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ORIGINAL ARTICLE

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Sleep quality and work ability among paramedics: opportunities for intervention in the healthcare system

Short title: Kacper Zając et al., Sleep quality and work ability among paramedics

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ABSTRACT

Introduction: Paramedics face unique professional demands, such as unpredictable emergencies, shift work, and physical and mental stresses. These factors can disrupt sleep rhythms, impair cognitive function, and reduce work capacity. Sleep quality plays a special role in this occupational group, as reduced concentration can affect patient safety. This study aimed to examine the relationship between sleep quality and the ability to work of paramedics.

Material and methods: The cross-sectional study included 117 professionally active paramedics working in the Polish health care system. Data were collected using questionnaires: the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality and Work Ability Index (WAI) to assess work ability. Statistical analyses, including correlations and analysis of variance (ANOVA), were performed using R and SPSS software. Participant anonymity and voluntary participation were ensured, in accordance with research ethics.

Results: The mean sleep quality in the study group was suboptimal (M = 8.68; SD = 3.29), while the mean WAI score indicated good work capacity (M = 37.79; SD = 6.04). There was a significant negative correlation between sleep quality and work ability (r = –0.255; p = 0.0056). ANOVA analysis revealed significant differences in workplace and work quality (F = 2.73; p = 0.033).

Conclusions: The study confirmed that sleep quality significantly affects paramedics' ability to work. Promoting sleep hygiene and optimizing shift schedules can improve professional performance and the quality of patient care. Further research is needed on the long-term effects of shift work and the health consequences in this occupational group.

Keywords: paramedics, sleep quality, work capacity, shift work, health interventions

Introduction

The work of a paramedic in the health care system involves high demands, both physical and mental. The need to respond quickly to situations that threaten the health and lives of patients, the unpredictability of events, intense physical strain, and shifts lasting many hours - including night shifts - are the daily reality of the job [1]. Constantly emerging new challenges can significantly affect work ability (work capability), defined as the level at which an employee can perform his or her duties, considering job requirements, health conditions,

and physical and mental resources [2]. Work ability is a key aspect that determines the efficiency and productivity of employees in the healthcare sector enabling the long-term performance of health professions. A specific factor affecting work capacity is shift work. This mode of work contributes to disruption of the diurnal rhythm and disruption of natural biological processes in the body which results in reduced immunity of the body, deterioration of the ability to perform duties, and in the long term may contribute to professional burnout. Insufficient quantity and quality of sleep can lead to cognitive disorders, fatigue, and a greater risk of professional errors [3, 4]. For paramedics, these phenomena are of particular importance, as even a temporary reduction in concentration can have serious consequences for the health and lives of patients.

Researching the quality of sleep and the ability of paramedics to work has important practical implications. Addressing sleep disorders through proper work organization and providing employees with access to stress management strategies and opportunities for physical recovery could have real benefits in terms of increasing their efficiency and reducing levels of sickness absence [5].

The study presented here focuses on assessing the impact of sleep quality on paramedics' ability to work. The main objective is to determine the relationship between sleep quality and the level of work capacity in this occupational group and to identify sociodemographic factors that may modify this relationship. Research hypotheses include, among others, the assumption that paramedics' sleep quality correlates negatively with their ability to work, which is supported by previous studies showing that shift work significantly affects the length and quality of employees' sleep [6]. This work will contribute to the body of knowledge in this area and may form the basis for recommendations to support the prevention of health disorders resulting from the type and mode of work performed. Future research may also contribute to a better understanding of the impact of shift work on other aspects of health, such as cardiovascular fitness and emotional state.

Materials and methods

Participants and data collection

Data for this study were collected over four months, from November 2023 to February 2024. The primary instrument for data collection was a structured online questionnaire, designed and administered using Google Forms to facilitate ease of access and ensure

participant confidentiality. The survey was distributed electronically to eligible participants via email and professional networks relevant to the paramedic profession. A total of 117 paramedics participated in the study, providing a robust sample for analysis of the investigated variables.

The questionnaire consisted of several sections, including demographic information, work experience, self-assessed health and sleep quality, and other variables relevant to the study objectives. Before distribution, the survey was tested in a pilot phase with a small group of paramedics to confirm clarity, relevance, and ease of response. Participation was entirely voluntary, and responses were collected anonymously, with participants' identities protected in accordance with ethical guidelines. Collected data were then securely stored and accessed only by authorized members of the research team for analysis.

This online approach allowed for efficient data gathering across a geographically diverse sample, ensuring a broad representation of paramedics currently active in the field.

Tools

The tool used in the study to diagnose work ability is the Work Ability Index (WAI). This survey was created by the Finnish Labor Institute. The questions it contains take into account characteristic psychosocial and physical factors related to work. The questionnaire also includes questions on self-assessment of the work performed, taking into account both psychological and physical factors. The tool makes it possible to examine work ability, regardless of the age of the respondent and the type of work he or she performs. The WAI allows employers and employees to predict the occurrence of future work incapacity. It can motivate employers to make work accommodations at the organizational and individual levels. The Work Ability Injury Scale consists of seven main questions from which an appropriate number of points can be earned for each answer, depending on the answer selected. The highest possible number of points is 49, while the lowest is 7. In the WAI questionnaire, the summed scores indicate respectively:

— 7–27 points — poor ability to work,
— 28–36 points — moderate ability to work,
— 37–43 points — good ability to work,
— 43–49 points — excellent ability to work [7].

The tool used to measure sleep quality was The Pittsburgh Sleep Quality Index (PSQI). The PSQI is a self-report questionnaire that assesses sleep quality and sleep disturbance over one month. It allows us to examine seven components of sleep quality: subjective sleep quality, time needed to fall asleep, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, and difficulties with daytime functioning. The sum of the scores for these seven components gives an overall score to determine the sleep quality of the individual under study. The PSQI was designed for use in clinical populations as a simple and reliable assessment of both sleep quality and disorders that may affect sleep quality. When scoring the PSQI, seven component factors are summed, with a score for each factor ranging from 0 points (indicating no difficulty) to 3 points (indicating great difficulty). Scores from each component factor are added together, yielding a final score ranging from 0 to 21 points. The higher the total score obtained, the worse the sleep quality is in the subject [8].

Inclusion criteria

The inclusion criteria for this study were as follows:

a) Holding a professional title of paramedic, obtained either through a completed bachelor's degree in Emergency Medical Services (EMS) or through a post-secondary school qualification in EMS before the year 2013.
b) Possession of qualifications recognized in the Republic of Poland to practice as a paramedic.
c) Active engagement in professional duties as a practicing paramedic.
d) Voluntary participation in the study.

These criteria ensured the selection of participants who were both professionally qualified and actively engaged in emergency medical services within the Polish healthcare system.

Data analysis

In the analysis of quantitative variables across study groups, parametric tests (Student's t-test or Analysis of Variance, ANOVA) or their non-parametric counterparts (Mann–Whitney U test or Kruskal–Wallis test) were employed, depending on data distribution and variance assumptions.

For assessing the relationship between variables, Spearman's rank correlation analysis was utilized. All analyses were conducted using the R statistical environment (version 3.6.0) [9],

IBM SPSS software [10], and Microsoft Office 2019. A significance level of $p = 0.05$ was adopted.

Ethical considerations

All procedures and methodologies used in this study were conducted by the ethical principles outlined in the Declaration of Helsinki. The research design was developed to ensure participants' safety, privacy, and well-being, with particular attention to voluntary participation, informed consent, and confidentiality of data. In alignment with the Declaration's guidelines, measures were taken to protect the participants' identities, and all data were anonymized before analysis.

This study did not involve any invasive procedures, interventions, or data collection methods that would require formal ethical approval under the current regulatory framework. Following national and institutional regulations, the research was reviewed and deemed exempt from requiring approval by a bioethics committee, as it involved no personal health information and posed minimal risk to participants.

Results

The study included 117 subjects, 59% of whom were women and 41% of whom were men, ranging in age from 22 to 64 (70.94% of the participants were between 22 and 30 years old). Most of the subjects had a university degree (57.3% bachelor's, 34.2% master's) and worked in shifts (85.5%), mainly in emergency rooms (50.4%) or hospital emergency departments (56.4%). The predominant weekly working hours were 40–59 hours (50.4%). Detailed data on the study group can be found in Table 1.

The statistical analysis conducted in the study provides significant information on the relationship between sleep quality, work capacity, and sociodemographic and occupational variables.

Relationship between sleep quality and work ability index

The average sleep quality in the study group was 8.68 [standard deviation (SD) = 3.29], and the work ability index averaged 37.79 (SD = 6.04). Correlation analysis showed a significant negative relationship between sleep quality and work ability index ($r = –0.255$, $p = 0.0056$). This relationship indicates that poorer sleep quality is associated with reduced work ability. The coefficient of determination ($r^2 = 0.065$) suggests that 6.5% of the variability in

work ability index scores can be attributed to sleep quality. In other words, sleep quality has some, albeit relatively small, impact on work ability. The remaining 93.5% of the variability in the work ability index is explained by other factors.

Impact of workplace and quality of work on work ability

The ANOVA model indicated that the interaction of workplace and job quality was statistically significant ($F = 2.73$, $p = 0.033$), meaning that the effect of workplace on work ability varies according to the job quality assessed (Table 3).

Analysis of Variance was conducted to examine the effect of the workplace and job quality on work ability. The results of the analysis showed that the interaction between workplace and job quality was statistically significant ($F = 2.73$, $p = 0.033$). This means that the impact of the workplace on work ability varies according to the job quality assessed (Table 3).

Summary of model quality

The adjusted ANOVA model explained 43.3% of the variation in work ability, which means that almost half of the variation in work ability scores can be attributed to the analyzed factors included in the model. The statistical significance of the model ($p = 0.009$) indicates that the model is valuable and describes well the relationships between the variables studied. Worse sleep quality negatively affects the ability to work, which underscores the importance of taking care of sleep hygiene in a professional context. The interaction between workplace and quality of work suggests that different occupational environments may affect work ability differently depending on the perceived quality of work performed. Detailed results are presented in the analytical tables (Tables 2 and 3).

The value of the correlation coefficient suggests that there is some correlation, but it is not a major factor in determining work ability.

The place of work and quality of work by themselves do not have a significant effect on work ability ($p > 0.05$), but their interaction is statistically significant ($p = 0.033$).

The results of the conducted study indicate a significant, albeit moderate, negative relationship between sleep quality and the ability to work of paramedics in the Polish health care system. The data obtained confirm previous studies that indicated that insufficient quantity or quality of sleep negatively affects cognitive function, physical condition, mental health, and overall ability to perform professional duties, especially in the case of shift work [3, 4, 11]. Also, a study of nurses in Poland confirmed that factors related to the work

environment that affect sleep disturbances, i.e. insomnia, sleep disturbances, include night work, occupational stress, and demanding working conditions [12, 13].

The observed correlation coefficient ($r = –0.255$, $p = 0.0056$) indicates that sleep quality is one of the factors affecting work ability, but not the only one. As explained by sleep quality, the variation in the work ability score was 6.5% ($r^2 = 0.065$), suggesting that other factors, such as work conditions, occupational stress levels, and general health, are also important. A study by Kafle and his team indicates that sleep quality can negatively affect work ability among healthcare workers [14]. The interaction between workplace and perceived quality of duties further underscores that different occupational environments affect rescuers' ability to work differently. This study supports the claim that different professional environments affect rescuers' ability to work differently.

The results of the study fit into a global context, confirming findings from other countries. In the literature, the problems of sleep quality vs. work ability also apply to many other occupational groups doing shift work. For example, a study in China among industrial workers found a similar relationship between short sleep duration and poor work ability scores [15]. Another study of sleep quality and the incidence of insomnia among security guards working shifts in the Delhi-NCR region showed that workers doing night work had poorer sleep quality and a higher incidence of insomnia compared to day workers [16]. Returning to the health sector, a survey of Chinese medical personnel found that sleep quality is critical to their mental and physical health. It identified three health-related quality of work life (HRQoL) profiles in which those with poor HRQoL often reported sleep problems. Factors such as night shifts and physical inactivity further exacerbated these results. The authors note that improving sleep hygiene can significantly improve the well-being of medical personnel and work performance [17]. Australian and Spanish studies, on the other hand, indicate that shift work, especially night work, has a significant impact on the health of employees, especially in the context of sleep quality and biological rhythm disorders [18, 19]. The findings of Boivin and colleagues show that shift work disrupts the body's natural diurnal rhythm, which can lead to disorders such as sleep difficulties and increase the risk of various health problems [20]. Sleep disturbances cause fatigue, impaired concentration, and decision-making abilities, and negatively affect overall productivity. These studies emphasize the need for systemic changes in work organization. More flexible shift schedules should be introduced to minimize the negative effects of night work. It is also worthwhile to improve rest conditions, such as silence, darkness, and the creation of adequate spaces for sleep during the shift [21]. In addition, educating employees about sleep hygiene and the importance of

recovery is crucial to improving their physical and mental health and increasing their efficiency at work [22, 23]. Numerous research findings show that following sleep hygiene recommendations significantly improves the quality of employees' sleep. Education on sleep hygiene improves mental and physical health and facilitates daily functioning [24]. Educational programs on sleep hygiene at many universities are becoming an integral part of classes for future medical professionals [25–27]. This is a very important aspect, as there is little knowledge about sleep hygiene among many healthcare workers [28]. We should also recognize the dangers of poor sleep quality vs. ambulance driving, since inadequate sleep quality increases the risk of traffic accidents, according to the results of studies among professional drivers [29, 30].

The results underscore the critical importance of promoting sleep hygiene among paramedics. Educational programs on sleep management, combined with organizational interventions such as flexible work schedules and providing sufficient recovery time, can mitigate the negative effects of shift work. Employers and policymakers should consider these findings when designing occupational health strategies, which can help improve the quality of patient care.

Study limitation

Limitations of the study include its cross-sectional nature, which does not allow for causal conclusions, and the use of self-reported data, which may be subject to error. Future studies should be longitudinal to better understand the long-term effects of sleep disorders. It would also be worthwhile to expand the analysis to include additional variables, such as stress levels, diet, and physical activity, which may affect work capacity. Further research on other medical professions will provide a more complete picture of the effects of shift work on various aspects of occupational health.

Conclusion

The present study highlights the critical link between sleep quality and work capacity among paramedics in the Polish healthcare system. The results show that poorer sleep quality is associated with reduced work capacity, highlighting the importance of sleep hygiene and the impact of shift work on health and productivity. Despite the low explanatory power of the

effect of sleep quality on work capacity, this variable contributes significantly to our understanding of the professional challenges facing paramedics.

The study also provides a basis for implementing targeted interventions, such as sleep hygiene education programs and systemic changes in work schedules, to mitigate the negative impact of shift work. Moreover, it is in line with global research, confirming that interventions to improve sleep quality can positively affect occupational well-being in a variety of healthcare settings. Future studies should examine longitudinal effects and additional sociodemographic and occupational factors affecting paramedics' ability to work.

By addressing the unique challenges of paramedic work, including the demands of emergency response and irregular working hours, this research can inform policies that will improve both the health of medical workers and the quality of patient care.

Article information and deceleration

Data availability statement: *The data that support the findings of this study are available on request from the corresponding author.*

Ethics statement: *Institutional review board statement: The approval of the bioethics committee according to the Polish legal order is not required due to the nature of the study.*

Authors' contributions: *conceptualization — ŁR, KZ; methodology — ŁR, KZ; software — KZ; validation — ŁR, KZ; formal analysis — KZ; investigation — KZ; resources — KZ; data curation — KZ; writing (original draft preparation) — MM, MR, KZ, ŁR; writing (review, editing) — MM, MR; visualization — MM, MR; supervision — ŁR; project administration — KZ; All authors have read, agreed to the published version of the manuscript.*

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31.

Table 1. Characteristics of the study group

Gender	**Frequency**	**Percent**
Female	69	59%
Male	48	41%
Age	Frequency	Percent
22–30	83	70.94%
31–40	26	22.22%
41–50	7	5.98%
51–64	1	0.85%
Height (cm)	Frequency	Percentage
155–165	33	28.2%
166–175	32	27.3%
176–185	46	39.3%
186–195	6	5.1%
Body weight (kg)	Frequency	Percent
44–64	30	25.6%
65–85	56	47.9%
86–105	28	23.9%
106–137	3	2.56%
Marital status	Frequency	Percent
In a relationship	73	62.4%
Single/Single	40	34.2%
Separated	4	3.4%
Widower	0	–
Place of residence	Frequency	Percent
Rural	18	15.4%
City up to 50 thousand residents	14	12.0%
City of 50–150 thousand residents	7	6.0%
City of 150–500 thousand residents	13	11.1%
City of more than 500 thousand residents	65	55.6%
Education	Frequency	Percent
Secondary vocational	7	6%

Higher education (bachelor's degree)	67	57.3%
Higher (second-degree master's studies)	40	34.2%
Higher (third-degree doctoral studies)	3	2.6%
Seniority	Frequency	Percent
Less than one year	19	16.2%
1–5 years	53	45.3%
6–10 years	30	25.6%
11–15 years	9	7.7%
16–20 years	3	2.6%
Over 20 years	3	2.6%
Weekly working hours	Frequency	Percent
20–39 hrs.	24	20.5%
40–59 hrs.	59	50.4%
60–79 hrs.	29	24.8%
80–99 hrs.	3	2.6%
100 hrs. and above	2	1.7%
Place of employment	Frequency	Percent
Ambulance service (ZRM and ZTM)	59	50.4%
Hospital emergency department	66	56.4%
Air ambulance	0	–
Hospital wards (other than ED)	28	23.9%
Long-term care facilities	4	3.4%
Shift work	Frequency	Percent
Yes	100	85.5%
No	17	14.5%
Working in more than one place		
Yes	65	55.6%
No	52	44.4%

ED — Emergency Department; ZRM — *Zespół Ratownictwa Medycznego*; ZTM — *Zespół Transportu Medycznego*

Table 2. Pearson correlation values for sleep quality and ability to work

	Mean	**SD**	**r(X,Y)**	**r2**	**t**	**p**
Sleep quality	8.68376	3.28699				
Work ability index	37.7906	6.040895	– 0.25474	0.064891	– 2.82496	0.005576

SD — standard deviation

Table 3. Results of analysis of variance for testing whether workplace differentiates the effect of job quality on sleep quality

	Type III sum of squares	**df**	**Mean square**	**F**	**Significance**
Adjusted model	272.222a	11	24.747	2.784	0.009
Constant	1335.957	1	1335.957	150.299	< 0.001
Workplace (code)	46.916	3	15.639	1.759	0.17
Quality of work (category)	26.288	3	8.763	0.986	0.409
Place of work (code) × Quality of work (category)	**121.31**	**5**	**24.262**	**2.73**	**0.033**
Error	355.548	40	8.889		
Total	4250	52			
Total adjusted	627.769	51			

Code — in the analysis of variance refers to the variable that represents the different jobs in the study; category — in the analysis of variance refers to the evaluation of job quality according to the subjective assessment of the participants