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Diseño ergonómico de un puesto de trabajo de bodeguero en una papelería con exposición al levantamiento y traslado de cargas

Ergonomic design of a warehouse workstation in a stationery store with risk exposure due to lifting and moving loads

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Abstract.

Introduction. The deterioration of the health of people who occupy handicraft positions, such as the reception and dispatch of warehouse materials in stationery stores, is an inevitable phenomenon that forces us to overcome multiple challenges using the application of ergonomic techniques for the design of work stations. **Objective**. This work is about the ergonomic design of a work station with risk exposure to lifting and moving of cargo within the sales area of a stationery store. **Methodology**. To perform a significant analysis of variables using Snook and Ciriello tables (ISO 11228). The study began with the identification of the elements susceptible to modification using field observation. Then,

Resumen.

Introducción. El deterioro de la salud de las personas que ocupan puestos artesanales como en el de recepción y despacho de materiales de bodega en papelerías es un fenómeno inevitable que obliga a superar múltiples desafíos con la aplicación de técnicas ergonómicas de diseño de puestos. **Objetivo**. Este trabajo realizó el diseño ergonómico de un puesto laboral con exposición al levantamiento y traslado de carga en el área de ventas de una papelería. **Metodología**. Se realizó un análisis de significación de variables mediante el uso de las tablas de Snook y Ciriello (ISO 11228). El estudio empezó con la identificación de los elementos susceptibles de modificación en el puesto

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a study was made to compare the significant variables of the result of risk level for manipulation and transfer of loads considering: postures and the characteristics of the lifting. Finally, the design was established considering modifications of the work plan in the reception and dispatch of materials. **Results**. The results indicate that for a warehouse dispatcher's work station, which handles a maximum weight of 17kg, it should be decreased by 3% to reach the maximum acceptable weight of 16.15kg. With a protected population of 90% and a lifting frequency of 30 transfer loads per hour, with loads that do not allow adequate grip and keeping the load away from the body and at vertical distances from the floor to the hands of 100cm. However, with the use of a reception table with a height of 100cm, it was possible to eliminate the risk level and improve postures in all activities exposed to a value of 0.95. **Conclusion** The final ratio result obtained under the Snook and Ciriello method, meets the permitted range, accounting for 15% risk level attenuation. Thus, this improvement allowed the loads' handling up to a maximum of 18kg.

Keywords: Snook tables, loading, ergonomics, lifting, moving, cargo handling.

utilizando observación de campo, luego se realizó un estudio de comparación de las variables más significativas en el resultado del nivel de riesgo por manipulación y traslado de cargas considerando: posturas y las características del levantamiento. Finalmente se estableció el diseño considerando modificaciones del plano de trabajo en la recepción y el despacho de los materiales. **Resultados**. Se indica que para un puesto de trabajo de despachador de bodega que manipula un peso máximo de 17kg se debe disminuir un 3% para llegar al peso máximo aceptable de 16,15 kg con una población protegida del 90%, una frecuencia de levantamiento de 30 transportes por hora, con cargas que no permiten agarre adecuado y manteniendo la carga alejada del cuerpo y a distancias verticales desde el suelo a las manos de 100cm. De todos modos, con el uso de una mesa de recepción de 100cm anuló el nivel de riesgo y mejoró las posturas en todas las actividades con exposición a un valor de 0,95. **Conclusión**. El resultado de la proporción final del método de Snook y Ciriello, que se encuentra dentro de lo permitido, obteniendo una mejora del 15% en el nivel de riesgo y permitiendo manejo de cargas de hasta 18kg.

Palabras claves: Tablas de Snook, carga, ergonomía, levantamiento, traslado, manipulación de carga

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Introduction.

The handling and transfer of loads in artisanal or empirical jobs are neglected by book stores' employers nationwide (Vargas-Calderòn, 2016), resulting in musculoskeletal disorders that involve hidden costs to business profits (Cali Proaño, 2014).

Stationery storekeepers' exposure to biomechanical overload not only includes load handling activities, but also traction, pushing and lifting actions (Pavanelli et al., 2020). Besides the flat transportation, there is also short distances moving, either by pushing or pulling, increasing muscular skeletal discomfort (Montoya Díaz et al., 2010).

Ergonomics allows adapting the work actions to a human being, who executes activities related to lifting and moving loads (Perrazo et al., 2019). The load influences in the handling ease, not only due to the weight and location conditions, but also to its shape, stability and size. (Estrada, 2001). The use of Snook and Ciriello boards is one of the techniques which analyses this ergonomics' field (Snook y Ciriello, 1991) establishing the maximum acceptable weight and strength values for certain population percentage under given conditions. The redesign of manual workstations related to heavy materials' handling applies to a large percentage of the working population and it constitutes of a tool to help in the health prevention management required by the control entities within each country. (Asensio Cuesta et al., 2012). The aim of redesigning workplaces is to modify certain elements avoiding the appearance of muscular-skeletal disorders, especially in the dorsal-lumbar area of the workers' back. Currently, workplace anthropometric measures improve static postures and decrease the overall ergonomic risk level (Ávila Torres, 2013).

Myopathy (muscle damage) is very common in warehouse activities as it involves lifting loads. The movement of loads in short distances is not only limited to long term discomfort, but is directly related to accidents caused by slopes and slippery floors (Diaz Zavalaga). It is common to find high frequency accident rates in businesses where their workers handle loads in which translates into absenteeism and financial losses for their managers (Acevedo González y Yánez Contreras, 2016).

The evaluation of these jobs and the use of methodological tools are necessary to determine a baseline to improve this risk situation by using the ISO 11228 standard (Becker, 2009) as a good option for understanding this problem and solving it. As such, some efforts exceed the tissue resistance. Furthermore, this worker's posture can be improved the by changing both the facilities' layout drawing and the reception area within the warehouse (Castillo y Ramírez, 2009).

This work aims to determine in quantitative terms the improvement achieved by redesigning the warehouse stationery work station. Besides, injuries and absenteeism percentages are alarming, there is a load handling instruction book which was created to minimize the risk

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(García Campana, 2012) besides all efforts done, job rotation or job restrictions do not reflect changes in the results.

Methodology

The methodology used in redesign the warehouse work station, considers three defined stages: a) field observation and determination of the variables necessary under ISO 11228 standards, b) study of significance of work station elements using the Snook and Ciriello method and c) estimation of ergonomic improvement percentage with the modification of facilities' layout drawings and change of static positions for reception and dispatch of materials workstations within the storage.

Determination of input variables required by the ISO 11228 standard

To use the Snook and Ciriello tables described in this ISO standard, their applicability is first defined considering these restrictions: handling loads equal or greater than 3kg, moderate circulation speeds between 0.1 and 1m/s and working hours limit of 8 hours a day for combined tasks (Martínez Cordovilla, 2018).

By means of field observation, the following parameters were determined: the number of cycles, the greatest exposure periods and workload, the mass of object lifted, the reference mass, the transportation frequency and distance (Jácome Analuisa, 2018).

Variables significance level in lifting and moving loads (Snook y Ciriello)

To estimate the variables, which influence the final result of lifting and transferring loads, the Snook and Ciriellomost method was used (Álvarez Casado, 2013) requiring the following information data*:*

- **Job information:** The job position was identified according to its respective description. In addition, the company, the department or area and the section where the evaluation was carried out were described.
- **Worker details**: The workers' name, sex, employee age, the position of seniority, the amount of time in a discomfort position in a day (minimum 10 minutes - maximum 16 minutes) and total working hours a day (minimum 4 hours - maximum 18 hours).
- **Worker's posture**: In this section, 5 positions were selected, which are: lifting, lowering, pushing, dragging and transport. Each of these postures was represented with an illustration (Snook & Norma, n.d.).
- **Load lifting characteristics**: The load average weight (0-60kg), the sex (male/female), and the population percentage to be protected (90, 75, 50, 25 and 10) were selected, later the corresponding frequency (lift/minute or lift/hour) was written down. Subsequently, it is required to know whether or not the load allows adequate grip, the load is handled away

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from the body, compliance with the initial and final height of the load (up to 175cm) and the load width (up to 100cm). Finally, the handling area was determined (from ground level to knuckle height, from knuckle height to shoulder height and from shoulder height to vertical reach of the arms),(Snook & Norma, n.d.).

- **Results**: The previously selected method of handling is displayed. In addition to the load weight configured in kg, the maximum acceptable weight is measured. Finally, the weight ratio with values of: 0; 0.5; 1; 1.5; 2; 2.5; 3 or more, with a horizontal color scale (green and red), is recorded with values below 1 as acceptable and values above 1 are harmful.

At this research stage, a study is carried out variable by variable to analyse which is the most significant final result regarding to the Snook and Ciriello method (Romá et al., 1989). This study started by identifying the elements which can be modified at the workplace: lifting height; lifting distance; load weight, the workplace unchangeable parts regarding to their characteristics were maintained such as lifting frequency; gender and percentile.

Ergonomic design proposal

After conducting the significant study, a modification in the reception and dispatch warehouse layout drawings was made, the ergonomic risk percentage can be decreased by comparing the initial conditions and endings (Cely Corredor, 2013)

Results y discussion

Result of ISO 11228 standard input variables

In table 1, the ISO elements for the warehouse dispatcher position are shown:

Table 1. Job Information

ITEM	Value / Data
Area	Warehouse
Gender	Male
Age	46
Length of working hours	8h
Average weight load	17kg
Load lifting frequency	30 lifts/hour
Load grip	Poor
Load width	0.6m

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Load location	close to the body
Population to protect	90%
Handling type	Transport
Distance travelled	5m
Position seniority	10 years
Lifting distance	0.1m
Final lifting distance	1.25m
Maximum acceptable weight	16.15kg
Ratio	1.05*

Note: The data are the result of the average handling during the peak working time. *The ratio exceeds 1, therefore there is affectation

Table 2 shows the variables significance results of the final risk outcome:

Table 2. Risk significance of input elements

ITEM	Value / Data	SIGNIFICANCE
Area	Warehouse	NO
Gender	Male	NO
Age	46	YES
Length of working hours	8h	NO
Average weight load	17kg	NO
Lifting frequency	30 lifts/hour	YES
Load Grip	poor	YES
Load width	0.6m	NO
Load location	Close to body	NO
Population to protect	90%	NO
Handling type	Tansportation	NO
Distance travelled	5m	NO
Position seniority	10 years	NO
Lifting distance	0.1m	NO
Final lifting distance	1.25m	NO

Note: The significance is determined by combining the elements until the value of the final risk outcome changes and the ratio is modified.

Table 3 shows the improvement results obtained by considering conveyor belt:

Table 3. Ideal working conditions

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Lift height	Initial ratio	Final ratio	% de nivel de riesgo disminuido
1m	1.1	0.94	15%*
1m	1.25	N/A	

Note: * The calculated decrease percentage takes into account an initial ratio of 0.95. The acceptable weight for this process is 18 kg.

Figure 1 shows both the working position adopted when performing the assigned task and the modifications, which are the results from the variables significance study and the workspace adaptation for working needs. Note that the distance does not influence the final results, so the collection distance was reduced to 3m from the load reception.

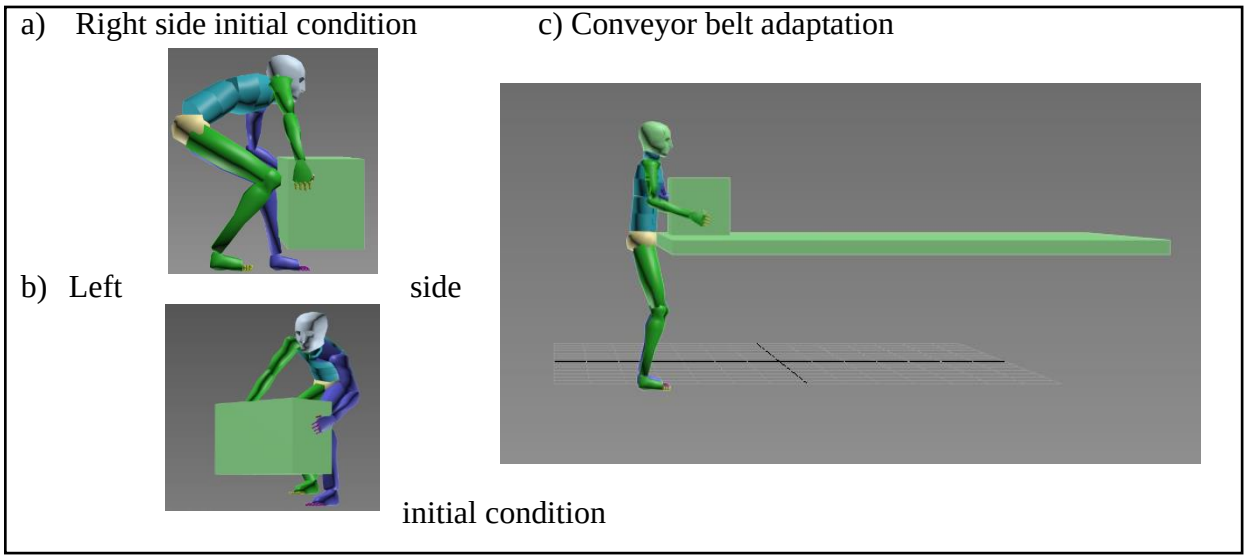

Figure 2. Initial and final conditions for adapting the workplace with the new configuration

Conclusions

A 15% decrease in the final ratio of the ISO 11228 standard method was achieved with the adoption of a 3m long conveyor belt at a height of 1m from the floor. The optimal working conditions determine a maximum lifting weight of 18kg with a frequency of 30 lifts/hour and a protected population of 90%. Thus, the working frequency reduction was not considered due to the supplier trucks arrival frequency at the warehouse, these are invariant working conditions.

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