

Participatory ergonomic intervention for prevention of low back pain: assembly line redesign case

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Abstract. This paper gives an overview of a participatory ergonomic intervention aimed at reducing low back pain cases in the dispatch department of a catalogue and e-commerce retail company. Based on the findings of the ergonomic analysis and design committee, the company's own employees redesigned the assembly line's layout. As a result of these changes two job tasks that involved manual material handling of boxes, identified by the revised NIOSH equation as posing an increased risk for lifting-related low back pain, were totally eliminated, and the employees responsible for moving boxes from the end of the assembly line to pallets on the ground were given more control over their jobs, and these jobs were also enriched with a new, less heavy task. These results demonstrate that participatory ergonomic interventions are a viable and effective strategy to reduce the exposure to work-related physical and psychosocial risk factors for low back pain.

Keywords: Work-related musculoskeletal disorders, low back pain, manual material handling, workplace interventions, participatory approach

1. Introduction

In spite of the extensive amount of information on the physiopathology, epidemiology and risk model of work-related musculoskeletal disorders (WMSD) accumulated in the last 20 years, they continue to be a major cause of lost time at work, lost productivity, workers' disability, compensation claims and health care costs, imposing a heavy burden on workers, workplaces and society at large [21,27,29]. In Brazil, according to data from the Social Welfare Ministry, WMSD represented 52.8% of all occupational diseases registered in 2001, 55.3% in 2002 and 50.1% in 2003 [9].

Low back pain (LBP) represents one of the most common forms of WMSD, accounting for more than

24% of all work-related musculoskeletal disorders [7,35]. Several factors that are important in LBP etiology are related with the workplace and as much as 30% of all LBP can be attributed to occupational exposures. The following physical occupational risk factors have been associated with the development of LBP: heavy physical work, bending and twisting, manual handling of objects or people and whole-body vibration [18,20,37].

In addition to the separate effects of each of these physical occupational risk factors, experimental evidence and biomechanical theory suggest that they may interact, producing a higher risk of LBP when combined. Biomechanical theory also predicts that local low-back muscle fatigue resulting from job-

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related physical effort may increase the risk of LBP associated with lifting [23,26,28,31,38].

Psychosocial factors at work have also been implicated in the development of LBP. Work-related psychosocial factors refer to the perceptions or beliefs that workers have about the way their work environment is organized [11,19]. Factors such as job dissatisfaction, monotony of work, limited job control, and lack of social support are the most commonly identified potential risk factors associated with the occurrence of LBP [5,8,19].

In order to prevent occupational LBP, ergonomic interventions are frequently implemented at the workplace to reduce biomechanical and psychosocial load. However, the findings of a recent systematic review showed that the implementation of physical and organizational ergonomic interventions alone were not effective to prevent LBP [24]. It has been hypothesized that this lack of effects might be due to the inadequate implementation of ergonomic measures (i.e., compliance, satisfaction and experience) [6], therefore, the use of participatory ergonomics (PE), as a strategy to implement ergonomic measures, has been recommended by the National Institute of Occupational Safety and Health (NIOSH) and the European Agency for Safety and Health at Work (EASHW) as an important method for controlling WMSD and initiating an ergonomic program [4].

PE, an increasingly utilized method of improving ergonomic aspects of work and workplaces, consists in the workers' active involvement in the process to identify risk factors in the workplace, and to select the most appropriate solutions for these risks, supported by their supervisors and managers, in order to improve their working conditions [16,17,22]. PE has been claimed to add some advantages to the traditional ergonomic intervention, including enhanced intervention efficacy, added problem solving capability (essential for effective assessment of the multifactorial risks associated with WMSD), as well as better communication among workplace parties and better acceptance of change by the workforce (as a result of their increased ownership of workplace changes) [3,13].

The participatory approach has already been used to reduce physical work demands and to prevent WMSD in several studies, presenting promising results [2,13-15,30,33]. Therefore, the purpose of this study was to present a participatory ergonomic intervention developed in the dispatch department of a Brazilian catalogue and e-commerce retail company, and its effectiveness in reducing exposure to work-

related physical and psychosocial risk factors for LBP.

2. Background

The subject for this case study was a mid-sized (approximately 500 employees) catalogue and e-commerce retail company located in Blumenau, a 300,000 inhabitants town in the state of Santa Catarina, in the south region of Brazil.

In 2007 the company launched its official e-commerce website. Joining the e-commerce website market led the company to increase operations and shipping volume. However, along with the increase in operations and shipping, an increase in the frequency and severity of LBP cases occurred. Concerned about this increase in LBP cases and recognizing the need for improvements, management brought in ergonomists to help in finding the source of problems and possible solutions.

3. Intervention process

The intervention was based on group work: the employees and the ergonomists identified problems in the workplace and developed and evaluated solutions for them; while the changes were implemented involving the ergonomists, employees, management and technical personnel working together. The PE intervention included the following steps:

3.1. Preparation

In this step top management appointed management representatives for the steering committee, which was comprised of representatives from top management, human resources, health and safety department and an ergonomist. Following the steering committee formation, all employees of the department were informed of the project and encouraged to participate. The steering committee then directed the formation of the ergonomics analysis and design committee, which included production supervisors, production employees, maintenance personnel and an ergonomist.

3.2. Workplace analysis

This step was divided in three stages. In the first stage employees were interviewed to capture their

responses to questions about musculoskeletal symptoms and the procedures, duration and the experienced heaviness of the tasks.

In the second stage the ergonomic analysis and design committee discussed a document which summarized the data obtained in the previous stage and had information on risk factors for LBP in the dispatch department, which had been identified in a previous workplace analysis made by an ergonomist.

In the third stage, the employees could include other risk factors of LBP, and evaluated all mentioned risk factors according to their frequency and severity. Based on the committee's observation, the two most frequent and severe risk factors were prioritized for improvements.

During this step the employees were informally educated about basic ergonomics principles, risk analysis techniques, and workstation design guidelines.

3.3. Solution building

Subsequently, the ergonomic analysis and design committee held a brainstorming session, during which the committee's members were invited to propose, without restraint, different types of ergonomic interventions targeting the prioritized risk factors.

Then, a discussion was held between the steering committee and the ergonomic analysis and design committee regarding the advantages/disadvantages of each ergonomic intervention previously proposed, according to a criteria list considering: relative advantage, costs, compatibility and complexity. Based on a consensus, the most appropriate ergonomic measures were chosen.

3.4. Solution implementation

In this stage, the improvements were implemented into the actual workplace. To improve the implementation process, all employees were informed, motivated and instructed, in an informal way, about the ergonomic measures, in order to facilitate the acceptance of the changes made to the work process and the work area.

3.5. Evaluation

This step will take place after 6 and 12 month of the implementation of the improvements, when a questionnaire concerning musculoskeletal symptoms and sick leave data will be sent to the employees,

providing information about the effectiveness of the intervention and indicating if adaptations or additional changes were necessary.

4. Results

4.1. Results of step 2 - workplace analysis

According to the workplace analysis, the two most frequent and severe risk factor for LBP in the dispatch department were related with configuration of the assembly line of the boxing and dispatch departments (Figure 1).

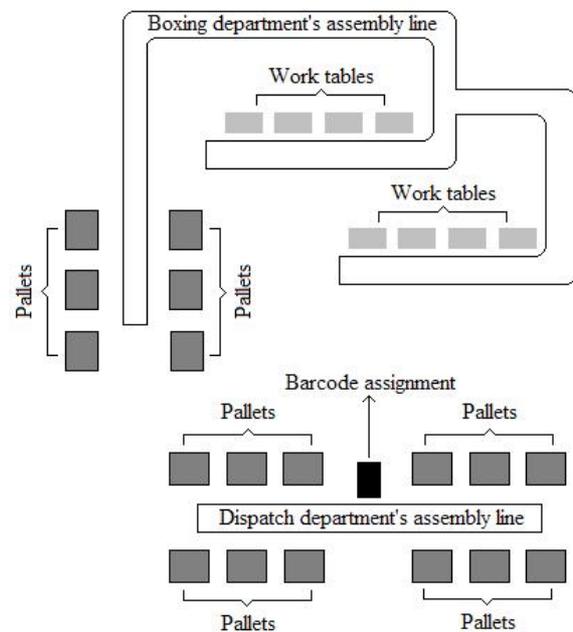


Fig. 1 - Boxing and dispatch departments' assembly line configuration before the intervention

As can be seen in Figure 1 both assembly lines were separated, therefore boxes coming from the boxing department had to be removed from the assembly line to pallets in the ground. Next, these pallets were moved to the dispatch department, where the boxes were put on the assembly line to receive their barcodes. Finally, the boxes were removed from the assembly line to pallets in the ground again. Consequently, these procedures required that employees handled the boxes three times, without any control over their work rhythm, since it was established by the assembly's line pace.

Thus, repetitive manual material handling in awkward postures (excessive reaching, bending and twisting) was identified by the ergonomic analysis and design committee as the most frequent and severe risk factor for LBP in the dispatch department, followed by low job control.

4.2. Results of step 3 - solution building

Based on the results of the workplace analysis step, during the meeting where the ergonomic interventions were discussed by the steering committee and the ergonomic analysis and design committee, it was decided that the assembly line of the dispatch department was going to be combined with the assembly line of the boxing department and the assembly line's layout would be redesigned from a straight configuration to a circular arrangement (Figure 2).

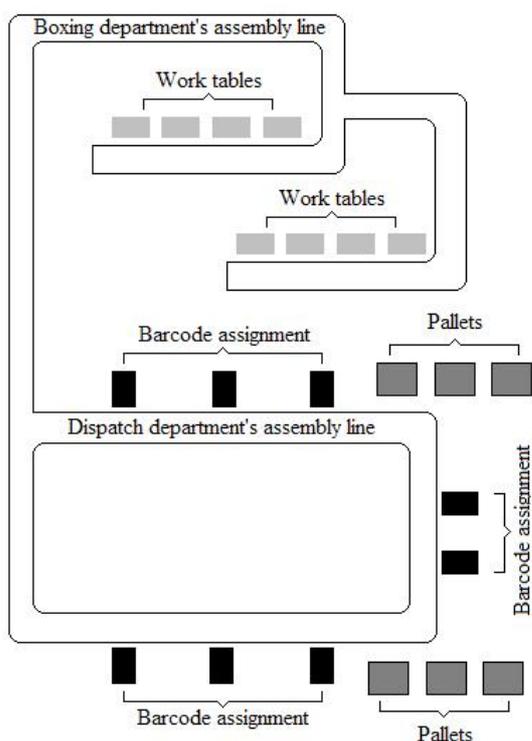


Fig. 2 - Boxing and dispatch departments' assembly line configuration after the intervention

This combination of the assembly lines eliminated manual material handling of boxes in the end of the boxing department's assembly line and in the beginning of the dispatch department's assembly line, two job tasks identified as posing an increased risk for lifting-related low back pain. The combination of

both assembly lines also created an opportunity for the enrichment of the dispatch department's workers' job, since they were relocated from the eliminated manual material handling tasks to the barcode assignment task, after receiving training.

The redesign of the assembly line from a straight configuration to a circular arrangement gave to the employees responsible for moving boxes from the assembly line to pallets on the ground more control over their jobs, since the assembly line's new circular configuration allows missed boxes to be moved to the pallet later, reducing the influence of the boxing department's assembly line on the dispatch department's work rhythm.

5. Discussion

As a result of the combination of the dispatch department's assembly line with the assembly line of the previous department (responsible for boxing sold products), two job tasks that involved manual material handling of boxes, identified by the revised NIOSH equation [34] as posing an increased risk for lifting related low back pain (Lift index > 1.0) were totally eliminated. Manual material handling involves considerable physical work demands and is considered to be high risk for the development or exacerbation of LBP symptoms; in fact numerous reviews have shown a relationship between manual material handling and musculoskeletal disorders in both industrial and health care settings [10].

The combination of both assembly lines not only eliminated two manual material handling tasks but also enriched the employees' jobs. It has been conjectured that work enrichment could provide both biomechanical diversity in work and the potential for muscular recuperation while securing long-term gains in organizational performance [36].

The redesign of the assembly line's layout, from a straight configuration to a circular arrangement, gave the employees responsible for moving boxes from the assembly line to pallets on the ground more control over their jobs. According to the work demand-control model [32], low control over one's job coupled with high demands, increases the likelihood of work-related health problems. In fact, in a longitudinal study of hospital workers [12], it was shown that low perceived job influence was an important predictor for musculoskeletal diseases; similarly, a longitudinal study of transit operators [25], showed that psychosocial factors were strong predictors of back and

neck pain independent of physical risk factor predictors.

The results obtained in this case study show that the intervention process was effective in reducing physical and psychosocial risk factors for LBP. These findings support the conclusion of a systematic review that PE is effective for reducing workers' exposure to both physical and psychosocial risk factors [14]. Other studies, however, showed that that PE led to statistically significant reductions in mechanical exposures among automotive industry workers [2], but did not lead to statistically significant reductions in psychosocial workload [1].

6. Conclusion

The case study presented here extends the literature on efforts to reduce the burden of WMSD by demonstrating that a PE intervention can be a viable and effective strategy to reduce the exposure to work-related physical and psychosocial risk factors for LBP. Moreover, this study strengthens the importance of employee participation in the whole process of change, since they know their workplace better than anyone else does and this knowledge allows them to develop a more thorough understanding of ergonomic problems and a more diagnostic approach to their solutions. As a result of the PE intervention, the assembly line of the dispatch department was combined with the assembly line of the previous department (responsible for boxing sold products) and the assembly line's layout was redesigned from a straight configuration to a circular arrangement. These changes eliminated two job tasks that involved manual material handling of boxes, identified by the revised NIOSH equation as posing an increased risk for lifting related low back pain (Lift index > 1.0) and gave to the employees responsible for moving boxes from the end of the assembly line to pallets on the ground more control over their jobs, which were also enriched with a new, less heavy task. It is expected that these improvements decrease the number of LBP complaints and sick leave because of back pain. The measurement of LBP incidence and sick leave in the dispatch department, after 6 and 12 month intervention period, is a priority for future research.

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