, containers with easy grip, fasteners for safe transport , and a maximum height of 80 cm that allows visibility to the worker in the handling of the total volume of load. As a whole, there is an ergonomic contribution when applying ergonomic evaluation methods in the occupational analysis in the agroindustrial sector.

Key words: Fruit harvester, REBA, OWAS, JSI and Occupational health.

1. INTRODUCTION

Worldwide, Mexico is the main producer of avocado, in 2012 it concentrated 30.19% of world production, followed by Indonesia and the Dominican Republic (6.75% and 6.65% respectively) (*FAOSTAT, 2016*).

In many of the activities in the field, workers use equipment and tools inappropriately, maintain long static postures, kneel, work with arms above shoulder level, or move their hands and wrists repetitively (*García, 2006*). To this situation we must add chemical risks, biological, psychosocial, mechanical risks, repetitive work, and excessively long schedules. As for activities developed with agricultural machinery, conditions are presented where the whole body is subject to vibrations produced by the equipment and unacceptable noise levels (*ILO, 2000*).

Musculoskeletal disorders are a special problem in the agro-industrial sector, as shown by the following figures: almost 60% of workers in the agriculture and fishing sector have to adopt painful positions at work half the time or more , this being the sector with the highest percentage; - almost 50% of workers in the agriculture and fisheries sector have to handle heavy loads half the time or more; - More than 50% of workers in the agriculture and fishing sector are exposed to repetitive hand movements half the time or more. Workers in the agriculture and construction sectors are exposed to mechanical risk factors, including lumbar injuries, while workers in the agriculture, forestry and fishing sectors have the highest risk of upper extremity disorders related to work. (*ILO, 2000*).

2. GENERAL OBJECTIVE

Identify the risks in the pole-and-line avocado harvesting activity by means of ergonomic methods and propose alternatives that counteract the potential risks detected.

2.1 Specific Objectives

1. Describe the work activities corresponding to the harvest of avocado with a pole vault.
2. Identify the risk factors obtained through the RULA, REBA, OWAS methods and supplemented with the JSI method of the described tasks.
3. Indicate recommendations to act on the risk factors detected in the fruit harvest with pole vault.

3. METHODOLOGY

The type of research conducted in the present work is descriptive (observe, record and interpret the existing information in order to define properties and characteristics), documental (data records were consulted), non-experimental (the natural process is observed) and of non-participating behavior (the researcher does not intervene in the process).

3.1 Study area

The study area corresponds to a 20,000 m^2 plantation in Uruapan, Michoacán with geographic location 19° 25'16"N-102° 03'47"W, with average temperature between 22-26ºC. The harvesting activity is carried out regularly in groups of 3 people per tree and it has a workforce of 30 workers in effective working hours of 9.5 hours, 0.5 hours of rest / hydration for 6 days a week.

3.2 Study material

The sample universe to determine the risks at work consisted of 15 workers exposed to various levels of risk that occurred in the harvest of avocado with a pole vault. The samplings were carried out in relation to the activities of the fish center from June to October 2017. The risks in the pole-harvesting activity were identified through Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA) methods, Ovako Working Análysis System (OWAS) and complemented with the Job Strain Index (JSI) method. The activities considered to determine the risks in the harvest of avocado with a pole are: Fruit selection and positioning of the pole (Activity 1), Cutting and sustaining the fruit (Activity 2) and container management (Activity 3). Samples were taken in 2 consecutive weeks from December 4 to 15, 2017.

3.3 Evaluation of harvest of avocado with a pole using ergonomic methods

The study first evaluated the harvest of avocado with a pole using the RULA, REBA and OWAS methods. Subsequently, the analysis is complemented by applying the JSI method. We considered 290 work cycles (production of one worker / day) with a duration of 124 seconds / box (error of 10%). Next, a complete analysis of the activity is presented before the conventional avocado harvesting method, for which videos, photographs and reports were analyzed where the process is described and exemplifies the daily action of the workers in the fields of cultivation the fruit.

Activity 1 (Selection of fruit and positioning of the pole): Developed in the plot, there are 3 workers per tree (10% of workers for harvesting the fruit). The activity begins with the selection of the fruit. The fruits are inspected and selected for cutting, among the characteristics to be evaluated is the color of the fruit, size and free of contaminants or pests. The activity is carried out by workers between 17-25 years of age and with a minimum experience of 6 months in the selection of fruits, since considerable skill is required to perform the work they do. For this, the worker moves his head upwards in order to locate a mature fruit (5 seconds), later with the pole (1.3-4.5m in length and 0.25kg in weight at its upper end) held by both hands position the end top of it under the fruit for 5 seconds (Figure 1a).

(a) (b) (c)

Figure 1. (a) Current method, (b) reference axes (c) fixed of the collector in the cup of the tree, using safety rope.

Table 1. Evaluation comparison of avocado harvest with pole (Activity 1)

Activity 1: Fruit selection and pole positioning				
	RULA	REBA	OWAS	Corrective actions
Left arm. Flexion> 90º	4	4	2	
Right arm. Flexion between 20º and 45º	1	1		
Left forearm. Flex <60º or> 100º	2	2		
Right forearm. Flexion between 60 and 100º	1	1		
Left wrist. Extended 0o and 15º	2	1		Urgent changes are
Radial or ulnar deviation	1	1		Required.
Right wrist. Radial deviation, Extended 0o and 15º	1	1		in the homework.
Radial or ulnar deviation	0	0		Action is necessary
I turn left wrist. Medium pronation	1	0		
I turn right wrist. Medium pronation	1	0	n/a	Normal and natural

Neck. Extension in any degree	4	2		**harmful effects on skeletal muscle.**
Broken head	1	1		
Trunk. Flexion between 0° and 20°	2	2	1	
Legs. Standing with symmetrically distributed weight and space	1	2	3	
Type of activity. Repetitive (repeated more than 4 times each	1	1		
Loads and forces. Load less than 2 Kg maintained	0	0	1	
Final score	**7**	6	1	
Risk level	**4**	**2 Medium**	**1**	

The JSI analysis assessed whether workers who occupy them are exposed to develop cumulative traumatic disorders in the distal part of the upper extremities due to repetitive movements.

Table 2. Evaluation of traumatic disorders of the avocado harvest with pole vault (Activity 1).

Intensity of effort (IE)		**Posición anatómica de la mano (HWP)**	
Perceived effort	Rating	Wrist Posture	Rating
Perceptible effort. A bit hard	2	Regular -No neutral	3
Duración de los esfuerzos (DE)		**Working speed (SW)**	
% Duration of efforts (DE)	Rating	Rhythm of work	Rating
10%-29%	2	Regular 91%-100%, Normal movement speed	3
Frequency of efforts (EM)		**Completion of the task (DD)**	
Efforts per minute	Rating	Duration of homework / day	Rating
4-8	2	>=8	5
Strain index			
score		Assessment	
6.75		**Activity associated with musculoskeletal disorders of the upper extremities.**	

Activity 3 (Container handling): Once the fruits are harvested with the pole, they are deposited in the corresponding plastic containers (figure 4a) of 25-26 times - with a duration of 104 seconds. It should be noted that the height of each container is 0.30m and in a day of 10 hours each worker fills 280 boxes approximately (figure 4b).

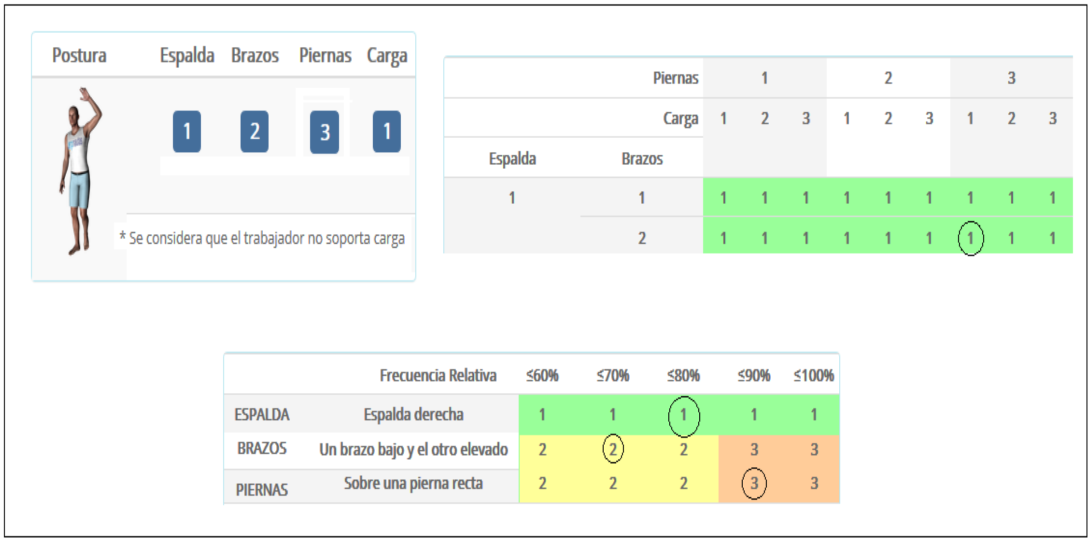

Figure 2. Results of OWAS analysis for activity 1.
(ergonautas.upv)

Figure 3. Cut and support of the fruit

Table 3. Evaluation comparison of avocado harvest with pole (Activity 2).

Activity 2: Cutting and sustaining the fruit				
	RULA	REBA	OWAS	Corrective actions
Left arm. Flexion> 90º	4	4	2	Urgent changes are Required in the Task.
Right arm. Flexion between 20º and 45º	1	1		
Left forearm. Flex <60º or> 100º	2	2	n/a	
Right forearm. Flexion between 60 and 100º	1	1		
Left wrist. Extended 0o and 15º	2	1		
Radial or ulnar deviation	1	1		
Right wrist. Radial deviation, Extended 0o and 15º	1	1		
Radial or ulnar deviation	1	0		

I turn left wrist. Medium pronation	0	0		
I turn right wrist. Medium pronation	1	0		
Neck. Extension in any degree	4	2		Action is necessary
Broken head	1	1		
Trunk. Flexion between 0° and 20°	2	2	1	
Legs. Standing with symmetrically distributed weight and	1	2	3	Normal and natural
Type of activity. Repetitive (repeated more than 4 times each	1	1		without effects harmful
Loads and forces. Load less than 2 Kg maintained	3	1	2	in the skeletal muscle
Final score	**7**	9	1	System.
Risk level	**4**	**3 Alto**	**1**	

Table 4. Evaluation of traumatic disorders of the avocado harvest with pole vault (Activity 2).

Intensity of effort (IE)		**Posición anatómica de la mano (HWP)**	
Perceived effort	Rating	Wrist Posture	Rating
Obvious effort; no change in facial expression	3	Regular -No neutral	4
Duración de los esfuerzos (DE)		**Working speed (SW)**	
% Duration of efforts (DE)	Rating	Rhythm of work	Rating
10%-29%	2	Regular 91%-100%, Normal movement speed	3
Frequency of efforts (EM)		**Completion of the task (DD)**	
Efforts per minute	Rating	Duration of homework / day	Rating
4-8	2	>=8	5
Strain index			
score		Assessment	
6.75		**Activity associated with musculoskeletal disorders of the upper extremities.**	

Figure 4a) Emptying fruit in plastic containers, b) Fruit harvesting term c) Truck load with containers.

Table 5. Evaluation comparison of avocado harvest with pole (Activity 3).

Activity 3: Container handling	RULA	REBA	OWAS	Corrective actions
Left arm. Flexion> 45° and 90°	3	3	2	
There is a point of support	-1	-1		
Right arm. Flexion> 45° and 90°	3	3	n/a	
Left forearm. Flexion between 60° and	1	1		
Right forearm. Flexion between 60° and	1	1		The activity requires redesign.
Left wrist. Flexion or extension> 0° and	2	1		
Radial or ulnar deviation	0	1		
Pronation or medium supination	0	0		
Right wrist. Radial deviation, Extended 0º	2	1		Action is necessary as soon as possible.
Radial or ulnar deviation	1	1		
Pronation or medium supination	1	0	1	
Neck. Flexion> 20°	3	1		
Trunk. Flexion> 60°	4	5		
Rotating trunk	1	1	3	The load caused by this posture extremely harmful effects on the musculoskeletal system. Corrective actions are required immediately.
Legs. Standing with symmetrically	1	3		
Type of activity. Repetitive (repeated more	1	1	2	
Loads and forces. Load less than 2 Kg	0	0		
Final score	6	9	4	
Risk Level	3	3 High	4	

Table 6. Evaluation of traumatic disorders of the avocado harvest with pole vault (Activity 3).

Intensity of effort (IE)		**Posición anatómica de la mano (HWP)**	
Perceived effort	Rating	Wrist Posture	Rating
Obvious effort; no change in facial expression	3	Regular -No neutral	3
Duración de los esfuerzos (DE)		**Working speed (SW)**	
% Duration of efforts (DE)	Rating	Rhythm of work	Rating
10%-29%	2	Regular 91%-100%, Normal movement speed	3
Frequency of efforts (EM)		**Completion of the task (DD)**	
Efforts per minute	Rating	Duration of homework / day	Rating
4-8	2	>=8	5
Strain index			
score		Assessment	
13.5		**Activity associated with musculoskeletal disorders of the upper extremities.**	

4. RESULTS/DISCUSSION

4.1 Evaluation of activity 1 (Fruit selection and pole positioning).

By means of the RULA method, workers' exposure to risk factors is evidenced due to a high postural load and that can cause disorders in the upper limbs of the body.

The final rating of groups A and B is 7. According to the repeatability of the operation, there is a C value of 8 (A +1), since the operation is repeated more than 4 times every minute. Finally, the D value is 7 (B +0). The score calculated for **this activity according to the action table corresponds to a level of action 4, concluding that the activity is dangerous and requires urgent changes.**

The method REBA (Evaluation of forced postures) allowed an analysis of upper body members (arm, forearm, wrist), trunk, neck and legs, as well as the analysis in tasks that involve changes in posture due to loads excessive or unpredictable.

The final score for group A is 4 and group B is 5. There is no increase in group A score due to load or forces exerted, nor increase of group B score for quality of the grip. The C score calculated for this activity according to the action table corresponds to an action level 5, plus an increase of 1 in the C score, since repetitive movements occur more than 4 times per minute. **Concluding that the activity has a level 2, medium risk and action is necessary.**

The results of the evaluation by the OWAS method of fruit selection and pole positioning, show a risk category 1, that is, the operator maintains a normal and natural posture without harmful effects on the musculoskeletal system. However, in the relative frequency of the position of arms (≤70%) there is a category of risk 2, posture with the possibility of causing damage to the musculoskeletal system, corrective actions are required in the near future. The relative frequency of the position of legs (≤90%) has a risk category 3, posture with harmful effects on the musculoskeletal system. **Corrective actions are required as soon as possible**.

The JSI analysis assessed whether workers are exposed to develop cumulative traumatic disorders in the distal part of the upper extremities due to repetitive movements. In summary, the multiplying factors corresponding to activity 1 are: Intensity of effort (IE) = 3, Duration of effort (DE) = 1, Frequency of efforts (EM) = 1, Anatomical position of the hand (HWP) = 1.5, Working speed (SW) = 1 and Completion of the task (DD) = 1.5. **It has a JSI of 6.75, so the activity is associated with musculoskeletal disorders of the upper extremities.**

4.2 Evaluation of activity 2 (Cutting and sustaining the fruit).

The grades of the Cut and support of the fruit when developing the RULA analysis are the following: Final rating of group A is 4 and group B is 7. As the repeatability of the operation has a C value of 5 (A +1), since the operation is repeated more than 4 times every minute. Finally, the D value is more than 7 (B + 3), due to sudden or sudden shocks or forces. The score calculated for this activity according to the action table corresponds to a level of action 4, **concluding that the activity is dangerous and requires urgent changes.**

The REBA method shows a final score of group A is 4 and of group B is 5. There is an increase of 1 point of group A due to the presence of forces or loads applied abruptly, group B did not increase. The C score calculated for this activity according to the performance table corresponds to an action level 6, plus an increase of 1 in the C score, since repetitive movements occur more than 4 times per minute. **Concluding that the activity has a level 2, medium risk and action is necessary.**

The results of the evaluation by the OWAS method of cutting and sustaining the fruit, show a risk category 1, that is, the operator maintains a normal and natural posture without harmful effects on the musculoskeletal system. However, in the relative frequency of the position of arms (≤70%) there is a category of risk 2, posture with the possibility of causing damage to the musculoskeletal system, corrective actions are required in the near future. The relative frequency of the position of legs (≤90%) has a risk category 3, posture with harmful effects on the musculoskeletal system. **Corrective actions are required as soon as possible.**

The multiplying factors corresponding to activity 2 of the JSI analysis are: Intensity of effort (IE) = 6, Duration of effort (DE) = 1, Frequency of efforts (EM) = 1, Anatomical position of the hand (HWP) = 2, Working speed (SW) = 1 and Completion of the task (DD) = 1.5. **There is a JSI of 18, so the activity is associated with musculoskeletal disorders of the upper extremities**.

4.3 Evaluation of activity 3 (Container handling).

The RULA analysis of this activity is as follows: Final qualification of group A is 3 and group B is 6. As the repeatability of the operation has a C value of 4 (A +1), since the operation is repeat more than 4 times every minute. Finally, the D value is 6 (B +0). The score calculated for this activity according to the action table corresponds to an action level 3, **concluding that the activity requires a redesign.**

The results of the REBA method are: final score of group A is 7 and group B is 1. There is an increase of 1 point of group A by load or force between 5 and 10 Kg, group B was not increased. The C score calculated for this activity according to the performance table corresponds to an action level 8, plus an increase of 1 in the C score, since repetitive movements occur more than 4 times per minute. Concluding that the activity has a level of risk 3, that is, high level, **so it is necessary to act as soon as possible.**

The results of the evaluation by the OWAS method show a category of risk 4, that is, the load caused by this posture has extremely harmful effects on the musculoskeletal system. **Corrective actions are required immediately.**

However, in the relative frequency of arm position (≤30%) there is a risk category 1, normal and natural posture without harmful effects on the musculoskeletal system, while the relative frequencies of the back and legs positions present risk category 2 (≤30%), postures with the possibility of causing damage to the musculoskeletal system.

The multiplying factors corresponding to activity 3 of the JSI analysis are: Intensity of effort (IE) = 6, Duration of effort (DE) = 1, Frequency of efforts (EM) = 1, Anatomical position of the hand (HWP) = 1.5, Working speed (SW) = 1 and Completion of the task (DD) = 1.5. There is a JSI of 13.5, so the activity is associated with musculoskeletal disorders of the upper extremities. **Task is probably dangerous.**

4.4 Proposal to improve the harvest of avocado with a pole.

To mitigate the risk factors of avocado harvesting activity, we propose the design of a fruit harvester capable of reducing / eliminating musculoskeletal injuries in operators and increasing productivity in the harvest of fruits through the following elements:

1. The ergonomic design should consider the 95th percentile of the anthropometric measurements of the central region of the country for male and female operators, aged 16-60 years and with a weight of 110 kg maximum.
2. The mechanism will handle standardized plastic containers of 30 Kg capacity (50 cm x 40 cm x 30 cm) with vertices or rounded edges, with ease of grip, fasteners for safe transfer, and a maximum height of 80 cm that allows visibility to the worker in the handling of the total volume of load, as well as avoiding the handling or accumulation of foreign materials, chemical substances, breaks or openings.
3. It will be provided with an upper cover or awning of 100 x 80 cm that allows to reduce the operator's exposure to solar radiation and rain conditions.
4. The use of green and self-sustaining technology (use of solar cells and energy storage systems) has been considered.
5. Cargo compartment with a front cover that will help to smoothly slide the cargo containers parallel to the floor, as well as an inclined position to place the containers on the floor, thereby avoiding the risk of falls in cargo handling , as well as reducing sanitary and phytosanitary risks.
6. Differentiating fruit system composed of a resolution camera 1270 x 340 pixeles, plus separate night vision, 90° lens that allows the selection and cutting of the fruit by an application of image recognition to identify the state of ripeness of the fruit, as well as some disease or plague.
7. Automatic cutting of the fruit integrated by an electric blade coupled to the collecting pole.

It is worth mentioning that the aforementioned elements are the result of the Blitz QFD methodology (*Mazur, 2012*), which allow to align the resources with the true needs of the client, besides not requiring application software or specific quality tools to obtain results. The deployment of the 7 steps contemplated a sample of 20 companies related to the cultivation and harvest of avocado in the region of Uruapan, Michoacán. The proposed prototype will look very similar to what is shown in Figure 5.

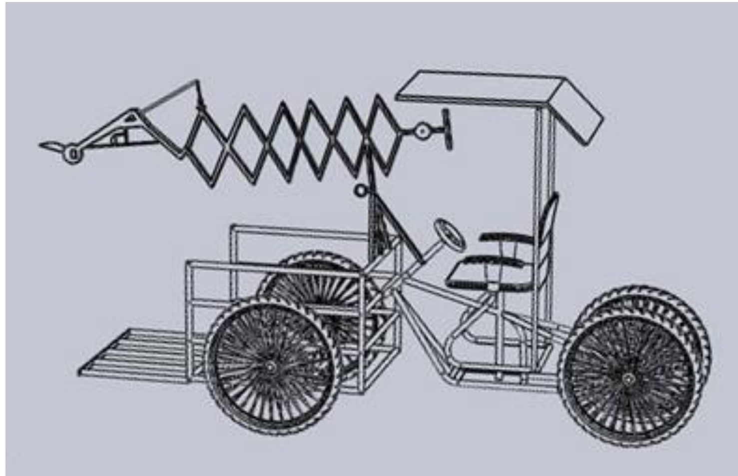

Figure 5. Prototype

5. CONCLUSIONS

There is an association between the level of postural risk and musculoskeletal pain with the symptoms that avocado harvesters have presented as pain / fatigue in the shoulders, neck and back, for which a prompt ergonomic intervention in these activities is recommended. Similarly, very repeated work cycles are observed that give rise to risk factors such as: rapid movements of muscle groups and insufficient rest times, together with the predominance of works of little content, monotonous in nature.

It is recommended a planning in the assignment of tasks according to the role to be played that allows to have a good work performance, contributing a temporary and regular distribution of the tasks, making possible a reduction of the work accumulation and greater control.

With the technological proposal is improved in the method of handling finished product, reduction of work risk as a result of the improvement of the position in the activity. Among the results of the work, we have the specifications and tolerances of each of the components of the fruit harvester, as a result of the translation of the client's voice when using Blitz QFD methodology.

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RELATIONSHIP OF WORK STRESS AND OBESITY EXPLAINED BY PHYSICAL ACTIVITY AND FOOD HABITS IN INDUSTRIAL STUDIES A REVIEW OF LITERATURE.

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RESUMEN: Cuando el estrés laboral está presente y se carece de formas de evaluación, medidas preventivas y de control adecuadas se comienza a observar el desarrollo de enfermedades. A pesar de que el estrés laboral es uno de los temas más estudiados en el ámbito de la salud mental en el trabajo, la relación de éste con la actividad física, los hábitos alimentarios y el índice de masa corporal carecen de la misma atención. Por tanto, los objetivos de este trabajo son: desarrollar una revisión de literatura que relacione los conceptos principales de estrés laboral, actividad física y hábitos alimentarios y el índice de masa corporal. La metodología utilizada consistió en una búsqueda en las principales bases de datos por palabra clave y por instrumento de medición. Los conceptos principales de búsqueda son el estrés laboral, la obesidad, la actividad física y los hábitos alimentarios y se delimita a solo estudios realizados en muestras de la industria. Los resultados se clasificaron en dos tablas una por concepto principal y otra por los instrumentos de medición utilizados para cada variable de estudio, se encontraron 254 artículos de los cuales solo 151 fueron tomados en cuenta debido a los criterios de descarte. Se concluye, basándose en los resultados obtenidos, que existe una oportunidad para desarrollar investigaciones donde se manejen los conceptos principales juntos, aparte de que estudios en México son muy escasos.

Palabras clave: estrés laboral, obesidad, actividad física y hábitos alimentarios.

Aportación a la Ergonomía: Esta revisión ayuda a tener una idea más clara de cómo se pueden relacionar estos términos y cuáles son los métodos e instrumentos adecuados para el manejo de cada uno de ellos.

ABSTRACT: When work stress is present and there is a lack of evaluation, preventive measures and adequate control; the development of diseases begins to be observed. Although work stress is one of the most studied topics in the field of mental health at work, its relationship with physical activity, eating habits and body mass index lack of the same attention. Therefore, the objectives of this work are: to develop a literature review that relates the main concepts of work stress, physical activity and eating habits and the body mass index. The methodology used consisted in a search of the main databases by keywords, and by measuring instrument. The main concepts of search are work stress, obesity, physical activity and eating habits and is limited to only studies conducted in industry samples. The results were classified into two tables, one for the main concept and the other for the measurement instruments used for each study variable, 254 articles were found of which only 151 were taken into account due to the discard criteria. It is concluded based on the results obtained, that there is an opportunity to develop investigations where the main concepts are handled together, apart from the fact that studies in Mexico are very scarce.

Key words: work stress, obesity, physical activity and eating habits.

Contribution to Ergonomics: This review helps to have a clearer idea of how these terms can be related and what are the appropriate methods and instruments for the management of each of them.

1. INTRODUCTION

The approach to the problem is based on the following aspects: disorders arising from stress are on the rise in our country; no studies have been found where the relationship between work stress addressed by burnout and work Content, obesity, physical activity and eating habits are clear or where all variables are studied together, and finally the measuring instruments are deficient.

Disorders in health have an impact on the development of the individual's activities, causing low productivity quality failures among other consequences (Forbes, 2011; Marrau, 2009), all the consequences that these disorders cause increase the production costs of companies (Arenas & Cantú, 2013, Gestal, 2003, Juno & Noriega, 2004, Valecillo et al., 2009, Kim & Han, 2014), on the other hand is a study of (Ahola 2012) who finds that the dimension of Burnout the efficacy Professional is related to the decrease of obesity and overweight, (Nevanpera et al., 2012 & Proper, Koppes, Meijer & Bemelmans 2013), found that the emotional exhaustion dimension is associated with uncontrolled eating and emotions. It is important to observe the negative effects that these syndromes produce since cardiovascular, gastrointestinal respiratory and many other problems have increased affecting the physical and mental health of the human being (Serrano & Costa, 2018), and every year mortality increases in industrial employees (Ahola et al., 2012). On the other hand, it increases the risk of suffering from diabetes and some cancers (Dávila, J., González, J. and Barrera, 2015) and cardiovascular diseases that are the main cause of global death (World Health Organization, 2013).

On the other hand, obesity is one of the main public health problems due to its magnitude, its accelerated growth and the negative effect on the health of the population that suffers it. Obesity is known as a systemic, chronic and multicausal disease, not exclusive of economically developed countries. The World Health Organization, for its part, defines it as an abnormal or excessive accumulation of fat. Regarding this problem, Mexico occupies the second place of worldwide prevalence of obesity in the adult population (30%), which is ten times greater than that of countries such as Japan and Korea (Dávila-Torres et al., 2015). The factors that will be taken into account to better explain obesity are physical activity (AF) and eating habits. The realization of AF, which includes the practice of a sport, increases the quality of life and contributes to the well-being of people by improving their health. On the part of the alimentary habits, these are essential in the daily life for the improvement of our health in matter of which our organs work efficiently, we acquire greater energy throughout the day and physically we see ourselves much better.

2. METHODOLOGY

In this section we present the steps that were followed to achieve an adequate literature review.

Step 1: Perform an exhaustive search in a period no greater than the last 5 years in the main databases such as: Science Direct, Scopus, Oracle and Emerald. The main concepts of each of the variables that are addressed in the research were used, among them: work stress, physical activity, eating habits and obesity.

Step 2: Subsequently, the keyword search was refined where the variable dimensions of the most used measurement instruments were used to study them, such as: Maslach Burnout Inventory (MBI) (Maslach and Jackson 1981), Job Content Questionnaire (JCQ) (Karasek and Theorell, 1990), FCQ-Trait (Cepeda-Benito et al., 1999), Baecke's Physical Activity Questionnaire (Baecke et al. 1982).

Step 3: Finally, the search focused on the variety of instruments for measuring work stress that have been used to study relationships with obesity considering physical activity and eating habits during the period from 2012 to 2017.

Step 4: We discarded those articles in which the variable of work stress is not considered to study its relationship with obesity, physical activity and eating habits in industrial studies.

3. RESULTS

At this point the results are presented, classified by search concept since it was the best option to identify articles to obtain an order with each of the main concepts of the research and the results are presented by measurement instruments.

In table 1. A sample of the articles found and the way they were classified are presented. A total of 254 articles were found of which only 151 were used due to the discard criteria mentioned in the previous chapter.

Table 1. Classification of literature review by concepts.

AUTHOR	WORK STRESS	PHYSICAL ACTIVITY	EATING HABITS	OVERWEIGHT AND OBESITY	INSTRUMENTS/ METHODOLOGY
(A. H. Acosta, n.d.)	X				MBI
(M. Acosta & Burguillos, 2014)	X				MBI

(Aldrete, González, Preciado, & Pando-Moreno, 2009)	X				MBI
(Aranda, Pando, & Pérez, 2014)	X				MBI
(Barquera, Nonato, Barrera, & Juan Rivera Dommarco, 2012)				X	National survey of health
(Bean, Winefield, Sargent, & Hutchinson, 2015)	X				JCQ
(Bijaoui, 2012)	X			X	Literature review
(Camacho, Aracely, Macías, Luis, & Alcaraz, 2015)	X			X	MBI,JCQ and BMI
(Castro Rodríguez, Bellido Guerrero, & Pertega Díaz, 2010)				X	Literature review
(Chen, Dong, Zhu, & Huang, 2016)	X				Structural equations
(Cossío Bolaños et al., 2016)		X		X	Descriptive and cross study
(Constaín et al., 2014)			X	X	EAT-26
(Craig et al., 2003)		X		X	IPAQ
(Damaske, Zawadzki, & Smyth, 2016)	X				Literature review
(De Araújo & Karasek, 2008)	X				JCQ
(De Irala et al., 2008)			X	X	EAT
(Díaz Benavente, Rodríguez Morilla, Martín Leal, & Hiruela Benjumea, 2003)			X		Literature review
(Ding & Gebel, 2012)		X		X	Literature review
(Duclos et al., 2013)		X		X	Literature review
(Escribà-Agüir, Más, & Flores, 2001)	X				JCQ
(Faghri & Mignano, 2013)	X	X	X	X	Literature review
(Gami et al., 2007)				X	Literature review
(Gil-Monte, 2002)	X				MBI

(Gómez-Ortiz & Moreno, 2010)	X				JCQ
(González Calvo, Hernández Sánchez, Pozo Rosado, & García López, 2011)				X	Literature review
(Gosk, 1992)		X	X	X	Physical activity survey (english versión)
(Gutiérrez Alanis, Sánchez López, & Argüello Sánchez, 2015)	X				Descriptive and cross study
(Hagströmer, Oja, & Sjöström, 2006)		X			IPAQ
(HEALTH, 2007)	X				JCQ
(Im[a], 2014)	X				General Survey the Saud of Goldberg
(Investigation, 2012)				X	Literature review
(Järvelä-Reijonen et al., 2016)			X	X	Literature review
(Kang & Xiang, 2017)		X		X	IPAQ
(Ra Karasek, 1985)	X				JCQ
(R Karasek et al., 1998)	X				JCQ
(Kariv & Heiman, 2005)	X				JCQ
(Kaur, 2014)				X	Literature review
(Kim & Han, 2015)				X	Descriptive study
(Li, Carter, & Robinson, 2016)		X			Descriptive study
(Liu, Li, Li, & Zhang, 2017)		X			Literature review
(Llargués et al., 2009)		X	X		Literature review
(Loerbroks et al., 2016)	X				JCQ
(López-Alvarenga, Reyes-Díaz, Castillo-Martínez, Dávalos-Ibáñez, & González-Barranco, 2001)		X		X	CAF
(Marcatto et al., 2016)	X				Logistic regression
(Marques, Bjørke-Monsen, Teixeira, & Silverman, 2015)	X	X			Literatura review

(Medellin Moreno et al., 2009)	X				MBI
(Medina Catalina, Simón Barquera, & Ian Janssen., 2012)		X		X	Healthy style survey
(Moraleda Barba et al., 2001)			X		Literatura review
(Nunez, Bauman, Egger, Sitas, & Nair-Shalliker, 2017)		X		X	IPAQ, IMC
(Omura, Carlson, Paul, Watson, & Fulton, 2017)		X			Healthy style survey
(Ostry et al., 2001)	X				JCQ
(Paredes & Sanabria-Ferrand, 2008)	X				MBI
(Peláez-Fernández, Ruiz-Lázaro, Labrador, & Raich, 2014)			X	X	EAT
(Pérez Borda et al., 2007)	X				MBI
(Perilla & Gómez, 2010)	X				JCQ
(Richardson, Leon, Jacobs, Ainsworth, & Serfass, 1994)		X		X	PAQ
(Ríos Risquez, Carrillo García, & Sabuco Tebar, 2012)	X				MBI
(Rueda Jaimes et al., 2005)		X		X	SCOFF
(E. G. de los F. Ruiz, 2012)	X				MBI
(L. Ruiz, 2011)	X				Structural equations
(Sampasa-Kanyinga & Chaput, 2017)	X	X		X	Longitudinal study
(Sánchez Socarrás, Aguilar Martínez, Vaqué Crusellas, Milá Villarroel, & González Rivas, 2016)			X		Literature review
(Santana-C??rdenas, 2016)	X		X		Literature review
(Santiago-Torres et al., 2016)				X	Structural equations

(Schnall et al., 2009)		X		X	SCOFF
(Schuch et al., 2017)		X			Literature review
(Serra Puyal, Casterad, & Lanaspa, 2014)		X			Influence questionnaire on physical activity
(Serrano Ríos, 2005)	X			X	Statistical study
(Shephard, 2003)		X			PAQ
(Taylor et al., 2009)	X				Descriptive study and training
(Tejada & Gómez, 2012)	X				MBI
(Tovalin, 2016)	X				JCQ
(Tran et al., 2017)		X			Descriptive study
(Uribe et al., 2014)	X				MBI

Due to the limited extension of this work, Table 2 shows a selection of the studies found in literature, this selection shows the instruments found and how they were classified according to some characteristics. The complete list of studies can be send by request. At this point, 47 instruments were found, of which 17 were for work-related stress, 16 for physical activity and 14 for eating habits, where at the end of this exhaustive review, the instruments used for future research were selected.

Table 2. Classification of literature review of measuring instruments.

INSTRUMENT	**AUTHOR AND YEAR**	**ÍTEMS/ DIMENSIONS**	**SAMPLE**
Staff burnout scale	(Jones, 1989)	4 dimensions/ 30Items	Health
Maslach Burnout Inventory	(Maslach y Jackson,1981)	3 dimensions/ 22 Items	General
Maslach Burnout Inventory-General Survey	(Moreno-Jiménez, Rodríguez-Carvajal, & Escobar Redonda, 2001)	3 dimensions/ 16 Items	General
Energy depletion index	(Garden, 1987)	2 dimensions/ 7 Items	General
Job content questionaire	(Karasek et al., 1998)	7 dimensions/ 27 Items	General
Questionaire of Burnout in nursing	(Moreno,2000)	20 dimensions/ 174 Items	Nursing

Questionaire of Burnout in Teachers	(Moreno, 1993)	3 dimensions/ 75 Items	Teachers
National survey of health and nutrition	(Instituto Nacional de Salud Pública, 2016)	4 dimensions	General
Eat-26	(Gandarillas, 2003)	26 Items	Womens (spanish versión)
Ipaq	(Craig, 2003)	2 dimensions/ 7 Items	Range 15-69 years general sample
Eat	(Garner y Garfinkellen 1999)	40 Items	General
ChEAT	(Gracia, 2008)	26 Items	Childrens
Questionaire of health Goldberg	(Goldberg, 1972)	4 dimensions/ 28 Items	General
Caf	(Goñi, 2006)	6 dimensions/ 36 Items	General (12 years and up)
BITE	(Rivas, 2004)	2 dimensions/ 33 Items	General (12 years and up)
Scoff	(Morgan, 1999)	5 Items	General

4. CONCLUSIONS

It is concluded based on the results obtained, that there are very few investigations where the main concepts are studied or correlated together. Additionally, the studies in Mexico are very scarce, it is worth mentioning that among the main results obtained were found methodologies and measurement instruments that we can consider for future investigations. This review is limited only to the main concepts to be able to raise our problem and the objectives of the main research. It should be mentioned that due to the complexity of the problem, this is a preliminary literature review that refined its search in the main instruments used to measure work stress, physical activity and eating habits. However, it highlights and presents a variety of instruments to measure the study variables and that can be used in future research.

This review organizes and classifies those studies devoted to studying the relationships between work stress and obesity considering eating habits and physical activity in industrial environments and their measuring instruments. In this way, we can better understand the attention given to the topic based on the number of publications found that met the search requirements and determine the different approaches, methodologies and instruments used for their study.

Due to the limited extension of this work, a selection of the studies found in the literature is shown, and how they were classified according to some characteristics of which were used in the search. The complete list of studies can be sent by request to those interested in seeing this investigation in more detail.

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ERGONOMIC EVALUATION OF THE USE OF THE WIRE MOORING TOOL FOR THE ASSEMBLY OF METALLIC STRUCTURES

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Resumen: La investigación de este trabajo presenta un análisis ergonómico de la manera en que los obreros realizan actividades dentro del sector de la construcción, de forma específica el amarre de alambres. Durante un mes se analizó: la actividad, las características de las 4 herramientas utilizadas y se observó a 25 trabajadores que laboraban realizando una barda perimetral en el municipio de Nextlalpan, Estado de México. Se utilizaron los métodos RULA y OCRA que arrojaron resultados para determinar los requerimientos ergonómicos para el desarrollo de soluciones a quienes deseen realizar proyectos relacionados con este tema de investigación. De la misma forma se documentó la manera en cómo se realizan las actividades para el armado de estructuras metálicas dentro del sector de la construcción, aportando información para llegar a soluciones que puedan trascender en proyectos posteriores.

Palabras Clave: Diseño industrial, Ergonomía, Antropometría

Abstract: The investigation of this work presents an ergonomic analysis of the way in which the workers carry out activities within the construction sector, specifically the wire tie. During one month were analyzed: the activity, the characteristics of the 4 tools used and 25 workers were observed working in a perimeter fence in the municipality of Nextlalpan, State of Mexico. We used the RULA and OCRA methods that yielded results to find the ergonomic requirements for the development of solutions to those who wish to carry out projects related to this research topic. In the same way we documented the way the activities for the assembly of metal structures within the construction sector are carried out, providing information to arrive at solutions that can transcend in later projects.

Keywords: industrial design, ergonomics, anthropometry.

Relevance for ergonomics: The information collected and the analysis developed allows improvements to work activities and tools in order to allow workers to have a better quality of working life.

1. INTRODUCTION

Within the construction industry, there are several trades that over time have managed to boost the development of the country, benefiting the economy, and placing this sector as one of the most important national (Poo Rubio, 2003). Similarly, it is necessary to mention that until 2017, according to data from (INEGI, 2017) at the national level were working 377, 504 workers, of which 3.8% are workers without belonging to a construction company.
In the State of Mexico, "there are 1.4% of workers in the construction sector and there is 0.2% of construction companies, which corresponds to 15 economic units that help maintain the development of the State" (INEGI, 2017). Likewise, in the municipality of Nextlalpan, in the State of Mexico, approximately 50 people equivalent to 0.01%, have an informal employment within the construction sector (INEGI, 2017).

On the other hand, Quara (2017) divides the different trades that are developed within the construction industry in the following:

Builder	Painter
Pawn	Plumber
Farrier	Electrical technician
Black carpenter	Steelworker
Official floor colander	Blacksmith
Plasterer	Cabinetmaker

Of the above-mentioned trades, a farrier is retaken to perform the analysis of his job in order to find what are the ergonomic risks involved in this job. A farrier is a worker who must be in contact with metallic elements to carry out their work activities and manipulate them using tools suitable for the job. Likewise, Orihuela (2010) mentions that, during the assembly of metallic structures, the activity that needs more time of work is the accommodation and mooring of stirrups.

When developing its activities, a metalworker can suffer ergonomic risks. Egarsat (2013) mentions that risks are generated when performing forced postures of trunk and arms, works in unstable or regular surfaces, manual manipulation of loads, application of forces and repetitive tasks with manual tools.

To determine the injuries to which the farriers are exposed, a construction site was located corresponding to the perimeter fence of the Carlos Mercenario Carvajal stadium, in the municipality of Nextlalpan, where interviews, photographic and video shots were taken to collect information, which was later analyzed to define ideal ergonomic evaluation methods, and whose concrete results served to generate recommendations for the benefit of workers and their quality of work life.

2. OBJECTIVE

Identify the ergonomic risk factors that intervene in a farrier's workplace, performing ergonomic evaluations within a construction site, to obtain the necessary information to establish recommendations for future uses in projects that improve the quality of working life of the workers. workers in the construction sector

3. METHODOLOGY

3.1 Context of the workplace

The municipal stadium Carlos Mercenario Carvajal was inaugurated on March 21, 2015 and is located in the municipality of Nextlalpan, State of Mexico. The completion of the perimeter fence of this stadium, which will have a length of 1000 meters, is underway and, to achieve this, there are 25 workers who are between 17 and 64 years old, with a schedule of eight in the morning to six in the afternoon, with an interruption of 60 minutes at one o'clock in the afternoon to eat their food.

In this space the activities of the fierrero are made outdoors, under some steps that provide shade for sun protection, have an electric saw to make cuts of materials, a pipe and a crane to make the square to the rods, steel rod tighteners, flexometer, a bending machine to make stirrups, during the assembly of the castles they are used metalic barrels that fulfill the function of a work table.

The activities carried out for the assembly of metallic structures are: enabled annealed wire; reinforced counter - bars with a half inch rod; reinforced footings with half-inch rod; rebar structures armed and armed with chains, both with a rod of three eighths. These structures form modules, each with:

a) 1 footer, with 1 meter wide by 6 meters long
b) 1 counter-girder, with 6 meters long by 15 centimeters wide by 70 centimeters high
c) 3 armex rebar structure, with 3 meters long, and stirrups 10 centimeters wide by 15 centimeters long.
d) 2 chains, with 3 meters long with stirrups 15 centimeters wide by 20 centimeters long.

3.2 Ergonomic evaluation methods

To carry out the analysis of the information gathered on the construction site, two ergonomic evaluation methods were used, which were chosen after observing directly in the workspace. Repetitive movements of the upper limbs and forced postures were identified at the time of performing the activities. It should be noted that there are several activities that the worker performs, so it was decided to take into account each of these and not just the job to define the evaluation methods to be used in this investigation.

Taking into account the above, a search was made of the adequate methods to accurately measure each observed risk factor.

As methods of evaluation, OCRA and RULA were chosen, which, due to their study characteristics, achieve an analysis of the ergonomic postures and repetitive movements that are carried out with the activities of the workers, as well as the force exerted during each activity, providing results that provide more concrete information to identify failures during each process to be carried out in the work within the construction site. With the analysis, it was possible to reach the requirements that will give a solution to the incorrect postures and minimize the risks of suffering from a musculoskeletal disorder.

Next, the characteristics of the chosen methods are explained, and the information that was obtained when using them. The results were expressed in a subjective way, where the researcher expresses according to the previous knowledge he has about the activities in a construction site and contemplating the data that arose when doing the research in the place to be studied.

3.2.1 Evaluation of the OCRA (Occupational Repetitive Action)

The OCRA method, "determines the risk associated with repetitive work in the upper limbs, measures the level of risk according to the probability of the appearance of musculoskeletal disorders in a certain time" (Diego-Mas, 2015).

3.2.2 Evaluation of the RULA (Rapid Upper Limb Assessment)

The RULA method, "evaluates the exposure of workers to risk factors that can cause disorders in the upper limbs of the body. Postures, repetitiveness of movements, applied forces, static activity of the musculoskeletal system are some of these "(Elia, Guadarrama, Vilchis, & Ilagor, 2013).

4. RESULTS

With the investigation and the analysis of the evaluations applied with the ergonomic methods OCRA and RULA the risks were determined when carrying out the activities of a farrier. During his labour day, the worker performs more than 20 repetitive movements when he acquires incorrect postures and does not have enough time to recover, which causes musculoskeletal injuries. We also took into account the different tools they use, which, due to their physical and functional characteristics, are what drive the worker to perform the postures and movements.

On the other hand, 31% of the time of the day, the worker exerts great strength to perform technical actions that are part of their work, which generates a greater risk of suffering an injury. Regarding the percentage of total activities is 28%, in which postures and muscular efforts intervene, which being repetitive make it more difficult to perform due to physical exhaustion, causing the force applied by the worker is very intense.

Within the activities carried out during each day, it was found that the activity where more moorings are made is that of the assembly of footings, in which there are 225 moorings in a module of 6 meters long by 1 meter wide, it is in this activity where the worker remains inadequate for longer without proper pause for recovery positions. Of the total time the activity lasts, only 0.28% is to perform the only non-repetitive movement. The activity of footing assembly is divided into 8 sub-activities, in which, in total, the worker performs 25 postures to be able to execute them. Adding to these, 10 postures that form 3 sub-activities to perform the enabled annealed wire that is used as a link between the rods.

During the whole activity, the worker uses postures in which the trunk flexes; the wrist rotates and flexes; there is a repetitive flexion of the forearm and there is flexion of the arms.

In particular, the worker performs 3 sub-activities to tie the annealed wire to the rods, 2 are flexing the trunk at an angle greater than 60 °; turning the wrist near its limit of rotation and flexing it at an angle greater than 15 °; performing a repetitive flexion of the forearm at an angle close to 100 ° and flexing the arms at a 90 ° angle. These positions are when the worker:

a) Place the wire at the point where the connection between rods is made: the posture is achieved in 12 seconds per wire, is done 3 times per minute and in total are 225 repetitions in a module of 6 meters long by 1 meter wide, where the force applied by the worker is moderate. For all this, the worker does not have an official break for his recovery.
b) Tie the rods with the annealed wire: the posture is achieved in 10 seconds, with 6 movements, is performed 3 times per minute and in total there are 225 repetitions in a module of 6 meters long by 1 meter wide, where the force applied by the worker is very intense. For all this, the worker does not have an official break for his recovery.

The risk of performing these 2 positions is to acquire some musculoskeletal injuries in the ankles, hips, waist, ligaments and lumbar intervertebrales discs. Also diseases such as: epicondylitis, Quervain tendonitis, wrist cyst, round pronator syndrome, radial tunnel syndrome and Teno - long finger extensor synovitis. However, due to the physical and functional characteristics of the wire mooring tool used, workers can not avoid these positions.

4.1 Analysis of the wire mooring tool

Next, an analysis is presented where the formal characteristics of a wire mooring tool is described.

To make the moorings in the work, the workers use a tempered steel rod tie rod. Its shape is simple, it only has the hook where the wire is stuck and the handle to hold it, its texture is smooth but its visual appearance makes it look heavy. The commercialization of this tool is in specialized stores in the construction area.

Its size ranges from 25 centimeters to 40 centimeters in length, making it easy to handle with the hands. However, the management does not adapt to the anthropometry of all workers, and this makes their work difficult, causing the worker to assume incorrect postures that injure his body.

The smooth texture of the mooring helps to make it practical to change the position of the worker's hand. It should be mentioned that this makes it easy to slip off the hand and fall to the ground or on the worker's feet.

The handle of the wire mooring tool presses the skin, muscles and tendons of the hand, which causes injuries such as calluses, wounds, redness and so on. It is necessary to hold it firmly, turn the wrist and forearm to be able to do the mooring, these postures of the upper extremities are repetitive which causes musculoskeletal injuries in the worker.

As it is made of a metallic material, when it is exposed to the sun, it heats up and causes damage to the worker when it is handled, so it must be cooled with water before being able to use it. Its weight is less than 1 kilogram, this favors the manipulation of the tool with the hands of the worker. The wire mooring tool is stored in a warehouse after the work day.

The function is manual, where the worker has to turn it to tie the wire to the rods. The practicality of this tool gives the worker confidence in being able to carry out the activity in a simple way. Even so, the force that is exerted is very intense when using all the muscles of his body, leaning on incorrect postures. And it can only be used for wire ties.

Being made of hardened steel, its tenacity is high, it is resistant to wear, traction, compression and is also characterized by its hardness. It has no finish so the environment starts to rust.

Figure 1 Wire Mooring tool used in the construction site.

4.2 Recommendations

In general, it is recommended: add pauses during the activity, so that the worker rests after a certain number of repetitive movements; provide worker protection equipment, this will help minimize injuries caused by the repetitive use of tools and constant contact with construction materials.

4.2.1. According to the use of the wire mooring tool.

• Avoid performing trunk flexions at an angle greater than 60 °.
• Reduce the wrist turn.
• Avoid doing push-ups on the wrist at an angle greater than 15 °.
• Avoid performing forearm flexion at an angle greater than 90 °.
• Avoid flexing the arm with an angle greater than 90 °.
• Moderate the intensity of force when placing the wire.
•Reduce the intensity of force that the worker uses when mooring the wire.
•Consider ergonomics as a fundamental factor in tools and workspace.
• Encourage manipulation with the hands of the worker, the use of tools and materials.

4.2.2. According to the function of the wire mooring tool.

• Use simple mechanisms for the operation of tools, this will improve the interaction with the worker.
• Perform the operation of the tools using both hands, to help in the stability of the worker.
• Use an element that can adapt to the way of working within the work.

4.2.3. According to the structure of the wire mooring tool

• Weather resistant materials will be used to maintain their useful life for a longer time.
• Hard materials will be used to avoid twisting the element when performing its function.
• To facilitate handling, its physical shape should have the essentials only to perform the activity
• To favor the manipulation of the tool, it should weigh less than 1 kilogram.
• The element must have qualities of resistance to compression, torsión and wear for better performance and life time.

4.2.4. According to the form of the wire mooring tool.

• For its formal appearance, the worker should perceive the element as light and resistant.
• The finishes of the tools will be with textures that improve grip and give a good visual appeal to the product.
• The tools must be adapted to the anthropometry of workers, with dynamic or organic forms.

5. CONCLUSIONS

Despite the fact that the wire mooring tool fulfills its function, the musculoskeletal injuries in the workers continue to appear because of the incorrect postures that are acquired during each work cycle. This is why it is necessary to find viable solutions that allow the mooring of metal structures, without receiving the damage that is suffered when interacting with current tools, taking into account ergonomic, anthropometric, functional and aesthetic aspects.

According to the above, an industrial designer, having the skills to develop products and services that meet the needs of each user, and relying on technology and research techniques, can intervene in this problem that affects workers, to be able to provide them with a safe work environment and the right tools to maintain their physical condition free of accidents. Which, indirectly, will influence their work performance, doing their activities in less time, and increasing productivity.

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ANALYSIS OF THE PERFORMANCE OF THREE TYPES OF PLACEMENT OF THE HANDS AND WRISTS DURING REPETITIVE WORK

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Resumen: La colocación de las manos y muñecas durante el desempeño de un trabajo repetitivo puede ser una variable que influye en el desempeño laboral, con el riesgo de ser causante de molestias y lesiones al realizar un trabajo prolongado. Por esta razón se pretende llevar a cabo un estudio para reducir los riesgos ergonómicos para los trabajadores. La investigación tiene como objetivo determinar el desempeño de trabajadores al realizar un trabajo repetitivo, analizando su rendimiento en base a la colocación de sus manos y muñecas para comprobar la posición óptima que ofrezca mejores resultados en su actuación laboral.

Palabras clave: Trabajo repetitivo, análisis de fatiga, desórdenes musculo-esqueléticos.

Abstract: The placement of the hands and wrists during the performance of repetitive work can be a variable that influences work performance, with the risk of causing discomfort and injury when performing a prolonged job. For this reason it is intended to carry out a study to reduce ergonomic risks for workers. The objective of the research is to determine the performance of workers when doing a repetitive job, analyzing their performance based on the placement of their hands and wrists to check the optimal position that offers better results in their work performance.

Key words: Repetitive work, analysis of fatigue, musculoskeletal disorders.

1. INTRODUCTION

Office work, including call centers, have expanded greatly because new communication technologies and information have grown rapidly, in addition to the low cost of calls. The evolution in the technology of the call centers, the system and the infrastructure have allowed the transformation of the big brands and organizations. Customer service, marketing and sales services are just some examples.

There are few studies that report on the incidence of musculoskeletal disorders (SMD), therefore it is intended to perform research that allows acquiring knowledge about muscle disorders in workers who perform computer-assisted work, as in the case of call centers, as well as presenting a model to implement knowledge of ergonomic risks and reduce the number of cases of workers with musculoskeletal disorders.

2. OBJECTIVES

The general objective of this study is to measure the effect of posture on the wrist and hand when using a computer keyboard using three key positions: neutral, extended and flexed posture. The volunteers will use the keyboard with both hands in each of the three positions to determine the performance that occurs and thus prove the hypothesis that indicates that muscle stress increases with repetitive stress in the joint. As particular objectives, it is intended to describe the worker's performance in each of the three positions of the wrist when using the computer and to describe the performance of people using the keyboard based on anthropometric measurements.

2.1 Limitations

The study will only represent people without previous muscular disorders, therefore the risks that the work entails for workers with previous illnesses or injuries cannot be defined. In addition, it is possible that the results do not completely coincide with previous studies due to the conditions of the volunteers when performing the test and this only covers the basic positions of the wrist when using the keyboard.

3. METHODOLOGY

The experiment will be carried out based on a study previously done by Jin, Q. et al (2013), who used the same procedure that is intended to be used in this research. In this study it was shown that muscle stress increases with non-neutral postures. The risk increases mainly with the wrist flexed. Another factor discovered in this experiment was that it requires a support for the arms, since this causes that there is no necessary balance for the weight created by the hand. This may be a reason why tendonitis is more prevalent in users who use the computer frequently

The experiment was carried out with two groups of volunteers, each with three half-hour sessions, in which they wrote a text in each of the positions of the wrist. The study was carried out in this way so that the volunteers had a rest between each session and that it would show in a more precise way the productivity that they had with each one of the positions that are used with the wrist when typing.

It should be considered that the results may not match fully with other studies due to the conditions that exist at the time of the volunteers take the test. For example, using support for the hand or wrist can reduce the load on the muscle and reduce muscle stress. Likewise, only the three basic positions will be considered.

Previous studies showed that there was a high ergonomic risk in which they were exposed to suffering from musculoskeletal disorders (MSD). To prevent this, there must be ergonomic training for workers, so that they know the risk factors in the office and work area. In addition, the behavior of the staff and the design of the work stations should be improved according to the ergonomic principles.

4. RESULTS

All the data was collected: the number of words that each volunteer managed to write in each of the positions and the total average in each of the positions was drawn by all the volunteers. The result was contrary to the hypothesis raised, in which it was wanted to prove that the neutral position, by being more comfortable and common is where there is more performance. The position in which there was a better performance was the flexed position, however, it was also in this same position in which there were major discomforts. Most of the participants expressed greater discomfort and pain in this than in the other two position.

The average in each of the positions were as follows: neutral position with 796 words, flexed position with 867 words and position extended with 841 words. There is a big difference in the performance in the flexed and extended positions with respect to the neutral, for that reason it was decided to carry out a second experiment with a group of different volunteers as it is shown in figure 1.

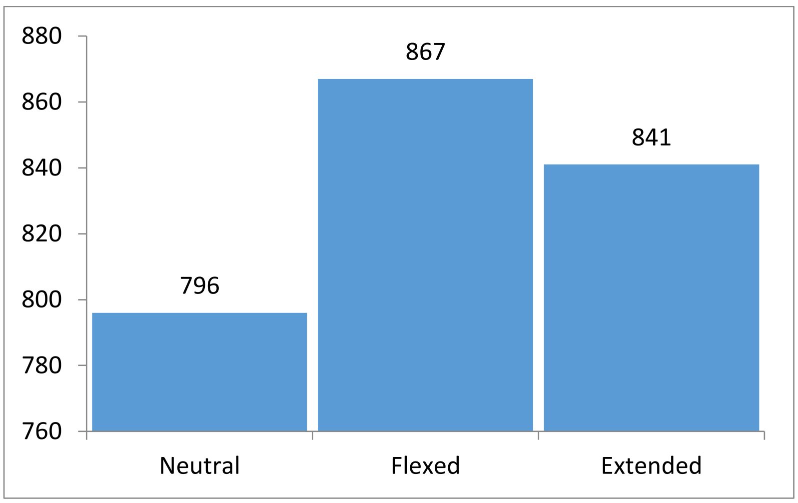

Figure 1: Perfomance of volunteers in experiment 1.

Figure 2 shows the second experiment with a productivity of 833 words for the neutral posture, 870 for the flexed posture and 861 for the extended posture, for which the hypothesis proposed is rejected again.

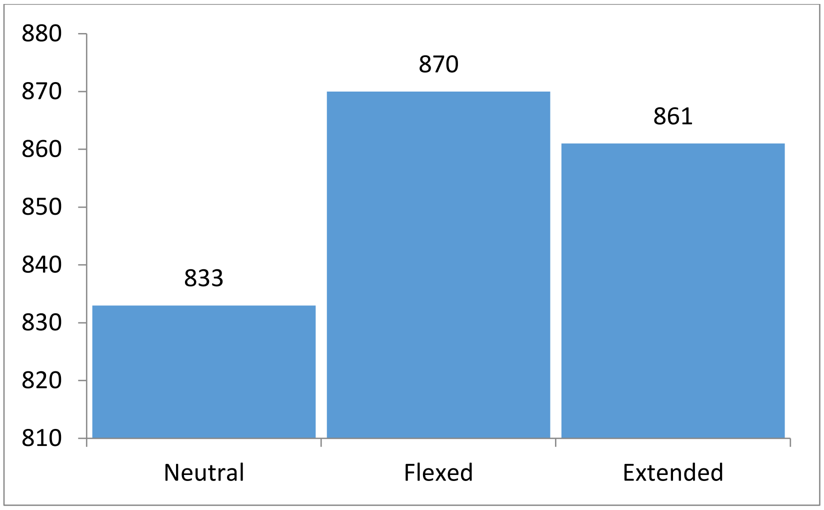

Figure 2: Performance in experiment 2.

The results of the second experiment matched with the first; the flexed position was in which there was better performance, however it was uncomfortable and caused problems in the participants.

5. CONCLUSIONS

With the results obtained in the investigation, it will be possible to determine the acceptance or not of the hypothesis that the neutral position is in which the worker has a better performance, therefore, the experiment must still be implemented in a company and corroborate results As additional data, there will be greater certainty about symptoms of pain or discomfort when performing abducted and extended positions.

It must be determined what the reason why the hypothesis was rejected is. Similarly, through the analysis of linear regression it was found the way in which the performance of workers with each position can be determined using their anthropometric measurements. This is because these measures directly affect the amount of words that the worker can type.

Although the flexed position shows a better performance, it may not be the most convenient to use it due to the discomfort and fatigue that the person could present. The analysis of fatigue is planned to determine in a future study.

The results of this study can be very useful when applying them to office jobs, such as the call center industry. This is because the efficiency of the workers can be determined based on their anthropometric measurements and we can know if these may end up presenting muscle skeletal disorder. It is still necessary to determine the level of fatigue that each of the positions can reach in each person.

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FATIGUE CHARACTERIZATION SHOWED IN WAITERS FROM A BAR RESTAURANT AND CARGO TRANSPORT DRIVERS AND THEIR INTERVENTION PROPOSAL, BOGOTÁ, 2017

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Resumen: Bajo el término fatiga se etiquetan estados de diferente intensidad (desde muy ligera hasta el agotamiento total) y no es fácil dar con una definición única y aceptable para todos. La fatiga provocada por el trabajo es una manifestación (general o local) de la tensión que éste produce y suele eliminarse mediante un adecuado descanso. INSHT. NTP-445, (1997)

Para el desarrollo de esta investigación se plantearon como objetivos específicos: establecer las características sociodemográficas, de meseros y conductores que laboran en un restaurante bar y en una empresa de carga; identificar los síntomas relacionados con la fatiga física y mental referidos por los trabajadores de dos empresas de Bogotá y diseñar una propuesta de intervención estableciendo los lineamientos y estrategias para manejar la fatiga.

Esta investigación, se realizo con la participación de dos empresas ubicadas en la ciudad de Bogotá: la primera un restaurante bar que cuenta con varios locales comerciales; la segunda, es una empresa de carga terrestre. El proyecto se realizó durante el primer y segundo semestre del año 2017.

Palabras Claves: Fatiga física y mental, Conductor de carga, mesero.

Abstract: Under the term fatigue, states of different intensity are labeled (from very light to total exhaustion) and it is not easy to find a single definition acceptable to all. The fatigue caused by work is a manifestation (general or local) of the tension it produces and is usually eliminated by adequate rest. INSHT. NTP-445, (1997)

For the development of this research, specific objectives were set: to establish the socio demographic characteristics of waiters and drivers who work in a bar restaurant and a freight company; identify symptoms related to physical and mental fatigue referred by the workers of two companies in Bogotá and design an intervention proposal establishing the guidelines and strategies to manage fatigue.

This investigation was carried out with the participation of two companies located in the city of Bogotá: the first a bar restaurant that has several commercial premises; the second is a land freight company. The project was carried out during the first and second semester of 2017.

Key Words: Physical and mental fatigue, cargo driver, waiter.

1. INTRODUCTION

The skeletal muscle disorder is one of the problem most common in medical consultation, nowadays, it's a workplace health' trouble; its etiology is multiple and it can produce painful symptoms, loss of functional capability, occupational disability and it may involve high cost.

The workplace illnesses' inform in Colombia for the years 2001-2002 and 2003-2004, show as main sickness' diagnosticated as carpal tunnel syndrome and back ache, that along with other musculoskeletal system involving correspond to 74% of the total diseases. Between 2009-2012 it was note an acknowledge increasing in occupational diseases of 42% with a major component derived from the musculoskeletal disorders with an 88%. (Ministerio de Protección Social de Colombia, 2006)

The second health and safeting at work' national survey, in the general system of occupational hazards, published in 2013, reported that repetitive movements in hands and arms in the most of the times has a 18,69% and stays all the time with a 31,40%. While positions that may produce fatigue or pain in any body part the most of the time has a 17.24% and it does all the time 25.48%. According to the report, the working conditions reported as critical are also being conducted the most of the time or all the time. (Ministerio de Trabajo, 2013)

The objective of this investigation is Identify the symptoms related with physic and mental fatigue presented in two worker groups in Bogotá D.C, in 2017, from the directives might set guidelines and strategies for appropriation of friendly practices with working atmosphere. This investigation has a qualitative and descriptive approaching of cross-section. Population is made up 22 waiters and 14 cargo transport drivers; we used a non-probabilistic sampling by researchers' convenience. We were taken into account inclusion criteria as: personnel hired by companies with operative work assignment.

The participants signed an informed consent, endorsed by ethic committee of the UMB. Subsequently, the applied two instruments: Yoshitake questionnaire (1978), it was adapted for Colombian population by Ahumada et al. (2006). This is a fatigue subjective symptom test. This deal with three dimensions in work's fatigue subjective perception, making 10 questions for mental demand, 10 for fatigue physic manifestations and 10 mixed questions (this evaluate three fields: a)drowsiness and monotony, b) difficulty in mental focus, c) Projection of physical deterioration). And the second one, is the fatigue complementary questionnaire, working accidents, designed and approved by Neisa and Rojas (2009) from The Bosque University; This include information related to personal data, employment history, time working organization, work perception, workload, work's accident history, work atmosphere, fatigue at work and usual conduct.

Recollected information was taken with a mathematic and statistic treatment using qualitative and quantitative variables, frequency distribution, percent distribution and measures of central tendency. It was processed in a sheet in Microsoft Office Excel from which were generated the charts and graphics for analysis.

2. RESULTS

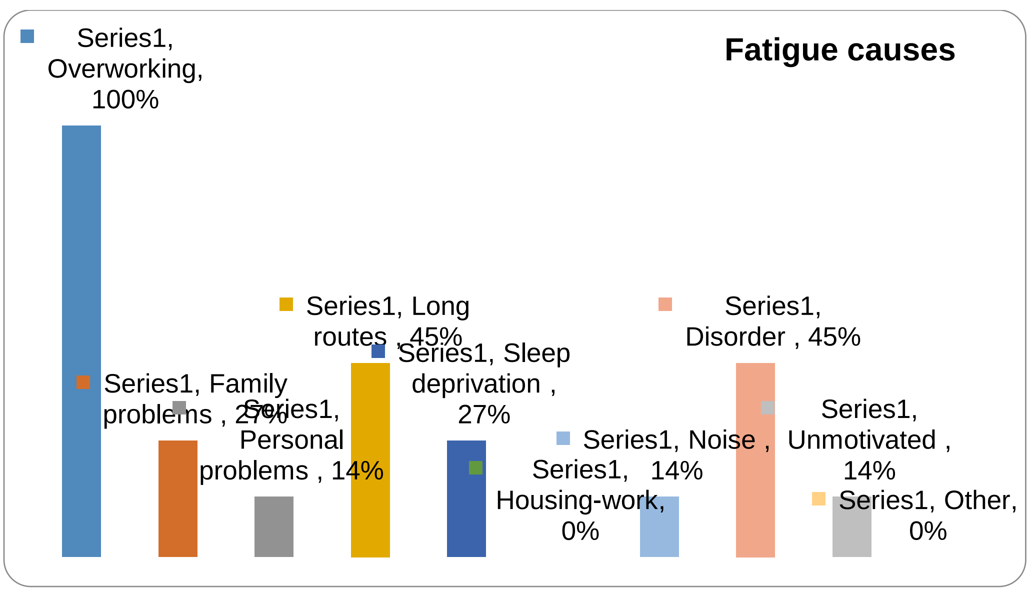
We found inside the socio-demographic characteristics. Between all the waiters, the 100% of the sample are men; the highest percentage belongs to single 20 to 30 years old men. The 60% of them are high school graduates; indeed, with the same percentage, they report an experience as a waiter among 1and 2 years. The 68% prove that they don't have any responsibility for someone.

Related by drivers, the 100% of sample are married 20 to 30 years old men. The 57% are high school graduated. The time working as drivers belongs to the 29% between 2 to 5 years, 6 to 10 years and more than 20 years. The 71% have reported that they have responsibilities with someone.

The waiters reported tiredness in their body and legs, frequently yawning, head ache, tired eyes, muscular straight need, back ache, breathing difficult and thirstiness. The 69% waiters reported feel slumber and sleepy.

We found too that waiters don't have right sleep times that allows them bounce back for the next working hours. The 73% of them expressed that they daily have periods between 4 to 6 hours of sleeping, which doesn't represent to a time enough for physical and mental recovering and it might to submit fatigue quickly.

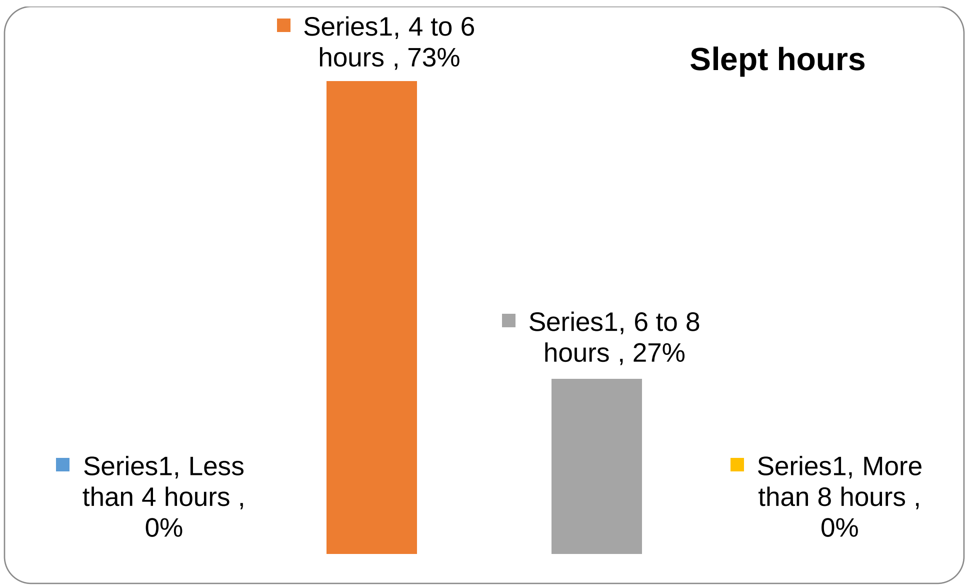
Overworking is one of the causes of waiters' cognitive and physical fatigue in a Company. The total of surveyed waiters, choose this as the principal factor followed for long routes and disorganized conditions in different branches of the company.



Self made one.

From found results in implementation of instruments about fatigue, we can see that there's a direct link among physical and cognitive fatigue with dreaming variables, bad eating schedules, legs and back tiredness perception, somnolence and short resting.

In drivers' results, we can see that there's a 36% with back ache, shoulders tension and frequent thirst. For the other hand, there's a mental exigency symptoms in surveyed workers with legs tiredness symptomatology in the 29%of drivers, followed by body and eyes tiredness. Inside the physical manifestations evaluated, the 2% of population argued that they feel discomfort connected to fatigue were identified not being able to pay attention or work concentration, oversights related to labor topics and difficult in righting their back after working.



Self made one.

In questionnaires applying, we found a positive answer in the 14% of drivers, related to mental fatigue symptoms, while just the 2% expressed physical fatigue.

Were set out a direct link between the age and gender of drivers surveyed and road accident statistics related to OMS and the ANSV identifying that this population (20 to 40 years old men) is more likely to suffer or have an traffic accident experience; with regard to the other socio- demographic profile data, weren't found another relationship with the statist published.

Finally, in the implementation of the questionnaire about working fatigue, accidents and incidents, were achieved provide that the workers surveyed have had 3 non-reporting traffic accidents as working accidents; and 8 incidents caused by distraction, obstacles in the way and others care Lessing, which were associated directly with physical and mental fatigue.

3. CONCLUSIONS

After instruments applying and results analysis, were establish the socio-demographic characteristics of waiters and drivers whose works in bar restaurants and cargo companies, we Were identifying the reported symptoms by their selves and related to physic and mental fatigue, to ultimately arised an intervention proposal with recommendations directed to the companies and some strategies for workers' fatigue management. The investigation in these companies contains background' searching, where information about waiters fatigue studies are scarce; otherwise, with drivers is frequently make an association with traffic accidents, for example, in Bogotá the 70% (2.408) of accidents occurred by cargo vehicles, belongs to vehicles as lorries, followed by trucks and dumpers. Therefore, it's important to include this kind of studies in hardworking population without underestimate the work of one or the other.

Finally, were propose the implementation of a fatigue warning program, which should include the following aspects:

- Evaluate the times and resting activities that workers have in their working and nonworking hours.
- Include in the training plan one meeting about dream, importance and its impact, incidents or almost incidents presented in the company as dream consequences. Further, the fatigue, alimentation, workout and others.
- Develop a following up of food consumption schedules, food contraindications. Well, according to OMS, make a nutritional living organized for a physical and psychological welfare.
- Set active pauses up, including breaks and specials exercises about stretching in the work place, to enable the cognitive and physic fatigue control.
- Teach to workers about culture of incidents and accidents report.
- Deploy the order and toilet program, considering the furniture and working tools distribution, to enable workers moving with minimal efforts.
- With the professional support and revising with the high management, make a wellbeing and incentives program, with generates motivation and sense of belonging.
- • Develop self-protective behavior with workers in their working place and out of it that will serve of factors guard.
- Encourage the culture of medical discomfort reports and mood that may arise before or during work being done, like almost incidents, incidents or accidents presented in the workplace.
- Bring forward the right register, where will bring control exams, medical permissions, and more to determine the causes of morbidity and its frequencies.
- Develop information and resource campaigns about the proper use of work clothing, security features and personal protection supplies for its using in the workplace.
- Increase the attendance in courses, trainings and other activities developed in the company into the management system in health and security at work and family and employee wellbeing.
- Perform preventive maintenance to equipment, tools and machines ensuring the thermic conditions keeping, avoiding the heat, ensure workplace ventilation and employees hydration.
- Provide conditions of cargo manual manipulation, like mechanic help or partner support seeking that no one of them overload.
- Ensure compliance with the working hours according to the regulations in

force and work permissions about implementation of active pauses each 2 hours of 10 minutes.

- Aim maintain a working plan and its programming alternatives avoiding struggling and setbacks to the colleagues.
- Within the preventive and work medicine program apply the fatigue and stress questionnaires in such way semi-annual labors with a high physic, mental and annual demand to medium and lows.
- The presence of fatigue reflect the working conditions in a company, therefore for charging undertake, time studies, movements and breaks, with methodologies and professional help to fatigue prevention and work motivation. Creating rolling systems and flexible schedules and others alternatives.

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RESEARCH OF ERGONOMIC RISKS IN LOCAL TORTILLERIA SHOP

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RESUMEN: En este artículo se presenta un sistema de evaluación ergonómico, que permite establecer los principales problemas relacionados con la interacción hombre – medio ambiente de trabajo, que se ha diagnosticado en un entorno de productos denominado tortillería, específicamente en el Noreste del estado de Sonora en México. El trabajo se fundamenta, en la investigación de las posiciones que se presentan en las estaciones de trabajo al tener un exceso de repetitividad y jornadas muy largas.

Palabras clave: Repetitivo, ambiente laboral, condiciones laborales

Abstract: In this article an ergonomic evaluation system is presented, which allows to establish the main problems related to the man - work environment interaction, which has been diagnosed in a product environment called tortillería, specifically in the Northeast of the State of Sonora in Mexico. The work is based on the investigation of the positions that are presented in the work stations because they have an excess of repetitiveness and very long shifts.

Keywords: Repetitive, work environment, working conditions.

Relevance to Ergonomics: The application of this research can be used as support for the development of studies related to the reduction of injuries caused by overuse or hand fatigue and thereby provide a better quality of living for a worker. Also make known the way of working small businesses as they are the tortillerías because although not all have the same working conditions many of them are similar since it is an almost similar way of how the process of tortillas is made, as well as the evaluations of more risky positions for the people who work within it. Similarly, part 2 of the project seeks to act on all the high-risk assessments found.

1. INTRODUCTION

In recent years, the growth of tortillería has increased considerably, due to population growth and the demand for food in the basic basket. The occupational risks that take place in the world, and in particular those of our country, demand a commitment, to strengthen safety and health at work, as well as decisive actions, through policies, strategic lines of action and projects with a preventive approach, so that safe companies prevail, in spite of the great growth of the tortillería continue to have very unorthodox and tired methods for the personnel that work directly in the process, taking into account more the profits than the own welfare of the employees being subjected to exposures of different risks in the work environment, such as: temperature variations, health problems that most often affect this sector: rhinitis, sore throat, bronchial asthma, as well as back pain, injuries the vertebral discs.

2. OBJECTIVES

General:

The project aims to involve the organization in ergonomic risk reduction projects, evidencing the benefit and comfort when performing the tasks of the employees in the work area that is carried out. Looking for the realization and modification of most of the risks found within the work area looking for greater comfort for the personnel that works within this company.

Specific objectives:

- Perform diagnostic evaluation to identify areas of opportunity.
- Analyze the results of the diagnostic evaluation to structure a possible proposal and / or ergonomic alternative.
- Indicate which is the critical operation ergonomically in the work area.
- Relate the results of the ergonomic evaluations with risk reduction implementation projects.
- Classify possible solutions to the most critical activity found in the work area.
- Reminding the benefit of the implementation of prevention projects and risks correction.

Delimitation

An investigation will be carried out on the tortillerías and the occupational health problems caused by the exhausting tasks that are carried out. The operations that are carried out are the following:

1. Dough preparation and rolling
2. Operation in automatic press
3. Pre-cooking tortillas in comal
4. Tortilla packaging

The project is divided into phases, we have proposed Phase I as General Research, which focuses on knowing and defining the following generalized points:

- Temperature
- noise
- stress
- Improper postures

- Repetitiveness
- Manual loads

As already mentioned, this project will be worked on phase I, later it is intended to work in more phases, separating the operations and attacking the riskiest, to propose improvements that help the workers to solve or reduce the problems that are present ergonomically

3. METHODOLOGY

From iron workers to bakers, many people work in a variety of hot environments: Many of the trades currently work with high temperatures and being uncomfortable is not the most serious problem of working in environments with high temperatures and humidity. Workers who are suddenly exposed to a very hot environment face health and safety hazards that can be avoided.

Working in tortillería employees are exposed to the heat for a long time to be in the press operations and the cooking of tortillas in comal, this can cause problems, the frequency of injuries seems to be higher in general in hot environments than in environments of moderate conditions. One reason for this is that when one works in a hot environment, mental capacity and performance decrease. Increased body temperature and physical discomfort can cause irritation, anger or stress. These and other emotional conditions can cause the worker to not pay enough attention to perform their activities correctly and be subject to hazards.

Another important factor is the positions they have during their work days, the work is done standing all day for all workers, except for operation 4 (packing tortillas) where the worker has a stack of chairs in the who sits down occasionally. This leads to different traumas in workers, because in addition to this, all operations are very repetitive in the upper body, arms, shoulders, wrists are most affected by the constant movement and the little rest they have.

The tortillería works based on demand. Depending on the season they make 5 to 7 sacks of flour per day, of 40 kg. Each. Approximately with a time of 1 hour and a half to 2 hours per bag. The days are sometimes very heavy for the workers and depending on the place of work they have different complications. The work area is not suitable for workers, the work tables were modified according to the person with the shortest stature and not the standard percentile.

The tools that were used were: observation, check list, bibliographic sources

No.	Activity	During
1	Planning meeting	1
2	Visit to tortillería and take videos	1
3	Video analysis and important factors	5
4	Previous research on tortillerías	14
5	Team feedback meeting	1
6	Development and application of check list	14
7	Evaluation and drafting of the document.	21
8	Final meeting of team	2

4. RESULTS

The results show the great risks that the personnel run. And in which the work team will be based on stage 2 of the project since this is to know all the risks within the company and knowing them we will have to decide on which actions will be based to improve the facilities within the work area. As well as publicizing the conditions in which they work inside the tortillerías, and in which many of them can be improved. Next, we will show the results obtained within the investigation:

In fig.1. as we can see that it is an inadequate posture and that it can bring about problems for the body. A quick assessment was developed in which the risk is shown, the operation is harmful and needs a redesign of the station. Figures 2, 3 and 4 are operations where repetitive movements are performed. The operations are: Automatic press to crush balls (Fig. 2 and 4), Tortilla cooking in comal (Fig. 3), Tortilla package. The rhythm of work is marked by the machinery, in the shift of 10 hours people rotate between these 3 jobs each sack to make, make a sack lasts about 1 hour and a half. Next, the repetitiveness analysis performed for these operations will be shown

.

Figure 1 shows the position that the person adopts when taking the tortillas that fall from the band.

Resultados

Estos son los resultados de la evaluación

Resultado

Carga estática

10

10

0 1 2 3 4 5 6 7 8 9 10 >

Valoración

Nivel de actuación

5

Actuación

La tarea es nociva para el trabajador. Es urgente el rediseño de la tarea.

Escala de valoración en función de la puntuación y colores asignados para su representación gráfica

Color/Puntuación	*Valoración*
0,1,2	Situación satisfactoria.
3,4,5	Débiles molestias. Algunas mejoras podrían aportar más comodidad al trabajador.
6,7	Molestias medias. Existe riesgo de fatiga.
8,9	Molestias fuertes. Fatiga
10	Nocividad.

Fig.2

Fig.3

Fig.4

Puesto	ICL-OCRA puesto	% ocupación trabajador	ICL-OCRA parcial trabajador
Operador de Prensa	27	30%	11,7
Operador de comal	28,5	30%	12,4
Empaque de tortillas	36	30%	15,6
	Valor medio	% Ocupación total	Valor medio
	30,5	90%	13,2

ICL-OCRA puesto: Índice Check List OCRA de cada Puesto a jornada completa - **% ocupación trabajador:** Porcentaje de la jornada que el trabajador ocupa cada puesto - **ICL-OCRA parcial trabajador:** Índice Check List OCRA del trabajador cuando ocupa el puesto sin considerar los demás puestos.

5. CONCLUSIONS

The tortillerías shop are not a very well-studied field ergonomically, since many of these companies are local and the owners do not focus on improving the well-being of the people who work there, but in the production of their goods and the profits that they make. they are obtained from these, with this project is intended to take a step forward to take into account workers who are at great risk for the tasks they perform and propose improvements in each of the phases that arise. It is intended that this project serve as a guide for the presentation of ergonomic projects to other local tortillerías shop.

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REDESIGN OF STATION ASSEMBLY OF METAL GUIDES OPERATORS AT RISK OF SUFFERING CUMULATIVE TRAUMA

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Resumen: Una Empresa metal mecánica ensambla guías metálicas en su área de producción. El ensamble de guías metálica expone a los operadores a riesgos por trauma acumulativo debidos a procesos de ensamble fuera de procedimientos operativos prediseñados. Las estaciones de trabajo de este ensamble no son confortables. Se realizaron entrevistas, medición de condiciones ambientales de trabajo, y se evaluaron posturas y manipulación de piezas.

Para disminuir y eliminar condiciones de operación, se diseñaron y rediseñaron accesorios y equipos de la estación de trabajo, basados en principios de ergonomía lo cual permitió posturas de operación y manipulación confortables que permitieron buen rendimiento y optimizar la producción de guías.

Palabras clave: Diseño de estaciones de trabajo, lesiones de trauma acumulado

Abstract : A company metalworking joins metal guides in its area of production. Assembly metal guides exposed to operators to risks by cumulative trauma due to processes of Assembly out of predesigned operating procedures. The workstations of this Assembly are not comfortable. Interviews, measurement of working environmental conditions, were carried out and evaluated postures and handling parts.

To reduce and eliminate conditions of operation, were designed and redesigned accessories and equipment of the workstation, based on principles of

ergonomics, which allowed positions for comfortable operation and handling that allowed for good performance and optimize the production of guides.

Contribution to ergonomics: Workstation ergonomic conditions can be improved with ergonomic administrative measures and preventive medical measures, improved engineering and principles of Automation when required

1. INTRODUCTION

A company metalworking joins metal guides in its area of production. Assembly metal guides exposed to 6 operators to risks by cumulative trauma due to processes of Assembly out of predesigned operating procedures on shift of 10.7 hours during 5 days. The workstations of this Assembly are not comfortable. Interviews, measurement of working environmental conditions, were carried out and evaluated postures and handling parts.

To reduce and eliminate conditions of operation, were designed and redesigned accessories and equipment of the workstation, based on principles of ergonomics, which allowed positions for comfortable operation and handling that allowed for good performance and optimize the production of guides. Finally with immediate actions, engineering measures, administrative measures and medical measures, improved working conditions.

2. OBJECTIVES

Redesign metal guides through Assembly station of evaluating and implementing comprehensive ergonomic improvements, to prevent injury by risks of cumulative trauma at Assembly station in order to optimize the efficiency, productivity, health and security of the labor force

3. METHODOLOGY

In station Assembly of metallic guides was applied, Step Zero, Problem Description, evaluation methods RULA, SUE Rodgers, REBA, OCRA and BRIEF, applied process reengineering and design of workstations.

3.1 Step Zero.

The answers to the questions of Step Zero, an operator surveyed during our work are shown in Table 1.

Table 1. Displays Step Zero, an analyzed operator

Paso Cero de operador			
Concepto	**Respuesta**	**Concepto**	**Respuesta**
Sexo:	Femenino	**Vasos de agua al día:**	2
Edad (años):	20	**Duerme horas por día:**	5
Talla (m):	1.55	**Fruta-verdura (veces/semana):**	2 a 3
Peso (Kg):	48	**Antecedente patológico:**	No
Hijos:	3	**Tiempo para comida (minutos):**	40
Mano de uso:	Ambidiestra	**Antigüedad en Empresa:**	3 reingreso y 5 meses antigüedad
Deporte:	no	**Antigüedad Puesto trabajo:**	3 semanas
Escolaridad:	Secundaria	**Rota Puesto de trabajo:**	1 vez al día a las 6 hrs
Estación:	Ensamble	**Proceso:**	Ensamble espaciadores a guía
Usa Silla:	Ergonómica	**Producto Elaborado:**	Guía metálica para línea blanca
Pausa Salud:	No	**Material utilizado:**	2 Guías y 4 componentes de plástico
Herramienta empleada:	No	**Procedimiento de operación:**	Archivo Confidencial. revisado con operador-supervisor
Químico empleado:	Grasa	**Equipo protección personal:**	Mandil, tapón auditivo, guante reforzado en mano izquierda

3.2 Problem Description

3.2.1 Ergonomic risk factors
Force. (see Figure1)

1. In work area, the operator hits with the region thenar right hand (soft tissue compression) to assemble Guide, don't use tool. (see Figure1(b))
2. Grab, handle and press with both hands to take components and assemble the Guide.

Frequency

1. Average greater than 1500 times per shift.

Positions (see Figure1)

1. Stretch both arms at the height of their shoulders without support of elbows, to take the components of the metal box. (see Figure1 (a))
2. The seated operator, has improper posture, to be charged at the back, nor rest their feet on the floor. In addition the Chair was wrong state

Figure1. (a) Placement of boxes front operator b) tool to press guides

3.2.2 History clinically relevant data:
1. Pain in neck, both wrists, region thenar right hand, fatigue at the end of the workday.
2. Physical examination: Edema and hyperemia of right hand.

3. Diagnosis: Cumulative trauma disorder to dismiss De Quervain's right hand syndrome.

3.3 Evaluation methods

3.3.1 RULA. Table 2a. It shows the results of the RULA method for analysis of Assembly Guide

Table 2. Analysis of Assembly of guide. (a) RULA method, b) Sue Rodgers method

MÉTODO RULA. Ensamblado de Guías	
GRUPO A. Análisis brazo, antebrazo y muñeca	
Puntuación de Brazo	4
Puntuación de antebrazo	2
Puntuación de la muñeca	4
Puntuación giro de muñeca	1
Tipo de actividad muscular(Grupo A)	1
Puntuación de carga/Fuerza (Grupo A)	3
GRUPO B. Análisis del cuello, tronco y pierna	
Puntuación del cuello	4
Puntuación del tronco	2
Puntuación de las piernas	1
Puntuación del tipo de actividad muscular (Grupo B)	1
Puntuación de carga/Fuerza (Grupo B)	0
NIVELES DE RIESGO Y ACTUACIÓN	
Puntuación Final RULA	**7**
Nivel de Riesgo	**4**
Actuación	**Se requieren análisis y cambios de manera inmediata**

MÉTODO SUE RODGERS Ensamblado de Guías	Esfuerzo	Duración	Por minuto	Puntaje	Evaluación
Cuello	2	2	3	8	Alto
Hombro	2	2	3	8	Alto
Espalda	1	2	3	5	Moderado
Brazo y Codo	2	2	3	8	Alto
Muñeca, mano, dedo	2	2	3	8	Alto
Piernas y Tobillos	1	1	1	1	Bajo

3.3.2 SUE Rodgers. Table 2b, shows the results of the SUE Rodgers method for analysis of Assembly guides

3.3.3 REBA. Table 3a shows the results of the REBA method for analysis of Assembly guides

3.3.4 OCRA. Table 3b shows the results of the OCRA method for analysis of Assembly guides

Table 3. Analysis of Assembly guides. a) REBA method, b) OCRA method

MÉTODO REBA. Ensamblado de Guías	
GRUPO A. Análisis Cuello, Piernas y Tronco	
Puntuación de Cuello	3
Puntuación de Piernas	1
Puntuación de Tronco	3
Resultado (Tabla A)	5
Puntuación de carga/Fuerza (Grupo A)	0
Puntuación de Grupo A	**5**
GRUPO B. Análisis de Brazos, antebrazos y muñecas	
Puntuación de Antebrazo	1
Puntuación de Muñecas	3
Puntuación de Brazos	4
Resultado (Tabla B)	5
Puntuación de Agarre (Grupo B)	0
Puntuación de Grupo B	**5**
Nivel de Corrección (Repetición superior a 4 veces/minuto)	**1**
Puntuación Final REBA	**7**
Nivel de Actuación (4-7)	**Necesario**

MÉTODO OCRA Ensamblado de Guías	Derecha	Izquierda
Tiempo de recuperación insuficiente	4	4
Frecuencia de movimientos	7	5
Aplicación de Fuerza	2	2
Hombro	6	6
Codo	0	0
Muñeca	2	2
Mano-dedos	2	2
Estereotipo	1.5	1.5
Posturas Forzadas	7.5	7.5
Factores de riesgo complementario	3	1
Factores duración	1.5	1.5
Índice de Riesgo y Valoración	Derecha	Izquierda
Índice de Riesgo	**35.2** No aceptable nivel alto	**29.2** No aceptable nivel alto
Escala de valoración del riesgo		
No aceptable nivel alto	≥22.5	

3.4 Process reengineering and design of workstations.

Figure 2. It shows improvement proposals for station Assembly guides, with change in pressure tool, component boxes, area to take and release guides on conveyor belt

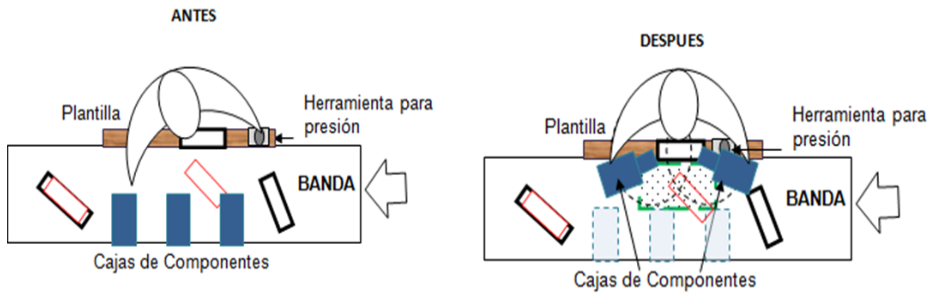

Figure 2. Application of results of process reengineering in station Assembly guides

4 RESULTS

Figure 3, shows the results of the application of reengineering and ergonomics in the before and after their application, obtained an improvement of 96% for the operational part and material handling.

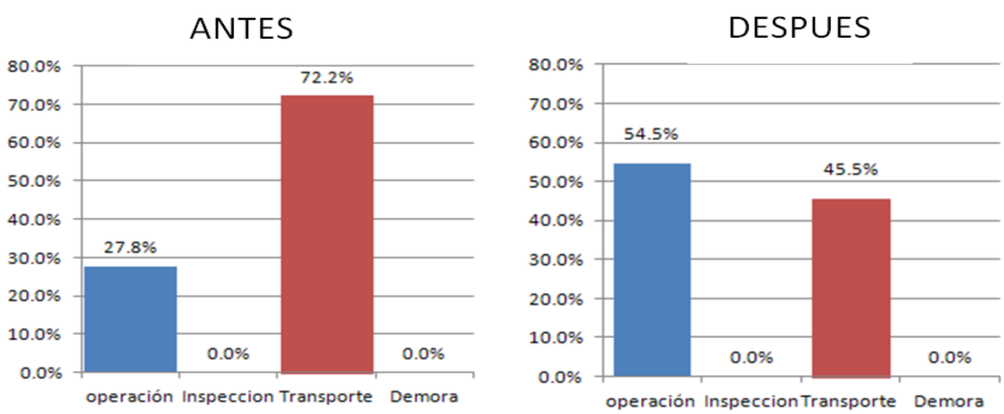

Figure 3. Results before and after applying reengineering and ergonomics

In table 4, displays the results with the new tool of manipulation, the performance obtained was 228%, with an annual saving in lives of $9,150.00 pesos.

Table 4. New tool performance results

CÁLCULO PARA DETERMINAR RENDIMIENTO DE HERRAMIENTA 1 Más producción y menos tiempo operador		
Concepto	**Herramienta 1**	**Herramienta 2**
Costo de Herramienta (Pesos)	$ 1000.00	$ 20000.00
Años de Garantía	2	5
Días/año	310	310
Usos/día	19200	28800
Usos de vida	11904000	44640000
Centavos /Uso de Herramienta	0.008400	0.044802
MANO OBRA		
Tiempo de uso de Herramienta (Segundo)	1.5	1
Costo de Hora Mano de Obra (Pesos)	10	10
Centavos Mano de obra en (centavo/segundo)	0.28	.28
Centavos Mano de obra por segundo de uso	0.42	.28
Suma Mano obra por segundo +Centavo/ Uso de Herramienta	0.43	0.32
Diferencia Costo con Herramienta propuesta (centavos/Uso)	0.10	
Ahorro Anual en Pesos en Usos Vida	$ 9150.00	
Rendimiento 228.75%		

Referencia: Dr. Carlos Espejo EMT MST PEC

Table 5. RULA method for analysis of improvement on Assembly guides

MÉTODO RULA. Ensamblado de Guías			
1.Colocar Cajas a los costados de operador, con salida frente a Plantilla 2.Prensar guías con mecanismo pulsado con sensores pulsados con ambas manos 3. Delimitar área para tomar y dejar guías (Área Neutra)			
GRUPO A. Análisis brazo, antebrazo y muñeca	**Antes**	**Después**	**Mejora**
Puntuación de Brazo	4	1	33.3%
Puntuación de antebrazo	2	1	33.3%
Puntuación de la muñeca	4	1	100%
Puntuación giro de muñeca	1	1	0%
Tipo de actividad muscular(Grupo A)	1	1	0%
Puntuación de carga/Fuerza (Grupo A)	3	0	100%
GRUPO B. Análisis del cuello, tronco y pierna	**Antes**	**Después**	**Mejora**
Puntuación del cuello	4	2	33.3%
Puntuación del tronco	2	2	0%
Puntuación de las piernas	1	1	0%
Puntuación del tipo de actividad muscular (Grupo B)	1	1	0%
Puntuación de carga/Fuerza (Grupo B)	0	0	0%
NIVELES DE RIESGO Y ACTUACIÓN	**Antes**	**Después**	**Mejora**
Puntuación Final RULA	7	3	**57.1%**
Nivel de Riesgo	**4**	**2**	**50%**
Actuación	**Se requiere una evaluación más detallada y posiblemente, algunos cambios**		

Table 6. Sue Rodgers method for analysis of the result of improvement in Assembly guides

Método Sue Rodgers Ensamblado de Guías	Antes				Después					Mejora
	Esfuerzo	Duración	Frecuencia	Puntaje	Esfuerzo	Duración	Frecuencia	Puntaje	Evaluado	
Cuello	2	2	3	8	2	1	3	**6**	**Modera**	**20%**
Hombro	2	2	3	8	1	2	3	**5**	**Modera**	**30%**
Espalda	1	2	3	5	1	2	3	**5**	**Modera**	**0%**
Brazo y Codo	2	2	3	8	1	2	3	**5**	**Modera**	**30%**
Muñeca, mano, dedo	2	2	3	8	1	2	3	**5**	**Modera**	**30%**
Piernas y Tobillos	1	1	1	1	1	1	1	**1**	**Bajo**	**0%**

Table 7. OCRA method for analysis of the result of improvement in Assembly guides

MÉTODO OCRA. Ensamblado de Guías	**Antes**		**Después**		**Mejora %**
	Derecha	Izquierda	Derecha	Izquierda	
Tiempo de recuperación insuficiente	4	4	4	4	0%
Frecuencia de movimientos	7	5	5	5	28.6%
Aplicación de Fuerza	2	2	2	2	0%
Hombro	6	6	0	0	100%
Codo	0	0	0	0	0%
Muñeca	2	2	0	0	100%
Mano-dedos	2	2	2	2	0%
Estereotipo	1.5	1.5	1.5	1.5	0%
Posturas Forzadas	7.5	7.5	3.5	3.5	53.3%
Factores de riesgo complementario	3	1	1	1	66.6%
Factores duración	1.5	1.5	1.5	1.5	0%
Índice de Riesgo y Valoración	Derecha	Izquierda	Derecha	Izquierda	
Índice de Riesgo	**35.2** No aceptable nivel alto	**29.2** No aceptable nivel alto	**23.2** No aceptable nivel alto	**23.2** No aceptable nivel alto	**34.1%**
Escala de valoración del riesgo					
No aceptable nivel alto	≥22.5				

Table 8. BRIEF method for analysis of the result of improvement in Assembly guides

MÉTODO BRIEF-BEST. Ensamblado de Guías								
Postura	Duración (Segundo)	Frecuencia (veces/min)	Fuerza	Puntaje BRIEF	Puntaje BEST	Compresión Tejido Blando	Nivel de Riesgo Antes	Nivel de Riesgo Después
Manos, Muñeca	10		X	2	3	2	Muy Alto	Medio
Codos		2		3	5		Alto	Medio
Hombro		2		3	5		Alto	Medio
Espalda		2		3	5		Alto	Medio

1. After the redesign has improved in each of the methods of evaluation of physical factors
2. Improved postures of assembling and handling parts with redesign and design of equipment
3. Elimination of risks by cumulative trauma per assembly by manual impact
4. Good performance was obtained when validating the tool proposals
5. Production of metal guides assembly was optimized

5. **DISCUSSION/CONCLUSIONS**

Once the physical ergonomic factors in the metallic guide assembly station have been evaluated, the following proposals are concluded to improve the operating conditions.

A. Immediate operational

1. Operating staff intends to sensitize it, train it, and prevent it from unsafe acts.
2. Administrative staff will warn you of conditions and unsafe acts observed in workstation

B. Engineering measures

3. It was proposed to redesign station by taking neutral positions of work at elbow level.
4. Proposed controls within easy reach and ergonomic
5. Proposed provision of material placed in comfortable and attainable containers in ergonomic position
6. Production was optimized when designing stations that work with ergonomic principles
7. Ergonomic chair adjustable to the anthropometry of the working population
8. Footrest on workstation.
9. Mechanism pulsed by sensor operated with both hands to assemble guides
10. Place bumper (fixture) template with ergonomic grip.
11. Delimit area for guidelines layout

12. Supplement Visual AIDS to standardize the process.
13. Light colors on workstation.

C. Administrative measures

14. Program of rotation of posts was proposed.
15. Proposed Committee ergonomic.
16. Was proposed to generate training program.
17. Specific induction to the job.
18. Timely detection of cases by suggestion mailbox.
19. Motivate people to participate.
20. Ergonomic audit and survey.
21. Verify performance in terms of safety and comfort.
22. Participatory ergonomics, positive reinforcement with the worker.
23. Ergonomic Map

D. Medical measures

24. Work gymnastics was proposed for breaks for health in turn. "Labor gymnastics"
25. Step zero promotion (lifestyle and healthy work, exercise, healthy food, lots of fluids, water, prevent drug addiction, have a hobby, sleep 8 hours).
26. Epidemiological surveillance to ergonomic stressors
27. Medical advice with specific employment restriction.
28. Prognosis and rehabilitation.
29. Timely detection of cases reported to medical consultation.
30. Adapting jobs for left-handed (if applicable).

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CONTRIBUTIONS FROM ERGONOMICS TO THE DESIGN OF MEDICAL DEVICE: A LITERATURE REVIEW

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Resumen: El sector de la salud es extremadamente complejo y está caracterizado por múltiples usuarios, de carácter clínico y no clínico; por varios entornos de atención, desde salas de terapia intensiva hasta el hogar de los pacientes. En el desarrollo de dispositivos médicos, la importancia de la eficacia clínica, la seguridad del usuario y la evaluación de los requisitos del usuario son de los aspectos más importantes en el diseño de los mismos y omitir algunos factores como la experiencia de uso, podría comprometer el uso de un dispositivo médico. El objetivo de este trabajo es identificar a través de una revisión de literatura las contribuciones de la investigación en Ergonomía en el desarrollo de dispositivos médicos. Es un trabajo que se limita a una revisión de literatura, específicamente en el área de diseño de los dispositivos médicos. La revisión final se completó con 20 artículos científicos. Los resultados muestran que para brindar atención segura y de alta calidad a los pacientes, la industria médica requiere dispositivos médicos clínicamente efectivos y bien diseñados. El diseño de los dispositivos debe tener en cuenta el entorno en el que se requiere que funcionen y debe apoyar los patrones de trabajo de los usuarios profesionales, así como los estilos de vida de los pacientes y cuidadores.

Palabras Claves: Ergonomía, Dispositivos médicos, características y necesidades de los usuarios.

Abstract: The health sector is extremely complex and is characterized by multiple users, clinical and non-clinical; for various care environments, from intensive care rooms to the home of patients. In the development of medical devices, the importance of clinical efficacy, the safety of the user and the evaluation of user requirements, are the most important aspects in the design of these type of devices and skip some factors, such as user experience, may compromise the use of a medical device. The aim of this paper is to identify through a literature review the contributions of Ergonomics research in the development of medical devices. The review of scientific papers was conducted in some databases using multiple keywords related to the subject of the review. The final review was completed with

20 scientific articles. The review shows that to provide safe and high-quality care to patients, the healthcare industry requires clinically effective and well-designed medical devices. The design of devices must take into account the environment in which they are required to work and lifestyles of patients and caregivers.

Keywords: Ergonomics, Medical Devices, Characteristics and User Needs.

Relevance to Ergonomics: Ergonomics has the opportunity to assist in the field of medical device design to capture user requirements and incorporate them into the design process. Because the principles and approaches of ergonomics are not currently used in the development of medical devices, especially considering the current approach that gives greater importance to the user in other design domains, such as consumer products and occupational environments.

1. INTRODUCTION

The healthcare sector requires clinically effective, safe and well-designed medical devices (Lang et al., 2013; Martin et al., 2008). Firstly, the medical device must be clinically effective and safe, but also consider meeting the needs of the people who will use it and be treated by it. There are factors that are important to get a well-designed, such as capabilities, working patterns of clinical users, lifestyles of clinical users, the environments in which the device will be used and the system of which it will be a part, are important to achieve a well-design (Martin et al., 2008; Sawyer, 1996). In the past, the healthcare professionals were normally considered the major user group of medical devices; but now there are multiple users, as a doctor, nurse, patient, relatives of the patients, among other; and are increasingly varied contexts of use, clinical and non-clinical (Furniss et al., 2014; Lang et al., 2013; Martin et al., 2008). Consequently, developers and manufacturers of medical devices need to be aware of these and how they will impact upon the design of these devices (Lang et al., 2013).

Medical devices “are a diverse group of products that range from simple items such as sticking plasters to complex devices such as heart by-pass machines” (Martin et al., 2008). The Federal Commission for Protection against Health Risks (COFEPRIS) defines the Medical Devices as "a substance, mixture of substances, material, apparatus or instrument (including the computer program necessary for its proper use or application), used alone or in combination in the diagnosis, monitoring or prevention of diseases in human or auxiliary in the treatment of them and of the disability, as well as those employed in the replacement, correction, restoration or modification of the anatomy or human physiological processes".

Given the relevance of Ergonomics in assisting the medical device design process to capture user requirements, the aim of this paper is to identify through a literature review the contributions of Ergonomics research in the development of medical devices.

2. METHODOLOGY

The literature review was performed through the Elsevier database and Google Scholar but in Ergonomics and Human Factors journals, as Applied Ergonomics, Ergonomics, Ergonomics in Design, Human Factors: The Journal of the Human Factors and Ergonomics Society, and Advance in Human Factors/Ergonomics. The keywords used in the search equation were classified into two categories: 1) medical device and 2) users, as shown in Table 1. The selection of articles began with the inspection of the titles which allowed related to 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.

Table 1. Categories of keywords used in the review

Medical Device	Users
Effectiveness	User center design
Device	User Requirements
Healthcare	Patient Safety

3. RESULTS

From the literature review, 20 scientific articles were identified providing information about the medical device in Ergonomics. The articles were classified into three subgroups according to the area of research each they focused: 1) studies of medical devices to generate the user requirements, 2) patient safety and 3) international standards.

The first subgroup included information about user requirements, as mentioned by Martin et al., (2012) these studies have been largely concentrated in the last stages of development, in prototype evaluation or when a device is already out in the market. Excepting in the study of Martin et al., (2012), this study was conducted in the earlier stage of user requirements of a new medical imaging device. Previous to this study had not yet been published any “research on collecting user requirements during the development of a completely novel medical device” (Martin et al., 2012). That study is divided into two phases, in the first stage, a brainstorm was carried out to identify potential users, who were subsequently interviewed. And the next stage was to evaluate the quality and usefulness of the data from the perspective of a small medical device company, to study how user data were incorporated into development and how they affected development. As results, the clinical needs of the new medical imaging device were obtained, which were refined and validated.

In another study, Furniss et al., (2014) present an assessment of a modern inpatient blood glucose meter from which arises seven themes that provide a starting point for further application and development, particularly for inpatient situated studies of devices. In the study by Furniss et al., the main users of the device were the nurses and is carried out in a clinical environment. Davcev & Jakimoski (2015) used ergonomic in order to improve the design of the proposed Near Field Communication based healthcare system, as a Furniss et al, Davcev & Jakimoski had clinical users: medical personnel and patients in medical centres. But there are other studies that collect the requirements of patient users outside of clinical environments, as Howard et al. (2017), Lang et al. (2013) Rogers et al. (2001) and Mykityshyn et al. (2002). Howard et al. (2017) gave seven adolescents with asthma an electronic monitoring device to use for one month to know their points of view on issues that important teenagers through interviews and questionnaires. This study seeks to improve the adherence of adolescents with respect to the use of inhalers. Lang et al. (2013) examine the role of device design in the real-world effectiveness of adolescents with a treatment of cystic fibrosis by interactive design interviews, this article is part of a thesis in which Lang (2012) develops some methods that help to collect information from adolescents for the development of medical devices. Rogers et al. (2001) perform a non-clinical study and carried out a usability analysis on glucometers used at home and find have over 50 procedural steps to take a reading of glucose. Mykityshyn et al. (2002) compare two groups, younger and older adults, about learning to use a blood glucose meter via user manual vs. instructional video obtaining more relevant results in the older adults. Martin et al. (2008) and Valdez et al. (2017) made a review of articles in Ergonomics. Martin et al. (2008) made a review of ergonomics methods for assessing user requirements, as contextual inquiry, cognitive task analysis, usability test, heuristics, cognitive walkthrough, focus group and Delphi technique; and mention the role of ergonomics in development of medical device and how this can help manufacturers to use their resources for studying user requirements during the development of their products. Valdez et al. conducted a systematic review to document the use and publication of Ergonomics Human Factors of qualitative research in health care and to know who commonly was used in conjunction with quantitative. All previous studies sought to know user requirements within a real context, Vincent & Blandford (2014) say that one way to represent users is through archetypal (persona) as it is a useful tool to support communication but it presents complications in its development since it was difficult to make them representative.

The second subgroup of studies is about patient safety. The use of Ergonomics methods and theories has been advocated by many experts and organizations to improve patient safety because the healthcare industry recognition that the errors are not attributed in entirety to the user, in some cases are consequences of a failure or the system within (Department of Health, 2001; Vincent & Blandford, 2011). Despite being aware of the needs of users, the major manufacturers had difficulties in implementation of those needs (Vincent & Blandford, 2011). Vincent & Blandford (2011) involving professionals from manufacturers of a medical device to understand their development practices and identified areas where developers need tools, techniques and evidence to inform the requirements for new designs and to evaluate it. After this study, Vincent & Blandford (2017) made another study focused on procurement of infusion devices and carried out a structured interview. They show if the hospital considers or not the human factor and the problems and decision making in which hospitals are involved when buying medical devices. Gray et al. (2015) taking a patient-centred approach for improving outcomes such as patient safety to the identification of risk factors for patient harm focused on parents, and also issues identified as an important policy issue in homecare. Carayon (2010) identified “factors that can either hinder or facilitate the spread of HFE innovations in healthcare” and makes recommendations for the professional and research in Human Factors and Ergonomics. Carayon et al. (2014) mention that experts play an important role in transforming and redesigning health care systems for improving patient safety. Carayon et al. described the model SEIPS (Systems Engineering Initiative for Patient Safety) and describes the principles for redesigning health systems using this model. Santos et al. (2016) carried out exploratory observations in nurse anaesthetists in low-income countries and showed there are different ways how work dynamics affect the performance, as their relation to medical equipment is continuously affected by more than user-related aspects.

The third subgroups included information about standards for medical devices. The FDA (2011) points out that the integration of human factors in the medical device design process is required to reduce risk and improve patient safety. Privitera et al. (2017) show some of the main challenges of meeting the agency's requirements with regard to the application of human factors in the medical device development process, as include a lack of direct access to users for the purposes of device development or the lack of understanding by users with regards to the impact of their feedback on the development process.

4. DISCUSSION

The main objective of this research was to review the studies that exist from the perspective of ergonomics in medical devices, as previously mentioned, most of the studies found in the literature focus on the last stages of device development. Martin et al., (2012) mention that “this may be because medical devices are frequently technology driven rather than resulting from an identified un-met need” (Martin et al., 2008). The inaccurate study of the potential users of medical device at the beginning of development, may lead into wrong suppositions and may soon become accepted and unquestioned, and in some cases may be erroneous and the medical device will be developed and evaluated based on incorrect information (Martin et al., 2012) and “devices generated in isolation of the ultimate users are vulnerable to failure” (Grocott et al., 2007).

In Mexico, Cofepris (2018) affirmed that our country is the largest market in Latin America in medical devices with a production of 15.220 million dollars and it is a priority to generate safe medical devices. Despite this, no studies were found in Mexican population about medical devices from the perspective of Ergonomics. This situation is startling since Human Factors and Ergonomics systems approaches are critical for improving healthcare quality and patient safety (Carayon et al., 2014) and to provide a clinically effective, safe and well-designed medical devices. (Martin et al., 2008).

Fajardo-Dolci et al. (2012) propose recommendations to prevent medical error, malpractice and professional responsibility, one of these recommendations is aimed at patient safety and preventing risks to patients. The Johns Hopkins (2016) calculated that more than 250,000 deaths per year are due to medical error in the U.S. Although, in Mexico there are no studies that allow knowing this information, the National Commission of Medical Arbitration (Conamed) is responsible for receiving all complaints coming from patients of any medical institution, and in 2016 received 14,210 complaints regarding this matter. These numbers raise the situation in which Ergonomics in Mexico could and should be involved in helping the medical device industry, healthcare systems and medical device users.

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MUSCULOSKELETAL DISORDERS DUE TO THE INTENSIVE USAGE OF COMPUTERS

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Resumen : El principal objetivo de esta investigación fue determinar la presencia de síntomas de desórdenes musculo esqueléticos por trauma acumulativo, en un grupo de estudiantes de la carrera de ingenieros en software. El grupo de estudio fue de 45 participantes con un promedio de edad de 19 años. Se encontró que las regiones corporales que presentan mayor cantidad de reportes de molestias de tipo musculoesquelética son: cuello, muñeca, codo, y parte superior e inferior de la espalda presentando los mayores puntajes de nivel de intensidad de molestia en hombro, cuello y parte superior de la espalda. Sobre el tiempo de exposición se obtuvo que un 82% de los usuarios utiliza un equipo de cómputo por más de 6 días a la semana y un 56% revela que el tiempo de uso es de más de 5 horas al día.

Palabras clave: Lesiones en el Sistema musculo-esquelético, factores de riesgo, usuario de computadora.

Summary: The main objective of this investigation was to determine the presence of symptoms of skeletal muscle disorder due to cumulative trauma, in a group of students in the career of software engineers. The group of study was of 45 students around the age of 19 years old. It was found that the body regions that represent most of the disturbance of the musculoskeletal kind were: the neck, the wrist, the elbow and the upper and lower part of the back presenting the higher scores in the level of intensity of disturbance in the shoulder, neck and upper part of the back. About exposure time it was obtained that 82% of the users use the computer equipment more than 6 days a week, and 56% reveals that the time they use it it's over 5 hours a day.

Key words: Disorders of the musculoskeletal system, risk factors, computer user.

Contributions to Ergonomics: Counting with a concerning of the situation that prevails with the computer users, it's important to consider and raise awareness about the usage, time of exposition and the adopted postures, as well as investing in proper furniture installations and equipment, with the purpose of eradicating and/or avoiding the appearance of possible musculoskeletal disorders.

1. INTRODUCTION

Since the decade of the 90's there have appeared articles related to the use of the computers and musculoskeletal problems, just as muscle tensions or tendon muscle overloads in the upper members and the cervical, dorsal and lower back zones of the column. The reports in the literature suggest that the computer users have elevated rates of muscle skeletal disorders when compared to those who are not computer users; specially between an 11% and 14% of the workers seem limited their activities due to neck pain. (Muñoz, Vanegas, 2012)

The increase of the use of the computers requires abundant studies, frequently and permanently, that answer the questions about the security and health of their users. The main ergonomic deficiencies or a computer workstation have been detected in the physical design and the provision of the post, in the position used, in the work practice and the entertainment. (Muñoz, Vanegas, 2012). Due to that, it is frequent to find health problems, especially those related to the sight and the musculoskeletal system, inside of the working population. For example, in the Bongers study it is indicated that those who work directly with monitors or video units show high prevalence (61.5%) of neck pain and shoulders that might interfere with their work activities. (Martínez, 2007)

La 2015 ENDUTIH revealed that 55.7 million of the people are computer users, and 62.4 million uses Internet in Mexico.

This context motivates the on-going investigation due to the actual situation of sufferings of musculoskeletal disorders in users of computer equipment because of the common pattern that falls en the complaint about the bothering in certain parts of the body, being this what arouses a point of attention for the evaluation of the job and its repercussions; in this case, the investigation will be based in the experiences of the use of this equipments for long times, taking as study case the alumnae of the career of Software Engineer, because of they're the ones who show most exposure to the problematic presented.

1.1 Objective

For all of the above, this investigation is proposed in students of 3rd, 5th and 7th semester, with the purpose of determining the presence of musculoskeletal disorders symptoms due to cumulative trauma, along with the exploration of the risk factors related to the prolonged usage of the computers, this will allow the proposal of actions to a proper execution of this equipments without the health and security risks to the users.

1.2 Delimitations

The study considers people born in the State of Sonora between 18 and 28 years old, students of the Software Engineer career.

2. METHODOLOGY

2.1 Sample

The population subjected to the study were students that are currently studying the Software Engineer career, aged between 18 and 28 years old; the entirety of students are in third, fifth and seventh semester, in the execution period of the August-December semester, 2017, where the study population is of 97 students of the career, as a criteria of inclusion it needs to be considered that the student it's active and regular (assists to class and/or lab), the he doesn't have record of syndromes or degenerative diseases of the musculoskeletal system and/or congenital deformities of the column, besides of their acceptance on being part of the study, obtaining a total of 45 samples, 39 males and 6 females.

2.2 Procedure

The development of this investigation consisted in the appliance of polls to the students, in order to obtain information, which contains questions pointing out the discomfort that it's presented in the moment of using computational equipment, just as the time invested, the characteristics of the job and the position used in it.

By the end, the analysis of the results was processed with statistic software.

Subsequent to it, will proceed to evaluate the conclusions and formulate recommendations to its possible implementation en the used jobs.

2.3 Materials

The instrument used to the obtainment of information was a poll developed by Fonseca and Moraga (2010) from the University Of Costa Rica Faculty Of Medicine. The poll it's divided in two sections (A and B). In the first section is collected information about the disturbance related to the disorders of the musculoskeletal system registered after using the computer. The analogous scale of pain it's used in this one, also known as the Likert subjective perception of pain scale, going from 0 to 3, where 0 is "no pain or disturbance", 1 is "mild disturbance", 2 is "moderated pain" and 3 is "strong pain or disturbance". In addition, a body outline is presented, in which the individual pinpoints the affected-by-the-disturbance zone. Also, 4 closed answer items in nominal scale are also used. The B section uses the same instrument, and it has the purpose of determining the risk factors related to the computer work, either individual, of the workstation and biomechanical (in the three environments of exposure more frequents: Lab, Home and Work), just as its execution. This section consists of 23 closed answer items and a Likert scale chart. To measure the liability the Cronbach alpha was determined obtaining as a result a value of .713, that, as general criteria, it is consider acceptable.

3.RESULTS

Of the entirety of subjects considered for this analysis, it was determined that the age range was between 18 and 28 years old, with an average of 19 years old, with a majority of males, with a 86%. Highlight that the 58% of the participants had never received any kind of information about the ergonomic measures in the usage of the computer, while the rest had received, on its majority, information about the position 49% (17), about rest 29% (10) adjustment of the workstation 14% (5) and about exercises 9% (3), see figure 1.

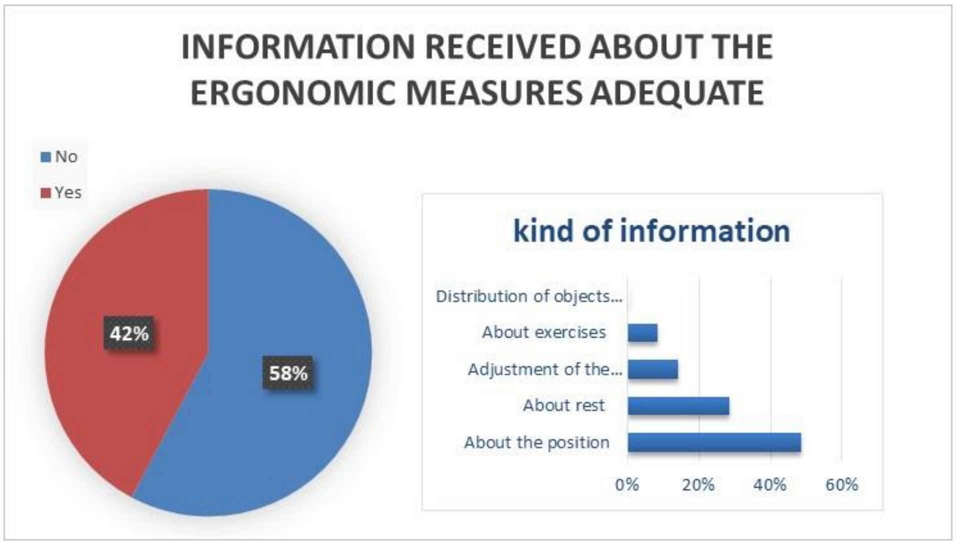

Figure 1, Percentage of information received from the user about the ergonomic measures adequate due the usage of the computer and the kind of information received.

About the time of exposure it was obtained that the 82% of the users uses the computer equipment more than 6 days a week, and a 56% reveals that the time of usage its above 5 hours a day (see figure 2) and an important fact is that, in the Labs as much as in the domestic use, the users don't have a straight back, nor they have the adequate furniture for their use. (>60%, see figure 3).

Body areas in which there are more discomforts of each type of intensity. The corporeal regions that show the most quantity of reports of discomfort of the musculoskeletal type are: the neck, the wrist, the elbow and the upper and lower back (see figure 4). This matches most of the investigations en computer users where the pain syndromes are more common, these being the back pain, neck pain, and the sore wrists. Besides there are level 4 intensity on the shoulder and neck in 11% of the reports and a 12.4% show a level 3 intensity en the upper back, a level 2 intensity in the neck In 22.5% of the cases and a level 1 intensity in the fingers the 53.9% of the time (see figure 5).

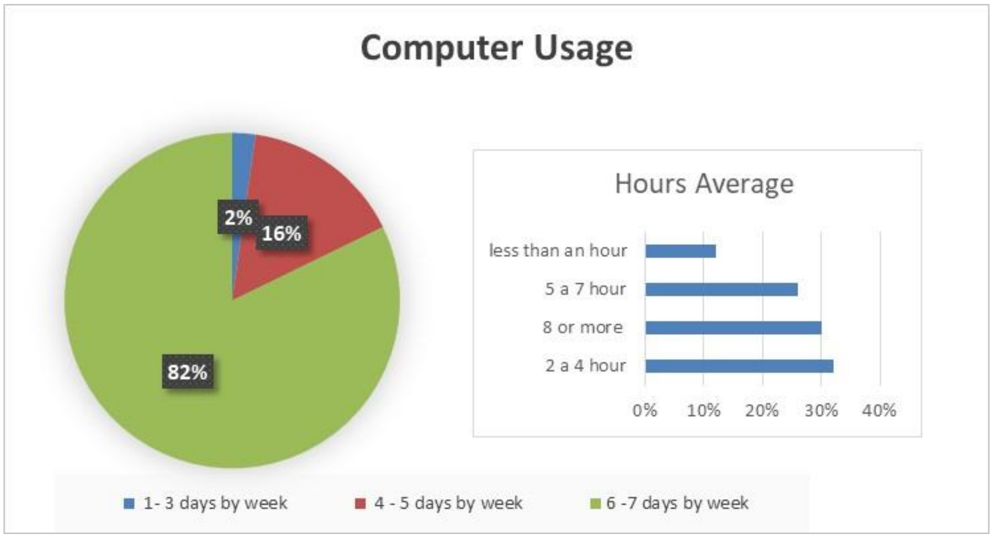

Figure 2. Percentage of hours per day worked on a computer.

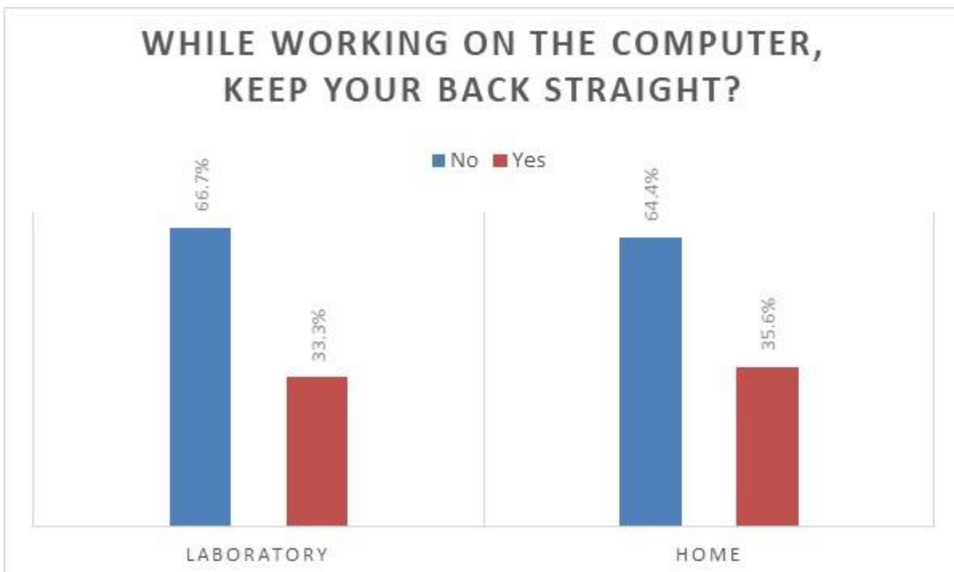

Figure 3, Posture of the back when working on a computer.

4. CONCLUSIONS

Based on the obtained results we get to the conclusion that the more critical zones of the development of musculoskeletal disturbance were the neck and the right shoulder, with a 4^{th} level intensity and the right wrist with a frequency of disturbing 16 people in total. The percentages show a usage of the computer an average time of 4 to 5 hours per day in the students used in this investigation. This conditions might differ in distinct types of musculoskeletal disturbances to develop in the affected zone, like the neck in inclination postures, the more frequent injuries are the herniated disc, lumbago, muscular pain, sciatica, muscular distension; for the shoulders because of maintaining the arms extended forward or to the sides, the kind of injuries for this are tendonitis, per-arthritis, and bursitis; and in the wrists because of moving the up and down or to the sides repeatedly and exerting force in the hands, this can end in tendonitis, carpal tunnel syndrome, numbing and distension.

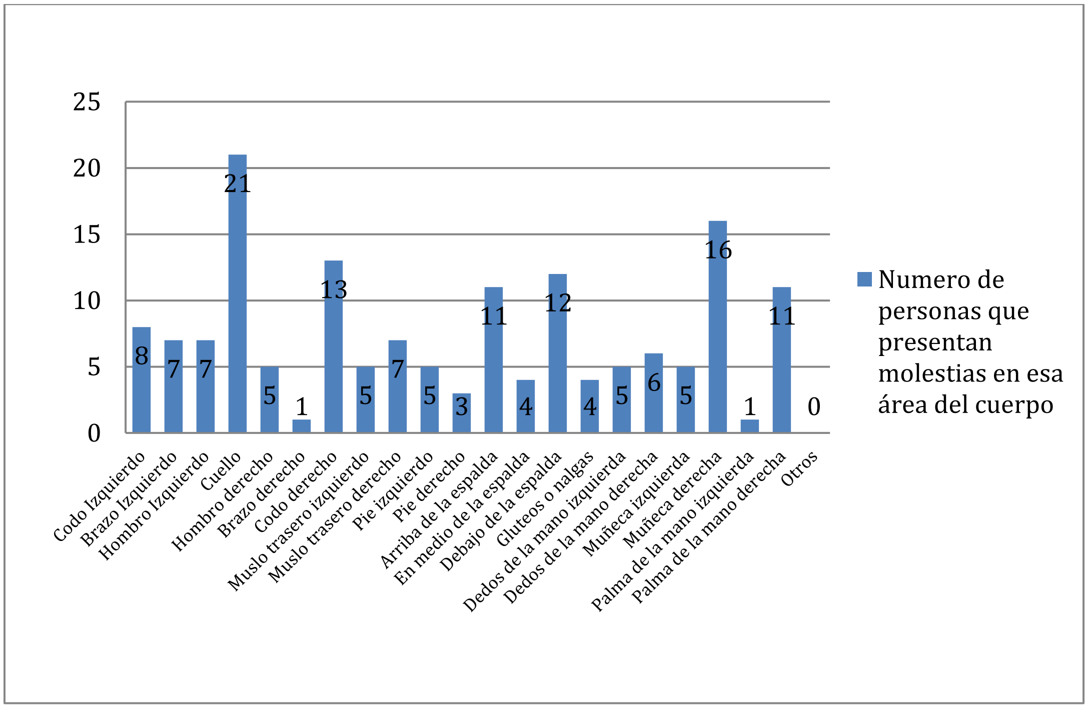

Figure 4. Number of people that show disturbance in certain body areas.

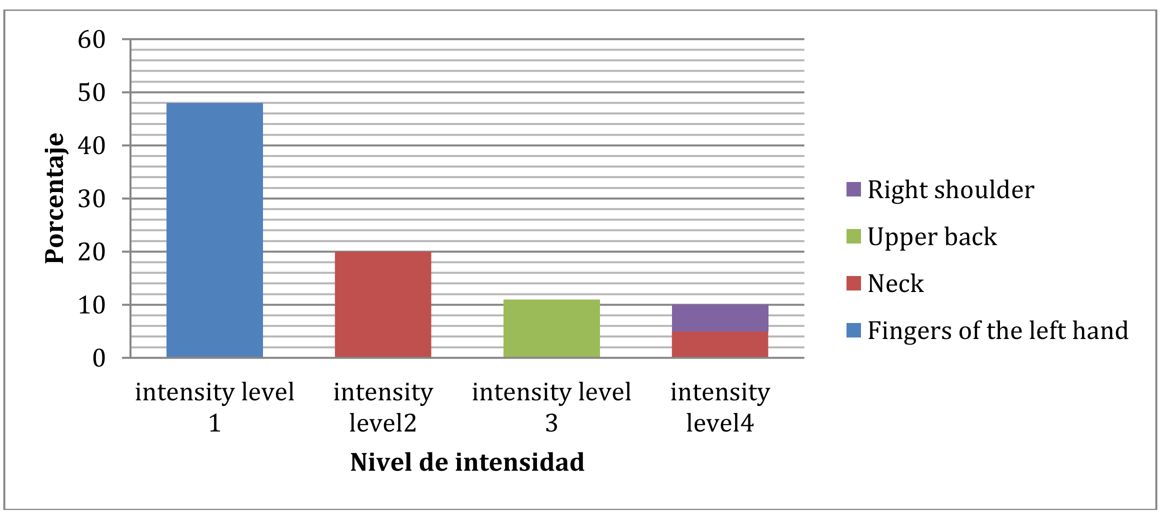

Figure 5. Body areas in which there are more discomforts of each type of intensity.

Said disorders are made because of the postures in long times, bad design of the workplace and repeated moves, which, if not treated in time, could augment the intensity of the pain or get to medical intervention, causing the student the absenteeism, lowers its productivity and long-term negative effect at the time of practicing its profession.

5. RECOMMENDATIONS

It is recommended to avoid using the computer for long times, in order to avoid fatigue due to static postures, and realize position changes every 15 minutes, with that having the benefit of the reduction in the index of appearance of discomfort and muscle skeletal disorders.

The adjustment of the workplace it's indispensable for the reduction of risk in the user, and at the same time, the training of the alumnae about the ergonomic positions adequate that benefit them in the prevention of possible musculoskeletal disturbances.

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APPLICATION OF LEAN - ERGONOMICS IN LINES OF TONER CARTRIDGE ASSEMBLY IN MAQUILADORA COMPANY IN CIUDAD JUÁREZ

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Resumen: En México, los trastornos Musculo –Esqueléticos son reconocidos como enfermedades del trabajo, dichos trastornos surgen cuando el trabajador se ve expuesto a factores de riesgo como: tareas repetitivas, el empleo de cierto tipo de herramientas, posturas no adecuadas para el cuerpo, hoy en día las es muy común encontrar que las empresas cuentan con una cultura lean, lo que con frecuencia implica que los trabajadores efectúen tareas que les generen algún tipo de trastorno Musculo-Esquelético.

Con la llegada de la industria 4.0, también conocida como cuarta revolución industrial, el sector productivo se ha enfrentado a la introducción de tecnologías digitales en sus procesos, como parte de estas tecnologías están los sistemas MES (Manufacturing Execution Systems), que permiten tener visión de lo que pasa en las líneas de ensamble. En este artículo demuestra que es posible utilizar estas tecnologías para disminuir el riesgo por disergonomía para los trabajadores.

Palabras Clave: Trastorno Musculo-Esquelético, Lean-Ergonomics, OCRA®, RULA.

Abstract: In Mexico, musculoskeletal disorders are recognized as occupational diseases, these disorders arise when the worker is exposed to risk factors such as: repetitive tasks, the use of certain tools, inadequate postures, etc.; Nowadays it is very common to find that companies have a lean culture, which often means that workers perform tasks that generate some kind of Muscle-Skeletal disorder.

With Industry 4.0, also known as the fourth industrial revolution, the productive sector has faced the introduction of digital technologies in their processes, as part of these technologies are the MES systems (Manufacturing Execution Systems), which allow to have vision of what happens in the assembly lines. This article shows that it is possible to use these technologies to reduce disergonomy risks for workers.

Keywords: Musculoskeletal Disorder, Lean-Ergonomics, OCRA®, RULA.

Contribution to Ergonomics: The study shows how it is possible to use MES applications (Manufacturing Execution System), which are the spearhead in the evolution to industry 4.0, to reduce the risks by disergonomy in the assembly processes in a toner cartridge assembly plant.

1. INTRODUCTION

A musculoskeletal disorder is defined as a lesion that mainly affects the soft parts of the locomotor system: muscles, tendons, nerves and other structures near the joints (Kester, 2013). These lesions are generated by small mechanical stresses: stretching, friction, compression, etc., repeated over long periods of time. This type of injuries is one of the most important health problems at work in industrialized and developing countries (Arenas-Ortiz and Cantú-Gómez, 2013).

The statistical reports of Instituto Mexicano del Seguro Social (IMSS) show that in Mexico, musculoskeletal disorders such as Enteopathies, Carpal Tunnel Syndrome, Synovitis and others, affect the health of the worker, as shown in Table 1 .

Table 1. Diseases according to the nature of injury, 2011-2016

Nature of Injury	2011	2012	2013	2014	2015	2016
Enteopathies	3.00%	4.70%	5.80%	5.70%	5.40%	5.50%
Carpal Tunnel Syndrome	3.60%	4.60%	5.30%	5.30%	4.50%	5.00%
De Quervain Stenosing Tenosynovitis	3.40%	4.30%	4.00%	4.00%	3.60%	3.30%
Synovitis, Tenosynovitis and Bursitis	3.50%	5.00%	3.60%	3.60%	2.80%	2.80%
Epicondylitis	1.10%	1.40%	1.60%	1.60%	1.30%	1.50%
Arthrosis	0.60%	0.60%	0.70%	0.70%	0.90%	1.20%

The lean manufacturing processes are intended to create value and reduce waste of productive activity (Monge et al. 2013). Unfortunately, lean processes can convert work into a highly repetitive task, which means that stressful postures are repeated over and over again during the worker's shift (Caraballo-Arias, 2013). A Manufacturing Execution Systems (MES), can be defined as industrial software, which receives, processes, generates and stores information in real time, with data from a production plant, this information comes to the system either automatically, by signal lines, OPC equipment, machinery and / or robots, and also manually, by capturing data by the worker. All this information, once processed, becomes a reliable and quantified source for decision making.

Figure 1 shows in which part of the production process are the MES systems, also details their relationship with other parts of the process, such as planning and control.

Since lean manufacturing and ergonomics have common objectives, it is possible to find natural points of integration (Morse, 2014), which allow identifying possible risk factors, reducing or eliminating the risk for the worker.

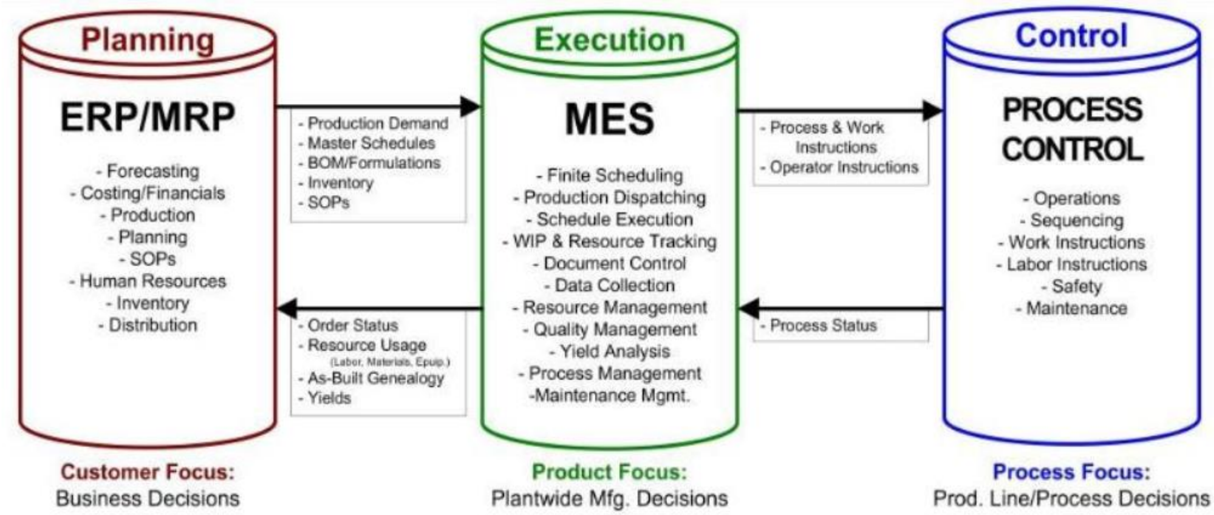

Figure 1. Relationship of an MES System in a Productive Process

2. OBJETIVES

The objective of this study is to use the OCRA® Check List and the RULA method, to determine the level of ergonomic risk present in the toner cartridge assembly stations and to present a new scanning methodology, based on the use of a system MES, allowing reduce that level of risk.

3. METHODOLOGY

3.1 Ergonomic Analysis

For this work the evaluation of an assembly line of toner cartridges was performed, considering only those stations where scanning batches of raw material and the serial number of the component assembly is effected, being a total of 5 stations, 4 assembly stations and 1 assembly and chip programming, Figure 2 shows the layout of the line and the stations included in the study marked with yellow.

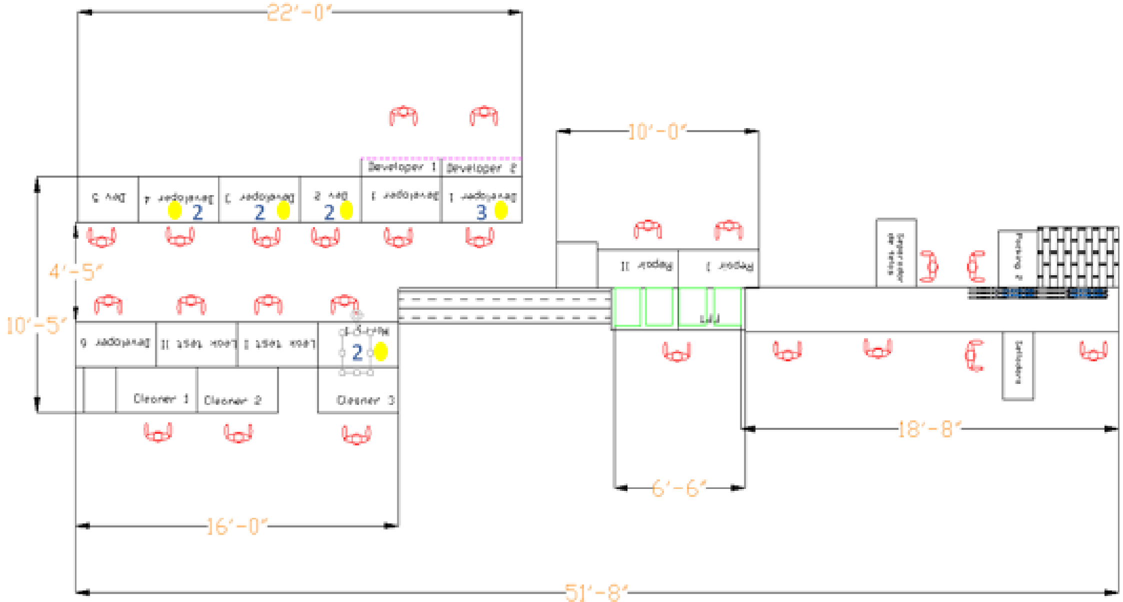

Figure 2. Analyzed line layout

OCRA® Check List, which is an abbreviated version of OCRA® method was used, this is a support tool in the assessment of risk associated with repetitive work, measuring the level of risk based on the probability of occurrence of musculoskeletal disorders in a given time, focusing on risk assessment in the upper limbs of the body (Diego-Mas, 2015). This checklist takes into consideration six aspects of the evaluated operation: time, recovery periods, frequency, posture, strength and other factors.

The online tool Ergonautas® of the Polytechnic University of Valencia, which offers a graphical interface multiple choice for each of the points to be evaluated, and the generation of the corresponding report for each evaluation was used for the application of the method, thereby generating OCRA® Check List Index (ICKL), which classifies the risk as optimal, acceptable, very light, light, medium or high, taking this reference value corrective actions are suggested, these values and recommendations they are summarized in Figure 3.

Índice Check List OCRA	Nivel de Riesgo	Acción recomendada	Índice OCRA equivalente
≤ 5	Óptimo	No se requiere	≤ 1.5
5.1 - 7.5	Aceptable	No se requiere	1.6 - 2.2
7.6 - 11	Incierto	Se recomienda un nuevo análisis o mejora del puesto	2.3 - 3.5
11.1 - 14	Inaceptable Leve	Se recomienda mejora del puesto, supervisión médica y entrenamiento	3.6 - 4.5
14.1 - 22.5	Inaceptable Medio	Se recomienda mejora del puesto, supervisión médica y entrenamiento	4.6 - 9
> 22.5	Inaceptable Alto	Se recomienda mejora del puesto, supervisión médica y entrenamiento	> 9

Figure 3. Risk Level, Recommended Action and Equivalent OCRA Index, source https://www.ergonautas.upv.es/

Postural load evaluation was performed by RULA, which allows to evaluate worker exposure to risk factors derived from a postural load and that can generate disorders in the upper limbs of the body (Diego-Mas, 2015). To make the corresponding assessment, individual positions or sequences of these are studied, in order to analyze the angles formed by each of the members studied with respect to a certain reference, the method must be applied to both sides of the body, individually.

The value obtained at the end of the analysis RULA, incise the risk involved in making certain task, so that higher values indicate a higher risk of musculoskeletal injuries, and serve to guide the evaluator on decisions to be taken once the study is finished, Figure 4 shows how the scores are obtained.

Figure 4. RULA Score Schema, source https://www.ergonautas.upv.es/

Like the evaluation with the OCRA® Check List, the RULA method was carried out using the Ergonautas® online application. These methods and tools were used to perform the ergonomic analysis before and after making changes in the scanning method of the stations.

3.2 Traditional Scan Method vs Multi-Scan Method

The original scanning procedure is called Traditional Scanning Method (MET) and the new methodology will be called Multi-Scanning Method (MME). Table 2 shows the comparison of both methods of scanning, for the new methodology, a fixed scanner has been installed on the assembly fixture, placed in such a way that it is possible to read the serial number (SN) of the piece while the operator performs the assembly.

Table 2. General Comparison, MET vs MME

Operation	MET	MME
1	The operator takes the piece that comes from the previous station.	The operator takes the piece that comes from the previous station.
2	Place the piece on the assembly fixture.	Place the piece on the assembly fixture.
3	Take the handheld scanner to scan the raw material.	The batch of raw material and the serial number of the assembled piece are read. using the fixed scanner
4	Scan the barcode of the raw material that is assembled in the cartridge.	The assembly operation corresponding to the station is performed
5	Returns the scanner to the worktable.	Send the piece to the next assembly station.
6	Takes the scanner to the SN of the assembled piece.	
7	Returns the scanner to the worktable.	
8	The assembly operation corresponding to the station is performed	
9	Send the piece to the next assembly station.	

In addition to attaching a fixed scanner to the fixtures for assembly, the logical structure that processes the information was changed; the changes made are listed in Table 3.

Table 3. Comparison of MET vs MME at Logical Level (Software)

Operation	MET	MME
1	Each scanner (two per station) is connected to a MOXA® device	A single scanner is connected to a MOXA® device
2	The scanned data is received in a TOP Server® where there are two listening channels, one for the raw material other for the SN	The scanned data is received in a TOP Server® where there is a single listening channel, through which it is possible to process both data (SN and raw material)

3	The batch of raw material is stored in an individual variable	the batch of raw material and the SN are stored in a single variable (array)
4	The SN is stored in an individual variable	This information is processed and stored to create product traceability
5	This information is processed and stored to create product traceability	

4. RESULTS AND CONCLUSIONS

By comparing the results of the Check List OCRA® analysis before and after the scanning method is changed, it is seen as the equivalent OCRA® index decreases from 9 (which represents a risk Unacceptable High) to 4 (Unacceptable Slight) Table 4 shows the results of both assessments, for each of the stations referred to in this article.

Table 4. OCRA® Checklist Results.

Station	First Evaluation		Second Evaluation	
	ICKL	OCRA® Index	ICKL	OCRA® Index
DV1	33.8	>9	14.3	4.6
DV2	33	>9	15.8	4.6
DV3	30	>9	15.8	4.6
DV4	30	>9	16.5	5
MRY	21.8	4.6	18	6

Table 5 shows the results obtained with the RULA method, where it is possible to appreciate the risk reduction associated with the postural load, in both cases, the assembly stations (DV's) show a greater change between the initial and final conditions, the station where the chip is programmed (MRY), the reflected impact is lower, but it continues to be important reducing risks for workers.

Taking these results as a reference, it is recommended a second study, focused on the analysis of the cartridge assembly operation. Additionally, it is recommended to analyze the other stations in the line, in order of continuing using the MES system to reduce the ergonomic risks for workers.

Finally, it is important to emphasize that with the implementation of the new scanning methodology, the number of scanners required in the line was reduced, which generates savings that had not been contemplated at the beginning of this work.

Stations	First Evaluation		Second Evaluation	
	Right Side	Left Side	Right Side	Left Side
DV1	4	2	3	2
DV2	7	6	4	4
DV3	7	7	4	4
DV4	7	5	4	4
MRY	7	6	6	6

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ERGONOMIC ANALYSIS OF THE WELDING LINE OF DE PEDESTAL CABINETS

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Resumen: El presente proyecto se realiza bajo la necesidad que existe hoy en día en la empresa HIRSH INDUSTRIES sobre la falta de un análisis ergonómico sobre sus estaciones de trabajo ya que se venían presentando diversas molestias por parte de los operadores relacionadas con la salud, posturas, levantamiento de peso y confort en las operaciones realizadas en el área de trabajo las cuales afectan su porcentaje de efectividad.

A raíz de esto, el departamento de Seguridad e Higiene da inicio con el programa de Ergonomía y Salud Ocupacional dentro de la empresa Hirsh Industries, contando con el apoyo del equipo presente del departamento y de practicantes de Ingeniería Industrial de la Universidad Autónoma de Baja California, el cual tiene como objetivo el analizar mediante diferentes herramientas ergonómicas las distintas estaciones de las áreas de soldadura, con la finalidad de encontrar áreas de oportunidad y proponer las mejoras correspondientes en dichas áreas adaptando las áreas de trabajo a la mayoría de los trabajadores y por consecuencia, reducir o eliminar posibles accidentes laborales como lesiones, fatigas, entre otros.

Se presentaron diferentes tipos de accidentes laborales en las distintas estaciones de las líneas de producción de la empresa HIRSH INDUSTRIES como lesiones en diferentes partes del cuerpo como espalda, hombros, cuello, piernas, así como fatiga y cansancio por realizar diferentes actividades de manera inadecuada como formas incorrectas de levantamiento de cargas y distintas posturas incorrectas, las cuales afectan a los operadores de dichas estaciones desde el año 2011.

Palabras clave: método RULA, método Suzanne Rogers y método FCD.

Abstract: The present project is made under the need that exists today in the company HIRSH INDUSTRIES on the lack of an ergonomic analysis on their work stations since they had been presenting various annoyances on the part of the operators related to health, postures, lifting of weight and comfort in the operations carried out in the work area which affect its percentage of effectiveness.

As a result of this, the Department of Safety and Hygiene begins with the program of Ergonomics and Occupational Health within the company Hirsh Industries, counting on the support of the present team of the department and of practitioners of Industrial Engineering of the Autonomous University of Baja

California , which aims to analyze by different ergonomic tools the different stations of the welding areas, in order to find areas of opportunity and propose the corresponding improvements in those areas adapting the work areas to the majority of workers and consequence, reduce or eliminate possible work accidents such as injuries, fatigue, among others.

Different types of work accidents were presented in different stations of the production lines of the company HIRSH INDUSTRIES as injuries in different parts of the body such as back, shoulders, neck, legs, as well as fatigue and fatigue due to performing different activities in an inadequate manner. incorrect ways of lifting loads and different incorrect postures, which affect the operators of said stations since 2011.

Keywords: RULA method, Suzanne Rogers method and DCF method.

Relevance to Ergonomics: Applying ergonomics through the evaluation of work is of vital importance to improve the design of your work station to minimize injuries or accidents at work and allows to develop a higher level of physical well-being for the worker, which leads to a higher level of occupational health, and even better performance.

1. INTRODUCTION

The new regulations establish the provisions that specify some of the obligations that mark the Federal Labor Law, as well as some Official Mexican Standards (NOM) issued by the Ministry of Labor and Social Security (STPS), to comply with safety and health matter.

The NOM-030-STPS-2009: preventive health and safety at work services, aims to establish the guidelines to develop and promote the Preventive Services of Safety and Health at Work and the necessary actions so that, with its application in The work center promotes a safe and healthy working environment that prevents work accidents and illnesses. [1]

Occupational health is a fundamental aspect, for any industry no matter how small, it allows the development of strategies to prevent accidents at work and also deals with studying ways or methods where the worker is also safe in the performance of their work this comfortable. [2] Thus, occupational health and ergonomics in production processes are fundamental for the operation of any industry, and for the optimization of it.

The study focuses on a company that manufactures and provides archival and storage products for personal and commercial use. Its current catalog of categories includes vertical and horizontal commercial file cabinets, cabinets for home or small office, metal shelves, file accessories, furniture ready to assemble of wood and other related items.

The company presented different types of work accidents such as injuries to the back, shoulders, neck, legs, as well as fatigue and fatigue due to not performing the job correctly, for example, when carrying out the lifting of loads and using inappropriate postures during the working day

Given this problem, it was determined to use ergonomic analysis methods for the evaluation and evaluation of work areas, such as the Rapid Upper Limb Assessment (RULA) method, the Suzanne Rogers method and the Disk Understanding Strength (CDF) method, to obtain a diagnosis about the ergonomic risk to which the worker is exposed in the welding process.

Objectives

Analyze the welding process by station of the company's products, through the application of the different ergonomic analysis tools, to propose improvements focused on avoiding or reducing the injuries and work accidents that have arisen.

2. METHODOLOGY

1. Project selection.

It was determined that the area in which the greatest number of injuries and problems of fatigue and fatigue occurred was in the welding and packing processes, for which the ergonomic conditions and the movements that are carried out will be evaluated.

2. Obtaining and presenting data

The procedure that was used was the following:

a) Observe the production line to be analyzed.
b) Take data, survey operators about how they feel at their work stations and if they have presented any injury.
c) Description of activities of the production line.
d) Filming of the production line by work station for its respective analysis.
e) Obtain medical history of the operators as well as weight and height.

According to the procedure, the following information was obtained:

- Material away from the operator.
- Inadequate provision of tools.
- Work space reduced or distributed in an inconvenient manner.
- Inadequate tool and material containers.
- Work table with opportunities for improvement.
- Inadequate operation mode (load, lift, hold, move, position).
- Rotation of staff inadequate for their various processes.
- Lack of visual aids for processes.
- Stations not designed to an adequate percentile.
- Lack of 5S's culture.
- Operator 2 delays sharing the electrode with operator 1.
- Work area at ground level (hip flexion).
- Material away from the work area for the operator 1.
- Cabinet transfer by operator 2 to station 2 (implies force wear due to elevation).

- The operator 2 has the material on the floor, there comes a time when he leans to take rack material causing a greater effort on the hip.
- Operator 2 takes his materials from another area and places them on the ground for later use (imposes a hip flexion).
- Operator 2 stresses the legs when placing part. Stretch tendons and bend knees back.
- Reduced space to move when working.
- Hip rotation of almost 90 degrees and support on knees; in other case the operator turns his body completely backwards walking in his reduced space operator 5 and 6.
- Arrangement of pieces and material at shoulder height (fatigue).
- Effort to raise the cabinet to the work table.
- Repetitive hip movement, foot movement and knee support.
- Operator 5 and 6 stretches when working with the piece and flex.
- High effort when transporting the cabinets to the welding conveyor from station 3.
- Place the turntable on the work tables with abrasive surface.
- The operator tried to load a piece of the line to the work table (approximately 1.5 meters).

3. Application of ergonomic evaluation methods

After analyzing the processes and the operators, various methodologies were applied for the ergonomic analysis as presented below:

- RULA method

One of the observational methods for the evaluation of postures more widespread in practice is the RULA method. It was developed in 1993 by McAtamney and Corlett, of the University of Nottingham (Institute for Occupational Ergonomics), with the objective of evaluating the exposure of workers to risk factors that cause a high postural load and that can cause disorders in the upper limbs. of the body. For the evaluation of the risk the adopted position is considered in the method, the duration and frequency of this and the forces exerted when it is maintained. For a certain position RULA will obtain a score from which a certain Level of Action is established.

The Level of Action will indicate if the position is acceptable or to what extent changes or redesigns are necessary in the position. In short, RULA allows the evaluator to detect possible ergonomic problems derived from an excessive postural load. [3] Figure # 1 shows the simulator of the RULA method that was used.

In the welding process in the operation of loading cabinet to the conveyor of station 2, it was evaluated with the RULA method and a grade 6 was obtained, which implies a moderate risk, as shown in figure # 2.

In the welding process, with the gauge placed in the cabinet welded the corresponding points, it was evaluated with the RULA method and a qualification was obtained 6 which implies a moderate risk, since the gauge is placed manually and has a weight of 4 kg., as shown in figure # 3.

In the welding process, after removing the gauge from the rails and accommodating it, move the piece to the line, evaluate it with the RULA method and obtain a grade 6 which implies a moderate risk, as shown in figure # 4.

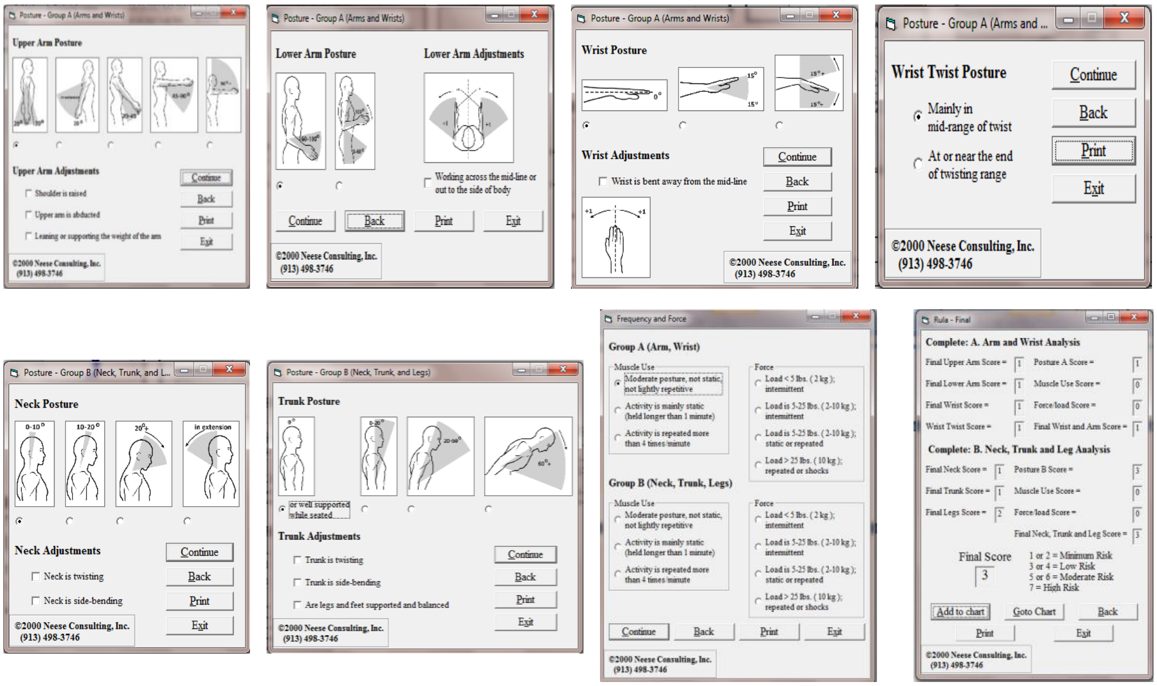

Fig. # 1. RULA Method Simulator

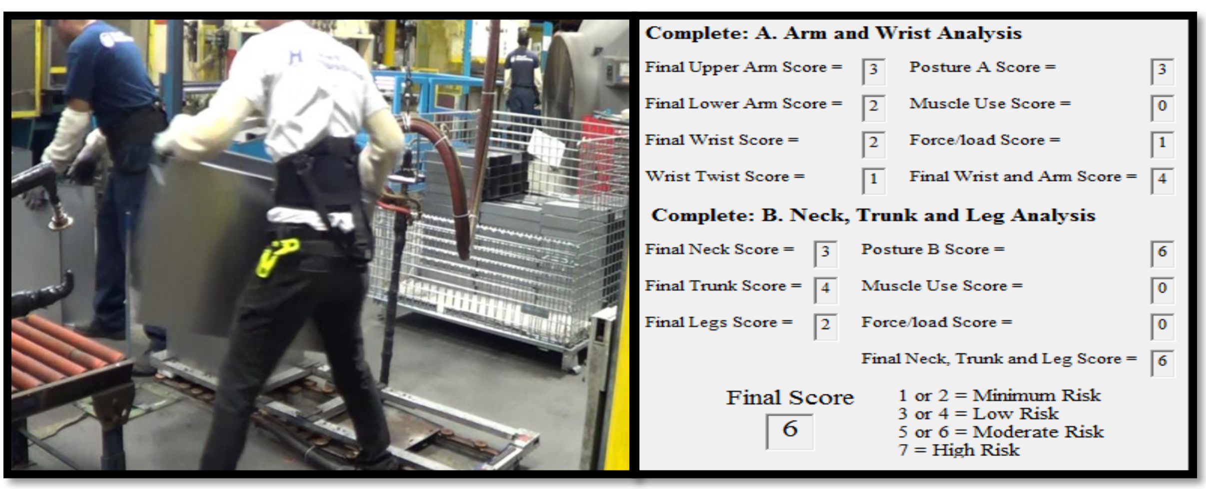

Fig. # 2. Operation: load cabinet, moderate risk.

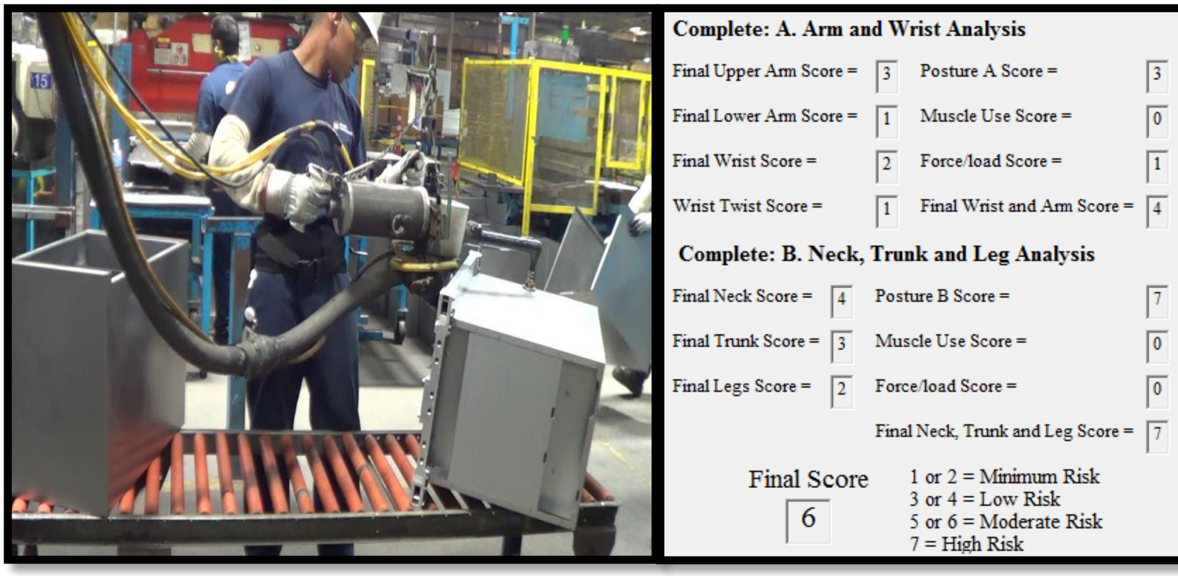

Fig. # 3. Operation: welding, moderate risk.

Fig. # 4. Operation: withdraw gauge, moderate risk.

- ROGERS method

In 1993, Dr. Suzanne Rodgers developed this method of ergonomic analysis, which is based on the study of the fatigue of the muscles of the body when performing a specific task.

The analysis of muscle fatigue was proposed by Rodgers as a means of assessing the amount of fatigue that accumulates in the muscles during various work patterns, in periods of 5 minutes of work. The hypothesis is that a muscle that is fatigued quickly is more susceptible to damage and inflammation. Seen this way, if we manage to intervene minimizing fatigue, we will also control the appearance of injuries or illness in the active muscles. This method of task analysis is more appropriate for the assessment of risk due to accumulation of fatigue in tasks performed for an hour or more, and in which there are forced postures or repeated effort.

Rodgers established the following major body groups:
1. Neck
2. Shoulders
3. Back
4. Arms-elbows
5. Dolls-hands-fingers
6. Leg-knee
7. Ankle-foot-fingers

This is an ergonomic analysis method that studies three important factors:
• The level of effort
• Its duration before relaxation (or before moving to a lower level of effort)
• The frequency of the performance of the muscles to carry out the activity

With these parameters we estimate the level of muscular fatigue that occurs in the neck, shoulders, back, arms-elbows, wrists-hands-fingers, legs-knees, ankles-feet-fingers. Figure # 5 shows the Suzanne Rodgers method that was used. [4]

In the welding process, the welding gun is taken and the necessary points are welded, evaluated with the Rodgers method and the operation was found to represent a moderate risk, as shown in figure # 6.

When placing the cabinet in gauge landed on the ground, it was evaluated with the Rodgers method and it was obtained that the operation represents a moderate risk for neck, shoulders, arms and elbows, and a high risk for back, hand, wrist, fingers, legs, knee, foot and ankle, as shown in figure # 7.

- DCF method

The Disc Compression Force Method (DCF) is the mechanical analysis to estimate the compression force that is exerted on the intervertebral discs, in order to evaluate the risk represented by the lifting of load.

This package allows us to estimate the compression force that is exerted on the invertebrate discs, in order to evaluate the possible risks of lifting loads, this is asking questions about the data of the person and the object in question, which are the following:

1. Weight of the person.
2. Height of the person.
3. Weight of the object.
4. Vertical Trunk Angle

5. Vertical Angle of the Arm.
6. Forearm Vertical Angle [4]

ANALISIS SUZANNE RODGERS								
TRABAJO:						ANALISTA:		
TAREA:		TURNO:						
NIVELES DE ESFUERZO si es un esfuerzo que la mayoria no puede hacer califique con 4						CALIFICACIONES		
PARTE	LIGERO-1	MODERADO-2	ALTO-3		ESF	DUR	FREC	CALF
CUELLO	Cabeza volteando ligeramente a un lado, atrás o levemente hacia delante	Cabeza volteando a un lado, o 20 grados hacia delante	Igual que modrado pero extension fuerte hacia atras o peso o muy flexionada hacia delante					###
HOMBROS	Brazos ligeramente alejados a los lados, brazos extendidos con	Brazos lejos del cuerpo, sin soporte, trabajando arriba de la cabeza	Ejerciendo fuerza o sosteniendo peso con brazos lejos del cuerpo o sobre la cabeza	DER				###
				IZQ				###
ESPALDA	Inclinando hacia un lado,o flexionando arqueando la espalda	Flexionando al frente; sin carga, cargando pesos moderados cerca del cuerpo, trabajando arriba de su	Cargando o ejerciendo fuerza mientras gira su columna, alto esfuerzo o peso mientras flexiona					###
BRAZOS CODOS	Brazos lejos del cuerpo, sin carga;esfuerzos ligeros cargando cerca del cuerpo	Rotando (pronación supinación de brazos) mientras se jerce fuerza moderada.	Alto esfuerzo ejercido con rotación, cargando con brazos extendidos.	DER				###
				IZQ				###
MANO, MUÑECA, DEDOS	muñecas rectas : agarres confortables	agarres con angulos de muñecas moderados especialmente en flexion con moderado	Pinzamientos frecuentes; muñeca muy estresada; alto	DER				###
				IZQ				###
PIERNA RODILLA	Trabajo parado, caminando sin doblarse o inclinarse; sostenido en sus dos pies.	Inclinandose hacia enfrente, apoyándose en la mesa; peso en una pierna; pivoteando mientras ejerce fuerza.	Ejerciendo gran fuerza mientras empuja, jala o carga; agazapado mientras ejerce fuerza	DER				###
				IZQ				###
TOBILLO PIE DEDOS	Trabajo parado, caminando sin doblarse o inclinarse; sostenido en sus dos pies	Inclinandose hacia enfrente, apoyándose en la mesa; peso en una pierna; pivoteando mientras ejerce fuerza.	Ejerciendo gran fuerza mientras empuja, jala o carga; agazapado mientras ejerce fuerza	DER				###
				IZQ				###
DURACION CONTINUA DE ESFUERZO		<6 s 1	6 - 20 s 2	20 - 30 s 3			>30 s	
FRECUENCIA DE ESFUERZO		<1 / min 1	1 - 5 / min 2	>5 - 15 / min 3			>15 / min 4	

Fig. # 5. Analysis sheet of the Suzanne Rodgers Method

ANALISIS SUZANNE RODGERS								
TRABAJO: Se Toma la Pistola para soldar y se Sueldan los Puntos Necesarios.						ANALISTA:		
TAREA: Estacion 1		TURNO:						
NIVELES DE ESFUERZO si es un esfuerzo que la mayoria no puede hacer califique con 4						CALIFICACIONES		
PARTE	LIGERO-1	MODERADO-2	ALTO-3		ESF	DUR	FREC	CALF
CUELLO	Cabeza volteando ligeramente a un lado, atrás o levemente hacia delante	Cabeza volteando a un lado, o 20 grados hacia delante	Igual que modrado pero extension fuerte hacia atras o peso o muy flexionada hacia delante		2	3	2	232
HOMBROS	Brazos ligeramente alejados a los lados, brazos extendidos con	Brazos lejos del cuerpo, sin soporte, trabajando arriba de la cabeza	Ejerciendo fuerza o sosteniendo peso con brazos lejos del cuerpo o sobre la cabeza	DER	1	3	2	132
				IZQ	1	3	2	132
ESPALDA	Inclinando hacia un lado,o flexionando arqueando la espalda	Flexionando al frente; sin carga, cargando pesos moderados cerca del cuerpo, trabajando arriba de	Cargando o ejerciendo fuerza mientras gira su columna, alto esfuerzo o peso mientras flexiona		1	3	2	132
BRAZOS CODOS	Brazos lejos del cuerpo, sin carga;esfuerzos ligeros cargando cerca	Rotando (pronación supinación de brazos) mientras se jerce fuerza moderada.	Alto esfuerzo ejercido con rotación, cargando con brazos	DER	1	3	2	132
				IZQ	1	3	2	132
MANO, MUÑECA, DEDOS	muñecas rectas : agarres confortables	agarres con angulos de muñecas moderados especialmente en	Pinzamientos frecuentes; muñeca muy estresada; alto	DER	2	3	2	232
				IZQ	2	3	2	232
PIERNA RODILLA	Trabajo parado, caminando sin doblarse o inclinarse; sostenido en sus dos pies.	Inclinandose hacia enfrente, apoyándose en la mesa; peso en una pierna; pivoteando mientras ejerce fuerza.	Ejerciendo gran fuerza mientras empuja, jala o carga; agazapado mientras ejerce fuerza	DER	2	3	2	232
				IZQ	2	3	2	232
TOBILLO PIE DEDOS	Trabajo parado, caminando sin doblarse o inclinarse; sostenido en sus dos pies	Inclinandose hacia enfrente, apoyándose en la mesa; peso en una pierna; pivoteando mientras ejerce fuerza.	Ejerciendo gran fuerza mientras empuja, jala o carga; agazapado mientras ejerce fuerza	DER	2	3	2	232
				IZQ	2	3	2	232
DURACION CONTINUA DE ESFUERZO		<6 s 1	6 - 20 s 2	20 - 30 s 3		>30 s		
FRECUENCIA DE ESFUERZO		<1 / min 1	1 - 5 / min 2	>5 - 15 / min 3		>15 / min 4		

Fig. # 6. Operation: welding points, moderate risk.

ANALISIS SUZANNE RODGERS								
TRABAJO: Colocar gabinete en gauge aterrizado sobre el suelo						ANALISTA:		
TAREA: Estación 1		TURNO: CCC						
NIVELES DE ESFUERZO	que la mayoría no puede hacer califique con 4		si es un esfuerzo			CALIFICACIONES		
PARTE	LIGERO-1	MODERADO-2	ALTO-3		ESF	DUR	FREC	CALF
CUELLO	Cabeza volteando ligeramente a un lado, atrás o levemente hacia delante	Cabeza volteando a un lado, o 20 grados hacia delante	Igual que modrado pero extensión fuerte hacia atrás o peso o muy flexionada hacia delante		1	2	3	123
HOMBROS	Brazos ligeramente alejados a los lados, brazos extendidos con algo de soporte	Brazos lejos del cuerpo, sin soporte, trabajando arriba de la cabeza	Ejerciendo fuerza o sosteniendo peso con brazos lejos del cuerpo o sobre la cabeza	DER	1	2	3	123
				IZQ	1	2	3	123
ESPALDA	Inclinando hacia un lado, o flexionando arqueando la espalda	Flexionando al frente; sin carga, cargando pesos moderados cerca del cuerpo, trabajando arriba de su cabeza	Cargando o ejerciendo fuerza mientras gira su columna, alto esfuerzo o peso mientras flexiona		2	2	3	223
BRAZOS CODOS	Brazos lejos del cuerpo, sin carga; esfuerzos ligeros cargando cerca del cuerpo	Rotando (pronación supinación de brazos) mientras se ejerce fuerza moderada.	Alto esfuerzo ejercido con rotación, cargando con brazos extendidos.	DER	1	2	3	123
				IZQ	1	2	3	123
MANO, MUÑECA, DEDOS	muñecas rectos : agarres conformable	agarres con ángulos de muñecas moderados especialmente en flexión con moderado esfuerzo	Pinzamientos frecuentes; muñeca muy estresada; alto esfuerzo.	DER	2	2	3	223
				IZQ	2	2	3	223
PIERNA RODILLA	Trabajo parado, caminando sin doblarse o inclinarse; sostenido en sus dos pies.	Inclinándose hacia enfrente, apoyándose en la mesa; peso en una pierna; pivoteando mientras ejerce fuerza.	Ejerciendo gran fuerza mientras empuja, jala o carga; agazapado mientras ejerce fuerza	DER	2	2	3	223
				IZQ	2	2	3	223
TOBILLO PIE DEDOS	Trabajo parado, caminando sin doblarse o inclinarse; sostenido en sus dos pies	Inclinándose hacia enfrente, apoyándose en la mesa; peso en una pierna; pivoteando mientras ejerce fuerza.	Ejerciendo gran fuerza mientras empuja, jala o carga; agazapado mientras ejerce fuerza	DER	2	2	3	223
				IZQ	2	2	3	223
DURACION CONTINUA DE ESFUERZO		< 6 s 1	6 - 20 s 2	20 - 30 s 3		> 30 s 4		
FRECUENCIA DE ESFUERZO		< 1 / min 1	1 - 5 / min 2	> 5 - 15 / min 3		> 15 / min 4		

Fig. # 7. Operation: place cabinet, moderate risk.

Figure #8 shows the simulator of the CDF method that was used.

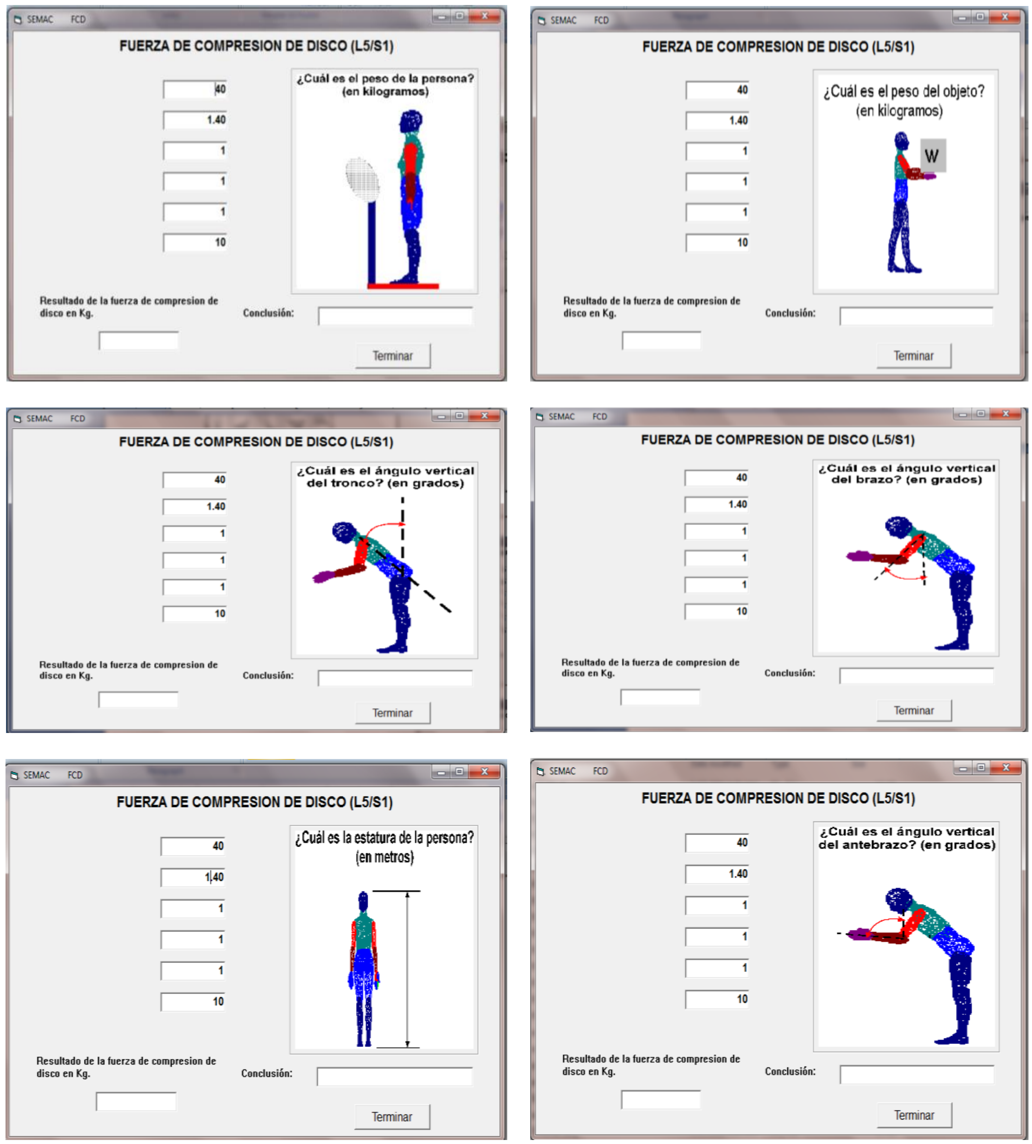

Fig. # 8. DCF Method Simulator

The operator was evaluated with the DCF method and it was found that in the lifting operation it is dangerous, as shown in figure # 9.

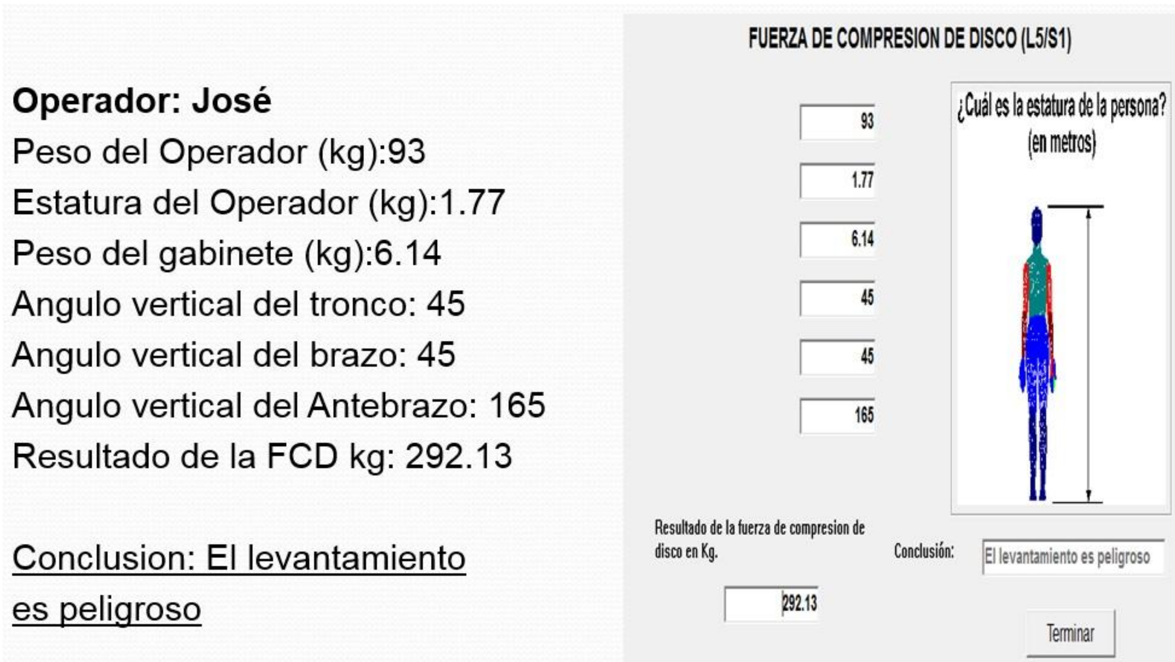

Fig. # 9. DCF method for load lifting

The operator was evaluated with the DCF method and it was found that in the lifting operation it is dangerous, as shown in figure # 10.

Fig. # 10. DCF method for load lifting

Results

- Station 1
  - Place the landed gauge on a self-adjusting surface.
  - Design a stand for U cabinets (or work one piece flow).
  - Table or container for the components
  - Hook system to load station 2.
- Station 2
  - Remove the structure where the gauge hangs and place a magnetic surface near the line to place the gauge.
  - Rotating table with anti-skid.
  - Place a hook to transport the cabinet to station 3.
- Station 3
  - Change the container by a gravity dispenser to avoid separating the rails.
  - A device to place the gauge.
  - A self-adjusting table with rollers.
  - A rotating platform, for the operator to fully rotate.
- Station 4
  - Security issues.
  - Cover the wiring of the earth (insulating tape).
  - A hook to transport the cabinet from station 3 to 4 or train a conveyor.
  - A fan for the operator.
- Station 5
  - Bring the work table closer to the conveyor.
  - Self-adjusting table.
  - Table with wheels to transport the cabinet to the line.
  - Use wrist bands.
- Station 6
  - Use a work table at a more convenient height.
  - Place a turntable on the employee 2, so that the trunk does not rotate.

Improvement in the process, correction of body postures, application of proper lifting techniques, implementation of tool improvements for a more comfortable handling, standardization of processes where the highest risks have been presented. With these proposals a reduction of 40% in work accidents is expected, a 30% increase in productivity and a 30% reduction in absenteeism, as shown in Figure # 11.

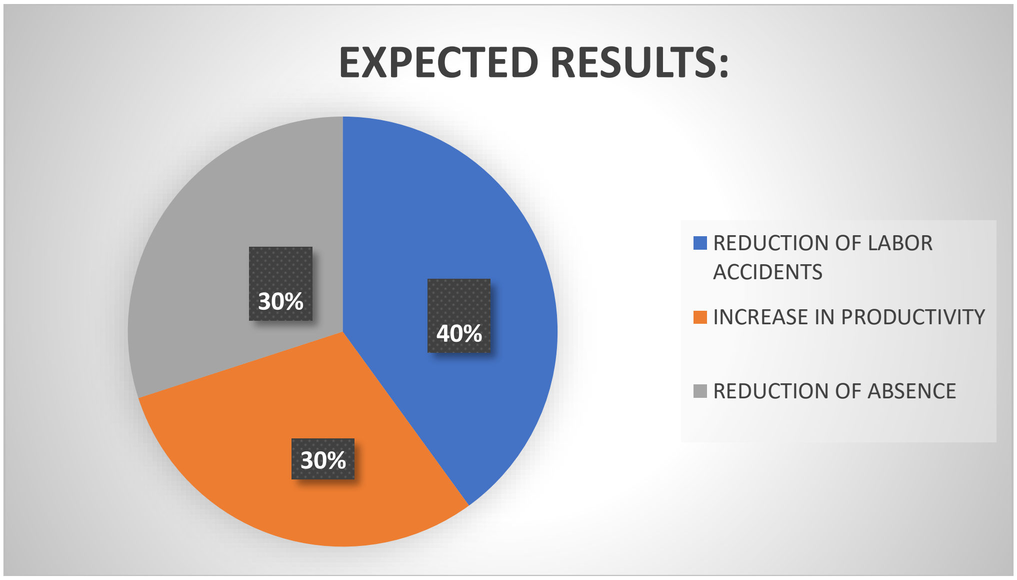

Fig. #10. Expected Results

3. CONCLUSIONS

Based on the previous observations, the analysis and the recommendations, it can be observed how the changes in the postures cause a great improvement when performing the operations in terms of problems of discomfort and pain on the part of the operator, time of process and future complications in health and accident prevention in operators. There were few changes that made much improvement, and if they were to apply in greater quantity the benefits would be much reducing the problems of health, safety and increasing productivity.

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ERGONOMIC EVALUATION IN JOBS: STUDY IN PORK PLANT

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Resumen: La presente investigación se realizó en una empresa dedicada a la elaboración de alimentos cárnicos, específicamente en el proceso de corte, con el fin de evaluar los riesgos ergonómicos que se puedan presentar, se aplicó la lista de verificación integrada y el cuestionario nórdico la cual determina la intensidad de los movimientos repetitivos de la muñeca, antebrazo y el hombro al momento de ejecutar su actividad durante tiempos prolongados y traer consigo un mayor porcentaje de lesiones en la muñeca, antebrazo y hombro. El tipo de investigación es aplicada, el diseño es no experimental transversal, alcance descriptivo, con enfoque cuantitativo. La población medida es de 20 trabajadores, para poder emitir un juicio en los resultados esperados, con el fin de obtener datos estadísticos relevantes y significativos. Los resultados del estudio ergonómico desarrollado en la empresa, se concluye que en el 85% de los operadores existe un nivel de riesgo de alto a muy alto en el lado izquierdo, mientras que en el 80% de los operadores existen las mismas condiciones en el lado derecho, esto debido a la adopción de posturas forzadas y movimientos repetitivos, por lo cual se determina que es posible mejorar el puesto de trabajo así como las posturas de los operadores, lo cual permitirá disminuir el grado de riesgo ergonómico del sujeto bajo estudio, atacando principalmente las posturas con nivel de riesgo alto a muy alto por ser prioritarias en relación a las de riesgo medio en las cuales el nivel de acción es necesario.

Palabras clave: Análisis postural, REBA, Riesgos

Abstract: The next investigation was carried out in a company that is dedicated to the elaboration of meat foods, specifically in the cutting process, in order to evaluate the ergonomic risks that may arise, an integrated checklist was applied and the Nordic questionnaire which determines the intensity of the wrist, forearm and shoulder repetitive movements at the time of performing their activity for long periods of time and bring with it a higher percentage of wrist, forearm and shoulder injuries. The type of this research is applied, the design is nonexperimental transversal, descriptive range**,** with a quantitative approach. The measured population are 20 workers, to be able to expose a judgement in the expected results, in order to obtain relevant and significant statistical data. The results in the ergonomic study developed in the Company, it is concluded that, on the left side, there is an 85% of the operators that have a risk level that goes from high to very high, while on the right side, there is an 80% of operators that are in the same conditions, this is due to the adoption of forced postures and repetitive movements by which it is determined that is possible to improve the workplace as well as the operators' postures, which will reduce the ergonomic risk of the subject under study, mainly attacking the risk postures that go from high to very high because they are priorities in relation to those of medium risk in which is necessary to be taken care off.

Keywords: Postural Analysis, REBA, Risks

1. INTRODUCTION

According to Erazo, (2014) the meat industry, in recent years, the risk study is a topic that has become very important for large and medium-sized companies that have noticed the need of carrying out human and material "improvement and accident avoid strategies" facing changes. That is why, a lot of organizations have decided to invest in the improvements in every single workplace, transforming them in nice and helpful environments for workers through norm and industrial safety planning and application once the needed studies have been carried out. From these studies, there are selected those that are urgent improvement elements as reference and support for the research development to reach and achieve the set objectives.

According to a study made in 495 meat industry companies in Spain about the risk incidence derived from performing repetitive movements in 75.24% of the positions in which there are repetitive tasks, 66.67% have suffered tendonitis, 56.76% muscle contractures in neck and shoulder, 42.34% have suffered carpal tunnel syndrome, 36.04% tenosynovitis, and in a lower percentage epicondylitis (29.73%), bursitis (24.32%), trigger finger (21.62%), cellulite (13.51%), 1.8% related to other types of injuries associated with repetitive movements and 4.5% did not know/did not answer. With regard to carpal syndrome, it can be appreciated that in 44.68% of the cases it was due to repeated hand movements, 29.79% is due to repetitive movements when using work tools such as knives, chamfering machines, etc. 25.53% is due to repeated efforts of the wrist in forced postures. 23.40% is due to repetitive work with the wrist bent, for example as in the deboning of hams. 50% of tendonitis injuries are due to repeated hand movements, 39.19% is due to repetitive movements to the use of work tools. 29.73% is produced by repetitive shoulder movements, 27.03% is due to repeated wrist efforts in forced postures and 20.27% is produced by performing repetitive work with the wrist bent. Regarding the trigger finger, 20.83% is due to pressure maneuvers with the palm or fingers, 16.67% is produced by repetitive movements when using work tools. In the case of bursitis, 29.63% is due to repetitive movements to the use of work tools (knives, chamfering machines, etc.) 18.52% of cases have been due to repeated movements of the hand.

In the case of epicondylitis, 45.45% is due to repetitive movements when using work tools, 24.24% of this kind of injuries are due to repeated hand movements. With regard to ganglia, 26.92% have been produced due to repetitive hand movements as well as repeated wrist efforts in forced postures. 23.08% is due to repetitive movements when using work tools as well as 23.08% is due to repetitive hunched doll work, (National Institute for Safety and Hygene at Work, 2005).

1.1 Problem Statement

The context motivates this investigation due to the fact that in the Company under study specifically in the cutting area, the integrated checklist was applied (NIOSH, Lifshitz and Armstrong & Kemmlert, 1995) in which were detected two production lines where the operators do repetitive movements in wrist, forearm and shoulder at the moment of executing their activity for long periods of time. According to the Nordic questionnaire (Kuorinka, et al., 1987) that was applied to the operators in the shoulder and leg lines, 55% of workers does not present any discomfort, this is mainly because they have less than a year working in the area, however 45% of workers who have more than 5 years working have presented injuries more frequently in the wrist, forearm and shoulder.
In general, it can be said that when performing repetitive movements for long periods of time, and not implementing any measure of improvement, this will result in a higher percentage of injuries to the wrist, forearm and shoulder. So the research question can be defined as: What is the ergonomic risk presented by the current conditions in the process under study?

1.2 Objective

Evaluate the ergonomic risk level, through the implementation of the REBA method, to make improvement proposals in search of ergonomic risks reductions.

1.3 Delimitations

The study was considered for 100% of the leg production line operators, considering a total of 20 operators in three processes.

2. METHODOLOGY

2.1 Type of research

This research is applied, as it was previously defined, it seeks the knowledge generation with direct application to the company problems in the area of project management, in order to improve the way to carry out the control, monitoring and measurement of the projects.

2.2 Research range

The type of range that fits the research carried out is the descriptive one, since it allows describing the situations or events, in this case describing the ergonomic risks situations that arise in the company workers.

2.3 Research design and focus

The design selected for this research is nonexperimental transversal, since the conditions were not modified intentionally and the questionnaires were applied in only one occasion. The approach is quantitative and descriptive, since the ergonomic risks will be measured, describing them only without taking correlations.

2.4 Sample

The population in which the study was based, was 100% of the 20 operators that make up the production line, divided into three types of processes: deboning, defatting and semi-degrowth, this due to the integrated checklist and the applied Nordic questionnaire was found that in this production line there are many repetitive movements, as well as pain and/or discomfort of the wrists, arms and shoulders were identified in 50% of the employees, see figure 1.

Figure 1. Evaluated operation example.

2.5 Procedure

The research development consisted in the application of the REBA method, using field sheets for each operator, for which the left and right part of each one were analyzed. Afterwards, the data of each one were analyzed using the REBA calculator from the National Institute for Safety and Hygiene at Work, which will evaluate the positions adopted by the workers in order to know the risk level (available online).

At the end, the analysis of the results were processed with statistical software. After that, we proceed to evaluate the conclusions and make recommendations for their posible implementation in the jobs used.

2.6 Materials

The instrument used to obtain information was through the field sheet of the REBA method, a camera and the processing through the REBA calculator of INSHT online.

3. RESULTS

According to the ergonomic evaluation scores with the REBA method, 80% of the workers are in High score for both left and right sides, this means that their action level requires immediate action. Likewise, 15% of the operators are at a moderate score level in the same way on both sides, for which a prompt action is required, it can be considered as the most critical process the deboning which represents 55% of the operators where the highest scores of the method were observed and 90% have high risk (see table 1 and figure 1).

Table 1. REBA process y operator scores

		REBA SCORE	
OP	PROCESS	LEFT	RIGHT
3	Semidesgrasado	11	9
6	Semidesgrasado	10	10
15	Semidesgrasado	9	9
16	Semidesgrasado	9	9
20	Semidesgrasado	5	5
7	Desgrasado	9	7
8	Desgrasado	7	7
9	Desgrasado	9	9
14	Desgrasado	9	9
1	Deshueso	9	9
2	Deshueso	10	11
4	Deshueso	11	13
5	Deshueso	11	10
10	Deshueso	10	10
11	Deshueso	11	9
12	Deshueso	11	11
13	Deshueso	7	7
17	Deshueso	10	10
18	Deshueso	10	11
19	Deshueso	9	9

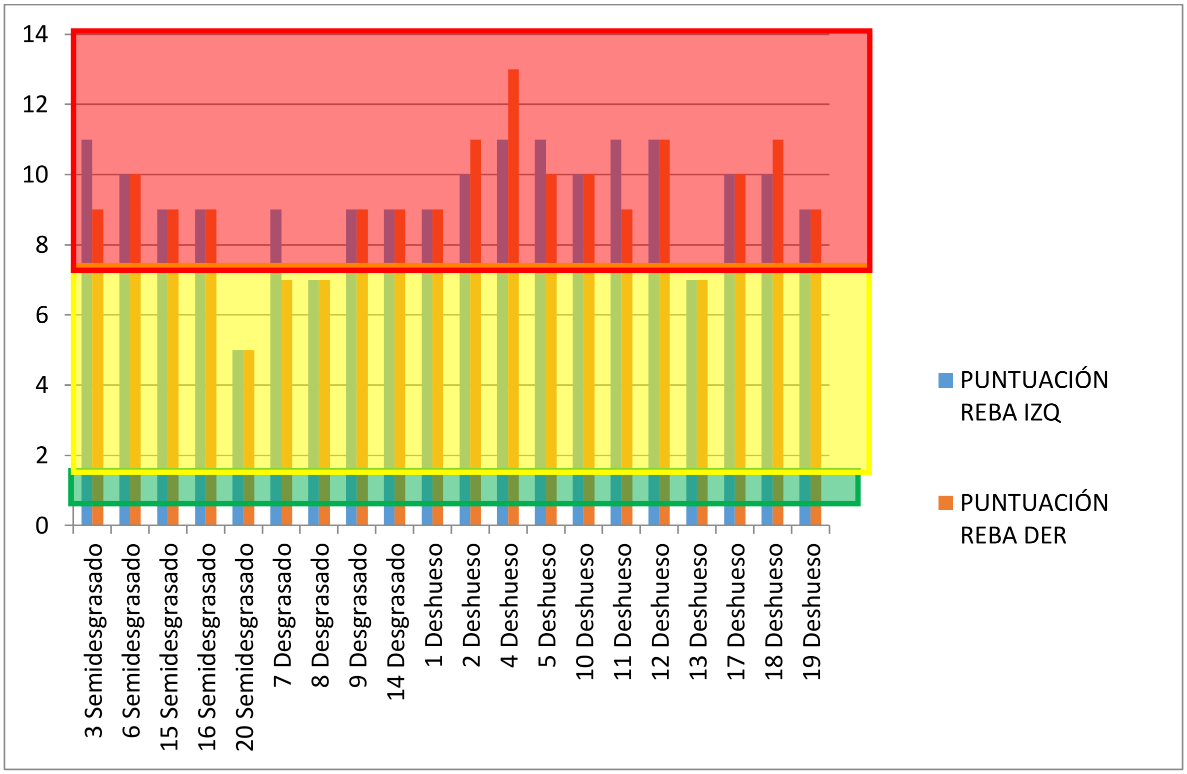

Figure 1. Risk Mapping and REBA Risk Indicators in Operational

4. CONCLUSIONS

According to the result of the ergonomic study developed in the meat pork plant, it is concluded that in 85% of the operators there is a high to very high risk level on the left side, while in 80% of the operators on the right side are in the same conditions, this is due to the adoption of forced postures and repetitive movements, for which a level of immediate action is required for the situation presented in the process studied.

The analysis of the results obtained allowed to determine that it is possible to improve the workplace with specific changes in it and also in certain postures, which will reduce the ergonomic risk of the subject under study, attacking mainly the postures with risk level high to very high because they are priorities in relation to those of medium risk which the level of action is necessary.

5. RECOMMENDATIONS

To improve the existing conditions in the subject under study, the following is proposed:

- Perform active pauses that allow the muscles and tendons of the operators to release the tension accumulated by the repetitiveness of operations during the workday and prevent the occurrence of cumulative traumatic disorders such as carpal tunnel syndrome, tendonitis, ganglions, trigger finger, etc.

- Consider the possibility of elevating the machine used to remove the leg, as well as the band and work table, which would eliminate or reduce the neck and trunk pressures, also reducing the ergonomic risk in workers, benefiting your health in the prevention of DTA'S as mentioned above.

6. ERGONOMICS CONTRIBUTIONS

Have a situation reference that prevails in the meat industry, since it is currently in a growth phase the export of these products and with it the expansion and development of companies, however it is important to consider and raise awareness about the exposures and the postures that the operators adopt, review the design of the facilities and that the equipment and furniture is adequate, in order to avoid the appearance of musculoskeletal disorders.

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EVALUATION OF LIGHTING LEVELS IN THE CORRIDORS AND WORK PLACES OF THE INSTITUTO TECNOLÓGICO SUPERIOR DE GUASAVE

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Resumen: En el Instituto Tecnológico Superior de Guasave se desarrollan diferentes actividades de trabajo que requieren niveles de iluminación específicos según las tareas realizadas en cada área. Por lo tanto, el estudio realizado tiene como objetivo evaluar los niveles de iluminación en las áreas y puestos de trabajo del Instituto. Delimitado a 193 áreas de trabajo operando en condiciones normales en un horario de 07:00 horas a 18:00 horas. La metodología que se aplicó fue con base a lo establecido en la NOM-025-STPS-2008. Como resultados se identificaron las áreas que cumple con los requisitos de dicho estándar así como las que no y las causas más comunes del incumplimiento. Después de analizar los resultados y las observaciones, se emitieron recomendaciones de acuerdo a las características de cada área evaluada.

Palabras clave: Evaluación, Iluminación, Diseño

Abstract: The Instituto Tecnológico Superior de Guasave develops different work activities requiring specific lighting levels according to the tasks performed in each area. Therefore, the aim of this conducted study is to assess levels of enlightenment in corridors and work places of this Educational Institute. Covering 193 work areas to operate under regular hours from 07:00 hours to 18:00 hours. The implemented methodology was based according to the NOM-025-STPS-2008. Obtaining the following results, the areas that fulfill the standard requirements as well as those which fail to meet the specifications including the most common causes of breaching these conditions. After analyzing the results and observations, some recommendations were issued according to the characteristics of each evaluated area.

Keywords: Evaluation, Illumination, Design

1. INTRODUCTION

It is know, that it is an obligation of companies or employers, to evaluate lighting levels in order to establish optimal conditions in each of the areas in the workplace. Which must be based according to the law NOM-025-STPS-2008 of the Labor Ministry, which seeks to maintain adequate lighting at the workplace for each worker performance, offering a safe and healthy environment. To accomplish this, it is fundamental to pay special attention to our workplace lighting, this also determines the job safety, due to sudden changes of light or glare can blind workers, therefore increases the risk of accidents and labor withdrawals. In this particular case the buildings at the Instituto Tecnológico Superior de Guasave, have detected the necessity of a certification in lighting analysis, in order to distinguish the actual lighting conditions, in order to meet the present lighting circumstances, assessing compliance with the requirements of the NOM-025-STPS-2008 which may lead a state of well-being of the staff and the students of the campus, avoiding any long term occupational risks and illnesses associated with the lighting conditions in the different work areas and corridors. The evaluation was conducted to the personnel and the facilities during regular working services from 7:00 to 18:00 hours or 24 hours a day, in the case of the security nightshifts.

2. OBJECTIVE

To evaluate the lighting conditions in the corridors and work places of the Instituto Tecnológico Superior de Guasave, to determine and fulfill the requirements of the NOM-025-STPS-2008, in order to provide a healthy and a safe environment in the implementation of the tasks that workers develop in this educational institute.

3. METHODOLOGY

In order to develop this study, it was necessary to implement the following steps:

Identification of working areas: Analyzing the original building plans and the facilities of the Instituto Tecnológico Superior de Guasave, areas of work also potential targets of assessment were identified also the characteristics of each of them, such as: dimensions, visual tasks, types of lighting (natural or artificial), among others.

Index Area Determination: According to the NOM-025-STPS-2008 and its methodology, the constant of the room, allows the evaluation of the average level of lighting in the workplace beyond a certain number of measurements and measuring points according to the constant of room K, in which the constant L is the length of the room, A is the width and H is the height of the luminaires based on the valid building plans. With the results of this method, it was possible to determine the minimum of measuring points required in each area.

Carrying out Measurements: According to what is established in the NOM-025-STPS-2008, the procedure was to collect data using a lux meter brand: CEM, model DT-1308, validating the calibration settings, certified with serial number 170301367. In areas with natural light, three measurements were made, each one of them during different times of the day in order to know the variability of a measurement. In areas without natural light, only one measurement was made during the day. Once the measurements were completed in the different corridors and work areas at the Instituto Tecnológico Superior de Guasave, the average lighting (Ep) was determined with the purpose of verifying the corresponding values when installing luminaires, taking necessary precautions so the evaluations can be managed under appropriate conditions (power supply voltage, temperature, type of lamps, etc.) or illuminance meter readings be corrected taking into account these important aspects. According to the NOM-025-STPS-2008, the estimated illumination level average for the constant room method, is performed with the following expression: Ep=1/N (ΣEi); where: Ep= lux average level, Ei= Light level measured in lux over each point and N = number of measurements carried out.

Determine the level of compliance according to the NOM-025-STPS-2008 Considering the result of the measurements average made and also compared with the minimum level of Lux established by the regulations, the areas that do not meet the minimum requirements were identified.

Developing appropriate recommendations: Referring to the observations of lighting conditions in each of the areas, such as: characteristics of the place, the activities that take place in each and one of them, among others, relevant recommendations were made in order to improve this specific environmental issue.

4. RESULTS

Once the evaluation of the lighting conditions in the work areas at the Instituto Tecnológico Superior de Guasave is completed, now it is possible to say that among the 193 areas subjected to evaluation, 156 fulfill the requirements of the NOM-025-STPS-2008 since they surpass the minimum of Lux according to the area of work, while 37 remaining areas do not meet the minimum requirements.

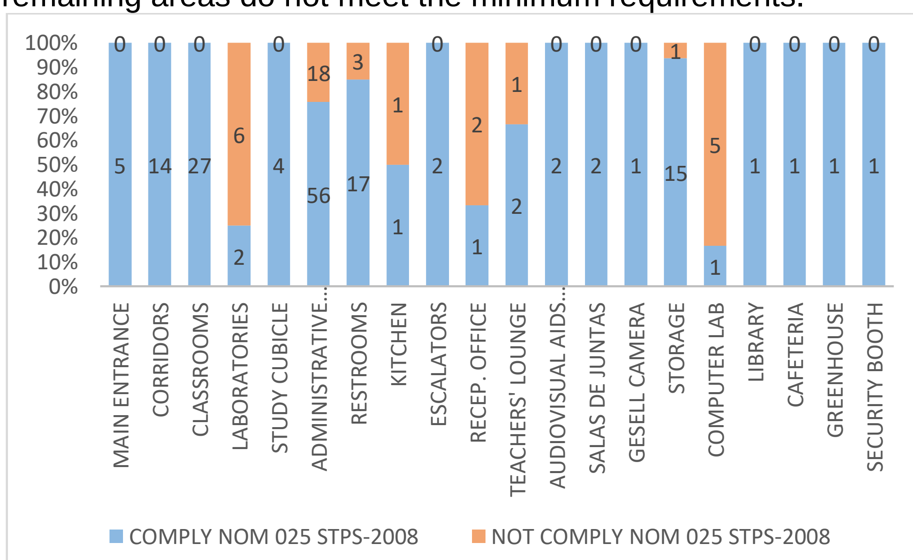

Table 1. Compliance of the NOM-025-STPS-2008 by work spaces at ITSG.

Obtaining the following result, 81% of the total areas fulfill the NOM-025-STPS-2008, 19% do not meet the requirements.

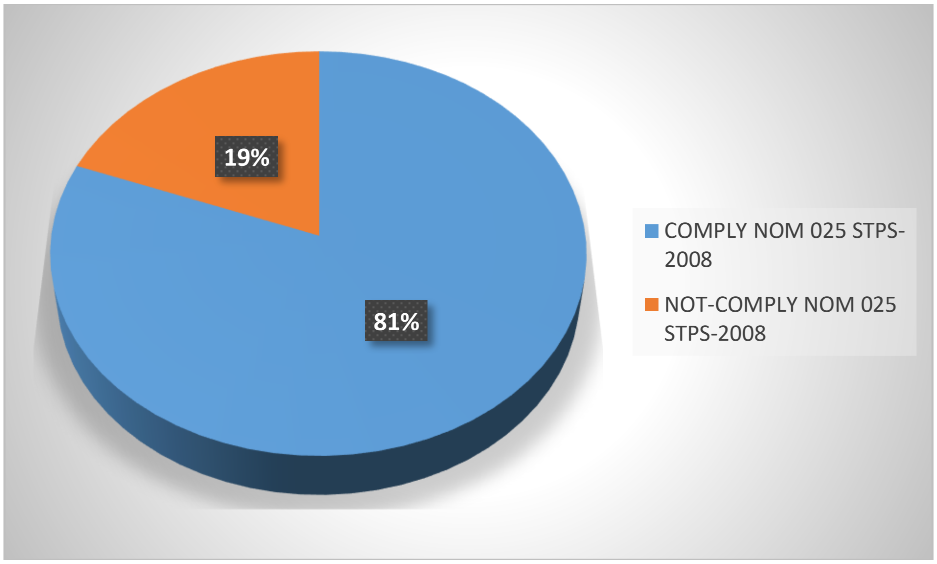

Table 2. Compliance of illumination conditions by working areas at ITSG.

According to the results obtained from areas that do not meet the standard requirements referred above, the observations made to the study, identified the main causes that affect the level of Lux inside each evaluated work area, which relies on the lack of maintenance whether the acrylic was opaque or burnt lamps, also the type of lighting installed in the area perhaps the positioning of the luminaires according to workspaces.

The result obtained as a main cause was the lack of cleanliness in acrylics with 54% of frequency.

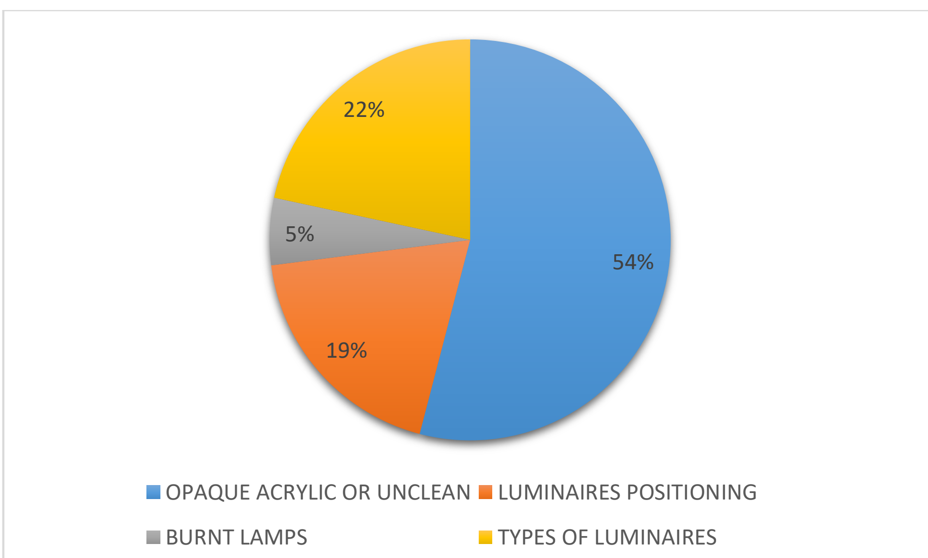

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Table 3. Main causes of non-compliance with the levels of lighting according to the NOM-025-STPS-2008.

5. CONCLUSION AND RECOMMENDATIONS

In contrast with the results obtained by Zapata, Quiceño and Arteaga (2016), which states that only 17% and 56% among the pedagogical environments under study comply with the standard technique Colombian, at the Instituto Tecnológico Superior de Guasave, 81% of the total areas fulfill the NOM-025-STPS-2008, which demonstrate the interest and concern of the Institute for occupational health, as well as the workers' improvement in the performance of daily activities. Portillo, Ortega, Guadarrama y Pulido (2014) according to Zapata, Quiceño, Arteaga (2016), the authors mention that "the visual conditions affect the attitude and the students' performance", for this reason the Institute is committed on providing the best environmental conditions for the students' benefit. The Instituto Tecnológico Superior de Guasave is certified based on the OHSAS 18001 safety management systems and occupational health, reflecting a strong interest in carrying out studies related to the safety and health of their workers in order to reduce operational risks and improve the organizational performance.

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THEORETICAL CONSIDERATIONS OF HUMAN ERROR ON QUALITY CONTROL TASKS

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Resumen: El análisis teórico de la inspección de calidad se realiza desde la perspectiva del error humano. La investigación tiene como objetivo describir algunos elementos de la actividad de inspección de calidad en la industria automotriz y se aborda el error humano, desde una perspectiva teórica, como parte inherente a la actividad.

Palabras clave: Error humano, inspección de calidad, industria automotriz.

Abstract: The theoretical analysis of quality inspection is carried out from the perspective of human error. The research aims to describe some elements of the quality inspection activity in the automotive industry and addresses human error, from a theoretical perspective, as an inherent part of the activity.

Key words: Human error, quality inspection, automotive industry.

1. INTRODUCTION

The automotive industry (IA) in the world has developed to such an extent that at the end of 2017 about 74.5 million units were manufactured, employing an approximate of 50 million people in jobs related to the automotive sector, according to data from the International Organization of Automobile Manufacturers, OICA (2018). The term automobiles is usually a reference for light vehicles, this includes passenger vehicles and light vehicles, in this last category it can be included in Pick Up, SUV, Light SUV, Crossover or Minivan, this is definitely a very dynamic segment.

The advance in manufacturing technology, in the overall design of the car, plus the financial incentives to acquire new vehicles, configure a demanding market in some segments where there are a lot of choices of makes and models, and within each model , an important variety of alternatives so that the final client can choose from.

In the AI there are very competitive markets that generate the demand for automobiles. The United States of America (USA) is one of the most important markets for this industry. If Mexico is considered as an example, according to the National Institute of Geography, Informatics and Statistics (INEGI), in 2014 more than 38% of automobile production is exported to that country, however, there are models manufactured in Mexico that practically they are destined for export.

There are high volume sales segments in the US market, where almost all brands are present, for example, the subcompact car segment accounted for 1,999,920 units in 2017. Tables 1 and 2 show the sales data for subcompacts and middle sedans.

Tabla 1. Small size sales in 2017

Make	Model	Sales USA 2017
Toyota	Corolla	329,196
Honda	Civic	377,286
Hyundai	Elantra	198,210
Chevrolet	Cruze	184,751
Nissan	Sentra	218,451

Source; Own elaboration with data from www.goodcarbadcar.net/2018/01/small-car-sales-in-america-december-2017-and-2017-year-end/

In the segment of the middle sedans, sales were 1, 774,854 units. They are two of the most competitive segments and with the greatest presence of brands, this represents a greater demand for manufacturers and is reflected by the number of options that the prospective buyer finds at their disposal.

Tabla 2. Midsize cars sales in 2017

Make	Model	Sales USA 2017
Toyota	Camry	387,081
Honda	Accord	322, 655
Nissan	Altima	254,996
Ford	Fusion	209,623
Chevrolet	Malibu	185,857

Source; Own elaboration with data from www.goodcarbadcar.net/2018/01/midsize-car-sales-america-december-2017-2017-year-end/

The number of models becomes wider as different options are incorporated, for example, engines, transmissions, clothing, etc. The availability has increased with the incursion of infotainment systems, including GPS, synchronization systems with cell phones, music players, hands-free, among other devices.

The manufacturer Ford has reacted to this and has announced a significant reduction in the number of options; from more than 35,000 to only 96 configuration options of the Fusion model, (Autoblog, 2018).

The concept of complexity in the automotive industry, especially in the final assembly, is related to the number of different options that are manufactured in the same production line, understanding as options the different versions of a type of material or component that will be installed in the unit, for example, the type of steering wheel, which may include audio system controls, option to answer the mobile phone, etc. A model such as Fusion can have more than a hundred different types of steering wheels.

The more options are offered, the higher the level of complexity of the manufacturing system, the present work addresses the theoretical components of human error in the inspection work in the area of quality control of an AI company. The assembly of the components in each vehicle has some visual aids to avoid the error or the quality defect, in Monden (2012), they refer to these as "error-proof" system, they are devices with the ability to detect faults, or to restrict the operation of a tool or to signal part of the process. Progress has been made in the methods of quality control, in Gutiérrez and de la Vara (2009), the achievements in a quality system are highlighted using the methodology "six sigma". However, the human factor, or better expressed, the quality inspector does his work depends on his visual, auditory or tactile abilities to identify defects in a finished unit, even when the quality inspector has been trained and environmental conditions are provided appropriate, the errors are presented at the time of accepting or rejecting a finished unit, colloquially referred to as "problem not found (NPF)" to the result of rejection of a unit that the defect was not found and omission when a defect is present, the inspector considers the unit acceptable. The consequences are different for each course of action, in the case of NPF, the unit is reviewed based on the reported defect, and this implies allocating additional time for inspection and repair. In the case of omission, the consequence may be more serious, the defect is detected by the final customer. Is the cause attributable to human error? The present work addresses the theoretical aspects of human error.

2. OBJECTIVES

The general objective of this study is to relate the inspection quality tasks with the theoretical conceptualization of human error.

2.1 Limitations

The study will only represent a theoretical analysis of inspection tasks.

3. METHODOLOGY

The research will be carried out based on an analysis of the available text books about the human error or cognitive analysis. The first part of the study is a description of the framework of quality control tasks within the automotive industry, the basic idea is to understand the complexity due to the great quantity of options that a manufacturer needs to produce and how it affect the quality control tasks. The Signal Detection Theory explains properly the actions taken by the inspectors. The second part is related with the understanding of human error and how the literature explains it, so there is a theoretical frame as a result of this research.

4. RESULTS

4.1 Some studies about inspection.

As the system becomes more complex, the possibilities of error in the assemblies increases, making it necessary to strengthen the quality controls and ultimately the quality inspection processes. Even though there is great technology for the manufacture of automobiles, quality inspection activities still relaying on the senses of people, basically sight, hearing and touch.

Quality inspection activities have been addressed mainly from statistical methods, in fact, the use of statistical sampling is a total inspection because it is applied once the operation has been fully stabilized, (Monden, 2012), meeting the needs maintenance of equipment and tools, most efforts to improve quality inspections are related to statistical methods, six sigma for example, however it is important to consider the inspector as part of the result.

In this sense, other approaches to improve inspection processes are related to more personal aspects of the process, in Chompu-inwai and Yajom (2010), mental fatigue is related to the results of quality visual inspections and they have found that rest periods at work are related to the decrease in mental fatigue perceived by inspectors.

The relation of the performance of the quality inspector with the personality types has also been analyzed in Hall (2014), it was found that three personality traits - consciousness, confrontation and extraversion - were statistically significant as predictors of the performance of the inspection. The strength of the association between inspection performance and each of these traits is modest, indicating that they are not sufficient to predict performance on their own.

In Hsu and Chan (1994), the importance of people in the performance of the systems is highlighted and emphasizes the role of quality inspectors that through detecting and reporting defects in the products contribute to the success of the production process. In their study they also found the relationship in some personality characteristics with the most competent inspectors, highlighting four characteristics mainly: stability, enthusiasm, sensitivity and suspicion.

In Pesante-Santana and Woldstad (2000), it is mentioned that although there have been contributions in the investigation of human factors in the understanding of human work in quality inspection activities, people are still responsible for this and it has been accepted human error as part of the inspection work and mention that only 80% of defects are detected.

4.2 Theoretical considerations about human error.

In studies for the understanding of human error and in an attempt to classify it, Swets (1961) describes four courses of action in an inspection according to the signal detection theory of (SDT) are defined as:

I. CORRECT REJECTION: the system does not detect the signal, and effectively there was only noise.
II. CONCERT: the signal was there (signal + noise) and the system detects it.
FALSE ALARM: the system thinks to detect the signal, but really there was only noise.
III. OMISSION (α): the signal was not there (noise) but the system detects it (that is, it confuses it with noise), no problem found (NPF)
IV. OMISSION (β): the signal was there (signal) but the system does not detect it.

The following table lists the actions of the quality inspector in reference to the SDT:

Table 3. SDT

Inspector action	**There is a defect**	**There is no defect**
Reject the product	Reject correct (I)	Omission (α) NPF
Accept the product	Omission (β)	Success (II)

Source; Own elaboration

In Letho and Buck (2012), they refer to the TDS model as to the comparison between the performances of the inspector in different inspection situations. When the TDS is used, it is assumed that a false alarm would correspond to an error type α in the inferential statistics models, that is, a good or non-defective product would be rejected, while when a bad or defective product is accepted, it would be incurring in an error type β. They mention four types of inspections:

- Quality assurance inspections.
- Maintenance inspections of machinery, equipment, or facilities.
- Screening of potentially dangerous materials, people, or devices before they are transported or brought into places they should not be.
- Detection of tampering or damage to shipped or stored materials.

The Cognitive Task Analysis (CTA), according to Hoffman and Militello (2008), is a methodology for the empirical study of workplaces and work patterns, resulting in:

• A description of the cognitive processes and phenomena that accompany work directed towards an objective.
• Explanations of work activity in terms of cognitive phenomena and processes.
• The application of the results to the improvement of work and the quality of working life by creating better working spaces, better support for artifacts (technologies), and by creating work methods that improve the level of worker

satisfaction, which amplify intrinsic human motivation and accelerate achievements and competition.

Currently, Cognitive Task Analysis (CTA) is considered by research organizations around the world to be, not only an important component of research and development efforts for complex man-machine systems, but a necessary component because the work that is being analyzed is of cognitive work.

Human Error Theory

Once task analysis has been completed, human error identification (HEI) can then be applied to consider what can go wrong. According to Kirwan (in Wilson and Sharples, 2015), human error has been defined as follows:

Any member of a set of human actions or activities that exceeds some limit of acceptability, i.e. an out-of-tolerance action where the limits of human performance are defined by the system.

"Such a definition gives rise to the following overt error types that should be considered during any human error analysis:

- *Omission error* – failing to carry out a required act
- *Action error* – failing to carry out a required act adequately:
  - Act performed without required precision, or with too much/little force
  - Act performed at the wrong time
  - Act performed in the wrong se*quence*
- *Extraneous act* – unrequired act performed (also called error of commission [EOC])

This classification tells us neatly what can happen, but gives little indication as to the causes or remedies for such errors. It also fails to capture the notion of different types of behavior and error forms in terms of different causes and internal or cognitive failure mechanisms, and the important notion of intentionality of error, that is, that some errors are intentional (e.g. due to a misunderstanding of the situation) and others are not."

To understand the term human error, it is important that we realize that when we say that an error has occurred, we are making a judgment comparing, explicitly or implicitly, the so-called error with some standard or performance criterion. That is, without a comparison it is not significant to say that an error has been made, even if the result is not desirable; it can only be said that there is an error if there is a clear performance standard to define the criteria for an acceptable response or result.

Human Error as Cause

In our daily language, we often say that an undesirable event occurred because of human error. In this context, the term human error is used with a denotation of being the cause of an event. Logically and philosophically, such a denotation represents a reverse causality (i.e., reasoning from effect to cause).

In Deckker (2014), present a new view about human error, basically looks for what is responsible instead who is responsible, sees the human error as a symptom not a cause, the human error is just the starting point to investigate and the human error is systematically connected to features of people's tools, tasks and operating environment.

5. CONCLUSIONS

The human error has been studied from different perspectives but usually in complex systems, where there is a risk for accidents, and there are some definitions about errors. The quality inspection has been studied from the behavior and other organizational elements, so it is pertinent to join the concepts and definitions on the study of the human error in quality inspections not only in manufacturing causes, it includes the SDT, cognitive analysis and the human error theory. It made possible to study some brain patterns using EEG technology to understand in a better way how a human error occurs.

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Musculoskeletal disorders and ergonomic factors in medical visitors of a pharmaceutical company

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RESUMEN: Los trastornos musculoesqueléticos (TME) causados por factores de riesgo ergonómicos (enfermedades del trabajo) son uno de los problemas de salud laboral más relevantes.
Objetivos: identificar la prevalencia de trastornos musculoesqueléticos asociados a factores ergonómicos en visitantes médicos en una empresa farmacéutica en Quito, en 2017.
Metodología: fue una investigación cuantitativa, transversal y comparativa, que inscribió a 78 visitantes médicos realizados en 2017, en una empresa farmacéutica. Se aplicaron criterios de inclusión y supresión, además de consideraciones éticas. Se utilizó el cuestionario nórdico, así como la lista de verificación de Ocra y Reba. Para procesar los resultados se utilizó un paquete cibernético SPSS; se obtuvieron promedios, desviaciones estándar y promedios aritméticos.
Resultados: el trastorno más relevante encontrado fue dolor lumbar con 23.07%, dolor de cuello 15.38%; dolor de espalda 14.10%, síndrome del túnel carpiano con 10.25% y tenosinovitis radial de Quervain 3.84%. El factor ergonómico más frecuente encontrado fueron los movimientos repetitivos 76.92%, las posiciones forzadas 58.97%. Se recomendó un programa de trabajo con descansos, así como una propuesta para rediseñar y mejorar las condiciones de trabajo.
Conclusiones: es necesario un especialista en salud ocupacional, destinado a implementar programas relevantes destinados a reducir el riesgo de sufrir TME.

PALABRAS CLAVE: Lista de Verificación Ocra, Reba, Trastornos Musculoesqueléticos, Visitantes Médicos.

ABSTRACT: Musculoskeletal disorders (MSD) caused by ergonomic risk factors (work diseases) are one of the most relevant work health troubles.
Objectives: Identify prevalence of musculoskeletal disorders associated to ergonomic factors in medical visitors in a pharmaceutical company in Quito, in 2017.
Methodology: It was a quantitative, transversal and comparative investigation, enrolling 78 medical visitors conducted in 2017, in a pharmaceutical company. Inclusion and suppression criterion were applied, in addition to ethical considerations. The Nordic questionnaire was used, as well as Ocra check list and Reba. In order to process results a SPSS cyber package was used; averages, standard deviations and arithmetic averages were obtained.

Results: The most relevant disorder found were low back pain with 23.07%, neck pain 15.38%; back pain 14.10%, carpal tunnel syndrome with 10.25% and Quervain's radial tenosynovitis 3.84%. The most frequent ergonomic factor found were repetitive movements 76.92%, forced positions 58.97%. A work programme with breaks was recommended, as well as a proposal to redesign and improve work conditions.
Conclusions: An occupational health specialist is necessary, intended to implement relevant programs intended to lower the risk of sustaining MSD.

KEYWORDS: Ocra Check List, Reba, Musculoskeletal Disorders, Medical Visitors.

1. INTRODUCTION

Ergonomics is a method addressed to find out diverse postures adopted by workers during the conduction of their tasks. Observation is used for such purpose. Posture refers to the position applied by a part of the human body to execute a static task. Such tasks cause a muscle to contract, which last for long, which in turn causes malaises, such as pains, tingling, muscle tremors and others, greatly affecting labor performance by workers. (S. Asensio-Cuesta, D. Diego-Mas, J. Alcaide, 2010).

Montalvo, Cortés, & Rojas (2015), Callizo (2015) describe ergonomy as "Preventive technics intended to address risk factors, mainly due to work loads and the organization".

The term elapsed between the worker's exposure to the risk and the onset of the professional illness is the latency period.

Such pathologies are prevalent since the beginning of every activity and across time, they ought to be seriously assessed, due to the fact their effects are evident in the short term and increase, and are caused by the exercise of the work itself, (Agila-Palacios, Colunga-Rodríguez, González-Muñoz, & Delgado-García, 2016) (OSHA, 2014).

Pursuant to Cavas (2016) a professional disease is "acquired by exercising labor activities made for the benefit of others or for oneself". When considering such an aspect in the investigation, it was intended to find out problematic faced by medical visits in real time and ergonomic precautions that can be taken during labor performance.

Ergonomics risks in the health field refer to labor conditions and activities to be developed by observing adequate precautions to prevent pathologies that affect and damage health, and labor performance. Physical conditions offered by the establishment to workers are vital for their good labor performance, which is translated into physical and emotional wellbeing, (INSHT 2014).

Medical visitors are exposed to diverse risk factors, especially the ergonomic ones, possibly due to lack of information on technics to be used during work, which can affect health, with a temporary or permanent deterioration of workers' health, which influences in the completion of organizational and personal goals and objectives (Agila-Palacios, Colunga-Rodríguez, González-Muñoz, & Delgado-García, 2016).

Musculoskeletal disorders can be seen in people of both sexes and any age, mostly at ages of the highest economic productivity; they are generally related to inadequate conditions prevalent in the work site (Gómez, González, Franco, 2018); hence, objects, jobs, machines, equipment and tools, with inadequate weight, size shape and design cause physical fatigue and bone-muscle disorders and are considered risk factors (Oñate, Chica, Jaraba, & Jaraba, 2015).

In the 4th European survey on labor conditions, it was reported that millions of workers sustain musculoskeletal disorders (MSD) caused by work, which have extended to all industry sectors.

More than a third of European workers suffer from MSD related to their job. A 24.7% of workers have reported back ache and 22.8% sustain muscular pain in their shoulder, neck and/or lower limbs; hence, 60 million workers reported having sustained MSD in Europa. Hence, in the European Union (EU), the back ache seems to be the most frequent labor health trouble, followed by overall fatigue with 22.5% and stress with 22.3% (Eurofound, 2015).

In regard to musculoskeletal disorders, pursuant to Gómez-Ceballos (2016), it is deemed to be the most relevant cause for labor absenteeism, which can impoverish workers and their families, reduce productivity and labor capacity, and greatly increase health care expenses. Additionally, Bettiol, 2016 (as cited by Sbriller 2016), stated that people, that due to the aftermaths seriousness were not able to continue with their labor trajectory, were unregistered.

Pereira, Da Silva, & Domínguez, (2016) stated there are factors that contribute to lumbago, among them “individuals, age, sex, body mass index, muscle unbalance, muscle strength, socioeconomic conditions, coexistence of other diseases and other labor factors”, which were exposed by this investigation work.
Arenas and Cantú-Gómez (2013) stated that workers in all countries of the European Union sustain a certain musculoskeletal malaise imputed to postures and efforts derived from work –low back, neck and high back, are the most frequently reported (40.1; 27.0 and 26.6 %, respectively)

Escudero, Aprili, Muñoz, De La Cruz, & Moscoso (2016), concluded that the carpal tunnel syndrome of labor origin is frequent in dentists and is related to intense manual efforts, forced manual positions, repetitive movements and the operation of hand-held vibratory and pressure tools that effect their wrist and hand, -so was stated by Hodelín, De los Reyes, Hurtado, & Batista (2016), showing that repetitive movements during a long period can cause compression of the median nerve.

In Ecuador, pursuant to Instituto Ecuatoriano de Seguridad y Salud (IESS)’s report 2014, 80 thousand work accidents were reported per year, 60 thousand professional diseases, such as hearing loss, loss of visual and smell capacity, musculoskeletal disorders and diseases for psychosocial risk factors, considering that most of them were due to a deficient management of the occupational safety.

2. GENERAL OBJECTIVE

Identify prevalence of musculoskeletal disorders associated to ergonomic factors in medical visitors of a pharmaceutical company of Quito during 2017.

3. DELIMITATION

A pharmaceutical company located in Quito city, pursuant to a study conducted during the last semester of 2017.

4. METHODOLOGY

In relation to the study, professional information was sent from medical visitors, discriminating gender, age, labor experience, work hours per day, type of activity and clinical symptoms of musculoskeletal disorders, such as pain, burning, paresthesia, numbness, weakness, lack of coordination, disesthesia, low pressure, scarce sensibility, itching, scarce proprioception and join pain. Medical visitors sustaining diabetes, rheumatoid arthritis, ill thyroid gland, fractures, diagnosis of a musculoskeletal disorder were excluded, and the universe was finally composed by 99.78 of medical visitors.

The investigation was conducted in three phases: in the first phase of the work the Kuorinka's Nordic questionnaire was applied in work places, with prior explanation of procedures. Afterwards, data were processed by using SPSS statistical software.

Second phase: An evaluation was conducted of ergonomic factors by applying Ocra Check list, Reba. (S. Asensio-Cuesta, D. Diego-Mas, J. Alcaide S. Asensio-Cuesta, D. Diego-Mas, J. Alcaide, 2010)

Third phase: data were analyzed by using the square chi test and the t-test with SPSS software ($p < 0.05$).

Inclusion criteria were applied such as: enrollment allowed for workers aged between 18 and 65 years, with a stay of 6 months or more as a plant worker in the establishment.

Exclusion criteria: labor stay of less than six months; having reported baseline pathologies, such as (rheumatoid arthritis, diabetes mellitus, hypothyroidism; pregnant medical visitors or in their menopause phase, remittance to their work after vacations, rest or due to a medical prescription for any pathology.

Ethical considerations were additionally applied. No interest conflict was found.

5. RESULTS

Investigation results were classified in phases. In the phase a pilot sample was prepared to validate measurement methods.

Out of 99 people working for the company, after applying exclusion criteria, measurement methods were applied to 78 medical visitors, 8 of them were administrative personnel, 5 were men and 3 were women, with average ages of 28 years, different from medical visitors, where there was a higher presence of men with an average age of 31 years. For administrative personnel, the labor shift was 8 hours a day from Monday through Friday; while for medical visitors their labor shift was up to 12 hours a day.

In respect to physical characteristics of medical visitors, 92.30% (n = 72) are right-handed; as per the body mass index 54.2% are in their normal range and a remarkable 25.64% (n = 20) are within overweight.

In respect to preexistent medical conditions, 17.94% (n = 14) declared having submitted general information on any diseases in the last 24 months and 8.97% (n = 7) having undergone a certain surgery during their life term. Consumption of tobacco was reported in 9.87%, alcohol consumption 76.92%, the practice of a sport 38.46%.

When a risk matrix was designed, it was found that the most relevant ergonomic factor was repetitive movement 76.92% in almost all jobs, both operating and administrative ones, and forced positions in 58.97%.

Table 1. Ergonomic risk factors and job

Job	Ergonomic risk factor		
	Repetitive movement	**Forced Postures**	**Manual handling of load**
Medical Visitor	High	Medium	Low
Warehouse Keeper	High	Medium	Low
Secretary	Medium	Medium	Low
Accountancy	High	Medium	Low
Janitor	Medium	Medium	Medium

Source: Investigation Data. Prepared by Guerrero, 2018

Table 2 contains medical visitors pursuant to Ocra check list, an unacceptable medium risk (15) for repetitive movements and for forced postures in the analysis; pursuant to REBA it is a medium risk (scoring 5). Additionally, it can be seen that warehouse personnel sustain an unacceptable medium risk (17) with the Ocra check list, with Reba score of 5, equivalent to a medium risk.

Table. 2 Job, Ocra check list and Reba

JOB	ACTIVITY	ERGONOMIC FACTORS			
		REPETITIVE MOVEMENT		**FORCED POSTURE**	
		Ocra Check list		**Reba**	
		L.D	**L.I**	**L.D**	**L.I**

MEDICAL VISITOR	MEDICAL VISIT	**13** Lightly inacceptable	**15** Unacceptabl e medium		**5** R. Medium
MEDICAL VISITOR	MEDICAL VISIT	**13** Lightly inacceptable	**13** Lightly inacceptable		**5** R. Medium
ADMINISTRATIVE	SECRETARY & ACCOUNTANCY	**10** Very light	**10** Very light		**4** R. Medium
	WAREHOUSE	**17** Unacceptabl e medium	**13** Unacceptabl e Light	**4** R. Medium	**5** R. Medium
	MANAGEMENT	**10** Uncertain	**10** Uncertain		**4** R. Medium
	CLEANING	**14** Mild inacceptable	**12** Mild inacceptable	**4** R. Medium	

Source: Investigation Data. Prepared by: Guerrero, 2018

While applying the Ocra Check List, the postural load during the performance of tasks was found high, in relation to repetitive movements, such as incorrect ways of grasping, breaks or unproductive breaks in almost all activities conducted daily.

During a medical visit, they should remain standing for most of the journey, 89.74% (n =70) and walk, 87.17% (n = 68).

Regarding factors associated to the health condition: 2.8% (n = 2) referred a disease related to the performance of the life job, 3.7% (n = 3) an accident or incident with minor injuries related to the work.

The most frequent disorder was lumbago with 23.07%, neck pain with 15.38%, back pain with 14.10%, carpal tunnel syndrome with 10.25%, Quervain's radial tenosynovitis 3.84% for 12 months; 7 injuries caused hindrance, and greatly decreased presentation at 7 days with a total number of 4 and out of them, the highest percentage of personnel maintains the low back pain.

Table. 3 Musculoskeletal disorders in medical visitors: 12 months and 7 days, malaises and hindrances

Anatomic Parte 12 months	**TWELVE MONTHS**				**7 DIAS**	
	Malaises		**Hindrance**		**Malaises**	
	Frequencies	%	Frequencies	%	Frequencies	%
Neck	12	15,38	1	1,28	1	1,28
Men	8	10,25	0	0,0	0	0,0
Elbow	0	0,0	0	0,0	0	0,0
Hands	11	14.10	0	0,0	0	0,0
High back	11	14,10	2	2,56	2	1,28
Low back	18	23,07	4	5,12	4	2,56
Thigh	0	0,0	0	0,0	0	0,0

Knees	5	6,41	0	0,0	0	0.0
Angle	1	1,28	0	0,0	0	0,0
No symptoms	**12**	9,36	71	91,02	71	94,87
	78					

Source: Investigation Data. Prepared: Guerrero, 2018

When analyzing musculoskeletal disorders causing malaises in twelve months and Ocra Check List disorders, a medium risk was found (between 14.1 and 22.5), with a 23.07% for low back pain, with an average of 1.2 and p = 0.53, for hindrance. The affected personnel is of less than 5.12 (4), in relation to 7 days, a noticeable decrease of 8.97% (7) was found for malaises.

Table 4. Musculoskeletal disorders: Malaises 12 months and Ocra Check List index.

OCRA CHECK LIST INDEX		**MUSCULOSKELETAL DISORDERS 12 months**															
RISK		**Neck**		**Shoulder**		**Wrist**		**High Back**		**Low back**		**Knees**		**Ankle**		**NO**	
		FRE	%	FRE	%	FRE	%	FRE	%	FRE	%	FRE	%	FRE	%	FRE	%
Less or equal to 5	Optimum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	15,38
From 11.1 to 14	Light unacceptable	0	0	8	10,25	11	14,10	11	14,10	18	23,07	5	6,42	1	1,28	0	0
From 14.1 to 22,5	Medium unacceptable	1	1,28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		**78**															
		X^2 1.2696										***P = 0.53***					

Source: Investigation Data. Preparation: Guerrero, 2018

Table 5. Musculoskeletal disorders: Malaises 7 days and Ocra Check List index.

OCRA CHECK LIST		**MUSCULOSKELETAL DISORDERS 7 DAYS**							
		FRE	**%**	**FRE**	**%**	**FRE**	**%**	**FRE**	**%**
RISK		**Neck**		**High Back**		**Low Back**		**NO**	
Minor or equal to 5	Optimum	0	0	0	0	0	0	71	91,02
Between 14.1 and 22.5	Medium Unacceptable	1	1,28	2	2,56	4	5,16	0	0

Source: Investigation Data. Prepared by: Guerrero, 2018

6. CONCLUSIONS AND RECOMMENDATIONS

In the initial diagnosis of the investigation applied to personnel by using the Nordic questionnaire, ¾ parts of medical visitors were found with a certain type of musculoskeletal affectation sustained since 1 year ago. Such result is alarming if we consider it is supposedly a light work; of course, there is a clear decrease in the report of malaises at 7 days. The parts of the body reported affected, directly match with inadequate postures adopted to develop labor activities.

By observing results for medical visitors, improvements are recommended for that job, as well as medical supervision and training.

A work program with breaks was recommended, as well as redesigning and improving work conditions was proposed.

For jobs related to secretariat and accountancy, as well as for the management position, a new analysis or enhancement was recommended for such jobs. For the warehouse keeper and janitor, an improvement of the job is recommended, as well as medical supervision and training.

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