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ORIGINAL ARTICLE

Association between Sleep Quality and Metabolic Syndrome among Healthcare Workers in Southern Iran: A Cross-sectional Study

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ABSTRAK

Kualiti tidur telah menjadi faktor penting dalam homeostasis metabolik. Pekerja penjagaan kesihatan (HCWs) yang terdedah kepada tekanan pekerjaan dan jadual yang ketat berisiko mengalami gangguan tidur dan disfungsi metabolik. Kami menyiasat hubungan yang berpotensi antara kualiti tidur dan sindrom metabolik (MetS) di kalangan HCWs. Kajian rentas secara menegak telah dijalankan menggunakan data daripada 5925 pekerja kesihatan dalam Kajian Kohort Kesihatan Pekerja SUMS (SUMS EHCS), yang merupakan sebahagian daripada kajian kohort PERSIAN yang dilancarkan oleh Kementerian Kesihatan, Perubatan dan Pendidikan Perubatan Iran pada tahun 2013. Prevalens MetS adalah 23.5% (ATP III) dan 30.2% (IDF). Sebanyak 65.7% menunjukkan kualiti tidur yang buruk. Analisis univariat menunjukkan hubungan antara MetS (ATP III) dan usia, penyakit asas serta stres kronik. Dalam model multivariat, hanya penyakit asas yang kekal signifikan. Menariknya, tiada hubungan signifikan ditemui antara MetS dan kualiti tidur. Penemuan kami mencadangkan bahawa penyakit asas dan stres kronik memainkan peranan yang lebih besar dalam MetS di kalangan HCWs. Walaupun kualiti tidur yang buruk adalah perkara biasa, ia mungkin bukan penyumbang utama kepada MetS dalam kohort ini. Intervensi yang komprehensif untuk menangani pelbagai faktor adalah penting untuk kesihatan HCWs. Kajian longitudinal adalah penting untuk memahami hubungan antara kualiti tidur, tekanan dan kesihatan metabolik dalam populasi ini.

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Kata kunci: *Kualiti tidur; pekerja penjagaan kesihatan; sindrom metabolik*

ABSTRACT

Sleep quality has emerged as a determinant of metabolic homeostasis. Healthcare workers (HCWs) exposed to occupational stress and demanding schedules, are vulnerable to sleep disturbances and metabolic dysregulation. We investigated the potential link between sleep quality and metabolic syndrome (MetS) among HCWs. A cross-sectional study was carried out using information from 5925 health workers in the SUMS Employee Health Cohort Study (SUMS EHCS), which was a branch of the PERSIAN cohort study launched by the Ministry of Health, Medicine, and Medical Education of Iran in 2013. MetS prevalence was 23.5% (ATP III) and 30.2% (IDF). 65.7% exhibited poor sleep quality. Univariable analysis showed associations between MetS (ATP III) and age, underlying disease and chronic stressors. In multivariable models, only underlying disease remained significant. Surprisingly, no significant association was found between MetS and sleep quality. Our findings suggest that underlying diseases and chronic stressors play a more substantial role in MetS among HCWs. While poor sleep quality is prevalent, it may not be an independent contributor to MetS in this cohort. Comprehensive interventions addressing multiple factors are crucial for HCW health. Longitudinal studies are essential to unravel the relationship between sleep quality, stress and metabolic health in this population.

Keywords: Healthcare workers; metabolic syndrome; sleep quality

INTRODUCTION

The escalating global burden of non-communicable diseases (NCDs), such as cardiovascular diseases and type 2 diabetes, has spurred a growing interest in identifying and understanding the underlying risk factors that contribute to their development (Belete et al. 2021; Guembe et al. 2020; James et al. 2020; Regufe et al. 2020; Tenenbaum et al. 2003; Tune et al. 2017). Among these risk factors, sleep quality has emerged as a significant determinant of overall health and well-being (Clement-Carbonell et al. 2021; Scott et al. 2021; Zhang et al. 2022). Adequate and restorative sleep is essential for maintaining metabolic homeostasis and optimal physiological functioning (Briançon-Marjollet et al. 2015; Sharma & Kavuru 2010; Troynikov et al. 2018; Zhang et al. 2021). Healthcare workers (HCWs), who often contend with demanding schedules and high levels of occupational stress, represent a particularly susceptible group at risk for sleep disturbances and subsequent metabolic dysregulation (Girma et al. 2021; Krupal et al. 2022; Liu et al. 2022; Pataka et al. 2022; Stewart et al. 2021; Vamvakas et al. 2022). In recent years, extensive research has explored the intricate relationship between sleep quality and metabolic health (Kim et al. 2018; Koren et al. 2016; Smiley et al. 2019; Che et al. 2021; Tsiptsios et al. 2022; Wang et al. 2023). Sleep disturbances is characterised by inadequate sleep

duration, poor sleep efficiency, and disruptions in sleep architecture, have been linked to various metabolic disorders, such as insulin resistance, dyslipidemia, and obesity (Carpentier et al. 2010; Jang et al. 2023; Mesarwi et al. 2013; Abreu Gde et al. 2015; Tsiptsios et al. 2022; Van Cauter 2011; Walia & Mehra 2016). The metabolic syndrome (MetS), a constellation of interconnected risk factors linked to an increased propensity for cardiovascular diseases and type 2 diabetes, presents a compelling avenue for investigating the interplay between sleep quality and metabolic derangements.

Against this backdrop, the present study endeavours to explore the potential association between sleep quality and MetS among HCWs in southern Iran. Leveraging the baseline data of the Persian cohort of HCWs, this cross-sectional analysis sought to illuminate the prevalence of sleep disturbances and MetS within this unique demographic. By employing rigorous methodology and a comprehensive approach to data collection, we aimed to discern whether poor sleep quality is independently linked to an increased prevalence of MetS among HCWs, thus contributing to our understanding of the complex interrelationship between sleep and metabolic health.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study was conducted among HCWs employed by Shiraz University of Medical Sciences (SUMS) between 2017 and June 2022. The study participants were selected from the SUMS Employee Health cohort study (SUMS EHCS), a component of the PERSIAN cohort study initiated by the Ministry of Health and Medical Education of Iran in 2013. The inclusion criteria were individuals aged 20 to 70 years, registered in the SUMS EHCS, and willing to participate voluntarily. Excluded from the study were individuals with physical or mental disabilities impeding their ability to complete the registration process, as well as pregnant women.

Data Collection

Trained personnel identified potential participants who met the inclusion criteria based on the PERSIAN protocol. Detailed explanations of the study objectives, along with information handouts, were provided to the participants. Participants were informed about the benefits of participating in the study and receiving free health services. A unique digital identification code was generated for each participant to ensure data confidentiality. A comprehensive questionnaire was administered to collect demographic information, occupational status, past medical history (with a focus on non-communicable diseases), and personal habits, including smoking history, opium and hookah use and alcohol consumption. The Pittsburgh Sleep Quality Index (PSQI), a validated Persian version questionnaire, was used to assess sleep quality. Anthropometric measurements, blood pressure readings and clinical laboratory tests, including fasting blood sugar levels, total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol and triglyceride levels, were conducted.

Diagnosis of Metabolic Syndrome

MetS was diagnosed using both the Adult Treatment Panel III (ATP III) and International Diabetes Federation (IDF) criteria (Alberti et al. 2006; Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults 2001; Huang 2009). According to ATP III criteria, MetS is established when an individual presents with three or more of the following conditions: (i) a waist circumference of at least 102 cm in men and 88 cm in women; (ii) serum triglyceride levels of 150 mg/dL or higher; (iii) HDL cholesterol levels below 40 mg/dL in men and 50 mg/dL in women; (iv) blood pressure readings of 130/85 mmHg or higher or ongoing treatment for hypertension; and (v) fasting plasma glucose levels of 100 mg/dL or higher.

Statistical Analysis

Categorical variables were described using frequency and percentage, while continuous variables were described using mean (with standard deviation) or median (with interquartile range). The relationship between MetS and background factors was analysed using robust Poisson regression with the sandwich estimator. Crude and adjusted prevalence ratios (APRs) were calculated, adjusting for baseline characteristics such as age, sex, smoking status, and familial history of cardiovascular diseases. Statistical significance was defined as $p<0.05$. All analyses were conducted with STATA software (version 17.0, Stata Corp).

RESULTS

Our sample included data from 5925 healthcare workers with an average age of 41.1 $\pm$ 6.9. Most of the participants were women (56.4%) and married (80.2%). Demographic and medical characteristics of EHCS participants was shown in Table 1. Majority of the participants (65.7%) had poor sleep quality, 66.6 % of the participants reported they had one or more intermediate ongoing stressors and 19.8 % of them reported one or more high level chronic stressors (Table 1).

The study encompassed 5925 HCWs, revealing an average age of 41.1 $\pm$ 6.9 and a predominance of women (56.4%) and married participants (80.2%). Analysis displayed that 65.7% had poor sleep quality, while 66.6% reported intermediate ongoing stressors and 19.8% experienced high-level chronic stressors. MetS's prevalence stood at 23.5% (ATP criteria) and 30.2% (IDF criteria) (Table 2). Associations between MetS and sleep quality were explored, with univariable analysis revealing significant connections to age and underlying disease (Table 3). However, in the multivariable model, only underlying disease maintained significant. Similarly, MetS (IDF criteria) showed a significant link with underlying disease and ongoing chronic stressors in univariable analysis, both of which remained significant in the multivariable model (Table 4). Importantly, no significant association between MetS and sleep quality was found. The study concluded that while certain baseline characteristics and stressors appear associated with MetS, its direct relationship with sleep quality remained inconclusive.

TABLE 1: Demographic and medical characteristics of EHCS participants

Variable	No. (%)	Variable	No. (%)
Sex		Employment status	
Female	3343 (56.4)	Official	2684 (45.4)
Male	2582 (43.6)	Treaty	330 (5.6)
Education		Contractual	2751 (46.5)
Illiterate	6 (0.1)	Corporate	149 (2.5)
Elementary School	239(3.9)	Occupational group	
Middle School	302 (5.1)	Administrative	1965 (33.2)
High School diploma	1104 (18.6)	Clinical therapeutic	2106 (35.6)
Associate degree	600 (10.1)	Public service	824 (13.9)
College education	3675 (62.1)	Technical and maintenance	223 (3.8)
Marital Status		Laboratory staff	225 (3.8)
Single	875 (14.8)	Guarding	324 (5.5)
Married	4753 (80.2)	Other	247(4.2)
Widowed	66 (1.1)	High-risk behaviors	
Divorced	230 (3.9)	Current smoker	400(6.3)
Other	1 (.01)	Ex-smoker	196 (3.3)
Underlying disease		Opium	88 (1.5)
0	2563 (43.3)	Hookah	788 (13.3)
1	1793(30.3)	Alcohol	304 (5.1)
2	912 (15.4)	Sleep Quality	
3 or more	653 (11)	High sleep quality	2029 (34.3)
Number of OCS†		Poor sleep quality	3888 (65.7)
No OCS	798 (13.5)	Age	41.17 ± 6.98¥
Intermediate OCS	3938 (66.6)	Work Experience	16.93 ± 6.49¥
1 high OCS	395 (6.7)	MET Levels*	
2 high OCS	476 (8.0)	Vigorous activities	487.42 ± 1649.14¥
3 or more high OCS	305 (5.2)	Moderate activities	1174.13 ± 2406.63¥
		Walk	2668.97 ± 2848.84¥
		Met Total	4330.52 ± 5293.83¥

*Physical activity of EHCS participants (According to MET-min/week); ¥Mean (SD); †Ongoing chronic stressors

DISCUSSION

This study findings reveal several key points. Firstly, a significant proportion of the HCWs (65.7%) exhibited poor sleep quality. This prevalence of poor sleep quality may have implications for their overall health and well-being, given the crucial role of adequate sleep in maintaining physical and mental health. This observation is in line with other studies such as Jahrami et al. (2021), which found that roughly 60% of both Frontline Healthcare Workers (FLHCW) and Non-Frontline Healthcare Workers (NFLHCW)

TABLE 2: Frequency of metabolic syndrome components in EHCS participants

	Total (%)	MeTs criteria	
		ATP	IDF
Metabolic syndrome diagnosis	5903 (100)	1387 (23.50)	1784 (30.22)
Metabolic syndrome component			
Low HDL-C Levels	2852 (48.1)	678 (11.5)	870 (14.7)
Hypertriglyceridemia	1870 (31.6)	445 (7.5)	564 (9.6)
Hyperglycemia	938 (15.8)	214 (3.6)	289 (4.9)
Hypertension	688 (11.6)	419 (7.1)	492 (8.3)
Abdominal obesity	2912 (49.3)	700 (11.9)	1417 (15.2)

TABLE 3: The mean PSQI components according to metabolic syndrome criteria in EHCS participants

PSQI components	Mean ± SD	MeTs criteria	
		ATP	IDF
Subjective sleep quality	.95 ± .64	.94 ± .65	.95 ± .66
Sleep latency	1.14 ± .95	1.14 ± .97	1.14 ± .97
Sleep duration	1.76 ± 1.02	1.77 ± 1.04	1.77 ± 1.04
Sleep efficiency	.78 ± 1.1	.80 ± 1.12	.80 ± 1.12
Sleep disturbances	.92 ± .53	.93 ± .54	.93 ± .54
Use of sleep medications	.13 ± .57	.11 ± .53	.14 ± .58
Day time dysfunction	.88 ± .82	.82 ± .87	.83 ± .86
PSQI total score	6.51 ± 3.67	6.50 ± 3.65	6.50 ± 3.65

TABLE 4: Crude and adjusted association between metabolic syndrome (ATP III) and sleep quality and baseline characteristics in EHCS cohort study

	Univariable Poisson regression models			Multivariable Poisson regression model		
Variable	PR	95% CI	P	Adjusted PR	95% CI	P
Age	.99	.98-.99	.03	.99	.97 - 1	.17
Sex						
Male	Ref					
Female	1.04	.94 – 1.14	.38			
Education					-	-
College education	Ref					
Elementary school	.86	.66 – 1.11	.27			
Middle school	1.05	.85 – 1.29	.60			
High school diploma	.99	.88 – 1.12	.93			
Associate degree	1.02	.87 – 1.19	.78			

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Marital Status						
Single	ref			-	-	-
Married	.91	.80 – 1.03	.14	.90	.79 – 1.02	.11
Widowed	.71	.42 – 1.20	.20	.74	.44 – 1.24	.25
Divorced	.86	.66 – 1.13	.30	.87	.67 – 1.14	.34
Underlying disease						
No	ref			-	-	-
Yes	1.93	1.74 – 2.14	<.001	1.94	1.75 – 2.16	<.001
Employment Status						
Official	ref			-	-	-
Treaty	1.14	.94 – 1.38	.16	1.10	.90 – 1.34	.33
Contractual	1.01	.91– 1.11	.81	.94	.83 – 1.06	.33
Corporate	.94	.68 – 1.28	.71	.83	.58 – 1.18	.31
Work Experience	.99	.98 – 1	.09	.99	.98 – 1.01	.94
Occupational group						
Administrative	ref			-	-	-
Clinical therapeutic	.93	.83 – 1.04	.20	.89	.79 – 1.006	.06
Public Service	.91	.79 – 1.06	.25	.98	.83 – 1.15	.80
Technical and maintenance	1.16	.93 – 1.45	.17	1.20	.95 – 1.51	.12
Laboratory staff	.83	.63 – 1.08	.17	.78	.60 – 1.02	.07
Guarding	.96	.78 – 1.19	.76	1.0005	.80 – 1.24	.99
Other	.84	.65 – 1.09	.20	.83	.65 – 1.08	.16
Opium use						
No	ref	.71 – 1.58	.76	-	-	
Yes	1.06					
Hookah use	ref	.96 – 1.28	.14	ref	.96 – 1.28	.13
No	1.11			1.11		
Yes						
Alcohol use						
No	ref			-	-	-
Yes	1.09	.88- 1.37	.39			
Smoking						
Never smoker	ref			-	-	-
Ex-smoker	.89	67 – 1.17	.40			
Current smoker	.97	.81 – 1.17	.80			
MET Total	.99	.99 – 1	.85	-	-	-
Sleep Quality						
High sleep quality	ref	.90 - .90	.97			
Poor sleep quality	.99					
Number of OCS						
1 OCS	1.03	.86 – 1.22	.71	1.01	.85 – 1.19	.90
2 OCS	.91	.76 – 1.10	.36	.90	.75 – 1.08	.29
3 or more OCS	.91	.79 – 1.04	.18	.91	.80 – 1.04	.17

exhibit subpar sleep quality in conjunction with moderate to severe stress levels. Similarly, Gao et al. (2022) found that participants in their study had an average PSQI score of 5.96 ± 3.64, indicating a moderate level of sleep quality. Among the participants, 62.3% (114 out of 187) experienced impaired sleep quality.

The distribution of MetS components among participants in the EHWC study reveals varying prevalence rates for different criteria sets ATP and IDF. Among the considered components, low HDL-C levels and abdominal obesity exhibit higher prevalence across both sets of criteria, suggesting their significance in the context of MetS. On the other hand, hyperglycemia and hypertension show relatively lower prevalence rates. These results underscore the potential influence of diagnostic criteria on the observed prevalence of individual components within the broader spectrum of MetS. Such insights emphasise the need for careful consideration of diagnostic guidelines when evaluating and addressing MetS in diverse populations.

The main focus of the study was to investigate the potential association between sleep quality and MetS. Interestingly, the study found no significant association between poor sleep quality and MetS according to both ATP III and IDF criteria, which contrasting with prior researches that suggest a link between sleep duration and MetS. Hua et al. (2021) and Iftikhar et al. (2015) reported that short sleep duration is associated with higher MetS risk, indicating that inadequate sleep may impact metabolic health through mechanisms like glucose metabolism and inflammation. The lack of association in our findings could be attributed to specific factors in our cohort, such as occupational stress, shift work and other confounders unique to healthcare settings, suggesting the need for further studies to explore these contextual influences.

Based on the current findings, it is crucial to consider the nuanced associations between specific sleep disorders such as insomnia, obstructive sleep apnea (OSA), and circadian rhythm disturbances and the risk of developing MetS among HCWs. While the present study did not find a direct association significantly between overall sleep quality and MetS, existing literature suggests that certain sleep disorders might have more targeted impacts on metabolic health. For instance, insomnia has been linked to an increased risk of hypertension, hyperglycemia and obesity, key components of MetS taht were demonstrated by Zhang et al. (2021). Similarly, OSA is characterised by intermittent hypoxia and sleep fragmentation, has been shown to independently contribute to metabolic dysfunctions such as insulin resistance, dyslipidemia, and visceral obesity, as discussed by Giampá et al. (2023) and Tasali et al. (2008). Circadian rhythm disturbances, often resulting from shift work and irregular schedules, common among HCWs, may further exacerbate these metabolic risks by disrupting hormonal regulation and metabolic homeostasis, as highlighted by Zimmet et al. (2019) and Lemmer & Oster (2018). While our study did not find a broad link between sleep quality and MetS, these findings emphasise the need for future research to focus on specific sleep disorders and their potential distinct pathways in contributing to metabolic dysregulation among HCWs. Tailored interventions targeting

these specific disorders could potentially mitigate MetS risk more effectively in this high-risk population.

When exploring potential contributing factors to MetS, the study considered various demographic and medical characteristics. In the univariable analysis, age and the presence of underlying diseases showed a significant association with MetS according to ATP III criteria. However, in the multiple model, only the presence of underlying diseases remained significantly associated with MetS. This suggests that underlying health condition may be a more influential factor in the development of MetS among HCWs than sleep quality. Similarly, for MetS according to IDF criteria, the presence of underlying diseases and the number of ongoing chronic stressors were significantly associated in the univariable analysis. In the multiple model, these associations remained significant. This suggests that sleep quality might not directly contribute to the prevalence of MetS, other factors such as underlying diseases and chronic stressors could play a more substantial role. The study offers valuable insights but has several limitations that should be considered. The cross-sectional design of the study prevents the establishment of causal relationships.

Furthermore, the dependence on self-reported sleep quality and current stressors could introduce biases in the data. The study employed the PSQI, a well-known and validated instrument, to evaluate sleep quality among HCWs. Although the PSQI offers important insights into multiple aspects of sleep, it relies on self-reported data, which can be affected by recall and response biases. To reduce these biases, future research could include objective sleep assessments, such as actigraphy, which provides a more accurate evaluation of sleep patterns and disturbances (Acker & Carter 2021). Additionally, exploring other sleep disorders, such as insomnia or sleep apnea, through specific questionnaires or polysomnography could provide a more comprehensive understanding of the sleep-health relationship (Chen et al. 2023). Longitudinal studies are recommended to establish causality between sleep quality and MetS and to assess the effectiveness of sleep interventions in improving metabolic health. Based on the study's findings, physicians should prioritise in managing chronic stress and underlying diseases, as these factors are strongly associated with MetS among HCWs. Regular health assessments that include evaluations of stress and disease management should be emphasised. Additionally, promoting healthy lifestyle choices and implementing wellness programs at work can support overall health. Longitudinal studies with more comprehensive assessments of sleep patterns, stress levels and other relevant variables would provide a clearer picture of the relationship between sleep quality and MetS.

CONCLUSION

In conclusion, the study contributes to the growing body of knowledge regarding the association between sleep quality and MetS. While no direct link was found between poor sleep quality and MetS among HCWs in southern Iran, other factors such as underlying diseases and ongoing chronic stressors were shown to be more influential in contributing to MetS prevalence. These findings emphasise the need for comprehensive

health interventions that consider multiple contributing factors in addressing the health of HCWs. Further research, particularly longitudinal studies, is warranted to better understand the complex interplay between sleep quality, stress and metabolic health in this population.

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ETHICS APPROVAL

The Ethical Committee of SUMS approved the current study.

COMPETING INTEREST

All authors declare no conflict of interest.

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