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

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Abstract

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 one in the production flow, since any error can generate unusable items that will often only be noticed at the end of the process. It also involves interactions with several tools, and has activities with a high number of repetitions. It has two proposed methods for its execution. In this sense, the study sought to analyze these two work methods and the impacts of the physical, organizational and psychological demands, aiming to contribute in a relevant way to the industry in the development of new products/processes and to the quality of life of the operator. As a methodology, the use of specific process and ergonomics tools, direct observation with photographic records, and application of sociodemographic and occupational questionnaires, Nordic and JSS - Karazek 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. Twenty-four operators who perform 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, evidencing the existence of occupational risk that can contribute to the emergence of complaints, and thus, recommendations were proposed aiming at improving the quality of the glue application activity and also indicating which process is the most suitable.

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 have a growth, even if small, in the world production of footwear. In 2016 the production was 932 million

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pairs, in 2017 it had an increase of 942 million pairs in its projection, 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 in the production line exposed to ergonomic risk factors, unsafe conditions in the work environment and increased illness at work, given that the production system requires knowledge and various skills from the worker, especially related to precision and manual dexterity (LUZ et al., 2013).

An important point is the increase in the rates of sick leave due to occupational disease in industry and service, between 2004 and 2014 this number grew by 9.4%, reaching almost 181 thousand cases in 2014 in Brazil, according to the Inter-Union Department of Statistics and Socioeconomic Studies - DIEESE (2016, p.28). It is known that occupational disease is the same as occupational disease, recorded by Delgado (2010), is any disease "produced or triggered by the exercise of work peculiar to a certain activity and included in the respective list prepared by the Ministry of Labor and Social Security" (Federal Senate, 2016). In the state of Paraíba, the number of leaves by the INSS related to musculoskeletal and connective tissue diseases, which are "motivated by situations related to ergonomics and work organization" (Ministry of Social Security, 2015), reached the number of 4,718 cases between 2012 and 2017, according to the Observatory of the Public Ministry of Labor. The Footwear Pole 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, with the main product being rubber slippers.

Rubber slippers are formed from six processes, depending on the model, the simplest go through fewer processes, namely: mixing, vulcanization, strip injection, stamping, which can be on the strip with film or on the slipper with film or ink, 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 the finish where it will be assembled or to the printing shop, where the arts and drawings 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 shop, and/or to the accessories application sector.

The focus of this research is on the process of stamping on the strip, characterized by the application of an adhesive with drawings and then go to the accessories process, followed by the assembly. For this process there are two methods, one is approved, in use and the other

is under analysis for implementation. Both are manual, 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, helping in the application process. This process is new in the factory and is growing exponentially, so there is great concern on the part of the managers involved in relation to quality, since in parallel with the increase in production the defect rate has increased.

2. GOALS

2.1. General

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

2.2. Specific

Evaluate and compare the two work processes regarding physical and biomechanical demands, cognitive demand and organizational demand;

To evaluate and compare the complaint of pain/discomfort and musculoskeletal overload of the two production processes;

3. MATERIALS AND METHODS

3.1. Study location and population

The place 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 stamping process only on the slipper strap, contemplating two operations, that of applying the glue and that of applying the transfer film.

The research will involve the group of workers in these processes, being men and women of different age groups and different times in the company. In all, there are 24 employees in 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 Quiz.

The 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; BROOK; 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 instrument for diagnosing the environment or the workplace.

It is composed 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 prior to the interview, as well as report 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 letter A to E) are intended to assess the psychological demand dimension, six (from letter F to K) to assess authority over decisions and six (from letter L to Q) to assess social support in the work environment. In Brazil, the Job Stress Scale (JSS) questionnaire was validated and adapted to 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 answered the sociodemographic questionnaire. This tool included some analysis variables, previously chosen and categorized with the objective of knowing the sociodemographic characteristics of this population and also identifying the perception that operators present about 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 listed equally, that is, 33.33% corresponds to the 1st shift (from 6 am to 2 pm), 33.33% to the 2nd shift (from 2 pm to 10 pm) and the rest of the 3rd shift (from 10 pm to 00 am).

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%) having the oldest 51 years of age, resulting in a young population.

From the analysis of the data, it was evidenced in a general way that the population (n=24) is young (up to 35 years old) and mostly male, having completed high school, being 42% below that, since it is not a prerequisite for entering this position to have 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, and these processes are directed to the male sex and young people are the most quoted because they do not have vices brought from other factories, thus being easier to "mold" according to the culture. This is relative in the footwear industries, depending on the footwear produced, with women as a population and a larger 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, since it is something meticulous. In the research by Medeiros Neto (2012) the sample was mixed, men and women.

In the process with the use of support, it was observed that in relation to the item "safe and effective leadership" there was a significant difference in the scores in all comparisons between groups, with the glue group having the highest score, followed by the Stamp Applicator group and then the Machine Operators group (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 Stamp 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 the worker can contract various diseases due to exposure to high temperatures, such as cataracts, psychoneurotic disorders.

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

Regarding pain or discomfort during activities, the machine operators reported less discomfort compared to the other groups, in divergence from the study by Renner (2002) which exposes that, in the standing posture throughout the workday, which is the case of the workstation under study, there is a greater group of muscles acting against gravity and greater discomfort of pain, adding early fatigue mechanism. The authors Nordin and Frankel (2003) also state that maintaining the standing posture requires a continuous contraction of the muscles responsible for sustaining this position. But, at the same time, the other operation that is also performed on my foot had a high level of discomfort, going against the study.

In the process with the use of the template, statistical significance was observed in only one parameter. The item was the issue of difficulties due to the small work space, a complaint more 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 pairs of forks/hour increases. Regarding 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 evaluated through the application of the Nordic questionnaire, and the frequency of changes between the groups of each process (Support and Feedback) was compared.

The Machine Operator group was the one with the lowest prevalence of musculoskeletal pain in the regions of the Nordic questionnaire, where most 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 not working was related to the upper back in the last 12 months.

The Pattern Applicator group had a higher frequency of reports of musculoskeletal pain. The regions with significantly increased frequency of pain in this group were: neck problems in the last 12 months, neck problems in the last 7 days, wrist problems in the last 12 months that made them stop working (50%), knee problems in the last 12 months (66%), that made them stop working (50%) and in the last 7 days (50%), and in the same way as knees, foot/ankle pain (Figure 2).

Figure 1 - Musculoskeletal Complaints – Machine Operator

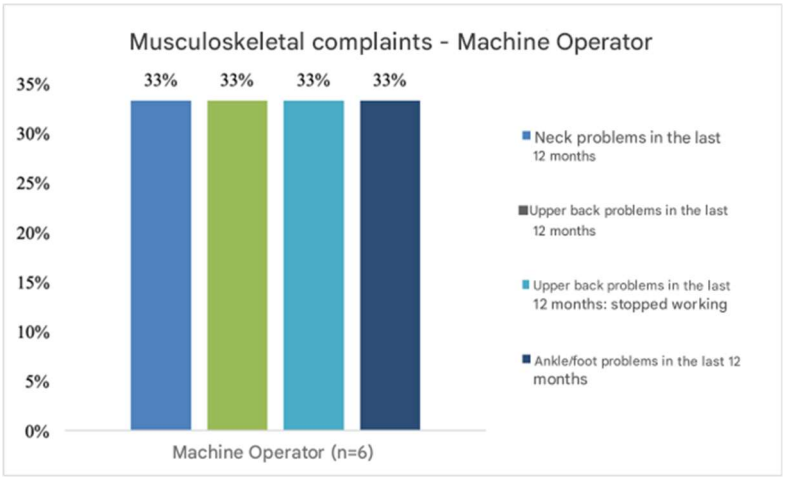


Figure 2 - Musculoskeletal Complaints – Print Applicator

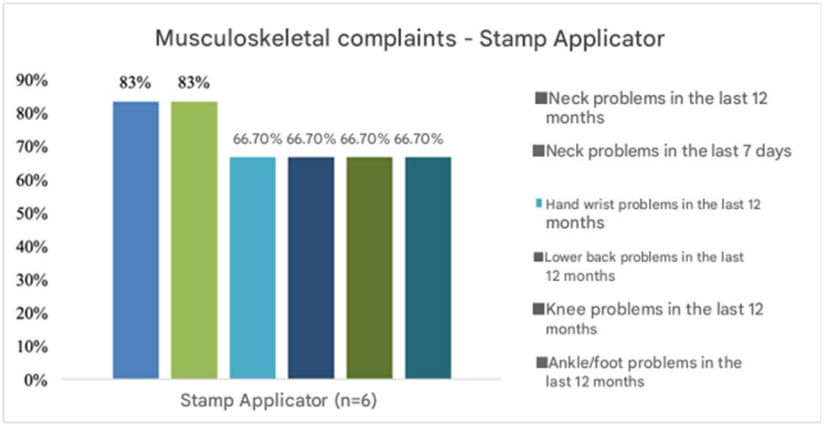
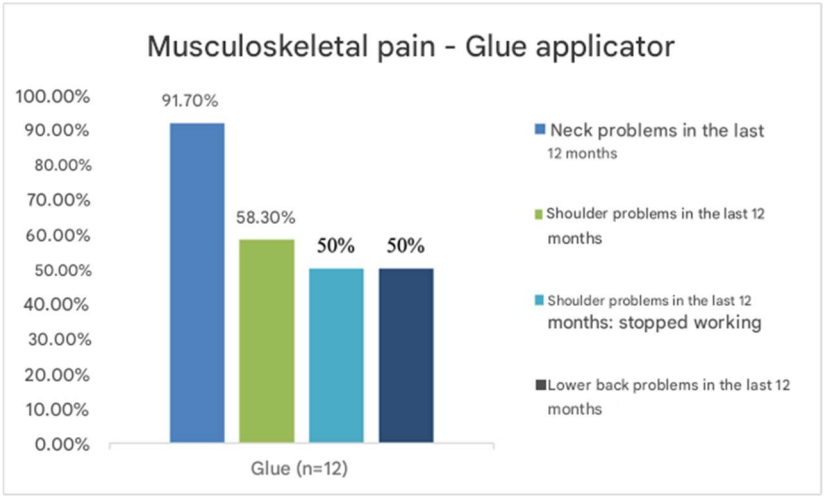


Figure 3 - Musculoskeletal complaints –Glue Applicator



It can be seen that in both operations that are performed standing, problems in the knees, feet and ankles have been reported that are justified by the static position of the operation and according to the 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 increased absenteeism, a drop in productivity, and an increase in the number of unused people.

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

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

Machine operators had a higher frequency of wrist, upper and lower back, and ankle/foot pain all in the past 12 months and with time off work.

The Cola group had more problems in the wrist of the right hand, neck, and upper back, all in the last 12 months. This reflects the posture during the activity, since the application of the glue is performed 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 an increase in simplified tasks, as the footwear industry has not kept up with the technological evolution of other industrial areas, which preserves a manual process

Comparing the two production methods, a higher 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 not working. On the other hand, the support process showed significance in the shoulders in the last 12 months.

Special attention was given to shoulder postures, as Colaço (2013) states that it is a more sensitive part of the risk and is present in the indications of the questionnaires applied in both processes. During the application of glue with the use of the support and with the aid of the template, it is necessary for the operator to maintain a static posture of the right shoulder holding the fork or the template, respectively, throughout the application of the glue, inappropriately overloading the limb.

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 point to inadequate postures, associated with repetitiveness of the upper limbs.

4.3. Prevalence of occupational stress according to the function performed

In the evaluation of the prevalence of occupational stress through the application of the Karazek questionnaire, differences in frequencies were observed between the groups only in two items: "needs to do tasks quickly" and "work demands a lot", both in the Support process and in the Feedback process. The Stamp Applicator group presented a frequency of 83% that sometimes they need to do the 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 through 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 only restricting itself to job issues, but also acting on an organizational level.

4.4. Parameters Occupational and ability from work between the same employees in different production processes: Support and Feedback

In relation to occupational parameters and work ability. Significance was observed in two items: "difficulties due to little work space" and "sufficient lighting for the activities in the sector", where the Feedback process was related to more difficulties due to little space (Figure 8) and reported sufficient lighting to carry out the activities in the sector. In which the difficulty per space is characterized by the use of the template that occupies 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) contribute to the origin of WMSD.

In the evaluation of the speed requirement even meeting the schedule, a higher median was observed in the template group. One possibility for this requirement to happen 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 greater speed from the aforementioned operator. Daniels et al. (2005) and Gascón et al (2013) state that job demands play an important role in the consequences of workload and its aggravation.

Regarding the time being enough to finish the work, there was a median of 5 in both production processes, not having statistical relevance, the same happened about the temperature being uncomfortable for the work, but it had a greater amplitude, reaching the maximum choices, which does present discomfort due to the temperature in specific classes.

The group of operators that make up the support process stated that the noise does disrupt the activities they perform, 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 observed that the two processes have a higher incidence of pain in different places, with support in the neck, hips and thighs, while the process with the template has in the left shoulder (the shoulder that it holds the template), right wrist and upper back.

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

Regarding the hypothesis that in both production processes there is the presence of pain, but in one of them the prevalence of pain will be higher is correct, by the sum the presence of pain is greater with the feedback process. The highest incidence of pain with the use of support is in the neck, elbow, as the figure shows that the posture of the activity has an alteration of these areas. With the use of the template, it is shoulder, wrist and upper back, precisely because of the posture in holding the template.

Regarding the hypotheses that the three physical, cognitive and organizational demands impact the production process, they were refuted, because as much as they were evidenced in

the research at the time of the evaluation, no negative loss of production volume was observed, but they should be worked on to minimize and even eliminate them.

With all these analyses and observations, it is concluded that the most suitable process is with the use of the template, and interventions and improvements are still necessary.

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