

**UNIVERSITY OF MEDICINE AND FROM CRAIOVA**

**DOCTORAL SCHOOL**



**PhD THESIS ABSTRACT**

**ERGONOMIC RISK FACTORS INVOLVED IN LUMBAR  
SPINE PATHOLOGY**

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## STATE OF KNOWLEDGE

Chapter I – *Spine anatomy* - reviews the concepts of anatomy, embryology and topography of the spine, essential knowledge for understanding of occupational diseases involving spine damage. Using data from the internationally recognized literature anatomy, embryology and regional differences in the structure of the spine are systematically exposed.

Chapter II – *Etiopathogenic aspects of spinal disorders* - this chapter describes the incidence, prevalence, etiology, pathophysiology and therapeutic indications (surgical and non-surgical) on the main spine diseases that occur in occupational diseases: kyphosis, scoliosis, hyperlordosis. The importance of this chapter consists of existing evidence in both classical and recent literature regarding the importance of this pathology in the genesis of occupational diseases involving the spine.

Chapter III – *Ergonomic evaluation of occupational risk associated with spine pathology* - This chapter deepens ergonomic assessment of professional risk associated with spine pathology using tools useful in risk assessment contained in ISO 11228-1, 11228-2 and 11228-3. Ergonomic Evaluation of risk from MHL, by the methods described above requires the participation of a multidisciplinary team: occupational physician, ergonomist, occupational safety responsible.

## PERSONAL CONTRIBUTIONS

PhD Thesis Objectives - workers spinal disorders entail high costs for employers caused by absenteeism, temporary disability, reintegration costs, lower productivity, stressing the importance of the addressed topic. This paper aims to study and achieve a causal link between professional activities involving manual handling of loads of different sizes and shapes and the risk of spinal static disorders. We will review several jobs in the motor and car parts industry involving a large number of employees in the Oltenia region. Despite technical advances, automation, mechanization and even robotization of technological stages, a large number of

employees are involved in various stages, including the control of the finished product. The increased incidence of vertebral static disorders among these employees led us to address this issue. The main objectives are to identify those activities that constitute a health risk to employees and other secondary etiologic factors. We also track the usefulness and accuracy of the data provided by the standard methods for assessing ergonomic work stations, namely ISO 11228-1, ISO 11228-2 and ISO 11228-3. Other purposes are:

- Identifying risks / causes
- Implementing standards for the design of new industrial machinery

**Methods** - The first aspect is medical. We will follow here the symptoms and clinical examination repeated over three years, during periodic medical examination of employees. Clinical examination will pay increased importance to the examination of osteo-muscular-articular system, analyzing the specific indices. A medical questionnaire for joint disorders will be used. The main issues pursued in the questionnaire: pain intensity, identifying activities with high-risk for pain induction, professional and extra-professional life impairment. Also it will seek medical absenteeism due to temporary disability due to osteo-muscular-articular diseases.

The second issue will be pursued in parallel and is represented by ergonomic assessment of work places according to European standards: ISO 11228-1. Ergonomics - Manual handling - Lifting and carrying - 2003; ISO 11228-2. Ergonomics - Manual handling - Pushing and ISO 11228-3 and pulling- 2007: 2009 Ergonomics - Manual handling - Part 3: Handling of low loads at high frequency. This evaluation was undertaken in agreement with the employer, respectively safety and health at work service. This evaluation consisted in tracking the movements and activities performed by an employee during a work shift, namely, average and maximum weight handled manually, the frequency of lifting, height from which and to which is raised, distance of load carrying, posture during these activities.

## ASSESSMENT OF KEY DEMOGRAPHIC AND OCCUPATIONAL

### FEATURES OF THE STUDIED BATCH

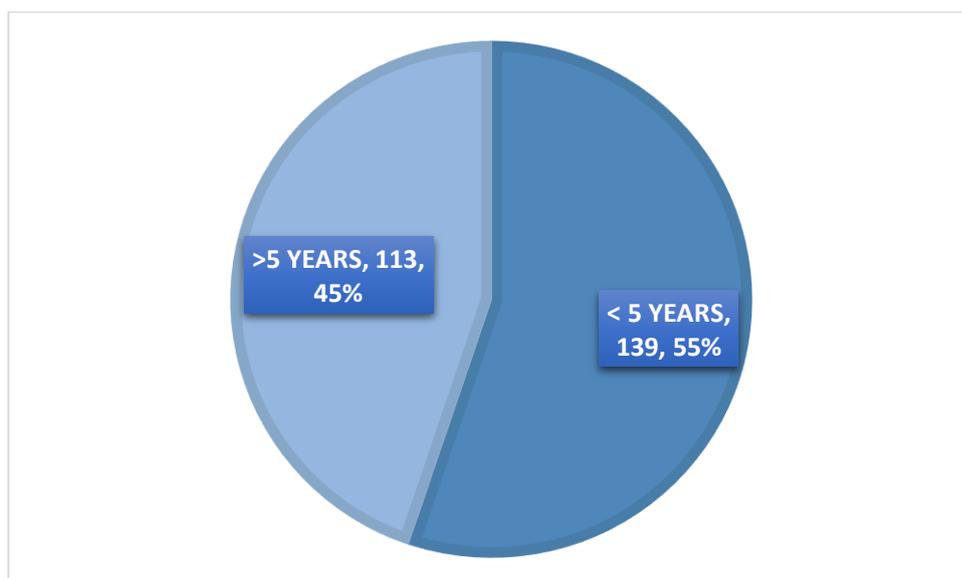
#### 1.1. DISTRIBUTION ANALYSIS BY GENDER

The study group reflected the demographic structure of the population at risk represented by the employees of cars industry. Therefore their distribution by gender will favor the male population that is prevalent in this industry, especially in heavy industry and engineering.

In the sample selected for this study male population accounted for nearly three-quarters of the sample size, including a total of 192 male employees. Female employees were in the minority, representing only 24% of the total number of employees, being represented in the study batch by a total of 60 female employees.

#### 1.2. ANALYSIS OF LENGTH OF SERVICE IN EMPLOYEES

Same customized distribution on the job profile required by the employer whose enterprise is imposed by organizational requirements on the one hand and on the other hand by the need to maintain quality standards.

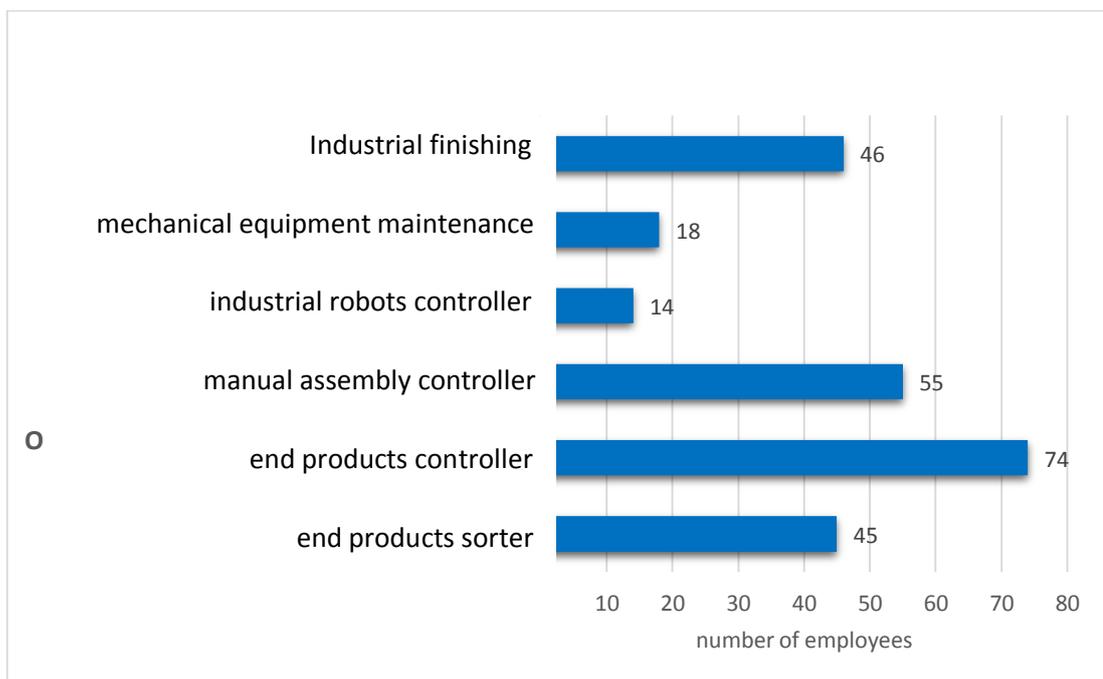


**Figure 7 – The relative frequency of employees according to work experience**

Almost half of the total employees already had a work experience of less than 5 years (113 of employees), the proportion of those older than 5 years in the organization structure being 44.8%. Only less than 20% of employees had a work experience of less than 50 years at the time of the study, only 50 employees did not have a work experience of more than 3 years, this meaning that one in five employees were employed with a profile oriented occupational category with little experience and low skilled or perhaps more than average.

### 1.3. REPARTITION OF EMPLOYEES BY WORK PLACE SPECIFICITY

Most employees worked as operators of products in the quality control of finished products, a total of 74 employees occupying this position, their share in the lot being almost 30%. The second category of employees worked as operators manual assembly, a number of 55 employees with this position, their representation in the lot being over 20%. Almost 50 employees occupied industrial finishing position (46 employees), their share is less than 20%.



**Figure 12 - Distribution of employees according to the position occupied in the company.**

### MEDICAL HISTORY OF COMPROMISED VERTEBRAE OR LIMBS

The possibility of employee personal history of traumatic events spine or other parts of the osteoarticular apparatus which concerned and affected upper limb and

lower limb was assessed by asking respondents to indicate whether he suffered from diseases or surgery on them.

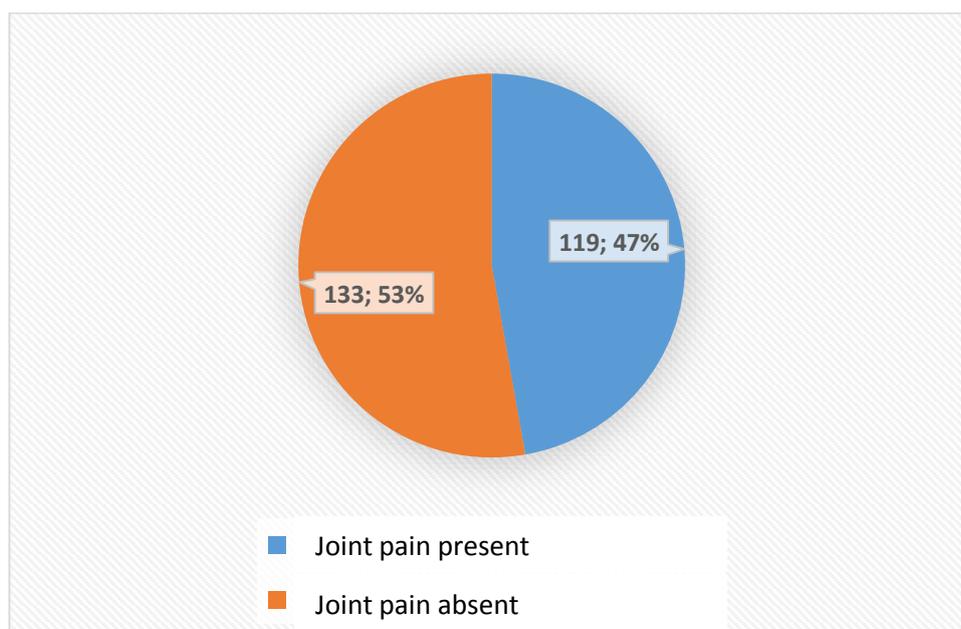
Thus, it was found that almost half of the employees surveyed had a history of pathologic events of different severity in the spine and / or limbs, mostly small and not serious childhood trauma type, but in subjects over the age of 20 years, the medical history noted the alarming increase in the spine or limbs pathology probably related to work usage.

## JOINT PAIN FREQUENCY AND IMPACT ANALYSIS

### 3.1. JOINT PAIN FREQUENCY IN THE LAST 12 MONTHS

Joint pain assessment covered a longer period of time, their frequency being pursued in employees for a period of 12 months.

The incidence of joint pain in the group of employees was rated 47%, almost half of the employees recognizing that they had experienced joint pain in the last 12 months from the date of the questionnaire, representing 119 of the employees evaluated in the lot. The frequency of back pain was noted in almost two thirds of female employees, a number of 39 women employees being from a total of 60 female employees being affected in the last 12 months by joint pain, adding up to an incidence of 65%.



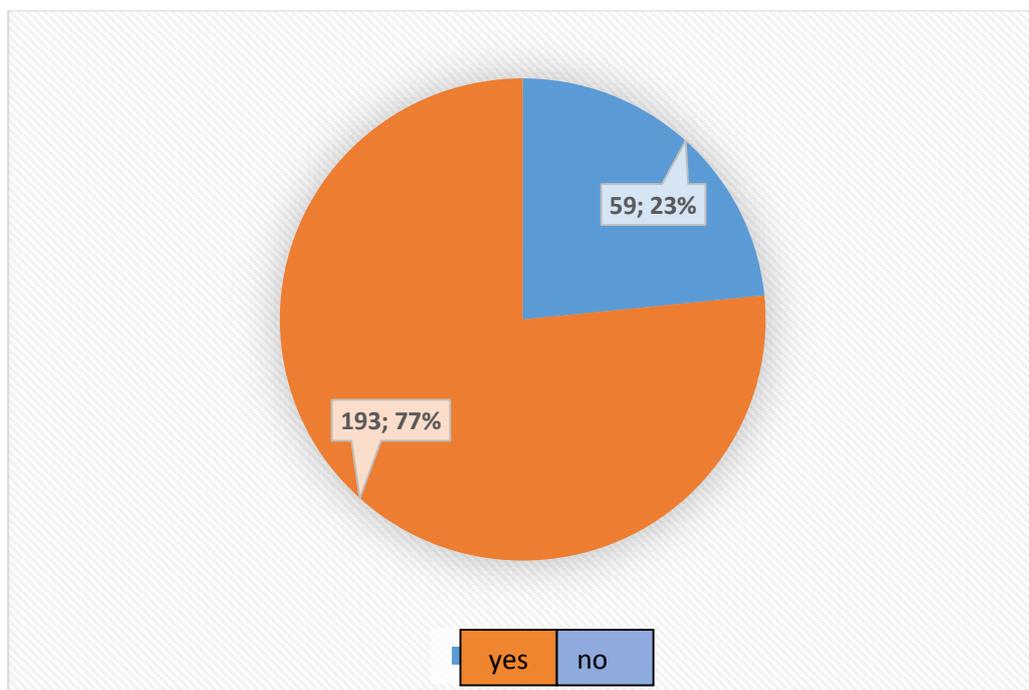
**Figure 21 - The incidence of back pain in the group of assessed employees**

## 3.2. JOINT PAIN IMPACT

### 3.2.1. The extent to which joint pain affected daily activities

A total of 59 employees stated that pain occurred in the last 12 months have prevented normal housekeeping or leisure activities. The incidence of damage to normal activities because of joint pain that occurred in the last 12 months in the study group was 23%.

In females, 27 of the 60 women included in the lot felt that pain affects their daily living activities, therefore almost half of employed women (45%) felt they were prevented by the painful symptoms to carry out current activities. By comparison, in males, only up to 16.67% of current activities suffered due to joint pain. (32 out of 192 employees).



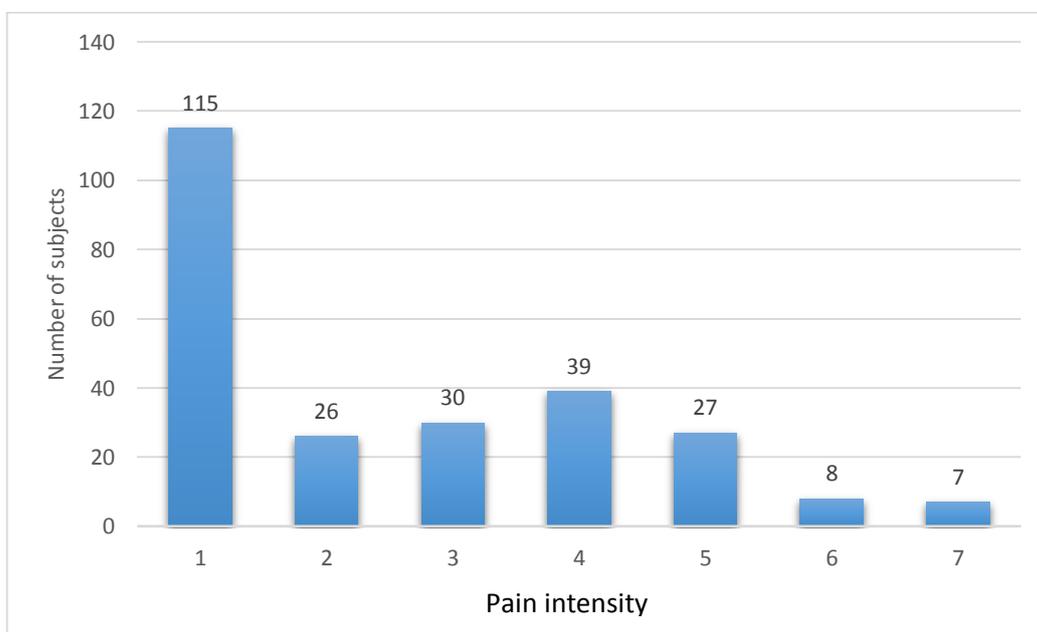
**Figure 27 - Impact exercised by the the presence of joint pain to normal activities.**

## 4. ANALYSIS OF JOINT PAIN INTENSITY TO EMPLOYEES

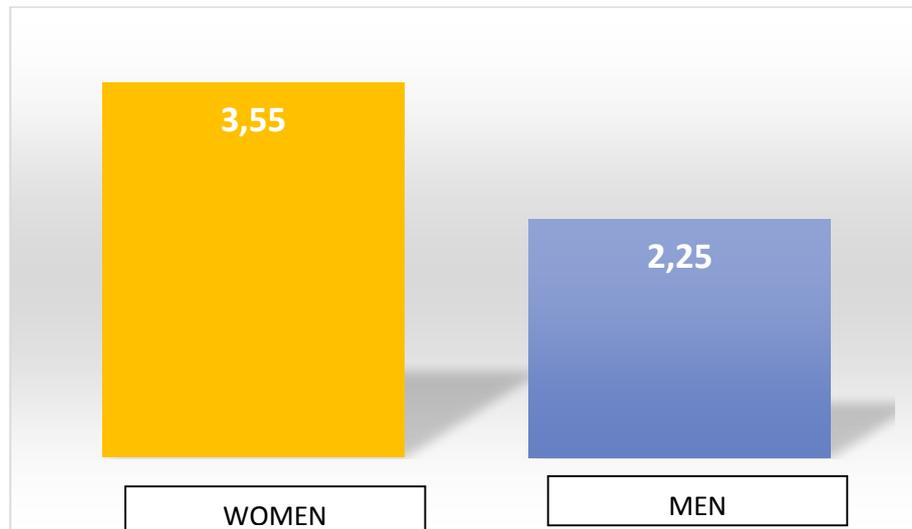
Most employees accused a minimum intensity of pain, a number of 115 employees estimating the intensity of pain as Grade 1, which means that almost half of the employees from the automobile industry (45.63%) had a minimum level of pain. Along with employees whose own estimates put the pain intensity felt in grade 2 (26 employees), subjects who were classified as having mild pain (141 employees) accounted for more than half of the evaluated employees (55.95 %).

Nearly 40 people have felt a pain intensity grade 4 (39 employees), representing 15.48%. Thus, an average pain intensity corresponding to grades 3, 4 and 5 was declared by a total of 96 evaluated employees; average pain intensity was assessed at 38% of the automobile industry employees.

The estimate by calculating the average of the degrees of pain in men and women showed that women tend to perceive joint pain as having a higher level compared to males. In these average pain intensity was  $2.25 \pm 1.64$ , placing the male perception of pain intensity rather to a low level compared to women who had an average pain intensity level ( $3.55 \pm 1.73$ ).



**Figure 45 - Distribution of employees according to the degree of pain intensity.**



	N	Mean	IC95%	DS	Mean	Min	Max
WOMEN	60	3,55	3,103 - 3,997	1,7313	4	1	7
MEN	192	2,25	2,016 - 2,484	1,6405	1	1	7

**Figure 47 - The mean values of pain intensity in the two sexes.**

## ELEMENTS OF WORK ERGONOMICS INVOLVED IN THE EMERGENCE AND MAINTENANCE OF PAIN

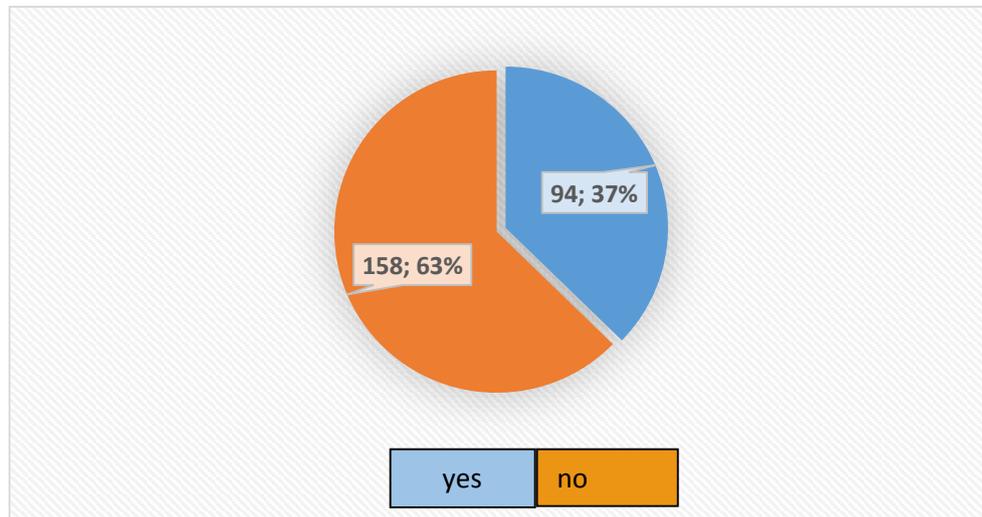
### 5.1. PAIN AT WORK

Occupational environment is the one that shapes the risk profile of the health of employees through the nature, intensity and frequency of required activities that expose humans to pressures exceeding its responsiveness and adaptability. It is responsible for the pathology of the spine in many situations, which however can be enhanced by occupational risk factors of external environment but end up generating amplified pathological effects.

In the present study, the analyzed population was affected of employees by pain during the working hours, thus affecting occupational activities at an impressive number of employees (132 employees). Basically, more than half of the employees included in the study (52%) were affected by pain occurred at the workplace.

## 5.2. PAIN CAUSED OR AGGRAVATED BY WEARING WEIGHTS

A total of 94 of the 252 subjects evaluated on the ergonomic factors involved in pain management in occupational context had pain that was caused or accentuated by workloads involving weight bearing.



**Figure 65 - The incidence of pain caused or aggravated by weight bearing.**

Over a third of employees surveyed identified as one of the triggers or potent pain involving weight bearing activities, 94 employees recognizing that such activity affects their pain at the workplace (37%).

## 5.3. PUSHING OR PULLING LOADS

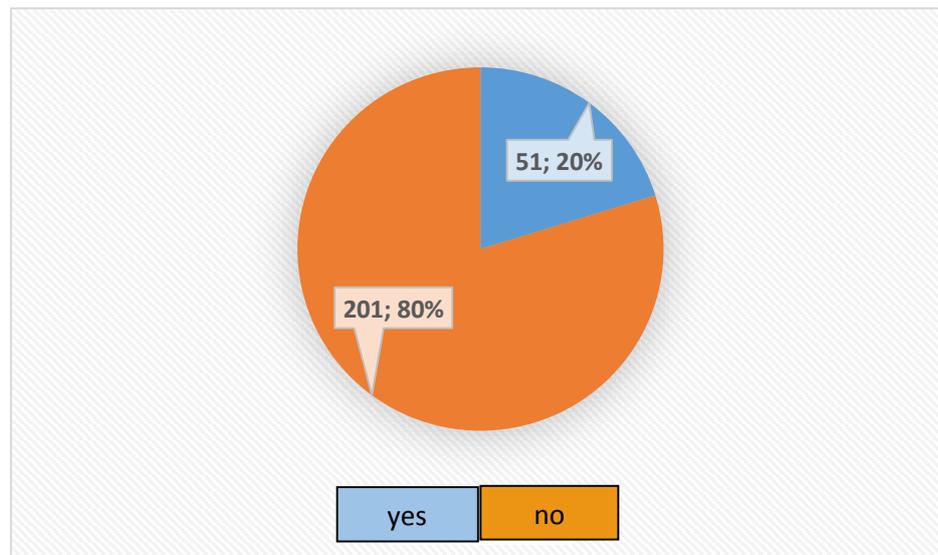
Pushing or pulling weights was assessed as one of the activities that may affect employees by triggering or worsening pain. In a total of 38 subjects pain was affected by occupational activities involving pushing or pulling weights (i.e. trolleys), meaning a 38% rate of pain triggered by this type of activity.

Involvement in such activities predominantly of young, male employees exposed them to a higher risk of pain associated with this type of physical activity. Men were 1.4 times more affected regarding pain triggered or aggravated by pulling or pushing weights, representing 66.7% of them opposed to women (46.7%); concerning decades of age, those under the age of 20 were 100% affected and those in the age group of 20-29 years, 66.99%.

Female gender seemed most affected by the impact of weight lifting above shoulder women noticing the pain rate influenced by the activities of 33.3%, which is double the frequency observed with male employees. (16.1%).

#### 5.4. LIFTING WEIGHTS ABOVE THE SHOULDERS

A total of 51 employees said that the pain is influenced by the work activities that involve lifting weights above the shoulders.



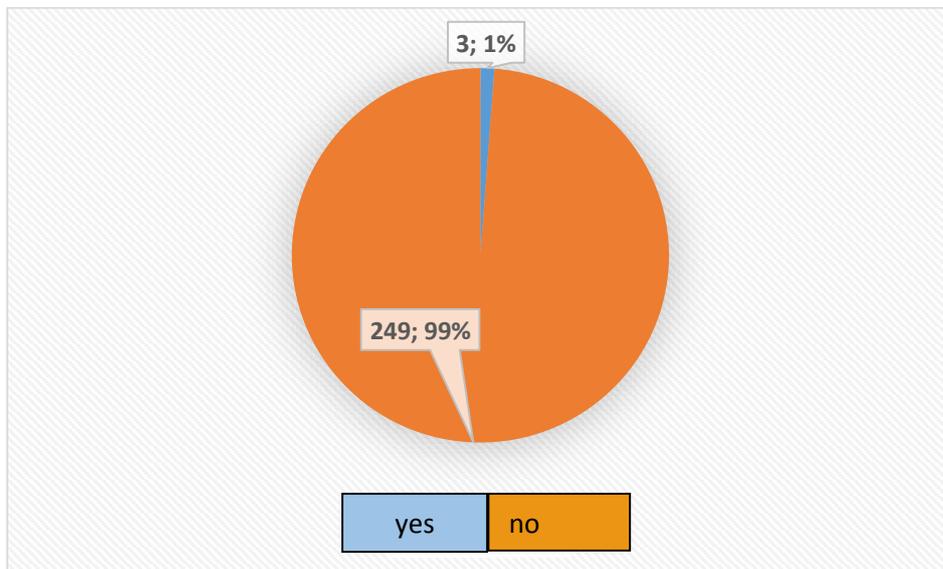
**Figure 76 - The incidence of pain influenced by occupational activities that involve lifting weights above the shoulders.**

Female gender seemed most affected by the impact of weight lifting above shoulder women - 33.3%, which is double the frequency compared with that observed by male employees (16.1%).

#### 5.5. WEIGHT LIFTING THAT REQUIRE BENDING

Apparently surprising only 3 employees stated that their pain is caused or exacerbated by workplace activities that involve heavy lifting that requires bending, its rate being only 1.3%. The explanation can be given, however, by the success of programs concerning work ergonomics that have identified this type of occupational activity as probably the most heavily involved in the development and worsening of pain, especially lumbar. Ergonomic measures aimed at limiting the activities of employees involving such movements and increasing the ergonomics of production flow by identifying positions and gestures that do not require such work seems to have led

to a significant decrease of impact, at least in the occupational target, of one of the most common causes of back pain.



**Figure 77 - The incidence of pain influenced by occupational activities that involve lifting weights that do not require bending.**

### 5.9. ERGONOMIC ASSESSMENTS

All workstations were analyzed ergonomically: manual handling of loads (lifting, carrying, pulling, pushing), repetitive movements.

According ergonomic evaluation, mechanics and operators of finished products have the highest risk. They frequently lift and carry weights exceeding 3 kg. (NIOSH Lifting Index 3,01; 3,38).

Job	Activity assessed: Lifting objects	
	NIOSH - Lifting Index	Risk Level
Industrial finishing	3,01	3
mechanical equipment maintenance	3,38	3
industrial robots controller	0,00	0
manual assembly controller	1,02	2
end products controller	0,00	0
	1,35	2

**Table 51 - Ergonomic Assessment - NIOSH - lifting index, according to profession**

## DISCUSSIONS

It was noted that employers tend to select according to their needs mostly young employees, preferably over 22 years and under 40 years. It was also noted that there are two peaks at the age of employees, one from 23 to 28 years and another 33 to 34 years. Specialized jobs will push the average age to higher values corresponding to necessary qualifications and experience required by the employer to occupy the position. Women employed in the motor industry generally occupy positions that require a high level of expertise, which may be one of the potential reasons for the higher average age of 8 years compared with men. The female employees average age was  $38.55 \pm 4.99$  years.

It was noted that there are two peaks in the manner of distribution of the number of employees according to length of service. The first sub-group emerges around the age of 2-3 years corresponding to employees with a lower level of specialization or another sub-group corresponding to employees with an experience of 6 years.

Analyzing the distribution of positions in the company by gender, it was noted the preponderance of male employees. The positions of finished products sorter or manual operators were occupied mostly by males. Almost half of the employees surveyed had a history of different gravity pathological events of spine and / or limbs, more common in women.

Age appears to be a cumulative factor in the medical history of the osteoarticular system, being observed an average age of those who acknowledged their presence in the history of trauma or other type of suffering. The excess risk assigned by stress caused by occupational risk factors captured a risk of medical history of the spine or limbs almost 2 times higher in workers who had work experience of less than 5 years compared to those with a minimum length of less than 3 years.

## CONCLUSIONS

One of the factors that modulates strongly the occupational pathology of employees is age, which is generally low, the employer preferring young workers. However the occurrence of lumbar suffering in the context of low age suggests strong impact of occupational stress that takes away the physiological advantage provided

by ages under 40, detaching itself as one of the most important of adult suffering. Strong correlation between joint and muscle pain with length of service rather shows the importance of exposure to risk factors in the occupational environment than natural link between increased frequency, intensity and impact of low back pain with age.

The pressure of occupational risk factors is managed differently by the two genders the higher vulnerability of females to solitary occupational activities being expressed by a higher incidence of back pain, intensity and its impact on current activities and the work is one of the factors explaining the propensity of employers to hire, at least for certain posts male of employees. Concern for analyzing the impact of low back pain is justified primarily by the need to combat or control the effect of painful symptoms and limit the frequency and degree of exposure to risk factors associated with employees health.

Equally it is also justified by its effects on their comfort and ability to conduct in an optimal framework not only occupational activities but also leisure and extra occupational current activities, all directly affecting site performance and productivity. Knowing the correct ergonomic workplace framework and its real effects on health, comfort and performance must be a priority both in occupational medicine specialists and employers. Multidisciplinary collaboration in understanding and managing ergonomic risk factors involved in the development and maintenance of lumbar suffering and not only remains the most feasible approach to control and limit the impact of ergonomic risk factors.

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