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GENDER DIFFERENCES IN SLEEP QUALITY, PERCEIVED STRESS AND CIRCADIAN RHYTHM AMONG INDUSTRIAL WORKERS

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Abstract. *This paper studied circadian rhythms, perceived stress and sleep quality among workers in the industrial sector, with particular emphasis on gender differences in these parameters. The results showed statistically significant differences between men and women in circadianity, with men having a greater preference for the evening type of activity and sleep. Also, women showed higher scores in perceived stress and poorer sleep quality compared to men. These studies provide a deeper insight into the specific needs of industrial workers with regard to circadian rhythms, stress and sleep quality, taking into account gender differences. The implications of these findings highlight the need to adapt work environments, shift schedules, and support practices to ensure better adaptation of work conditions to individual circadian preferences and reduce woman-specific stressors. Additional research can provide deeper understanding into the causes of these differences and inform the development of targeted interventions to improve the health and well-being of workers in the industrial sector.*

Key words: *Gender Differences, Industrial Workers, MEQ, Circadian Rhythms, Perceived Stress, Sleep quality.*

1. INTRODUCTION

Working in the industrial sector encompasses a wide range of jobs that take place in production facilities, factories or other industrial environments. This type of work environment is often characterized by noise, work shifts, intensive physical efforts and demands for high productivity. This sector often includes the manufacture of goods, as well as the application of technology and systems for the production or processing of materials. Depending on the area, jobs in the industry can be extremely diverse. Workers may be involved in production processes, machine maintenance, quality control, research

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and development of new technologies or products, and logistics and distribution management. There are a variety of differences amongst industrial sector workers. Often, these differences are manifested through different roles and responsibilities at the workplace, as well as through individual approaches to tasks. Also, there are differences in biological characteristics, social environment and the way they face work challenges.

Stress, sleep quality and circadian rhythm are key factors affecting the well-being and productivity of industrial workers. Research has shown that there is a complex relationship between these three factors and that gender differences can have a significant impact on the way employees perceive them [1]. The circadian rhythm, as a natural biological process that regulates our internal clock, can be disrupted by work schedules, shifts, or long working hours, which can have a direct impact on the quality of sleep and the body's ability to recover. The quality of sleep, on the other hand, is directly related to emotional, cognitive and physical functions, which makes it an important factor for assessing the experience of stress [2]. Duties, shift work, and specific work demands frequently impair sleep quality, which is a critical component of overall health and well-being. The perception of stress among employees, on the other hand, can be the result of work pressures, organizational factors, and interpersonal interactions in the workplace [3]. Therefore, the investigation of factors such as circadian rhythm, noise sensitivity and sleep quality is crucial to understand the impact of stress in this specific industrial context.

Specifically, differences between men and women in these factors may contribute to variations in stress experience, sleep quality, and circadian rhythm. Biological, social and psychological differences between sexes can influence the way these factors are perceived and how they affect the overall well-being of workers in the industrial sector. Therefore, this research aims to investigate in more detail the differences between men and women in the perception of sleep quality, stress experience and circadian rhythm among workers in the industrial sector. The analysis of these differences can provide useful insights for the development of adapted stress management strategies and the improvement of working conditions in this sector, taking into account specificities related to gender differences.

The relationship between circadian rhythms, stress responses, and potential gender differences were explored with regard to individual preferences for morning and evening activities. These preferences, which reflect different personality types, may have implications for how individuals cope with different stressful situations. Studies suggest that morning and evening types show different patterns of coping with stress depending on the time of day when stressful demands occur [4]. Evening types often show greater susceptibility to stress [5.6], and have a greater heart rate variability and a more limited ability to cope with stress [7]. The quality of sleep is important for good emotional regulation and reactions to stress [8]. Roeser et al. [5] identify sleep quality as a key mediator in the relationship between circadian typologies and stress responses. Belonging to the evening type is associated with poorer sleep quality and more pronounced reactions to stress compared to the morning type. Evening types also report lower subjective sleep quality and longer sleep latency than morning types. Poor sleep quality may be associated with increased health risks in evening types. Furthermore, evening types report higher perceived stress after completing the task compared to morning types.

2. METHOD

2.1. Problem

The general problem of this research was the examination of statistically significant differences between male and female subjects in terms of circadian rhythm, perceived stress and sleep quality in a sample of industrial workers.

2.2. Variables and instruments

Circadian rhythmicity is operationalized by the Morningness - Eveningness Questionnaire - MEQ [9] and registers the individual's functioning on a continuum from morning, through the so-called intermediate, to the evening optimum, depending on sleeping and waking habits. The mentioned questionnaire distinguishes five types: definitely evening type, moderately evening type, mixed type, moderately morning type, and definitely morning type. The types are determined by adding up the scores on all items and the final result (ranging from 16 to 86 points) determines the position to which the respondent dominantly belongs based on arbitrarily determined scores. The reliability of internal consistency on the initial sample is satisfactory (of medium intensity) and expressed through Cronbach's α coefficient is 0.83.

Sleep quality - the Pittsburgh Sleep Quality Index (PSQI) [10] will be used to measure this variable. The questionnaire consists of 19 items, to which the respondent answers on a four-point Likert-type scale. The scale measures seven dimensions of sleep quality: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disorders, use of hypnotics, and daytime dysfunction. The global score of the PSQI scale ranges from 0 to 21 points, with a higher score indicating poorer sleep quality. A total score of 5 or above indicates poor sleep quality. Psychometric testing of the PSQI has shown that the questionnaire has good internal consistency and differentiation between good and poor sleepers [10].

Perceived stress - will be registered with the Perceived Stress Scale (PSS-10) [11] in the Serbian standardized version [12]. The scale consists of 10 items that were composed in such a way as to assess the experience of being overwhelmed and the feeling of being unable to control or predict events in an individual's life. The score on each item is evaluated on a five-point Likert-type scale (1 = I do not agree at all, 5 = I completely agree). Some of the items are: "In the past month, how often have you been angry because things were not under your control?", or "In the past month, how often have you felt nervous or stressed?". The scale is intended for adults who have at least a high school education. The instrument is very economical in terms of the time required to complete it. The metric properties of this instrument were also determined on a domestic (non-clinical) sample, showing satisfactory reliability of internal consistency, all coefficients $\alpha > .70$ [12].

2.3. Sample

The sample in this research consisted of 208 workers employed in the industrial sector. Of these, 131 respondents were male (or 63%), and 77 were female (or 37%). The age of the respondents ranged from 23 to 59 years. The sample included in this research was purposive and selected from the population of employed workers in the industrial sector. Before starting to fill out the questionnaire, the respondents were given instructions how to fill out the questionnaire, and what to do in case of misunderstanding;

they were familiarized with the purpose and anonymity of the research. This information served as the basis for obtaining their informed consent to participate in the study.

2.4. Procedures of testing and data processing

The survey was conducted in June and July 2023 at a multinational company. , The respondents were first given instructions how to fill out the questionnaire, what to do in case of misunderstanding, they were informed about the purpose and anonymity of the research, on the basis of which they gave their consent to participate in the research.. SPSS software was used for data processing and T-tests were used to detect gender differences for MEQ, PSS and PSQI scores.

3. RESULTS AND DISCUSSION

Table 1 Independent Samples Test

		Levene's Test		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
MEQ	eq.var. assumed	6.783	.609	2.795	466	**.005**	.44137	.15790	.13110	.75165
	eq.var. not assumed			2.937	263.179	.004	.44137	.15029	.14544	.73730
PSS	eq.var. assumed	.782	.377	-3.566	466	**.000**	-.20432	.05730	-.31691	-.09173
	eq.var. not assumed			-3.610	242.868	.000	-.20432	.05660	-.31582	-.09282
PSQI	eq.var. assumed	.446	.504	-2.142	466	**.033**	-.10908	.05093	-.20916	-.00899
	eq.var. not assumed			-2.108	229.361	.036	-.10908	.05176	-.21105	-.00710

Note: MEQ – Morningness - Eveningness Questionnaire, PSS – Perceived Stress, PSQI - Sleep quality - the Pittsburgh Sleep Quality Index

In Table 1, we see that Levene's test is not significant, which means that both men and women belong to the same population group and that these groups are comparable in all three variables. Levene's test for equality of variances is used to assess whether the variances of two or more groups are significantly different. When Levene's test is not statistically significant, it indicates a lack of statistically significant differences between variances between groups, in this case between male and female samples.

This result suggests that the variances in the assessed values (eg, stress, sleep quality, circadian rhythm) between men and women are not sufficiently different to consider the two groups as statistically different populations. This means that statistically they can be considered approximately similar or comparable in relation to the examined variables. When groups are statistically similar in variance, it can facilitate comparison of their means or averages in a study, as the lack of significant differences in variance implies greater comparability between male and female samples. This can be useful in interpreting the results and drawing conclusions about possible differences in mean values between male and female workers in the industry.

Table 2 Group differences between male and female

	Gender	N	Mean	Std. Deviation	Std. Error Mean
MEQ	**Male**	131	**6.4463**	1.57346	.08345
	Female	77	6.0254	1.43085	.12327
PSS	**Male**	131	1.7662	.56079	.03051
	Female	77	**1.9808**	.57577	.04659
PSQI	**Male**	131	0.7865	.47543	.02565
	Female	77	**0.9132**	.50033	.04448

Note: MEQ – Morningness - Eveningness Questionnaire, PSS – Perceived Stress, PSQI - Sleep quality - the Pittsburgh Sleep Quality Index

Results from Table 1. and Table 2. show that there was a significant difference in the MEQ scores for Males (M=6.44, SD=1.57) and Females (M=6.02, SD=1.43); t (466)=2.79, p=0.005. The results showed that there are statistically significant differences regarding circadianity in favor of men, which implies that there is a greater preference for the evening type in men compared to women. This difference may suggest that men tend to have later activity and sleep rhythms than women. Circadian rhythm is a biological process that influences preferred patterns of wakefulness and sleep, and higher scores in men indicate that they are more inclined to engage in activities later in the day and in the evening. Although the circadian rhythm in men and women is based on similar mechanisms, there are some differences in their rhythms. According to research, women have a shorter circadian rhythm than men, which means that their internal clock turns faster [13]. This may explain why women often have a greater tendency to wake up earlier and go to bed earlier compared to men [14]. Also, women are more sensitive to changes in circadian rhythms, which may affect their ability to adapt to changes in sleep-wake schedules [15].

Results from Table 1. and Table 2. shows that there was a significant difference in the PSS scores for Female (M=1.98, SD=0.57) and Male (M=1.76, SD=0.56); t (466)=-2.142, p=0.033. The results showed that there are statistically significant differences in the perception of stress between men and women in favor of women, which have key implications for working in the industry. Understanding these differences is important because it can affect stress management strategies, worker productivity, and overall employee well-being.

Several studies have investigated gender differences in perceived stress levels. The findings suggest that females generally report higher levels of perceived stress compared to males. For example, a study on college students found that females indicated higher levels of stress than their male counterparts, with more females reporting "moderate" levels of stress compared to males [16]. Another study on unemployed subjects also reported higher mean perceived stress scores among women compared with men [17]. Additionally, research on undergraduate students in Armenia revealed that male students experience higher stress levels, but their perceived stress level was much lower than that among females [18]. These findings indicate that there are indeed gender differences in perceived stress levels, with females often reporting higher levels of stress than males. However, it's important to note that the literature offers inconsistent findings regarding gender relative to perceived levels of stress, and more investigation is warranted to fully understand these differences. Vulnerability theory suggests that certain groups of people, in this case women, may have greater sensitivity or susceptibility to certain stressors or

challenges (Tytherleigh et al., 2007). In the context of an industrial environment, the results showing that women perceive more stress and worse sleep quality than men can be interpreted through the prism of this theory.

Results from Table 1. and Table 2. shows that there was a significant difference in the PSS scores for Female (M=0.91, SD=0.50) and Male (M=0.78, SD=0.47); t (466)= -3.56, p=0.000. The results showed that there are statistically significant differences in terms of sleep quality between men and women in favor of women. Thus, women working in the industrial sector have poorer sleep, and the results can serve as guidelines for important implications for managing their health, performance and general well-being in the workplace. Poorer sleep quality in women can have negative effects on their productivity, concentration and ability to perform tasks during working hours. In an industrial environment where physical and mental demands are often high, a lack of quality sleep can increase the risk of accidents, reduce efficiency and affect workers' health in the long term. Gender differences in the Pittsburgh Sleep Quality Index (PSQI) have been investigated in several studies. According to a study by Li and Thompson [20], women reported having less sleep than men, and the PSQI measure evaluates the same factors in a comparable manner for men and women. A study [21] found that there are notable differences between men and women in the prevalence of poor sleep quality in the adult population, with an overall average in the PSQI of 5.74 (SD: 4.2) for the first and 4.37 (SD: 3.6) for the second. Two latent classes were found in men and four in women, which further corroborates the viewpoint that the PSQI comprises multidimensional dimensions of sleep quality. A systematic review and meta-analysis [22] found that men were on average more evening-oriented than women, with a standardized mean difference of -0.072 (95% CI from -0.062 to -0.082) in the fixed effects and of -0.066 (95% CI from -0.043 to-0.089) in the random effects model. A study od Tang et al, 2017 [23] found that female participants tended to have higher scores than males in multiple PSQI component scores, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, and sleep disturbance, while there were no significant gender differences in the need for sleep medications and daytime dysfunction components. A study found that the PSQI may have different factor structures for men and women depending on the population being examined [24]. The standardized mean difference in chronotype between genders is predicted to change from negative to positive with increasing mean age, suggesting that the differences between men and women diminish with time [25]. In conclusion, there are some gender differences in the PSQI, with women generally reporting poorer sleep quality and and men and women having different latent classes. However, the differences in chronotype between genders tend to diminish with age which is why one study failed to find any differences.

4. CONCLUSION

According to the findings, men are more inclined to the evening activity rhythm, which can affect the organization of shift work. Adjusting shift schedules can result in better productivity, taking into account the circadian preferences of different groups of workers. Understanding circadian differences can be key to tailoring work schedules to suit workers' preferences. Also, adjusting high-risk jobs over different time intervals can help reduce potential occupational hazards for certain groups of employees. Differences in perceived stress, with women showing greater stress tendencies than men, imply the

need for adjustments in management policies and support practices. This could include specific stress reduction programs and adjustments to work tasks to reduce stressors specific to women. Perceived stress and sleep quality are also important aspects to consider. Adapting support policies and practices to reduce specific stressors for women, provide additional mental health support, and improve sleep quality could have a significant impact on employee well-being. Also, women in the industry have poorer sleep quality compared to men, which can have long-term consequences for worker productivity and well-being. Therefore, it is important to adapt the work environment to support better sleep among female workers. The lack of consistency in the literature on gender differences in perceived stress and sleep quality indicates the need for further research. A more precise understanding of these differences is critical to developing targeted interventions to support the mental health and well-being of all workers in the industry. Future research should explore the reasons behind these differences in more depth. The focus should be on understanding the specific biological, social and psychological factors that contribute to circadian differences between the sexes and identifying stressors that are particularly present in the work environment of women. Integrating the results into management practices and work environments can be key to promoting inclusivity and developing tailored strategies to support workers, especially women, to ensure their health, safety and satisfaction in the workplace. In addition, it is important to develop mental health support programs that are sensitive to stressors specific to women.

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KVALITET SPAVANJA, PERCIPIRANI STRES I CIRKADIJANI RITAM: RODNE RAZLIKE MEĐU INDUSTRIJSKIM RADNICIMA

U ovom radu su proučavane su polne razlike u odnosu na cirkadijalne ritmove, percipirani stres i kvalitet sna među radnicima u industrijskom sektoru. Rezultati su pokazali statistički značajne razlike između muškaraca i žena u cirkadijalnosti, pri čemu muškarci imaju više pripadaju večernjem tipu a žene jutarnjem. Takođe, žene su pokazale veće skorove u percipiranom stresu i imaju lošiji kvalitet sna u poređenju sa muškarcima. Ove studije pružaju dublji uvid u specifične potrebe industrijskih radnika u pogledu cirkadijalnih ritmova, stresa i kvaliteta sna, uzimajući u obzir rodne razlike. Implikacije ovih nalaza naglašavaju potrebu prilagođavanja radnog okruženja, rasporeda smena i prakse podrške kako bi se obezbedilo bolje prilagođavanje radnih uslova individualnim cirkadijalnim preferencijama i smanjili stresori specifični za žene. Dodatna istraživanja mogu pružiti dublji uvid u uzroke ovih razlika i dati informacije o razvoju ciljanih intervencija za poboljšanje zdravlja i blagostanja radnika u industrijskom sektoru.

Ključne reči: *Rodne razlike, industrijski radnici, MEQ, cirkadijalni ritmovi, percipirani stres, kvalitet sna*