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Predictors of sleep quality subscales among medical university employees in Iran: a Bayesian analysis of cross-sectional data

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Abstract

Background Poor sleep quality is prevalent among medical employees and adversely affects their performance and well-being. Limited evidence exists regarding behavioral, psychological, and health-related risk factors for poor sleep quality in medical university staff. We aimed to assess the sleep quality subscales among Iranian medical university employees, and to analyze their association with behavioral, psychological, and health-related factors.

Methods This cross-sectional analysis utilized baseline data from 1,250 employees at Qazvin University of Medical Sciences who participated in a cohort study conducted between 2021 and 2022. Demographic, behavioral, psychological, and health-related characteristics were assessed in relation to Pittsburgh Sleep Quality Index (PSQI) subscales and effort-reward imbalance (ERI). Participants were selected using a convenience sampling method. Statistical analyses included correlation, chi-square tests, and multinomial Bayesian modeling.

Results Among participants (56.56% male, mean age 40.57 ± 8.01 years) moderate-to-severe difficulties in sleep duration were most prevalent (54.08%), while sleep medication use was least reported (7.5%). ERI credibly associated with increased odds of sleep difficulties across all PSQI subscales (minimum OR for severe duration sleep quality difficulty = 1.78, 95% CrI: [1.02, 2.90]), except sleep medication use. Depression was associated with all PSQI subscales except sleep latency (minimum OR for severe sleep efficiency difficulty = 2.65, 95% CrI: [1.48, 4.38]). Comorbidity (> 2) was linked to sleep difficulties in specific subscales, including subjective sleep quality, sleep latency, sleep disturbances, and sleep medication use (minimum OR for severe sleep efficiency difficulty = 4.39, 95% CrI: [1.14, 12.28]).

Conclusion This first population-based study of Iranian medical employees demonstrates that demographic, behavioral, psychological, and health-related factors differentially affect sleep quality subscales, with ERI emerging as a key risk factor. These findings emphasize the importance of tailored interventions to address workplace stress and promote mental and physical health, aiming to enhance sleep quality and overall well-being among medical employees.

Keywords Pittsburgh sleep quality index (PSQI), Sleep quality subscales, Effort-reward imbalance, Bayesian multinomial logistic regression, Iran

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Introduction

Sleep disorders represent a major global public health challenge. These disorders include poor sleep quality, trouble falling or staying asleep, and excessive daytime sleepiness [1, 2]. Poor sleep quality can exacerbate many medical and mental disorders and impair workplace functioning [3]. Furthermore, poor sleep quality is a contributing factor to increased morbidity and mortality and can negatively impact quality of life [4].

Sleep quality is defined as an individual's self-satisfaction with all aspects of the sleep experience. it includes four key attributes: sleep efficiency, sleep latency, sleep duration, and wake after sleep onset [5]. In addition, the National Sleep Foundation expert panel considers the following indicators of good sleep quality: sleep efficiency, sleep latency, rapid eye movement (REM) and non-REM sleep ratios, naps, arousals, and awakenings [6]. While objective tools like polysomnography and actigraphy provide precise measurements [7, 8], subjective questionnaires are widely used in epidemiological research. The Pittsburgh Sleep Quality Index (PSQI) is one such validated instrument, strongly correlated with objective polysomnographic findings [9].

The prevalence of poor sleep quality is high, particularly among high-stress occupational groups. Epidemiological studies estimate that between 9% and 45% of the general population experiences poor sleep [10, 11], with higher prevalence rates reported among healthcare professionals—58.9% in Ethiopia [12], 39.2% in China [1], and 86.3% in Saudi Arabia [13]. However, sleep disturbance is a critical issue not only for clinical staff but for the entire academic workforce within a medical university. These employees often experience chronic stress from factors such as high workload, administrative pressures, and irregular shift work schedules, all of which may negatively impact their sleep quality [14–16]. Research has demonstrated increased sleep latency and other negative effects on the sleep quality of medical residents [13]. Furthermore, factors such as work-related stress, work-family conflict, and depressive symptoms are consistently identified as key predictors of poor sleep in this population [12, 17, 18]. While social support has been shown to have a protective effect [19, 20], other modifiable risk factors like physical inactivity and smoking are associated with worse sleep outcomes [12, 21].

Although several studies in Iran have assessed overall sleep quality in healthcare settings [19, 22–24], critical gaps remain. First, few have undertaken a comprehensive analysis of the predictors influencing the specific subscales of sleep quality among the broad population of medical university employees. Second, the role of theoretical psychosocial models like Effort-Reward Imbalance [25, 26] in predicting sleep quality subscales in this specific context remains underexplored. This is particularly relevant in Iran, where medical university employees may experience a significant mismatch between their high efforts and received rewards, potentially worsening sleep outcomes. Thus, this study aims to fill these gaps by examining the prevalence of poor sleep quality and its subscales among medical university employees in Iran, and identifying factors associated with each specific sleep quality subscale. The findings will contribute to the literature by providing a nuanced understanding of sleep disturbances in this population and may inform the development of targeted interventions to improve sleep quality and overall well-being.

Methods

Setting and participants

This cross-sectional study utilized baseline data from the Qazvin Employee Health Cohort Study, conducted between 2021 and 2022 to investigate behavioral, psychological, and health-related factors among employees at Qazvin University of Medical Sciences (QUMS) [27].

In Iran, medical universities are integrated health systems responsible for both training healthcare professionals and providing public health services; thus, employees of public hospitals and healthcare centers are university staff. This study's target population was all permanent employees from the clinical, administrative, educational, and health departments of QUMS with a minimum of two years of employment.

Participants were recruited using a proportional quota sampling method. First, the total number of employees in each university department was determined. Recruitment quotas for each department were then set proportional to its size within the total workforce. Within each department, these quotas were filled by recruiting participants on a voluntary, convenience basis. The sole exclusion criterion was unwillingness to participate. The overall response rate among QUMS employees was 61%. Data from all 1,250 participants who completed the baseline assessment were included in this analysis.

Measurements

Data collection was performed at the cohort center for all enrolled participants through face-to-face interviews by trained research personnel. Informed consent was obtained from all participants prior to their enrollment in the QUMS study.

Demographic variables

Collected data included age, sex, marital status, and educational level. Body mass index (BMI) was calculated from measured weight and height and categorized as normal, overweight, or obese. Wealth status consisted of ownership of assets (e.g., car, freezer, washing machine, microwave, computer) and housing conditions (including

number of rooms), as well as number of foreign trips taken. Wealth status was assessed using financial assets and related indicators through principal component analysis [28] (PCA). PCA with varimax rotation was performed to extract three principal components representing the wealth index. The scores from the first principal component were used to rank households, and participants were subsequently categorized into low, moderate, and high wealth tertiles based on these scores.

Behavioral variables

Smoking status was categorized as non-smokers or smokers. Average daily mobile device use was self-reported and categorized into three groups: <3 h, 3–5 h, and ≥ 5 h. Physical activity was assessed using the long form of the International Physical Activity Questionnaire (IPAQ), which comprises 27 items measuring the frequency (days/week) and duration (minutes/day) of vigorous, moderate, and walking activities across four domains: job-related, transportation, household, and leisure-time. Total physical activity volume was calculated as metabolic equivalent of task (MET) minutes per week. Participants were categorized into three physical activity levels based on their total MET-minutes/week as follows: low (< 600 MET-minutes/week), moderate (≥ 600 to < 3000 MET-minutes/week), and high (≥ 3000 MET-minutes/week) [29].

Psychosocial factors

We assessed history of depression through self-reported physician diagnosis. Job stress was assessed using the Effort-Reward Imbalance (ERI) questionnaire developed by Siegrist et al.. (2004). This instrument consists of 22 items rated on a four-point Likert scale ranging from 1 ("completely agree") to 4 ("completely disagree"), comprising three subscales: effort (5 items), reward (6 items), and over-commitment (11 items). Subscale scores were averaged, and effort-reward ratio (ER ratio) was calculated as effort/(reward*c) where c is a correction factor accounting for the differing number of items [25]. An ER ratio >1 indicates effort-reward imbalance (high job stress). The Persian version of the ERI questionnaire has demonstrated acceptable validity and reliability among employee populations. Internal consistency, assessed using Cronbach's alpha coefficients, was 0.61 for effort, 0.85 for reward, and 0.67 for over-commitment [30].

Health-related factor

Comorbidities (e.g., ischemic heart disease, hypertension, diabetes, chronic lung disease, thyroid disorders, fatty liver disease, cancers) were obtained by self-report and the total number for each participant was categorized as: zero, one, two, or more than two.

Sleep quality

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) [31]. This validated 19-item instrument generates seven component scores: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleep medications, and daytime dysfunction. Each component is scored on a 0–3 scale, corresponding to no difficulty (0), mild (1), moderate (2), or severe (3) difficulty experienced over a one-month recall period [31]. The Persian version of the PSQI has demonstrated acceptable reliability (Cronbach's alpha = 0.77) and validity in previous studies [32].

Statistical analysis

Demographic, behavioral, psychological, and health-related factors were summarized using descriptive statistics. Categorical variables were expressed as frequencies and percentages, while continuous variables (e.g., age) were reported as mean ± standard deviation (SD). Sleep difficulty distributions were analyzed across seven PSQI subscale components. Inter-subscale correlations were evaluated using Spearman's rank correlation.

Given the multinomial nature of these outcomes and the presence of sparse data in some response categories, a Bayesian multinomial regression model was employed for each subscale. This approach was chosen for its ability to provide stable parameter estimates, its intuitive probabilistic interpretation via credible intervals, and its robustness in complex models. Weakly informative priors were used to ensure stable parameter estimation without imposing strong assumptions. Specifically, the intercept terms were assigned normal priors with a mean of 0 and a variance of 4, expressed as $\alpha \sim N(0, 4)$. Similarly, the regression coefficients were assigned normal priors with the same parameters, $\beta_k \sim N(0, 4)$. Markov Chain Monte Carlo (MCMC) sampling was conducted with 10,000 draws, including a burn-in period of 4,000 iterations. Results are reported as adjusted odds ratios (ORs) with 95% Bayesian credible intervals (CrIs) (Tables 3, 4, 5, 6, 7, 8 and 9). All subscales are illustrated collectively in Fig. 2 using effect displays. The reference levels for all categorical independent variables are explicitly defined in the tables.

To assess the convergence of the Markov Chain Monte Carlo algorithm for the seven sleep subscales, we used trace plots and computed the Gelman-Rubin statistic. A value below 1.1 was considered indicative of convergence. All diagnostic plots and statistics indicated that the algorithm had reached its target distribution for all parameters. All analyses were conducted using R software version 4.4.3.

Results

This cross-sectional analysis included 1,250 employees from QUMS. Table 1 presents the demographic, behavioral, psychosocial, and health-related characteristics of the participants. The sample comprised 707 (56.56%) males and 543 (43.44%) females, with a mean age of 40.57 ± 8.01 years. The study revealed that 46.36% of participants were overweight, 49.39% reported daily mobile phone use exceeding three hours, 14.72% were unmarried, and 71.28% held an academic degree. Participants were evenly distributed across wealth tertiles. More than two-thirds of the participants (78.08%) had moderate or high physical activity. Regarding occupational factors, 60.61% reported effort-reward imbalance at work. Additionally, 7.02% reported a history of depression, and nearly one-third reported at least one comorbid condition.

Table 1 Demographic, behavioral, psychosocial, and health-related factors

Variables		Total ($n = 1250$)
Demographic Factors		
Age		40.57 ± 8.01
BMI	Underweight	20 (1.69%)
	Normal	386 (32.66%)
	Overweight	548 (46.36%)
	Obese	228 (19.29%)
Sex	Female	543 (43.44%)
	Male	707 (56.56%)
Wealth status	Poor	412 (33.36%)
	Middle	411 (33.28%)
	Rich	412 (33.36%)
Marital status	Single	184 (14.72%)
	Married	1066 (85.28%)
Education	Under diploma	87 (6.96%)
	Diploma	272 (21.76%)
	Undergraduate	685 (54.8%)
	Postgraduate	206 (16.48%)
Behavioral Factors		
Mobile use (hours/day)	< 3	625 (50.61%)
	3–5	473 (38.3%)
	≥ 5	137 (11.09%)
Physical activity	Low	271 (21.93%)
	Moderate	572 (46.28%)
	High	393 (31.8%)
Smoking status	Non-smokers	1054 (88.05%)
	Smokers	143 (11.95%)
Psychosocial Factors		
Effort-Reward Imbalance	Balance	488 (39.39%)
	Imbalance	751 (60.61%)
Depression	No	1139 (92.98%)
	Yes	86 (7.02%)
Health-Related Factor		
Comorbidity	Zero	877 (70.16%)
	One	277 (22.16%)
	Two	78 (6.24%)
	> two	18 (1.44%)

The results are reported as n (%) for qualitative variable and mean ± SD for quantitative

Preliminary analyses included correlation and chi-square tests to examine initial relationships between variables. Table 2 presents associations between PSQI sleep components and ERI, depression, and comorbidity based on chi-square tests. Significant associations were found between ERI and all sleep subscales (P-value < 0.05) except sleep medication use (P-value = 0.881). Depression showed significant associations with all seven sleep components (P-value < 0.05). Comorbidity was significantly associated with four subscales: subjective sleep quality (P-value = 0.004), sleep latency (P-value = 0.005), sleep disturbances (P-value = 0.008), and sleep medication use (P-value = 0.001).

Figure 1 illustrates the distribution of sleep difficulties across the seven subscales and their correlations. The highest prevalence of moderate-to-severe difficulty observed for sleep duration (54.08%), while the lowest prevalence was found for sleep medication use (7.5%). The strongest correlation was between sleep duration and sleep efficiency ($r = 0.73$, P-value < 0.001), while the weakest correlations were between daytime dysfunction and both sleep latency ($r = 0.13$, P-value < 0.001) and sleep efficiency ($r = 0.14$, P-value < 0.001).

Bayesian multinomial logistic regression analysis was conducted to examine associations between predictor variables and sleep quality subscales. Figure 2 provides an overview of these effects, with detailed results presented in Tables 3, 4, 5, 6, 7, 8 and 9. Odds ratios (ORs) in Tables 3, 4, 5, 6, 7, 8 and 9 represent the relative odds of experiencing "mild", "moderate" or "severe" problems compared to "no problem" for each sleep subscale. Reference categories for independent variables were: normal BMI, female sex, poor wealth status, single marital status, under-diploma education, < 3 h/day mobile use, low physical activity, non-smoker status, balanced ERI, and zero comorbidities.

The results indicate that older age was not associated with difficulties in subjective sleep quality or sleep latency. It was associated with higher odds of moderate sleep disturbances (OR = 1.05, 95% CrI: [1.01, 1.09]) and severe sleep medication use (OR = 1.05, 95% CrI: [1.00, 1.10]), but with lower odds of severe daytime dysfunction (OR = 0.91, 95% CrI: [0.85, 0.96]) and moderate sleep medication use (OR = 0.94, 95% CrI: [0.89, 1.00]). Trends were observed for severe difficulties in sleep duration and efficiency.

Overweight participants, compared to those with a normal BMI, were associated with lower odds of severe sleep latency difficulties (OR = 0.50, 95% CrI: [0.28, 0.84]) and mild sleep medication use (OR = 0.43, 95% CrI:

Table 2 Distribution of psychological and health-related factors across PSQI subscales and results of chi-squared tests for independence

χ

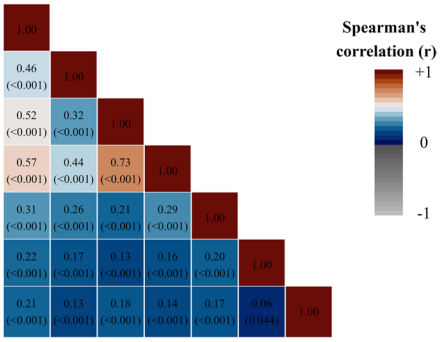
Subscales	Level of Difficulty	Effort-Reward Imbalance			Comorbidity Count					Depression		
		Balance (*n* = 488)	Imbalance (*n* = 751)	P-value	Zero (*n* = 877)	One (*n* = 277)	Two (*n* = 78)	> two (*n* = 18)	P-value	No (*n* = 1139)	Yes (*n* = 86)	P-value
Subjective sleep quality	No	225 (46.2%)	246 (32.98%)	**< 0.001**	352 (40.6%)	93 (33.7%)	25 (32.05%)	4 (22.22%)	**0.004**	448 (39.51%)	21 (24.71%)	**< 0.001**
	Mild	208 (42.71%)	369 (49.46%)		400 (46.14%)	135 (48.91%)	38 (48.72%)	7 (38.89%)		536 (47.27%)	36 (42.35%)	
	Moderate	41 (8.42%)	87 (11.66%)		83 (9.57%)	34 (12.32%)	6 (7.69%)	5 (27.78%)		109 (9.61%)	13 (15.29%)	
	Severe	13 (2.67%)	44 (5.9%)		32 (3.69%)	14 (5.07%)	9 (11.54%)	2 (11.11%)		41 (3.62%)	15 (17.65%)	
Sleep Latency	No	210 (43.12%)	209 (28.02%)	**< 0.001**	310 (35.76%)	81 (29.35%)	28 (35.9%)	3 (16.67%)	**0.005**	391 (34.48%)	22 (25.88%)	**0.011**
	Mild	216 (44.35%)	376 (50.4%)		407 (46.94%)	147 (53.26%)	33 (42.31%)	8 (44.44%)		553 (48.77%)	37 (43.53%)	
	Moderate	30 (6.16%)	77 (10.32%)		81 (9.34%)	17 (6.16%)	8 (10.26%)	1 (5.56%)		93 (8.2%)	11 (12.94%)	
	Severe	31 (6.37%)	84 (11.26%)		69 (7.96%)	31 (11.23%)	9 (11.54%)	6 (33.33%)		97 (8.55%)	15 (17.65%)	
Sleep Duration	No	39 (8.01%)	47 (6.3%)	**0.009**	65 (7.5%)	13 (4.71%)	7 (8.97%)	1 (5.56%)	0.115	77 (6.79%)	8 (9.41%)	**< 0.001**
	Mild	211 (43.33%)	269 (36.06%)		348 (40.14%)	105 (38.04%)	24 (30.77%)	6 (33.33%)		462 (40.74%)	16 (18.82%)	
	Moderate	130 (26.69%)	206 (27.61%)		237 (27.34%)	79 (28.62%)	20 (25.64%)	2 (11.11%)		307 (27.07%)	26 (30.59%)	
	Severe	107 (21.97%)	224 (30.03%)		217 (25.03%)	79 (28.62%)	27 (34.62%)	9 (50%)		288 (25.4%)	35 (41.18%)	
Sleep Efficiency	No	304 (62.42%)	380 (51.01%)	**0.001**	492 (56.81%)	151 (54.71%)	40 (51.28%)	6 (33.33%)	0.053	647 (57.11%)	32 (37.65%)	**< 0.001**
	Mild	53 (10.88%)	122 (16.38%)		122 (14.09%)	39 (14.13%)	12 (15.38%)	2 (11.11%)		159 (14.03%)	14 (16.47%)	
	Moderate	50 (10.27%)	85 (11.41%)		102 (11.78%)	27 (9.78%)	6 (7.69%)	1 (5.56%)		127 (11.21%)	8 (9.41%)	
	Severe	80 (16.43%)	158 (21.21%)		150 (17.32%)	59 (21.38%)	20 (25.64%)	9 (50%)		200 (17.65%)	31 (36.47%)	
Sleep Disturbance	No	65 (13.35%)	64 (8.58%)	**0.003**	104 (12%)	22 (7.97%)	4 (5.13%)	1 (5.56%)	**0.008**	127 (11.2%)	3 (3.53%)	**< 0.001**
	Mild	395 (81.11%)	616 (82.57%)		712 (82.12%)	231 (83.7%)	64 (82.05%)	7 (38.89%)		934 (82.36%)	64 (75.29%)	
	Moderate	26 (5.34%)	66 (8.85%)		50 (5.77%)	23 (8.33%)	10 (12.82%)	10 (55.56%)		73 (6.44%)	17 (20%)	
	Severe	1 (0.21%)	0 (0%)		1 (0.12%)	0 (0%)	0 (0%)	0 (0%)		0 (0%)	1 (1.18%)	
Use of Sleep Medication	No	455 (93.43%)	690 (92.49%)	0.881	818 (94.35%)	255 (92.39%)	65 (83.33%)	13 (72.22%)	**0.001**	1070 (94.36%)	63 (74.12%)	**< 0.001**
	Mild	13 (2.67%)	26 (3.49%)		23 (2.65%)	10 (3.62%)	5 (6.41%)	1 (5.56%)		34 (3%)	3 (3.53%)	
	Moderate	7 (1.44%)	11 (1.47%)		10 (1.15%)	6 (2.17%)	2 (2.56%)	0 (0%)		12 (1.06%)	6 (7.06%)	
	Severe	12 (2.46%)	19 (2.55%)		16 (1.85%)	5 (1.81%)	6 (7.69%)	4 (22.22%)		18 (1.59%)	13 (15.29%)	
Daytime Dysfunction	No	232 (47.64%)	259 (34.72%)	**< 0.001**	338 (38.99%)	108 (39.13%)	38 (48.72%)	10 (55.56%)	0.416	470 (41.45%)	16 (18.82%)	**< 0.001**
	Mild	193 (39.63%)	359 (48.12%)		397 (45.79%)	121 (43.84%)	31 (39.74%)	5 (27.78%)		501 (44.18%)	43 (50.59%)	
	Moderate	55 (11.29%)	112 (15.01%)		118 (13.61%)	40 (14.49%)	8 (10.26%)	2 (11.11%)		147 (12.96%)	19 (22.35%)	
	Severe	7 (1.44%)	16 (2.14%)		14 (1.61%)	7 (2.54%)	1 (1.28%)	1 (5.56%)		16 (1.41%)	7 (8.24%)	

The results are reported by n (%)

Associations between all qualitative variables were evaluated using the chi-squared (χ^2) test, with significant associations highlighted in **bold**

Sleep Subscales	Difficulty*			
	No	Mild	Moderate	Severe
Subjective Sleep Quality (SSQ)	474 (38.26%)	580 (46.81%)	128 (10.33%)	57 (4.60%)
Sleep Latency (SL)	422 (34.06%)	595 (48.02%)	107 (8.64%)	115 (9.28%)
Sleep Duration (SDU)	86 (6.94%)	483 (38.98%)	338 (27.28%)	332 (26.80%)
Sleep Efficiency (SE)	689 (55.65%)	175 (14.14%)	136 (10.99%)	238 (19.22%)
Sleep Disturbance (SDI)	131 (10.57%)	1014 (81.84%)	93 (7.51%)	1 (0.08%)
Use of Sleep Medication (USM)	1151 (92.90%)	39 (3.15%)	18 (1.45%)	31 (2.50%)
Daytime Dysfunction (DD)	494 (39.87%)	554 (44.71%)	168 (13.56%)	23 (1.86%)

Correlations**



* The results is reported for difficulty of sleep Subscales as frequency (%).

** The results is reported as Spearman's rank correlation coefficient (P-value).

Fig. 1 Difficulty distribution of sleep subscales and the heatmap of correlations

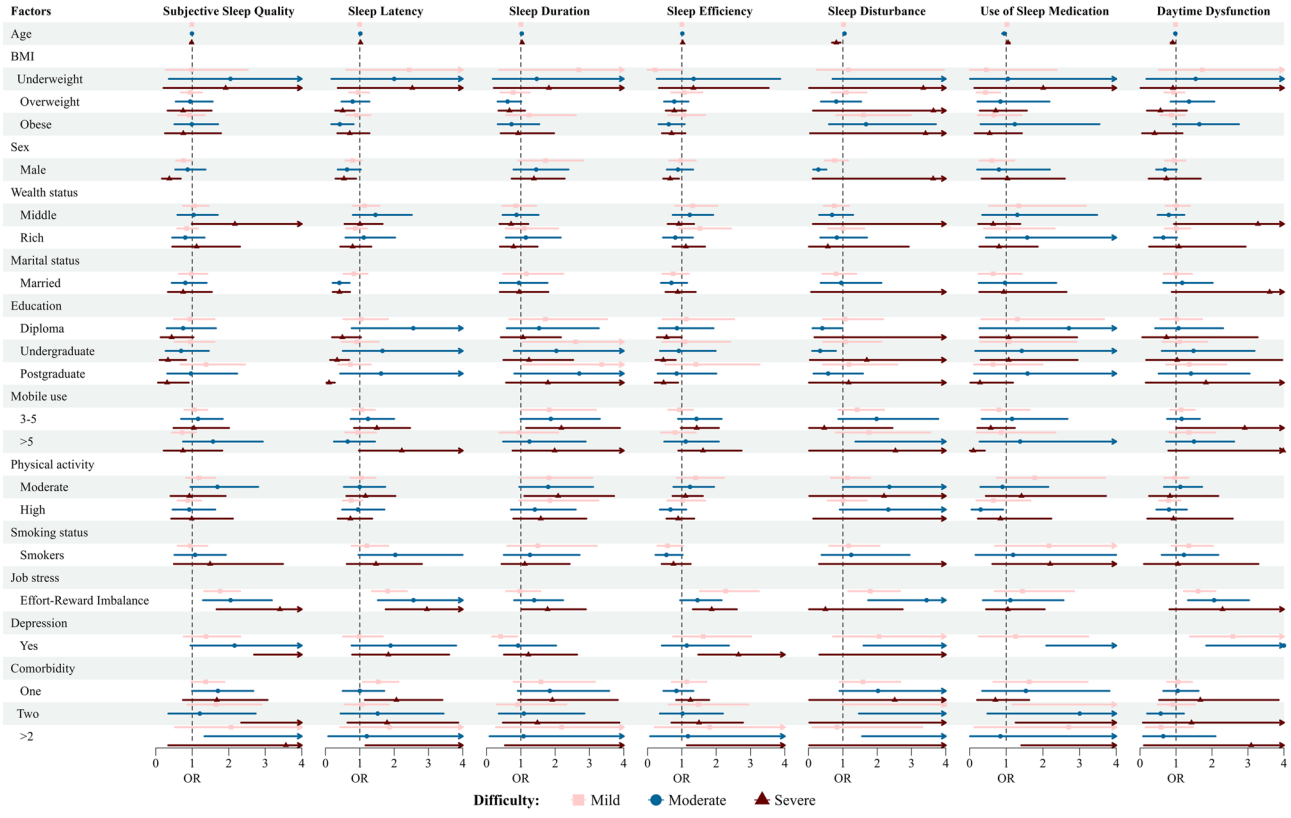


Fig. 2 Bayesian multinomial logistic regression results: association of demographic, behavioral, psychological, and health-related factors with all seven PSQI sleep subscales

Table 3 The effect of demographic, behavioral, psychological and Health-Related factors on subjective sleep quality using Bayesian multinomial logistic regressions

Factors		Difficulty of Subjective sleep quality		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		0.99 (0.97, 1.01)	0.99 (0.96, 1.02)	0.98 (0.94, 1.02)
BMI	Underweight	0.99 (0.28, 2.52)	2.05 (0.36, 6.38)	1.92 (0.21, 6.83)
	Overweight	0.94 (0.69, 1.27)	0.94 (0.55, 1.56)	0.75 (0.32, 1.53)
	Obese	0.92 (0.61, 1.34)	0.99 (0.51, 1.71)	0.76 (0.25, 1.79)
Sex	Male	0.76 (0.56, 1.00)	0.87 (0.53, 1.37)	**0.37 (0.17, 0.69)**
Wealth Status	Middle	1.06 (0.75, 1.44)	1.04 (0.59, 1.70)	2.17 (0.99, 4.30)
	Rich	0.85 (0.59, 1.15)	0.81 (0.45, 1.34)	1.12 (0.45, 2.31)
Marital status	Married	0.98 (0.63, 1.41)	0.81 (0.44, 1.39)	0.75 (0.33, 1.54)
Education	Diploma	0.93 (0.50, 1.61)	0.75 (0.30, 1.65)	0.44 (0.13, 1.03)
	Undergraduate	0.95 (0.51, 1.61)	0.69 (0.27, 1.46)	**0.34 (0.10, 0.83)**
	Postgraduate	1.38 (0.68, 2.45)	0.96 (0.32, 2.23)	**0.31 (0.06, 0.91)**
Mobile use (hours/day)	3–5	1.06 (0.78, 1.41)	1.16 (0.69, 1.84)	1.05 (0.49, 2.01)
	≥ 5	0.72 (0.44, 1.10)	1.57 (0.75, 2.93)	0.75 (0.22, 1.82)
Physical activity	Moderate	1.18 (0.83, 1.63)	1.69 (0.95, 2.81)	0.92 (0.40, 1.92)
	High	0.88 (0.60, 1.25)	0.92 (0.46, 1.63)	0.99 (0.42, 2.11)
Smoking status	Smoker	0.94 (0.60, 1.41)	1.08 (0.51, 1.92)	1.49 (0.50, 3.49)
Effort-Reward	Imbalance	**1.77 (1.33, 2.31)**	**2.05 (1.29, 3.18)**	**3.40 (1.67, 6.47)**
Depression		1.38 (0.76, 2.32)	2.16 (0.95, 4.22)	**6.62 (2.69, 13.55)**
Comorbidity	One	1.37 (0.97, 1.88)	1.70 (0.99, 2.67)	1.67 (0.75, 3.06)
	Two	1.65 (0.87, 2.90)	1.21 (0.34, 2.74)	**7.02 (2.34, 16.73)**
	> 2	2.06 (0.53, 5.80)	**6.54 (1.33, 19.83)**	3.57 (0.34, 13.41)

Abbreviation: *CrI* Bayesian Credible Interval

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Odds ratios (OR) that are credibly significant are highlighted in bold

[0.19, 0.84]). Similarly, obese participants were associated with lower odds of moderate sleep latency difficulties (OR = 0.42, 95% CrI: [0.17, 0.82]) (Tables 4 and 8, respectively).

Males showed significantly lower odds than females of severe difficulties in subjective sleep quality (OR = 0.37, 95% CrI: [0.17, 0.69]), sleep latency (OR = 0.54, 95% CrI: [0.29, 0.89]), and sleep efficiency (OR = 0.66, 95% CrI: [0.46, 0.92]), as well as moderate sleep disturbances (OR = 0.29, 95% CrI: [0.13, 0.52]) (Tables 3, 4, 6 and 7, respectively).

The analysis revealed that, compared to low physical activity, high physical activity was associated with higher odds of severe sleep duration difficulties (OR = 2.09, 95% CrI: [1.10, 3.72]) and moderate physical activity was associated with 70% lower odds of moderate sleep medication use (OR = 0.30, 95% CrI: [0.05, 0.92]).

Marital and smoking status were generally not associated with sleep difficulties. The exception was marital status, where married participants had lower odds of both moderate (OR = 0.40, 95% CrI: [0.21, 0.70]) and severe (OR = 0.41, 95% CrI: [0.21, 0.72]) sleep latency problems compared to single participants (Table 4).

Effort-reward imbalance was credibly associated with difficulties in all sleep components, except for sleep medication use (Table 8). Participants in the imbalanced group consistently showed higher odds of sleep difficulties in all sleep subscales compared to the balanced group.

Higher education levels were generally protective across most sleep subscales, except for mild sleep duration difficulties where higher education was associated with increased odds (OR = 3.35, 95% CrI: [1.05, 8.13]) (Table 5). Furthermore, higher education was not associated with sleep medication use or daytime dysfunction.

A history of depression was associated with higher odds of difficulties in all sleep components except for sleep latency. The strongest associations were observed for severe subjective sleep quality (OR = 6.62, 95% CrI: [2.69, 13.55]), severe sleep medication use (OR = 12.59, 95% CrI: [4.61, 27.88]), and severe daytime dysfunction (OR = 14.95, 95% CrI: [4.25, 38.69]).

Mobile device use was associated with several sleep difficulties. Using a mobile for 3–5 h daily was associated with higher odds of severe sleep duration difficulties (OR = 2.18, 95% CrI: [1.15–3.89]) and severe daytime dysfunction (OR = 2.91, 95% CrI: [1.01–7.66]). Using a

Table 4 The effect of demographic, behavioral, psychological and health-related factors on sleep latency using Bayesian multinomial logistic regressions

Factors		Difficulty of sleep latency		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		0.99 (0.98, 1.01)	1.02 (0.99, 1.04)	1.02 (0.99, 1.05)
BMI	Underweight	2.44 (0.60, 7.09)	2.00 (0.17, 8.23)	2.53 (0.36, 9.50)
	Overweight	0.95 (0.69, 1.27)	0.79 (0.47, 1.28)	**0.50 (0.28, 0.84)**
	Obese	0.90 (0.59, 1.31)	**0.42 (0.17, 0.82)**	0.71 (0.34, 1.28)
sex	Male	0.79 (0.58, 1.05)	0.63 (0.35, 1.03)	**0.54 (0.29, 0.89)**
Wealth Status	Middle	1.13 (0.80, 1.57)	1.46 (0.80, 2.52)	1.00 (0.55, 1.67)
	Rich	0.87 (0.61, 1.22)	1.11 (0.58, 2.03)	0.79 (0.43, 1.34)
Marital status	Married	0.82 (0.53, 1.22)	**0.40 (0.21, 0.70)**	**0.41 (0.21, 0.72)**
Education	Diploma	1.04 (0.52, 1.82)	2.56 (0.76, 6.83)	0.49 (0.19, 1.03)
	Undergraduate	0.91 (0.47, 1.55)	1.66 (0.50, 4.29)	**0.34 (0.13, 0.69)**
	Postgraduate	0.73 (0.37, 1.32)	1.62 (0.43, 4.39)	**0.10 (0.03, 0.27)**
Mobile use (hours/day)	3–5	1.06 (0.78, 1.44)	1.24 (0.73, 2.00)	1.50 (0.83, 2.47)
	≥ 5	0.94 (0.58, 1.47)	0.65 (0.25, 1.44)	2.22 (0.97, 4.31)
Physical activity	Moderate	1.04 (0.73, 1.46)	1.00 (0.53, 1.74)	1.16 (0.61, 2.04)
	High	0.75 (0.50, 1.07)	0.95 (0.49, 1.72)	0.73 (0.36, 1.36)
Smoking status	Smoker	1.20 (0.76, 1.83)	2.03 (0.96, 4.00)	1.47 (0.62, 2.81)
Effort-Reward	Imbalance	**1.81 (1.36, 2.37)**	2.56 (1.53, 4.05)	**2.96 (1.75, 4.79)**
Depression		0.97 (0.51, 1.67)	1.90 (0.76, 3.81)	1.83 (0.78, 3.60)
Comorbidity	One	**1.54 (1.08, 2.13)**	1.00 (0.50, 1.71)	**2.07 (1.15, 3.41)**
	Two	1.06 (0.56, 1.84)	1.52 (0.44, 3.44)	1.79 (0.64, 3.87)
	> 2	1.87 (0.43, 5.39)	1.20 (0.08, 4.96)	**6.35 (1.17, 18.98)**

Abbreviation: *CrI* Bayesian Credible Interval

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Odds ratios (OR) that are credibly significant are highlighted in bold

mobile for ≥ 5 h daily was associated with higher odds of moderate sleep disturbances (OR = 4.31, 95% CrI: [1.36–10.57]) but with lower odds of severe sleep medication use (OR = 0.10, 95% CrI: [0.01–0.42]).

A higher comorbidity burden was associated with increased odds of severe sleep difficulties. Participants with more than two comorbidities had substantially higher odds of severe sleep latency difficulties (OR = 6.35, 95% CrI: [1.17, 18.98]), severe sleep efficiency difficulties (OR = 4.39, 95% CrI: [1.14, 12.28]), and severe sleep medication use (OR = 8.00, 95% CrI: [1.41, 25.43]) compared to those with no comorbidities. No credible associations were found between comorbidity status and either sleep duration (Table 5) or daytime dysfunction (Table 9).

Discussion

This cross-sectional study provides a comprehensive evaluation of the associations between a wide range of factors and the seven subscales of all seven sleep quality subscales among medical university employees in Iran, using Bayesian multinomial logistic regressions.

Sleep disturbances represent a significant public health concern, potentially exacerbating existing health conditions and impairing occupational functioning [1]. The PSQI offers a robust framework for multidimensional sleep assessment, capturing specific subscales such as sleep latency, duration, efficiency, disturbances, use of sleep medication, and daytime dysfunction [22]. By focusing on these subscales, our findings provide novel insights into the predictors of sleep quality subscales within this occupational group.

Our multivariate analysis revealed differential associations between various factors and the PSQI subscales.

Subjective sleep quality

Analysis revealed that being male, and higher education levels were associated with lower odds of reporting severe difficulties. Conversely, ERI and depression were strongly associated with higher odds of impairment.

While the associations for depression and comorbidity align with established literature [33], the significant association with ERI provides a more nuanced understanding

Table 5 The effect of demographic, behavioral, psychological and Health-Related factors on sleep duration using Bayesian multinomial logistic regressions

Factors		Difficulty of sleep duration		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		1.00 (0.97, 1.03)	1.03 (0.99, 1.06)	**1.04 (1.00, 1.07)**
BMI	Underweight	2.69 (0.37, 10.34)	1.46 (0.18, 5.46)	1.82 (0.21, 7.05)
	Overweight	0.78 (0.41, 1.26)	0.61 (0.32, 1.01)	0.67 (0.35, 1.12)
	Obese	1.24 (0.57, 2.60)	0.73 (0.33, 1.54)	0.92 (0.41, 1.97)
sex	Male	1.72 (0.93, 2.81)	1.45 (0.78, 2.39)	1.38 (0.73, 2.28)
Wealth Status	Middle	0.86 (0.46, 1.45)	0.87 (0.47, 1.52)	0.72 (0.38, 1.22)
	Rich	1.10 (0.56, 2.09)	1.15 (0.56, 2.16)	0.79 (0.39, 1.49)
Marital status	Married	1.16 (0.49, 2.23)	0.95 (0.39, 1.78)	0.95 (0.39, 1.80)
Education	Diploma	1.71 (0.67, 3.51)	1.53 (0.59, 3.27)	1.06 (0.42, 2.17)
	Undergraduate	**2.59 (1.06, 5.39)**	2.03 (0.79, 4.34)	1.24 (0.49, 2.53)
	Postgraduate	**3.35 (1.05, 8.13)**	2.70 (0.81, 6.82)	1.79 (0.57, 4.30)
Mobile use (hours/day)	3–5	**1.83 (1.01, 3.19)**	1.87 (0.99, 3.30)	**2.18 (1.15, 3.89)**
	≥ 5	0.95 (0.38, 2.09)	1.25 (0.48, 2.89)	1.98 (0.76, 4.48)
Physical activity	Moderate	1.82 (0.98, 3.08)	1.80 (0.95, 3.11)	2.09 (1.10, 3.72)
	High	1.85 (0.95, 3.26)	1.41 (0.71, 2.60)	1.58 (0.78, 2.91)
Smoking status	Smoker	1.49 (0.60, 3.22)	1.27 (0.50, 2.71)	1.12 (0.44, 2.42)
Effort-Reward	Imbalance	0.98 (0.57, 1.57)	1.39 (0.80, 2.23)	**1.78 (1.02, 2.90)**
Depression		**0.41 (0.16, 0.89)**	0.92 (0.37, 2.03)	1.22 (0.51, 2.64)
Comorbidity	One	1.59 (0.79, 3.16)	1.84 (0.91, 3.58)	1.92 (0.92, 3.83)
	Two	0.90 (0.29, 2.32)	1.09 (0.35, 2.86)	1.48 (0.48, 3.87)
	> 2	2.19 (0.28, 9.11)	1.08 (0.09, 4.77)	4.19 (0.54, 17.98)

Abbreviation: *CrI* Bayesian Credible Interval

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Odds ratios (OR) that are credibly significant are highlighted in bold

of psychosocial work stress. This finding is similar to the results of Güngördü et al. [34], who also identified significant work stress using a different construct (workload-control-support). Our results specifically suggest that an imbalance between effort and reward is a key predictor of impaired subjective sleep quality, highlighting the importance of addressing reward equity, such as through recognition programs, in workplace policies.

Sleep latency

Being female was associated with higher odds of severe difficulties, while being married and having higher education levels were associated with lower odds. Furthermore, compared to those with a normal BMI, overweight participants had lower odds of severe sleep latency difficulties. ERI was a consistent predictor, associated with higher odds of sleep latency difficulties across all severity levels. A higher comorbidity burden was also associated with increased odds of severe difficulties; notably, participants with more than two conditions had substantially higher odds compared to those with none.

The finding that a greater number of chronic diseases is associated with prolonged sleep latency aligns with Hsu et al. who proposed that higher number of diseases are linked to increase the difficulty in falling asleep or prolonged sleep latency [35].

Sleep duration

Older age and male sex were associated with higher odds of severe difficulties. Moderate physical activity and ERI were also associated with higher odds of this outcome. Furthermore, mobile device usage of 3–5 h per day was associated with increased odds of severe sleep duration difficulties compared to lower use.

The association between digital device use and sleep duration difficulties is supported by existing literature on technology-mediated sleep disruption [36]. The finding that higher physical activity levels were associated with sleep duration difficulties adds to a complex body of evidence; while some studies report benefits [37], others note null [38] or even negative associations [39]. These inconsistencies could be due to factors such as exercise timing [40] and age-related factors [41].

Table 6 The effect of demographic, behavioral, psychological and Health-Related factors on sleep efficiency using Bayesian multinomial logistic regressions

Factors		Difficulty of sleep efficiency		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		1.00 (0.97, 1.02)	1.01 (0.99, 1.04)	**1.02 (1.00, 1.05)**
BMI	Underweight	0.22 (0.01, 1.03)	1.34 (0.27, 3.87)	1.34 (0.33, 3.53)
	Overweight	1.07 (0.69, 1.60)	0.78 (0.48, 1.19)	0.78 (0.53, 1.11)
	Obese	1.06 (0.60, 1.68)	0.62 (0.32, 1.08)	0.70 (0.42, 1.10)
sex	Male	0.96 (0.63, 1.40)	0.89 (0.56, 1.33)	**0.66 (0.46, 0.92)**
Wealth Status	Middle	1.31 (0.81, 2.04)	1.23 (0.73, 1.91)	0.91 (0.59, 1.36)
	Rich	1.52 (0.91, 2.44)	0.81 (0.45, 1.32)	1.12 (0.73, 1.68)
Marital status	Married	0.75 (0.43, 1.20)	0.69 (0.39, 1.15)	0.88 (0.52, 1.40)
Education	Diploma	1.13 (0.44, 2.52)	0.86 (0.32, 1.92)	**0.55 (0.27, 1.00)**
	Undergraduate	1.09 (0.43, 2.41)	0.91 (0.36, 1.99)	**0.46 (0.23, 0.82)**
	Postgraduate	1.41 (0.51, 3.26)	0.85 (0.29, 2.01)	**0.47 (0.21, 0.89)**
Mobile use (hours/day)	3–5	0.92 (0.60, 1.33)	1.43 (0.89, 2.16)	1.43 (0.97, 2.08)
	≥ 5	0.80 (0.39, 1.40)	1.11 (0.49, 2.08)	1.62 (0.90, 2.74)
Physical activity	Moderate	1.40 (0.85, 2.23)	1.24 (0.75, 1.94)	1.11 (0.73, 1.61)
	High	1.02 (0.58, 1.68)	0.67 (0.36, 1.13)	0.89 (0.55, 1.36)
Smoking status	Smoker	0.58 (0.29, 1.04)	0.55 (0.23, 1.02)	0.76 (0.41, 1.26)
Effort-Reward	Imbalance	**2.28 (1.53, 3.25)**	1.46 (0.95, 2.16)	**1.87 (1.32, 2.60)**
Depression		1.62 (0.74, 3.02)	1.14 (0.42, 2.37)	**2.65 (1.48, 4.38)**
Comorbidity	One	1.14 (0.71, 1.71)	0.84 (0.46, 1.34)	1.25 (0.83, 1.80)
	Two	1.48 (0.62, 2.94)	1.02 (0.36, 2.20)	1.50 (0.70, 2.78)
	> 2	1.81 (0.21, 6.11)	1.18 (0.07, 4.62)	**4.39 (1.14, 12.28)**

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Abbreviation: CrI Bayesian Credible Interval

Odds ratios (OR) that are credibly significant are highlighted in bold

We found no significant association for comorbidity status, a result consistent with the prior findings of Hsu et al. [35].

Sleep efficiency

Older age, being female, ERI, depression, and higher comorbidity count were associated with increased odds of severe difficulties, while higher education was associated with lower odds.

The association between being female and poorer sleep efficiency aligns with the findings of Raju et al. [42], and the strong link with depression is consistent with established literature on its debilitating effects on poor sleep efficiency [43].

A novel finding of our study is the significant association between ERI and impaired sleep efficiency. This contrasts with the null results reported by Jackowska et al. [44] in their female-only cohort, suggesting that ERI's effect on sleep may be more pronounced in a gender-mixed occupational population. Furthermore, our finding that comorbidity burden impairs sleep efficiency contrasts with the null findings of with Hsu et al.'s [35], potentially indicating population-specific differences.

Sleep disturbance

Older age, being female, mobile device use exceeding five hours per day, ERI, depression, and a greater comorbidity burden were all associated with higher odds of sleep disturbances.

Our results reinforce and extend existing literature in two key areas. First, the association between ERI and sleep disturbances aligns with the work of Fahlen et al. [45]. Second, we found that high mobile device use was associated with disturbances. While prior research has often focused on youth [46, 47], our study confirms that this association extends to medical employees across adult age groups. Furthermore, we found a significant association between comorbidity burden and sleep disturbances, which contrasts with the null findings reported by Hsu et al. [48].

Table 7 The effect of demographic, behavioral, psychological and health-Related factors on sleep disturbance using Bayesian multinomial logistic regressions

Factors		Difficulty of sleep disturbance		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		1.02 (0.99, 1.04)	**1.05 (1.01, 1.09)**	**0.81 (0.68, 0.93)**
BMI	Underweight	1.16 (0.25, 3.95)	5.64 (0.70, 19.77)	3.34 (0.01, 22.71)
	Overweight	1.10 (0.67, 1.69)	0.81 (0.36, 1.53)	3.64 (0.13, 14.88)
	Obese	1.60 (0.81, 2.98)	1.68 (0.59, 3.71)	3.41 (0.04, 25.95)
Sex	Male	0.76 (0.48, 1.15)	**0.29 (0.13, 0.52)**	3.63 (0.12, 20.50)
Wealth Status	Middle	0.75 (0.44, 1.18)	0.69 (0.31, 1.30)	10.07 (0.12, 49.66)
	Rich	1.00 (0.57, 1.63)	0.82 (0.34, 1.70)	0.56 (0.01, 2.92)
Marital status	Married	0.80 (0.40, 1.39)	0.95 (0.35, 2.12)	4.54 (0.07, 32.14)
Education	Diploma	1.06 (0.42, 2.17)	**0.40 (0.11, 0.98)**	14.71 (0.17, 98.05)
	Undergraduate	1.07 (0.42, 2.12)	**0.34 (0.10, 0.80)**	1.70 (0.04, 10.33)
	Postgraduate	1.18 (0.42, 2.59)	0.57 (0.14, 1.59)	1.17 (0.01, 7.77)
Mobile use (hours/day)	3–5	1.42 (0.87, 2.20)	1.98 (0.87, 3.78)	0.46 (0.02, 2.45)
	≥ 5	1.76 (0.80, 3.55)	**4.31 (1.36, 10.57)**	2.53 (0.02, 17.93)
Physical activity	Moderate	1.13 (0.65, 1.79)	2.36 (1.00, 4.57)	2.20 (0.02, 12.98)
	High	1.01 (0.56, 1.70)	2.32 (0.91, 4.92)	4.57 (0.14, 31.29)
Smoking status	Smoker	1.17 (0.60, 2.07)	1.24 (0.38, 2.94)	37.07 (0.31, 237.99)
Effort-Reward	Imbalance	**1.80 (1.16, 2.66)**	**3.44 (1.74, 6.14)**	0.49 (0.01, 2.74)
Depression		2.05 (0.71, 5.35)	**5.59 (1.60, 15.17)**	26.52 (0.32, 161.59)
Comorbidity	One	1.58 (0.90, 2.68)	2.02 (0.90, 4.14)	2.51 (0.02, 19.51)
	Two	3.97 (0.97, 12.88)	**8.59 (1.47, 32.16)**	4.02 (0.02, 27.40)
	> 2	0.83 (0.12, 3.32)	**12.31 (1.56, 50.31)**	4.12 (0.02, 29.60)

Abbreviation: *CrI* Bayesian Credible Interval

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Odds ratios (OR) that are credibly significant are highlighted in bold

Sleep medication use

Older age, depression, and a greater comorbidity burden were all associated with increased odds of severe sleep medication use. Conversely, and unexpectedly, high mobile device use (≥ 5 h daily) was associated with lower odds of severe sleep medication use.

This finding regarding comorbidity burden differs from the null results reported by Hsu et al. [35]. Collectively, these findings underscore the complex interplay between psychological factors (depression), physical health (comorbidity), and behavioral patterns (mobile use) in understanding sleep medication use.

Daytime dysfunction

Older age was associated with lower odds of daytime dysfunction. In contrast, mobile device use of ≥ 5 h per day, ERI, and a history of depression were associated with increased odds of impairment.

The association with depression is consistent with findings from Liu et al. [49]. A novel contribution of our study is the identification of ERI as a significant predictor of daytime dysfunction, highlighting it as a previously under-investigated occupational risk factor for daytime impairment. This suggests that workplace interventions targeting psychosocial stress, such as efforts to reduce effort-reward imbalance, may be beneficial for improving daytime alertness.

In summary, this study highlights important factors that affect each of the seven PSQI sleep quality subscales in medical employees. These findings offer a basis for creating tailored sleep interventions in medical settings and guide future research on sleep health at work.

Strengths and limitations

This study benefits from a large sample, comprehensive multidimensional sleep assessment, and Bayesian modeling that stabilizes estimates despite sparse data in severe categories. However, several limitations must be acknowledged. The cross-sectional design precludes causal inferences, and self-reported measures

Table 8 The effect of demographic, behavioral, psychological and health-related factors on sleep medication using Bayesian multinomial logistic regressions

Factors		Difficulty of sleep medication		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		1.02 (0.98, 1.06)	**0.94 (0.89, 1.00)**	**1.05 (1.00, 1.10)**
BMI	Underweight	0.46 (0.01, 2.38)	1.05 (0.01, 6.18)	2.01 (0.13, 7.78)
	Overweight	**0.43 (0.19, 0.84)**	0.84 (0.21, 2.18)	0.71 (0.28, 1.56)
	Obese	0.66 (0.23, 1.41)	1.23 (0.30, 3.54)	0.55 (0.14, 1.43)
Gender	Male	0.61 (0.27, 1.22)	0.80 (0.21, 2.19)	1.03 (0.33, 2.60)
Wealth Status	Middle	1.34 (0.54, 3.17)	1.30 (0.34, 3.48)	0.64 (0.24, 1.38)
	Rich	1.06 (0.39, 2.32)	1.57 (0.45, 4.42)	0.80 (0.27, 1.86)
Marital status	Married	0.64 (0.24, 1.42)	0.97 (0.25, 2.36)	0.93 (0.27, 2.64)
Education	Diploma	1.30 (0.32, 3.67)	2.71 (0.27, 11.91)	1.06 (0.28, 2.93)
	Undergraduate	1.08 (0.29, 2.92)	1.42 (0.15, 5.94)	1.07 (0.30, 2.95)
	Postgraduate	0.64 (0.12, 1.98)	1.58 (0.12, 7.06)	0.28 (0.02, 1.18)
Mobile use (hours/day)	3–5	0.80 (0.33, 1.64)	1.16 (0.33, 2.67)	0.58 (0.21, 1.24)
	≥ 5	0.86 (0.19, 2.34)	1.38 (0.27, 4.52)	**0.10 (0.01, 0.42)**
Physical activity	Moderate	1.77 (0.74, 3.69)	0.90 (0.29, 2.15)	1.42 (0.44, 3.72)
	High	0.65 (0.19, 1.66)	**0.30 (0.05, 0.92)**	0.84 (0.23, 2.23)
Smoking status	Smoker	2.17 (0.70, 4.96)	1.19 (0.16, 4.00)	2.20 (0.62, 5.70)
Effort-Reward	Imbalance	1.45 (0.68, 2.85)	1.11 (0.36, 2.56)	1.04 (0.45, 2.05)
Depression		1.25 (0.25, 3.24)	**7.79 (2.09, 19.15)**	**12.59 (4.61, 27.88)**
Comorbidity	One	1.63 (0.65, 3.22)	1.53 (0.34, 3.82)	0.70 (0.20, 1.63)
	Two	**4.14 (1.17, 10.60)**	3.00 (0.49, 9.76)	**4.27 (1.25, 10.59)**
	> 2	2.70 (0.13, 11.19)	0.84 (0.01, 4.67)	**8.00 (1.41, 25.43)**

Abbreviation: *CrI* Bayesian Credible Interval

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Odds ratios (OR) that are credibly significant are highlighted in bold

may introduce bias. we encountered limited sample sizes across some sleep subscale categories, resulting in data sparsity issues particularly for severe difficulty classifications. While we addressed this through Bayesian analytical methods with weakly informative priors to stabilize estimates, these statistical adjustments cannot fully compensate for small subgroup numbers and we have wide credible interval in some of them. The convenience quota sampling limits generalizability beyond medical university employees. Residual confounding, particularly from unmeasured occupational roles or circadian factors, remains possible. Future studies with longitudinal design, objective sleep measures, and stratified occupational analyses are needed. We recommend future studies employ: (1) substantially larger samples to ensure adequate representation across all subscale severity levels, (2) complementary objective sleep measures to validate self-reports, (3) longitudinal designs to establish temporal relationships and causal pathways and (4) consider important confounders like occupational status.

Conclusion

This study provides the first comprehensive analysis of the multifaceted determinants of sleep quality among Iranian medical employees, revealing that demographic, behavioral, psychological, and health-related factors distinctly influence each PSQI subscale. Notably, effort-reward imbalance consistently emerged as a prominent risk factor across nearly all sleep subscales, underscoring the pervasive impact of workplace stress on sleep health in this occupational group. These findings advance current knowledge by identifying both established and novel predictors-such as the unique role of ERI-thereby offering actionable insights for targeted interventions and workplace policies aimed at improving sleep quality among healthcare professionals. While Bayesian methods mitigated data sparsity limitations, the study's reliance on self-reported measures and modest sample sizes across subscales suggests the need for future research with larger, more diverse cohorts incorporating objective sleep measurements. Despite these limitations, our

Table 9 The effect of demographic, behavioral, psychological and health-related factors on daytime disfunction using Bayesian multinomial logistic regressions

Factors		Difficulty of daytime disfunction		
		Mild	Moderate	Severe
		OR (95% CrI)	OR (95% CrI)	OR (95% CrI)
Age		0.99 (0.97, 1.01)	0.98 (0.96, 1.01)	0.91 (0.85, 0.96)
BMI	Underweight	1.73 (0.52, 4.36)	1.55 (0.18, 5.03)	0.91 (0.01, 5.09)
	Overweight	0.93 (0.68, 1.24)	1.36 (0.85, 2.07)	0.57 (0.19, 1.30)
	Obese	0.87 (0.57, 1.24)	1.65 (0.91, 2.75)	0.41 (0.06, 1.18)
Sex	Male	0.95 (0.69, 1.25)	0.69 (0.45, 1.02)	0.73 (0.24, 1.69)
Wealth Status	Middle	1.00 (0.71, 1.38)	0.80 (0.49, 1.23)	3.28 (0.94, 8.56)
	Rich	1.00 (0.69, 1.40)	0.65 (0.39, 1.03)	1.08 (0.25, 2.93)
Marital status	Married	1.00 (0.66, 1.44)	1.17 (0.65, 2.02)	3.60 (0.88, 10.71)
Education	Diploma	1.02 (0.56, 1.72)	1.07 (0.42, 2.31)	0.74 (0.06, 3.27)
	Undergraduate	1.10 (0.62, 1.87)	1.49 (0.60, 3.18)	1.03 (0.17, 3.95)
	Postgraduate	1.37 (0.72, 2.40)	1.42 (0.52, 3.05)	1.83 (0.16, 7.89)
Mobile use (hours/day)	3–5	1.15 (0.85, 1.52)	1.16 (0.75, 1.66)	**2.91 (1.01, 7.66)**
	≥ 5	1.36 (0.82, 2.09)	1.50 (0.73, 2.62)	3.98 (0.79, 11.73)
Physical activity	Moderate	0.97 (0.68, 1.34)	1.12 (0.66, 1.73)	0.83 (0.25, 2.18)
	High	0.79 (0.53, 1.13)	0.81 (0.45, 1.30)	0.93 (0.20, 2.58)
Smoking status	Smoker	1.36 (0.87, 2.03)	1.22 (0.60, 2.18)	1.05 (0.11, 3.29)
Effort-Reward	Imbalance	**1.61 (1.22, 2.09)**	**2.06 (1.33, 3.03)**	2.29 (0.82, 5.51)
Depression		**2.58 (1.39, 4.54)**	**4.00 (1.84, 7.76)**	**14.95 (4.25, 38.69)**
Comorbidity	One	1.06 (0.75, 1.45)	1.05 (0.65, 1.63)	1.68 (0.53, 3.86)
	Two	0.91 (0.50, 1.54)	0.57 (0.19, 1.22)	1.43 (0.08, 5.41)
	> 2	0.58 (0.15, 1.47)	0.65 (0.09, 2.10)	3.09 (0.11, 14.17)

Abbreviation: *CrI* Bayesian Credible Interval

The reference levels were set as normal (BMI), female (sex), poor (wealth status), single (marital status), under diploma (education), less than 3 h/day (mobile use), low (Physical activity), non-smoker (smoking status), balanced (effort-reward), and zero (comorbidity)

Odds ratios (OR) that are credibly significant are highlighted in bold

findings show how workplace stress and mental health affect sleep in medical staff. These results can help hospitals and medical schools inform the development of targeted programs to improve sleep, which could benefit both workers and patient care. Furthermore, our findings provide valuable evidence based for developing targeted workplace interventions to improve sleep health among medical employees. The identified associations between occupational stressors, psychological factors, and sleep disturbances offer concrete pathways to enhance both staff well-being and healthcare system performance.

Abbreviations

REM Rapid eye movement
PSQI Pittsburgh Sleep Quality Index
QUMS Qazvin University of Medical Sciences
BMI Body mass index
ERI Effort-Reward Imbalance
SD Standard deviation
OR Odds ratios

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Authors' contributions

ZH and NM developed and designed the research project overall. NM led the analysis and the writing of the manuscript and ZH, EK and MH contributed to the analysis and co-wrote the manuscript. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The Research Ethics Committee of Qazvin University of Medical Sciences approved this study (Ethics Code: IR.QUMS.REC.1404.057). Written informed consent was obtained from all participants prior to study implementation. Anonymous data were kept confidential and used according to the Declaration of Helsinki.

Competing interests

The authors declare no competing interests.

Consent for publication

Not applicable.

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