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Original Article

Postural stress and risk conditions in manual load handling of Chilean industrial workers

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ABSTRACT

Introduction: Although, there is a current regulatory framework for optimal manual handling of loads to preserve health conditions in the industrial sector, technical assessment and the use of certain instruments are still required for the diagnosis of occupational hazards. This study aimed to identify the occupational hazards associated with manual load handling in industry workers and estimate those resulting from postural stress.

Methods: Fifty-two (52) industry workers took part in this cross-sectional study. All participants were evaluated using the Manual Handling Guide and the Reba assessment tool. Subjects were characterized, and risks associated with different tasks were detected.

Results: 59.6% of workers were between 18 and 45 years old. Lifting, lowering, and transporting loads activities had a repetitive task risk of 94%, exceeding the weight limit in 85.7% of cases. Pushing and pulling activities, mostly showed a working postural risk of 82% and a high perception of initial effort (Borg> 8). Reba score warned to intervene immediately in both types of tasks.

Conclusion: Risk from the manual handling of loads found in this study constitutes an alert that suggests reviewing compliance with the current regulation, as well as effective use of working pauses and the improvement of strategies to minimize physical efforts used by workers.

Keywords: Ergonomic assessment, occupational health, posture load, work risk

Introduction

Important work procedures and processes are associated with manual load handling (MLH), most of which are involved in productive sectors such as agriculture, construction, and industry.[1] An important aspect that has caught the attention of occupational health units, ergonomics departments, and public health centers is the collection of data that relate risks associated with MLH with postural load and the prevalence of musculoskeletal disorders in workers.[2,3]

Although the approach to occupational health includes various disciplines, the study of the workplace continues to be a powerful diagnostic tool, as work in the industrial area continues to present serious problems about the adoption of poor harmful postures to carry out productive tasks.[4] In fact, there are several instruments and methods available for the assessment of risk because of postural stress, including its application in different working environments[5,6] to identify forced postures adopted by workers and use this information to design workplace adjustments as well as to promote hazard management strategies to minimize stress on the locomotor system.[7]

In Chile, management derived from the analysis regarding load handling hazards in workers allowed the incorporation of new regulations about maximum weight to be lift by humans into the labor code in 2005 by law 20.001, which is ruled by the guide of manual handling risk assessment, however, it was modified through law 20,949;

which reduced to only 25-20 kilos for maximum MLH limit in adult men and those under 18 years of age and /or women respectively since 2016 through the technical guide for assessment and control of risks associated with manual load handling.[8] Despite the existence of current regulations on risk assessment in MLH; recent studies have shown that the working population is exposed to work overload variables, physical-biomechanical factors, and perception of musculoskeletal discomfort;[9] and in other cases it is noted that the maximum legal load limit should not be interpreted as a safety health value.[10]

This study aimed to evaluate the risk present in tasks that include manual load handling, as well as postural load in industrial workers.

Methods

This is a cross-sectional study that took place in a furniture and mattress factory in the metropolitan region (Santiago de Chile) between April and August 2019 and by request of the Occupational Safety and Health Administration (Law 16.744).

The company has 180 workers with an indefinite employment contract and the investigation was carried out in a branch office that included 80 workers (the biggest of this company).

Workers in this area primarily perform mattress manufacturing activities through quilting, edge definition, and assembly processes. Finally, they carry out the closure and the product is packaged to distribute to commercial stores for later sale. The manufacturing and assembly areas included in this study require manual load handling activities through lifting, lowering, transporting, pushing and dragging tasks. 20 workers were excluded from this study due to administrative work activities.

The study included 60 male workers. To calculate the sample size of a finite population, the following formula was used:

$$n = \frac{N \times z_{\alpha}^{2} \cdot p \ x \ q}{e^{2} \times (N-1) + z_{\alpha}^{2} \ x \ p \ x \ q}$$

Where: n: Sample size to consider; N: Population size; Z: Statistic that depends on N; p: Probability of occurrence of the occupational risk t; q: Probability that the event does not occur q = (1-p) and e: Error. For this study, a significance level of 5% was considered, so that Z corresponds to: 1.96. Finally, a margin of error of 5% was used. Calculations established a size sample of 51.7. Therefore, the sample finally consisted of 52 subjects. Workers were separated into two groups according to their functions and tasks performed after the evaluation (interview and job observation); 35 subjects performed lifting, lowering and transportation tasks, while 17 performed pushing and pulling activities.

Subject selection considered the following inclusion criteria: men between 18 and 65 years old, subjects who worked 44 hours a week, presented an indefinite employment contract, and whose tasks included lifting, lowering, transporting, pushing, and pulling actions. Subjects perform functions for 8 hours a day and a 1-hour break was established for rest and feeding. Exclusion criteria involved working in the administration department or those with jobs outside the branch office. Tasks performed by workers were mostly carried out manually and physically, however, some of them used the help of machinery.

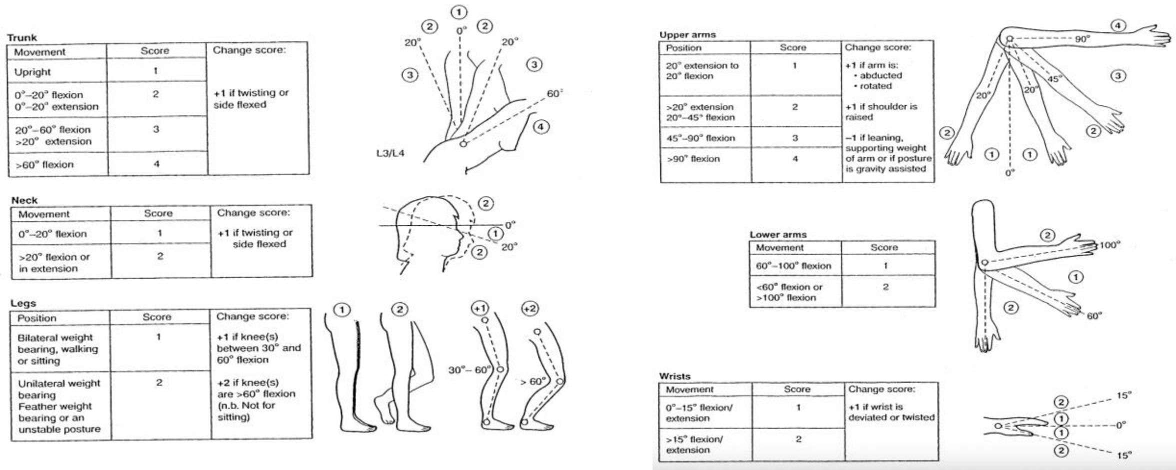
The assessment involved a technical visit by a professional with training in ergonomics and 3 years of experience in assessing risks associated with work and in the implementation of the current technical standard for manual load handling. The evaluation considered the Reba observational method, based on the observation of postures used in the execution of the task in the subject's workplace. The observation is captured by images. In addition, a 20-minute interview was conducted with each worker in which a structured questionnaire was applied on basic aspects related to age, sex, type of tasks performed, number of hours and breaks during the working day, and exposure times. The questionnaire was reviewed by experts in job evaluation. In addition, the technical guide for the evaluation and control of risks associated with manual handling of the load was applied. The information collected was recorded in an excel spreadsheet for later analysis. This made it possible to analyze the jobs individually.

Additionally, according to the type of tasks performed by the workers, the advanced ergonomic instrument Reba[11] was used to specify the risk associated with the postural load. This tool includes a systematic full body assessment of the postural risk to which the worker is exposed and involves dynamic and static postural load factors as well as person-load interaction by examining separately; right and left upper and lower extremities, trunk position, and variation of posture in the cervical region.[12] Later, the data collected were compared and analyzed.

The work was reviewed by the university's ethics committee and was approved according to the ethical criteria, instruments applied, and protection of the information. Confidentiality certificates were used for each of the participants authorizing the subsequent use of the data resulting from the evaluation with full protection of the information of the company and each of its workers.

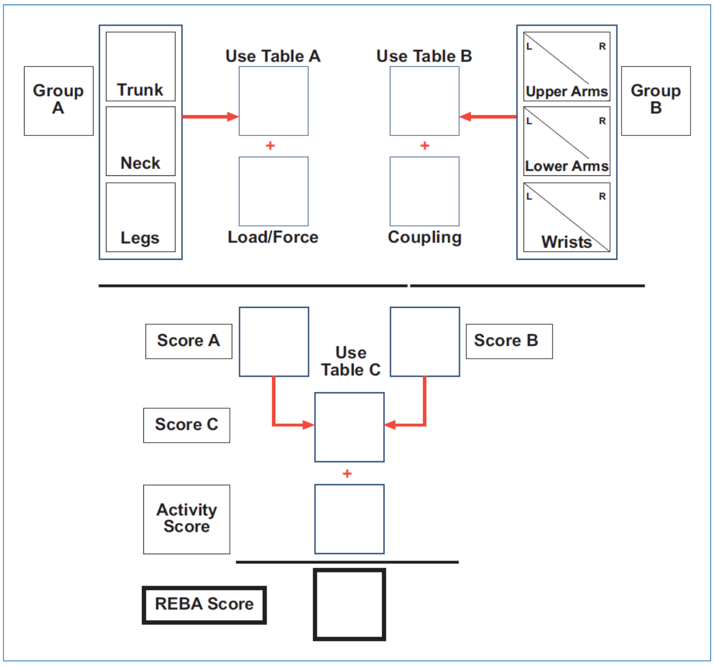
Data of the number of workers by type of task, the percentage of vertebral asymmetry, and the deficit in maintaining the vertical position during lifting, lowering and transportation tasks were described as discrete variables. Likewise, for the tasks of pushing and pulling, the Borg scale was described as the percentage of poor posture. On the other hand, the comparison of the repetition of the activity between both types of tasks was analyzed according to the student's test.

The Reba method was used to evaluate the observation of the posture of each body segment of both hemibodies during a task from the analysis of the images obtained in the workplace. Based on observation and image analysis, Reba suggests scores, and the sum of them gives a final score for each hemibody, which will be categorized according to the level of risk suggested by the method (Fig 1 A - B). Data obtained from the Reba score suggested levels of intervention for each hemibody and was compared according to the student's test.



Group A **Group B**

Figure 1A. Reba group A and B body diagrams



REBA Score	Risk level
1	Negligible
1 -3	Low
4 -7	Medium
8 -10	High
11 - 15	Very High

Figure 1B. Reba Scoring Sheet

Results

A total of 52 persons participated in this study. The largest number of workers were engaged in activities involving lifting, lowering, and carrying loads in comparison to pushing and pulling activities. For both activities, there was greater involvement of workers between 18 and 45 years of age. Regarding task description, evidence showed a greater number of tasks evaluated, involving lifting, lowering, and transporting loads, which also presented a lower average time duration corresponding to 40.64 seconds. However, the longest exposure time was longer for the tasks that involved pushing and pulling activities, reaching an average of 84.27 minutes. Regarding the presence of observed risk conditions, repetitiveness in both activities was positive, reaching 94% for lifting, lowering, and load transport activities. In its counterpart, the highest static load was observed in 82% of pushing and pulling activities. However, there are no significant differences in repeatability between these two types of tasks (t-test, p> 0,05). The postural instability factor was only observed in two-thirds of the workers during lifting, lowering, and carrying loads, meanwhile, it was absent in pushing and pulling activities (Table 1).

Table I: Characterization of the activity carried out by a worker

Workers characterization	Lifting, lowering, transport	Pushing and pulling
	n	**n**
Total number of workers	35	17
Age 18 to 45 years	20	11
Age> 45 years	15	6
Task characterization	**n**	**n**
Number of tasks	10	7
	Mean ± SD	**Mean ± SD**
Task duration (seconds)	40.64±38.57	96.36±73.11
Exposure time (minutes)	41.58±35.13	84.27±52.90
Risk conditions present in workers	**% (n)**	**% (n)**
Repeatability factor	94 (49)	58 (30)
Static postural load on one or more parts of the body	65 (34)	82 (43)
Postural instability	65 (34)	0 (0)

When examining the weight load limit according to the current regulation, 85.7% of subjects developed their task with excess load, being more prominent in lifting, lowering, and transportation activities. Between 70 and 100% of subjects evaluated experienced risk conditions associated with their type of task. For the lifting, lowering, and transportation activities, asymmetry of the spine and the deficit in maintaining the vertical position were observed.

For pushing and pulling activities, showed a high perception of initial effort (Borg> 8), and poor posture. When comparing both types of tasks, the duration of the work cycle and time exposure were considered for analysis. Using these data, the average number of repetitions for each worker estimated according to their performed activities was 103 times for lifting, lowering, and transport, and 86 times for pushing and pulling (Fig 2).

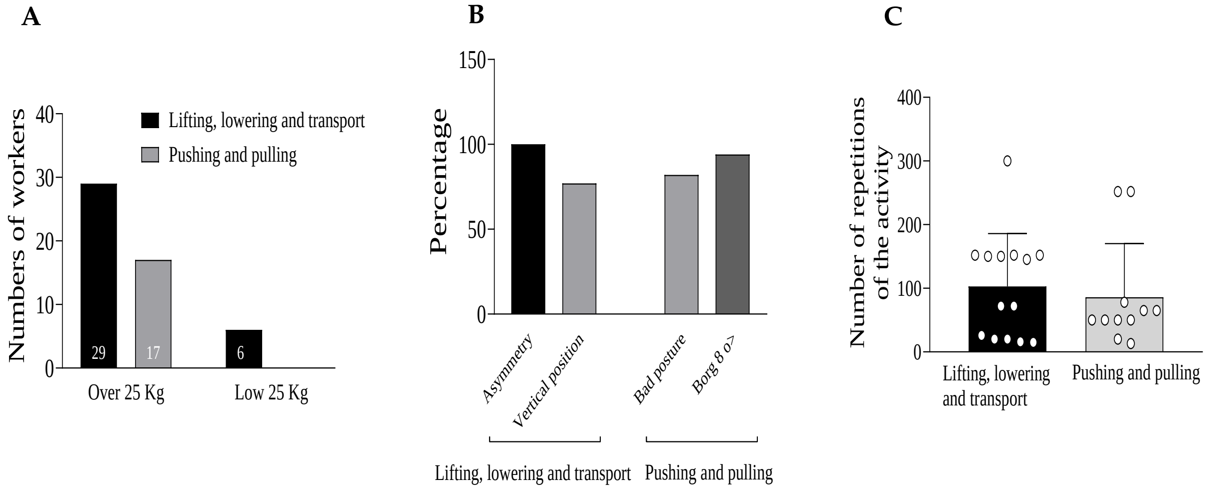


Figure 2. Load limit, risk conditions and repeatability of the activity.

A. 85.7% of the workers who carry out lifting, lowering, and transport are over the load limit, while 100% of the workers who carry out the push and pull activity are over the load limit. B. Presence of asymmetry (100%) and vertical position (77%) in lifting, lowering and carrying and presence of poor posture (82%) and effort (94%) in pushing and pulling. C. Repeatability in work activity both for lifting, lowering and transporting (103 times) and for pushing and pulling (86 times). Data are represented as means ±SEM.

When analyzing the risk estimation for postural load using the Reba assessment tool when applied to both hemibodies, the same trend was observed in terms of the achieved score and suggested levels of action for lifting, lowering and transportation activities as well as for pushing and dragging. A slightly higher score out of 12 points was recorded for lifting, lowering, and carrying compared to the pushing and pulling activities, which cataloged risk as "very high". Regarding the level of action suggested when comparing the two groups of tasks, the same trend was observed on both sides of the body, suggesting an "immediate intervention" (Fig 3).

When analyzing and comparing the breakdown of the scores obtained by applying the Reba method for each body segment and the variables of load/strength and type of grip in each group of evaluated tasks, it was evidenced that for lifting, lowering and transporting the highs Overall scores were derived from the higher contribution made by the referred score of the arm segment, while for pushing and pulling activities the higher score is due to the higher estimate of trunk load, and levels of load/force used. In both types of tasks, the load estimation turned out to be homogeneous for each right and left half body (Fig. 4).

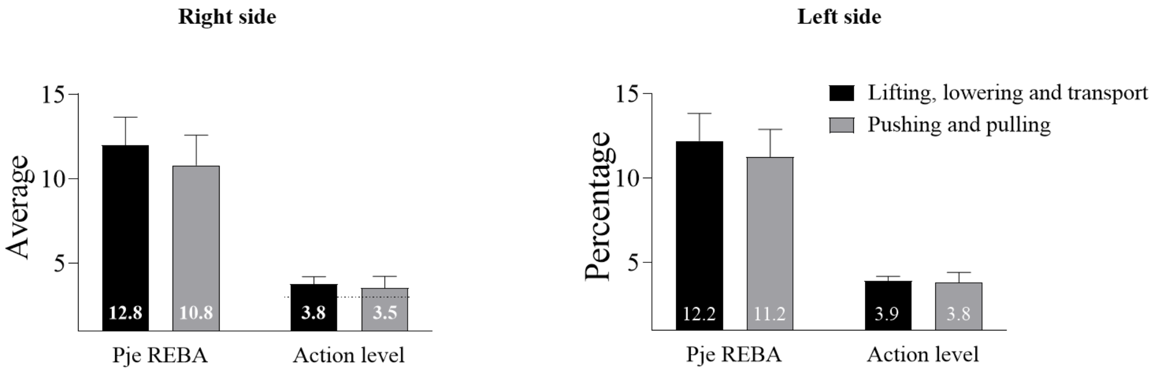
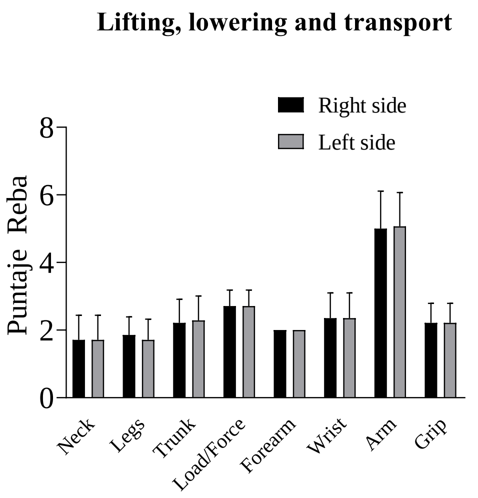


Figure 3. REBA score and level of action by laterality.

The evaluation of the risk estimates for postural load determined that, for the activity of lifting, lowering and transport, both for right and left laterality it obtained a score out of 11 with a level higher than 3, which suggests immediate intervention. For the push and pull activity, the REBA score (10,8 right laterality and 11,2 left laterality) associated with action levels 3,5 and 3,8 respectively indicate the need for immediate intervention. Data are represented as means ±SEM.



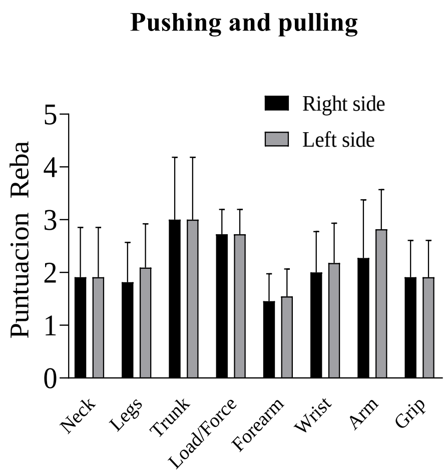


Figure 4. Scoring of the REBA method by the task group

A. Higher scores were observed in the arms, forearms, and wrist, while for group B the segments that gave the highest score in the assessment correspond to the trunk, neck, and legs, in both considering the level of load/force exerted and type of grip. Data are represented as means ±SEM.

Discussion

The novelty of this study is that a highly variable and versatile work system is assessed in terms of the tasks performed by the subjects and allowed each of them to be specifically evaluated. The foregoing was based on the difference and specificity of the tasks performed by the subjects, where not all perform the same activity in the same work circuit, and also the tasks performed by each of the workers vary during the work circuit. The selected instruments were appropriate in characterizing the sample and in investigating the risk conditions present in both groups of tasks examined. In the first place, although there is repetitiveness both in lifting, lowering and transportation, as well as for pushing and pulling activities, the differences found may be related to the different productive rhythms, whereas in the case of lifting, lowering, and transportation, the duration of work cycle is practically double.[13] A second relevant aspect, common for both types of activities, is the presence of risk as a result of postural load, static load, and/or unstable posture. In this sense, the risk conditions were related to the asymmetry of the spine, the difficulty to maintain a vertical cervical position and the adoption of poor posture and/or functional compensation during a task [14], fringes were also found in other studies in which the main issue originates from poor technique and/or training for workers regarding the use of mechanical advantage for their body segments to perform motor skills.[15]

On the other hand, for pushing and pulling activities, considerate is worth noting that most workers scored initial effort with the Borg scale> 8, while 85.7% of subjects who participated in lifting, lowering and transportation activities reported having approached the human load limit (25 kilograms). Although workloads used for both activities are within the norm, they require a great effort from the worker to put a load into motion [16,17].

Regarding evaluation using the Reba assessment tool for both types of activities for each hemibody, data revealed different score contributions according to the body region involved in the process. Once again, the score resulting from the load magnitude and/or the exerted force stands is highlighted in both activities. For lifting, lowering and transportation, the highest score by body segment was observed in the arms, forearms, and wrists, which could be explained to a greater extent by working angles of 45 and/or 90 degrees in the lateral and frontal planes, in addition to movements in another plane such as rotations [18], working angles that are responsible for imposing greater load and stress on the tissues involved.[19]. In its counterpart, for pushing and dragging, the topographic regions mostly involved in the scoring were the trunk, neck, and legs, which are regions commonly implicated in maintaining a posture in a flexing, antigravity pattern and/or used for coupling between the body and load.[20] A study on ergonomics evaluation of manual lifting task on biomechanical stress conducted in India showed that heavier weights produced higher stresses than lower weights, and the loading rate was found to be same at waist or knee level. It was observed to be linearly increasing after waist level.[21]

The study proposes the following measures which should be adopted by occupational health units to improve working conditions: a) evaluate and train the best technique to perform different tasks to make more efficient use of biomechanics and mechanical advantage[22], b) evaluate mechanical assistance to push loads of greater magnitude or the conformation of task teams to minimize the initial push and/or drag effort [23], c) review and incorporate the use of working pauses combined with the rotation of workers in different jobs to reduce the repetitiveness component and improve the recovery of tissues and joint structures involved in the execution of activities, and by reducing the stress imposed on the musculoskeletal system in the tasks performed.[24]

A limitation of this study was not to consider or preliminarily assess clinical aspects such as signs and symptoms associated with musculoskeletal disorders and organizational aspects, including those that determine the productive rhythms, criteria that would have allowed to clarify if the detected risks compromise occupational health as well as the development of sustainable work [25].

Another limitation was the size of the sample (n=52), however, this study considers it important for future or continuity work to increase the sample by assessing other company branches and the inclusion of women to improve representativeness, and be able to transfer the obtained results to other productive sectors with more statistical significance.

In this sense, the main implications and applications of the study show that in terms of risk prevention associated with the manual handling of loads, the implementation of the technical guide for the evaluation and control of risk factors could include sections in which variables are established. of risk for different tasks because not all present the same risks, for example in the observed variables of postural load, and repetitiveness. A better application could be to separate and classify the type of tasks and from this categorize the risks as well as their evaluation, management, and control measures.

Conclusion

This work concludes the presence of associated risks derived mainly from the postural load in the manual load handling, as well as indicators that constitute an alert, including the absence of pauses/rest times or a change of activity during the work cycle. Although there is a current regulation on the weight limit for of loads, it is wise to review its compliance through audits and by finding ways to minimize the physical efforts used by workers.

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