VERIFICATION OF MAXIMUM ACCEPTABLE WEIGHT OF LIFT, TABULATED IN LIBERTY MUTUAL TABLES, IN WOMEN OF CABORCA

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RESUMEN: Esta investigación se realizo con la intención de verificar la aplicación de los datos, de peso máximo de levantamiento (MLW), tabulados en las Tablas Liberty mutual, en la población laboral femenina de Caborca, Sonora, México. El experimento se limito a tareas de levantamiento vertical, frecuencia de uno por minuto, cajas de 34 cm de ancho (distancia desde el cuerpo), distancia de movimiento 51 cm, en tres niveles de levantamiento, bajo, que corresponde a levantamientos entre el suelo y la altura de nudillos, medio, de altura de nudillos a altura de hombros y alto, de altura de hombros a brazo extendido. Ésta fue realizada con alumnas estudiantes del programa de Ingeniería Industrial y de Sistemas adoptando el supuesto de que ellas pudieran estar formando parte de la fuerza laboral de las empresas establecidas en la región. Como resultado de este experimento se observo que los peso máximos tabulados en la Tabla Liberty Mutual para tareas similares a las de este experimento, son cuantitativamente mayores y existe evidencia estadística suficiente para rechazar que se pueden aplicar a la población laboral bajo estudio.

Palabra clave: levantamiento de carga mujeres, tareas de levantamiento mujeres, máxima peso aceptable

ABSTACT: The intention of this investigation was verify the application of maximum lifting weight data tabulated in the Liberty Mutual Tables (MLW), on the female labor population of Caborca, Sonora, Mexico. The experiment was limited to vertical lifting tasks, frequency of one per minute, boxes of 34 cm of wide (distance since the body), distance of movement 51 cm, in three levels of

lifting, low, that corresponds to lifting among the floor and the height of knuckles, medium, of height of knuckles to height of shoulders and high, of height of shoulders to arm extended. This investigation was done with 14 students, female gender, of the program Industrial and Systems Engineering, with the assumption that they could be part of the workforce of firms established in the region. As a result of this experiment was observed that the information of maximum acceptable weight tabulated in liberty mutual tables for similar tasks this experiment are quantitatively greater and there is sufficient statistical evidence to reject that we can apply it to working population under study.

Keyword: women lifting weight, women lifting tasks, maximum acceptable weight

1. INTRODUCTION

Webster et al (1994) suggest that low back pain, associated with manual handling of loads, has been recognized as a major problem worldwide is the most costly injury in the industrial world. De la Vega (2006), citing The National Institute for Occupational Safety and Health (NIOSH) 1991, indicates the factors that directly influence the risk of lower back injuries are the weight and dimensions of the object, the distance is raised, lowered, pulled or pushed, and the repetition rate, as well as indirect factors such as age and physical condition of the worker. The consequences of ignoring the weight limit on the repetitive handling of loads can result in decreased performance at work and presents a risk of back pain that can become a cumulative trauma disorder (CTD) Putz-Anderson (1994). There are some studies about amount of weight that an individual is capable of lifting and about task design of the handling manual of loads with minimal risk of injury considering their characteristics and physical abilities. The reports of these studies represent guides to the industry which requires manually moving loads repeatedly. Among the most widely used guides include the NIOSH equation and the Liberty Mutual tables. The first is a tool through which, considering 7 factors involved in a lifting task, calculate the recommended weight limit (LPR) and, once known, is calculated the Lifting index that he is the ratio between the load weight and the recommended weight limit. The values that can take this index may fall into three risk zones, namely: limited risk (lifting index <1) where the majority of workers performing these tasks should have no problems, moderate increase in risk (1 < lifting index <3) situation in which some workers could suffer illness or injury when performing these tasks same should to be redesigned or assigned a selected workers on which shall be strictly control; sharp increase in risk (lifting index>

3), this type of task is unacceptable from an ergonomic standpoint and should be changed. Moreover, the Liberty Mutual Company has developed the Liberty Mutual tables or tables of Snook which are a collection of tables which sets the maximum acceptable weight for help to control the risk of injury in the lower back in activities of manual handling of loads. In particular for lifting load, use the frequency of the task, the distance of movement of the load, the height at which the movement is placed, the size of the object and its grips and the horizontal distance (distance from the body) like parameters. With these parameters, the maximum acceptable weight it is tabulated in 10, 25, 50, 75 and 90 percentiles for male and female peoples. These studies and the respective conclusions were generated from the experimental data obtained of developed workers populations countries and the findings and their recommendations they are apply in Mexico without considering that data were obtained without including the characteristics and physical abilities of the Mexican population.

In the Mexican Republic from 1992 to 2002 the Mexican Social Security Institute reported cases of 191.639 spine injuries, including back pain, accounting for 4.7% of total workplace injuries. Likewise, there is 42.422 dorsopatias with total disability in the period reported, including low back pain associated with lifting loads, representing 18.98% of total disability (Review IMSS 2004), which indicates the relevance of the lesions of the spine. From the above, born the need to conduct this study which seeks to identify injury risks in applying the criteria of acceptable loads in the female population in Caborca, Sonora, Mexico, on grounds that it may be a cause for lower back pain that result of the manual materials handling, a problem that is occurring more often in companies. This raises the question "The maximum acceptable weight, reported by the Liberty Mutual tables for women, applies to women workers of Caborca? About this question the present investigation was made and it focuses only on tasks of vertical lift in frequency of one per minute, boxes width 34 cm, (distance from the body), movements 51 cm distance and three levels lifting: low , corresponding to uprisings between the ground and knuckle height, medium level, from height to knuckle to shoulder height and from shoulder height to arm's length.

2. OBJETIVE

The objective of this study is to identify risks in applying the criteria of maximum acceptable charges Liberty Mutual tabulated in Tables in the female working population Caborca, Sonora,

Mexico, because it can be one of the causes of lower back pain , resulting from manual material handling, is a problem that is occurring more often in business. This led to pose the question "The maximum acceptable weight women, the tables set by Liberty Mutual, is applicable to workers in Caborca?

3. MATERIALS AND METHODS

Details of the experiment, from where the Liberty Mutual Tables were made, it is found in the publications of Ciriello et al 1983, 1990 and 1991. The experiment was conducted using psychophysical approach. This approach requires that the subject is motivated by an incentive, and He,based on the perceived sensations, select the maximum load that it considers may sustain for a working day of 8 hr. According to Shoaf (1997), the major hypothesis of the psychophysical approach is that: at a given time, adjusted to 40 minutes, a person is able to predict the maximum weight or force that could be manipulated during a period of 8 hr; Mital (1983) states, people can estimate the amount of weight that can lift comfortably in 8 hr, based on experiencing fatigue in 25 min and, hopefully, the weight selected by the subject is the same whether the person continues lifting it for 8 hr; Additionally, he states: there is no literature evidence to validate this claim. Under these criteria, basically, the subject is given control of the weight of the load, the participant monitors their own sensations of fatigue and adjusts the weight which he believes could bear. All other variables such as task frequency, load weight, distance of movement, etc.. are controlled by the experimenter. The participants in this experiment were 14 young female between 19 and 22 years, they were university-level students they could be part of the workforce in the Caborca region. All signed in writing that they were free of lower back injury and had no cardiovascular disease. They used casual clothing and tennis shoes, jeans and loose shirts.

To all participant in the experiment and for verify that the heights and distances of movement of loads in lifting tasks was be according to the experiment of Snook, were taken the anthropometric measures of weight, height, knuckle height, acromial height and extended arm height. Given the limited experience of the participants in manual handling of loads were given a belt to help keep your lower back straight. The participants were given training equal to the training done it in Ciriello et al (1983) experiment, to familiarize them with the activities to performed and gain experience in adjusting the load, increase or decrease according to their own

perceptions, they doing efforts themselves but without reaching a state of extreme tiredness, weakness, overheating or running out of breath, this, doing movements of vertically lifting , at a distance of 51 cm, with bending the knees and keeping your back straight, no turns or twists, without pull or push the load. For four consecutive days of tasks were performed lifting low (floor knuckle hight), increasing gradually the time. During first and second day were made a task for 10 min with light load and heavy load respectively, the third day two tasks of 10 minutes each with light and heavy load respectively, without resting, the fourth day two tasks of 15 minutes with light load and heavy load respectively, without resting. The fifth, sixth and seventh days were for do the data collection. The daily tasks were made with duration of 40 minutes divided into two periods of 20 minutes each one, without rest between periods, in the first period it gave them a heavy load and in the second light load, all randomly selected.

Each day were made only the task for each level indicated for in the lifting Liberty Mutual tables, namely between floor level and knuckle height (lifting low), between knuckle height and acromial height (lifting medium) and between airmail height and arm extended length (lifting height). For the experiment were used rigid polypropylene boxes with length of 55 cm (distance between hands), 34 cm wide (distance from the body) and 17 cm in height. The handgrips were located at half of the distance from the body and 15 cm from the floor of the box. The box contained a false bottom in which was placed a burden whose weight was randomly selected as in the experiment of Ciriello and Snook (1990). This hidden weight was not known by the participant in an attempt to minimize the visual effect. The load management was welding rods and it was used a balance T31P Ohaus, a decimal minute chronometer, a bell and shelves height-adjustable. For each level of uprising were select, at random, 14 heavy load values, between 32 and 45 kg, then was decreased in 3 kg each, which corresponds to the box weight, and the lid of the double bottom, the resulting value were divides random, to place the burden in the hidden compartment and the visible, subsequently the same procedure was performed for 14 light loads between 2 and 18 kg, Snook (1990). These two procedures were repeated for each of the three levels of lifting the experiment. In the collection of field data were given in the first period a heavy load and the second period a light load., Participants adjusted the load in each period, they decreased or increased it according to their own perceptions until it represented the maximum they could lift in 8 hr of task, if the load of the second period was between 15% of the first, the average of the two

loads is registered as the maximum acceptable load of the participant, otherwise the information is removed and a new test was performed.

4. RESULTS AND DISCUSSION

According to the working hypothesis raised in this investigation, if the maximum acceptable weight (MAW) of Table Liberty Mutual is applicable to the female population of the Caborca region, then the percentile distribution of the maximum load obtained from the participants, must statistically to exist a matching with the distribution of the liberty mutual table percentiles. Under this approach was performed the analysis for low level lifting. The results of the analysis are show in Table No 1

Table 1 Analysis of field data, low level

liberty mutual tabla data		Hypotesis test					
percentile	MAW (Kg)	Null hypothesis	statistical test	standard desviation	t	α	decisión
90	11	P_0 = 0.90	$\overline{p}$= 0.79	0.08	-1.38	0.10	No rechazar Ho
75	14	P_0 = 0.75	$\overline{p}$= 0.36	0.12	-3.25	0.00	Rechazar Ho
50	16	P_0 = 0.50	$\overline{p}$= 0.21	0.13	-2.23	0.02	Rechazar Ho
25	19	P_0 = 0.25	$\overline{p}$= 0.00	0.12	-2.08	0.03	Rechazar Ho
10	22	P_0 = 0.10	$\overline{p}$= 0.00	0.08	-1.25	0.12	No rechazar Ho

From the above table it is seen that for the 10th percentile there is not sufficient evidence to reject the null hypothesis. For 75, 50 and 25 percentile the significance levels of the test statistic permit reject the null hypothesis. The 10th percentile, has significance level to accept Ho but, is not feasible to accept the hypothesis that it applies the maximum load in the female working population Caborca because there is no real data to the percentiles 25 and 10, for what there is certainty to make the decision that both hypotheses may be rejected.

For mid level lifting was performed an analysis similar to the previous data, the obtained information shown in Table No 2

Table 2 Analysis of field data, medium level

liberty mutual tabla data		Hypotesis test					
percentile	MAW (Kg)	Null hypothesis	statistical test	standard desviation	t	α	decisión
90	10	$P_0 = 0.90$	$\bar{p}= 0.64$	0.08	-3.25	0.00	Rechazar Ho
75	12	$P_0 = 0.75$	$\bar{p}= 0.50$	0.12	-2.08	0.03	Rechazar Ho
50	14	$P_0 = 0.50$	$\bar{p}= 0.07$	0.13	-3.31	0.00	Rechazar Ho
25	16	$P_0 = 0.25$	$\bar{p}=0.00$	0.12	-2.08	0.03	Rechazar Ho
10	18	$P_0 = 0.10$	$\bar{p}= 0.0$	0.08	-1.25	0.12	No rechazar Ho

In the analysis can be seen that, for the 90, 75, 50 and 25 percentiles, the levels of significance of the test statistic are able to reject the null hypothesis. The 10th percentile has a high significance level to not accept H_0 but there is not feasible to accept it because, there is not real evidence.

For high lifting, was performed the analysis data that it is show in table3.

Table 3 Analysis of field data, hight level

liberty mutual tabla		Hypotesis test					
percentile	MAW (Kg)	Null hypothesis	statistical test	standard desviation	t	α	decisión
90	9	$P_0 = 0.90$	$\bar{p}= 0.77$	0.08	-1.63	0.06	No rechazar Ho
75	11	$P_0 = 0.75$	$\bar{p}= 0.31$	0.12	-3.67	0.00	rechazar Ho
50	12	$P_0 = 0.50$	$\bar{p}= 0.08$	0.14	-3.00	0.01	rechazar Ho
25	14	$P_0 = 0.25$	$\bar{p}= 0.00$	0.12	-2.08	0.03	rechazar Ho
10	15	$P_0 = 0.10$	$\bar{p}= 0.00$	0.08	-1.25	0.12	No rechazar Ho
datos correspondientes a 13 participantes							

In this last analysis presents a situation similar to the results for lifting low, one can see that for the 90th percentile there is no sufficient evidence to reject that, at this level, we can apply the maximum weight indicated by the table, for the percentiles 75, 50 and 25 the level of significance of the test statistic is at able to reject the null hypothesis. For the 10th and 25th percentiles, same

that in previous analysis is not feasible to accept the hypothesis Ho because there is no real evidence.

5. CONCLUSIONS

With the results and analysis of the data above we can accept that, in general, there is not sufficient evidence to accept that the maximum weight recommended in Liberty Mutual Table for lifting in women, in vertical lifting for frequency of one per minute, boxes of 34 cm wide (distance from the body), movement distance of 51 cm, at the three levels of survey, can be applied to the female workforce of the Caborca region without running the risk of injury. Given this information we can conclude that, it is not appropriate to apply the recommendations in Table Liberty Mutual in the female working population in the Caborca region since it is possible that this population has a lower lifting capacity or possibly with a less dispersion in capacity lifting. As a result of this research we recommend that define the acceptable maximum weights in lifting burdens on women in different regions of our country since there are no recommendations in this regard and are a cause of interest public health

6.REFERENCES

Ciriello, VM and Snook, SH 1990., *Ergonomy 1990, vol 33, no.3 ,187-200,* "The effects of container size, frequency and extended horizontal reach on maximum acceptable weights of lifting for female industrial workers."

Ciriello, VM and Snook, SH 1991, *Ergonomy 1991, Vol 34, No 9,1194-1213,* "The design of manual handing tasks: revised tables of maximum acceptable weights and forces".

De La Vega Bustillos, Enrique 2005, "checklists, methods and mathematical models for ergonomic evaluation of work environments", Technological Institute of Hermosillo http://www.estrucplan.com.ar/articulos/verarticulo.asp?IDArticulo=982 visited in June 2009

Mital, Anil (1983*), Human Factors, 1983, 25 (5), 488-49*, The Psychophysical approach in manual lifting, a verification study.

National Institute for Occupational and healt (NIOSH), 1991*, "Scientific support documentation for revised 1991 NIOSH lifting equation".*

Putz Anderson, V (1994) "Cumulative Trauma Disorders*. A Manual for Musculoskeletal Diseases of the Upper Limbs.* Taylor & Francis, London.

Snook, SH and Ciriello, VM 1983*, Human Factors, 1983.25 (5), 473-483,* "A study of size, distance, Height and Frequency Effects of manual handling tasks