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IMPACT OF JOB ROTATION IMPLEMENTATION: ANALYSIS OF PERCEPTIONS OF ERGONOMIC IMPROVEMENT, COMFORT, AND MUSCULOSKELETAL SYMPTOMS FROM THE PERSPECTIVE OF WORKER EXPERIENCE

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ABSTRACT

Job rotation is an ergonomic intervention applied in sectors with repetitive activities to diversify functions, reduce physical overload, and increase motivation. This study aimed to compare the perceptions of ergonomic improvement, comfort, and musculoskeletal symptoms between workers who experienced the implementation of job rotation (the "experienced" group) and those who joined after the program was consolidated (the "inexperienced" group). The quantitative, exploratory, and descriptive research used structured questionnaires on the perception of the benefits of job rotation and the Nordic Musculoskeletal Questionnaire. Data were collected on demographic profile, perception of the benefits of job rotation, intention to recommend, and reports of pain and bodily discomfort. The analyses involved descriptive statistics and Fisher's exact test to compare responses between groups, performed using R software. The results indicated that most operators recognize gains in multifunctionality, task variety, and bodily comfort, with a significant association between experience and positive perception of benefits. However, the average intensity of musculoskeletal pain remained moderate in both categories, with no statistical difference. These findings suggest that, although job rotation increases satisfaction and motivation, when applied in isolation it is not sufficient to reduce musculoskeletal symptoms. This contributes to the evidence that integrated programs—with continuous training, ergonomic redesign of workstations, and workload management—are essential for full effectiveness. Future research should preferably adopt a longitudinal design and include indicators of productivity, absenteeism, and quality of life to evaluate the pre- and post-implementation effects.

Keywords: Job Rotation, Musculoskeletal Disorders, Ergonomics.

1 INTRODUCTION

Since the Industrial Revolution, the relentless pursuit of productivity has been constant in organizations. Production process models have gained prominence, with the Taylorist/Fordist model being a fundamental milestone in the history of organizational management. Known as "Scientific Management of Work," this approach aimed primarily to increase productivity by reducing production time, among other losses. Among its pillars, the following stand out: time and motion studies, the rigid division of labor, detailed prior planning, and meticulous task descriptions—components that shaped the way work was organized and performance measured Björkman, 1996). Taylorism, by standardizing and simplifying work, brought significant advances to industrial production. However, it also had adverse impacts on workers' health

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(Törnström et al., 2008). The classic film "Modern Times," directed by Charlie Chaplin and released in 1936, already highlighted the negative effects of repetitive, monotonous, and demanding work in terms of cadence and rhythm. This way of organizing work frequently harms the physical and mental health of workers, causing illnesses, injuries, decreased productivity and product quality, as well as high turnover rates that hinder the acquisition of tacit knowledge and expertise, increasing the risk of errors and workplace accidents (Guimarães et al., 2012).

Fatigue and musculoskeletal disorders resulting from work tasks with unbalanced workloads can negatively impact productivity and work quality. Furthermore, lost production time, increased employee turnover, illnesses, accidents, and decreased work capacity are some of the consequences of fatigue (Asensio-Cuesta, Diego-Mas, Cremades-Oliver, et al., 2012; Tirloni et al., 2012). Therefore, it is important for contemporary industries to seek initiatives that reduce the adverse impacts of workload without compromising productivity (N. Dias et al., 2019; Karsh et al., 2001).

Scientific reviews show that ergonomic measures reduce injuries, lost workdays, and costs resulting from absences. (Goggins et al., 2008; Guimarães et al., 2015)Among the main strategies are: (i) operator training; (ii) reducing exposure time to risk factors through breaks and job rotation; (iii) redesigning workstations and processes; and (iv) automating or mechanizing higher-risk tasks.

Job rotation has been used as a low-cost organizational alternative, demonstrating effectiveness in reducing work-related musculoskeletal injuries (N. F. Dias et al., 2020; Kuijer et al., 1999), especially in manufacturing environments and in tasks involving repetitive movements. (Saavedra Robinson, 2022)Furthermore, it contributes to the development of new skills and the versatility of workers (Asensio-Cuesta, Diego-Mas, Canós-Darós, et al., 2012; Guimarães et al., 2012, 2015), as well as gains in productivity (Mossa et al., 2016). Its benefits also extend to psychosocial aspects, especially in combating boredom and monotony, factors that directly influence job satisfaction, motivation, and commitment (Azizi et al., 2010; Tsai, 2016). However, the implementation of job rotation faces significant challenges (Comper et al., 2017; Comper & Padula, 2014), such as the time required for rotation planning, balancing workload between different functions, (Otto & Scholl, 2011, 2013)and the need for training that enables workers to operate in diverse activities (Anzanello & Fogliatto, 2011; Guimarães et al., 2012; Morlock et al., 2017).

The rationale for this study lies in the premise that the effectiveness of an ergonomic intervention should not be measured solely by the remission of clinical symptoms, but also by the worker's perception of well-being and operational improvement. For the literature, this work contributes by valuing the 'voice of the worker' in ergonomic improvement processes. For professional practice, the results offer support for ergonomists and managers to understand that job rotation can be a factor in preserving productive capacity and worker satisfaction, even in scenarios where there is no variation in musculoskeletal symptoms.

The research was conducted in a metalworking manufacturing plant located in the state of Rio Grande do Sul, focusing on large-scale production processes for hand tools, where repetitiveness is inherent to the operation. Although the study uses indicators of musculoskeletal symptoms, the central focus lies in the comparative analysis of perceptions of comfort and effectiveness of the job rotation system.

In this context, this study aims to identify and compare the perceptions of ergonomic improvement and comfort between workers who experienced the implementation of job rotation ("experienced group") and those who joined after the program was consolidated

("inexperienced group"), analyzing these perceptions in parallel with the panorama of musculoskeletal symptoms presented by the groups.

2 MATERIALS AND METHODS

This study is characterized as quantitative, exploratory, and descriptive research, conducted with the workforce of a hand tool production line, specifically screwdrivers (simple and Phillips). In this sector, a job rotation program was formally implemented, which was included in the work instructions and included operator training to adapt to the new strategy. The sample consisted of 16 respondents, selected through voluntary participation, corresponding to more than 90% of the workforce in this sector. Of these, 10 workers experienced the transition and effective implementation of the rotation program, while 6 were hired after its consolidation.

The production process analyzed comprises five main stages: cutting, sanding, bending, machining (CNC), and straightening. Although the pace is not rigidly imposed by machines, most of these stages require high repetitiveness of upper limb movements, specifically wrists and hands. Postural requirements are dynamic and vary according to the operation: cutting and straightening activities are predominantly performed in a seated or semi-seated position, while sanding, bending, and machining demand a standing posture with frequent displacements.

Despite the inherent repetitiveness of the tasks, workers set their own pace of production and have formal breaks available throughout their shifts. The work cycle combines core functions with internal logistics activities, such as machine setup and manual transport of materials, from raw materials to finished products. The work schedule follows a 44-hour week, Monday to Friday, with regulated breaks for rest and meals; no overtime was identified during the study period.

Data collection was conducted in person by the researcher through the assisted application of a structured questionnaire. Prior to distributing the instrument, a detailed explanation of each item on the form was given to the group of workers, aiming to clarify doubts and ensure full comprehension of the questions and response scales. Participants were duly informed about the objectives of the research and participated voluntarily, under a guarantee of anonymity.

The instrument was limited to the collection of occupational data (specifically the length of time working in the sector), without recording personally identifiable information. The study is exempt from submission to the CEP/CONEP system according to CNS Resolution No. 510/2016 (Art. 1, VII) and Circular Letter No. 17/2022 CONEP, as it is an investigation aimed at deepening professional practice without identifying the subjects. It is emphasized that all ethical precepts were rigorously observed, ensuring the confidentiality and integrity of information at all stages of the research.

The questionnaire addressed two main themes: (i) workers' perceptions of the impacts of the job rotation program on ergonomics and comfort during work, as well as their attitudes regarding the acceptance and recommendation of job rotation for other sectors; and (ii) the assessment of musculoskeletal health, investigating pain, discomfort, and limitations in specific body regions, using the Nordic Musculoskeletal Symptom Questionnaire, validated by [reference needed (Kuorinka et al., 1987)]. The questions were objective, with dichotomous, ordinal, and multiple-choice formats, allowing responses such as "yes/no," scales from "much better" to "much worse," and multiple-choice selection. The table below summarizes the questionnaire.

Table 1 - Summary of the dimensions, variables and structure of the research instrument

Dimension	Variables / Indicators	Response Format
Socio-occupational	Department, position, and time in the role.	Open and Numeric
Perception of Impact	Contribution to ergonomics; perception of comfort and fatigue.	Categorical trichotomous scales and Perception Scale (5 points - Much better to Much worse).
Benefits and Attitudes	Perceived gains (multifunctionality, motivation, productivity, etc.) and intention to recommend.	Multiple choice; Categorical trichotomous (Yes/No/Maybe).
Musculoskeletal Health (Nordic Questionnaire)	Symptoms in 9 body regions. Occurrence of symptoms (12 months); Pain intensity (0-10); Functional impairment (12 months); and Recent symptoms (7 days).	Categorical Dichotomous: Occurrence (Yes | No), Impediment (Yes | No) and Recent Symptoms (Yes | No). Numerical Scale: Intensity (0-10)

For comparative analysis purposes, participants were divided into two groups according to their length of service in the role since the implementation of the job rotation program in March 2023. The survey was conducted in June 2025, i.e., 2 years and 3 months after implementation. Thus, the "experienced" group included workers with more than this period in their role, while the "inexperienced" group consisted of workers with less time in the role, i.e., those who joined after the implementation of the rotation. Data analysis began with an exploratory and descriptive approach to characterize the responses. Subsequently, comparisons were made between the 'experienced' and 'inexperienced' groups to verify associations in perceptions and differences in pain reports. Fisher's exact test was used to assess the association between categorical variables. Additionally, the Mann-Whitney test (Wilcoxon rank-sum test) was used to compare the mean pain intensities between the groups, considering the non-parametric nature of the data and the sample size. Statistical analyses were conducted using the R software.

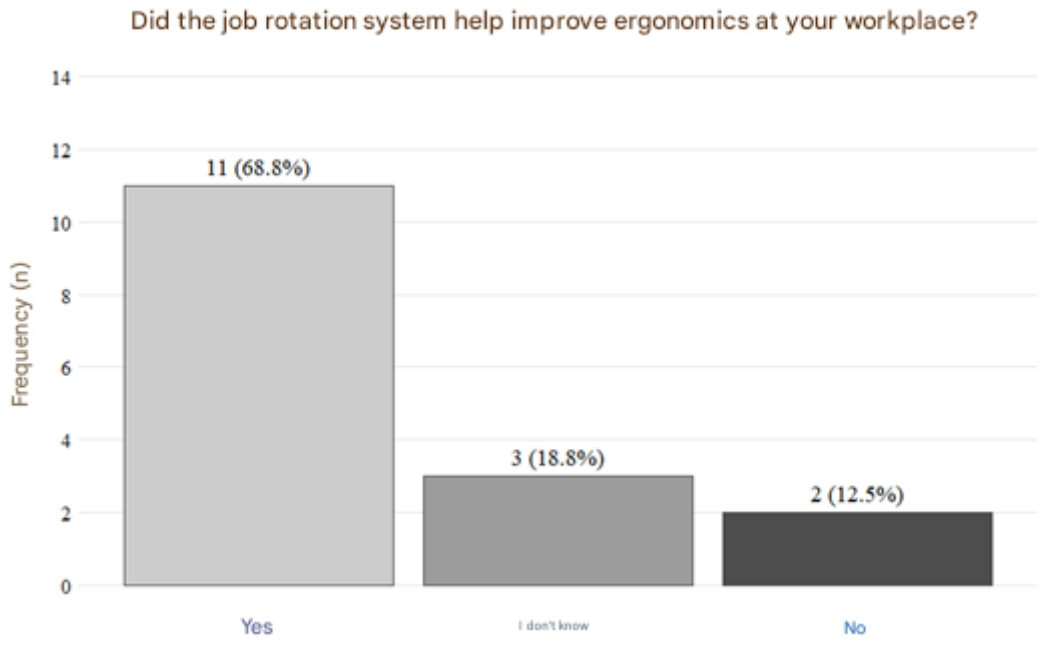
3 RESULTS

Analysis of questionnaires administered to workers revealed significant aspects regarding the implementation of job rotation and its impacts on ergonomics and occupational health. The results will be presented following the two main themes investigated: (1) the general perception of the rotation program and its ergonomic benefits, as well as its acceptance and recommendation to other colleagues, including a statistical comparison between “experienced” and “inexperienced” workers; and (2) the prevalence and intensity of musculoskeletal symptoms in different body regions, as identified by the Nordic Questionnaire.

3.1 Analysis of the Perception of the Benefits of Job Rotation

The results regarding workers' perception of the impact of job rotation on optimizing ergonomic working conditions are summarized in Figure 1.

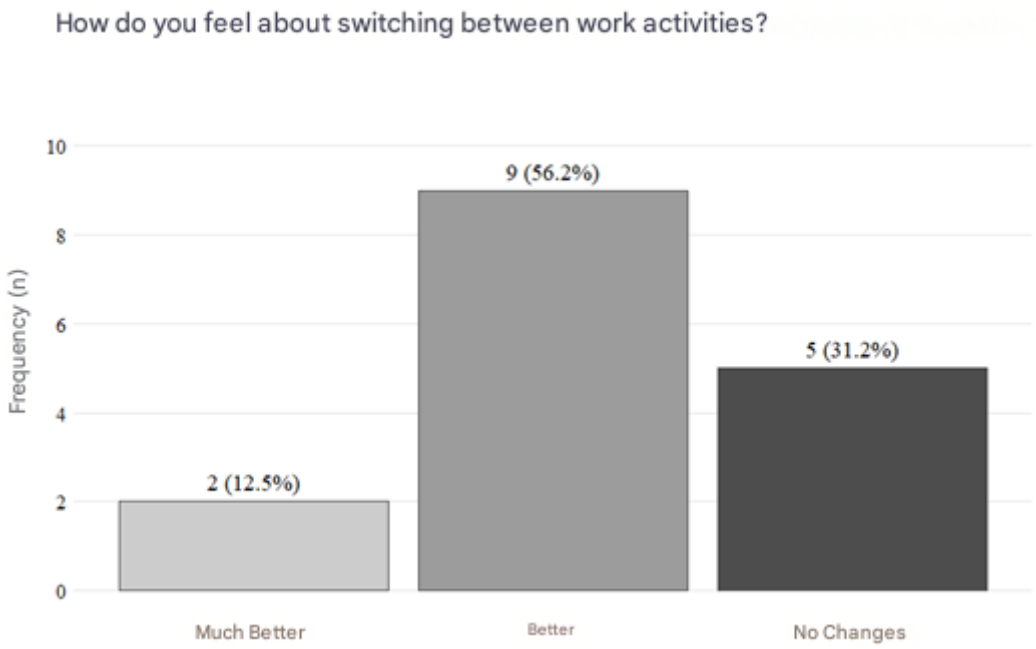
Figure 1- Workers' perception of the impact of job rotation on improving ergonomic working conditions.



Source: Author's own work, 2025

Of the respondents, the majority, comprising 11 workers (68.8%), indicated that they perceived a positive impact of job rotation on improving ergonomic conditions in their work routine. Another 3 respondents (18.8%) stated that they did not know how to comment on the subject, while 2 employees (12.5%) stated that they did not identify such benefits. These data suggest that the strategy is perceived as effective by most of the workforce, who directly associate the alternation of tasks with increased comfort and a reduction in perceived workload.

Figure 2- Perception of Comfort After Implementing Job Rotation

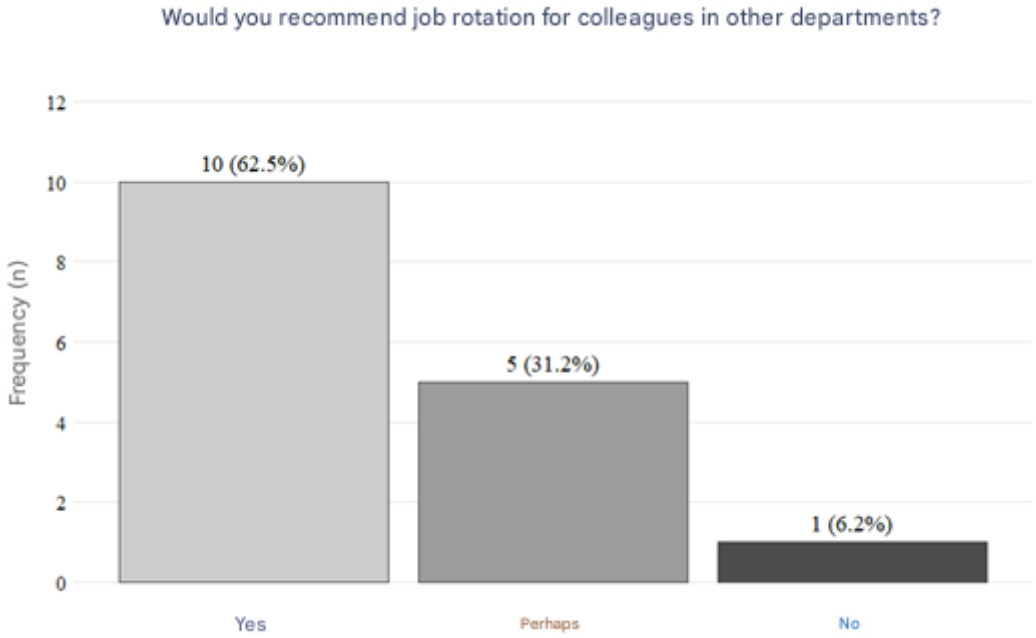


Source: Author's own work, 2025

When assessing workers' perceptions of the impact of job rotation on bodily discomfort and fatigue (Figure 2), it was observed that the vast majority of participants (68.7%; n=11) reported feeling 'better' or 'much better' after the implementation of job rotation. Specifically, 56.2% (n=9) indicated feeling better and 12.5% (n=2) much better. On the other hand, 31.2% (n=5) of respondents indicated not perceiving significant changes. These results reflect a predominantly positive assessment of job rotation, indicating that the strategy is effective in reducing perceived discomfort and fatigue, which corroborates the ergonomic benefit and validates the adoption of the system as a preventive measure in the workplace.

The perceived effectiveness of job rotation was also evaluated from the perspective of workers recommending it to other sectors or jobs, as shown in Figure 3. It was observed that the majority (62.5%) stated that they would recommend the practice to colleagues in other sectors, while 31.2% responded that they might. Only 6.2% said they would not recommend it. These results indicate a favorable trend towards the adoption of job rotation, although a significant portion of respondents still express doubts about its applicability.

Figure 3- Intention to Recommend Job Rotation Among Workers



Source: Author's own work, 2025

After analyzing workers' perceptions of job rotation, this section presents a statistical comparison between the "experienced" and "inexperienced" groups, using Fisher's exact test. The comparative analysis between the "experienced" and "inexperienced" groups regarding the perceived contribution of job rotation to improved ergonomics revealed significant associations.

The comparative analysis presented in Figure 4 reveals a statistically significant association between length of experience in the role and the perception of the ergonomic benefits of job rotation ($p = 0.0357$). Among 'experienced' workers, the perception of improvement was overwhelmingly predominant (n=9), while in the 'inexperienced' group only two participants shared this view. Conversely, the absence of perceived improvement was reported by only one experienced worker, compared to four inexperienced workers. Fisher's exact test resulted in an *Odds Ratio* (OR) of 14.0, indicating that employees with longer experience are significantly more likely to recognize the benefits of job rotation. Although the confidence interval is wide due to the sample size (n=16), the significance of the p-value and the magnitude of the odds ratio suggest that the value of the intervention is clearer for those who have been exposed to the workload for a longer time.

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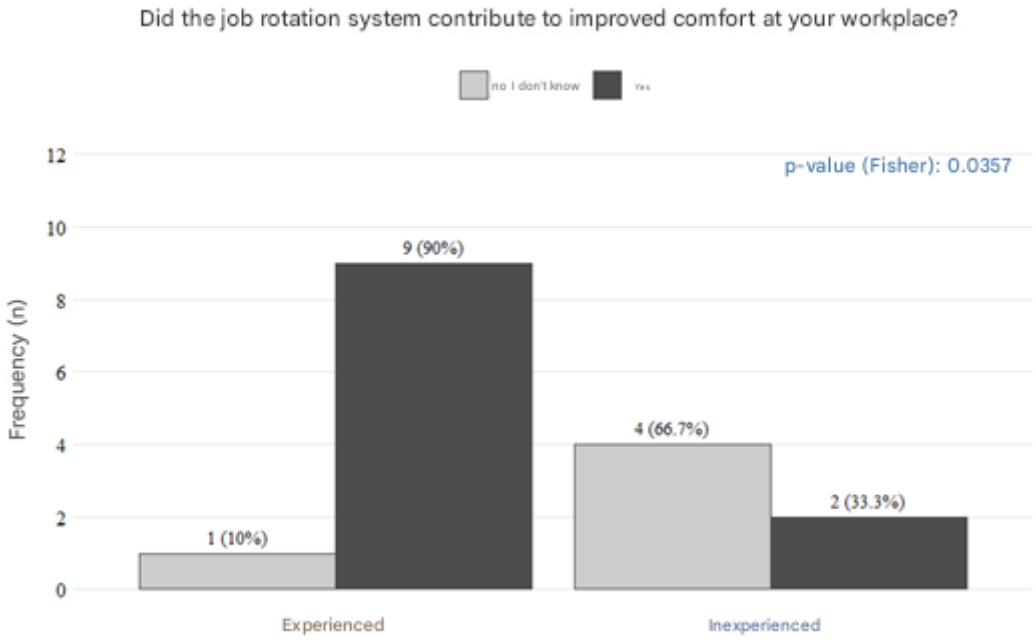
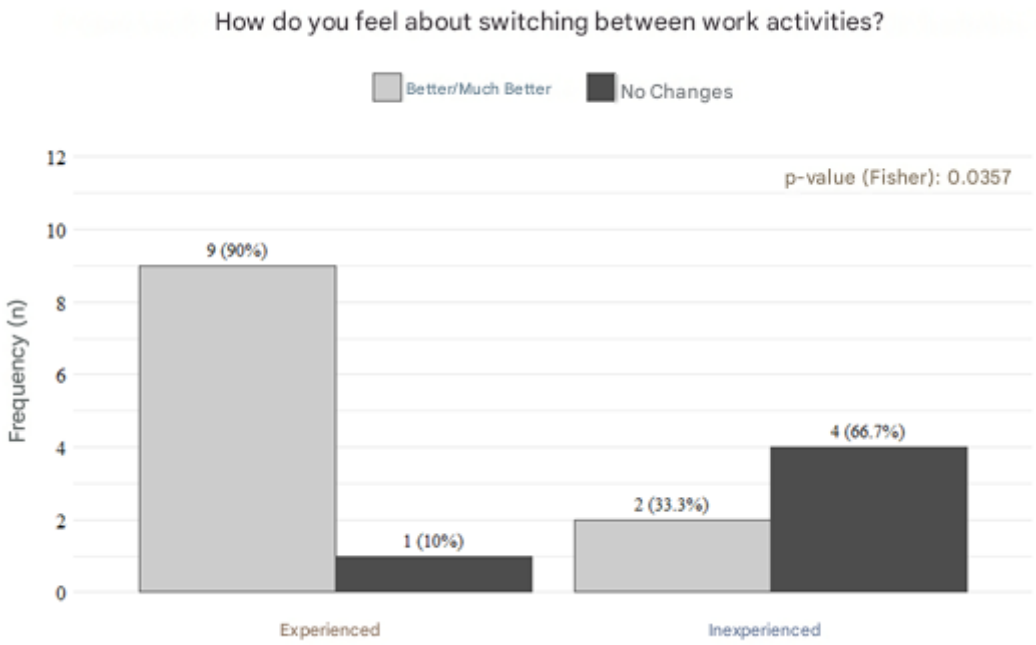
Figure 4- Comparative Analysis of the Perception of Job Rotation Benefits by Experience Level



Source: Author's own work, 2025

Regarding the perception of comfort after the implementation of job rotation (Figure 5), the results confirm the trend observed previously. The vast majority of 'experienced' workers (n=9) reported feeling 'better' or 'much better' with the alternation of activities, in contrast to only two 'inexperienced' workers who shared this assessment. On the other hand, the report of 'no change' was predominant among the 'inexperienced' workers (n=4), compared to only one 'experienced' worker. Fisher's exact test again confirmed the significant association ($p = 0.0357$), with an Odds Ratio of 14.0 (95% CI: 0.85 – 972.43). This total agreement between the indicators of ergonomic improvement and physical comfort reinforces the thesis that functional maturity and the time of exposure to the task are determinants for the appreciation of the benefits provided by job rotation. The predominance of the 'no change' response among inexperienced participants may be associated with the absence of a comparative reference point prior to the implementation of the measure, a point that will be explored further in the discussion section of this study.

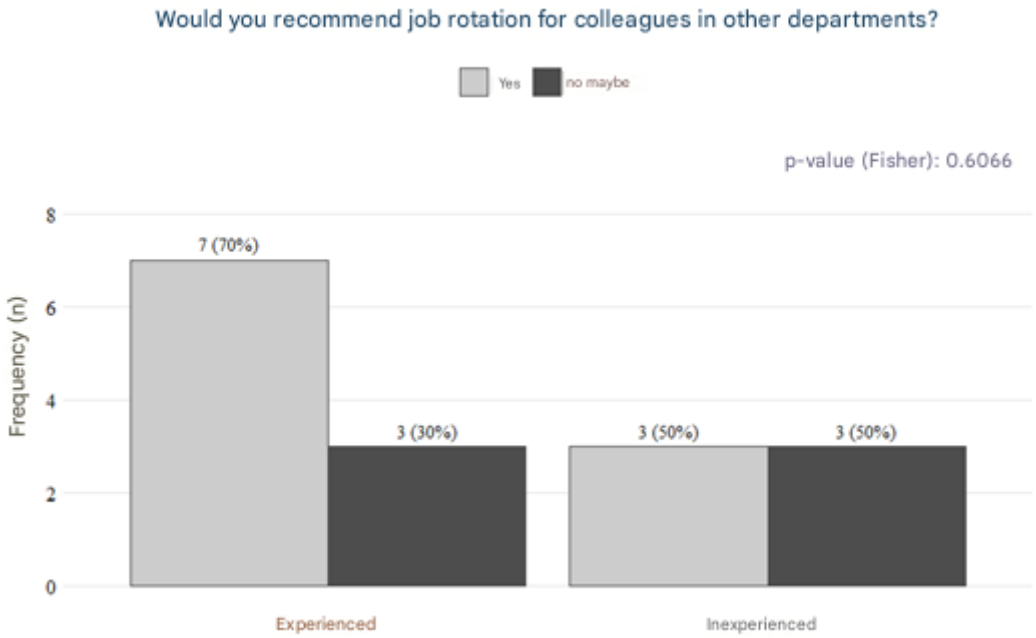
Figure 5- Comparative Analysis of the Perception of Comfort Gains after Job Rotation by Experience Level



Source: Author's own work, 2025

The comparison between the "experienced" and "inexperienced" groups regarding the recommendation of job rotation to colleagues from other sectors (Figure 6) revealed that, in the "experienced" group, 7 workers would recommend the practice, while 3 responded "no" or "maybe". Fisher's exact test indicated no statistically significant association between the level of experience and the recommendation of job rotation to colleagues ($p > 0.05$). The 95% confidence interval of the odds ratio (0.03–5.51; estimate 0.45) suggests that there is no relevant difference in the probability of recommendation between the groups.

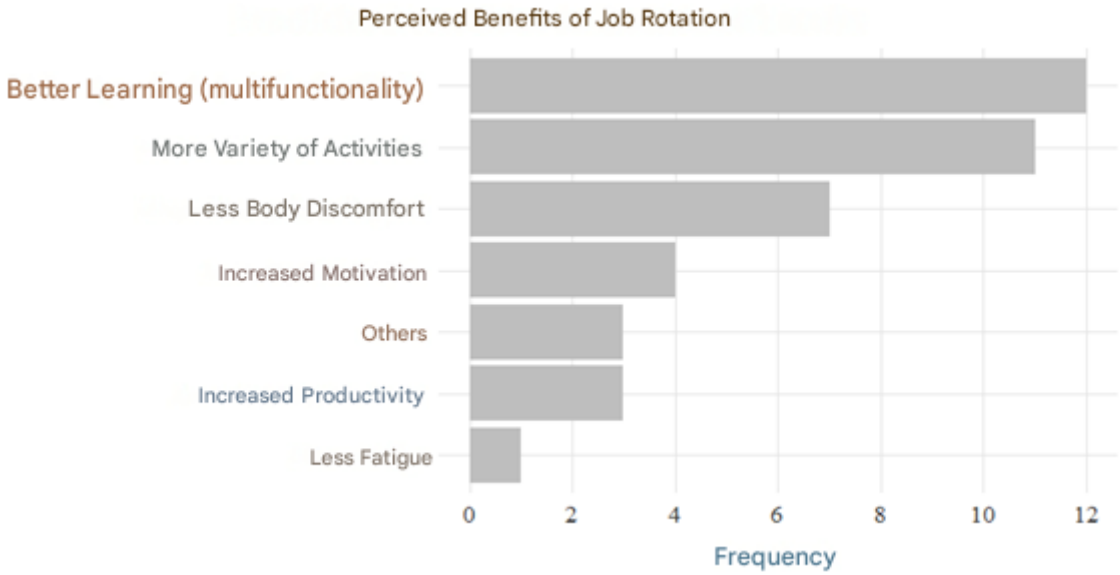
Figure 6- Comparative Analysis of the Recommendation for Job Rotation to Colleagues from Other Sectors by Level of Experience



Source: Author's own work, 2025

Regarding the perceived benefits of job rotation (Figure 7), the three most cited by participants were improved learning and multi-functionality, mentioned 13 times, a greater variety of activities, with 11 citations, and a reduction in bodily discomfort, mentioned 8 times.

Figure 7- Perceived Benefits of Job Rotation



Source: Author's own work, 2025

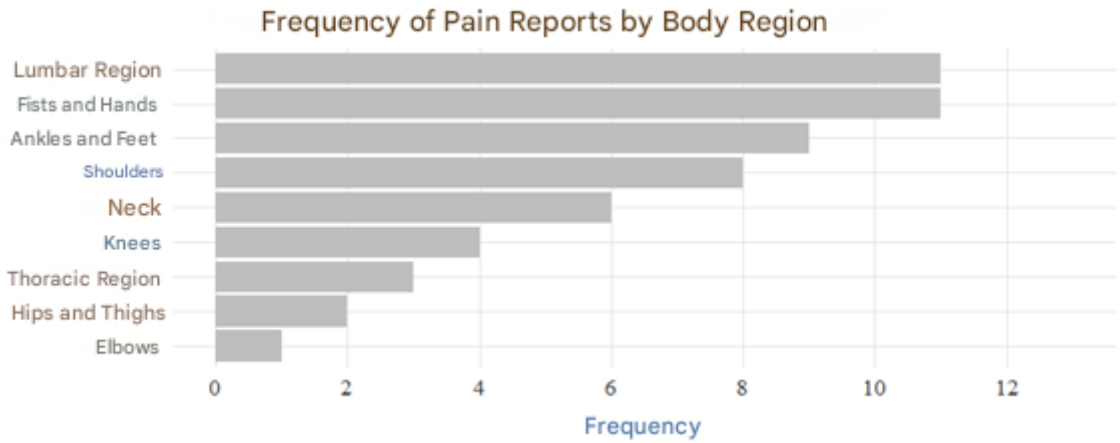
Other benefits, such as increased motivation and productivity, were less frequent, while reduced fatigue was mentioned only once. This low number related to fatigue may be explained by the use of the technical term, which may not have been clearly understood by the

participants, influencing their responses. These results indicate that job rotation is valued primarily for expanding skills, diversifying tasks, and improving physical comfort in the workplace.

3.2 Pain Analysis (Nordic Musculoskeletal Questionnaire)

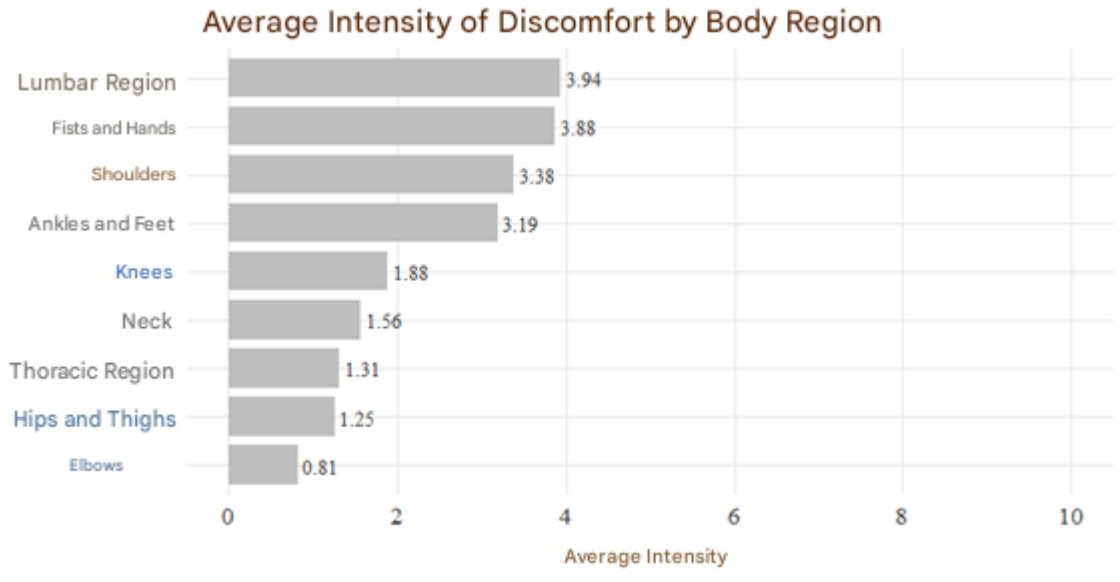
This section presents the assessment of the frequency and intensity of musculoskeletal symptoms reported by workers, based on the Nordic Questionnaire. The analysis showed a higher prevalence of complaints in the wrists/hands and lumbar spine, followed by the ankles and feet, and shoulders, both in the frequency analysis (graph 8) and in the intensity analysis (graph 9).

Figure 8– Frequency of Pain and Discomfort by Body Region



Source: Author's own work, 2025

Figure 9- Intensity of Pain and Discomfort by Body Region

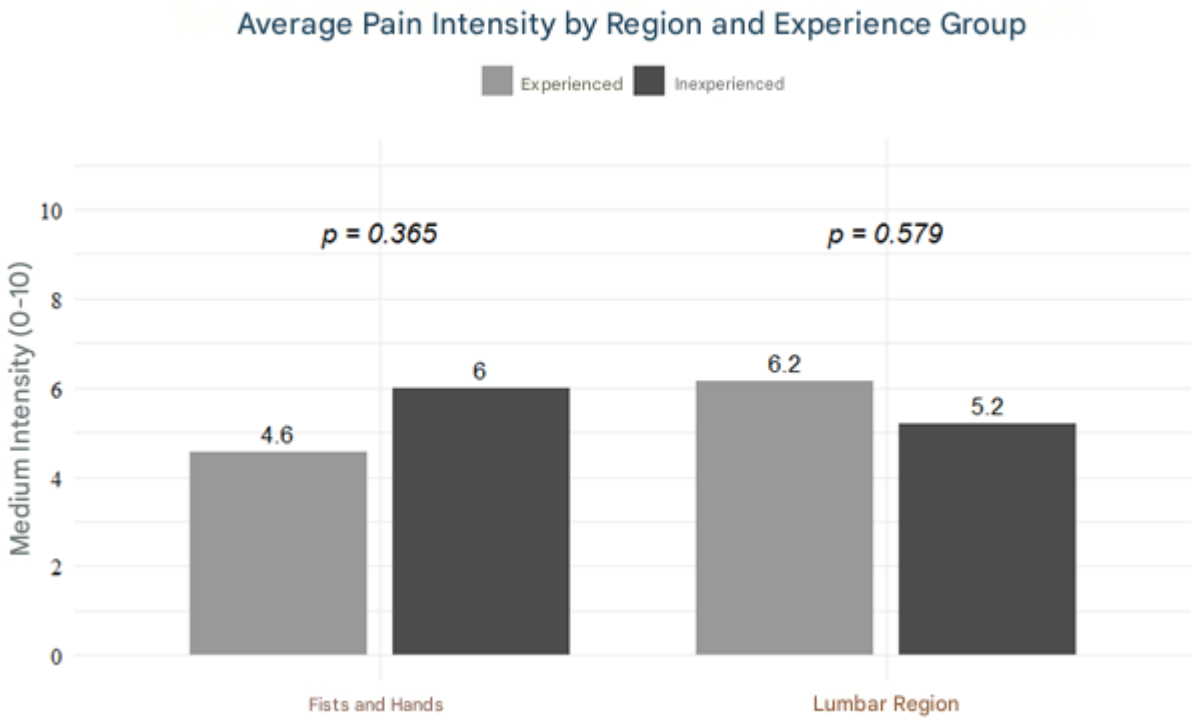


Source: Author's own work, 2025

To enhance the analysis of this context of pain and discomfort and to perform a comparison between groups, we selected the most prevalent regions: lower back and wrists/hands. The assessment of average intensity was performed considering only respondents who reported pain intensity greater than zero in at least one of these regions of interest. When evaluating the average pain intensity among those affected, the data showed variation between

4.6 and 6.2 on a scale of 0 to 10, indicating moderate intensity pain. In the 'experienced' group, the lower back region presented the highest average intensity of 6.2 (standard deviation of 1.9), followed by the wrists and hands, with 4.6 (standard deviation of 1.3). In the 'inexperienced' group, the lower back region presented an average of 5.2 (standard deviation of 3.1), while pain in the wrists and hands registered 6.0 (standard deviation of 2.8). In the comparison between groups, in both pain segments, the Mann-Whitney (Wilcoxon) test did not indicate statistically significant differences ($p > 0.05$).

Figure 10- Comparative Analysis of Pain Intensity by Experience Level



Source: Author's own work, 2025

There is insufficient evidence to state that pain intensity differs between the 'experienced' and 'inexperienced' groups. Both groups exhibit similar patterns of discomfort, suggesting that rotation has not yet demonstrated a clear impact on modulating pain severity, or that factors other than experience time influence the observed musculoskeletal discomfort.

4 DISCUSSION

The findings of this research reveal that the majority of respondents positively evaluate job rotation, citing multifunctionality, a greater variety of activities, and reduced bodily discomfort as the main advantages. Nevertheless, significant complaints of pain remain, particularly in the wrists, hands, and lower back.

The literature presents heterogeneous results in this regard. For example, studies that implemented comprehensive ergonomic interventions, including training and adjustments to the work environment, such as in vehicle assembly lines, demonstrated a significant reduction in exposure to demanding postures and musculoskeletal symptoms after one year of follow-up

(Jin et al., 2025). However, specific results on the impact of job rotation are varied. In complex environments, such as underground mines, the implementation of rotation schedules showed practical difficulties, with few observed effects on reducing musculoskeletal discomfort, reflecting the challenges inherent in the execution and adaptation of the intervention (James et al., 2021; Jones & James, 2018). However, psychological benefits, such as increased satisfaction and reduced mental fatigue, were reported by these studies, suggesting that rotation contributes positively to the well-being of workers, even when the physical effects are less evident.

Different methodological approaches reinforce the effectiveness of work restructuring in mitigating discomfort. In the furniture sector,(Guimarães et al., 2015) The authors measured the perception of physical symptoms using instruments structured according to Macroergonomic Design, which utilize continuous visual metrics to assess the severity of musculoskeletal complaints. Before the intervention, they identified that severe pain in regions such as the lower back, arms, and hands was associated with repetitive movements and the handling of loads. With the implementation of a cellular manufacturing model, which included task expansion and job rotation, a 42% reduction in workload and a significant improvement in postural risk were observed, with risk levels 4 and 3 dropping to level 2 in the OWAS method. These changes resulted in a decrease in fatigue and muscle pain reported by workers during the validation period. Although the present study did not find a statistically significant reduction in pain in the short term ($p > 0.05$), the results (Guimarães et al., 2015)demonstrate the preventive and modulating potential of this strategy when integrated with broader ergonomic and organizational improvements.

This dissociation between the statistical reduction of pain and the gain in subjective well-being is similarly corroborated by [reference missing] (Tirloni et al., 2021). When analyzing poultry slaughterhouses through interviews about bodily discomfort and satisfaction, the authors identified that, although there was no significant association between rotation schemes and the perception of discomfort ($p = 0.759$), worker satisfaction with the strategy was almost unanimous (96.5%). The main reasons cited for this satisfaction were the diversification of activities (65.6%), the reduction of fatigue (60.6%), and the reduction of monotony (18.8%). Such evidence reinforces that, regardless of the immediate modulation of chronic painful symptoms—which may not reach statistical significance in the short term ($p > 0.05$)—the implementation of rotation is fully justified by the improvement in the perception of comfort and job satisfaction.

However, not all studies corroborate these benefits.(Leider et al., 2015) While inconsistent evidence was documented (Comper et al., 2017)in studies conducted after 12 months of monitoring in textile factories, they did not detect a significant difference in hours lost due to musculoskeletal disorders between groups with and without job rotation. Corroborating this diversity of results, (Padula et al., 2017), they concluded that job rotation does little to alter exposure to ergonomic risk factors, although it increases job satisfaction. In this sense, although the present study did not show a statistically significant reduction in pain intensity after implementing job rotation, its effectiveness is validated by the perception of the employees. This perception of improved ergonomic conditions is associated with the optimization of comfort in repetitive activities, acting as a motivational element that improves the workday. Thus, while the study delimits physical discomfort through the Nordic Questionnaire, it is recognized that the perceived benefits reflect a gain in overall well-being, essential for the sustainability of the operation and team engagement.

5 CONCLUSIONS

In summary, both our results and the literature indicate that job rotation promotes noticeable gains in comfort and motivation, but its impact on the effective reduction of musculoskeletal injuries remains contingent on additional factors—especially training, ergonomic workstation design, and workload management.

The data from this study reveal that workers, especially those with more experience in the program, recognize important ergonomic benefits, such as multi-functionality, diversification of activities, greater comfort, and reduced fatigue. This positive perception points to a gradual adaptation to new demands and ways of working, influencing the appreciation of the improvements promoted by job rotation.

However, analysis of musculoskeletal pain intensity in the lumbar region, wrists, and hands showed that these symptoms persist at moderate levels, with no significant differences between experienced and inexperienced workers. This suggests that, despite the perceived advantages, physical discomfort related to work activities remains, indicating that job rotation alone may not be sufficient to fully mitigate ergonomic risks.

The persistence of symptoms may be related not only to the nature of the tasks, but also to organizational factors, such as the overall workload, environmental issues, and the suitability of the workstations. Furthermore, the importance of continuous training is highlighted so that workers can perform different functions safely and efficiently, an essential aspect for the success of job rotation programs.

The results partially diverge from studies that report significant reductions in pain and absenteeism after implementing job rotation, highlighting the complexity of the topic and the need for integrated approaches. Therefore, it is concluded that job rotation should be integrated with other ergonomic practices and strategies that consider the particularities of the production environment, the profile of the workers, and the demands of production. For future research, it is recommended, preferably with a longitudinal design, to investigate the combination of job rotation with complementary interventions—such as continuous training, ergonomic redesign of workstations, and/or workload balancing—and evaluate their effects through objective indicators of productivity, absenteeism, and quality of life, with pre- and post-implementation measurements.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the proposed article.

STATEMENT REGARDING DATA AVAILABILITY

The data supporting the results of this study are available upon request from the corresponding author.

AUTHORSHIP CONTRIBUTIONS (CREDIT)

Author 1: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Visualization, and Fundraising.

Author 2: Conceptualization; Writing – revision and editing, Project supervision and administration.

ADDITIONAL INFORMATION

The research did not require approval from an Ethics Committee, as it was developed within the context of the researcher's professional practice and involved non-interventional quantitative research, in accordance with Circular Letter No. 17/2022/CONEP and CNS Resolution No. 510/2016, Article 1, item VII.

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