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ERGONOMIC ANALYSIS OF WORK IN SUPERMARKET CHECKOUT OPERATORS

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Abstract: Introduction: The checkout operators' workstation is an example of the need for ergonomic adaptations due to the risks that workers are exposed to while performing their tasks. Thus, ergonomic studies have been gaining ground in Brazil within organizations, since preventive work is less financially costly than corrective work. **Goal:** To carry out an ergonomic analysis of the work of checkout operators of a supermarket in the city of Campina Grande-PB. **Metodologia:** This is an exploratory descriptive research, developed in the work environment of checkout operators of the company MINIMERCADO FILEZÃO LTDA of Rede CompreMAIS. Ergonomic tools were used as instruments: RULA, SI, TLV-HAL and NASA-TLX, as well as a semi-structured ergonomics questionnaire adapted to the Renault method and the Corlett and Manenica diagram. **Results**: The results of the RULA, SI and TLV-HAL tools showed a high risk for the development of musculoskeletal disorders in the upper limbs based on the analysis of the tasks performed. The presence of a high mental load was also found, affecting cognitive and psychosocial aspects. The body regions with the highest pain intensity were the lumbar region and lower limbs, followed by shoulders and cervical region. **Conclusion:** There was a high risk of repetitiveness and mental demand, as well as a high risk for the development of musculoskeletal disorders. The presence of ergonomic risks were also identified. Thus, it is suggested the implementation of corrective measures to minimize such risks.
Keywords: Ergonomics. Ergonomic Analysis of Work. Checkout Operator.

INTRODUCTION

Currently, the human being spends an important part of his life in the work environment performing different tasks that demand that working conditions are adequate in order to avoid the existence of risks that can cause work accidents and the emergence of occupational diseases. The workstation of checkout operators in supermarkets is an example of the need for adaptations due to the risks to which workers are exposed while carrying out their activities (BATIZ; SANTOS; LICEA, 2009).

Although the number of employees employed as checkout operators has declined in recent decades in the United States, the number of occupational illnesses has increased in this population. In Brazil, among trade and service workers, the supermarket sector has the highest incidence of Work-Related Musculoskeletal Disorders (WRMD), growing by 184% between 2016 and 2017, with women aged between 40 and 49 years old. the most affected (BRAZIL, 2018).

This fact can be explained by the maintenance of inadequate postures, repetitiveness and organizational situations such as the intensity of tasks, accumulation of activities and excess responsibilities, which can generate as a consequence the development of muscle problems and impairments, especially for the joints of the hands, wrists, arms, shoulders and cervical vertebrae, thus promoting physical and mental overload (MOREIRA; BASTOS; NEPOMUCENO, 2011).

Some companies have been looking for alternatives to adapt the work place to the worker, in such a way that they can improve their productivity and reduce the number of exposures to risk factors that can generate injuries. Thus, ergonomic studies have been gaining ground in Brazil within organizations due to the need to present ergonomic risks to the government through eSocial (ZAVARIZZI; ALENCAR, 2018).

In this context, the Regulatory Norm 17 (NR-17), which is the textual basis that regulates the standards of comfort and safety at work, has gained increasing importance in the practical field, which favors preventive work that is less costly financially. for companies, than a corrective, since a worker on leave provides a financial burden without the provision of services (SOUZA; MAZINI FILHO, 2017; BRASIL, 2002).

For this reason, it is important to carry out an ergonomic analysis of the work in order to identify and assess the ergonomic risks present in the activities of the checkout operator, in order to detect problems and impacts caused by the work environment on the health of the worker, so that in a In the near future, the company can work to eliminate or minimize the risks encountered, obtain satisfaction from all workers involved in the tasks performed, thus promoting increased productivity and reduced rates of absenteeism, leave and accidents at work (ZAVARIZZI; ALENCAR, 2018).

Thus, the study had as general objective to carry out an ergonomic analysis of the work in checkout operators of a supermarket in the city of Campina Grande-PB and as specific objectives: To analyze the tasks performed by the professional checkout operator of a supermarket in the city of Campina Grande -PB; Identify the ergonomic risks existing in the tasks performed by these professionals; Evaluate the biomechanical pattern of the upper limb extremities; Analyze the pattern of pain reported by checkout operators; Identify the effort associated with the work posture assumed in carrying out static or repetitive activities developed by checkout operators; Evaluate the mental load as a cognitive and psychosocial ergonomic risk and Evaluate the level of manual activity and the level of force

application present in the performance of the checkout operator activity.

METHODOLOGY

This is an exploratory descriptive research with a qualitative approach, developed in the work environment of checkout operators, from the company MINIMERCADO FILEZÃO LTDA of Rede CompreMAIS, located in the city of Campina Grande - PB, with the permission and signature of the Term of Institutional Authorization (Annex A).

The sample consisted of 2 female employees who performed the role of Checkout Operator in this supermarket. All employees who agreed to participate in the study, signing the Free and Informed Consent Term (Appendix A) and who had worked in the role of Checkout Operator for approximately 01 year, were included in the survey. Workers who did not meet the criteria required in the act of inclusion, and those who for some reason were away from work during data collection were excluded.

The instruments used in this research consisted of a semi-structured ergonomics questionnaire adapted to the Renault method (1976) – (Appendix E) with the objective of tracing a socio-demographic profile. In relation to the evaluation of the regions of pain or discomfort, the Diagram of Corlett and Manenica (1980) (Appendix B) was used, which refers to an easy-to-understand diagram, composed of a division of the human body separated into 24 segments, which has with the objective of providing answers regarding the location and intensity of pain.

The ergonomic tool Rapid Upper Limp Assessment (RULA) was applied in order to analyze the working postures that were inadequate, to verify the most harmful postures to the worker, as well as to identify the body regions most affected during the execution of the activities. For this purpose, direct and indirect observation (video or photographic recording) was carried out, allowing a subsequent analysis through the application of the method by the researcher with the program: Ergolândia v. 7.0

In turn, the assessment and quantification of exposure to risk factors for musculoskeletal disorders of the hands and wrists was analyzed using the Strain Index (SI) method by Moore and Garg (2006), which established a biomechanical overload index for the extremities. upper limbs from the measurement or estimation of six variables, namely: Effort Intensity Factor (FIT); Duration of Effort Factor (EDF); Effort Frequency Factor (FFE); Hand and Wrist Posture Factor (FPMP); Work Pace Factor (FRT) and Work Duration Factor (FDT).

In this context, the level of manual activity and application of force present during the performance of tasks at the workplace was determined by using the ergonomic tool Threshold Limit Value for Hand Activity Level (TLV-HAL), which is based on the frequency of activity. manual during the work cycle. The determination of the values studied by this method is carried out based on the division of the normalized peak force by the level of manual activity, allowing to find a level of risk for the activities performed.

The multidimensional assessment of mental workload was measured using the Nasa Task Load Index (NASA-TLX) tool, which provides a global score of Workload based on a weighted average of assessments in six subscales, with 3 demands imposed on the subject: Mental Demand ; Physical Demand and Temporal Demand; and 3 dimensions referring to the interaction between subject and task: Performance, Effort and Frustration.

A Sony brand camera was also used to record the images and videos in order to stop for a later analysis. Thus, the results obtained from the Corlett & Manenica Diagram (1980)

were inserted into the Excel/v.2016® Software and their results were expressed through a graph, while the information, images and/or videos captured were studied by the tools ergonomics RULA, SI, TLV-HAL and NASA -TLX in Ergolândia v 7.0 and Kinovea v 0.8.15 software, and their results are expressed through figures.

In view of the guidelines of the National Health Council, through Resolution 466/12/CNS/MS (BRAZIL, 2012), this study composed all the ethical issues related to research involving human beings, being submitted and approved by CAEE: 43139321.5. 0000.5175 (Annex C).

RESULTS

Of the employees who participated in the survey (2 valid questionnaires), all were sedentary and female, aged between 25 and 41 years, with an average height of 1.54 cm and an average weight of 72 kg. Of these, one was married and the other was single, with incomes between R$1,120.00 to R$1,200.00, and had completed high school. Regarding the time with the company, one employee had 1 year and the other 1 year and 5 months. The employees stated that they do not perform labor gymnastics or rotate activities at other posts, although they perform tasks when the supermarket turnover is reduced.

Regarding the physical work environment, it was observed that the sound environment, lighting conditions, aesthetics and cleanliness of the place, as well as the thermal environment during summer and winter are pleasant. Although the work station evaluated has shown to only partially meet the needs in terms of functionality of the employees and exposure to electric shocks in the machines used has been reported as a frequent event by the operators.

It was also observed through the semi-structured ergonomics questionnaire adapted to the Renault method (1976), that the employees consider the work light, but tiring and with a high level of mental demand due to the requirement of necessary attention, the great possibilities of errors and the number of decisions to be made.

The analysis of the biomechanical pattern of the upper extremities and the tasks performed by the checkout operators revealed, in the cervical region, the presence of a maximum left lateral rotation to pick up the bag (Figure 1A), followed by the opening of the bag with the realization of a maximum right lateral rotation in order to check the opening of the system to start reading new purchases (Figure 1B).

In figures 1C and 1D we also observe the reading of the bar code for each product. Note that for this task, the employee performs a shoulder flexion of 39º without static contraction of the trapezius muscles, with positioning of the elbow at 102º supported on the corner of the furniture (red arrow), associated with movements in flexion with repetitions constants for the closing of the fingers in order to position the bar code of the product in front of the optical reader, also associated with the presence of the Frankfurt angle of 26º above the recommended by the literature. In addition, it is possible to identify the presence of anterior trunk flexion accompanied by lateral inclination to carry out the grip of products placed at the beginning of the counter (Figure 1E), with trunk twisting during the opening of the cashier (Figure 1F) and the return of the maximum lateral cervical rotation movement to the right associated with shoulder flexion to check the values received and changes (Figure 1G).

To assess the pattern of pain reported by the employees, it was observed, through the application of the Body Diagram of Corlett & Manenica (1980), the presence of pain located

Figure 1 - Tasks performed by the checkout operator.

Source: Research data, 2021.

Sequence of tasks: Picking up the bag (A), opening the bag (B), reading the product bar code (C and D), approaching new purchases from the optical reader (E), opening the cashier (F), checking of the amounts received and change (G). Analysis of the biomechanical pattern in the upper extremities (D).

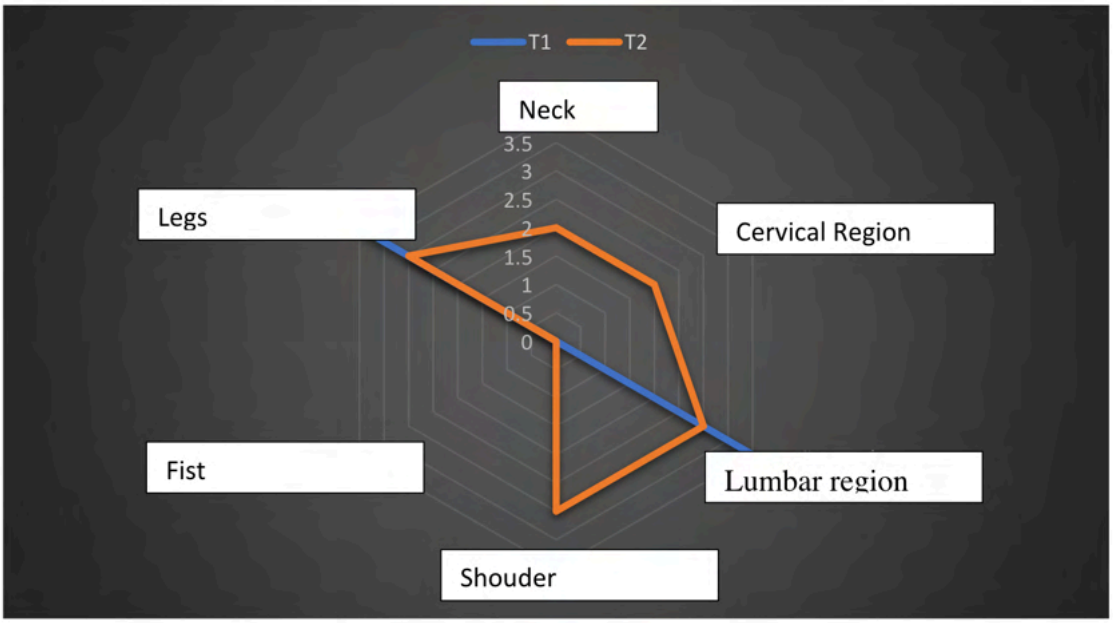

Figure 2 – Analysis of the pain site and its intensity reported by the checkout operators.

Source: Corlett & Manenica Body Diagram Results, 2021.

T1: Worker 1; T2: Worker 2

in the lower back (lumbar) and legs bilaterally at grade 4 intensity (quite discomfort/pain) in worker 1. While employee 2 pointed out pain in grade 2 (some discomfort/pain) in the cervical and neck regions, and grade 3 (moderate pain) in the shoulder, lower back (lumbar) and legs regions bilaterally. Thus, it was observed that the areas with the highest pain complaints reported by both employees were predominantly the lumbar region and legs, followed by complaints in the shoulder, cervical region and neck, respectively. Such results were expressed in Figure 2.

Through the ergonomic tool RULA, the degrees of joint range of motion of the upper limbs and the effort associated with the postures adopted during the performance of static and repetitive activities performed by the checkout operators, such as picking up the product at the start of the bench, the transport of goods to the optical reader, the optical reading of the product, the typing of bar code numbers, when not read by the optical reader, the packaging of the goods and collection activity. Thus, it was possible to identify a final score of 4, indicating an action level of 2, in which it is necessary to carry out a complete observation of the workplace, in order to analyze possible changes to be implemented (Figure 3).

The risks for the development of disorders in the upper limbs were evaluated by the ergonomic tool SI, considering the intensity of the effort as something heavy, although its duration has been shown to be around 50 to 79% of the work cycle and the frequency of the effort. between 9 and 14 per minute, this finding being found from the analysis of videos and images of the activities performed by the checkout operators. The posture of the hand and wrist assumed during the performance of the tasks was considered reasonable and the work rhythm was defined as fast. In addition, the duration of work around 4 to 8 hours a day was another factor used to obtain the overload index, which resulted in a value of 20.25, indicating that there is a high risk for the development of musculoskeletal diseases related to work. work (Figure 4).

The repeatability and force applied in performing the checkout operator tasks was evidenced through the TLV-HAL method, in which the level of manual activity was defined as rapid and constant movement/ effort, without regular breaks, both for the right side as left, since both hands perform similar activities during the work cycle. The peak force, on the other hand, was classified as moderate, based on the average weight of the products that are lifted by the employees during the passage of the goods. Thus, the score found was 1.5 for both hands, being, therefore, higher than the tolerance limit value of 0.78, thus indicating an activity with potential risk factors for generating hand and wrist injuries (Figure 5).

The level of mental load was identified as a cognitive and psychosocial ergonomic risk using the NASA-TLX tool, and it was observed that in relation to the demands imposed on the subject, the mental demand showed a weight of 4, being, therefore, higher than the physical and temporal. In turn, the dimensions referring to the interaction between subject and task with the highest level of overload for the execution of activities was frustration. The average value for the intensity of the analyzed factors was 80, and the temporal demand was the only one with an average value of 90. Thus, the average global score for the workload was 81.33 (Figure 6), indicating that the tasks performed require a high mental load for these professionals.

Finally, the ergonomic risks were identified through the analysis of the workstation by the observational method, through ergonomic

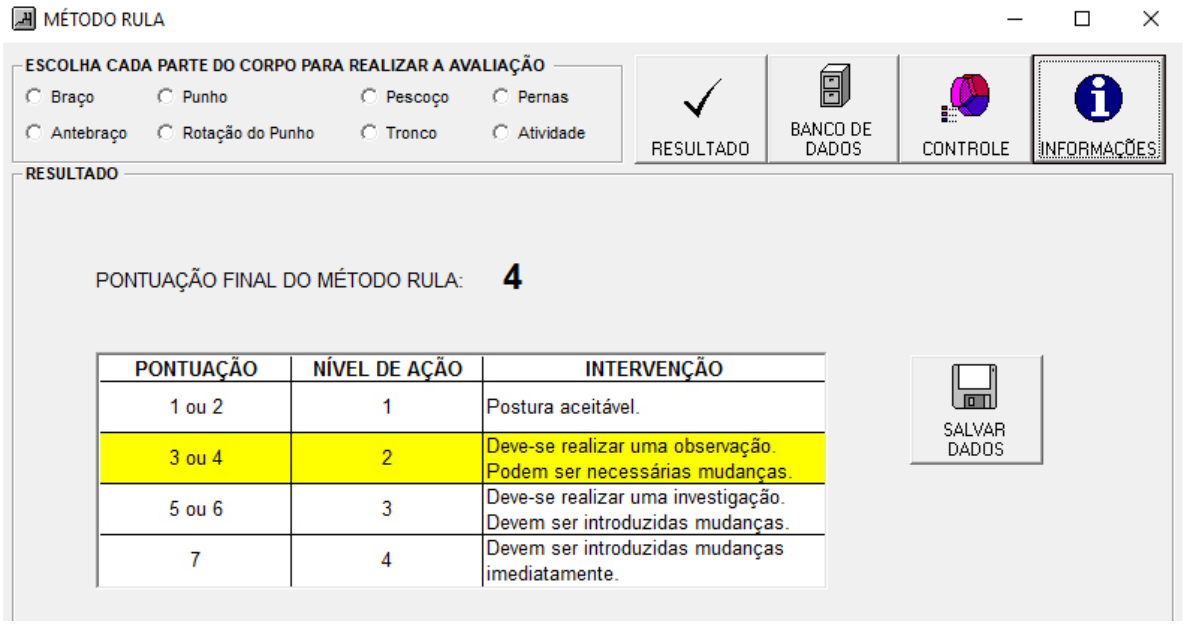

Figure 3 – Final score of the RULA method for the activities performed by the checkout operators.

Source: Ergonomic tool results: *RULA*, 2021.

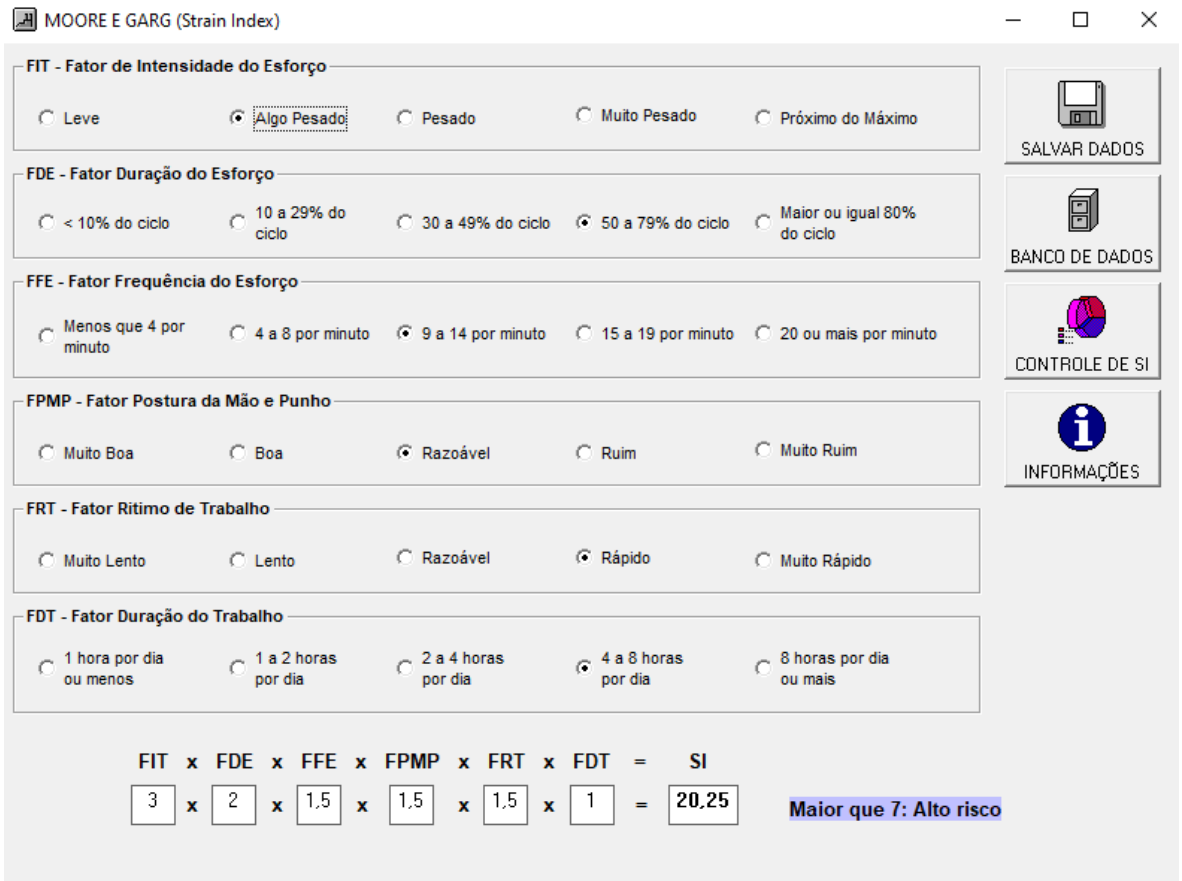

Figure 4 - Result of the SI method for the activities performed by the checkout operators.

Source: Ergonomic tool results: *SI*, 2021.

Figure 5 – Result of the analysis of the TLV-HAL method, with the respective scores and interpretations.

Source: Ergonomic tool results: *TLV-HAL,* 2021.

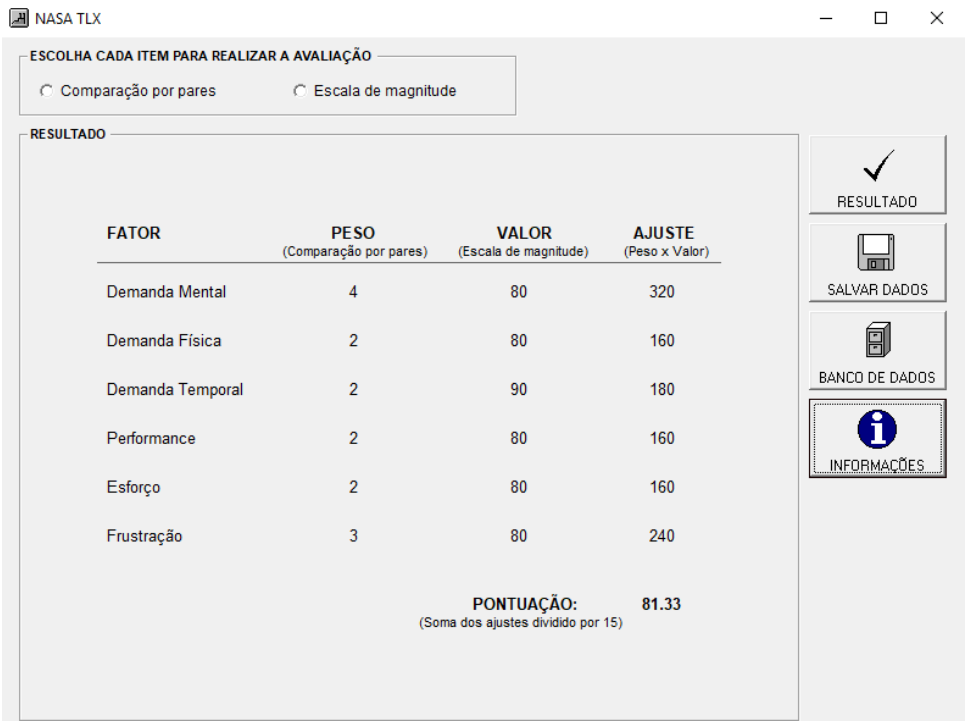

Figure 6 - Analysis of checkout operators' mental load through the *NASA-TLX.*

Source: Ergonomic tool results: *NASA-TLX,* 2021.

Category	Ergonomic risks encountered	Risk found by tool
Biomechanics	Repeatability	Observational, NR 17.6.4c e *TLV-HAL*
	Extreme cervical rotation	Observational
	Inadequate working posture	Observational and *RULA*
	Hand grip movement	Observational and *TLV-HAL*
	Frankfurt angle above the limit	NBR ISO 11226.2.2
	Sitting posture for long periods	Observational
	Requirement for frequent use of force, pressure, grip, flexion, extension or twisting of body segments	Observational, *TLV-HAL and RULA*
	Compression of body parts by angled surfaces.	Observational and NR17
	Requirement for frequent elevation of upper limbs	Observational and *SI*
	Requirement for frequent spinal flexions	Observational
Furniture and equipment	Chairs without support for the lumbar region	NR 17.2.1e
	Lack of foot support	NR 17.2.1f
	Presence of sharp edges in furniture	NR 17.2.1j
	Absence of electro-mechanical conveyor to facilitate the movement of goods at checkouts	NR 17.2.1g
	The furniture does not meet the anthropometric characteristics of 90% of the workers	NR 17.2.1a
Organizational	Excessive work pace	Observacional, *NASA-TLX* and NR17.6.2e
	Lack of rotation between checkout operators	Observational and NR17.4.1e
Psychosocial and cognitive	High mental demand	Observational and *NASA-TLX*
	Too many stressful situations	Observational and *NASA-TLX*
	High level of concentration or attention required	Observational and *NASA-TLX*
	Requirement to perform multiple tasks with high cognitive demand	Observational and *NASA-TLX*
	Absence of visible identification device with the operator's name and/or surname	Observational and NR17.5.1

Table 1: Summary of ergonomic risks found during the analysis performed.

Source: Survey data (2021).

tools based on the images and videos captured, as well as the use of NR17 and Brazilian Standard ISO 11226 (NBR ISO 11226), being summarized in Table 1.

DISCUSSION

Several studies have been conducted with checkout operators from different countries, given the large number of complaints, illnesses and/or disorders presented by this population, mainly due to the intense repetitiveness during the execution of their tasks (ALGARNI et al., 2020). ; SIRGE et al., 2014; RODACKI et al., 2006; RISSÉN et al., 2002; RODACKI et al., 2010). However, it is known that high repeatability is not the only factor responsible for such changes. Thus, other factors inherent to the work, such as the inadequate conditions of the job and the level of physical and mental demand were also taken into account during the execution of this study.

In this context, it was observed that the regions of the body in which the employees reported the greatest complaint of pain were the lumbar and lower limbs regions, with these pains classified as moderate intensity (grade 3) to a lot of discomfort (grade 4). This fact may be related to irregularities found at the workstation, such as the type of layout, the height and type of chair, the lack of support for the lumbar region and for the feet, as well as other equipment, causing the operator to keep harmful postures for body biomechanics, which are harmful to your health (SIRGE et al., 2014).

The presence of sharp edges in the furniture of the evaluated unit (NR 17.2.1j) seems to favor the emergence of pathologies such as carpal tunnel syndrome, considering that the mechanical compression of the wrist structures, especially the vasa nervorum, responsible for irrigating protective conjunctive structures, such as the epineurium, endoneurium and perineurium, which stimulate nociceptive and sympathetic fibers to release peptide related to the calcitocin gene (CGRP) and substance P. Thus, the vasodilating action presented by these substances contributes to the formation of the process inflammation and intraneural edema, which in turn leads to a decrease in nutritional support to the median nerve, associated with a large decrease in venous return, resulting in hypoxia and ischemia of neural tissue (SARIKCIOGLU et al., 2008; EKSTROM; HOLDEN), 2002).

The persistence of this condition commonly causes a deterioration of the capillary endothelium, with greater leakage of proteins and edema, triggering the onset of pain, paresthesia, paresis and muscle hypotrophy in the area of competence of the median nerve. From this situation, fibroblast proliferation becomes inevitable, with formation of intraneural adhesions (epineural and intrafascicular), axonal injury with possible degeneration and alteration of nerve conduction and anterograde and retrograde axoplasmic flow, exposing such anatomical structures to the risk of development of pathologies such as carpal tunnel syndrome, common in these activities (JEONG et al., 2009).

The checkout evaluated here does not have an electromechanical conveyor, requiring operators to flex the trunk and maximum extension of the limbs, in order to bring the goods close to them, and this factor can be further aggravated by the presence of small mass products, however in large volume that contribute to a high number of shoulder abductions and flexions, which consequently can lead to the emergence of important pathological changes (TRELHA et al., 2007).

In this context, although the checkout furniture and its dimensions are emphasized in Annex I of NR-17.2.1 (BRASIL, 2002), a study carried out by Ballardin et al. (2005) in the workplace of checkout operators,

demonstrates that furniture is not an exclusive factor for poor posture and physical overload, since the lack of body awareness and ergonomic notions on the part of workers was identified. This fact becomes relevant to emphasize the essential role of organizational programs aimed at raising awareness and education of workers about safety at work and ergonomics, aiming to promote the well-being and health of workers (FERNANDES; ARÃO, 2018).

It is also known that women have a higher risk than men for back pain, although some epidemiological studies attribute this finding to an information bias (ALPEROVITCH-NAJESON et al., 2010; MATOS et al., 2008; HALES et al., 2008; HALES et al. al., 1994), it is believed that this justification is plausible, since women have increasingly combined household chores with work outside the home, where they are exposed to ergonomic loads, especially repetitiveness, position and work at high speed (FERREIRA et al., 2011).

In addition, anatomically women still have intrinsic characteristics inherent to the female sex, such as smaller stature, less muscle mass, less bone mass, more fragile joints and less adapted to strenuous physical effort, greater weight of fat, still related to modulation in the which can collaborate for the onset and greater intensity of pain (QUITON; GREESPAN, 2007; SIQUEIRA et al., 2005).

The presence of pain in the cervical and neck region was also identified, and these findings are possibly related to the presence of values above the recommended for the angle formed by the Frankfurt horizontal plane and the presence of constant static contractions during the maintenance of inadequate postures for execution of tasks (WILANDER et al., 2014).

These changes can be explained by the fact that the muscles are nourished mainly during the period of relaxation, since their internal pressure during the period of static activity can exceed the value of blood pressure and cause compression and consequent occlusion of the responsible blood vessels. for its nutrition, resulting in the accumulation of lactic acid and irritation of the nerve endings, leading to symptomatological conditions of pain. Thus, static postures require the continuous action of the same muscle groups, not allowing periods of relaxation for an adequate blood supply (SIRGE et al., 2014).

On the other hand, still on the analysis of postures, although the result of the RULA method in our study indicates a score of 4 with action level 2 with the need for possible changes only after a complete observation, these results are similar to those found by Piccinini et al. (2009). This finding is probably due to the fact that the products handled are less than or equal to 10 kg and this has a fundamental influence on the final evaluation. However, when the work environment is studied in greater detail, the risks of the activities to which operators are exposed are explicit, such as the presence of inadequate postures and the lack of furniture with standardized measures and formats to meet the individual anthropometric differences of workers. (BATIZ; SANTOS; LICEA, 2009).

In this way, even a considerable part of the load that is repetitively manipulated presents weights equal to or less than 3 kg, such findings may mean favorable conditions for the occurrence of musculoskeletal pathologies, which according to Moretto (2017) has become a serious public health problem. in Brazil, since they can lead to temporary or permanent work disability, resulting from the combination of overload of the musculoskeletal system with lack of time for muscle recovery, which can cause functional limitation and psychosocial disorder.

According to Shinnar et al. (2004), professional checkout operators can handle a new item every 1-2 seconds or 500 to 1,000 items per hour, the equivalent of filling more than 80 bags performing wrist flexion and extension movements averaging up to 600 times, with an average repetition rate of 1,442 movements per hour for the dominant hand, a rate that falls into the medium risk category for the development of occupational injuries. Plus they lift over 6,000 lbs or 2,722 kg of groceries during an average eight-hour shift.

Due to the nature of their work, workers are at high risk of developing musculoskeletal disorders in the upper extremities. A recent study by Algarni et al. (2020) in checkout operators in Saudi Arabia revealed that 90% of the supermarket cashiers evaluated had symptoms of musculoskeletal disorders in the last 12 months. Of these, approximately 55% reported shoulder pain, demonstrating consistency with our study and also with previous studies that reveal the prevalence of shoulder pain among supermarket cashiers to be between 43% and 51% (SIRGE et al., 2014; NIEDHAMMER et al, 1998).

These findings also corroborate our results obtained through the application of the SI method, which evidenced the existence of a high risk for musculoskeletal disorders of the upper limbs, as well as the TLV-HAL method, which indicated a high level of manual activity during the execution of the tasks. tasks, which according to Harris-Adamson et al. (2016) may predispose to an increase in the rate of occurrence of carpal tunnel syndrome in this population.

Rodacki et al. (2006) states that this is also due to the fact that the activities performed in this function expose the upper limbs to bear more stress load than other areas of the body, due to the presence of strength and excessive gripping movements with the hands, associated with repetitiveness of the same movement pattern, mechanical compression of structures and insufficient time to perform a certain task. Thus, pathologies of an inflammatory nature and compressive neuropathies of the upper limbs are currently the most prevalent and most commonly found alterations in these workers, being the main causes of absence from work in this population, especially in women aged 40 to 49 years. years in the Brazilian supermarket sector (ZAVARIZZI; ALENCAR, 2018).

Regarding the high mental workload found by the NASA-TLX tool, this can be justified by the fact that the checkout operator performs activities that require great attention, such as passing all items, collecting payment, counting money and the correct supply of change, in addition to the need to close the cashier during the end of the day, an activity that includes, in addition to other functions, the organization of banknotes, coins, tickets and checks (RODACKI et al., 2010; SHINNAR et al., 2004).

Not only that, in view of the direct contact of these professionals with customers, these workers often perform tasks beyond what is established for their function, complaints are often received about the service, which most often fall on the operators, such as complaints of different types, which can range from poor customer service, according to the customer's opinion, to the lack of a particular product on the market, priceless goods, delays in the card or check payment system, some of which do not correspond to the work content of the station and which are not the responsibility of the supermarket checkout operator (BATIZ; SANTOS; LICEA, 2009).

In this way, all these situations directly influence the health of workers and especially the productivity of the company, since they are causes that cause absenteeism at work. For this reason, carrying out ergonomic analyzes at work stations with the implementation

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of possible changes are recommended in this context, since organizational changes in the work environment, such as the implementation of rotation of activities and the increase in the number of hours worked, are important aspects evaluated by organizational ergonomics (CROON et al., 2008).

CONCLUSION

It is concluded that there is a high risk of repetitiveness and mental demand in the tasks performed, as well as a high risk for the development of musculoskeletal disorders in the upper limbs resulting from the movement pattern and inadequate postures assumed during the workday.

The inadequacy of furniture and the presence of biomechanical, organizational, psychosocial and cognitive risks were identified, as well as the predominance of pain in the lumbar region and legs. Thus, it is suggested the implementation of corrective measures to minimize such risks.

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