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ANÁLISE ERGONÔMICA DA CARGA FÍSICA NO TRANSPORTE E MANUSEIO DE CARGAS: UM CASO COM O MÉTODO REBA

ERGONOMIC ANALYSIS OF PHYSICAL LOAD IN TRANSPORT AND CARGO HANDLING: A CASE WITH REBA METHOD

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Resumo

O transporte e manuseio de cargas frequentemente exigem que os operadores exerçam força física para alcançar seu destino final. Portanto, é crucial que os gestores de frotas gerenciem adequadamente os riscos envolvidos nessas atividades. O presente estudo tem como objetivo realizar uma análise ergonômica da carga física de trabalho utilizando o método Rapid Entire Body Assessment (REBA) e demonstrar que este método pode ser efetivo no processo de tomada de decisão dos gestores em relação às questões ergonômicas. O método fornece resultados rápidos sobre os impactos da carga física de trabalho no corpo do trabalhador, tornando-se uma ferramenta valiosa para que os gestores avaliem e abordem os riscos ergonômicos. Os resultados mostraram que o método foi útil para a situação proposta e que os operadores realizam 50% de suas atividades sob um risco ergonômico muito alto.

Keywords: Análise Ergonômica do Trabalho; Movimentação de cargas; Carga física; Saúde do trabalhador; Gerenciamento de riscos.

Abstract

The transportation and handling of loads often require operators to exert physical force to reach their final destination. Therefore, it is crucial for fleet managers to adequately manage the risks involved in these activities. The present study aims to perform an ergonomic analysis of the physical workload using the Rapid Entire Body Assessment (REBA) method and to demonstrate that this method can be effective in the decision-making process of managers regarding ergonomic issues. The method provides rapid results on the impacts of physical workload on the worker's body, making it a valuable tool for managers to assess and address ergonomic risks. The results showed that the method was useful for the proposed situation and that operators perform 50% of their activities under a very high ergonomic risk.

Palavras-chave: Ergonomic Work Analysis; Cargo handling; Physical load; Worker's health; Risk management.

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1 INTRODUÇÃO

The domain of occupational activities encompasses a vast range of sectors, particularly those involving the loading and unloading of materials. Such tasks frequently require the use of tools and machinery that expose workers to significant biomechanical hazards and physical overload. These risks are exacerbated by a recurring lack of knowledge on the part of workers regarding ergonomic principles, as well as the health risks associated with repetitive movements, improper postures, and excessive physical demands. This knowledge gap can contribute to a higher incidence of accidents and work-related illnesses. Moreover, environmental factors such as thermal comfort and lighting also influence workers' health and overall well-being (FIEDLER; VENTUROLIS; MINETTI, 2006).

Occupational biomechanics, a subfield of ergonomics, seeks to understand the physical interaction between workers and elements such as machines, workstations, and materials, with the primary goal of mitigating the risks associated with musculoskeletal disorders (Iida, 2018). In Brazil, workers' health is recognized as a public health priority under the Unified Health System (SUS), which is responsible for preventive actions, care, and monitoring of work-related health risks (CUNHA; MENDES, 2021). In alignment with global efforts, the International Labour Organization (ILO) has established the concept of "Decent Work" as a key objective, advocating for employment that is productive, fairly remunerated, and conducted under conditions of safety and dignity (ABRAMO, 2015). This agenda is also reflected in Sustainable Development Goal 8 (SDG 8), which emphasizes the promotion of sustained and inclusive economic growth, full employment, and decent work for all (FAYOMI, 2021).

In this context, ergonomics emerges as a critical discipline not only for reducing occupational risks but also for contributing to the strategic design of productive, safe, and human-centered work environments. According to the International Ergonomics Association (IEA, 2021), ergonomics involves the systematic application of theoretical knowledge, methods, and data to design work systems that optimize human well-being and system performance.

Significant progress has been made in ergonomic studies related to posture, body mechanics, environmental stressors, and task design (Iida, 2018). However, many investigations remain limited to diagnostic functions, focusing only on identifying ergonomic risks without advancing toward concrete interventions or operational improvements. Several recent studies underscore this issue. For instance, Bumrungtham and Suraraksa (2023) demonstrated that corrective posture interventions, combined with assistive equipment, significantly reduced REBA scores and improved productivity in industrial settings. Similarly, Ruslan, Jamian and Zulkarnain (2024) identified ergonomic risks among warehouse workers, yet emphasized that practical implementation of improvements remains a challenge in the field.

Other research has demonstrated how lean tools and ergonomic techniques can be integrated to optimize time and reduce physical strain (MUHACIR; AKTAŞ; ÖZCEYLAN, 2022), or how organizational and technical interventions, when supported by stakeholder engagement, can reduce musculoskeletal complaints (ZARE et al., 2020). Nonetheless, such examples remain scarce, and the absence of applied, replicable tools continues to limit the translation of ergonomic knowledge into practical workplace transformations.

Addressing this gap, the present study aims to evaluate the physical workload involved in loading and unloading tasks using the Rapid Entire Body Assessment (REBA) method. The core contribution lies in demonstrating the practical applicability of REBA as a managerial decision-support tool, enhanced by the use of a low-cost, accessible technological platform (Ergolândia). By integrating assessment and action, the study offers a replicable ergonomic methodology for organizations seeking to transform diagnostics into tangible workplace improvements, particularly within the logistics sector.

This paper is organized into five sections. The first section introduces the topic and presents the research objective and methodological approach. The second section reviews the theoretical and regulatory foundations of ergonomics. The third outlines the materials and methods used, including REBA and the Ergolândia platform. The fourth presents the results of the postural assessment and then there is a section dedicated to discussing its implications. Finally, the last section provides the study's conclusions and suggestions for future research.

THEORETICAL ASPECTS

2.1 The Brazilian regulatory norm for ergonomics

Ergonomic risk in the workplace is a key factor contributing to a variety of occupational illnesses, many of which can be mitigated or prevented through the proper ergonomic adaptation of work environments. In Brazil, Regulatory Norm No. 17 (NR-17), supported by the Consolidation of Labor Laws (CLT), aims to establish clear ergonomic standards by identifying the physical, organizational, and environmental conditions that shape a healthy and safe work context (MAAS et al., 2020).

NR-17 sets forth guidelines for adapting working conditions to the psychophysiological characteristics of workers, seeking to enhance productivity while ensuring safety and comfort. These regulations cover critical aspects such as material handling, furniture and equipment design, workplace environmental factors, and task organization (BRASIL, 1978). Importantly, the norm assigns to employers the responsibility of evaluating these working conditions and implementing ergonomic analyses to improve job quality. Failure to comply may result in not only diminished worker well-being but also reduced operational performance.

According to Barboza et al. (2021), ergonomic analysis is a collaborative and interdisciplinary process that addresses the multifactorial nature of work environments. It involves understanding the tasks, activities, and constraints that affect performance and health outcomes. The NR-17 regulation is instrumental in guiding this process, providing standardized frameworks for implementation across diverse economic sectors.

Recent studies (Zare et al., 2020; Ruslan et al., 2024) have reinforced the relevance of such regulatory approaches, especially when they lead to practical interventions, such as task reallocation, ergonomic redesign of workstations, and participatory stakeholder engagement. These examples demonstrate how compliance with ergonomic norms can evolve from a legal obligation into a strategic element of organizational management.

2.2 Managing musculoskeletal disorders caused by poor posture

The absence of ergonomic practices within organizations can result in numerous harmful outcomes for workers, particularly regarding work-related musculoskeletal disorders (WMSDs), commonly referred to as Repetitive Strain Injuries (RSIs). These injuries typically stem from repetitive movements, inappropriate postures, and inadequate work tools or environments (SAKATA; ISSY, 2003). Although early symptoms may resemble general fatigue, untreated cases can evolve into chronic or disabling conditions (RENNER, 2005).

WMSDs primarily affect the spine, shoulders, and upper limbs (REPULLO-JUNIOR, 2005), and are characterized by symptoms such as pain, paresthesia, muscle weakness, and fatigue, which may lead to permanent or temporary incapacity. Factors such as intensification of work, prolonged standing or sitting, and repetitive tasks, especially in logistics and cargo handling activities, are strongly associated with the emergence of these disorders (LIMA et al., 2020).

Ensuring occupational health requires not only early detection but also systemic actions aimed at preventing physical and psychological strain. These include ergonomic risk mapping, posture analysis, and redesign of task flows and equipment (BARBOZA; TEIXEIRA; LIMA, 2017).

According to Bella et al. (2021), job satisfaction is a topic of great interest in work psychology. Nevertheless, when it comes to the quality of life at work, the focus should not only be on recovering from mental exhaustion, but also on physical exhaustion resulting from work routines, enhancing production quality, optimizing time and resources, reducing workplace accidents, and achieving positive outcomes in social and staff-related aspects (CARVALHO-NETO, 2022).

Studies such as those by Bumrungtham and Suraraksa (2023) have shown that implementing ergonomic adjustments can drastically reduce REBA scores and improve operational efficiency. Similar contributions are seen in Muhacır and Aktaş (2022), who demonstrate that combining REBA with lean production tools enables reductions in both physical risks and delivery times. These findings support the notion that ergonomic interventions are not merely corrective, but also strategic and integrative, adding value across operational and managerial dimensions.

According to Mattos et al. (2019), it is critical to incorporate ergonomic perspectives into the evaluation of new technologies, considering how automation and digitization may generate novel forms of overload or discomfort. In line with this, Barboza, Boêta, and Silva-Júnior (2016) stress the importance of analyzing workloads not only in terms of physical output, but also in terms of individual variability and task complexity.

In contemporary ergonomic practice, promoting correct posture and reducing physical strain are essential strategies to minimize the occurrence of musculoskeletal injuries. Such actions must be systematized through ergonomic methods like REBA, which allow structured assessments and data-driven decision-making. This approach can optimize services while reducing the occurrence of problems caused by improper load handling, allowing workers to enjoy healthier lives.

METHODOLOGICAL ASPECTS

The research methodology adopted in this study presents multiple classifications. From the perspective of its nature, the study is categorized as applied research, as it aims to produce practical knowledge to address specific and contextualized problems (PRODANOV; FREITAS, 2013). Regarding the approach to the problem, the study is classified as quantitative, since it employs structured data collection and analysis methods to evaluate ergonomic risks. Although qualitative data such as observations and informal reports were also collected during the fieldwork, such data were not analyzed in this publication, and their inclusion is reserved for future research. In terms of its objectives, the study is of descriptive nature, seeking to characterize ergonomic risks and postural conditions based on systematic assessment techniques.

The study was conducted in the loading and unloading sector of a transport and logistics company located in the municipality of Araruama, in the state of Rio de Janeiro. The sector handles various operations involving physical load handling under distinct environmental and organizational conditions. Data collection focused on a group of six workers, aged between 20 and 43 years, all employed by the company and working during the night shift.

A total of 20 photographs were taken during real work activities to document postures adopted by the employees while handling cargo. From this initial set, six images were selected for analysis, based on the criticality of the postures, that is, those representing high levels of biomechanical effort, postural asymmetry, or repetitive strain. These images provided the foundation for structured postural analysis through the REBA method.

Participants were selected through a non-probabilistic sampling by convenience, given the accessibility and availability of the workers during the scheduled data collection. The inclusion criteria considered: (i) active employment in the company during the research period; (ii) current assignment to tasks involving manual cargo handling; (iii) availability during night shifts; and (iv) voluntary consent to participate. As exclusion criteria, workers in administrative or supervisory positions, those on medical leave, or those who refused to participate were not included in the study. All participants were fully informed about the objectives and procedures of the study and voluntarily signed the Free and Informed Consent Form.

To assess postural risk, the Rapid Entire Body Assessment (REBA) method, developed by Hignett and McAtamney (2000), was applied. This method is widely recognized for its practicality and efficiency in the ergonomic evaluation of postures involving the entire body. REBA divides the body into three groups: Group A (Trunk, Neck, Legs), Group B (Upper Arm, Lower Arm, Wrist), and Group C, which includes additional modifiers such as load/force, coupling, and activity level. Each body segment is scored based on angular deviation, support, and movement intensity, and the scores are then cross-referenced using standardized tables to calculate a final risk level and corresponding action level.

Table 1 presents the classification levels of ergonomic risk according to the REBA scale.

Table 1: REBA Action Levels

Action Level	REBA score	Risk Level	Action (including further assessment)
0	1	Negligible	None necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very High	Necessary NOW

Source: HIGNETT; MCATAMNEY, 2000.

To support the application of the REBA method, the Ergolândia 7.0 software was used. This free, user-friendly tool developed by FBS Sistemas provides an interactive interface for the coding and scoring of each posture. The software facilitated the assignment of values to Groups A and B, as well as the consideration of coupling and load conditions, allowing for the automatic calculation of the final risk score and associated recommendations.

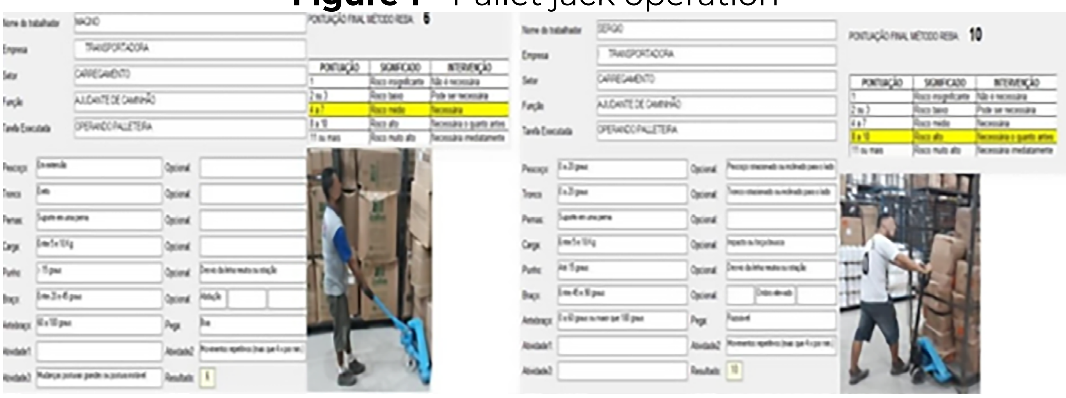
While numerous studies employing the REBA method focus solely on the diagnostic aspect, identifying postural risks and cataloging ergonomic deficits, this research goes a step further by integrating an accessible technological platform that streamlines the analysis process and generates objective inputs for managerial decision-making. By linking REBA results to potential interventions, such as task redesign or workstation adjustments, this study presents a practical application model that can be directly employed by logistics firms with similar characteristics. Thus, the study not only maps ergonomic problems but also provides actionable information for operational improvement, contributing to both scientific literature and professional practice.

RESULTS

Analyses were conducted on the main tasks performed by six loading and unloading assistants of a transport company, commonly referred to as truck helpers. The observations focused on two typical postures during pallet jack operation, two related to manual handling over short distances, and two involving container loading.

Figure 1 presents the performance of workers using pallet jacks, as well as the corresponding REBA scores and risk levels derived from the analysis.

Figure 1 - Pallet jack operation

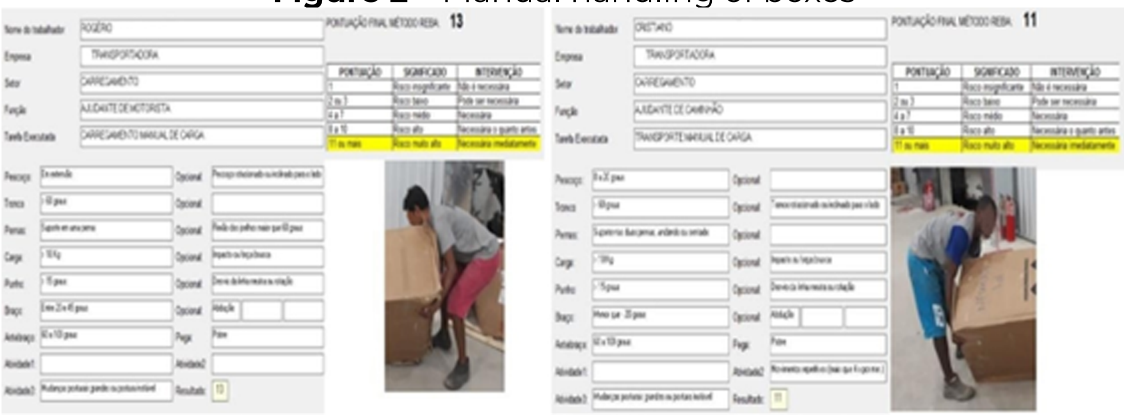


Source: Authors

The application of the REBA method to these tasks revealed that, despite the use of equipment, ergonomic risks remain. The two observed postures received REBA scores of 6 and 10, indicating a medium risk (action level 2) and a high risk (action level 3), respectively. The discrepancy stems from differences in body positioning: the worker with the lower score maintained a more upright posture, minimizing biomechanical stress. This highlights the importance of postural training and peer modeling as cost-effective ergonomic strategies. It is therefore recommended that the worker scoring 10 adopt the ergonomically safer techniques observed in the lower-risk case.

Figure 2 illustrates the outcomes of manual box handling, a critical and frequent task both within the company's facility and during customer deliveries.

Figure 2 – Manual handling of boxes

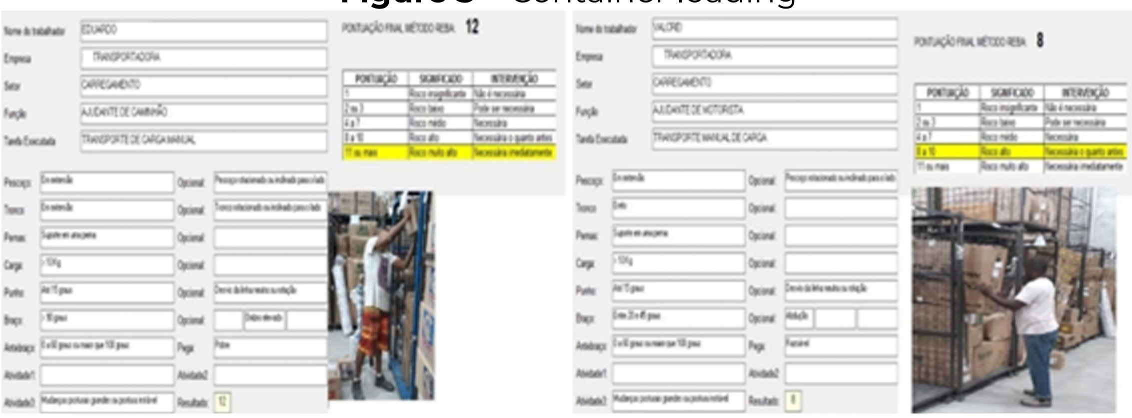


Source: Authors

This activity emerged as the most critical in terms of ergonomic risk. Both observed cases received REBA scores of 11 and 13, corresponding to a very high risk level (action level 4). Immediate corrective actions are recommended, including the provision of wheeled carts to reduce physical strain and improve task efficiency.

Figure 3 presents the analysis of container loading operations, which serve as temporary storage points for goods awaiting distribution.

Figure 3 – Container loading

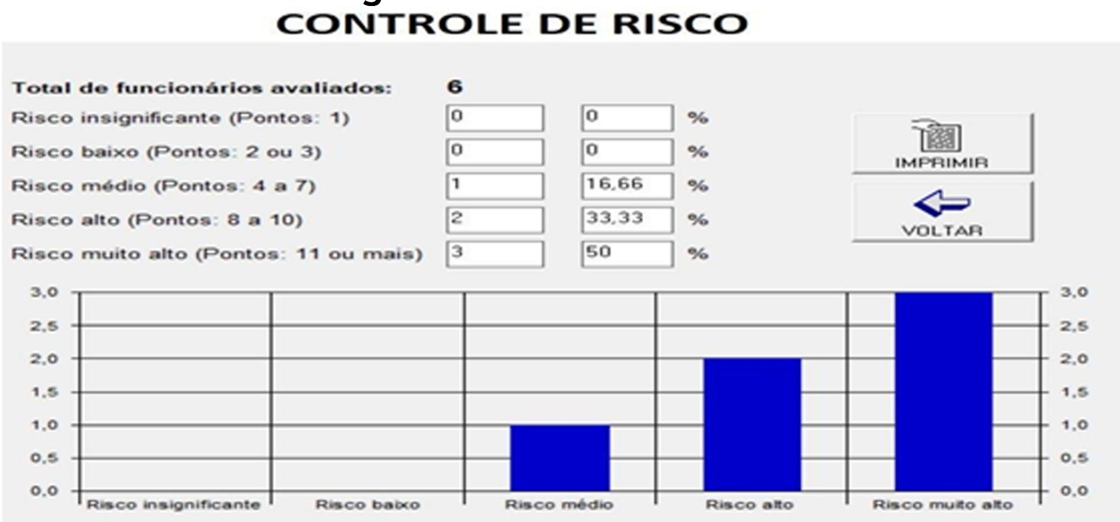


Source: Authors

In the first scenario, a REBA score of 12 indicated a very high risk requiring immediate action. The posture involved lateral torso rotation during load handling, a factor known to increase the likelihood of musculoskeletal injuries, particularly in the lumbar region. In the second scenario, a forward-facing posture yielded a REBA score of 8, still within the high-risk category. In both situations, the use of portable lifting platforms with adjustable shelves is advised to reduce physical strain and support proper body mechanics.

The global distribution of risk levels across all evaluated scenarios is presented in Figure 4, generated using the Ergolândia software.

Figure 4 - Risk Control Chart



Source: Authors

Notably, 50% of the analyzed tasks were classified as very high risk, necessitating immediate intervention. None of the cases exhibited negligible or low risks; in all situations, corrective action was either necessary or urgent. This reinforces the importance of implementing ergonomic strategies not only reactively but also proactively in similar operational contexts.

DISCUSSION

The results highlight a persistent challenge in manual work environments: the presence of ergonomic risks despite the availability of tools and equipment, often due to inadequate posture practices and insufficient training. Comparable findings have been reported in other sectors through the application of the REBA method, particularly in logistics and material handling. For instance, Ruslan, Jamian, and Zulkarnain (2024) identified REBA scores ranging from 5 to 7 among warehouse workers in Malaysia, recommending targeted and continuous ergonomic interventions, such as worker training, task redesign, workplace modifications, and health promotion programs, ruslato mitigate risks and enhance both health and productivity. Similarly, Muhacır and Aktaş (2022) observed higher REBA scores (11 to 13) in textile packaging operations and proposed the adoption of machinery with integrated weighing and bagging modules. This intervention not only led to a marked reduction in ergonomic risk but also facilitated partial automation, which contributed to decreased physical strain, reduced process inefficiencies, optimized staffing, and improved overall productivity.

While these studies confirm the utility of REBA in diagnosing ergonomic risks, they often stop short of proposing specific, accessible interventions for small and medium-sized enterprises (SMEs). This study distinguishes itself by going beyond diagnostic application, offering replicable corrective measures aligned with financial and operational constraints typical of SMEs. The recommendation to adopt portable elevators, trolleys, and peer modeling strategies, for instance, stems directly from observed cases and offers practical solutions grounded in evidence.

An important methodological innovation is the integration of REBA with the Ergolândia software. This partnership enhances the reproducibility and efficiency of ergonomic risk assessments while democratizing access to such tools. The software's intuitive interface facilitates real-time data interpretation and visualization, making it suitable for on-site use by health and safety teams, even in contexts with limited technical resources. As highlighted by Bumrungtham & Suraraksa (2023), there is a growing demand for low-cost ergonomic solutions that support rapid decision-making, a need that this study directly addresses.

Despite these contributions, certain gaps remain. For example, the long-term impacts of interventions based on REBA-identified risks are rarely assessed in the literature. Additionally, very few studies target microenterprises or include longitudinal follow-up of ergonomic improvements. Future research should consider these dimensions, as well as explore how ergonomic enhancements translate into productivity gains, employee retention, and public health outcomes.

Theoretically, this study contributes to the growing field of applied ergonomics in logistics, particularly in underrepresented economic segments. Practically, it provides a framework for action that is grounded in scientific rigor yet accessible to practitioners. The findings also offer valuable input for public policy, especially regarding occupational health in informal or under-regulated labor markets. The evidence presented here could inform municipal or regional initiatives that incentivize ergonomic improvements in small-scale logistics operations.

By combining diagnostic rigor with implementable interventions and an accessible technological interface, this study contributes to bridging the gap between ergonomic theory and practice, an area where much of the current literature remains insufficiently applied.

CONCLUSION

This study conducted an ergonomic analysis of physical workload in transport and cargo handling using the REBA method supported by the Ergolândia software. The assessment focused on the main postures adopted by workers during loading, unloading, and internal transport tasks in a logistics company. The results revealed that all analyzed tasks presented medium to very high ergonomic risk levels, with 50% of them classified as very high, indicating the urgent need for corrective interventions. These findings confirm the presence of biomechanical overload and postural inadequacies, which, if not addressed, may lead to the development of work-related musculoskeletal disorders (WMSDs), such as tendinitis, low back pain, and bursitis.

Unlike studies that limit themselves to diagnosing ergonomic risks, this work stands out by proposing concrete, low-cost, and applicable solutions, such as postural reorientation, the use of trolleys, and the adoption of portable lifting equipment. The methodological integration of the REBA tool with the Ergolândia software proved to be effective and accessible, especially for micro, small, and medium-sized enterprises, which are often excluded from high-cost ergonomic assessments. This combined use not only enhanced the accuracy of the evaluation but also facilitated the interpretation and visualization of risks, making it a replicable model in other logistical environments.

From a theoretical standpoint, the study advances the literature by applying ergonomic analysis to a segment often overlooked, manual labor in small logistics operations, contributing to the operationalization of Sustainable Development Goal 8, which promotes decent and safe work. Practically, the results offer guidance for companies aiming to comply with NR-17 and implement risk-reducing measures without major structural changes. Moreover, the findings may support the development of public policies that incentivize ergonomic improvements in informal or underregulated occupational settings.

Future research should explore the long-term impacts of implementing the suggested ergonomic interventions, as well as assess how such measures affect productivity, employee satisfaction, and occupational health indicators. Studies that apply this methodology in other contexts, such as microenterprises, rural logistics operations, or urban delivery services, are also necessary to broaden the evidence base and adapt interventions to different realities. Additionally, incorporating longitudinal data collection and digital monitoring systems could improve the evaluation of ergonomic programs over time.

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