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ERGONOMIC EVALUATION OF TRANSPORT WORKSTATIONS. A SURVEY-BASED APPROACH

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This paper presents the results of a survey of mobile transport operators such as drivers, professional drivers, couriers and paramedics. The main objective of the study was to assess the state of ergonomics in means of transport and to identify the problems they face in their daily work. An expert survey was used for the assessment. The questionnaire comprised 48 questions, which were divided into 5 main sections: general questions, questions on psycho-physical condition, questions on work organisation, questions on means of transport and the nuisances that prevail at the workplace, and questions related to factors of the material working environment. More than 300 operators took part in the survey. The online surveys were conducted, among others, via a Google form, using the CAWI method. For the purpose of this article, selected results from surveys on ergonomic issues at the transport operator's workstation using the descriptive characteristics method are discussed. The results directly describe the intensities of nuisances and complaints. The results indicated exposures and discomforts occurring at the workplace of transport equipment operators. Among others, the following were found: the discomfort of being in a forced position or being exposed to the need to carry heavy loads, with the indicated total weight of the loads carried averaging about 50 kg, and the need to maintain an awkward position for long periods of time. This results in musculoskeletal disorders and occupational diseases as well as a decrease in work efficiency, indirectly in fatigue and an increased risk of errors. The welfare of people should be prioritized over technical requirements and the designed workspace should be created with people for people.

Keywords: surveys, discomfort, ergonomics, transport operator

1. INTRODUCTION

Ergonomics, as an interdisciplinary field of science, focuses on optimizing working conditions by adapting workplaces, tools, and environments to meet

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human needs. Key aspects of this discipline include reducing the arduousness of work, managing human physical effort, and minimizing harmful microclimatic factors such as noise, vibrations, lighting, and dust (Chaffin, Andersson, 1991; Wilson, Corlett, 2005). The application of ergonomic principles aims not only to improve comfort and work efficiency but also to prevent accidents, injuries, and reduce stress and fatigue associated with work (Grandjean, 1980; Wilson, Sharples, 2015).

The scientific literature offers a wealth of studies documenting the benefits of implementing ergonomic solutions, which translates into better occupational quality of life and employee health. As emphasized by Smith and Carrell (2021), ergonomics should be considered during the design phase of workplaces, which can lead to significant improvements in the safety and efficiency of transport operators' work (Smith, Carrell, 2021). Bridger (2008) and Stanton et al. (2017) highlight that appropriate working conditions can significantly reduce the risk of accidents and enhance work comfort, which is crucial in the transport sector, where operators face daily challenges related to driving vehicles and managing transportation systems (Bridger, 2008; Stanton et al., 2017).

Particular attention to the ergonomics of transport operators has been drawn due to the development of technologies such as autonomous vehicles and intelligent transportation management systems. Adapting workplaces to these new challenges requires workers to acquire new skills and adapt to changing working conditions (Wilson, Sharples, 2015; Karwowski, Marras, 2006). Consequently, ergonomic research in the transport sector not only remains relevant but becomes crucial for further development and optimization of this industry (Dul, Weerdmeester, 2008; Salvendy, 2012).

Assuming we work 40 hours a week between the ages of 20 and 65, with two weeks of annual leave, the total time spent working is 90,360 hours. This is equivalent to over 10 years of life. The conditions in which work is conducted affect our health both during and after our careers. It is therefore essential to study workplace ergonomics, including the workstations of transport operators.

The author's extensive research in the area of human-vehicle-environment interaction inspired the development of an ergonomic methodology for assessing transport workstations. Initially, the author's research focused solely on the evaluation of professional drivers; however, the studies discussed in this article have been expanded to include train drivers and paramedics. For the purposes of this article, the author presented one element of the methodology, which includes selected results from a survey-expert study conducted among operators of mobile transport means: train drivers, professional drivers, couriers, and paramedics. Therefore, the research goal was formulated, which was the ergonomic assessment of non-stationary workstations of transport operators. The author's division is presented below (fig. 1).

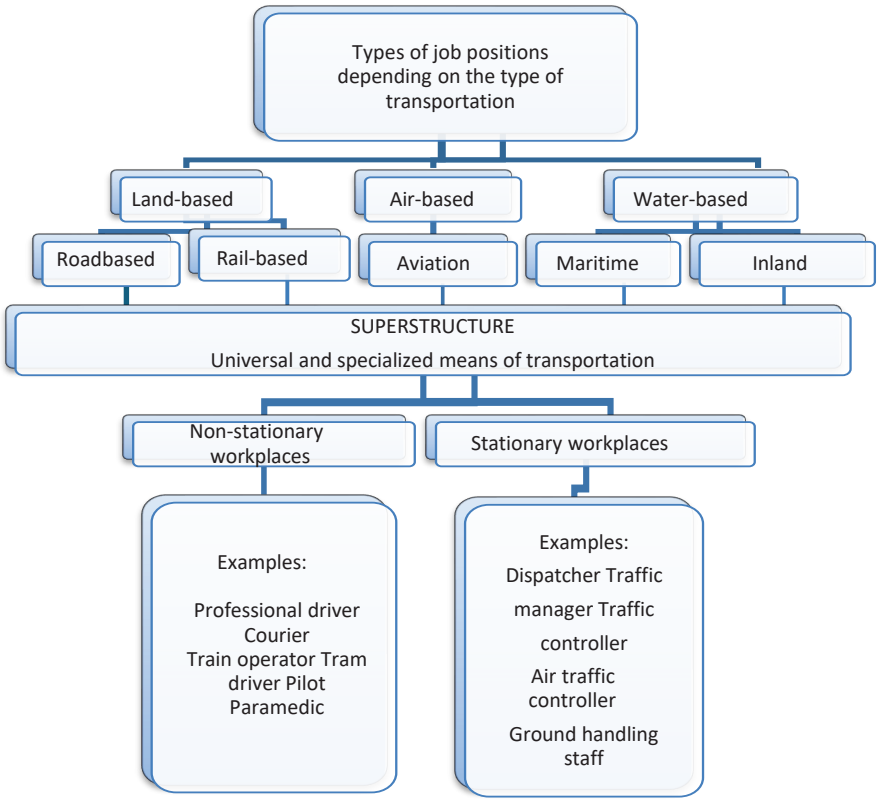

Fig. 1. Types of job positions depending on the type of transportation (authors' own study)

This study, based on survey-expert results, aimed to understand the needs and expectations of these professional groups and identify problems affecting their daily work, including fatigue, errors, injuries, and stress (Kroemer, Grandjean, 1997; Wickens, Hollands, 2000). The results provide valuable information about the specific challenges faced by transport operators, which can be used to formulate recommendations and implement effective ergonomic solutions (Karwowski, 2012).

2. METHODOLOGY

The author's research method consisted of several stages. The first step was to develop a survey questionnaire. Questions were prepared regarding transportation, its quality, as well as the needs and expectations of transport operators, ergonomics, and work strain. Subsequently, the author conducted both electronic and

paper surveys. Online surveys were conducted using a Google form, employing the computer-assisted web interview (CAWI) technique (http://www.cawisurveys.com/future.html). This method allowed for gathering necessary information from transport operators across Poland. The surveys were also conducted in paper form in the Mazowieckie Voivodeship, mainly in cities such as Warsaw, Nowy Dwór Mazowiecki, Grodzisk Mazowiecki, Węgrów, Sokołów Podlaski, and Siedlce. After conducting the surveys, the results were analyzed. Data collected from both types of surveys were subjected to analysis and interpretation to extract main trends and conclusions. This approach enabled the collection of significant information regarding the work of transport operators, mainly from the perspective of ergonomics, from various regions of Poland. It was assumed that the research would focus only on non-stationary, selected workstations. This is because such workstations pose a greater threat to other road users and the environment. Additionally, operators face other external factors such as variable weather conditions, reactions of other users, vibrations, noise, sitting position, or monotony.

2.1. Questionnaire preparation

The study on the ergonomic conditions of transportation operators used a questionnaire-based method aimed at gathering detailed information on the challenges and experiences of this professional group. The questionnaire, comprising 48 questions, was designed to capture various aspects related to work ergonomics, including operators' psychophysical condition, work organization, workplace conditions, and factors related to the physical work environment.

The questionnaire was divided into five main sections:

General information: This section included demographic and general questions regarding psychophysical condition and basic aspects of work. The sample questions covered age, gender, height, type of work performed, the nature of work (temporary/permanent), self-assessment of psychophysical condition, perceived mental fatigue, and participation in ergonomics training.

Work safety and ergonomics:

- Organizational factors: Questions regarding the organization of work, including the time of day when work is performed, shift work, time pressure, difficulty of work, working hours, weather conditions, and work monotony.
- Technical factors: Questions concerning work position, comfort, safety, and workspace adequacy.

Means of transportation and workplace nuisances: Questions about the specifics of transportation means used by operators and nuisances related to their work, such as perceived vibrations, noise, and microclimatic conditions.

Factors of the physical work environment: Questions regarding aspects of the work environment, such as the quality of lighting, temperature, and other physical conditions affecting work ergonomics.

Table 1. Sample section of the questionnaire

Category	Answers	Answer Options
I. General Information		
1. Age	–	
2. Gender	–	
3. Height	–	
4. What is your job position?	Driver, Train driver, Paramedic, Other	
5. Nature of work:	Temporary, Permanent	
6. How do you rate your psychophysical condition?	Poor, Good, Very good, No opinion	
7. To what extent do you experience mental fatigue?	Low, Medium, High, Very high	
8. Have you participated in ergonomics training?	Yes, No	
II. Work Safety and Ergonomics		
9. What time of day do you mostly work?	Day, Night	
10. Is your work shift-based?	Yes, No	
11. Do you feel time pressure at work?	Yes, No	
12. How difficult is your work?	Low, Medium, High, Very high	
13. What is your working time (hours range)?	0-8, 9-12, More than 12 h	
14. How often do you work in difficult weather conditions?	Never, Rarely, Often, Very often	
15. Is your work monotonous?	Yes, No, No opinion	
16. What is your position at work?	Standing, Sitting	
17. Is your work position uncomfortable?	Yes, No	
18. Is your work position comfortable?	Yes, No	
19. Is your work position safe?	Yes, No	
20. Is your seat at work comfortable?	Yes, No	
21. Is the workspace sufficiently large?	Yes, No	
22. Are the dimensions of the workspace adapted to the operator's size and position?	Yes, No	
23. How do you rate the heaviness of your work?	Very light, Light, Medium, Heavy, Very heavy	
26. Are vibrations perceptible at the workplace?	Yes, No	
28. Is the workplace lighting adequate?	Yes, No	

Source: authors' own study.

The questionnaire employed various types of response scales, including binary nominal scales ("yes/no"), as well as four- and five-point ordinal scales, enabling a more precise measurement of the assessed characteristics. Semi-open and open questions were also included to provide a more comprehensive understanding of the phenomena under investigation. Compared to nominal scales, ordinal scales offer a higher level of reliability and precision in respondents' evaluations, allowing for a more detailed data analysis.

The collected data underwent statistical analysis using descriptive techniques and inferential statistics to identify key factors influencing fatigue, errors, injuries, and stress among transportation operators.

2.2. Conducted research

The study engaged over 300 operators of the aforementioned mobile transportation means. The research commenced on March 10, 2020, and data collection is ongoing; however, this article will present selected results from the first phase of the study, which concluded on December 6, 2021. It is noteworthy that the initial phase of data collection coincided with the COVID-19 pandemic, offering valuable insights into the working conditions, particularly for medical responders. The questionnaire ensured the anonymity of participants, enabling transportation operators to freely report various difficulties and hazards in their work environment. This anonymity was crucial for obtaining candid responses, providing a comprehensive understanding of the ergonomic challenges faced by these professionals.

3. RESEARCH RESULTS

The data collected enabled a variety of analytical methods to be applied, with a primary focus on descriptive analysis. The choice of method was dictated by the fact that descriptive characteristics play a key role in ergonomic research, as they help identify underlying patterns and data distributions, which can then be used for more advanced analyses. In the context of studying the ergonomics of transport operators' workstations, this analysis served several important purposes:

Identification of patterns: Descriptive analysis enabled the identification of basic patterns in the data, such as mean values, distribution of variables, and standard deviations. This provided an understanding of which nuisances are most commonly reported by operators and which working conditions most often lead to ailments.

Data visualisation: By creating graphs, tables and histograms, descriptive analysis allows the collected data to be visualised in a way that is easier to interpret. This type of presentation helps to quickly identify key trends and problems related to work ergonomics. Foundations for Statistical Inference Research:

The results of the descriptive analyses formed the basis for more complex studies, such as correlational or regression analyses. These analyses will be performed in the next steps of the ergonomic assessment methodology. In addition, the Descriptive Analysis made it possible to identify which aspects of mobile transport workstations require immediate intervention. With such information, it is possible to adapt vehicles and equipment to the real needs of operators, which can lead to increased work efficiency and improved user comfort. Selected results are discussed below and presented in graphs and tables.

The survey has several important limitations that may affect its results and their interpretation. Firstly, the sample selection was based on online surveys (CAWI method), which might have led to participant selection bias. Another limitation lies in the study's reliance on self-assessment by participants. For instance, the reported weights of carried loads or perceptions of discomfort related to work posture may differ from objectively measurable values. It is also worth noting that the study was conducted during a specific period, largely coinciding with the COVID-19 pandemic, which may have influenced respondents' working conditions and, consequently, their answers. Therefore, the conclusions may be partially limited to this particular period and may not reflect long-term trends.

3.1. Descriptive characteristics

The number of participants in the study was N = 305. Basic data characterizing the respondents are presented in tables 2 and 3. In the study, men accounted for 81.6%, while women accounted for 18.4%. Such a division mainly results from the type of job positions examined, where men predominantly dominate. The most numerous group consisted of individuals aged 25-29 years (38%), followed by those aged 18-24 years (19%) and 30-34 years (19%). Age plays a significant role in an operator's work, because, on the one hand, with age, one gains experience and knowledge, but on the other while experience and knowledge increase with age, reaction time slows, and fatigue accumulates. The vast majority of respondents (93.1%) were transport operators working on a permanent basis, while the remaining respondents worked temporarily.

Table 2. Characteristics of study participants

Variable	N	n (%)
Gender	305	
Female		56 (18.4%)
Male		249 (81.6%)
What is your job position?	305	
Driver		109 (35.7%)
Machine operator		90 (29.5%)
Paramedic		106 (34.8%)
The nature of work is:	305	
Temporary		21 (6.9%)
Permanent		284 (93.1%)

Source: authors' own study.

Table 3. Basic descriptive statistics

Variable	N	M	SD	Me	Min.	Maks.	Skewness	Kurtosis
Age	305	37.63	10.870	36.00	18.00	61.00	0.36	–0.92
Height	305	177.45	7.456	178.00	154.00	200.00	–0.17	0.48
Length of service in the current transport position	305	10.05	9.658	6.00	0.25	55.00	1.74	3.84
Number of hours worked per day in the current position	305	11.83	4.046	12.00	7.35	24.00	2.08	3.93

N – number of valid observations, M – mean, SD – standard deviation, Me – median, Min. – minimum value, Max. – maximum value.

Source: authors' own study.

The average age of the study participants was M = 37.6 years (SD = 10.87). The average height of the respondents was M = 177.5 cm (SD = 7.46). The average length of service in the transportation job position was M = 10.05 years (SD = 9.66). Participants spent an average of M = 11.83 hours (SD = 4.05) at their job position. This is a concerning finding, because long hours on the job can lead to fatigue, decreased concentration, and increased risk of accidents. For transport operators, this carries particularly dangerous consequences.

To examine the normality of the distribution of variables, the Shapiro-Wilk test was utilized. The obtained results are presented in table 4.

Table 4. Results of Shapiro-Wilk normality test

Variable	W	p
Age	0.96**	<0.001
Height	0.99*	0.008
Tenure on the current transportation job	0.82**	<0.001
Number of hours worked per day at the current job	0.68**	<0.001

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: authors' own study.

The results of the Shapiro-Wilk test indicate a lack of normality in the distribution of all analyzed variables. Further analyses of the obtained results illustrate how operators assessed the comfort of their work and ergonomic factors. The results are shown in table 5.

Table 5. Results of the study on the ergonomic level at the workplace

Variable	N	n (%)
Is the position at the workplace forced and burdensome?	305	
yes		146 (47.9%)
maybe		41 (13.4%)
no		118 (38.7%)
Is the position during work safe?	305	
yes		208 (68.2%)
no		97 (31.8%)
Is the seat at the workplace comfortable?	305	
yes		172 (56.4%)
no		133 (43.6%)

Variable	N	n (%)
Does the space at the workplace allow for the proper execution of required tasks?	305	
yes		221 (72.5%)
no		84 (27.5%)
Are the dimensions of the workplace adjusted to the position you assume (working)?	305	
yes		214 (70.2%)
no		91 (29.8%)
Does the arrangement of the main control devices at the workplace allow easy access to them?	305	
yes		243 (79.7%)
no		62 (20.3%)
Does the arrangement of other necessary equipment/devices at the workplace allow easy access to them?	305	
yes		208 (68.2%)
no		97 (31.8%)
Do you experience any discomfort/difficulties while working in a vehicle other than usual?	305	
no		199 (65.2%)
yes		106 (34.8%)

Source: authors' own study.

The results based on the collected data provided valuable insights:

Safety of work position: The majority of respondents (68.2%) considered their work position to be safe. This is a positive result, suggesting that most workplaces provide adequate safety conditions. However, 31.8% of respondents reported their

work position as safe, indicating the need for improvement in workplace ergonomics to ensure workers safety.

Seat comfort: Nearly half of the respondents (43.6%) reported that their workplace seat was not comfortable. This is a significant aspect because an uncomfortable seat can lead to discomfort, fatigue, and health problems for workers. Improving comfort can contribute to increased work comfort and reduced discomfort associated with prolonged sitting.

Accessibility of control devices: The majority of respondents (79.7%) reported that the main control devices at their workplaces are easily accessible. This is important as it facilitates task execution and can contribute to increased work efficiency. However, 20.3% of respondents reported difficulties in accessing these devices, which can lead to work delays and worker frustration.

Accessibility of other essential devices: Over 30% of respondents (31.8%) reported that they do not have easy access to other essential devices and equipment at their workplace. The lack of access to necessary work tools can lead to task difficulties and increased risk of errors. Therefore, it is important to ensure easy access to all necessary devices and equipment at workplaces. Additionally, medical rescuers noted in their comments that the lack of standardization in ambulance layouts means they typically need up to 33 minutes to familiarize themselves with the equipment arrangement in a new vehicle.

Comfort of work in vehicles: Almost one-third of respondents (34.8%) experienced discomfort when working in unfamiliar vehicles. This is an important issue because working in different vehicles may involve different levels of discomfort, which can affect work efficiency, as well as workers' health and well-being. It is necessary to understand the causes of this discomfort and taking action to reduce it.

The collected data indicate a significant ergonomic problem that could potentially increase the risk of accidents and negatively impact workers' health and well-being. Making changes to work procedures and implementing appropriate ergonomic solutions can contribute to improving working conditions and reducing the occurrence of forced operator positions.

In workplace evaluations, the weight of items being handled is a critical factor to consider. Improper lifting techniques and excessive load weights pose significant health risks. Mismanagement of these factors often leads to chronic conditions such as back pain, hernias, muscle fatigue, joint damage, and ultimately to injuries and occupational diseases. Recent studies indicate that musculoskeletal disorders (MSDs) are among the leading causes of work-related disabilities and limitations in both professional and personal activities (Smith, Johnson, 2019; Jensen A.A., 2018). The survey asked respondents about carrying heavy loads, including patients in the case of paramedics. Analysis of the responses to this question showed that nearly three-quarters of survey participants (n = 225; 73.8%) confirmed that they were exposed to carrying or moving heavy objects. Only 26.2% of respondents (n = 80) reported no such workloads (fig. 2).

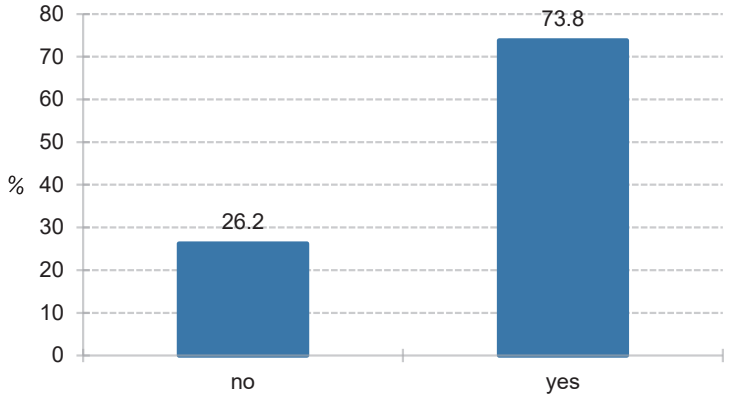

Fig. 2. Percentage distribution of responses to the question,
"33. Are you exposed to carrying or moving heavy objects?" (n = 305)

To investigate it further, respondents were asked to indicate the maximum weights of loads they handle during a work shift, measured in kilograms. For consistency and data reliability, results exceeding 200 kg were excluded from the analysis.

The table below presents the basic descriptive statistics for the weight of the handled loads.

Table 6. Basic descriptive statistics for the weight of handled loads

Variable	N	M	SD	Me	Min.	Max.	Skewness	Kurtosis
What are the maximum weights of loads you carry during a work shift in kg?	302	49.58	31.078	50.00	2.00	150.00	0.53	-0.21

N – Number of valid observations, M – Mean, SD – Standard deviation, Me – Median, Min. – Minimum value, Max. – Maximum value.

Source: authors' own study.

The analysis shows that the average maximum load carried during a work shift was M = 49.6 kg (SD = 31.08). The median (Me = 50.0 kg) was close to the mean, indicating a fairly even distribution of responses in terms of handled weights. The minimum reported load weight was 2 kg, while the maximum weight carried by respondents was 150 kg.

The skewness (0.53) and kurtosis (–0.21) values suggest a slightly asymmetric distribution with a slight skew towards lower weight values, but not enough to significantly deviate from a normal distribution. The analysis revealed that the average maximum weight of loads handled during a work shift was M = 49.6 kg (SD = 31.08). According to regulations, the maximum permissible weight of items that can be

lifted and carried by a single worker depends on the gender and the nature of the work. These regulations specify the following limits:

Legal Limits on Maximum Load Weights for Employees (Regulation of the Minister of Labour and Social Policy, 2000):

- for women: continuous work: 12 kg, intermittent work: 20 kg (defined as manual movement of objects, loads, or materials no more than 4 times per hour, provided the total duration does not exceed 4 hours per day);
- for men: Continuous work: 30 kg, Intermittent work: 50 kg.

Additionally, the weight of objects lifted above shoulder height must not exceed:

- for women: Continuous work: 8 kg, Intermittent work: 14 kg;
- for men: Continuous work: 21 kg, Intermittent work: 35 kg.

Comparing the average maximum load weight handled during a work shift (M = 49.6 kg) with the legal limits shows significant exceedances of permissible weights for employees, both for continuous and intermittent work, across genders:

- for women, the average weight of 49.6 kg significantly exceeds the permissible limits of 12 kg (continuous work) and 20 kg (intermittent work);
- for men, this average weight also exceeds the recommended limit of 30 kg for continuous work, although it is below the maximum limit of 50 kg for intermittent work.

Lifting objects above shoulder height also requires careful consideration. According to the regulations, such weights should be limited to: 8 kg (continuous work) and 14 kg (intermittent work) for women, 21 kg (continuous work) and 35 kg (intermittent work) for men.

The average value of 49.6 kg far exceeds these limits, indicating a significant risk to employee health, especially regarding lifting heavy objects to higher levels.

Implications of Exceeding Legal Limits

Exceeding these limits poses significant health risks to employees, increasing the likelihood of injuries and MSDs. Prolonged exposure to handling heavy loads above the allowable limits can lead to: chronic back pain, joint damage, muscle fatigue, hernias, other serious injuries and occupational diseases.

Therefore, adherence to regulations concerning maximum load weights is crucial for ensuring worker safety and minimizing the risk of health issues. Employers should regularly monitor working conditions, adjust employee duties to their physical capabilities, and implement supportive technologies to reduce the burden.

In a survey on the perceived difficulty of their jobs, nearly half of the respondents (n = 152; 49.8%) described their work as moderately strenuous. Heavy work was reported by 36.1% of participants (n = 110), while 7.9% (n = 24) indicated performing light work. The remaining participants classified their jobs as very heavy (n = 18; 5.9%) or very light (n = 1; 0.3%).

The results presented in figure 3 show that operators engaged in tasks involving the movement of heavy items often perceive their work as physically demanding.

This work is predominantly perceived as moderately strenuous or heavy, which raises concerns about potential long-term health effects. The emerging pain and discomfort associated with continuous physical strain can significantly decrease the productivity of respondents, which warrants considerable attention.

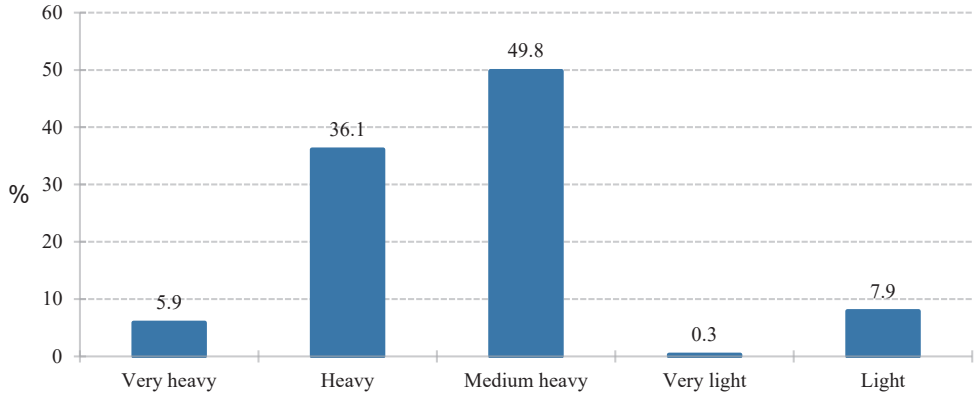

Fig. 3. Perceived job strain among survey participants

The distribution of job strain assessments reveals that a substantial portion of workers experience a significant level of physical burden. With nearly half of the respondents reporting their work as moderately heavy and more than one-third as heavy, the findings suggest that their tasks require considerable physical effort.

- Moderately heavy work (49.8%): tasks in this category likely involve regular lifting of moderately heavy objects, leading to a noticeable level of discomfort, but not enough to classify the work as heavy.
- Heavy work (36.1%): this category includes tasks requiring substantial physical effort and frequent lifting or moving of heavy items, significantly increasing the risk of injuries.
- Very heavy work (5.9%): jobs in this category involve the highest level of physical strain, which can result in serious health issues.

The remaining categories, including very light (0.3%) and light work (7.9%), suggest lower physical strain, which does not pose a significant health risk to the workers.

These findings highlight the necessity of considering ergonomic interventions to reduce physical workload. Implementing measures aimed at reducing the movement of heavy objects, such as better lifting and transport tools, can significantly improve worker comfort and health, thereby enhancing their long-term productivity and efficiency.

In the study assessing participant discomfort, responses to the question “Do you experience any discomfort?” revealed that participants most frequently reported discomfort in the following areas:

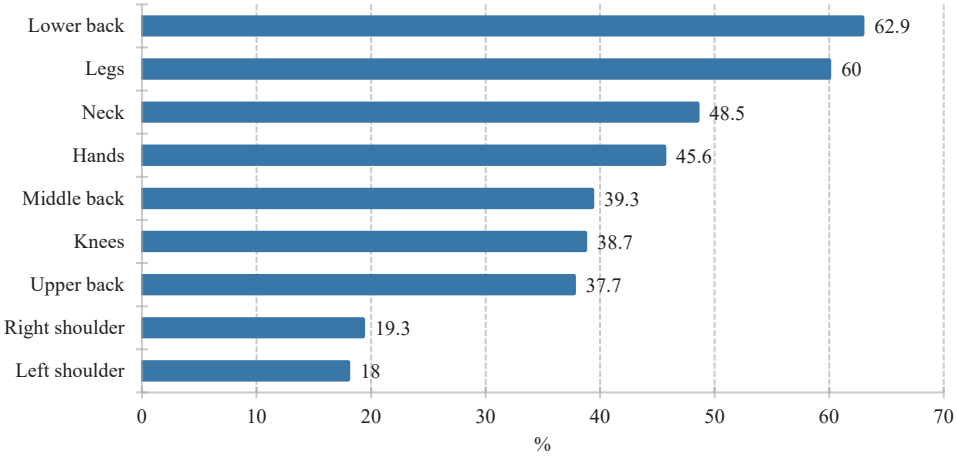

Fig. 4. Percentage distribution of responses to the question: "39. Do you experience complaints?" (n = 305)

lower back: 192 participants (62.9%), legs: 183 participants (60.0%), neck: 148 participants (48.5%). Conversely, discomfort in the following areas was least commonly reported: right shoulder: 59 participants (19.3%) and left shoulder: 55 participants (18.0%).

These findings illustrate that a significant majority of participants suffer from musculoskeletal discomfort, primarily affecting the lower back, legs, and neck. The lower incidence of discomfort in the shoulders suggests variability in ergonomic stress across different body regions among the surveyed population.

In order to minimize the negative effects of workloads, it may be beneficial to introduce ergonomic improvements such as proper workstation design, providing arm and shoulder support in the form of armrests, as well as introducing regular breaks to allow for recovery and also making employees aware of ergonomic principles. This is why the survey included a question whether respondents had received training in ergonomics. The results for the question, "16. Have you participated in ergonomics training?" are shown in figure 5.

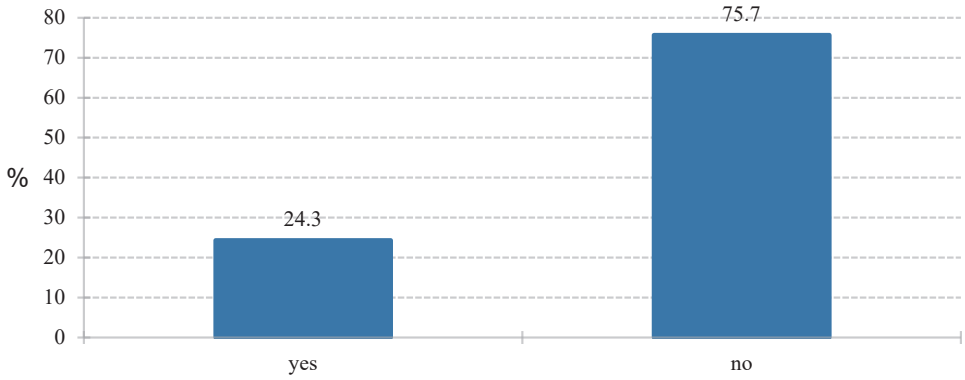

Fig. 5. Percentage distribution of responses to the question,
"16. Have you attended ergonomics training?" (n = 305)

The majority of respondents had never received training in ergonomics (n = 231; 75.7%). Only 24.3% of those surveyed (n = 74) indicated having attended such training. Lack of sufficient knowledge of ergonomics and failure to adhere to its principles result in, among other things, improper use of rest time, inadequate equipment, or the lack of or inability to use the correct equipment. It is worth noting, as reported by (Kadir, Broberg, da Conceição (2019), Current research and future perspectives on human factors and ergonomics in Industry 4.0. Comput. Ind. Eng. 137), that good health is directly proportional to life satisfaction. Pain interferes with the state of satisfaction, making it difficult to function and carry out social and professional roles, ultimately reducing a person's well-being.

4. CONCLUSIONS

The statistical analysis of the selected survey results illustrated in the article consisted of performing descriptive characteristics to assess the ergonomic level of the mobile transport operator workstation. The study sheds light on significant problems related to the ergonomics of transport operators' workstations, pointing to serious health consequences resulting from the numerous nuisances at the workstations assessed. The results of the surveys indicate associations between the weight of the objects being handled and the incidence of pain and MSDs, which is consistent with recent national and international research. Our study showed that nearly three-quarters of respondents (73.8%) are exposed to carrying or moving heavy objects, which is a significant physical load. The average weight of loads carried was M = 49.6 kg (SD = 31.08). Such high values indicate that the recommended standards are exceeded, which coincides with the results of international studies that indicate similar problems. For example,

in his review of work ergonomics studies, Bernard (2023) found that the physical overload associated with carrying heavy loads leads to an increased risk of lower back discomfort and reduced work capacity (Bernard, 2023). International literature supports these findings. Guo et al. (2023) analyzed the impact of carrying heavy loads on workers' health in a global context and found that regularly exceeding recommended load standards leads to persistent back problems and general muscle fatigue (Guo et al., 2023). In contrast, a study by Smith et al. (2022) found that transport operators are at high risk of musculoskeletal injuries, which correlates with excessive physical exertion and carrying loads above the norm (Smith et al., 2022).

In our study, almost half of the respondents rated their work as moderately heavy (49.8%) and 36.1% as heavy, which is comparable to the findings of Jensen (2021), who highlights that work intensity is a key factor influencing the occurrence of pain and the overall physical strain of workers (Jensen, 2021). Only a small percentage of participants rated their work as light, indicating the common problems associated with intense physical work in this occupation. The most commonly reported complaints were related to the lower back (62.0%), legs (60.0%) and neck (48.5%), confirming the findings of Nowak (2022) and Kowalski (2021), who found that these complaints are directly related to excessive physical loading and improper weight-bearing techniques (Nowak, 2022; Kowalski, 2021). The least frequently reported problems were related to the shoulders, suggesting that upper body loads are less common but still present. In the context of the results analyzed, the lack of adequate ergonomics training reveals itself as a key problem affecting the health and safety of workers, especially those exposed to manual handling of heavy loads. Our research indicates that, despite significant physical strain, workers rarely receive ergonomic training, which increases the risk of musculoskeletal complaints due to lack of adequate knowledge.

In addition, ergonomics training is also crucial for reducing injuries related to load carrying and other physical loads. Karwowski and Marras (2022) emphasize that appropriate ergonomics training programmers can significantly reduce the incidence of MSDs by promoting proper lifting and carrying techniques, as well as workstation organization (Karwowski, Marras, 2022). Similarly, Gonzalez et al. (2023) also found that workers without proper training are more likely to adopt inappropriate body positions and lifting techniques, resulting in greater musculoskeletal strain (Gonzalez et al., 2023). In our study, the most commonly reported complaints were in the lower back, legs and neck, suggesting a direct link between a lack of training and the occurrence of these problems.

On the other hand, it is worth noting that employers have a key role in creating working conditions that minimize the risk of occupational injuries and illnesses. Employers should therefore strive to ensure that workstations can be personalized so that each employee can work under optimal conditions. Therefore, it is important to conduct ergonomics studies of workstations and modify them to reduce the

likelihood of occupational accidents, as well as to increase knowledge of the causes of their occurrence. Ergonomics training, on the other hand, is only a supplement to a proper work organization process. The welfare of people should be prioritized over technical requirements and the designed workstation space should be created with people for people.

The results of the conducted survey provide valuable insights but should be treated as preliminary, identifying existing ergonomic issues in the work of transport operators. The next stages of research should incorporate more advanced measurement techniques and an individualized approach to ergonomic assessment to better understand the complexity of the problems and develop effective strategies to address them. Based on the conducted analysis, I propose the following recommendations:

1. Ergonomics training

It is essential to implement mandatory ergonomic training for all transport operators. Such training should cover both theoretical knowledge about risk factors and practical skills, including proper lifting techniques, workstation organization, and maintaining correct body posture.

2. Organizational culture change

Promote awareness among employees and employers about the importance of ergonomics and foster an organizational culture where employee health and safety are prioritized.

3. Individualized ergonomic assessments

Individual ergonomic assessments of workstations should be conducted, considering the specific tasks performed and the physical characteristics of operators. This approach would allow for the identification of individual risk factors and the development of tailored solutions.

4. Need for further research

Future research should focus on leveraging advanced biomechanical methods such as motion analysis using the Myo Motion system by Noraxon, Arizona, USA and surface electromyography (EMG).

Myo Motion Technology will enable precise recording of body movement patterns during routine tasks performed by operators. The analysis will facilitate the identification of improper body positions that may lead to chronic musculoskeletal strain and enable the monitoring of movement dynamics, including moments of overload, such as lifting heavy objects or maneuvering in confined spaces.

Electromyography will allow for detailed examination of muscle activity during specific occupational tasks, such as: carrying loads of varying weights, prolonged sitting in an operator's cabin, operating control devices from different positions.

The EMG results will help identify muscles that are overstrained or underutilized, which is crucial for designing individualized ergonomic interventions.

The conducted survey was exploratory in nature, aiming to identify the main ergonomic challenges faced by transport operators. It provides a foundation for more detailed and advanced studies, which in the future should also include:

- validation of survey results using objective measurement tools such as Myo Motion and EMG;
- expansion of the sample size: engaging a larger number of participants from various occupational groups and geographic regions to achieve more representative findings;
- Preventive Strategy Development.

Based on more precise results from future research, a preventive strategy can be developed, which will include: early identification of operators particularly at risk of developing MSDs, development of algorithms for individualized workstation adjustments, for example, using artificial intelligence technology.

These measures will ensure that transport operators work in conditions optimized for their health, safety, and productivity.

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ERGONOMICZNA OCENA TRANSPORTOWYCH STANOWISK PRACY. PODEJŚCIE OPARTE NA ANKIECIE

Streszczenie

W artykule przedstawiono wyniki ankiety przeprowadzonej wśród operatorów środków transportu, takich jak kierowcy zawodowi, kurierzy i ratownicy medyczni. Głównym celem badania była ocena stanu ergonomii na stanowiskach pracy oraz identyfikacja problemów, z jakimi spotykają się w codziennej pracy. Do oceny wykorzystano ankietę ekspercką. Kwestionariusz składał się z 48 pytań, które zostały podzielone na 5 głównych sekcji: pytania ogólne, pytania dotyczące kondycji psychofizycznej, pytania dotyczące organizacji pracy, pytania dotyczące środków transportu i uciążliwości występujących w miejscu pracy, pytania związane z czynnikami materialnego środowiska pracy. W badaniu wzięło udział ponad 300 operatorów. Ankiety internetowe przeprowadzono m.in. za pośrednictwem formularza Google, metodą CAWI. Na potrzeby niniejszego artykułu omówiono wybrane wyniki badań ankietowych dotyczących zagadnień ergonomicznych na stanowisku pracy operatora transportu metodą charakterystyk opisowych. Wyniki bezpośrednio opisują

natężenie uciążliwości i dolegliwości, wskazując na narażenia i dyskomfort na stanowisku pracy operatorów, m.in. dyskomfort związany z przebywaniem w wymuszonej pozycji lub narażeniem na konieczność dźwigania ciężkich ładunków, przy wskazanej łącznej masie dźwiganych ładunków wynoszącej średnio ok. 50 kg, oraz konieczność długotrwałego utrzymywania niewygodnej pozycji. Skutkuje to zaburzeniami układu mięśniowo-szkieletowego i chorobami zawodowymi, a także spadkiem wydajności pracy, pośrednio zmęczeniem i zwiększonym ryzykiem błędów. Dobro ludzi powinno mieć pierwszeństwo przed wymaganiami technicznymi, a projektowana przestrzeń robocza powinna być tworzona z myślą o ludziach.

Słowa kluczowe: badania ankietowe, stanowisko pracy, dyskomfort, ergonomia