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The Relationship Between Insomnia Symptoms, Night Sleep of Less than 7 Hours, and Impaired Fasting Glucose in Shift Workers

Vardiyalı Çalışanlarda Uykusuzluk Belirtileri, 7 Saatten Az Gece Uykusu ve Bozulmuş Açlık Glikozu Arasındaki İlişki

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Abstract

Objective: The aim of this study was to examine the relationship between insomnia symptoms, night sleep of less than 7 hours, and the prevalence of impaired fasting glucose (IFG) in healthcare personnel in workplaces with shifting hours.

Materials and Methods: In this study, a total of 410 healthcare workers from an educational hospital were included. The presence of insomnia symptoms, difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), and early morning awakening (EMA) were assessed using the Insomnia Severity Index questionnaire. The participants' average sleep duration was categorized into three groups: <7 hours (short sleep), 7-8 hours (normal), and ≥9 hours (long). The diagnosis of glucose intolerance IFG was made following the recommendations of the American Diabetes Association. The relationship between sleep duration, insomnia symptoms, and IFG was evaluated using multivariate logistic regression analysis.

Results: The frequency of IFG was significantly higher among healthcare workers with DIS [OR=4.28, 95% confidence interval (CI): 3.28-5.19], DMS (OR=2.14, 95% CI: 1.78-3.86), EMA (OR=4.54, 95% CI: 1.09-5.63), and night sleep <7 hours (OR=1.84, 95% CI: 1.08-1.89) compared to others. Furthermore, according to logistic regression analysis, the presence of DIS, DMS, and EMA with night sleep <7 hours significantly increased the likelihood of IFG by 5.16 (adjusted OR=5.16), 2.15 (adjusted OR=2.15), and 5.26 (adjusted OR=5.26) times, respectively.

Conclusion: This study revealed that short night sleep (less than 7 hours) with insomnia symptoms in shift workers increases the risk of developing IFG. Therefore, it is important to focus on sleep hygiene, conduct regular screenings for insomnia, and promote access to healthy foods and physical activity to prevent the occurrence of IFG.

Keywords: Health personnel, glucose intolerance, insomnia, sleep duration

Öz

Amaç: Bu çalışmanın amacı, vardiyalı çalışanlarda uykusuzluk semptomları, 7 saatten az gece uykusu ve bozulmuş açlık glukozu (BAG) prevalansı arasındaki ilişkiyi incelemektir.

Gereç ve Yöntem: Bu çalışmaya bir eğitim hastanesinden toplam 410 sağlık çalışanı dahil edilmiştir. Uykusuzluk semptomlarının varlığı, uykuya geçmede zorluk (UGZ), uykuyu sürdürme güçlüğü (USG) ve sabah erken uyanma (SEU), Uykusuzluk Şiddet İndeksi anketi kullanılarak değerlendirilmiştir. Katılımcıların ortalama uyku süresi üç gruba ayrılmıştır: <7 saat (kısa uyku), 7-8 saat (normal) ve ≥9 saat (uzun). BAG tanısı Amerikan Diyabet Derneği'nin önerileri doğrultusunda konulmuştur. Uyku süresi, uykusuzluk semptomları ve BAG arasındaki ilişki çok değişkenli lojistik regresyon analizi kullanılarak değerlendirilmiştir.

Bulgular: UGZ [olasılık oranı (OR)=4,28, %95 güven aralığı (CI): 3,28-5.19], USG (OR=2,14, %95 CI: 1,78-3,86), SEU (OR=4,54, %95 CI: 1,09-5,63) ve gece uykusu <7 saat (OR=1,84, %95 CI: 1,08-1,89) olan sağlık çalışanlarında BAG sıklığı diğerlerine kıyasla anlamlı derecede yüksekti. Ayrıca, lojistik regresyon analizine göre, gece uykusu <7 saat ile birlikte UGZ, USG ve SEU varlığı BAG olasılığını sırasıyla 5,16 (düzeltilmiş OR=5,16), 2,15 (düzeltilmiş OR=2,15) ve 5,26 (düzeltilmiş OR=5,26) kat artırmıştı.

Sonuç: Bu çalışma, vardiyalı çalışanlarda uykusuzluk semptomlarıyla birlikte kısa gece uykusunun (7 saatten az) BAG gelişme riskini artırdığını ortaya koymuştur. Bu nedenle, BAG oluşumunu önlemek için uyku hijyenine odaklanmak, uykusuzluk için düzenli taramalar yapmak ve sağlıklı gıdalara ve fiziksel aktiviteye erişimi teşvik etmek önemlidir.

Anahtar Kelimeler: Sağlık çalışanı, bozulmuş açlık glukozu, uykusuzluk, uyku süresi

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Introduction

Impaired fasting glucose (IFG) is a condition characterized by blood glucose levels that are higher than normal but not high enough to be classified as diabetes. IFG is associated with an increased risk of cardiovascular disease and type 2 diabetes.[1,2] Prediabetes, which includes IFG, is significantly associated with several factors. These factors include advanced age, a family history of diabetes, being overweight, obese, or centrally obese, high systolic blood pressure, and elevated serum triglyceride levels.[3,4] Numerous studies have indicated that prediabetes can be influenced by various factors, including the quantity, quality, and duration of sleep. Adequate and regular sleep is crucial for the proper functioning of the body's metabolism, hormonal processes, and regulation of glucose metabolism.[5,6] Research has shown that short-term sleep restriction or sleep disturbances,[5,7] as well as chronic sleep deprivation,[5,8,9] are associated with glucose intolerance, insulin resistance, and metabolic and endocrine changes in healthy individuals. Additionally, there is a correlation between inadequate sleep (less than five hours) or excessive sleep (more than nine hours), difficulty initiating and maintaining sleep, and metabolic disorders such as type 2 diabetes and obesity.[10,11] A study conducted by Gottlieb et al.[12] demonstrated an increased prevalence of impaired glucose tolerance (IGT) and diabetes among individuals with both short and long sleep durations. The Western New York Health Study, which compared short sleep (less than 6 hours) to the usual sleep length (6-8 hours per night), found that sleeping less than 6 hours was associated with an increased frequency of IFG.[13] However, the results of these studies are inconsistent. Rafalson et al.[13] showed an association between IFG and short sleep duration, but Hung et al.[14] observed no link between IFG and disturbed sleep. Additionally, poor sleep quality and sleep fragmentation can lead to impaired glucose regulation and metabolism, increasing the risk of IFG.[7,15,16] In a study by Lou et al.[17] the frequency of IFG increased in individuals reporting less restful sleep (based on PSQI) and shorter sleep durations (less than 7 hours) compared to those with good sleep quality and a duration of 6 to 8 hours. To our knowledge, the majority of studies in this field have focused more on sleep quality, and studies exploring the relationships between insomnia symptoms, sleep duration, and IFG are scarce. This study aimed to examine the relationships between insomnia symptoms, sleeping less than 7 hours at night, and the prevalence of IFG in shift workers

Materials and Methods

This descriptive-analytical study was conducted on all healthcare personnel (n=443) at an educational hospital in Tehran from December 2022 to April 2023. The inclusion criteria comprised individuals engaged in shift work and having at least one year of work experience. Before participating in the study, each subject provided written informed consent, and the research protocol was reviewed and approved by the ethical committee of the Iran University of Medical Sciences and Health Services (approval number: IR.IUMS.FMD.REC.1401.182, date: 27.06.2022).

An occupational medicine resident conducted in-person interviews with the study's participants. The interviews covered general information such as age, gender, education level, marital status, history of underlying diseases (including hypothyroidism and diabetes), cigarette smoking, physical activity, and family history of diseases (diabetes, hypertension, cardiovascular disease, and malignancy). Additionally, occupational details were gathered, including job title, work history, employment status, possession of primary and supplemental insurance, daily and weekly working hours, shift worker status (regular or non-regular), and the number of shifts worked in a month. Participants with pre-existing conditions including diabetes, chronic obstructive pulmonary disease, neuropathy, psychosis, depression, cardiovascular disease, stroke, a history of antihypertensive treatment, or those who were pregnant were excluded from the study.

Sleep Assessment Instrument

In this study, the Insomnia Severity Index (ISI) questionnaire was employed to assess insomnia and its symptoms. The ISI questionnaire consists of seven questions, each rated on a 5-point Likert-Type Scale ranging from 0 to 4. The total score, ranging from 0 to 28, provides an evaluation of the type and severity of insomnia experienced during the preceding month. Based on the total score, the following classifications were used: a score of 0-7 indicated no clinical insomnia, 8-14 indicated subthreshold insomnia, 15-21 indicated moderate insomnia, and 22-28 indicated severe insomnia.[18] Additionally, three specific questions were used to assess insomnia symptoms, namely difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), and early morning awakening (EMA).

In the DIS question, participants were asked to indicate whether it took them an hour or more to fall asleep. For the DMS question, participants were asked if they woke up more than three times during the night. In the EMA question, participants were asked if they experienced sleep problems due to waking up too early in the morning. A 5-point Likert Scale (ranging from 0 to 4) was used to rate each question, with 0 indicating "never", 1 indicating "rare", 2 indicating "occasional", 3 indicating "usually", and 4 indicating "always". A score of 3 or 4 on each of these questions determined the occurrence of the related problem.[18]

Furthermore, participants were asked about their sleep duration on weekdays (Saturday through Wednesday) and weekends (Thursday and Friday) during the preceding seven days. To calculate the average weekly sleep length, the following formula was used: [(5 × weekday sleep duration) + (2 × weekend sleep duration)] / 7. This formula took into account the weighted average of weeknights and weekend nights.[19] Based on the reported sleep duration, participants were categorized into the following groups:

- Less than 7 hours per night, indicating short sleep
- 7 to 8 hours per night, indicating normal sleep (reference group)
- 9 hours or more per night, indicating long sleep.[20]

The STOP-BANG questionnaire was employed to assess the risk of obstructive sleep apnea (OSA). It consists of eight yes or no questions, which are as follows: 1. Frequent snoring (S), 2. Daily fatigue (T), 3. Observed apnea (O), 4. Hypertension (P), 5. Body Mass Index (BMI) >35 kg/m^2 (B), 6. Age >50 years old (A), 7. Neck circumference >40 cm (N), 8. Male gender (G). In this study, the participants were divided into two groups based on their STOP-Bang score: a low-risk group (0-2 points) and a high-risk group (3-8 points).[21] All participants underwent a 12-hour overnight fasting period, and blood samples were collected to measure fasting blood sugar (FBS) levels. "According to the current definition by the American Diabetes Association, FBS levels ≤99 mg/dL were categorized as normal, while levels ranging from 100 mg/dL to 125 mg/dL were considered indicative of IFG. Participants with blood sugar levels exceeding 126 mg/dL were excluded from the study".[22]

Statistical Analysis

The study data were entered and analyzed using SPSS version 22.0, a statistical software. Descriptive statistics, such as mean and standard deviation, were used for quantitative variables, while frequency and percentage were used for qualitative variables. The independent Student's t-test was employed to compare quantitative variables between two groups of participants. The chi-square test was used to compare qualitative variables between the two groups. To investigate the relationships between the frequency of IFG and sleep-related variables (insomnia and sleep duration), multivariable logistic regression models were utilized. The results of the multivariable analysis were presented as adjusted odds ratios (ORs) along with 95% confidence intervals (95% CIs). The models also included appropriate interaction terms to assess the combined effects of specific insomnia symptoms and sleep duration on the prevalence of IFG. All statistical tests were two-tailed, and a significance threshold of 0.05 was applied.

Results

The present study involved 410 healthcare workers, with a mean age of 40.71±1.9 years (ranging from 24 to 63 years) and a mean work experience of 14.5±1.04 years (ranging from 1 to 32 years). Among these participants, 287 (70%) were married, 256 (62.43%) were female, and 33 (8.04%) were smokers. More than half of the workforce (53.6%) possessed a bachelor's degree. The average daily working hours were 7.71±1.72 hours, and the average weekly working hours were 53.32±2.15 hours. Additionally, 160 (39.02%) participants had regular shift work. The workers had a mean BMI of 24.18±4.06 kg/m^2 (ranging from 17.35 to 33.9 kg/m^2) and a fasting blood glucose rate of 103.05±8.20 mg/dL (ranging from 85 to 126 mg/dL). Among the workers, 24.87% (n=102) had IFG.

Table 1 indicates that individuals with IFG were significantly more likely to be male (70.58% vs. 26.62%), older (42.64±3.9 vs. 38.86±2.2 years), had higher work experience (15.39±3.2 vs. 12.39±5.3 years), had a higher prevalence of cigarette smoking (12.74% vs. 6.49%), had OSA (26.47% vs. 13.96%), and experience moderate-severe insomnia (41.19% vs. 26.62%) compared to those without IFG. Moreover, subjects with IFG had a significantly higher BMI (25.12±1.16 kg/m^2) compared to those without IFG (21±2.76 kg/m^2) (Table 1).

Table 1. Baseline characteristics of study participants according to the presence or absence of impaired fasting glucose

Impaired fasting glucose				
Baseline characteristics	**Yes (n=102)**	**No (n=308)**	**p**	**OR (CI)***
Age (years) (mean ± standard deviation)	42.64±3.9	38.86±2.2	<0.001	
BMI (kg/m^2) (mean ± standard deviation)	25.12±1.16	21±2.76	<0.001	
Male gender n (%)	72 (70.58)	82 (26.62)	<0.001	6.61 (4.03-10.85)
Marital status (married) n (%)	65 (63.72)	222 (72.07)	0.055	0.68 (0.424-1.09)
Cigarette, (smoker) n (%)	13 (12.74)	20 (6.49)	0.024	2.10 (1.00-4.3)
Physical activity (regular) n (%)	41 (40.19)	217 (70.45)	0.023	0.62 (0.39- 0.99)
Work experience (year) (mean ± standard deviation)	15.39±3.2	12.39±5.3	0.01	
Type of shift (non-regular) n (%)	46 (45.09)	204 (66.23)	<0.001	0.41 (0.26-0.66)
Insomnia (moderate-sever) n (%)123	41 (41.19)	82 (26.62)	0.01	1.85 (1.15-2.96)
OSA** (high risk) n (%)	27 (26.47)	43 (13.96)	<0.001	2.21 (1.28-3.82)

*OR: Odds ratio, CI: Confidence interval, **OSA: Obstructive sleep apnea

According to the ISI questionnaire, the mean insomnia score among the participants was 11.4±5.7, ranging from 0 to 24. The distribution of insomnia severity categories was as follows:

- 45% of participants had no clinical insomnia.
- 25% of participants had subthreshold insomnia.
- 23% of participants had moderate insomnia.
- 7% of participants had severe insomnia.

In total, 123 participants (30%) had moderate to severe insomnia. Based on insomnia symptoms, 21.95% of participants had DIS, 16.34% had DMS, and 23.17% had EMA. The mean sleep duration on weeknights was 6.88±1.02 hours, on weekend nights it was 8.1±1.31 hours, and the average weekly sleep duration was 7.5±1.9 hours. Based on participants' reported sleep duration, 42.4% were classified as short sleepers, sleeping less than 7 hours per night, 51.5% were considered normal sleepers, sleeping 7-8 hours per night, and 6.1% were classified as long sleepers, sleeping 9 hours or more per night.
According to the STOP-BANG score, 340 participants (82.92%) were classified as low risk for OSA, while 70 participants (17.07%) were classified as high risk for OSA.

Comparison of the Prevalence of IFG Between Healthcare Workers with and Without Insomnia Symptoms

It was found that healthcare workers with DIS, DMS, and EMA had a significantly higher prevalence of IFG: (OR=7.38, 95% CI: 4.41-12.37), (4.09, 95% CI: 2.42-6.11), and 7.71, 95% CI: 4.63-12.81) than those without insomnia symptoms respectively.
After adjusting for potential confounding factors such as sex, age, BMI, work experience, cigarette smoking, physical activity, and sleep duration, there was still a significant association between short sleep duration and IFG (Table 2).

Comparison of the Prevalence of IFG Between Healthcare Workers with Short, Normal and Long Sleep Durations

In terms of sleep duration, healthcare workers with short sleep duration (<7 hours per night) had a significantly higher prevalence of IFG compared to those with normal sleep duration (7-8 hours per night) (OR=2.21, 95% CI: 1.38-3.54). After adjusting for potential confounding factors including sex, age, BMI, work experience, cigarette smoking, physical activity, and insomnia symptoms, there was still a significant association between short sleep duration and IFG (OR=1.84, 95% CI: 1.08-1.89). On the other hand, long sleep duration (≥9 hours per night) did not show a significant association with IFG. (Table 2 provides further details on these associations.)
Table 3 presents the results obtained from multiple logistic regression models assessing the prevalence of IFG in relation to sleep duration and insomnia symptoms. The analysis revealed that compared to the reference group (individuals with a normal

Table 2. Associations of impaired fasting glycaemia with sleep characteristics

		Impaired fasting glucose				
Individual symptoms of insomnia		**No n (%)**	**Yes n (%)**	**p**	**OR (95% CI)**	**Adjusted OR (95% CI)**
Difficulty initiating sleep	No n=320	270 (84.37%)	50 (15.62%)	<0.001	1	1
	Yes n=90	38 (42.22%)	52 (57.77%)		7.38 (4.41-12.37)	4.27 (3.28-5.19)*
Difficulty maintaining sleep	No n=333	269 (80.78%)	64 (19.21%)	<0.001	1	1
	Yes n=77	39 (50.64%)	38 (48.05%)		4.09 (2.42-6.91)	2.14 (1.78-3.86)*
Early morning awakening	No n=312	266 (85.25%)	46 (14.74%)	<0.001	1	1
	Yes 98 n=	42 (42.85%)	56 (57.14%)		7.71 (4.63-12.81)	4.54 (1.09-5.63)*
Sleep duration (hours per night)	<7 n=143	93 (65.03%)	50 (34.96%)	<0.001	2.21 (1.38-3.54)	1.84 (1.08-1.89)**
	7-8 n=241	194 (80.49%)	47 (19.50%)		1	1
	≥9 n=26	21 (80.76%)	5 (19.23 %)	0.48	0.98 (0.35-2.74)	

*Odds ratios were adjusted sex, age, BMI, work experiences, cigarette smoking, shift working, physical activity, OSA and sleep duration.
**Odds ratios were adjusted sex, age, BMI, work experiences, cigarette smoking, shift working, physical activity, OSA and insomnia symptoms.
OR: Odds ratio, CI: Confidence interval, BMI: Body max index, OSA: Obstructive sleep apnea

sleep duration and no symptoms of insomnia), individuals who had less than 7 hours of sleep per night and experienced DIS, DMS, or EMA had significantly higher prevalence of IFG, (adjusted OR=5.16, 95% CI: 3.21-6.12), (adjusted OR=2.15, 95% CI: 1.23-2.58), and (adjusted OR=5.26, 95% CI: 3.78-5.89), respectively. Using likelihood ratio tests, it was determined that short sleep duration and the presence of individual insomnia symptoms (DIS and EMA) were significant predictors of the prevalence of IFG.

Discussion

The findings indicated that healthcare workers with insomnia symptoms (DIS, DMS, and EMA) are at a higher risk of IFG compared to workers without insomnia symptoms, with OR of 4.27, 2.14, and 4.54, respectively. Additionally, workers who slept less than 7 hours per night had a significantly higher prevalence of IFG (OR=1.84) compared to those with a normal sleep duration, regardless of the presence of insomnia symptoms. Additional analysis revealed that the presence of insomnia symptoms (DIS, DMS, and EMA) combined with less than 7 hours of night sleep significantly increased the likelihood of IFG by 5.16, 2.15, and 5.26 times, respectively. The main findings of the study were that both short sleep duration and insomnia symptoms had an impact on the prevalence of IFG. Previous epidemiological studies have demonstrated a connection between sleep durations of less than five hours or more than nine hours, difficulties in initiating and maintaining sleep, and metabolic disorders such as type 2 diabetes and obesity.[10,11]

Consistent with our results, Rafalson et al.[13] reported an association between IFG and short sleep duration, while Hung et al.[14] found no link between IFG and disrupted sleep. Short sleep duration has been shown to increase appetite and calorie intake, particularly for carbohydrate-rich foods, by 14% in individuals with normal weight,[23,24] and 15% in middle-aged obese individuals.[7]

Our results indicate that healthcare workers with insomnia symptoms (DIS, DMS, and EMA) face an elevated risk of IFG compared to workers without insomnia symptoms. In a study conducted by Lou et al.[17] the frequency of IFG increased among individuals who reported less restful sleep (based on PSQI) and shorter sleep durations (less than 7 hours) compared to those who experienced a good night's sleep lasting 6-8 hours. While Lou et al.[17] examined the combined effect of sleep quality and

Table 3. Associations of impaired fasting glucose with the joint effects of short sleep duration and individual symptoms of insomnia

Impaired fasting glucose						
Sleep duration (hours per night)			**No n (%)**	**Yes n (%)**	**Adjusted OR* (95% CI)**	**p value** for interaction**
DIS	No n=195	7-8	173 (88.71%)	22 (11.28%)	1	0.03
	No n=99	<7.	76 (76.76%)	23 (23.23%)	1.14 (1.06-2.02)	
	Yes n=46	7-8	21 (7.31%)	25 (25.77%)	3.17 (2.15-4.89)	
	Yes n=44	<7	17 (38.63%)	27 (61.36%)	5.16 (3.21-6.12)	
DMS	No n=196	7-8	167 (85.20%)	29 (14.79%)	1	0.07
	No n=111	<7	81 (72.97%)	30 (27.02%)	1.07 (0.89-1.81)	
	Yes n=45	7-8	27 (60%)	18 (40%)	1.87 (0.52-1.58)	
	Yes n=32	<7	12 (37.5%)	20 (62.5%)	2.15 (1.23-2.58)	
EMA	No n=190	7-8	170 (89.47%)	20 (10.52%)	1	0.02
	No n=96	<7	75 (78.12%)	21 (21.87%)	2.14 (1.69-3.25)	
	Yes n=51	7-8	24 (47.05%)	27 (52.94%)	3.99 (2.87-3.57)	
	Yes n=47	<7	18 (38.29%)	29 (61.70%)	5.26 (3.78-5.89)	

*: Odds ratios were adjusted sex, age, BMI, work experiences, cigarette smoking, physical activity.

**: p value for interactions was based on the likelihood ratio test.

DIS: Difficulty initiating sleep, DMS: Difficulty maintaining sleep, EMA: Early morning awakening, OR: Odds ratio, CI: Confidence interval

quantity on IFG, our study focused on the impact of insomnia symptoms and sleep duration on IFG. Despite this difference in approach, we obtained similar results.

In our study, we observed that the impact of sleeping less than 7 hours per night on the prevalence of IFG (OR=1.84) was less significant compared to the effect of insomnia symptoms: DIS (OR=4.27), DMS (OR=2.14), and EMA (OR=4.54). IFG is physiologically caused by reduced liver sensitivity to insulin or impaired insulin production.[25] Several studies have indicated that poor sleep quality and sleep fragmentation can contribute to impaired glucose regulation and metabolism, thereby increasing the risk of IFG.[7,15,16]

The anorexigenic leptin levels,[26-29] tolerance to glucose, glucose effectiveness, sensitivity to insulin, and β cell function are reduced after sleep deprivation.[5,23,30,31] Following three nights of disrupted sleep with slow wave patterns, insulin sensitivity decreases by 25%,[32] while glucose tolerance decreases by 23%,[7] thereby increasing the risk of diabetes and IGT.

Additionally, in our study, 17.07% of participants had OSA, and the frequency of obstructive apnea was higher in subjects with IFG. OSA is characterized by repeated closure or narrowing of the upper airway during sleep, while insomnia is characterized by difficulty initiating or maintaining sleep, early awakening without being able to return to sleep, or a combination of these symptoms.[33]

The concept of the "sleep apnea and insomnia syndrome" was first described in 1973.[34] This clinical syndrome has garnered significant attention, leading to numerous studies, and it has been observed that insomnia and OSA often coexist. However, the extent of their coexistence varies across different studies. For instance, Smith et al.[35] found that 39% of patients with OSA also experienced insomnia, while Cronlein et al.[36] reported that 10.7% of patients diagnosed with insomnia had clinically significant OSA. Several studies have demonstrated a correlation between OSA and insulin resistance, as well as glucose intolerance.[37,38] Therefore, the increased frequency of IFG observed in individuals with insomnia may be partly attributed to the presence of OSA alongside insomnia. However, it is important to note that this factor (sleep apnea) was taken into account and adjusted for in the multivariable logistic regression analysis, and the significant association between insomnia symptoms and IFG remained.

In our study, we did not find a significant correlation between long sleep duration and the prevalence of IFG. However, our findings differ from a study conducted by Lou et al.[17], where individuals with long sleep duration were found to have a significant risk of developing IFG compared to those with high-quality sleep and normal night sleep duration of 6 to 8 hours. One possible explanation for these discrepant results is that the number of individuals with long sleep duration was very small in our study. Therefore, it is recommended to conduct larger-scale studies to further investigate the relationship between sleep duration of more than 8 hours and the prevalence of IFG, as well as its connection with insomnia.

Our research has several advantages and limitations. One of the strengths is that it investigated both sleep duration and insomnia symptoms, which sets it apart from other studies. However, there are three notable limitations to consider. Firstly, the methodology of the study relied on cross-sectional data, which means that it is not possible to establish a causal relationship between insomnia symptoms, sleep duration, and IFG. Longitudinal studies would be needed to determine the temporal sequence and potential causal links between these factors. Secondly, the information regarding sleep duration and insomnia symptoms was gathered through self-reported questions. While valid questionnaires such as the ISI are commonly used for screening sleep disorders, objective measures were not employed. Objective instruments, such as polysomnography or actigraphy, could provide more accurate and reliable data on sleep duration and sleep disturbances. Lastly, the study focused on shift workers, who are known to experience higher levels of sleep disturbances compared to the general population. This specific population may have unique characteristics that could impact the generalizability of the study's findings to other groups. Considering these limitations, it would be beneficial for future research to incorporate longitudinal designs, objective measures of sleep, and diverse populations to further investigate the relationship between sleep duration, insomnia symptoms, and IFG.

Recent research indicates that the disruption of circadian rhythm caused by shift work can increase the risk of impaired glucose and lipid metabolism, adipose tissue dysfunction, and cardiovascular and hemostatic dysfunction.[39-42] Since IFG is a risk factor for type 2 diabetes and cardiovascular disease, it is recommended to regularly screen shift workers for insomnia and IFG. In addition to addressing sleep disturbances, promoting access to healthy foods, fostering appropriate and healthy eating habits, and encouraging physical activity in the workplace are vital for the well-being of shift workers.

Conclusion

In conclusion, the current study demonstrates that healthcare workers who experience less than 7 hours of night sleep and exhibit insomnia symptoms, particularly EMA, DIS, and DMS, have a significantly higher risk of IFG by 5.16, 2.15, and 5.26 times, respectively, compared to workers with normal sleep (both in terms of quality and quantity). Considering the impact of insomnia symptoms and short sleep duration on glucose metabolism and endocrine function, it is important to prioritize sleep hygiene, make adjustments to working hours, promote access to healthy foods, and encourage regular exercise in order to prevent the occurrence or worsening of IFG. Additionally, it is recommended to conduct periodic screenings for insomnia among shift workers to prevent the development of IFG.

Ethics

Ethics Committee Approval: The research protocol was reviewed and approved by the ethical committee of the Iran University of Medical Sciences and Health Services (approval number: IR.IUMS.FMD.REC.1401.182, date: 27.06.2022).

Informed Consent: Before participating in the study, each subject provided written informed consent.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: E.K.M., Concept: E.K.M., S.M., Design: E.K.M., S.M., Data Collection or Processing: O.A., N.S., Analysis or Interpretation: E.K.M., N.S., Literature Search: O.A., N.S., Writing: E.K.M., S.M., O.A., N.S.

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