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EVALUATION OF A PRODUCTION PROCESS IN THE FOOTWEAR INDUSTRY FROM THE POINT OF VIEW OF ERGONOMICS

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SUMMARY

This study was motivated by the importance of the production process of a specific model in a footwear industry. The process encompasses three operations, the main one for the study being the application of glue to the shoe strap. This activity requires a high level of attention, it is the main part of the production flow, as any error can cause unusable results that will often only be observed at the end of the process, it also has interactions with various tools, and it has activities with a high number of repetitions. It has two method proposals for its implementation, in this sense the study sought to analyze these two work methods and the impacts of physical, organizational and psychological demands, aiming to contribute in a relevant way to the industry in the development of new products/processes and with the operator's quality of life. As a methodology, the use of specific process and ergonomics tools, direct observation with photographic records, and application of socio-demographic and occupational, Nordic and JSS - Karazek questionnaires to employees, were essential to obtain data to achieve the objective of this research and evaluate which of the two processes can favor the performance of the activity and the health of the operator. 24 operators who carry out the three operations participated in the research, representing the three work shifts. Based on the analysis of the tools used, negative points were identified in the two methods in comparison, highlighting the existence of occupational risk that could contribute to the emergence of complaints, and thus, recommendations were proposed aimed at improving the quality of the glue application activity and However, it has been pointed out which is the most suitable process.

Keywords: Ergonomics; Footwear Industry

1. INTRODUCTION

According to data from the Brazilian Association of Footwear Industries - ABICALÇADOS (2019), the production, export and import of footwear will see growth, even if small, in global footwear production. In 2016 production was 932 million pairs, in 2017 it was projected to increase by 942 million pairs, in 2018 944 million and for 2019 the projection is for a growth of 3%. In this sense, flexibility for the production of new articles in the footwear industry is essential for its maintenance and competitive advantage in the market (ULUTAS; ISLIER, 2015). This also means that new jobs will be created, requiring more employees on the production line exposed to ergonomic risk factors, unsafe conditions in the work environment and an increase in illnesses at work, given that the production system requires the worker to have knowledge and several skills, in particular, related to precision and manual dexterity (LUZ et al., 2013).

An important point is the increase in rates of absences due to occupational illness in industry and services, between 2004 and 2014 this number grew 9.4%, reaching almost 181 thousand cases in 2014 in Brazil, according to the Inter-Union Department of Statistics and Studies Socioeconomic - DIEESE (2016, p.28). It is known that occupational disease is the same as professional disease, recorded by Delgado (2010), it is any disease “produced or triggered by the exercise of work peculiar to a given activity and included in the respective list drawn up by the Ministry of Labor and Social Security” (Senate Federal, 2016). In the state of Paraíba, the number of INSS absences related to musculoskeletal and connective tissue diseases, which are “motivated by situations related to ergonomics and work organization” (Ministry of Social Security, 2015), reached 4,718 cases among 2012 and 2017, according to the Observatory of the Public Ministry of Labor. The footwear hub of Paraíba was concentrated with 96.9% in 2018 in the city of Campina Grande, the object under study, according to the ABICALÇADOS 2019 survey, encompassing the manufacture of footwear in general, the main product being flip-flops of rubber.

Rubber slippers are formed from six processes, depending on the model, the simplest ones go through fewer processes, namely: mixing, vulcanization, injection of the strip, stamping, which can be on the strip with film or on the slipper with film or paint, accessories and assembly. Mixing is the initial process, in which the entire combination of raw materials is made to prepare the rubber. The next process is vulcanization, where the rubber from the previous process will be used and pressed to shape the slipper. After that, it can go to finishing where it will be assembled or to printing, where the arts and designs are applied. Parallel to these processes, there is the injection of the strips, which will be used in assembly, but can also go to the stamping process, and/or to the accessories application sector.

The focus of this research is on the strip printing process, characterized by the application of an adhesive with drawings and then going to the accessories process, followed by assembly. There are two methods for this process, one is approved and in use and the other is being analyzed for implementation. Both are done manually using a brush as an instrument for applying the glue and the main difference between them is the one under analysis uses a template to fix the strips, assisting in the application process. This process is new at the factory and is growing exponentially, which is why there is great concern on the part of the managers involved regarding quality, since in parallel with the increase in production the defect rate has increased.

2. OBJETIVES

2.1 General

Study in a comparative way two production processes of a work cell, from the point of view of Ergonomics

2.2 Specifics

Evaluate and compare the two work processes in terms of physical and biomechanical demands, cognitive demand and organizational demand;

Evaluate and compare complaints of pain/discomfort and musculoskeletal overload of the two production processes;

3. MATERIALS AND METHODS

3.1 Study location and population

The location chosen for the development of this research was in a shoe factory in Paraíba whose main objective is the manufacture of rubber slippers. Although the factory has a multitude of processes, from the preparation of the raw material to the distribution of the product, this research is limited to a specific printing process only on the slipper strip, covering two operations, applying the glue and apply the transfer film.
The research will involve a group of workers in these processes, including men and women of different age groups and different lengths of time at the company. In total, there are 24 employees on the three shifts, representing the study population.

3.2 Sociodemographic questionnaire

Questionnaire aimed at surveying the sociodemographic profile containing variables of individual, psychosocial, institutional, personal and work ability aspects.

3.3 Nordic Questionnaire.

Standard Nordic questionnaire corresponds to a self-response form, applied with the aim of standardizing types of measurement of descriptions of musculoskeletal symptoms and, thus, facilitating the comparison of results between studies related to work activities (PINHEIRO; TRÓCCOLI; DE CARVALHO, 2002). This questionnaire is recognized worldwide for its simplicity of application and good reliability rates. It evaluates musculoskeletal problems within an ergonomic approach, for this reason, it is an important instrument for identifying musculoskeletal symptoms in the workplace (MESQUITA; RIBEIRO; MOREIRA, 2010). The authors of this questionnaire do not indicate it as a basis for clinical diagnosis, but for the identification of musculoskeletal disorders and, as such, it can be an important tool for diagnosing the environment or workplace. It consists of a human figure divided into nine anatomical regions, consisting of multiple or binary choices regarding the occurrence of musculoskeletal pain in these regions. The respondent must report the occurrence of symptoms considering the 12 months and seven days preceding the interview, as well as reporting the occurrence of absence from routine activities in the last year.

3.4 Job stress scale – short version

Task control and demand questionnaire (Job Stress Scale – Karazek) composed of 17 questions: five (from the letter A to E) are designed to evaluate the psychological demand dimension, six (from the letter F to K) to evaluate the authority over decisions and six (from the letter L to Q) to evaluate social support in the workplace. In Brazil, the Job Stress Scale

(JSS) questionnaire was validated and adapted into Portuguese by Alves et al., (2004). In this questionnaire, all questions receive scores from one (1) to four (4), based on their own score.

4. RESULTS AND DISCUSSION

4.1. Sociodemographic and occupational parameters of operators

The 24 operators participating in the study responded to the socio-demographic questionnaire. This tool included some analysis variables, previously chosen and categorized with the aim of understanding the socio-demographic characteristics of this population and also identifying the perception that operators present on organizational issues related to the work environment. Thus, the following results were found:

It was found that in the composition of the general population under study (n=24), the male gender is predominant, corresponding to 100%. The work shift was related equally, that is, 33.33% corresponds to the 1st shift (6am to 2pm), 33.33% to the 2nd shift (2pm to 10pm) and the remainder to the 3rd shift (hours 22h to 00h).

The population was classified into three age groups: up to 25 years of age, with the youngest operator being 19 years old (representing 42%); between 26 and 35 years old (representing 37%), and operators over 36 years old (representing 21%) with the oldest being 51 years old, resulting in a young population.

From data analysis, it was generally clear that the population (n=24) is young (up to 35 years old) and mostly male, having completed high school, with 42% below that, as it is not A prerequisite for entry into this position is having completed high school. This is due to the fact that the industry under study has a wider range of processes with a high workload and a high level of repetitiveness, these processes being aimed at males and young people are the most cited because they do not have vices brought from other factories. , making it easier to “shape” according to the culture. This is relative in the footwear industries, depending on the footwear produced, with women as a population and a higher age group, as, for example, in the research by Santos (2016). In Lima's research (2011), the majority are female, which depending on the shoes manufactured is the most suitable, if you work with sewing, for example, as it is something detailed. In the research by Medeiros Neto (2012), the sample was mixed, men and women.

In the process using the support, it was observed that in relation to the item “safe and effective leadership” there was a significant difference in scores in all comparisons between groups, with the glue group having the highest score, followed by the Print Applicator group and then the Printing Operators. Machine (p=0.014). The glue group also reported more discomfort in relation to the temperature of the work environment in relation to the other groups, followed by the Print Applicator group in relation to the Machine Operator group, where no discomfort with the working temperature was reported (p=0.005). Coutinho (2005,P. 155) states that workers can contract various diseases due to exposure to high temperatures, such as cataracts and psychoneurotic disorders.

The Print Applicator group reported less discomfort with noise in the workplace compared to the other groups (p=0.04).

In relation to pain or discomfort during activities, machine operators reported less discomfort compared to other groups, which is in disagreement with the study by Renner (2002) which states that, in standing posture throughout the working day, which is In the case of the workplace under study, there is a larger group of muscles acting against gravity and greater pain discomfort, adding to the fatigue mechanism early. The authors Nordin and Frankel

(2003) also state that maintaining a standing posture requires a continuous contraction of the muscles responsible for supporting this position. But, at the same time, the other operation that was also performed on the foot had a high level of discomfort, in line with the study.

In the process using the template, statistical significance was observed in only one parameter. The issue was the issue of difficulties due to the lack of working space, a complaint most reported by the Print Applicator group in relation to the other groups, which is justified by the greater number of forks on the bench, since with the use of the template the number of fork pairs/hour increases. In relation to pain/discomfort during activities, a trend towards statistical significance was observed (p=0.08) and, as in the Support process, the Machine Operator group reported lower pain/discomfort scores.

4.2 Prevalence of musculoskeletal pain according to the function performed

The prevalence of musculoskeletal pain was also assessed through the application of the Nordic questionnaire, and the frequency of changes between the groups of each process (Support and Template) was compared.
The Machine Operator group was the one with the lowest prevalence of musculoskeletal pain in the regions of the Nordic questionnaire, where the majority had zero % of reports. The regions that presented complaints representing 33.3% were: neck, upper back, ankle/foot, figure 1. The only region in which the operator was out of work was related to the upper back in the last 12 months.
The Print Applicator group had a higher frequency of reports of musculoskeletal pain. The regions with a significantly increased frequency of pain in this group were: neck problems in the last 12 months, neck problems in the last 7 days, hand wrist problems in the last 12 months and which caused them to stop working (50%), knee problems in the last 12 months (66%), which caused them to stop working (50%) and in the last 7 days (50%), and in the same way as knees, pain in the foot/ankle (Figure 2).

Figure 1 - Complaints musculoskeletal – Operator Machine

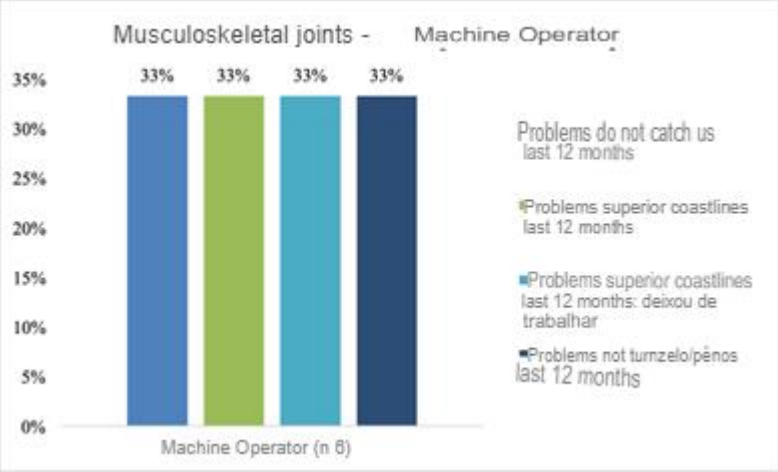


Figure 2 - Complaints musculoskeletal – Applicator Print

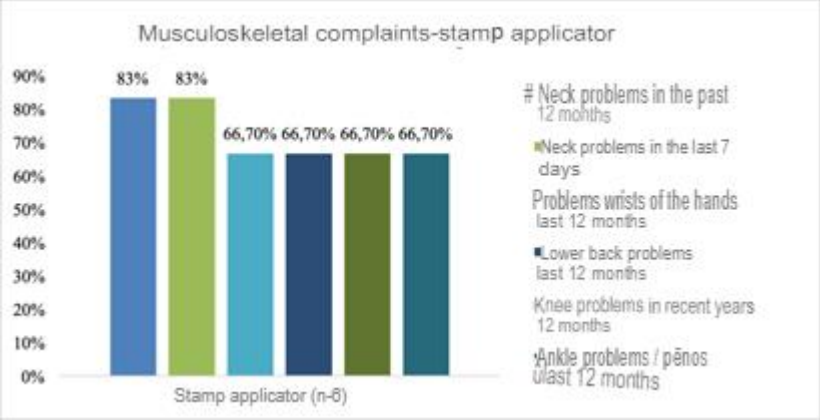
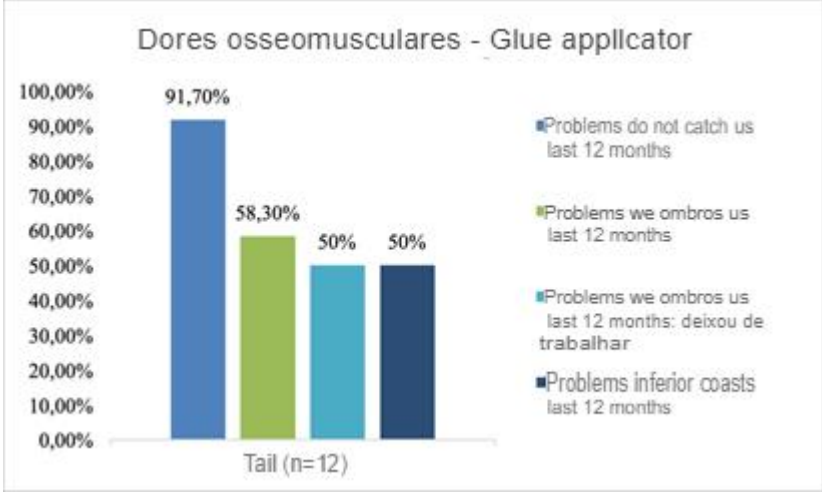


Figure 3 - Complaints musculoskeletal – Applicator Glue



It can be seen that in both operations that are performed standing up, problems with the knees, feet and ankles have been reported, which are justified by the static position of the operation and according to studies (Antle and Côté, 2013; Lin et. al. , 2012). These problems are directly associated with a significant increase in fatigue at the end of the working day (Zander et. al., 2004), which can lead to an increase in absenteeism, a drop in productivity, and an increase in the number of employees unused.

The Glue Applicators group showed a significantly increased frequency of neck problems in the last 12 months, figure 3, and a significant frequency of shoulder problems that stopped working in the last 12 months, lower back. Since most of the time during the activity, during the actual application of the glue, your neck is flexed.

In relation to the Template process, fewer statistically significant changes were observed between the groups. The machine operator group presented a significant frequency of shoulder pain in the last 7 days, having stopped working in the last 12 months, upper back.

Machine operators had a higher frequency of pain in the wrists, upper and lower back and ankle/foot all in the last 12 months and with absence from work.

The Cola group had more problems with their right wrist, neck and upper back, all in the last 12 months. This reflects the posture during the activity, as the glue is applied with a

brush in the right hand, always varying flexion and extension and with repetitive movements.

Guimarães (2004), explains the reason for this characteristic of repetitive activities and increase in simplified tasks, as the footwear industry has not kept up with the technological evolution of other industrial areas, which maintains a manual process

Comparing the two production methods, a greater frequency of neck problems was observed in the last 12 months, in the last 7 days and in the lower back in both processes. The feedback process showed a statistically significant increase in frequency in the upper back in the last 12 months and in the shoulders in the last 12 months of stopping work. The support process has shown significant significance in the last 12 months.

Given the special attention to shoulder postures, as Colaço (2013) states that it is a part more sensitive to risk and is present in the indications of the questionnaires applied in both processes. During the application of glue using the support and with the aid of the template, it is necessary for the operator to maintain a static posture with the right shoulder holding the fork or the template, respectively, throughout the application of the glue, placing inappropriate load on the glue. member.

According to Couto (2007), pain and discomfort are just some symptoms derived from anti-ergonomic situations, such as: poor posture of the spine, arms and legs for a long period of time, as well as repetitive and static movements that favor musculoskeletal diseases. in the footwear sector.

Corroborating these data, the studies by Lourinho (2011) and Moretto (2017) also presented several risks that contribute to the development of occupational diseases, and comparing the three operations in this research with the activities analyzed by these authors, all ergonomic conditions indicate postures inadequate, associated with repetitiveness of the upper limbs.

4.3 Prevalence of occupational stress according to the role performed

When evaluating the prevalence of occupational stress through the application of the Karazek questionnaire, differences in frequencies between the groups were observed only in two items: “need to do tasks quickly” and “work demands a lot”, both in the Support process and in the Support process. Template. The Print Applicator group showed a frequency of 83% that they sometimes need to do tasks quickly and 67% considered that the work is very demanding in the Support process. In the Cola group, it was reported by 50% of employees that they need to do the task quickly. Regarding the assessment of occupational stress using the Karazek questionnaire, an equal frequency was observed between the two processes, with no statistical difference between them.

Guimarães (2002) comments that the importance of ergonomics also focusing on a broader context, not just restricting itself to workplace issues, but also acting at an organizational level.

4.4 Occupational parameters and work capacity between the same employees in different production processes: Support and Template

In relation to occupational parameters and work capacity. significance was observed in two items: “difficulties due to little work space” and “sufficient lighting for activities in the sector”, where the Template process was related to more difficulties due to little space (figure 8) and they reported sufficient lighting to carry out activities in the sector. In which the difficulty in space is characterized by the use of the template that takes up more space than the support, leaving the bench with limited space for the two operators. Two variables that were listed by Pereira and Lech (1997) as contributing to the origin of WMSD.

In the assessment of the requirement for speed even when complying with the schedule, a higher median was observed in the answer key group. One possibility for this requirement to occur in this specific group is that with the change in the process that increases the number of fork pairs per hour, the machine operator receives more pairs on

the bench, and the production leader, erroneously, demands a faster than the aforementioned operator. Daniels et al. (2005) and Gascón et al (2013) state that work demands play an important role in the consequences of workload and its worsening.

Regarding the time being sufficient to complete the work, it had a median of 5 in both production processes, not having statistical relevance, the same happened regarding the temperature being uncomfortable for work, but it had a greater range, reaching the maximum choices, which presents yes, discomfort due to the temperature in specific classes.

The group of operators who make up the support process stated that the noise actually interferes with the activities they perform, this is because the location of this process is close to the heavy machinery sector, which generates noise for the surrounding sectors. As Du and Weerdmeester, 2012 state, environmental factors such as noise, climate, lighting, do have an influence on the health, safety and comfort of individuals.

5. CONCLUSIONS

With the Nordic Questionnaire, it can be seen that the two processes have a higher incidence of pain in different locations, with the support being on the neck, hips and thighs, while the process with the template has it on the left shoulder (the shoulder that holds the template) , right wrist and upper back.

Regarding the KARAZEK questionnaire, the process with the answer sheet reported that it presents a difficulty due to the limited space and that the lighting is sufficient in the workplace. For the Pain and Discomfort and Work Ability options, there were no significant differences.

Regarding the hypothesis that pain is present in both production processes, but in one of them the prevalence of pain will be greater is correct, in sum, the presence of pain is greater with the template process. The highest incidence of pain when using the support is in the neck and elbow, as the figure shows that the posture of the activity changes these areas. When using the template, the shoulder, wrist and back are superior, precisely due to the posture in holding the template.

Regarding the hypotheses that the three physical, cognitive and organizational demands impact the production process, they were refuted, as despite what was evidenced in the research at the time of the evaluation, no negative loss in production volume was observed, but they must be worked on to minimize them. and even eliminate them.

With all these analyzes and observations, it is concluded that the most appropriate process is to use the template, with interventions and improvements still being necessary.

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