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Review / *Derleme*

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The Central Role of Oxidative Stress in the Pathogenesis of Obstructive Sleep Apnea Syndrome: Mechanisms, Biomarkers, and Clinical Implications

Obstrüktif Uyku Apnesi Sendromunun Patogenezinde Oksidatif Stresin Merkezi Rolü: Mekanizmalar, Biyobelirteçler ve Klinik Sonuçlar

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Abstract

Obstructive sleep apnea (OSA) syndrome is an increasingly prevalent sleep disorder characterized by recurrent upper airway obstructions and associated intermittent episodes of hypoxia. OSA is associated with cardiovascular, metabolic, and neurological morbidity. Recent evidence indicates that the oxidative stress and inflammation caused by intermittent hypoxia play a central role in the pathophysiological consequences of OSA. This review aims to summarize the mechanistic links between OSA and oxidative stress, biomarkers, clinical implications, and treatment approaches. Future research directions are also discussed in light of emerging data from human and animal studies.

Keywords: Obstructive sleep apnea, oxidative stress, reactive oxygen species

Öz

Obstrüktif uyku apne (OSA) sendromu, tekrarlayan üst solunum yolu tıkanıklıkları ve buna bağlı aralıklı hipoksi ataklarıyla karakterize, giderek yaygınlaşan bir uyku bozukluğudur. OSA, kardiyovasküler, metabolik ve nörolojik morbidite ile ilişkilidir. Son yıllarda, aralıklı hipoksinin neden olduğu oksidatif stres ve enflamasyonun OSA patogenezinde merkezi bir rol oynadığına dair güçlü kanıtlar ortaya çıkmıştır. Bu derleme, OSA ile oksidatif stres arasındaki mekanik bağlantıları, biyobelirteçleri, klinik sonuçları ve tedavi yaklaşımlarını özetlemeyi amaçlamaktadır. Gelecekteki araştırma alanları da insan ve hayvan çalışmalarından elde edilen kanıtlar ışığında tartışılacaktır.

Anahtar Kelimeler: Obstrüktif uyku apnesi, oksidatif stres, reaktif oksijen türleri

Introduction

Obstructive sleep apnea (OSA) syndrome is a respiratory disorder characterized by recurrent partial or complete obstruction of the upper airway during sleep, resulting in cumulative physiological disruptions. Clinically, the condition typically presents with loud snoring, repeated arousals, excessive daytime sleepiness, and a marked decrease in attention, memory, and executive functions (1). In recent years, large cohort studies have emphasized that OSA is not merely a sleep disorder but a systemic disease with multifaceted links to cardiometabolic disorders such as hypertension, atherosclerosis, ischemic stroke, heart failure, atrial fibrillation, insulin resistance, and metabolic syndrome (2). Intermittent hypoxia (IH) is central to this broad spectrum of OSA comorbidities. Through frequent nocturnal oxygen fluctuations, IH severely disrupts cellular metabolism. This cycle of hypoxia and reoxygenation creates irregularities in mitochondrial membrane flow, increases NADPH oxidase (NOX) activation (especially NOX2), and leads to excessive reactive oxygen species (ROS) production (3). ROS accumulation triggers the production of pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein (CRP), as well as endothelial dysfunction by activating transcription factors such as nuclear factor kappa B (NF-κB)

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and hypoxia-inducible factor 1-alpha (4). The same process reduces nitric oxide (NO) bioavailability, accelerates lipid peroxidation [yielding byproducts such as malondialdehyde (MDA) and 4-hydroxynonenal (4-HNE), and promotes vascular wall stiffening.

Recent experimental models have shown that IH not only induces oxidative stress but also impairs mitochondrial biogenesis, exacerbates endoplasmic reticulum stress, dysregulates autophagic balance, and triggers epigenetic changes associated with clinical severity (5). Over the long-term, these mechanisms severely compromise cardiovascular integrity. Impaired endothelial function, increased arterial stiffness, autonomic nervous system dysfunction, and shifts in metabolic homeostasis drive the systemic effects of OSA (6).

Understanding the relationship between OSA and oxidative stress is important not only for elucidating the pathophysiology of the disease but also for identifying novel therapeutic targets. Anti-inflammatory molecules, NOX inhibitors, mitochondria-targeted antioxidants (e.g., Mitochondria- targeted Coenzyme Q10 (MitoQ). agents that modulate the hypoxic response, and non-invasive approaches that improve sleep architecture are among the potential therapeutic options (7). This review discusses the molecular mechanisms of IH, ROS sources, oxidative stress biomarkers, clinical outcomes, and current treatment strategies.

Materials and Methods

This narrative review is based on a comprehensive literature search of the PubMed, Scopus, and Web of Science databases. Studies published in English were screened using the keywords "obstructive sleep apnea", "oxidative stress", "biomarkers", "pathogenesis", and related terms.

Articles were evaluated according to their scientific relevance, methodological quality, and their contribution to understanding the molecular mechanisms and clinical implications of oxidative stress in OSA. Priority was given to original research articles, clinical studies, and recent review papers addressing oxidative stress pathways, associated biomarkers, and their potential role in disease pathogenesis and management.

Statistical Analysis

As this study is a narrative review based on previously published literature, no statistical analysis was performed.

Oxidative Stress and Its Cellular Basis

Oxidative stress refers to an imbalance between oxidant molecules [primarily ROS and reactive nitrogen species (RNS)] and cellular antioxidant defense systems, in favor of the oxidants. Under physiological conditions, redox signaling plays an essential regulatory role; however, excessive oxidant generation or impaired antioxidant capacity disrupts cellular homeostasis and promotes tissue injury.

In OSA, recurrent cyclical IH and reoxygenation act as a major trigger for oxidative stress by activating mitochondrial and enzymatic oxidant-producing pathways. This process contributes to endothelial dysfunction, inflammation, and progressive organ damage. An overview of the major oxidative stress-related mechanisms involved in OSA is presented in Figure 1.

Intermittent Hypoxia and Oxidative Stress Mechanisms in Obstructive Sleep Apnea Syndrome

Oxidative stress in OSA primarily arises from repetitive cycles of IH and reoxygenation, which markedly increase the production of ROS and RNS. While low levels of ROS are involved in physiological processes such as cellular signaling and vascular regulation, sustained hypoxia-induced oxidant generation overwhelms antioxidant defenses and leads to pathological redox imbalance (8).

The principal cellular sources of ROS in OSA include the mitochondrial electron transport chain (ETC), particularly complexes I and III, and enzymatic systems such as NOX isoforms (NOX1, NOX2, and NOX4), xanthine oxidase, and inducible NO synthase (9). Mitochondrial electron leakage during hypoxia–reoxygenation cycles represent a major source of superoxide anion ($O_2•^-$), while NOX enzymes amplify inflammatory ROS production, especially in endothelial cells and immune cells (10).

ROS, including $O_2•^-$, hydrogen peroxide, and hydroxyl radicals (•OH), along with RNS such as peroxynitrite ($ONOO^-$), induce oxidative damage to DNA, proteins, and lipids. This process leads to the generation of lipid peroxidation products such as MDA and 4-HNE, further exacerbating inflammation and vascular injury (11).

To counteract oxidative damage, cells rely on a coordinated antioxidant defense system. Enzymatic antioxidants—including superoxide dismutase (SOD), catalase, and glutathione peroxidase (GPx)—work alongside non-enzymatic molecules such as glutathione, vitamins C and E, carotenoids, flavonoids, and coenzyme Q10 to maintain redox balance (12). In OSA, oxidative stress emerges from the combined effects of increased oxidant production and insufficient or exhausted antioxidant capacity, a dual mechanism that underlies persistent oxidative injury in chronic disease states (8).

Mitochondrial Sources

IH disrupts the efficiency of oxidative phosphorylation by causing irregular electron flow in the mitochondrial ETC. During periods of hypoxia, electron accumulation occurs particularly at steps I and III of the ETC; during the reoxygenation phase, these accumulated electrons rapidly interact with oxygen, significantly increasing $O_2•^-$ formation (13). This process constitutes the most fundamental source of oxidative stress in the hypoxia–reoxygenation cycles specific to IH.

Chronic IH exposure is associated with more persistent effects beyond an acute increase in ROS production. These include mitochondrial dysfunction, decreased ATP synthesis, collapse of the mitochondrial membrane potential, decreased complex I activity, and suppression of mitochondrial biogenesis (14). Mitochondrial DNA is highly susceptible to oxidative damage because it lacks protective histones. Under IH conditions, a decrease in mitochondrial DNA copy number and impaired DNA replication have been reported, along with the accumulation

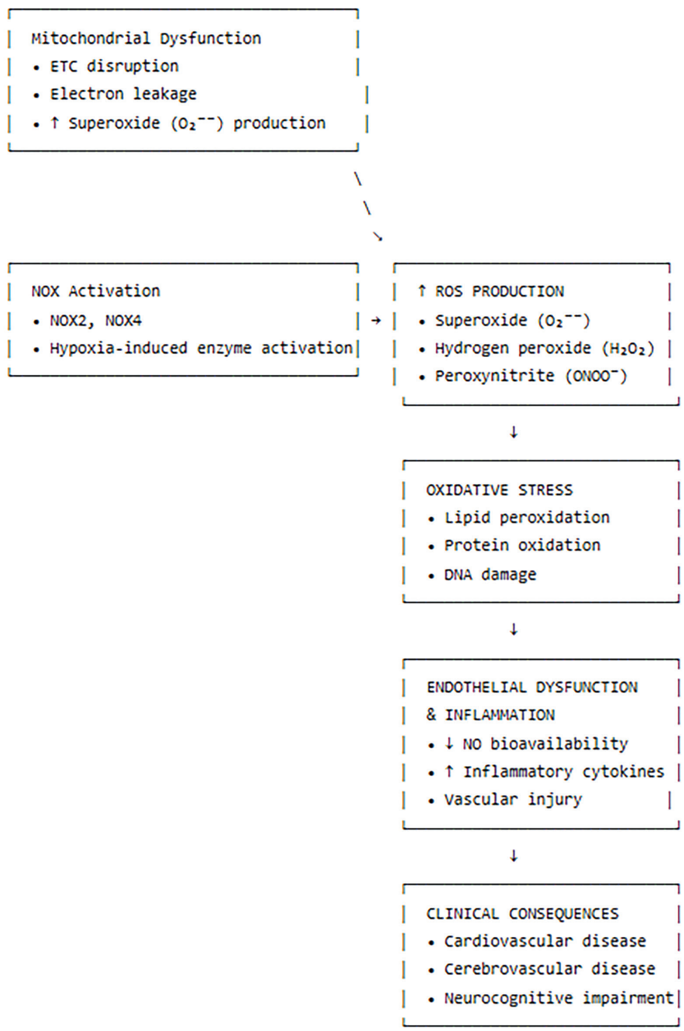

Figure 1. Schematic overview of oxidative stress pathways in obstructive sleep apnea.
ETC: Electron transport chain, NO: Nitric oxide, NOX: NADPH oxidase, ROS: Reactive oxygen species.

of 8-hydroxy-2′-deoxyguanosine (8-OHdG), an indicator of oxidative DNA damage (15).

Increased ROS accumulation triggers cytochrome c release, activating mitochondria-dependent apoptosis. This is supported by experimental models demonstrating that IH induces a pro-apoptotic shift in the Bcl-2- associated X protein/ B-cell lymphoma 2 (Bax/Bcl-2) balance, increases caspase-3 activation, and compromises cellular integrity (16). Therefore, IH is associated not only with oxidative stress but also with chronic disruption of mitochondrial integrity.

NADPH Oxidase

The NOX enzymes are among the primary oxidative enzyme complexes responsible for the production of extracellular $O_2^{•-}$ and are particularly abundant in endothelial cells, neutrophils, and monocytes. IH significantly upregulates NOX2 and NOX4 expression via increased sympathetic nervous system activation, elevated angiotensin II levels, and increased inflammatory cytokines such as TNF-α and IL-6 (17). This increases basal ROS production and heightens cellular sensitivity to hypoxia–reoxygenation cycles.

NOX-derived ROS are key triggers of endothelial dysfunction, primarily by reducing NO bioavailability in the endothelium. Specifically, $O_2^{•-}$ reacts with NO to form $ONOO^-$. This potent oxidant causes nitration damage, markedly reduces vascular relaxation capacity, and impairs endothelial NO synthase function through a phenomenon known as "uncoupling" (18). Furthermore, NOX activation contributes to structural remodeling of the vessel wall by promoting proliferation of vascular smooth muscle cells (19).

In chronic IH models, NOX2 has been identified as the predominant ROS source, and NOX2 inhibition has been shown to improve endothelial function, reduce oxidative damage, and significantly attenuate vascular inflammation (20). Therefore, NOX activation is considered a key pathobiological driver in both the onset and progression of IH-related vascular damage.

Ischemia–Reperfusion-Like Processes and Other Sources

IH and sleep fragmentation in OSA activate multiple sources of oxidative stress. Xanthine oxidase activation, combined with ROS production by neutrophils and macrophages, leads to increased local and systemic oxidative load (21). Xanthine oxidase produces $O_2{\bullet}^-$ and H_2O_2 during purine metabolism. This mechanism is particularly critical in vascular endothelial and cardiovascular tissue damage (22).

In addition, the NAD^+/SIRT (sirtuin) balance plays an important role in regulating cellular energy metabolism and antioxidant defense pathways. IH can reduce NAD^+ levels and impair SIRT activity, which contributes to increased oxidative stress by hindering mitochondrial ROS scavenging capacity (23).

Endoplasmic reticulum stress and mitochondria–endoplasmic reticulum interactions are also mechanisms that increase oxidative load in the context of OSA. The endoplasmic reticulum stress response (specifically the unfolded protein response) is associated with excessive ROS production, and mitochondria-associated membranes facilitate ROS signaling and cellular apoptotic responses (24). Collectively, these pathways contribute to the development of both vascular and metabolic complications in individuals with OSA.

Biomarkers: Diagnosis, Severity Assessment, and Prognosis

Both direct and indirect biomarkers are used to assess oxidative stress in OSA. Significant changes in most of these markers have been reported due to IH-associated ROS increase, systemic inflammatory activation, and impaired antioxidant defense capacity. The categories of commonly used biomarkers and their relationship with OSA are summarized below.

Although no single gold-standard biomarker of oxidative stress in OSA has been established, current evidence suggests that certain markers may hold greater clinical promise. Among these, circulating asymmetric dimethylarginine and 8-isoprostane appear particularly relevant due to their reproducibility, association with disease severity, and links to endothelial dysfunction. When combined with inflammatory markers such as high-sensitivity CRP, these biomarkers may offer a more pragmatic and clinically informative approach than relying on a single oxidative stress indicator.

Lipid Peroxidation Products

MDA and 4-HNE levels are significantly elevated in OSA patients. Meta-analyses have reported a dose-response relationship between MDA levels and OSA severity and demonstrated that continuous positive airway pressure (CPAP) treatment reduces these levels (25).

Protein Oxidation

Protein carbonyls are relatively stable and easily measurable indicators of oxidative stress. Current literature demonstrates that protein carbonylation is increased in OSA patients and positively correlates with disease severity (26).

DNA Damage

The molecule 8-OHdG, a key marker of DNA oxidation, is elevated in both the serum and urine samples of OSA patients. This increase is particularly associated with severe OSA and intense IH exposure. Studies have also shown that 8-OHdG levels decrease with CPAP treatment (27).

Antioxidant Defense Markers

Total antioxidant capacity (TAC), SOD, catalase, and GPx activities have been investigated in numerous studies. Although findings are heterogeneous, most studies show that antioxidant capacity is reduced in OSA, consistent with increased oxidative load (28). Furthermore, more pronounced decreases in erythrocyte SOD and GPx activities have been reported in severe OSA.

Nitrosative Stress and Nitric Oxide Metabolites

Nitrite/nitrate levels and protein nitrosylation products may be elevated in OSA. $ONOO^-$ formation exacerbates vascular dysfunction by reducing endothelial NO bioavailability (29). Furthermore, nitrosative stress is implicated in the pathogenesis of cardiometabolic comorbidities.

Most of these biomarkers correlate with OSA severity, IH severity, and CPAP compliance. However, their clinical use has not yet been standardized due to differences in measurement methods, biomarker stability, and heterogeneity in study designs.

Table 1 summarizes the main oxidative stress biomarkers used in OSA studies, their measurement methods, and their clinical correlations.

Table 1. Oxidative stress biomarkers commonly used in obstructive sleep apnea.

Biomarker	Measurement method	Clinical correlation
MDA	TBARS method	Lipid peroxidation indicator; correlates with OSA severity
4-HNE	ELISA/GC-MS	Lipid oxidation product
8-OHdG	HPLC/ELISA	DNA oxidation indicator; correlates with apnea-hypopnea index
Protein carbonyl	DNPH method	Protein oxidation
TAC	Spectrophotometric tests	Total antioxidant capacity
SOD, GPx, catalase activities	Enzymatic analyses	Antioxidant defense

4-HNE: 4-hydroxynonenal, 8-OHdG: 8-hydroxy-2′-deoxyguanosine, DNPH: 2,4-dinitrophenylhydrazine, ELISA: Enzyme-linked immunosorbent assay, GC-MS: Gas chromatography-mass spectrometry, GPx: Glutathione peroxidase, HPLC: High-performance liquid chromatography, MDA: Malondialdehyde, OSA: Obstructive sleep apnea, SOD: Superoxide dismutase, TAC: Total antioxidant capacity, TBARS: Thiobarbituric acid reactive substances.

Clinical Effects: Vascular and Metabolic Outcomes

Oxidative stress in OSA leads to multifaceted systemic damage through the ROS increase triggered by IH, endothelial dysfunction, and inflammatory activation. This pathophysiological cascade leads to significant clinical consequences affecting the cardiovascular, metabolic, and neurological systems.

Cardiovascular Effects

Oxidative stress associated with OSA is one of the key determinants of vascular dysfunction, along with increased vascular tone, decreased endothelial NO bioavailability, and increased proinflammatory cytokines (30). Reactive species such as $O_2^{\bullet-}$ and $ONOO^-$ further reduce NO production by inducing endothelial NO synthase "uncoupling." This results in decreased vasodilation capacity, increased arterial stiffness, and elevated blood pressure (31).

Furthermore, lipid peroxidation and endothelial activation accelerate the formation and progression of atherosclerotic plaques. Platelet activation and hyperaggregability are other common oxidative stress-related changes in OSA that increase the risk of cardiovascular events (32).

Metabolic Consequences

Oxidative stress impairs the IRS-1 and PI3K/Akt pathways, which are critical for insulin signaling. This increases insulin resistance by reducing glucose uptake in muscle and adipose tissue (33). Furthermore, increased free fatty acid levels, lipolysis activation, and accelerated steatogenic processes in the liver exacerbate the adverse effects of OSA on metabolic syndrome components. In untreated OSA, chronic inflammation, adipokine dysregulation (particularly increased leptin and decreased adiponectin), and ongoing oxidative damage significantly raise the risk of type 2 diabetes (34).

Neurological Effects

Oxidative stress caused by IH compromises neural integrity through mitochondrial dysfunction, glial cell activation, and neuroinflammation. Both animal and human studies have demonstrated structural and functional impairments, particularly in the hippocampus and prefrontal cortex regions. These changes are associated with deficits in attention, memory, and executive function. Furthermore, oxidative stress has been linked to a reduction in neuronal connectivity and a decrease in hippocampal neurogenesis rate. This is one of the key findings explaining the neurobiological basis of OSA's cognitive effects (35).

These multidimensional effects of OSA demonstrate that oxidative stress serves as both a trigger and perpetuator of systemic pathology. Therefore, oxidative stress markers are considered valuable tools not only for understanding pathophysiology but also for monitoring treatment response.

Treatment Effects and Antioxidant Strategies

Continuous Positive Airway Pressure and Oxidative Stress

CPAP is the standard treatment for OSA and reduces the oxidative stress load by preventing IH. Following CPAP therapy, a decrease in ROS production, an increase in NO bioavailability, and a marked improvement in endothelial function have been reported. These clinical benefits are supported by improvements in flow-mediated dilation, increased circulating NO levels, and decreased lipid peroxidation markers (36).

When evaluated in terms of oxidative stress markers, studies have shown significant decreases in parameters such as MDA, thiobarbituric acid reactive substances, advanced oxidation protein products, 8-OHdG, and TAC following CPAP treatment. However, the magnitude of this effect varies across studies; while no significant reduction was observed in some studies, most demonstrated moderate improvement (37).

The main reasons for this variability are as follows:

- **Treatment Duration:** CPAP therapy lasting eight weeks or longer yields more pronounced improvements in biomarkers compared to shorter-term applications (1).
- **Patient Compliance:** The reduction in oxidative stress is directly correlated with the duration of nighttime usage. Thus, the therapeutic effect is limited in patients with low compliance (38).
- **Biomarker Diversity:** The biochemical markers used in studies vary and may exhibit different sensitivities to CPAP therapy (39).
- **Comorbid Conditions:** Factors such as obesity, metabolic syndrome, diabetes, and smoking independently modulate oxidative stress levels, leading to heterogeneity in the CPAP response (40).

Overall, the literature supports the beneficial impact of CPAP on oxidative stress and inflammation. However, considering the methodological differences, biomarker diversity, and compliance variability, there remains a need for long-term studies utilizing standardized biomarker panels in highly compliant cohorts to more clearly characterize the oxidative stress response to CPAP (41).

Surgery and Oral Appliances

Upper airway surgeries and mandibular advancement appliances may indirectly reduce oxidative load by decreasing apnea severity. However, data are limited, and more studies are needed to determine the long-term effects.

Pharmacological and Nutrition-Based Antioxidant Approaches

Pharmacological approaches targeting oxidative stress in OSA include antioxidant vitamins (C and E), coenzyme Q10, N-acetylcysteine, and melatonin. These agents can reduce ROS production at the cellular level, limit lipid peroxidation and DNA damage, and upregulate antioxidant enzyme activities.

In animal models, N-acetylcysteine or melatonin administration in mice exposed to IH has been shown to decrease mitochondrial ROS production and partially preserve endothelial function (42). Small-scale human studies corroborate these findings. For example, short-term vitamin C and E supplementation has been associated with decreased serum MDA and 8-OHdG levels in OSA patients (43).

However, current clinical evidence remains limited, as most studies have been small, short-term, and conducted in heterogeneous populations. Large-scale, randomized controlled trials are scarce, and the effect of antioxidant therapy on the clinical outcomes of OSA, particularly cardiovascular events, insulin resistance, or neurological dysfunction, is unclear (44). Furthermore, it is not clearly established whether the combination of antioxidants with CPAP therapy provides additional benefit.

In summary, while antioxidant agents have the potential to modulate oxidative stress associated with OSA, these therapies have not yet been incorporated into standard treatment protocols. More extensive clinical studies are needed to assess their long-term efficacy and safety.

Lifestyle Interventions

Weight loss, regular exercise, and smoking cessation are important lifestyle interventions in OSA management that reduce both IH frequency and oxidative stress. Weight loss, particularly in obese patients, reduces the severity of OSA by decreasing the structural load on the upper airway and reducing ROS production caused by IH. In clinical studies, weight loss of approximately 10–15 kg has been associated with a significant decrease in the frequency of hypoxic episodes and reductions in oxidative stress biomarkers such as serum/plasma MDA and 8-OHdG (45).

Regular aerobic exercise is also beneficial in terms of modulating oxidative stress. Exercise improves vascular function and enhances cellular defenses against ROS by upregulating antioxidant enzyme activities. Additionally, smoking cessation may reduce cardiovascular risks associated with OSA by decreasing both systemic inflammation and oxidative load (46).

In summary, lifestyle interventions offer effective and low-risk strategies for reducing OSA severity and modulating oxidative stress. When combined with pharmacological or device therapies, these approaches may enhance clinical benefit.

Experimental Evidence: Animal Models and Cellular Studies

Animal studies using IH models provide important insights into the oxidative stress mechanisms and vascular-structural changes associated with OSA. In these models, IH has been shown to trigger NOX activation, mitochondrial dysfunction, endothelial dysfunction, and increased systolic blood pressure (3). For example, exposure to IH in mice has been found to increase $O_2^{\bullet -}$ production, decrease SOD and glutathione levels, and impair vascular smooth muscle tone (47).

Cell culture experiments also support these mechanisms. When repeated oxygen deprivation is applied to endothelial cells, ROS production increases, NF-κB activation is triggered, and the expression of proinflammatory cytokines (TNF-α, IL-6, and IL-1β) rises (48). This indicates that IH contributes to vascular damage by simultaneously activating inflammatory and oxidative pathways. Findings from animal and *in vitro* models parallel the clinical oxidative stress and vascular complications seen in OSA. Therefore, these models are critical for understanding pathophysiology and testing new treatment strategies.

Implications from Clinical Studies and Evaluation of Evidence

Current human studies consist mostly of prospective, small-scale randomized controlled trials or cross-sectional analyses. Heterogeneous study populations, different biomarker measurement methods, and variability in CPAP compliance limit the comparability of the results obtained (49). However, the general trend in the literature indicates that oxidative stress markers increase with OSA severity, and partial improvement is observed with CPAP therapy (37).

Several critical points regarding study design emerge in the clinical and biomarker-based assessment of oxidative stress in OSA:

Standardized Biomarker Panels: The combined assessment of parameters such as MDA, 8-OHdG, F2-isoprostanes, TAC, SOD, and GPx activities increases the comparability of data from different studies (50).

CPAP Compliance and Treatment Duration: Objective CPAP usage monitoring (e.g., via device data cards) and sufficient treatment duration (generally ≥3 months) are required for an accurate assessment of treatment efficacy (51).

Separation of Comorbidities: Isolating the effects of concomitant conditions such as obesity, type 2 diabetes, hypertension, and cardiovascular disease is crucial to understanding the direct relationship between oxidative stress and OSA.

Follow-up of Long-Term Clinical Outcomes: The correlation of cardiovascular events, mortality, or metabolic parameters with biomarker changes provides critical information for assessing the clinical significance of oxidative stress and treatment responses (51).

This approach will both enhance methodological standardization in future studies and more clearly elucidate the clinical significance of OSA-related oxidative stress.

Recommendations for Future Studies

While current knowledge on oxidative stress associated with OSA and IH is substantial, many questions remain unanswered. The following recommendations are proposed to guide future research and provide clearer, more comparable data:

Large-Scale, Randomized Controlled Trials: The effectiveness of antioxidant agents (e.g., vitamins C and E, coenzyme Q10, N-acetylcysteine, melatonin) and other pharmacological interventions on OSA-related oxidative stress biomarkers and clinical outcomes (cardiovascular events, neurological function, mortality) should be evaluated.

Investigation of Genetic and Epigenetic Markers: Responses to IH and oxidative stress levels vary considerably among individuals. The role of genetic polymorphisms and epigenetic modifications in this variability warrants investigation. In particular, the effects of Nrf2, SOD, and NOX genes and miRNA profiles can be investigated.

Implementation of Standardized Biomarker Panels: Multicenter cohort studies using standardized protocols for the measurement of biomarkers such as MDA, 8-OHdG, F2-isoprostanes, TAC, SOD, and GPx will enable the collection of comparable data across different populations.

Personalized Medicine and Biomarker-Based Treatment Strategies: Given the heterogeneous nature of OSA, personalized treatment algorithms based on the individual's oxidative stress profile should be developed. This approach can optimize combinations of CPAP, lifestyle interventions, and surgical or pharmacological antioxidant treatments.

These recommendations will contribute to a better understanding of OSA-related oxidative stress pathophysiology and facilitate the development of targeted clinical management strategies.

Study Limitations

Despite providing a comprehensive overview of the role of oxidative stress in the pathogenesis of OSA, several limitations should be acknowledged. First, as a narrative review, the present study relies on previously published literature, which may introduce selection bias depending on the availability and scope of existing studies. The heterogeneity of the included studies in terms of study design, sample size, patient characteristics, and methodological approaches may also limit the generalizability of the conclusions.

Second, oxidative stress biomarkers such as MDA, SOD, and GPx are measured using different analytical techniques across studies, which may lead to variability in reported results and complicate direct comparisons between studies. Additionally, variations in OSA severity, the presence of comorbid conditions, and differences in treatment status (particularly the use of CPAP therapy) may influence oxidative stress parameters and contribute to inconsistent findings.

Another limitation is the scarcity of longitudinal and large-scale clinical studies examining the causal relationship between oxidative stress pathways and disease progression. Most available studies are cross-sectional, making it difficult to establish definitive cause–effect relationships. Furthermore, although several biomarkers of oxidative stress have been proposed, there is currently no universally accepted biomarker panel for routine clinical assessment in patients with OSA.

Finally, this review primarily focuses on biochemical and molecular mechanisms and may not fully address all clinical, environmental, and lifestyle factors that can modulate oxidative stress. Future studies, particularly well-designed prospective clinical trials and multi-center investigations, are needed to clarify the precise role of oxidative stress biomarkers and to determine their clinical utility in the diagnosis, prognosis, and therapeutic monitoring of patients with OSA.

Conclusion

OSA increases mitochondrial and enzyme-derived ROS production through IH and sleep disruptions, while simultaneously weakening antioxidant defense mechanisms (8-52). This increased oxidative stress load drives the development of OSA-related morbidities such as vascular dysfunction, systemic inflammation, metabolic disorders, insulin resistance, and cardiovascular complications (30-53).

CPAP therapy can reduce ROS production by decreasing IH and sleep fragmentation, improve endothelial function, and partially improve certain biomarkers (e.g., MDA, 8-OHdG, TAC) (37-54). Similarly, lifestyle interventions such as weight loss, regular exercise, and smoking cessation can reduce both OSA severity and the oxidative burden (55).

However, the efficacy of antioxidant pharmacotherapies (e.g., vitamins C and E, N-acetylcysteine, coenzyme Q10, and melatonin) on oxidative stress and clinical outcomes associated with OSA has not yet been confirmed by robust, large-scale randomized controlled trials beyond the current small-scale studies (56). Therefore, antioxidant approaches remain experimental and have not yet been incorporated into standard treatment protocols in clinical practice.

In summary, the relationship between OSA and oxidative stress is fundamentally characterized by IH-induced increases in ROS and compromised antioxidant defenses. While CPAP therapy and lifestyle interventions can reduce this burden, further high-quality studies are needed to determine the clinical benefit of pharmacological antioxidant treatments.

Footnotes

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Investigating the Quality of Sleep and the Prevalence of Insomnia Among Adolescents with Self-Injury and Suicidal Behaviors

Kendine Zarar Verme ve İntihar Davranışları Gösteren Ergenlerde Uyku Kalitesinin ve Uykusuzluğun Yaygınlığının Araştırılması

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Abstract

Objective: Sleep disorders and insomnia are major health problems that significantly impact mental health, quality of life, and risky behaviors such as self-harm in adolescents. This study aimed to investigate sleep quality, insomnia severity, and demographic and clinical factors affecting sleep quality among adolescents in Kerman, Iran.

Materials and Methods: In 2023, 80 adolescents aged 12—20 years with self-harming behaviors were recruited from the psychiatry and counseling centers of Kerman University of Medical Sciences. Data were collected using the Pittsburgh Sleep Quality Index and Insomnia Severity Index questionnaires, structured interviews, and self-report questionnaires. The questionnaires were scored using standardized rules, and various statistical tests were used in the analysis.

Results: The mean age of the participants was 16.36, and 56.2% were male. Poor sleep quality was detected in 96.25% of adolescents. Insomnia severity was determined as mild (13.75%), moderate (23.75%), severe (40%), and very severe (22.5%). A significant negative correlation was found between age and insomnia severity, with poorer sleep quality in males. Insomnia severity was higher in those with higher education levels and sleep quality was significantly lower in those with chronic illnesses. Associations were also found between a history of hospitalization and substance abuse.

Conclusion: In conclusion, factors such as age, gender, education, chronic illness, and harmful behaviors were shown to play significant roles in sleep quality and insomnia severity in adolescents. The importance of multidimensional interventions (cognitive-behavioral therapy for insomnia, stress management, and sleep hygiene education) is emphasized.

Keywords: Sleep disorders, insomnia, sleep quality, adolescents, self-harm

Öz

Amaç: Uyku bozuklukları ve uykusuzluk, ergenlerde ruh sağlığını, yaşam kalitesini ve kendine zarar verme gibi riskli davranışları önemli ölçüde etkileyen önemli sağlık sorunlarıdır. Bu çalışma, İran'ın Kerman kentindeki ergenlerde uyku kalitesini, uykusuzluk şiddetini ve bunu etkileyen demografik ve klinik faktörleri araştırmayı amaçlamaktadır.

Gereç ve Yöntem: 2023 yılında, Kerman Tıp Bilimleri Üniversitesi psikiyatri ve danışmanlık merkezlerinden kendine zarar verme davranışları gösteren 12—20 yaş arası 80 ergen çalışmaya dahil edilmiştir. Veriler, Pittsburgh Uyku Kalitesi İndeksi ve Uykusuzluk şiddeti Uykusuzluk Şiddeti İndeksi anketleri, yapılandırılmış görüşmeler ve öz bildirim anketleri kullanılarak toplanmıştır. Anketler standart kurallara göre puanlanmış ve analizde çeşitli istatistiksel testler kullanılmıştır.

Bulgular: Katılımcıların yaş ortalaması 16,36 olup, %56,2'si erkektir. Ergenlerin %96,25'inde kötü uyku kalitesi tespit edilmiştir. Uykusuzluk şiddeti sırasıyla hafif (%13,75), orta (%23,75), şiddetli (%40) ve çok şiddetli (%22,5) olarak belirlendi. Yaş ve uykusuzluk şiddeti arasında anlamlı negatif korelasyon bulundu ve erkeklerde uyku kalitesi daha düşüktü. Uykusuzluk şiddeti, eğitim seviyesi yüksek olanlarda daha yüksek, kronik hastalığı olanlarda ise uyku kalitesi anlamlı derecede düşüktü. Ayrıca, hastaneye yatış ve madde bağımlılığı öyküsü ile de ilişki bulundu.

Sonuç: Sonuç olarak, yaş, cinsiyet, eğitim, kronik hastalık ve zararlı davranışlar gibi faktörlerin ergenlerde uyku kalitesi ve uykusuzluk şiddetinde önemli rol oynadığı gösterilmiştir. Çok boyutlu müdahalelerin (bilişsel davranışçı terapi - uykusuzluk, stres yönetimi ve uyku hijyeni eğitimi) önemi vurgulanmaktadır.

Anahtar Kelimeler: Uyku bozuklukları, uykusuzluk, uyku kalitesi, ergenler, kendine zarar verme

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Introduction

Sleep is a highly complex process that goes beyond simply closing one's eyes and plays a fundamental role in physical and mental health. It is defined as an active, unconscious state in which the brain is relatively at rest and primarily responds to internal stimuli. Although the exact purpose of sleep has not been fully elucidated, several theories, including the inactivity theory, energy conservation theory, restorative theory, and brain plasticity theory, have attempted to clarify its functions (1). However, none of these theories is comprehensive, reflecting the complex and not fully understood nature of sleep. Thus, it is widely accepted that no single theory explains all aspects of sleep, and a combination of these theories may provide a better explanation (2-4).

Insomnia is defined as dissatisfaction with sleep quality or quantity, encompassing difficulties in falling asleep, staying asleep, or waking up early in the morning, with an inability to return to sleep. According to the Diagnostic and Statistical Manual of Mental Disorders, insomnia is diagnosed as a clinical disorder when these issues cause significant distress or impairment in daily functioning (5,6). Insomnia is one of the most prevalent sleep disorders globally, affecting 10–30% of the general population, with rates reaching 50–60% in certain groups, such as the elderly and those with chronic illnesses (7). In Iran, the prevalence of insomnia ranges between 28% and 42% across different age and social groups (8).

Poor sleep quality in adolescents is linked to declining academic performance, reduced concentration, behavioral issues, and emotional problems such as anxiety and depression (9). A critical and alarming consequence of insomnia in this population is the increased risk of self-harm and suicidal behavior (10). Multiple studies have demonstrated that adolescents with insomnia have higher suicidal ideation and are more prone to engage in self-injurious behaviors. Sleep disturbances impair emotional regulation, increase impulsivity, and disrupt cognitive function, all factors contributing to suicidal ideation and behaviors (9-11).

Neurobiological research suggests that chronic sleep deprivation alters stress response systems, increases inflammatory markers, and affects neurotransmitter balance, potentially creating a biological pathway for suicidal thoughts (12,13). Suicide is a major public health concern worldwide and a leading cause of death, particularly among the youth. Given these considerations, investigating the relationship between sleep quality and self-harm in adolescents is crucial (14-16).

This study aimed to investigate sleep quality and insomnia prevalence among adolescents with self-injurious and suicidal behaviors admitted to Shahid Beheshti Hospital in Kerman, providing insights for targeted interventions and preventive strategies.

Materials and Methods

Research Setting, Population, and Sample Size

In 2023, 80 adolescents aged 12 to 20 years, presenting with self-injurious behaviors and suicidal ideation, were recruited from the psychiatry and counseling centers of the Kerman University of Medical Sciences. Inclusion criteria included age between 12 and 20 years, documented self-harm or suicidal behavior within the previous six months, and ability to provide informed consent. The exclusion criteria were severe cognitive impairment, psychotic disorders, and current use of medications affecting sleep quality.

Inclusion and Exclusion Criteria

Inclusion criteria were adolescents aged 12–19 years presenting with non-suicidal self-injury or suicide attempts, willingness to participate, obtaining written informed consent from parents or legal guardians, verbal assent from adolescents, and ability to complete the questionnaires. Exclusion criteria included failure to obtain informed consent; presence of severe physical or psychiatric conditions (e.g., active psychosis, severe intellectual disability, or acute intoxication) impairing participation; use of psychotropic or sleep-altering medications not stabilized for at least one month; a current primary diagnosis of severe substance use disorder that would confound sleep assessment); withdrawal from the study at any point; cognitive impairments or neurological disorders that interfered with comprehension or completion of the questionnaires; and incomplete or unreliable responses.

Ethical Considerations

The study protocol was approved by the Research Ethics Committee of Kerman University of Medical Sciences (approval code: 402000337/IR.KMU.AH.REC.1402.104, date: 02.08.2025). The research was conducted in 2023, and ethics approval was obtained retrospectively in 2025. Participation was voluntary, and all participants and their legal guardians were fully informed about the study's objectives and procedures. Written informed consent was obtained from the guardians of all participants. Confidence in personal information was maintained throughout the study by assigning each participant a code. Participation was voluntary, and individuals were free to withdraw at any time. In case of significant psychological concerns identified during the assessment, participants were referred for further psychiatric evaluation.

Method and Tools of Data Collection

Three tools were used for data collection. First, a Demographic and Clinical History Checklist was used, which collected data on age, gender, education, physical and mental health history, past sleep patterns, and medication use. The second was the Pittsburgh Sleep Quality Index (PSQI), a validated 19-item questionnaire assessing sleep quality over the past month across seven domains. Scores ranged from 0 to 21, with scores higher than 5 indicating poor sleep quality. The Persian version of the PSQI has demonstrated good reliability (Cronbach's alpha: 0.78) (17). We also used the Insomnia Severity Index (ISI), a 7-item scale evaluating insomnia symptoms, including difficulty falling asleep, difficulty staying asleep, early morning awakenings, dissatisfaction with sleep, and their impact on daily functioning. The scores ranged from 0 to 28 and were categorized into four levels: mild (0–7), moderate (8–14), severe (15–21), and very severe (22–28). The Persian version has shown good reliability (18,19).

After obtaining consent, the participants completed the questionnaires in a quiet, distraction-free environment. For those unable to complete the forms independently, a trained researcher conducted face-to-face interviews. Each session lasted for approximately 30–45 minutes. Data were checked daily for completeness and accuracy, entered into a secure database, and double-entered by two independent researchers for validation.

Statistical Analysis

Data were entered into SPSS version 27 and Python statistical libraries by two independent researchers to minimize entry errors. Descriptive statistics were used to summarize the demographic and clinical data. Inferential statistical methods, such as t-tests, chi-square tests, Firth logistic regression (due to high prevalence of the outcome), and pathway analysis, were used to assess the relationships between sleep patterns and suicidal behaviors. The significance level was set at $p < 0.05$.

Results

In this study, 80 participants were included, with a mean age of 16.36 ± 1.90 years. Boys comprised 56.2% of the sample, while girls accounted for 43.8%. Most participants were in the first stage of secondary school (71.2%) and lived in a private home with their family. A history of addiction was reported by 67.5% of the participants, and 63.7% had parents with a history of addiction. All participants had consumed tea or coffee and a high proportion (77.5%) had a history of psychiatric problems. Additionally, 23.8% of participants reported underlying medical conditions. Among the self-harm methods, wrist cutting (36.25%) was the most frequently observed (Table 1).

The PSQI and ISI were used to assess the sleep patterns. The median subjective sleep quality score was 3 [interquartile range (IQR), 2–3], indicating poor perceived sleep quality. The mean score for sleep onset delay was 2.05 ± 0.90, reflecting a prolonged time to fall asleep. Sleep duration had a median of 1 (IQR, 0–2), while sleep efficiency was extremely low (median, 0; IQR, 0–0). Sleep disturbances were notable (mean 1.71 ± 0.62), and the use of sleep medications was minimal (median 0, IQR 0–3). Daytime dysfunction was also common (median, 2.50; IQR, 2–3). The overall PSQI score was 11.03 ± 3.15, with 96.25% (77) of participants exhibiting poor sleep quality. The overall ISI score was 16.60±5.72, with 40% (32) having severe insomnia, 23.75% (19) moderate, 22.5% (18) very severe, and 13.75% (11) mild insomnia.

Analysis by age showed no significant differences in sleep quality ($p = 0.385$) or overall insomnia severity ($p = 0.23$). Moderate insomnia, however, was more prevalent in the 19–20 years age group ($p = 0.033$).

Gender did not significantly influence overall sleep quality ($p = 0.335$), although mild insomnia was more common among girls ($p < 0.001$) and moderate insomnia was more common in boys ($p < 0.001$). No significant differences were observed for severe or very severe insomnia between genders. Regarding education level, the prevalence of sleep quality disorders was similar ($p = 0.637$); mild insomnia was more frequent among high school students ($p = 0.017$), and severe insomnia was more frequent among middle school students ($p = 0.018$) (Table 2).

When considering clinical characteristics, participants' history of addiction did not significantly affect sleep quality ($p = 0.551$), although mild insomnia was more prevalent among those without a history of addiction ($p = 0.007$). Parental addiction did not affect overall sleep quality ($p = 0.084$); however, mild insomnia was more frequent among participants whose parents did not have a history of addiction ($p < 0.001$) (Table 3).

A history of psychiatric disorders did not significantly influence overall sleep quality ($p = 0.805$); however, moderate insomnia was more common among participants with a history of psychiatric disorders ($p = 0.018$), whereas severe insomnia was more prevalent in those without such a history ($p = 0.019$). Sleep quality was also not significantly associated with hospitalization history ($p = 0.295$), although mild insomnia occurred more frequently among participants without a hospitalization history ($p = 0.003$) (Table 4).

The mechanism of self-harm did not significantly influence overall sleep quality ($p = 0.139$). However, moderate insomnia was significantly associated with wrist cutting ($p = 0.005$), whereas no significant differences were found for severe or very severe insomnia across different self-harm mechanisms (Table 5).

Correlation analyses revealed no significant relationship between age and the total PSQI score (r: 0.08, $p = 0.538$), whereas age was negatively correlated with the total ISI score (r: -0.52, $p < 0.001$), indicating that insomnia severity decreased with increasing age. No significant correlation was observed between the total PSQI and ISI scores (r: 0.1, $p = 0.42$).

Results from the Firth Logistic Regression Model indicated that age, gender, education level, personal or parental addiction history, hospitalization, medication consumption, and self-harm mechanism did not significantly affect the odds of experiencing a sleep quality disorder (all $p > 0.05$) (Table 6).

Pathway analysis showed that age had a positive direct effect on PSQI (0.60), with a negligible indirect effect via ISI (0.02), resulting in a total effect of 0.62. Male gender had a negative direct effect on PSQI (-4.16) and an indirect effect through ISI (1.21), yielding a total effect of -2.95, indicating overall poorer sleep quality in males. Higher education level had a minor negative total effect on PSQI (-0.66), which was partially mediated by insomnia severity. Underlying medical conditions had a strong negative direct effect (-4.58) on PSQI, with a mediating indirect effect (3.18), producing a total effect of -1.40, suggesting that insomnia severity partially mitigated the negative impact of underlying diseases on sleep quality (Figure 1).

Discussion

This study demonstrated a high prevalence of poor sleep quality and insomnia among adolescents with self-harm and suicidal behaviors. These findings align with previous literature indicating that sleep disturbances are closely associated with emotional dysregulation, impulsivity, and increased risk of self-injury (20). The significant negative correlation between age and insomnia severity suggests that younger adolescents may experience more severe sleep difficulties, which may exacerbate mental health challenges. This finding suggests that age may be a protective factor against insomnia in this age group. This relationship appears to be linked to developmental changes, cognitive and behavioral maturation, and improved emotion-regulation abilities in older adolescents. With age, adolescents may develop better skills for managing stress and anxiety, and adopt healthy sleep habits, which may contribute to improved sleep quality. Similar results have been reported previously. For example, Shi et al. (21) demonstrated that as adolescents age, sleep patterns tend to stabilize and insomnia severity decreases. Their study highlighted the role of neural structural development, particularly in emotion-regulating regions such as the prefrontal cortex and amygdala, in this improvement. Furthermore, Casement et al. (22) explained that central nervous system maturation and improved stress response regulation might reduce the impact of stressors on sleep in older adolescents. Enhanced circadian rhythms and reduced sensitivity to sleep-disrupting factors may also play a role. Pathophysiologically, the efficiency of negative feedback mechanisms in the hypothalamic-pituitary-adrenal (HPA) axis improves with age, leading to reduced stress responses. This improvement may help adolescents avoid sleep disturbances when facing daily stressors and anxieties (23). Additionally, hormonal changes associated with puberty, such as gradual declines in melatonin levels at certain times of the day, may contribute to better sleep-wake cycle regulation and reduced insomnia in older adolescents (24). However, some studies have reported conflicting findings. For instance, Yuksel et al. (24) found that increasing age in some adolescents may be associated with heightened academic pressure, social stressors, and greater responsibilities, which could disrupt sleep. These discrepancies may stem from cultural differences, social structures, sleep assessment methods, or study samples. Overall, the findings of the present study align with a significant portion

Table 1. Distribution of demographic and clinical characteristics of participants in the study.

Variable		**Frequency (percentage)**
Gender	Boys	45 (56.2%)
	Girls	35 (43.8%)
Education level	First stage of secondary school	57 (71.2%)
	Second stage of secondary school	23 (28.7%)
Residence	Personal home with family	44 (55.0%)
	Rental home with family	30 (37.5%)
	Dormitory	3 (3.8%)
	Rental home with roommates	3 (3.8%)
Addiction in participants	Yes	54 (67.5%)
	No	26 (32.5%)
Addiction in parents	Yes	51 (63.7%)
	No	29 (36.2%)
Tea or coffee consumption	Yes	80 (100.0%)
	No	0 (0%)
History of psychiatric problems in participants	Yes	62 (77.5%)
	No	18 (22.5%)
History of underlying medical conditions in participants	Yes	61 (76.2%)
	No	19 (23.8%)
Hospitalization history in participants	Yes	43 (53.8%)
	No	37 (46.2%)
Drug consumption in participants	Yes	44 (55.0%)
	No	36 (45.0%)
Self-harm method	Wrist cutting	29 (36.25%)
	Self-inflicted wounds on other parts of the body	4 (5%)
	Pill ingestion	9 (11.25%)
	Combination of pill ingestion and self-inflicted wounds	15 (18.75%)
	Head trauma	9 (11.25%)
	Unspecified	14 (17.5%)

of prior research and suggest that increasing age may be associated with improved sleep quality and reduced insomnia severity. This relationship is likely mediated by a combination of psychological, neurological, and hormonal factors occurring during adolescent development.

Gender differences in sleep quality and insomnia patterns were observed, consistent with existing research showing higher insomnia prevalence in females but poorer subjective sleep quality in males (25). Latina et al. (9) also reported that adolescent girls, due to greater vulnerability to stress and anxiety, exhibit more disrupted and prolonged sleep patterns than boys. These factors may contribute to the higher prevalence of mild insomnia in girls. Pathophysiologically, sex differences in cortisol and melatonin secretion may explain these findings. Studies suggest that girls are more sensitive to hormonal fluctuations related to the menstrual cycle, which can disrupt sleep-wake rhythms (26). Additionally, adolescent girls often experience greater psychosocial stressors and exhibit heightened sensitivity to these factors, potentially leading to persistent but milder insomnia (27). In contrast, among boys, environmental and behavioral factors, such as greater pre-sleep digital device use and irregular sleep patterns, may explain the higher prevalence of moderate insomnia (28). However, some studies have noted that gender alone may not be a strong independent predictor of insomnia, with mediating factors such as mental health, sleep habits, and social stressors playing significant roles (29). In summary, the findings of this study align with much of the existing literature, indicating that insomnia patterns differ between adolescent boys and girls and may be influenced by psychological, biological, and social factors.

Higher education levels were paradoxically linked to increased insomnia severity, possibly reflecting academic stress, although further investigation is warranted. Chronic medical conditions and a history of hospitalization were strongly associated with worse sleep outcomes, likely reflecting the bidirectional relationship between physical and mental health. Previous studies have reported similar findings. Liu et al. (30) demonstrated in a longitudinal study that students with higher academic levels may experience insomnia symptoms due to academic pressures and performance expectations. These pressures include prolonged study hours, exam stress, and reduced sleep time. Shi et al. (21) also noted that daytime fatigue from sleep deprivation and insomnia can negatively impact academic performance, creating a vicious cycle of academic stress and poor sleep. Pathophysiologically, academic stress may disrupt the HPA axis and chronically elevate cortisol

Table 2. Comparison of the frequency of sleep quality disorders and different insomnia severities by age, gender and education level.

Variables		Sleep quality		Insomnia severity			
		Sleep disturbance	Good sleep quality	Mild insomnia	Moderate insomnia	Severe insomnia	Very severe insomnia
Age groups	12-14 years	13 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	7 (53.8%)	6 (46.2%)
	15-16 years	19 (100.0%)	0 (0.0%)	4 (21.1%)	3 (15.8%)	6 (31.6%)	6 (31.6%)
	17-18 years	36 (92.3%)	3 (7.7%)	7 17.9%	13 (33.3%)	13 (33.3%)	6 (15.4%)
	19-20 years	6 100.0%	0 (0.0%)	0 (0.0%)	3 (50.0%)	3 (50.0%)	0 (0.0%)
	p-value	0.385		0.23	0.033	0.484	0.053
Gender	Boys	42 (93.3%)	3 (6.7%)	0 (0.0%)	19 (42.2%)	17 (37.8%)	9 (20.0%)
	Girls	35 (100.0%)	0 (0.0%)	11 (31.4%)	0 (0.0%)	15 (42.9%)	9 (25.7%)
	p-value	0.335		< 0.001	< 0.001	0.818	0.736
Education level	First stage of secondary school	54 (94.7%)	3 (5.3%)	4 (7.0%)	13 (22.8%)	28 (49.1%)	12 (21.1%)
	Second stage of secondary school	23 (100.0%)	0 (0.0%)	7 (30.4%)	6 (26.1%)	4 (17.4%)	6 (26.1%)
	p-value	0.637		0.017	0.983	0.018	0.848

Table 3. Comparison of sleep quality disorder and various insomnia severity levels based on personal and parental history of addiction.

Variable		Sleep quality		Insomnia severity			
		Sleep disturbance	Good sleep quality	Mild insomnia	Moderate insomnia	Severe insomnia	Very severe insomnia
History of addiction	Yes	51 (94.4%)	3 (5.6%)	3 (5.6%)	16 (29.6%)	23 (42.6%)	12 (22.2%)
	No	26 (100.0%)	0 (0.0%)	8 (30.8%)	3 (11.5%)	9 (34.6%)	6 (23.1%)
	p-value	0.551		0.007	0.133	0.661	1
Parental addiction history	Yes	51 (100.0%)	0 (0.0%)	0 (0.0%)	16 (31.4%)	20 (39.2%)	15 (29.4%)
	No	26 (89.7%)	3 (10.3%)	11 (37.9%)	3 (10.3%)	12 (41.4%)	3 (10.3%)
	p-value	0.084		< 0.001	0.064	1	0.092

levels, a key mechanism in sleep disturbances among higher-achieving students (23). Elevated cortisol not only makes falling asleep difficult but also impairs deep, restorative sleep. Yuksel et al. (24) further found that adolescents in higher grades may experience persistent insomnia due to increased social and academic pressures. These pressures can disrupt sleep onset and maintenance through heightened stress, anxiety, and pre-sleep rumination. However, some studies have reported contradictory findings. For example, adolescents in lower grades may develop insomnia due to irregular sleep habits and excessive digital device use (31). These discrepancies may arise from cultural, educational, or social differences. Overall, the results of this study align with prior research, suggesting that education level may indirectly affect insomnia severity through academic stress and changes in sleep patterns, both of which are mediated by multiple psychological and pathophysiological factors.

The present study found that adolescents with underlying medical conditions exhibited higher insomnia severity. Path analysis confirmed a significant adverse direct effect of medical history on sleep quality, which was partially mediated by insomnia severity. Previous studies have supported this association. Yuksel et al. (24) demonstrated that adolescents with chronic conditions (e.g., asthma, diabetes, autoimmune disorders) face greater insomnia risk due to medication needs, activity limitations, and illness-related anxiety. Van Someren (23) noted that chronic diseases may disrupt sleep via biological pathways such as HPA axis dysfunction and systemic inflammation. Pro-inflammatory cytokines (e.g., interleukin-6 and tumor necrosis factor-alpha) directly impair sleep architecture. De Zambotti et al. (27) found that chronic pain from medical conditions fragments sleep patterns, increasing nighttime awakenings. Psychologically, adolescents with chronic illnesses may experience sleep difficulties due to health-related worries and pre-sleep rumination (32). However, not all chronic conditions affect sleep equally; well-controlled diseases (e.g., mild asthma) may be associated with lower insomnia severity (33,34). Collectively, these findings indicate that medical conditions influence insomnia through physiological and psychological pathways, highlighting the need for symptom management and stress reduction interventions.

The present study found that mild insomnia severity was significantly higher among adolescents without prior hospitalization than among those hospitalized. Other insomnia levels and sleep quality did not differ significantly between the groups. This suggests that hospitalization during adolescence may have long-term sleep-disrupting effects. Previous studies have supported this relationship. Uccella et al. (34) found hospitalized adolescents face greater insomnia risk due to hospitalization-related stress, negative hospital experiences, and circadian disruption. Hom et al. (35) noted that repeated hospitalizations may trigger post-traumatic anxiety, directly impairing sleep through intrusive pre-sleep thoughts. Pathophysiologically, frequent hospitalizations may chronically elevate cortisol levels and alter HPA axis activity, disrupting normal sleep initiation and maintenance (36). Hospital environments (e.g., artificial lighting, medical equipment noise, and staff interruptions) also

Table 4. Comparison of sleep quality disorder and various insomnia severity levels based on history of psychiatric disorders, chronic underlying diseases, and hospitalization.

Variable		Sleep quality		Insomnia severity			
		Sleep disturbance	Good sleep quality	Mild insomnia	Moderate insomnia	Severe insomnia	Very severe insomnia
Psychiatric disorder history	Yes	59 (95.2%)	3 (4.8%)	8 (12.9%)	19 (30.6%)	20 (32.3%)	15 (24.2%)
	No	18 (100.0%)	0 (0.0%)	3 (16.7%)	0 (0.0%)	12 (66.7%)	3 (16.7%)
	p-value	0.805		0.984	0.018	0.019	0.724
	Yes	58 (95.1%)	3 (4.9%)	8 (13.1%)	16 (26.2%)	28 (45.9%)	9 (14.8%)
	No	19 (100.0%)	0 (0.0%)	3 (15.8%)	3 (15.8%)	4 (21.1%)	9 (47.4%)
	p-value	0.769		1	0.532	0.096	0.008
Hospitalization history	Yes	37 (100.0%)	0 (0.0%)	0 (0.0%)	12 (32.4%)	19 (51.4%)	6 (16.2%)
	No	40 (93.0%)	3 (7.0%)	11 (25.6%)	7 (16.3%)	13 (30.2%)	12 (27.9%)
	p-value	0.295		0.003	0.153	0.09	0.327

Table 5. Frequency of sleep quality disorders and different levels of insomnia based on self-harm mechanism.

Variables	Sleep quality		Insomnia severity			
	Sleep disturbance	Good sleep quality	Mild insomnia	Moderate insomnia	Severe insomnia	Very severe insomnia
Self-inflicted wounds on other parts of the body	4 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (100.0%)	0 (0.0%)
Wrist cutting	29 (100.0%)	0 (0.0%)	0 (0.0%)	13 (44.8%)	10 (34.5%)	6 (20.7%)
Pill ingestion	21 (87.5%)	3 (12.5%)	0 (0.0%)	3 (12.5%)	12 (50.0%)	9 (37.5%)
Head trauma	9 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (66.7%)	3 (33.3%)
p-value	0.139		-	0.005	0.052	0.312

severely disrupt sleep patterns (37). However, some studies suggest that these effects may be temporary, with social support and psychological interventions mitigating the negative impacts (38). Overall, hospitalization history may influence insomnia severity through psychological, physiological, and environmental pathways, warranting supportive interventions for affected adolescents.

The present study found that mild insomnia severity was significantly higher among adolescents without a history of substance use than among those with such a history. Other insomnia levels and sleep quality did not show significant differences. This suggests that substance use may complexly influence sleep quality and insomnia severity, mediated by factors such as substance type, duration of use, withdrawal, and psychosocial elements. Previous studies support this association. Basu et al. (39) demonstrated that substance addiction directly and indirectly disrupts sleep architecture, particularly with stimulants and alcohol, increasing nighttime awakenings and reducing sleep quality. Fernandez-Mendoza et al. (31) noted that adolescents with a substance use history exhibit elevated systemic inflammation and HPA axis hyperactivity, both sleep-disrupting factors. Pathophysiologically, addictive substances (especially opioids and stimulants) alter dopamine and serotonin levels, impairing natural sleep processes (40). Yuksel

Table 6. Firth logistic regression model to assess the impact of study variables on the odds of sleep quality disorder.

Variable		Odds ratio	95% CL (lower)	95% CL (upper)	p-value
Age (years)		2.47	0.08	75.94	0.606
Gender	Girls	1	-		0.633
	Boys	0	0	3.18E+10	
Educational level	First stage of secondary school	1	-		0.96
	Second stage of secondary school	5.47	0	2.54E+29	
Addiction	Negative	1	-		0.966
	Positive	4.27	0	9.32E+29	
Addiction in parents	Negative	1	-		0.788
	Positive	0	0	2.21E+24	
Hospitalization history	Negative	1	-		0.937
	Positive	12.65	0	2.3E+28	
Medication consumption	Negative	1	-		0.92
	Positive	27.29	0	2.93E+29	
Self-harm method	Pill ingestion		-		0.893
	Wrest cutting	0.01	0	1.71E+25	

CL: Confidence limit.

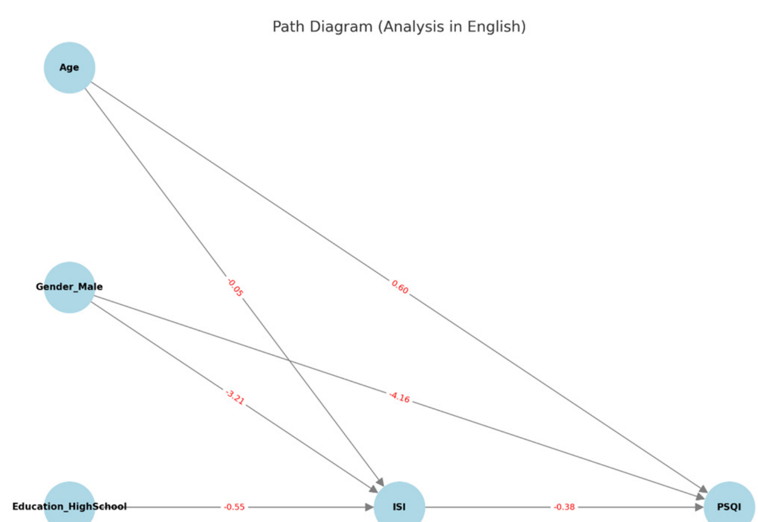

Figure 1. Pathway Analysis of the impact of the main study variables on insomnia severity and sleep quality questionnaire scores.
PSQI: Pittsburgh Sleep Quality Index, ISI: Insomnia Severity Index.

et al. (24) highlighted psychological factors, as substance-using adolescents often experience vicious cycles of anxiety, depression, and sleep disturbances. However, some insomnia symptoms may temporarily improve during withdrawal, although this improvement is often unstable (20). A history of substance use may influence the severity of insomnia through neurological, psychological, and physiological changes, necessitating integrated pharmacological and psychological interventions.

The present study found that mild insomnia severity was significantly higher among adolescents without a history of parental substance use than among those with such a history. Other insomnia levels and sleep quality did not show significant differences. This may reflect the environmental, psychological, and genetic factors linking parental substance use to adolescent sleep quality and insomnia severity. Previous studies have supported this relationship. Uccella et al. (34) explained that adolescents with substance-using parents face greater sleep problems due to chronic family stress, household instability, and adverse childhood experiences. Basu et al. (39) found that these adolescents exhibit more irregular sleep patterns and poorer sleep quality, associated with anxiety, rumination, and HPA axis hyperactivity. Pathophysiologically, chronic stress from dysfunctional family environments elevates cortisol and other stress hormones, directly disrupting sleep-wake cycles (23). Edwards et al. (41) suggested genetic predispositions may also play a role, as these adolescents may inherit greater susceptibility to insomnia. Psychologically, lack of emotional support and chronic insecurity may exacerbate insomnia, with some adolescents adopting unhealthy parental sleep habits (38). However, supportive environments and psychological interventions may mitigate these effects (42). Overall, parental substance use may influence adolescent insomnia severity through environmental, psychological, and genetic pathways, highlighting the need for family centered interventions.

The present study found that different self-harm mechanisms were associated with varying insomnia severity patterns. Adolescents using specific methods (e.g., wrist-cutting or pill ingestion) exhibited different insomnia severity levels. This suggests that self-harm mechanisms may reflect distinct psychological and pathophysiological features linked to insomnia severity. Previous studies support this association. Nguyen et al. (20) found that aggressive self-harm methods (e.g., cutting) correlate with more severe and persistent insomnia. Zhou et al. (43) identified poor sleep quality and anxiety symptoms as mediators between self-harm experiences and insomnia severity, with emotional dysregulation exacerbating sleep disturbances. Pathophysiologically, self-harm may transiently reduce stress via dopamine-driven reward system activation, but ultimately perpetuates sleep-disrupting cycles (10). Pill ingestion for self-harm may further destabilize sleep through drug side effects and metabolic changes (44). Khazaie et al. (10) emphasized the interplay between psychological (e.g., emotional regulation) and physiological (e.g., HPA axis hyperactivity) factors in the sleep-self-harm relationship. However, the self-harm mechanism alone may not predict insomnia severity, with anxiety severity, depression, and social support also playing key roles (45). Overall, different self-harm mechanisms may influence insomnia severity through distinct psychological and biological pathways, underscoring the need for tailored sleep intervention.

Study Limitations

This study adds to the literature by specifically characterizing sleep patterns in adolescents engaged in self-harm in an Iranian context, where data are limited. However, the small sample size and cross-sectional nature of this study limit causal inference. Future longitudinal and large-scale studies are needed to confirm these associations and evaluate interventions.

These findings underscore the importance of targeted sleep interventions, such as cognitive-behavioral therapy for insomnia (CBT-I), stress management techniques, and sleep hygiene education integrated within mental health services for this vulnerable population. Early identification and management of sleep problems may reduce the burden of suicidal behaviors among adolescents.

Conclusion

This study highlights the high prevalence and severity of sleep disturbances, especially insomnia, among adolescents with self-harming behaviors and suicidal ideation. Age, gender, education level, and chronic medical conditions significantly influence sleep quality and insomnia severity in this population. The findings emphasize the necessity of integrating comprehensive sleep assessments and interventions into adolescent mental health services, particularly targeting those at risk of self-injury and suicide. Evidence-based approaches, such as CBT-I, sleep hygiene education, and stress management, should be prioritized. Further research using larger sample sizes and longitudinal designs is needed to establish causal relationships and develop effective sleep-focused interventions to reduce self-harm and suicide risk in adolescents.

Ethics

Ethics Committee Approval: The study protocol was approved by the Research Ethics Committee of Kerman University of Medical Sciences (approval code: 402000337/IR.KMU.AH.REC.1402.104, date: 02.08.2025).

Informed Consent: Written informed consent was obtained from the guardians of all participants.

Footnotes

Authorship Contributions

Concept: M.Y., F.J., Design: M.Y., F.J., Data Collection or Processing: S.V.S., Analysis or Interpretation: S.V.S., Literature Search: L.S., Writing: L.S.

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Relationship Between Self-Perceived Sleep Quality, Healthy Eating, and Emotional Eating in Dance Students

Dans Öğrencilerinde Öznel Uyku Algısının Sağlıklı Beslenme ve Duygusal Yeme ile İlişkisi

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Abstract

Objective: Dance practice has been linked to eating disorders and sleep-related problems. This study examined the associations between self-perceived sleep quality, healthy eating, and emotional eating among dance students.

Materials and Methods: The sample consisted of 114 participants. The instruments used were the Pittsburgh Sleep Quality Index, the composite scale of morningness, the Healthy Eating Index (HEI) for the Spanish population, and the eating and appraisal due to emotions and stress questionnaire.

Results: Overall, 80.7% of students reported poor sleep quality, and 72.8% required dietary changes to improve their diet. Participants with poor sleep quality showed significantly higher scores on the emotional eating scale-both total and subscale scores-than those with good sleep quality. Sleep disturbances, daytime dysfunction due to poor sleep, and the presence of nightmares were all associated with emotional eating. Although the number of hours slept was not related to emotional eating, it was associated with healthy eating. No significant differences in the HEI were found based on subjective sleep quality. Finally, students with a morning chronotype exhibited better diet quality than those with an evening chronotype.

Conclusion: These findings are discussed in the context of promoting conservatories as potential healthy environments.

Keywords: Dance, sleep, chronotype, students, emotional eating, healthy diet

Öz

Amaç: Dans pratiği, yeme bozuklukları ve uyku ile ilgili sorunlarla ilişkilidir. Bu çalışma, dans öğrencileri arasında öznel uyku algısı, sağlıklı beslenme ve duygusal yeme arasındaki ilişkileri analiz etmektedir.

Gereç ve Yöntem: Çalışma grubunda 114 dans öğrencisi yer aldı. Kullanılan ölçüm araçları şunlardır: Pittsburgh Uyku Kalitesi İndeksi, sabahçıllık bileşik ölçeği, İspanyol nüfusu için Sağlıklı Beslenme İndeksi ve duygular ve stres nedeniyle yeme ve değerlendirme anketi.

Bulgular: Öğrencilerin %80,7'si düşük uyku kalitesi bildirmiştir ve %72,8'i daha sağlıklı bir diyete ulaşmak için değişiklik yapmaları gerektiğini belirtmiştir. Düşük uyku kalitesine sahip öğrenciler, toplam puan ve alt ölçeklerde duygusal yeme açısından iyi uyuyanlara göre daha yüksek puan almıştır. Uyku bozuklukları, uykudan kaynaklanan gündüz işlev bozuklukları ve kâbusların varlığı, duygusal yeme ile ilişkili bulunmuştur. Uyunan saat süresi ile duygusal yeme arasında bir ilişki bulunmazken, sağlıklı beslenme ile bir ilişki tespit edilmiştir. Öznel uyku kalitesine göre sağlıklı beslenme indeksi açısından istatistiksel olarak anlamlı bir fark bulunmamıştır. Son olarak, sabah kronotipi olan bireylerin akşam tiplerine göre daha iyi beslenme kalitesine sahip olduğu görülmüştür.

Sonuç: Sonuçlar, konservatuvarların potansiyel sağlıklı ortamlar olarak değerlendirilmesi bağlamında tartışılmıştır.

Anahtar Kelimeler: Dans, uyku, kronotip, öğrenciler, duygusal tüketim, sağlıklı beslenme

Introduction

The practice of dance has been shown to positively influence dancers' mental health and well-being (1-3). However, it also places considerable physical and cognitive demands on both students and professionals, making them susceptible to physical fatigue, pain, psychological distress, injury, and school dropout (4,5). Among the most prevalent issues associated with dance are eating disorders (6) and sleep-related problems (7-9).

Sleep is strongly linked to physical activity levels (10,11). Furthermore, for dance students, the academic demands they face can compound their sleep issues, particularly towards

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the end of the semester (9,12). In terms of sleep-related issues, it has been reported that 35% of dancers attending primary health care centers and mental health services list psychological fatigue and sleep deprivation as their primary reasons for seeking medical assistance (13). Moreover, some studies indicate that 59.5% of dance students experience poor sleep quality, affecting 62.9% of women and 42.1% of men (7).

It is important to recognize that the demanding nature of dance training and rehearsals does not allow for the maintenance of regular chronobiological patterns or a normal sleep-wake rhythm (8,9). Previous research (7) has shown that approximately half of professional ballet dancers scored above 5 on the Pittsburgh Sleep Quality Index (PSQI), indicating poor sleep quality, while 16.7% reported mean sleepiness scores exceeding the normal range.

A significant proportion of dancers experience disordered eating alongside sleep problems. When considering different dance styles, the prevalence of eating disorders has been found to range between 12% and 26.5% (14,15). In this regard, an analysis of a group of professional dance students revealed that 12% had a history of or a formal diagnosis of an eating disorde. Therefore, it appears that eating disorders are present across various dance disciplines (17).

In the field of dance, emotional eating has received limited attention despite its potential relevance, as it is often linked to compulsive eating patterns. This form of eating behavior involves food consumption driven by emotional cues-such as irritability, anxiety, or stress-as well as by external stimuli, including the smell or visual appeal of food (18). Consequently, emotional eating tends to involve excessive intake of food in response to negative emotional states, particularly anxiety, depression, and irritability (4).

Emotional eating is a common issue among individuals struggling to control their weight (19). Those who engage in emotional eating are particularly prone to consuming foods high in fat, sugar, and calories in response to negative emotional states (20). Research indicates an increased risk of developing metabolic disorders, such as diabetes and cardiovascular diseases, when emotional eating is combined with higher body weight (21,22). Similarly, these emotional eating patterns may serve as a precursor to potential binge-eating disorders, including food addiction (23). In this context, gender-related differences have been observed: in men, emotional eating is typically associated with body mass index and uncontrolled eating behaviors, whereas in women, a stronger correlation has been found with uncontrolled eating, anxiety, and poor sleep quality (24).

Research in the field of dance has not only focused on eating behavior disorders (14-16). but has also explored the energy requirements and sources necessary to achieve a healthy and optimal performance in ballet (25). In this regard, food consumption as an indicator of diet quality and a determinant of dancers' nutritional health has not received the attention it may require. Additionally, an association has been recognized between the intake of specific nutrients and an increased risk of developing diseases (26) or conversely, their potential protective effects (27).

The literature describes various methodologies for assessing overall dietary quality in individuals. Among these, evaluation systems such as the Diet Quality Index, the Diet Quality Index (28,29), and the Healthy Eating Index (HEI) (30,31) have been widely established. Specifically, the North American HEI (32) has been adapted for the Spanish population as the HEI-Spanish version (HEIS) (33). This index classifies an individual's diet into three categories: healthy, requiring modification, or unhealthy.

Eating behavior and sleep problems are closely interrelated. Sleep disturbances have been associated with compensatory changes in eating behavior (34,35). Research shows that adolescents who report fewer hours of sleep (e.g., 6.5 hours per night) tend to display disinhibition traits related to the consumption of highly palatable foods rich in sugar, salt, and fat (36,37). Similarly, Parker et al. (38) found that both the duration and timing of sleep may be linked to eating behavior.

When examining chronotype and eating behavior, significant associations have also been observed (39). Evening chronotypes and individuals experiencing so-called social jetlag (SJL)-that is, evening types forced to adopt a morning-oriented schedule on working days- are linked to higher rates of obesity, poorer performance, greater depressive symptoms, and increased tobacco use (40,41). Evening chronotypes or individuals with SJL tend to skip breakfast more frequently and consume a greater proportion of their meals in the evening (42,43). They also display irregular mealtime patterns, which have been associated with obesity (40).

Within this context, the present study aims to examine the relationships between chronotype, self-reported perception of sleep characteristics and problems, and eating behavior among dance students. Based on previous research, three hypotheses were proposed. First, it was expected that dance students with poor sleep quality would score higher on the emotional eating scale than those with good sleep quality. Second, it was hypothesized that students with poor sleep quality would have lower diet quality scores, reflecting a greater need for dietary improvement, compared with those with good sleep quality. Finally, it was predicted that students with a morning chronotype would exhibit better diet quality than those with an evening chronotype.

Materials and Methods

Participants

Participants were recruited through non-probabilistic sampling, selecting individuals who met the following inclusion criteria: being of legal age; having studied dance for at least three years under the supervision of a teacher (thus excluding self-taught dancers); being enrolled in a conservatory course (elementary, intermediate, or professional level) or in a dance school-academy; and providing signed informed consent.

An a priori power analysis was conducted using G*Power 3 to determine the required sample size. Results indicated that a minimum of 117 participants was needed to achieve 95% statistical power for detecting a medium effect size (α = 0.05) in independent-samples t-tests. A total of 118 students participated; three were excluded for having less than three years of formal dance instruction, and one for being under 18 years of age. The final sample consisted of 114 dance students, which provided adequate power (90%) and a significance level of $\alpha = 0.05$ to test the study hypotheses.

Instruments

To characterize the sample, an ad hoc interview was conducted to collect sociodemographic and educational data (gender, year of birth, weight, height, and level of education), as well as dance-related information. The dance-specific variables included years of formal training under the guidance of an instructor, number of days and hours per week dedicated to dance practice, place of study (conservatory, academy, or both), current level of study (elementary, intermediate, advanced, or school level), and dance specialty (classical, flamenco, contemporary, Spanish, urban, or other).

Subjective sleep quality was assessed using the PSQI (44) in its Spanish-adapted version (45). Buysse et al. (44) showed the predictive validity of the PSQI for identifying poor sleep quality, with a cut-off score of >5 yielding a sensitivity of 89.6% and a specificity of 86.5%. The instrument comprises 19 items grouped into the following components: (a) subjective sleep quality, (b) sleep latency, (c) sleep duration, (d) sleep efficiency, (e) sleep disturbances, (f) use of sleep medication, and (g) daytime dysfunction related to sleep. Each component is scored from 0 to 3, yielding a global score ranging from 0 to 21, with higher scores indicating (PSQI >5). In the present study, internal consistency for the total score was acceptable ($\alpha = 0.812$).

Chronotype was assessed using the composite scale of morningness (CSM) (46,47) in its Spanish-adapted version (48). This scale consists of 13 items that evaluate participants' typical wake-up and bedtime, preferred hours for physical and mental activity, and subjective alertness. The instrument yields a total score (CSM-total; lower scores indicate a stronger evening chronotype) and two subscales: general morningness (CSM-general) and alertness (CSM-alert). In the current study, internal consistency was satisfactory for CSM-total ($\alpha = 0.862$), CSM-general ($\alpha = 0.853$), and CSM-alert ($\alpha = 0.715$).

Diet quality was assessed using the HEIS (33), an adapted version of the North American HEI (32). The HEIS categorizes food into twelve groups: 1) fresh fruit, 2) meat, 3) eggs, 4) fish, 5) pasta, rice, potatoes, 6) bread and cereals, 7) vegetables, 8) legumes, 9) processed meats and cold cuts, 10) dairy products, 11) sweets, and 12) sugar-sweetened beverages. Each group is further classified into five consumption categories: 1) daily consumption, 2) three or more times per week but not daily, 3) once or twice per week, 4) less than once per week, and 5) never or almost never. To calculate the HEIS, each variable is rated on a scale of 0 to 10, with higher scores indicating greater adherence to the recommendations established by the Spanish Society of Community Nutrition (49). The total score is then classified into three categories: healthy (>80 points), needs modification (50–80 points), and unhealthy (<50 points).

Emotional eating was assessed using the questionnaire of eating and appraisal due to emotions and stress (EADES) (50), in its Spanish-adapted version (51). The questionnaire consists of 40 items, with nine items from the original version excluded during adaptation due to low factor loadings. Higher scores indicate a weaker association between eating behavior and negative emotional states. Responses are rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire yields a total score and three subscales, all of which demonstrated excellent internal consistency in this study: F1. Self-efficacy in emotion- and stress-related eating ($\alpha = 0.898$); F2. Self-confidence in emotion- and stress-related eating ($\alpha = 0.889$); and F3. Appraisal of resources and ability to cope ($\alpha = 0.913$). The overall Cronbach's alpha reliability coefficient for the total scale was 0.924.

Procedure

Data were collected in both paper and online formats. Paper-based data collection took place through visits to public conservatories and private dance academies. At the same time, the online data were gathered following contact with the management teams of conservatories and academies across the country. After agreeing to collaborate, administrators disseminated information about the study via social media and email invitations to students.

The online survey began with a detailed description of the study's objectives, legal and ethical terms, and assurances regarding the anonymity and confidentiality of responses. The study was approved by the Andalusian Ethics Committee of Biomedical Research (Huelva Evaluation Committee; Internal Code: 0423-N-23; Act: 06/23; dated: 20/06/2023). Participants were informed that their data would be used exclusively for research purposes, that participation was voluntary, and that they could withdraw at any time without penalty. Informed consent was required before proceeding with the questionnaire.

Statistical Analysis

An a priori power analysis was conducted using G*Power 3.5 (52) to determine the minimum sample size required to test the study hypotheses. Descriptive statistics were calculated for all variables, including frequencies, percentages, means, and standard deviations (SDs). The Kolmogorov–Smirnov test was used to assess the normality of the distributions. For variables that did not meet the assumption of normality, non-parametric tests were applied-specifically, the Mann–Whitney U test and the Kruskal–Wallis test. Internal consistency reliability was evaluated using Cronbach's alpha (α). Effect sizes for the Mann–Whitney U test were estimated using the formula $r = Z/\sqrt{n}$, interpreted as follows: r <0.099 (negligible), 0.10–0.299 (small), 0.30–0.499 (medium), and >0.50 (large). Associations between categorical variables were analyzed using the chi-square (χ^2) test, with effect size estimated via Cramér's V (<0.20: small; 0.20–0.60: moderate; >0.60: large). All analyses were performed using the IBM SPSS Statistics software package, version 25.0 (IBM Corp., Armonk, NY, USA).

Results

The final sample consisted of 114 dance students, of whom 87.7% were women. Participants had a mean age of 23.87 years (SD = 5.47). Regarding dance specialization, 7.0% were studying classical dance, 43.9% flamenco, 13.2% contemporary dance, 20.2% Spanish dance, 11.4% urban dance, and 4.4% other styles.

Although the variables met the assumption of normality, non-parametric tests were applied due to the unequal sample sizes between male and female participants. Analysis of age revealed statistically significant differences by gender: male students (M = 28.29, SD = 8.84) were significantly older than female students (M = 23.25, SD = 4.56), Z = -2.894, p = 0.004.

The mean weight of the sample was 59.43 kg (SD = 9.61), and the mean height was 163.18 cm (SD = 16.56). As expected, significant gender differences were found for both variables, with men being generally heavier and taller than women (weight: Z = -4.350, p <0.001; height: Z = -5.471, p <0.001). Differences were also observed in educational level, $\chi^{2(2,114)}$ = 6.667, p = 0.036, with women more likely to have completed university studies, whereas men were more likely to have completed secondary education (Cramér's V = 0.242).

Regarding dance-related characteristics, no significant gender differences were found in years of formal dance instruction, the frequency of rehearsals (days per week), or the hours dedicated to dance per week (see Table 1). However, women were more likely to study in conservatories, whereas men more often attended private dance schools (Cramér's V = 0.241). Additionally, women tended to be enrolled in higher levels of training (Cramér's V = 0.259), and dance specialization differed significantly by gender: men more frequently specialized in urban dance, whereas women predominantly studied Spanish dance (Cramér's V = 0.340).

Analysis of the variables using the Kolmogorov-Smirnov test indicated that all distributions met the assumption of normality: subjective sleep quality (PSQI: Z = 0.872, p = 0.563), chronotype (CSM: Z = 0.807, p = 0.533), emotional eating (EADES: Z = 1.312, p = 0.064), and healthy eating (HEIS: Z = 1.076, p = 0.197). Table 2 presents the mean scores obtained on each of these instruments according to the gender of the dance students.

Regarding perceived sleep characteristics, a significantly greater proportion of women reported higher scores indicative of poor sleep quality, with a small effect size (r = -0.23). Overall, 80.7% of students presented poor sleep quality (PSQI >5). No significant gender differences were found in chronotype scores or in behaviors related to healthy eating. With respect to dietary patterns, 27.3% (n = 31) of students followed a healthy diet, 68.4% (n = 78) required some modifications to achieve a healthier diet, and 4.4% (n = 5) had an unhealthy diet.

However, significant differences emerged in emotional eating. Women exhibited lower total EADES scores-indicating a greater tendency to use food as an emotion-regulation strategy-with a small effect size (r = -0.25). Similar small effect sizes were observed for the subscales self-efficacy in emotion- and stress-related eating (r = -0.24) and self-confidence in emotion- and stress-related

Table 1. Training-related characteristics of the sample of dance students according to gender.

	Total n = 114	Men 14 (12.3)	Women 100 (87.7)	Z Mann–Whitney U test	p
Years with teacher	12.99 (5.30)	14.64 (8.98)	12.76 (4.59)	-0.542	0.588
Days/week dancing	4.72 (1.22)	5.00 (1.11)	4.68 (1.23)	-1.009	0.313
Hours/week dancing	20.31 (11.73)	21.57 (13.41)	20.13 (11.53)	-0.251	0.802
Place of study				$\chi^{2(2,114)}$ = 6.608	0.037
Conservatory	68 (59.6)	4 (28.6)	64 (64.0)		
Dance school	30 (26.3)	7 (50.0)	23 (23.0)		
Both	16 (14.0)	3 (21.4)	13 (13.0)		
Stage of training				$\chi^{2(2,114)}$ = 7.627	0.022
Elementary-intermediate	53 (46.5)	8 (57.1)	45 (45.0)		
Higher	34 (29.8)	0 (0.0)	34 (34.0)		
School	27 (23.7)	6 (42.9)	21 (21.0)		
Dance specialty				$\chi^{2(2,114)}$ = 13.149	0.022
Classical	8 (7.0)	1 (7.1)	7 (7.0)		
Flamenco	50 (43.9)	7 (50.0)	43 (43.0)		
Contemporary	15 (13.2)	0 (0.0)	15 (15.0)		
Spanish	23 (20.2)	0 (0.0)	23 (23.0)		
Urban	13 (11.4)	4 (28.6)	9 (9.0)		
Another	5 (4.4)	2 (14.3)	3 (3.0)		

Quantitative variables are expressed as M (SD); categorical variables as n (%).
SD: Standard deviation.

eating (r = -0.19). No significant gender differences were found for the appraisal of resources and ability to cope subscale.

When examining the relationships among the study variables (Table 3), significant correlations were observed between subjective sleep quality and emotional eating. A negative correlation indicated that PSQI was associated with greater reliance on food as an emotion-regulation strategy. However, subjective sleep quality did not show a significant relationship with healthy eating.

Regarding chronotype, the scores showed a positive correlation with emotional eating, indicating that students with more morning-oriented tendencies were less likely to use food as an emotional regulator. Chronotype was also positively and significantly correlated with healthy eating, suggesting that dance students with a stronger morning orientation reported healthier dietary patterns and required fewer changes to improve their eating habits.

Correlational analyses between eating behavior and the sleep-related variables assessed by the PSQI revealed that neither hours spent in bed nor sleep efficiency were significantly associated with the emotional eating or healthy eating measures. However, sleep efficiency showed a marginally significant association with

Table 2. Scores on perceived sleep quality (PSQI), healthy eating index (HEIS), Chronotype (CSM), and emotional eating questionnaire (EADES) of dance students according to gender.

	Total n = 114	Men 14 (12.3)	Women 100 (87.7)	Z Mann–Whitney U test	p
PSQI	8.80 (3.78)	6.64 (2.67)	9.10 (3.82)	-2.403	0.016
PSQI categories				$\chi^{2(1,114)}$ = 0.047	0.829
Poor quality	92 (80.7)	11 (78.6)	81 (81.0)		
Good quality	22 (19.3)	3 (21.4)	19 (19.0)		
CSM	31.56 (6.75)	30.36 (5.76)	31.73 (6.89)	-0.873	0.383
CSM-general	24.96 (5.28)	22.93 (4.45)	25.24 (5.79)	-1.639	0.101
CSM-alert	6.61 (1.81)	7.43 (1.70)	6.49 (1.81)	-1.817	0.069
EADES	138.00 (19.24)	151.14 (18.37)	136.17 (18.73)	-2.602	0.009
F1-EADES	40.54 (9.92)	47.14 (7.97)	39.62 (9.85)	-2.545	0.011
F2-EADES	29.88 (7.04)	33.21 (6.49)	29.41 (7.02)	-1.980	0.048
F3-EADES	67.59 (7.53)	70.79 (8.77)	67.14 (7.29)	-1.483	0.138
HEIS	70.73 (12.99)	67.79 (13.08)	71.15 (12.99)	-0.807	0.419
HEIS classification				$\chi^{2(1,114)}$ = 1.343	0.247
Needs change	83 (72.8)	12 (85.7)	71 (71.0)		
Healthy	31 (27.2)	2 (14.3)	29 (29.0)		

Quantitative variables are expressed as M (SD); categorical variables as n (%).
PSQI: Pittsburgh sleep quality index, CSM: Composite scale of morningness, CSM-general: General morningness factor, CSM-alert: Alertness factor, EADES: Eating and appraisal due to emotions and stress questionnaire, F1-EADES: Self-efficacy in emotion- and stress-related eating, F2-EADES: Self-confidence in emotion- and stress-related eating, F3-EADES: Appraisal of resources and ability to cope, HEIS: Healthy eating index for the Spanish population, SD: Standard deviation.

Table 3. Pearson's bivariate correlations between subjective sleep characteristics and eating behaviors.

	1	2	3	4	
(1) PSQI	1				
(2) CSM	-0.083/0.383	1			
(3) EADES	-0.335/ <0.001	0.323/ <0.001	1		
(4) HEIS	0.140/0.138	0.313/0.001	0.104/0.138	1	
	Hours in bed	Sleep efficiency	Sleep duration	Sleep disturbances	Daytime dysfunction
HEIS	-0.165/0.079	-0.126/0.180	-0.224/0.017	-0.008/0.931	-0.077/0.418
EADES	-0.003/0.974	0.090/0.342	0.046/0.629	-0.413/<0.001	-0.486/<0.001
F1-EADES	0.025/0.792	0.177/0.060	0.129/0.172	-0.325/<0.001	-0.364/<0.001
F2-EADES	0.056/0.553	0.031/0.741	0.075/0.428	-0.308/0.001	-0.387/<0.001
F3-EADES	-0.093/0.324	-0.033/0.728	-0.123/0.193	-0.340/<0.001	-0.400/<0.001

Values are presented as r/p (Pearson's correlation coefficient/significance).
PSQI: Pittsburgh sleep quality index, CSM: Composite scale of morningness, EADES: Eating and appraisal due to emotions and stress questionnaire, F1-EADES: Self-efficacy in emotion- and stress-related eating, F2-EADES: Self-confidence in emotion- and stress-related eating, F3-EADES: Appraisal of resources and ability to cope, HEIS: Healthy eating index for the Spanish population.

the self-efficacy in emotion- and stress-related eating factor. While self-reported hours of sleep were not significantly related to emotional eating, they were negatively and significantly correlated with healthy eating, suggesting that students who reported longer sleep durations tended to have less healthy diets and required more dietary modifications.

In contrast, both sleep disturbances and daytime dysfunction due to poor sleep were significantly correlated with emotional eating, but not with healthy eating. These correlations were negative and highly significant, indicating that greater sleep disturbances and more pronounced daytime dysfunction were associated with a stronger tendency to use food as an emotional coping mechanism, both in the total emotional eating score and across all subscales.

Table 4 presents the scores obtained on the instruments assessing eating behaviors according to the presence of nightmares during the past month, as measured by the PSQI. Dance students who reported not experiencing nightmares during this period showed less reliance on food as an emotional regulator compared to those who experienced nightmares less than once per week. Significant differences were found in the total EADES score, with a small effect size (r = -0.28), and in the appraisal of resources and ability to cope factor, which showed a medium effect size (r = -0.43). However, no significant differences were observed in the self-efficacy in emotion- and stress-related eating or self-confidence in emotion- and stress-related eating subscales.

Furthermore, the presence of nightmares did not appear to be related to healthy eating scores, as no statistically significant differences were found between students who reported experiencing nightmares and those who did not.

Table 5 displays the scores obtained by dance students on the instruments assessing eating behaviors and chronotype according to subjective sleep quality. Students categorized in the poor sleep quality group reported greater use of food as an emotional regulator. Specifically, significant differences were observed in the total EADES score (medium effect size, r = -0.35), as well as in the self-efficacy in emotion- and stress-related eating (small effect size, r = -0.27), self-confidence in emotion- and stress-related eating (medium effect size, r =

Table 4. Contingency table of emotional eating (EADES) and healthy eating index (HEIS) scores by the presence of nightmares in the past month (PSQI).

		Presence of nightmares (past month)			
	Total 114	**No nightmares 22 (19.3)**	**< once per week 92 (80.7)**	**Z Mann–Whitney U test**	**p**
EADES	138 (19.24)	148.41 (17.429)	135.52 (18.909)	-2.959	0.003
F1-EADES	40.54 (9.92)	42.82 (8.867)	40.00 (10.128)	-0.967	0.334
F2-EADES	29.88 (7.04)	31.77 (7.380)	29.42 (6.929)	-1.682	0.093
F3-EADES	67.59 (7.53)	73.82 (6.021)	66.10 (7.108)	-4.582	<0.001
HEIS	70.73 (19.99)	69.46 (13.739)	71.04 (12.872)	-0.223	0.824

Quantitative variables are expressed as M (SD); categorical variables as n (%).
PSQI: Pittsburgh sleep quality index, CSM: Composite scale of morningness, EADES: Eating and appraisal due to emotions and stress questionnaire, F1-EADES: Self-efficacy in emotion- and stress-related eating, F2-EADES: Self-confidence in emotion- and stress-related eating, F3-EADES: Appraisal of resources and ability to cope, HEIS: Healthy eating index for the Spanish population, SD: Standard deviation.

Table 5. Contingency table of composite scale of morningness (CSM), emotional eating (EADES), and healthy eating index (HEIS) scores by good/poor sleep quality (PSQI).

		PSQI			
	Total 114	**Good quality 22 (19.3)**	**Poor quality 92 (80.7)**	**Z Mann–Whitney U test**	**p**
CSM	31.56 (6.75)	35.68 (6.011)	30.58 (6.574)	-3.120	0.002
EADES	138 (19.24)	150.96 (13.45)	134.91 (19.19)	-3.742	<0.001
F1-EADES	40.54 (9.92)	45.68 (6.69)	39.32 (10.20)	-2.857	0.004
F2-EADES	29.88 (7.04)	34.36 (6.18)	28.80 (6.84)	-3.641	<0.001
F3-EADES	67.59 (7.53)	70.91 (6.20)	66.79 (7.64)	-2.769	0.006
HEIS	70.73 (19.99)	70.23 (10.33)	70.85 (13.60)	-0.266	0.790
HEIS classification				$\chi^2_{(1,114)} = 1.118$	0.290
Needs change	83 (72.8)	18 (81.8)	65 (70.7)		
Healthy	31 (27.2)	4 (18.2)	27 (29.3)		

Quantitative variables are expressed as M (SD); categorical variables as n (%).
PSQI: Pittsburgh sleep quality index, CSM: Composite scale of morningness, EADES: Eating and appraisal due to emotions and stress questionnaire, F1-EADES: Self-efficacy in emotion- and stress-related eating, F2-EADES: Self-confidence in emotion- and stress-related eating, F3-EADES: Appraisal of resources and ability to cope, HEIS: Healthy eating index for the Spanish population, SD: Standard deviation.

-0.34), and appraisal of resources and ability to cope (small effect size, r = -0.26) factors.

No significant differences in healthy eating patterns were found between students reporting good versus poor sleep quality. However, those in the good sleep quality group exhibited significantly more morning-oriented chronotypes than those in the poor sleep quality group, with a large effect size (r = -0.55).

Discussion

The present study aimed to examine the relationships between self-reported sleep perception-specifically subjective sleep quality and chronotype-and eating behaviors among dance students, focusing on both healthy eating and the use of food as an emotional regulation strategy.

The first hypothesis proposed that dance students with poor sleep quality would exhibit higher scores on the emotional eating scale than those with good sleep quality. The findings supported this hypothesis: students in the poor sleep quality group demonstrated significantly greater use of food as an emotional regulatory mechanism. This association was evident in both the total eades score and across its three subscales-self-efficacy in emotion, stress-related eating, self-confidence in emotion, and appraisal of resources and ability to cope.

These findings align with previous evidence in the general population indicating that poor sleep quality is associated with problematic eating behaviors (34,35,38). Similarly, prior research has indicated that poor sleep quality is closely linked to impaired emotional regulation (53) and compensatory changes in eating behavior (34). Assuming a bidirectional relationship between sleep difficulties and emotional distress (54), it appears that individuals with low sleep quality often exhibit dysregulated and impulsive eating patterns as a strategy for emotional control (55)- even from very early ages (56).

Regarding sleep duration, no significant relationship was found between sleep duration and behaviors associated with emotional eating among dance students. However, this finding contrasts with prior research showing that shorter sleep duration is linked to poorer emotional and behavioral functioning (57). Insufficient sleep has been associated with alterations in the maturation of brain structures-particularly the prefrontal cortex-which negatively impacts executive functioning and inhibitory control in adolescents (58). Sleep-deprived adolescents are therefore more likely to experience difficulties in emotional regulation and an increase in behavioral impulsivity (58). Moreover, short sleep duration has been associated with increased sensitivity to others' negative emotions, a higher likelihood of experiencing negative affect, and a reduced capacity to express and experience positive emotions (57).

Dance students have shown clear relationships between emotional eating and sleep disturbances, as well as with daytime dysfunction due to inadequate sleep. These findings are consistent with previous research in the general population, which suggests that adolescents experiencing sleep difficulties are more likely to face emotional stress, thereby increasing the risk of emotional eating (55). This relationship may be explained by the fact that emotional eating often emerges as a coping response to feelings of depression, anxiety, and loneliness (59), emotions commonly linked to poor sleep quality and sleep-related difficulties (60).

It is important to note that the presence of nightmares is strongly associated with negative affective states and psychological distress (61-63), and, in this study, showed significant relationships with emotional eating. Dance students who reported experiencing nightmares in the past month displayed greater use of food as an emotional regulation strategy compared to those who had not experienced nightmares. This relationship was evident in both the total EADES score and the appraisal of resources and ability to cope factor. However, no significant differences were found in healthy eating scores.

The second hypothesis proposed that students with poor sleep quality would obtain lower diet quality scores-indicating a greater need for dietary modifications-than those reporting good sleep quality. This hypothesis was not supported, as no statistically significant differences in the HEI were observed between students with poor and good sleep quality. In this regard, previous literature has suggested that poor sleep quality may be related to the type of food consumed (38). Specifically, individuals experiencing low sleep quality-often associated with emotional distress-are more likely to consume highly palatable foods rich in sugar, salt, and fat (64). Accordingly, adolescents with poor sleep quality often exhibit greater disinhibition in the consumption of such palatable foods (36,37).

No differences in diet quality were observed between dance students with poor and good sleep quality, regardless of hours spent in bed, sleep efficiency, sleep disturbances, or daytime dysfunction due to sleep. However, contrary to expectations, a negative relationship emerged between total sleep hours and diet quality. This finding contradicts previous evidence suggesting that shorter sleep duration is a marker for the development of unhealthy eating habits (38,59), with young adults often adopting unhealthy eating behaviors (65). Shorter sleep duration has also been associated with increased consumption of foods high in sugar and fat (66) as well as with a higher risk of obesity (19,59).

The third hypothesis proposed that dance students with a morning chronotype would have better diet quality than those with an evening chronotype. The data obtained from the present sample confirmed this prediction. These findings are consistent with previous research demonstrating significant associations between chronotype and eating behavior (39). Evening chronotypes and individuals experiencing what is known as SJL have been linked to less healthy diets, higher rates of obesity, poorer performance, and greater mood disturbances (41). They also tend to skip breakfast more frequently, consume a greater proportion of their meals in the evening (42,43), and maintain irregular eating schedules (40). Moreover, differences in nutrient intake have been reported according to chronotype (67,68), with individuals experiencing SJL showing higher overall caloric and fat intake (69).

Given the impact that sleep and eating problems have on both dance students and professionals, it would be valuable to analyze the role conservatories could play in promoting health by including sleep hygiene and nutrition programs in their training curricula. Such initiatives could help transform these institutions into genuinely health-promoting environments. In this sense, fostering a holistic educational approach is essential-one that not only emphasizes physical and technical preparation but also supports the development of psychological and lifestyle factors that are critical to students' professional and personal well-being.

Study Limitations

This study presents several limitations that should be addressed in future research. First, its correlational design precludes establishing causal relationships among the variables examined. Second, although the self-report questionnaires used demonstrated adequate validity and reliability, such instruments are inherently subject to potential biases and measurement limitations.

Future studies should aim to expand the sample size, particularly by increasing the number of participants within each dance specialty, as different modalities may entail distinct physical and psychological demands. Achieving a more balanced gender representation would also enhance generalizability, given the underrepresentation of male students in the current sample. It is additionally important to account for the influence of cultural context and students' expectations regarding their dance practice-whether oriented toward leisure, fitness maintenance, or professional training.

Further research should control for levels of physical activity and training intensity, as these factors are closely linked to both sleep characteristics and eating behaviors. Conducting longitudinal studies across an entire academic year would help identify stressors associated with fluctuations in sleep and eating patterns, particularly during periods of high academic or rehearsal demands. Combining subjective and objective sleep measures (e.g., actigraphy) and analyzing the specific composition of students' diets in relation to sleep outcomes would provide a more comprehensive understanding of these interactions. Finally, incorporating additional variables-such as career aspirations, professional goals, injury history, and years of dance experience-would strengthen the external validity and generalizability of future findings.

Conclusion

The findings indicate that a high proportion of dance students experience poor sleep quality and require dietary adjustments to achieve a healthier diet. Students with poor sleep quality reported greater use of food as an emotional regulation strategy compared to those with good sleep quality, and sleep disturbances were significantly associated with emotional eating. No statistical differences were observed in the HEI according to subjective sleep quality. Finally, students with a morning chronotype exhibited better diet quality than those with an evening chronotype.

Ethics

Ethics Committee Approval: The study was approved by the Andalusian Ethics Committee of Biomedical Research (Huelva Evaluation Committee; Internal Code: 0423-N-23; Act: 06/23; Date of approval: 20/06/2023).

Informed Consent: Informed consent was required before proceeding with the questionnaire.

Footnotes

Authorship Contributions

Surgical and medical practices: J.D.-A., F.A., Concept: J.D.-A., F.A., Design: J.D.-A., F.A., Data Collection or Processing: J.D.-A., F.A., Analysis or Interpretation: J.D.-A., F.A., Literature Search: J.D.-A., F.A., Writing: J.D.-A., F.A.

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Sleep Habits and Problems among Children Aged 5–15 Years in Northern Cyprus

Kıbrıs'ta 5–15 Yaş Arası Çocuklarda Uyku Alışkanlıkları ve Sorunları

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Abstract

Objective: This study aims to examine the sleep habits of children living in Northern Cyprus and to identify socio-demographic factors that influence these habits.

Materials and Methods: Designed as a cross-sectional, descriptive, and comparative study, the research was conducted between September 1, 2023, and April 1, 2024, in a pediatric outpatient clinic. A total of 182 children aged 5–15 and their parents participated. Ethics committee approval and written informed consent were obtained. Data were collected using a Personal Information Form and the Children's Sleep Habits Questionnaire (CSHQ), which demonstrated high internal consistency (Cronbach's alpha = 0.812).

Results: Findings revealed that 24.7% of the children had clinically significant sleep problems. A statistically significant difference was found between gender and total CSHQ scores ($p < 0.05$), with boys scoring higher than girls. However, no significant differences were observed based on age or educational level ($p > 0.05$). When comparing total and subscale scores based on the presence of clinical sleep problems, all subscales except bedwetting showed statistically significant differences ($p < 0.05$). These subscales included difficulty waking in the morning, parasomnias related to sleep disruption, morning wake-up behavior, sleep onset delay, sleep duration, need to sleep with others, daytime sleepiness, sleep anxiety, sleep-disordered breathing, and other parasomnias.

Conclusion: The findings highlight that sleep problems are prevalent among children and are associated with specific behavioral and demographic factors. Early identification and intervention for childhood sleep issues may contribute positively to children's overall development and well-being.

Keywords: Sleep habits, sleep disorders, child, nursing, Northern Cyprus

Öz

Amaç: Bu araştırmanın amacı, Kuzey Kıbrıs'ta yaşayan çocukların uyku alışkanlıklarını ve bu alışkanlıkları etkileyen sosyo-demografik faktörleri belirlemektir.

Gereç ve Yöntem: Kesitsel, tanımlayıcı ve karşılaştırmalı desenle yürütülen çalışmaya, 1 Eylül 2023–1 Nisan 2024 tarihleri arasında bir çocuk polikliniğine başvuran 5–15 yaş arası 182 çocuk ve ebeveynleri katılmıştır. Çalışma için etik kurul onayı ve yazılı gönüllü onam alınmıştır. Veriler, Kişisel Bilgi Formu ve Çocuk Uyku Alışkanlıkları Anketi (ÇUAA) ile toplanmış; anketin iç tutarlılık katsayısı 0,812 olarak hesaplanmıştır.

Bulgular: Katılımcıların %24,7'sinde klinik düzeyde uyku sorunu saptanmıştır. Cinsiyet ile ÇUAA toplam puanları arasında anlamlı bir fark bulunmuş ($p < 0,05$) ve erkek çocukların puanlarının daha yüksek olduğu belirlenmiştir. Yaş ve eğitim düzeyine göre anlamlı bir fark saptanmamıştır ($p > 0,05$). Klinik uyku sorununa göre yapılan karşılaştırmalarda; gece altını ıslatma dışındaki tüm alt boyutlarda anlamlı farklılıklar bulunmuştur ($p < 0,05$). Bu boyutlar arasında sabah zor uyanma, uykunun bölünmesiyle ilgili parasomniler, sabah uyanma şekli, uykuya geçiş güçlüğü, uyku süresi, başkasıyla yatma ihtiyacı, gündüz uykululuğu, uyku kaygısı, uykuda solunumun bozulması ve diğer parasomniler yer almaktadır.

Sonuç: Elde edilen bulgular, çocukluk dönemindeki uyku alışkanlıklarının çok boyutlu bir şekilde ele alınması gerektiğini ve belirli demografik faktörlerin uyku kalitesi üzerinde etkili olabileceğini göstermektedir.

Anahtar Kelimeler: Uyku alışkanlıkları, uyku bozuklukları, çocuk, hemşirelik, Kuzey Kıbrıs

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Introduction

Sleep is an indispensable and fundamental requirement of human life. Although it is often described as a "half-death" in reality, it is a physiological process characterized by a biologically active state of unconsciousness, in which bodily systems slow down, allowing living beings to rest (1,2). The influence of sleep on maintaining a healthy life extends far beyond mere rest; it is also recognized as a critical factor that directly impacts cognitive, emotional, and physical functions (3).

According to Buysse (4), health cannot be defined solely as the absence of disease; likewise, sleep health cannot be explained merely by the absence of sleep disorders. Sleep is a natural process that varies depending on an individual's age, biological rhythm, and living conditions. For adults, the average sleep duration is approximately 7–8 hours, whereas in childhood, this duration differs significantly according to age (2,5). While newborns sleep an average of 12–16 hours per day, this duration decreases to 8–10 hours during adolescence (6).

In childhood, sleep differs not only in duration but also in structure. During this period, children exhibit a polyphasic sleep pattern, sleeping multiple times throughout the day and night. Over time, this pattern transitions to a monophasic pattern during the school-age years, when children, similar to adults, rely on a single night-time sleep period (7,8).

Sleep plays a vital role in numerous aspects of children's lives, ranging from physical growth and emotional regulation to learning, memory processes, and immune system function. However, in recent years, changes in lifestyle, exposure to digital screens, academic pressure, and environmental factors have adversely affected children's sleep patterns (9,10). Sleep disorders can have lasting consequences not only on daily functioning but also on children's physical and mental health in the long-term (11).

A comprehensive understanding of children's sleep problems requires multidimensional approaches. In this context, it is important to focus not only on parental perceptions but also on the experiences of children, which vary according to their age groups. The scarcity of data in the literature on this subject underscores the need for new studies, particularly those supported by local evidence. Accordingly, this study aims to examine the sleep habits of children living in Northern Cyprus and the factors influencing these habits.

Aim of the Study

The aim of this study was to identify the sleep habits of children aged 5–15 years living in Northern Cyprus and the socio-demographic factors influencing these habits. Within this scope, variables such as sleep onset latency, total sleep duration, frequency of nighttime awakenings, and clinically significant sleep problems were analysed using various statistical method. The findings of the study are intended to contribute to the development of individualized recommendations for improving children's sleep patterns and raising awareness among families on this issue.

Research Design

This study was conducted using cross-sectional, descriptive, and comparative method.

Research Setting, Timeframe and Sample

The study was carried out between September 1, 2023, and April 1, 2024, with children aged 5–15 years and their parents who presented to the Pediatric Outpatient Clinic of Near East University Hospital, located in the Nicosia region of Northern Cyprus.

Sample Size

The sample size was calculated using the following formula:

$n = (Z^2 \times P \times q)/d^2$

$Z = 1.96$ (95% confidence level),

$P = 0.12$ [prevalence of sleep problems; Malloggi et al. (12)],

$q = 1 - P = 0.88$,

$d = 0.05$ (margin of error).

The calculated sample size was n = 163; however, to increase the statistical power of the study, the sample size was increased to 182 participants.

Inclusion Criteria

The inclusion criteria for the study were as follows:

- The participating child was between 5 and 15 years of age,
- The parents voluntarily agreed to participate in the study and signed a written informed consent form,
- The child presented to the Pediatric Outpatient Clinic of Near East University Hospital for any reason.

Instruments for Data Collection

Data were collected between September 1, 2023, and April 2024 using a questionnaire technique. The following instruments were employed during the data collection process:

Personal Information Form

This form, developed by the researcher, consists of three questions designed to determine the children's basic socio-demographic characteristics, such as age, sex, and educational level.

Children's Sleep Habits Questionnaire

Developed by Owens et al. (3) and adapted into Turkish with established validity and reliability by Fiş et al. (13), this scale evaluates children's sleep habits over the past week on the basis of parental observations.

The scale consists of 33 items and is scored on a three-point Likert scale (3 = usually, 2 = sometimes, 1 = never), yielding a total score ranging from 33 to 99. Higher scores indicate that the child experiences more sleep-related problems. A cut-off score of 42 was established for identifying clinically significant sleep problems.

In the present study, the internal consistency coefficient (Cronbach's alpha) of the scale was found to be 0.812, indicating a high level of reliability. The scale was not administered directly to the children; however, it was observed that, for certain items, parents considered their child's self-reported experiences when providing responses. This approach contributed to reducing potential bias errors.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics Version 22.0.

- Descriptive statistics: For continuous variables, arithmetic mean, standard deviation, minimum, and maximum values were calculated; for categorical variables, frequency and percentage distributions were determined.
- Inferential statistics: The distribution characteristics of the data were examined.
- For normally distributed data, independent samples t tests and one-way analysis of variance (ANOVA) were applied.
- For non-normally distributed data, the Mann–Whitney U test and Kruskal–Wallis H test were used.

Statistical significance was set at $p < 0.05$ for all analyses.

Ethical Issues

The study was approved by the Scientific Research Ethics Committee of Near East University (approval number: NEU/2023/110-1688, date: 12.06.2024). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants after they were informed about the purpose of the research. Participants were advised that they could withdraw from the study at any time. Data confidentiality was maintained, and no personally identifiable information was recorded at any stage. The findings are securely stored and will be presented to the relevant institutions if needed.

Findings

Table 1 presents the distribution of the participating children according to sex, age, and educational level. Approximately half of the participants were male (51.1%), and half were female (48.9%). In terms of age group, the highest proportion was in the 9–12–year group (48.9%), followed by the 5–8-year group. The majority of the children were receiving education at the primary school (37.9%) and middle school (42.9%) levels.

Table 2 presents the findings related to the children's bedtime, wake-up time, and sleep duration. A total of 67.6% of the children were found to fall asleep at or after 22:00, while 67.0% woke up between 07:00 and 07:59 in the morning. A total of 71.4% of the participants reported sleeping an average of 8–10 hours per day. In addition, 50.5% of the children remained awake for 1–29 minutes during the night, whereas 42.9% did not wake at all throughout the night.

Table 3 presents the distribution of clinical sleep problems based on the scores obtained from the Children's Sleep Habits Questionnaire (CSHQ). The findings indicate that 24.7% of the children experienced sleep problems at the clinical level. It was determined that one-quarter of the children included in the study had sleep problems.

Table 4 presents the findings of the comparison of total CSHQ scores according to the children's socio-demographic characteristics. The analyses revealed no statistically significant differences in the CSHQ scores by age group or educational level ($p > 0.05$). In contrast, a significant difference was found in relation to sex ($p < 0.05$). Cohen's d values of 0.1, 0.3, 0.5, and 1 or above were considered to indicate a small, medium, large or very large difference, respectively. The effect size (Cohen's $d = 0.36$) indicated a moderate difference, with male children exhibiting higher sleep problem scores than female children did.

In this study, the independent samples t-test was applied to data that met the assumption of a normal distribution, while the Mann–Whitney U test was used for data that did not. A comparison of total and subscale scores according to the presence of clinical sleep problems revealed statistically

Table 1. Findings related to children's socio-demographic characteristics.

Variables	Groups	n	%
Sex	Male	93	51.1
	Female	89	48.9
Age group	5–8 years	53	29.1
	9–12 years	89	48.9
	13–15 years	40	22.0
Level of education	Preschool	7	3.8
	Primary school	69	37.9
	Middle school	78	42.9
	High school	28	15.4
Total		**182**	**100.0**

Table 2. Descriptive statistics regarding children's sleep habits.

Variables	Groups	n	%
Bedtime	Between 8:00–9:59 p.m.	59	32.4
	After 10 p.m.	123	67.6
Wake-up time	06:00–06:59 a.m.	55	30.2
	07:00–07:59 a.m.	122	67.0
	08:00–08:59 a.m.	3	1.6
	09:00–09:59 a.m.	2	1.1
Amount of sleep	6–8 hours	22	12.1
	8–10 hours	130	71.4
	10–12 hours	28	15.4
	12 hours	2	1.1
Wake time (min.)	Absent	78	42.9
	1–29 minutes	92	50.5
	30–59 minutes	4	2.2
	60–119 minutes	7	3.8
	120 minutes and over	1	0.5
Total		**182**	**100.0**

Min: Minimum, a.m.: Before midday, p.m.: After midday.

Table 3. Distribution of clinical sleep problems according to children's CSHQ scores.

Clinical sleep problems	n	%
Absent	137	75.3
Present	45	24.7

CSHQ: Children's Sleep Habits Questionnaire.

significant differences ($p < 0.05$) for all the subscales—except nocturnal enuresis—including difficulty waking in the morning, parasomnias related to sleep fragmentation, morning waking behaviour, sleep duration, sleep onset, the need to sleep with another person, and daytime sleepiness (Table 5), as well as sleep anxiety, sleep-disordered breathing, and other parasomnias (Table 6).

Table 4. Comparison of CSHQ total scores according to socio-demographic characteristics.

Variables	Groups	n	Mean	SD	t/F	SD	p	d
Sex	Female	89	37.52	6.44	-2.418	180	0.017	0.36
	Male	93	39.87	6.68				
Age group	5–8 years	53	39.19	6.75	2.216	2–179	0.112	-
	9–12 years	89	37.74	6.71				
	13–15 years	40	40.28	6.17				
Level of education	Preschool/primary school	76	39.28	6.99	1.385	2–179	0.253	-
	Middle-school	78	37.79	6.30				
	High-school	28	39.79	6.57				

SD: Standard deviation, CSHQ: Children's Sleep Habits Questionnaire.

Table 5. Comparison of total CSHQ scores and subscale scores (normally distributed) according to clinical sleep problems.

Score	Clinical sleep problems	n	Mean	SD	Difference	S.H.	t	SD	p	d
Total score	Absent	137	35.49	2.97	-13.07	0.76	-17.084	55.2	**<0.001**	3.71
	Present	45	48.56	4.84						
Difficulty waking in the morning	Absent	137	1.14	0.28	-1.06	0.12	-8.559	47.4	**<0.001**	2.25
	Present	45	2.20	0.81						
Parasomnias related to sleep fragmentation	Absent	137	1.18	0.25	-0.19	0.04	-4.222	180	**<0.001**	0.72
	Present	45	1.37	0.29						
Morning waking behaviour	Absent	137	1.81	0.47	-0.45	0.11	-4.229	59.3	**<0.001**	0.86
	Present	45	2.26	0.65						
Sleep duration	Absent	137	1.29	0.38	-0.53	0.08	-6.392	60.4	**<0.001**	1.28
	Present	45	1.82	0.51						
Sleep onset	Absent	137	1.35	0.46	-0.84	0.11	-7.442	56.4	**<0.001**	1.59
	Present	45	2.19	0.71						
Need to sleep with another person	Absent	137	1.10	0.24	-0.22	0.06	-3.476	55.0	**0.001**	0.76
	Present	45	1.32	0.40						
Daytime sleepiness	Absent	137	0.24	0.45	-0.40	0.11	-3.504	55.9	**0.001**	0.75
	Present	45	0.64	0.72						
Nocturnal enuresis	Absent	137	1.15	0.25	-0.11	0.06	-1.954	59.8	0.055	-
	Present	45	1.26	0.35						

SD: Standard deviation, CSHQ: Children's Sleep Habits Questionnaire.

Table 6. Comparison of CSHQ subscale scores (non-normally distributed) according to clinical sleep problems.

Score	Clinical sleep problems	n	Average rank	Rank total	Z	p	d
Sleep anxiety	Absent	137	83.80	11480.50	-4.173	**<0.001**	0.31
	Present	45	114.94	5172.50			
Sleep-disordered breathing	Absent	137	87.20	11947.00	-2.974	**0.003**	0.22
	Present	45	104.58	4706.00			
Other parasomnias	Absent	137	82.56	11310.50	-4.817	**<0.001**	0.36
	Present	45	118.72	5342.50			

CSHQ: Children's Sleep Habits Questionnaire.

Discussion

In this study, the sleep habits and distribution of clinical sleep problems among children aged 5–15 years who presented to the Pediatric Outpatient Clinic of Near East University Hospital in the Nicosia region of Northern Cyprus were examined. Approximately one-quarter (24.7%) of the children experienced clinical-level sleep problems. Malloggi et al. (12) reported a prevalence of 11.3% for school-age sleep disorders, Bharti et al. (14) reported a 42.7% rate of sleep problems, Demir-Uysal and Çalışır's (15) reported a 72.9% sleep problem rate, Ünsal et al. (16) reported a 26.9% sleep problem rate, Lewien et al. (17) reported sleep problems in 22.6% of children and 20.0% of adolescents and Durmuş et al. (18) reported a 59% sleep problem rate, which are consistent with the 25–77% range reported in the literature for children. These results support the notion that sleep problems are common and clinically significant in childhood.

The finding that compared with female children, male children had significantly higher CSHQ scores reflects the complex sex-related patterns reported in the literature. Some studies (15-19) have indicated that sleep problems are more prevalent among boys, whereas other studies (20,21) have reported no significant sex differences. Factors such as higher levels of physical activity, later bedtimes, and psychological influences among boys may explain this outcome (22). Additionally, the literature has emphasized that biological and hormonal differences between sexes may influence both the quality and duration of sleep (23).

The absence of a statistically significant relationship between sleep habits and age group or educational level in this study is noteworthy. Some studies (3,7) have reported decreased sleep duration and increased sleep problems with advancing age; however, this trend was not clearly evident in our findings. Nevertheless, a systematic review by Matricciani et al. (24) demonstrated that modern living conditions and increased technological engagement contribute to a general decline in children's sleep duration. In our study, there was a tendency towards reduced sleep duration with increasing age, although this did not reach statistical significance. This may be attributable to the sample size or the measurement method used.

The observation that children with clinical sleep problems had significantly higher total and subscale CSHQ scores—particularly in areas such as difficulty waking in the morning, sleep fragmentation, parasomnias, difficulty initiating sleep, and daytime sleepiness—underscores the multifactorial and complex nature of sleep problems. This aligns with the findings of Williamson et al. (25), who, in a large-sample study, reported that sleep problems are associated with behavioural and developmental issues. Similarly, Yayan et al. (26) highlighted the link between children's sleep habits and psychosocial status and reported that these problems affect not only physical but also emotional health.

The significant associations between clinical sleep problems and subscales related to sleep anxiety, sleep-disordered breathing, and other parasomnias are consistent with the literature on the types and clinical implications of sleep problems (20). In particular, sleep-disordered breathing in children contributes to growth impairment, learning difficulties, and behavioural problems (27), underscoring the importance of early diagnosis and intervention.

The mean CSHQ score in our study (38.72 ± 6.65) was lower than the values reported by Lionetti et al. (28) and Stafford et al. (29). This difference may be related to sample characteristics, cultural factors, and parental perceptions of sleep problems. Sleep habits, sleep environments, and parental attitudes can vary significantly across cultures (30). Moreover, recruiting participants from a general outpatient setting rather than a specialized clinical population may have resulted in a sample with less severe sleep problems.

Finally, it should be noted that the factors influencing children's sleep problems are becoming increasingly diverse. Research has demonstrated the effects of increased screen time, social media use, digital devices, and elevated stress levels on sleep health (31,32). In this context, comprehensive interventions aimed at preserving and improving sleep health are essential.

Study Limitations

This study has several limitations. Its cross-sectional design does not allow for causal inferences. Moreover, the findings are limited to the Northern Cyprus sample, which may restrict generalizability. In addition, the absence of a control group for comparison and the use of only one parent-reported scale without objective sleep assessments, such as actigraphy, may limit the robustness of the results. Future studies incorporating multiple measurement tools and a control group could provide more comprehensive and generalizable findings.

Conclusion

This study investigated the prevalence of sleep habits, clinical sleep problems, and associated factors among children aged 5–15 years in the Nicosia region of Northern Cyprus. These findings indicate that male children are at greater risk for sleep problems and that sleep duration decreases significantly with increasing age. Furthermore, approximately one-quarter of the children were found to have clinical sleep problems, which had notable effects across various subdomains. These results are consistent with the international literature supporting the significant effects of sleep problems on children's physical and psychosocial development. Nonetheless, the influence of cultural and environmental factors on sleep habits warrants particular attention.

Ethics

Ethics Committee Approval: The study was approved by the Scientific Research Ethics Committee of Near East University (approval number: NEU/2023/110-1688, date: 12.06.2024). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Informed Consent: Written informed consent was obtained from all participants after they were informed about the purpose of the research.

Footnotes

Authorship Contributions

Concept: C.Ö., Design: D.A., C.Ö., Data Collection or Processing: D.A., Analysis or Interpretation: D.A., C.Ö., Literature Search: D.A., Writing: D.A., C.Ö.

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Original Article / *Özgün Makale*

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Investigation of the Relationship Between Restless Legs Syndrome and Sleep Quality in Multiple Sclerosis Patients

Multipl Skleroz Hastalarında Huzursuz Bacak Sendromu ile Uyku Kalitesi Arasındaki İlişkinin İncelenmesi

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Abstract

Objective: This study aimed to determine the prevalence of restless legs syndrome (RLS) in patients with multiple sclerosis (MS) and to evaluate its effect on sleep quality.

Materials and Methods: This cross–sectional study was approved by the Ethics Committee of Kütahya Health Sciences University. A total of 151 patients with a confirmed diagnosis of MS were included. The Cambridge–Hopkins RLS Questionnaire, RLS Severity Scale, and Pittsburgh Sleep Quality Index (PSQI) were administered. Demographic, clinical, and radiological data were recorded. Patients were divided into two groups according to the presence of RLS, and appropriate parametric and non–parametric statistical tests were used for comparisons.

Results: The mean age of the participants was 40.6 ± 8.6 years, and 68.9% were female. The prevalence of RLS was 37.7%. Patients with RLS were older and had higher Expanded Disability Status Scale scores, a greater proportion of secondary progressive MS and primary progressive MS subtypes, and more frequent spinal lesions ($p < 0.05$). Poor sleep quality was observed in 63.2% of patients with RLS ($p = 0.01$). Logistic regression analysis showed that the presence of RLS increased the risk of PSQI by 3.37–fold ($p = 0.006$), and a family history of RLS was also an independent risk factor ($p = 0.01$).

Conclusion: RLS is common among MS patients and is associated with PSQI. The presence of RLS, spinal lesions, higher disability levels, and older age negatively affect sleep quality. Early recognition and management of RLS in MS patients may improve sleep quality and overall quality of life.

Keywords: Multiple sclerosis, restless legs syndrome, sleep quality

Öz

Amaç: Bu çalışmada, multipl skleroz (MS) hastalarında huzursuz bacak sendromu (HBS) sıklığını belirlemek ve HBS’nin uyku kalitesi üzerindeki etkisini değerlendirmek amaçlanmıştır.

Gereç ve Yöntem: Kütahya Sağlık Bilimleri Üniversitesi Etik Kurulu onayıyla yürütülen kesitsel çalışmaya, MS tanısıyla izlenen 151 hasta dahil edilmiştir. Katılımcılara Cambridge–Hopkins HBS Anketi, HBS Şiddet Skalası ve Pittsburgh Uyku Kalitesi İndeksi uygulanmıştır. Demografik, klinik ve radyolojik veriler kaydedilmiştir. Gruplar HBS varlığına göre karşılaştırılmış, istatistiksel analizlerde uygun parametrik ve non–parametrik testler kullanılmıştır.

Bulgular: Katılımcıların yaş ortalaması 40,6 ± 8,6 yıl olup, %68,9’u kadındı. HBS sıklığı %37,7 olarak saptandı. HBS’si olan MS grubunda yaş, Genişletilmiş Özürlülük Durum Ölçeği skoru, sekonder progresif MS ve primer progresif MS oranları ile spinal lezyon varlığı anlamlı olarak daha yüksekti ($p < 0,05$). HBS’si olan hastaların %63,2’sinde uyku kalitesi kötü bulundu ($p = 0,01$). Lojistik regresyon analizine göre HBS varlığı kötü uyku kalitesi riskini 3,37 kat artırdı ($p = 0,006$); ailede HBS öyküsü de bağımsız risk faktörüydü ($p = 0,01$).

Sonuç: MS hastalarında HBS sık görülmekte ve kötü uyku kalitesiyle ilişkili bulunmaktadır. HBS varlığı, spinal lezyonlar, yüksek engellilik düzeyi ve ileri yaş ile birlikte uyku kalitesini olumsuz etkiler. MS hastalarının takibinde HBS’nin erken tanı ve tedavisi uyku kalitesinin iyileştirilmesi açısından önem taşır.

Anahtar Kelimeler: Multipl skleroz, huzursuz bacak sendromu, uyku kalitesi

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Introduction

Restless legs syndrome (RLS) is a chronic neurological disorder characterized by abnormal sensory symptoms. Although well known, it is still easily overlooked or misdiagnosed in clinical practice. RLS manifests as restlessness, sensations of burning or tingling in the legs, and a strong urge to move the legs. Although these sensations are not typically painful, they cause considerable discomfort. Symptoms predominantly occur during rest, intensify at night, and consequently lead to chronic sleep disturbances and emotional distress. Epidemiological studies show that RLS occurs in 1–15% of the population, with a higher frequency in women (1,2). Allen et al. (3) reported a prevalence of 7% in the general population.

Multiple sclerosis (MS) is a chronic autoimmune disease characterized by neuroinflammation and neurodegeneration and typically diagnosed between the ages of 20 and 40 years. Until recently, RLS in individuals with MS was considered a primary sensory manifestation of MS. However, subsequent studies have established MS as a secondary cause of RLS.

RLS occurs in approximately 30% of MS patients, a rate significantly higher than seen in general population (4). Auger et al. (5) identified RLS in 37.5% of 200 MS patients, compared to 16% in a control group of 100 individuals. Current literature suggests that RLS reduces sleep quality and increases fatigue in people with MS (6,7). In fact, greater RLS symptom severity in MS was shown to be associated with poorer sleep quality (8).

Given its high prevalence in MS patients, RLS is likely to contribute to impaired sleep quality and fatigue in these patients. However, there is a limited number of studies exploring the relationship between these variables. Therefore, this study aimed to investigate the effect of RLS on sleep quality and fatigue in patients with MS.

Materials and Methods

Patients aged 18 years and older with a diagnosis of MS were included in this cross–sectional study. Exclusion criteria were pregnancy, a diagnosis of any chronic disease other than MS (e.g., diabetes mellitus, renal failure, malignancy, rheumatological diseases, obstructive sleep apnea syndrome), and previous diagnosis or treatment for RLS. Following the provision of written informed consent, the Cambridge–Hopkins RLS Questionnaire was administered to 151 patients who had been followed with a definitive MS diagnosis for at least 6 months in the MS outpatient clinic (3). Based on the questionnaire results, patients were categorized into two groups: MS patients with RLS (n = 57) and MS patients without RLS (n = 94).

The Pittsburgh Sleep Quality Index (PSQI) was administered to all patients, and the RLS Severity Scale was also administered to patients with RLS. Routine neurological examinations were conducted and medical records were reviewed. Personal data forms were used to record demographic characteristics, MS subtype, disease duration, Expanded Disability Status Scale (EDSS) scores, lesion locations on brain and spinal (cervical and thoracic) magnetic resonance imaging (MRI), antidepressant medication use, immediate family history of RLS, and laboratory values including ferritin level. Immunotherapy was classified as first–line (interferon–beta, glatiramer acetate, teriflunomide, dimethyl fumarate) or second–line (fingolimod, natalizumab, cladribine, ocrelizumab, rituximab) treatment.

This study was approved by the Local Ethics Committee of Kütahya Health Sciences University (decision number: 2021/01–04, date: 20.01.2021).

Statistical Analysis

The normality of data distribution for continuous variables was assessed using the Kolmogorov–Smirnov test for continuous variables. Normally distributed variables were presented as mean and standard deviation, while non–normally distributed variables were expressed as median and range. Comparisons between groups for continuous variables were performed using the independent samples t–test or the Mann–Whitney U test, as appropriate. Categorical variables were compared using Pearson's chi–square test, continuity correction, or Fisher's exact test. Potential predictors of PSQI were evaluated using logistic regression analysis. IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY), and a p–value <0.05 was considered statistically significant.

Results

The mean age of the 151 patients included in the study was 40.62±8.6 years. Of these, 47 (31.1%) were male and 104 (68.9%) were female. When grouped by the presence of RLS, 57 patients (37.7%) were included in the MS/RLS+ group and 94 patients (62.3%) in the MS/RLS–group. The demographic, clinical, and social characteristics of all patients are presented in Table 1.

In the comparison between groups, the mean age was significantly higher in the MS/RLS+ group than in the MS/RLS– group (43.07±8.72 years vs. 39.13±8.23 years, p= 0.006). Regarding MS disease course, the secondary progressive MS (SPMS) and primary progressive MS (PPMS) subtypes were more frequent in the MS/RLS+ group (p=0.006). The median EDSS score was 2.5 (range, 0–8) in the MS/RLS+ group, which was significantly higher than in the MS/RLS– group (median 1.5, range 0–7.5; p<0.001).

Comparison of MRI findings showed that spinal lesions were more common in the MS/RLS+ group, affecting 41 patients (71.9%) compared to 51 patients (54.3%) in the MS/RLS– group (p=0.04). According to PSQI results, PSQI was identified in 36 patients (63.2%) in the MS/RLS+ group versus 39 patients (41.5%) in the MS/RLS– group (p=0.01). Regarding employment status, the proportion of unemployed patients was significantly higher in the MS/RLS+ group (57.9% vs. 30.9%, p=0.02). In terms of immunotherapy, significantly more patients in the MS/RLS+ group were receiving second–line treatment (59.6% vs. 38.3%, p=0.01). No significant differences between the groups were found for other variables (Table 1).

Based on PSQI scores, 76 patients (50.3%) were classified as having good sleep quality and 75 patients (49.7%) as having PSQI. Demographic, clinical, and social variables were compared between these groups. Patients with PSQI had a

Table 1. Comparison of clinical and demographic characteristics of MS patients with and without RLS.

	Total (n = 151)	MS/RLS+ (n = 57, 37.7%)	MS/RLS- (n = 94, 62.3%)	Test statistics	p
Age (years), (mean ± SD)	40.62 ± 8.60	43.07 ± 8.72	39.13 ± 8.23	2.78	**0.006**
Gender, n (%) • Male • Female	47 (31.1) 104 (68.9)	20 (35.1) 37 (64.9)	27 (28.7) 67 (71.3)	0.40	0.52[¥]
MS duration (years), median (range)	7 (0.3-28)	7 (0.3-21)	7 (0.5-28)	2561	0.65
MS subtype, n (%) • RRMS • PPMS • SPMS	127 (84.1) 4 (2.6) 20 (13.2)	42 (73.7)[a] 4 (7)[a] 11 (19.3)[a]	85 (90.4)[b] 0[b] 9 (9.6)[b]	10.31	**0.006**[≠]
EDSS, median (range)	1.5 (0-8)	2.5 (0-8)	1.5 (0-7.5)	1731	**<0.001**
Family history of RLS, n (%)	17 (11.3)	5 (8.8)	12 (12.8)	0.23	0.62[¥]
Antidepressant use, n (%) • Yes • No	47 (31.1) 104 (68.9)	22 (38.6) 35 (61.4)	25 (26.6) 79 (63.4)	1.85	0.17[¥]
Ferritin, n (%) • Normal • Low	128 (84.8) 23 (15.2)	45 (78.9) 12 (21.1)	83 (88.3) 11 (11.7)	1.73	0.18[¥]
MRI lesions, n (%) • Periventricular • Juxtacortical • Infratentorial • Spinal lesion	146 (96.7) 88 (58.3) 68 (45) 92 (60.9)	57 (10.0) 28 (49.1) 22 (38.6) 41 (71.9)	89 (94.7) 60 (63.8) 46 (48.9) 51 (54.3)	- 2.5 1.53 3.94	0.15[ğ] 0.10[¥] 0.21[≠] **0.04**[¥]
PSQI score, mean ± SD					
Poor sleep quality (PSQI <5), n (%) • Good • Bad	76 (50.3) 75 (49.7)	21 (36.8) 36 (63.2)	55 (58.5) 39 (41.5)	6.66	**0.01**[≠]
Oligoclonal band positive, n (%)	142 (94)	53 (93)	89 (94.7)		0.61[ğ]
Education, n (%) • Primary School • High School • University	22 (14.6) 52 (34.4) 77 (51)	12 (21.1) 22 (38.6) 23 (40.4)	10 (10.6) 30 (31.9) 54 (57.4)	5.13	0.07[≠]
Marital status, n (%) • Married • Single	133(88.1) 18 (11.9)	53 (93) 4 (7)	80 (85.1) 14 (14.9)	1.41	0.23[¥]
Employment status, n (%) • Employed • Unemployed	89 (58.9) 62 (41.1)	24 (42.1) 33 (57.9)	65 (69.1) 29 (30.9)	9.63	**0.02**[¥]
Immunotherapy, n (%) • First-line treatment • Second-line treatment	83 (53.6) 70 (46.4)	23 (40.4) 34 (59.6)	58 (61.7) 36 (38.3)	6.50	**0.01**[≠]
RLS severity score, n (%) • Mild • Moderate • Severe • Very severe	5 (3.3) 28 (18.5) 18 (11.9) 6 (4)	5 (3.3) 28 (18.5) 18 (11.9) 6 (4)	- - - -		

[¥]Continuity correction, [≠]Pearson chi-square test, [ğ]Fisher's exact test.

a-b: Shows the difference between MS subtypes.

SD: Standard deviation, EDSS: Expanded Disability Status Scale, RLS: Restless legs syndrome, MS: Multiple sclerosis, MRI: Magnetic resonance imaging, PSQI: Pittsburgh Sleep Quality Index, RRMS: Relapsing-remitting MS, SPMS: Secondary progressive MS, PPMS: Primary progressive MS.

significantly higher rate of RLS (48.0% vs. 27.6%, p=0.01) and family history of RLS (17.3% vs. 5.3%, p=0.03) compared to those with good sleep quality. No significant differences in other variables were observed between the groups (Table 2).

Predictors of PSQI identified by logistic regression analysis are presented in Table 3. The multivariate model was statistically significant (p<0.001) and demonstrated good fit with the data (p=0.01). The analysis revealed that the presence of RLS was a

Table 2. Comparison of variables associated with sleep quality among all MS patients.

	Good sleep quality (PSQI <5) (n = 76; 50.3%)	Poor sleep quality (PSQI >5) (n = 75; 49.7%)	Test statistics	p
Age (years), mean ± SD	40.59±9.02	40.65±8.22	-0.04	0.96
Gender, n (%)				
• Male	22 (28.9)	25 (33.3)	0.33	0.56≠
• Female	54 (71.1)	50 (66.7)		
MS duration (years), median (range)	7 (0.5-28)	7 (0.3-24)	2775	0.78
MS subtype, n (%)				
• RRMS	65 (85.5)	62 (82.7)	4.26	0.11≠
• PPMS	0	4 (5.3)		
• SPMS	11 (14.5)	9 (12)		
EDSS, median (range)	1.5 (0-7.5)	2 (0-8)	2818	0.90
RLS, n (%)				
• Yes	21 (27.6)	36 (48)	6.66	**0.01**≠
• No	55 (72.4)	39 (52)		
Family history of RLS, n (%)	4 (5.3)	13 (17.3)	4.36	**0.03**¥
Antidepressant use, n (%)				
• Yes	27 (35.5)	20 (26.7)	1.38	0.24≠
• No	49 (64.5)	55 (73.3)		
Ferritin, n (%)				
• Normal	66 (86.8)	62 (82.7)	0.23	0.62¥
• Low	10 (13.2)	13 (17.3)		
MRI lesions, n (%)				
• Periventricular	74 (97.4)	72 (96)	-	0.68§
• Juxtacortical	41 (53.9)	47 (62.7)	1.18	0.27≠
• Infratentorial	36 (47.4)	32 (42.7)	0.33	0.56≠
• Spinal lesion	40 (52.6)	52 (69.3)	4.42	0.03≠
Oligoclonal band positive, n (%)	71 (93.4)	71 (94.7)	0.13	0.93≠
Education, n (%)				
• Primary School	12 (15.8)	10 (13.3)	0.60	0.74≠
• High School	24 (31.6)	28 (37.3)		
• University	40 (52.6)	37 (49.3)		
Marital status, n (%)				
• Married	65 (85.5)	68 (90.7)	0.52	0.46¥
• Single	11 (14.5)	7 (9.3)		
Employment status, n (%)				
• Employed	43 (56.6)	46 (61.3)	0.35	0.55≠
• Unemployed	33 (43.4)	29 (38.7)		
Immunotherapy, n (%)				
• First-line treatment	42 (55.3)	39 (52)	0.16	0.68≠
• Second-line treatment	34 (44. 7)	36 (48)		
RLS severity score, n (%)				
• Mild	1 (4.8)	4 (11.1)		
• Moderate	11 (52.4)	17 (47.2)	2.17	0.53≠
• Severe	8 (38.1)	10 (27.8)		
• Very severe	1 (4.8)	5 (13.9)		

≠Pearson chi-square test, ¥Continuity correction, §Fisher's exact test.

SD: Standard deviation, EDSS: Expanded Disability Status Scale, RLS: Restless legs syndrome, MS: Multiple sclerosis, MRI: Magnetic resonance imaging, PSQI: Pittsburgh Sleep Quality Index, RRMS: Relapsing-remitting MS, SPMS: Secondary progressive MS, PPMS: Primary progressive MS.

Table 3. Results of logistic regression analysis of predictors of sleep quality.				
	Univariate logistic regression model		Multivariate logistic regression model (enter)	
	OR (95% CI)	p	OR (95% CI)	p
Presence of RLS	0.41 (0.21-0.81)	**0.01**	3.37 (0.18-0.75)	**0.006**
Family history of RLS	0.26 (0.08-0.85)	**0.02**	0.22 (0.06-0.75)	**0.01**
Constant			6.80	**0.003**

Cox & Snell $R^2 = 0.08$; Nagelkerke $R^2 = 0.11$; Hosmer-Lemeshow chi-square test = 0.01.
RLS: Restless legs syndrome, OR: Odds ratio, CI: Confidence interval.

significant independent predictor, with 3.37 times higher odds of PSQI in these patients (p=0.006). A family history of RLS was also an independent predictor, associated with 78% lower odds of PSQI (p=0.01).

Discussion

In our study, the frequency of RLS among patients with MS was 37.7%, which falls within the range of 13.3% to 65.1% reported in the literature (8).

Our findings indicated that spinal lesions were more common in the MS/RLS+ group, consistent with numerous studies suggesting that such lesions increase the risk of RLS in patients with MS. This association is likely driven by multiple mechanisms. The spinal cord serves as the primary relay for sensory signals from the legs and for descending dopaminergic inhibition. Lesions in this region can disrupt the spinothalamic and dorsal column pathways, leading to the disorganized sensory input and the subsequent urge to move that characterizes RLS. Furthermore, reduced dopaminergic inhibition promotes hyperexcitability in spinal neurons. The combination of sensory impairment, increased neuronal excitability, and disrupted motor control provides a robust explanation for the higher prevalence of RLS among MS patients with spinal cord involvement (9-12).

The frequent occurrence of RLS in MS may be attributed to sensory symptoms of MS that mimic RLS (13,14). Beyond symptomatic overlap, several clinical factors have been identified as risk factors for RLS in this population, including older age, longer disease duration, greater pyramidal and sensory dysfunction, and the PPMS subtype (15). In contrast, Vávrová et al. (16) reported that RLS was most common in the SPMS subtype. Consistent with this finding, our study revealed a higher frequency of RLS in the SPMS and PPMS subtypes, with a particularly significant association with SPMS, while no significant difference was observed in RRMS patients. Although Güneş et al. (17) similarly found that RLS was more frequent in SPMS patients, they also reported a higher frequency of RLS in RRMS patients.

Several studies have shown that patients with MS and comorbid RLS tend to have higher EDSS scores. Patients with a higher EDSS score may develop RLS more easily, and the pathological processes underlying RLS may concurrently worsen the course of MS (18). Consistent with this, both EDSS scores and mean age were substantially higher in the MS/RLS+ group compared to the MS/RLS– group in our study.

The higher rate of RLS among patients receiving second–line immunotherapy in our study may be attributable to the higher prevalence of RLS in the SPMS and PPMS subtypes, rather than a direct relationship with the medications themselves. Furthermore, older age and higher disability levels in the second–line immunotherapy group are other likely contributing factors. Younis et al. (19) examined the relationship between immunotherapies and RLS in MS patients and found that RLS was more severe in those receiving fingolimod and teriflunomide. While their study suggests that RLS severity may vary depending on immunotherapy type, the results remain inconclusive because of the small sample size. In contrast, Monschein et al. (12) found no relationship between immunotherapies and the frequency and severity of RLS in patients with MS. A limitation of our study is that the specific relationship between individual immunotherapy agents and RLS was not directly examined.

Another finding of this study was the significantly higher proportion of unemployed individuals in the MS/RLS+ group. This may be related to the higher mean age, higher EDSS scores, and longer disease duration in the unemployed group.

Consistent with previous research, our results underscore the clinical impact of RLS on patient well–being. Moreira et al. (6) confirmed that RLS is common in MS patients and is associated with PSQI and fatigue. Similarly, Manconi et al. (4) and Miri et al. (20) demonstrated that insomnia is highly prevalent among MS patients with RLS. In our study, 49.7% of MS patients were found to have PSQI, and this rate increased to 63.2% among those with RLS.

Conclusion

Patients with MS and RLS demonstrated poorer sleep quality, higher levels of physical disability, and a greater prevalence of spinal lesions compared to those without RLS. Additionally, the RLS group was characterized by a higher mean age, lower employment rate, and larger proportions of the SPMS and PPMS subtypes. While PSQI in MS was associated with personal and family history of RLS, there was no relationship with RLS severity. Given that early detection and management of RLS can significantly improve sleep quality, clinicians should routinely screen for RLS during the follow–up of patients with MS.

Ethics

Ethics Committee Approval: This study was approved by the local ethics committee of Kütahya Health Sciences University (decision number: 2021/01–04, date: 20.01.2021).

Informed Consent: Informed consent was obtained.

Footnotes

Authorship Contributions: Concept: F.A.A., M.Ç., S.C.K., Design: G.A., M.Ç., S.C.K., Data Collection or Processing: F.A.A., G.A., M.Ç., Analysis or Interpretation: F.A.A., G.A., S.C.K., Literature Search: F.A.A., M.Ç., Writing: F.A.A.

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Original Article / *Özgün Makale*

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Relationships Between Work Schedule and Chronotype, Nutrition Attitude, Mood, and Sleep Quality: Police–Teacher Comparison

Çalışma Düzeni ile Kronotip, Beslenme Tutumu, Ruh Hali ve Uyku Kalitesi Arasındaki İlişki: Polis-Öğretmen Karşılaştırması

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Abstract

Objective: This study aimed to compare the relationships between chronotype and nutrition attitudes, mood, and sleep quality among police officers and teachers with different work schedules.

Materials and Methods: This cross-sectional, comparative study was conducted with 176 participants (104 teachers and 72 police officers). Participants completed an online survey including demographic data, dietary habits, the Attitude Scale for Healthy Nutrition, Morningness–Eveningness Questionnaire, Depression Anxiety Stress Scale, and Pittsburgh Sleep Quality Index.

Results: Police officers' eating habits were more affected by their work schedule than those of teachers ($p < 0.05$). In terms of chronotype, the majority of police officers were intermediate types, while the majority of teachers were morning types ($p < 0.05$). Teachers reported better sleep quality than police officers, although the difference did not reach significance ($p > 0.05$). Evening- and intermediate-type participants had higher depression, anxiety, and stress scores than morning types (2- to 4-fold higher for teachers; 5- to 6-fold higher for police officers). In addition, evening-type police officers had significantly poorer sleep quality than morning types.

Conclusion: These findings suggest that the intermediate and evening chronotypes may be associated with a greater negative impact on mood and sleep quality, particularly in rotating shift workers.

Keywords: Chronotype, circadian rhythm, mood, nutrition, police officer, sleep, teacher

Öz

Amaç: Bu çalışma, farklı çalışma düzenlerine sahip polis memurları ve öğretmenler arasında kronotip ile beslenme tutumları, duygu durumu ve uyku kalitesi arasındaki ilişkileri karşılaştırmayı amaçlamıştır.

Gereç ve Yöntem: Kesitsel ve karşılaştırmalı nitelikte olan bu araştırma 176 polis ve öğretmenden ile gerçekleştirilmiştir. Çevrimiçi anket ile katılımcılara demografik verilere ait sorular, beslenme alışkanlıkları (öğün düzenleri, diyet yapma durumu vs.), Sağlıklı Beslenmeye İlişkin Tutum Ölçeği, Sabahçıl–Akşamcıl Testi, Depresyon Anksiyete Stres Ölçeği ve Pittsburgh Uyku Kalitesi İndeksi yönlendirilmiş ve verilen cevaplar değerlendirilmiştir.

Bulgular: Polis memurlarının beslenme durumunun, öğretmenlerin beslenme durumuna göre çalışma düzenlerinden daha fazla etkilendiği gözlemlenmiştir ($p < 0,05$). Kronotip açısından, polislerin çoğu ara tip, öğretmenlerin ise çoğunluğunun sabahçıl olduğu görülmüştür ($p < 0,05$). Uyku kalitesi açısından, öğretmenlerin polislere oranla daha iyi uyku kalitesine sahip olduğu bulunmuştur ($p > 0,05$). Sabahçıllara kıyasla, diğer kronotiplerdeki öğretmenlerin depresyon, anksiyete ve stres puanları 2 ila 4 kat daha yüksekken, polis memurlarının puanları 5 ila 6 kat daha yüksektir. Ayrıca, akşam tipi polis memurlarının uyku kalitesinin sabah tiplerine kıyasla yaklaşık 2 kat daha kötü olduğu tespit edilmiştir.

Sonuç: Bu bulgular, ara ve akşam kronotipine sahip olmanın polis memurlarının duygu durumu ve uyku kalitesi üzerinde öğretmenlere göre daha olumsuz bir etkiye sahip olabileceğini göstermektedir.

Anahtar Kelimeler: Beslenme, duygu durumu, kronotip, öğretmen, polis, sirkadiyen ritim, uyku

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Introduction

In modern society, fluctuations in working hours can have a detrimental effect on mental and behavioral health outcomes, including dietary behaviors, depression, stress, and sleep quality (1). Bibliometric analyses have shown that epidemiological publications related to shift work and health have increased rapidly over the past 10–15 years, with the focus broadening to include cancer and mental/psychological health (2). In this context, increasing attention has been directed toward the circadian system, which includes the central clock in the suprachiasmatic nucleus of the hypothalamus and peripheral clocks in the metabolic tissues. This system regulates many of the body's daily physiological processes, from hormone release to body temperature regulation and the sleep-wake cycle (3).

In the natural circadian rhythm, individuals should rise early in the morning and carry out activities such as eating and working during daylight hours (1,4). As exposure to sunlight decreases, individuals typically reduce their activity levels and spend the nighttime hours obtaining restorative sleep. However, there are individual variations in the preferred timing of sleep and daily activities, which are termed chronotypes. People inclined to be more active during daylight hours are considered morning types, while those who are more active in the evening hours are called evening types. Morning types have been shown to be more closely aligned with the endogenous circadian rhythm (5). Shift work has been shown to significantly alter sleep-wake cycles and eating patterns (6). These alterations can in turn disrupt the circadian rhythm, disturbing the body's equilibrium and negatively impacting health. A large-scale epidemiological study showed that the prevalence of circadian rhythm sleep-wake disorders (particularly delayed sleep phase and shift work disorder) in the general population is around 10% to 13% (7). In professions with shift work systems, such as policing, night shifts cause individuals to spend their mornings sleeping and being physically inactive, while being active at night when sleep would normally occur. This disruption of biological rhythms can affect mood, causing them to feel more depressed and stressed (8,9). In a study examining the sleep patterns and nutritional status of police officers working different shifts, the authors noted their inability to adequately assess the long-term effects of circadian rhythm disruptions because of the participants' constantly changing shift schedule (10).

Chrononutrition, a subfield of chronobiology, is an emerging area of interest, with research focusing on the role of meal timing and its alignment with the body's natural circadian rhythms in regulating metabolic health and energy balance (11,12). Eating/feeding time is a well-known zeitgeber (13). Irregular working hours or shift work, which can lead to fluctuations in mealtimes and irregular eating habits, have been associated with negative health outcomes such as obesity and type 2 diabetes, although definitive evidence remains limited (14).

The fundamental principle of chrononutrition is the optimization of the release of hormones such as insulin, cortisol, and melatonin through the consumption of meals at specific times of the day. Given that the body's insulin sensitivity is elevated during the day and reduced at night, the consumption of a late-night meal can elevate blood sugar levels and impair insulin sensitivity (13). Consequently, in addition to the traditional focus of dietary guidelines, namely food quantity and quality (i.e., how much we eat and what we eat), it is also important to consider the timing of food intake (i.e., when we eat) (15). Although previous studies have examined the circadian rhythms and nutritional status of shift workers, the exact nature of these disruptions remains poorly defined (16).

To the best of our knowledge, there has been no analysis and comparison of potential relationships among chronotype, dietary habits, nutrition attitudes, mood, and sleep quality in police officers and teachers, two occupational groups with different work schedules. Therefore, this study aimed to compare the relationship between chronotype, an individual determinant of circadian rhythm, and nutrition attitudes, mood, and sleep quality among shift-working police officers and daytime-working teachers.

Materials and Methods

Study Design

This cross-sectional, comparative study compared the possible relationship between the work schedules of two occupational groups, police officers and teachers, and their chronotype, nutrition attitudes, mood, and sleep quality. According to a power analysis performed using G*Power 3.1 software, assuming a significance level (α) of 0.05 and a test power ($1-\beta$) of 0.90, a total of 140 participants were required, with a minimum of 70 for each group. The study was conducted with 104 teachers and 72 police officers.

Participating police officers worked in a two-shift system with rotation every two weeks. The day shift runs from 6:00 AM to 6:00 PM, and the night shift runs from 6:00 PM to 6:00 AM. All participating teachers worked standard daytime shifts (approximately 8:00 AM to 4:00 PM).

Inclusion criteria were (1) age over 18 years, (2) at least one year of professional experience, (3) ability to speak and understand Turkish, and (4) absence of any chronic disease (e.g., diabetes mellitus, insulin resistance, hypertension, ischemic heart disease, thyroid disorders, chronic kidney or liver disease), psychiatric diagnosis, or eating disorder. Exclusion criteria were (1) pregnancy, (2) currently following any specific diet, and (3) use of medications that affect sleep quality or nutritional status.

Study data were obtained using an online survey from volunteer participants. All participants were informed of the purpose of the study and provided written informed consent online, in accordance with the Declaration of Helsinki. Ethical approval for the study was obtained from the Ordu University Social and Human Sciences Research Ethics Committee (date: 29 April 2025; session no: 04; decision no: 2025-74).

Data Collection Tools

Participants were asked questions about their demographic information, and completed the Attitude Scale for Healthy

Nutrition (ASHN), Morningness–Eveningness Questionnaire (MEQ), Depression Anxiety Stress Scale (DASS-21), and Pittsburgh Sleep Quality Index (PSQI).

Demographic Information Form: This form was used to determine the participants' general characteristics and included questions about their age, gender, health status, smoking and alcohol use, length of professional experience, typical sleep duration, and dietary habits. In addition, height and weight information was collected based on participants' self-report. Body mass index (BMI) was calculated from these data and evaluated according to the World Health Organization (WHO) classification (17,18).

ASHN: The ASHN was developed in 2019 by Tekkurşun Demir and Cicioğlu (19) to determine attitudes toward nutrition in adults, and its validity and reliability have been established. It is a 21-item, 5-point Likert-type scale with 4 factors (nutrition knowledge, attitudes toward nutrition, positive nutrition, and poor nutrition). Responses to positive items range from "strongly disagree" (1 point) to "strongly agree" (5 points). Scoring is reversed for negative items. Higher scores indicate better nutrition knowledge, attitudes, and behaviors (19).

Morningness-Eveningness Questionnaire: The MEQ was developed by Horne and Östberg (20) in 1976. Its validity and reliability in Turkish were established in 2005 (21). It consists of 19 multiple-choice and time-based items regarding lifestyle, sleep-wake patterns, and peak performance times. Each item receives a point value ranging from 0 to 6 points. Chronotype is determined according to total MEQ score, with total scores of 16–41 classified as "evening type," 42–58 as "intermediate type," and 59–86 as "morning type" (21).

Depression Anxiety Stress Scale (DASS-21): This study utilized the 21-item DASS scale, adapted from the studies by Henry and Crawford (22) and Mahmoud et al. (23). The validity and reliability study of this version in Turkish was conducted by Yılmaz et al. (24) in 2017. The DASS-21 contains 7 items in each of 3 dimensions: depression, stress, and anxiety. Items are rated on a 4-point Likert-type scale from "does not apply to me" (0 points) to "applies to me very much" (3 points). Based on the respective subscale scores, the individual's depression, anxiety, and stress levels are assessed as normal, mild, moderate, severe, or very severe (24).

Pittsburgh Sleep Quality Index (PSQI): The PSQI, developed in 1989 by Buysse et al. (25), was used to assess participants' sleep quality over the previous month. The Turkish validity and reliability study was conducted by Ağargün (26) in 1996. The index consists of 7 subscales: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, sleep medication use, and daytime sleep dysfunction. Each component is scored between 0 and 3 points, yielding a total score ranging from 0 to 21 points. A score of 5 or below indicates good sleep quality, while a score of 6 or above indicates poor sleep quality (25,26).

Statistical Analysis

SPSS Statistics version 27.0 software (IBM Corp., Armonk, NY) was used for statistical analyses, with a significance level of $p < 0.05$. Categorical data are expressed as frequencies (n) and percentages (%). The normality of continuous variables was examined using the Kolmogorov-Smirnov test, as well as evaluation of skewness and kurtosis. In descriptive analyses, normally distributed data were expressed as mean ± standard deviation (SD) and non-normally distributed data were expressed as median and interquartile range (IQR). Comparisons among variables were assessed using chi-square analysis for categorical data, parametric tests (t-test, analysis of variance) for normally distributed data, and non-parametric tests (Mann-Whitney U, Kruskal-Wallis H) for non-normally distributed data. Spearman correlation analysis was used to identify associations between variables, and linear regression analysis was performed to determine the strength of these relationships. Due to the limited number of participants in the highest severity categories of the DASS-21, the 'severe' and 'very severe' classifications were combined for the depression and anxiety subscales. Similarly, for the stress subscale, the four severity levels were reduced to two categories, 'mild to moderate' and 'severe to very severe', to ensure sufficient data for analysis.

Results

A total of 104 teachers and 72 police officers participated in the study. The sociodemographic characteristics of both groups are shown in Table 1. The proportion of female teachers and police officers was 59.6% and 20.8%, respectively ($p < 0.001$). Police officers reported significantly higher rates of smoking and alcohol use than teachers ($p < 0.001$ for both). Teachers were significantly older than police officers (mean ± SD: 40.3 ± 8.20 vs. 34.0 ± 6.25 years; $p = 0.011$) and had more professional experience (median [range]: 3 [1–4] vs. 2 [1–4] years, respectively; $p < 0.001$). Work schedule impacted diet more frequently for police officers than teachers ($p < 0.001$).

The chronotypes, depression, anxiety, and stress levels, sleep quality, and nutrition attitudes of teachers and police officers are examined in Table 2. In terms of chronotype (determined by the MEQ), the majority of police officers were classified as intermediate type (69.4%), whereas a higher proportion of teachers were classified as morning type (54.8%). When stress levels were examined according to the DASS-21, most teachers (84.6%) had normal stress levels, while a greater percentage of police officers (19.4%) reported mild/moderate stress ($p = 0.037$). Regarding sleep quality, teachers tended to have better sleep quality than police officers, although the difference was not significant ($p > 0.05$). There was also no significant difference in nutrition attitudes between teachers and police officers as determined by the ASHN ($p > 0.05$).

Table 3 shows that evening-type teachers had higher depression (median [IQR]: 11.1 [20.00]; $p < 0.001$), stress (10.0 [20.00]; $p = 0.045$), and sleep quality (7.3 [2.63]; $p = 0.037$) scores compared to morning and intermediate types (higher PSQI score indicates worse sleep quality). Evening-type police officers were also found to have significantly higher depression (median [IQR]: 9.1 [4.17]; $p = 0.002$), anxiety (8.0 [15.00]; $p = 0.017$), and stress levels (6.0 [18.00]; $p = 0.022$) compared to morning and intermediate types. No significant difference in nutrition attitudes was observed among chronotypes in either occupational group.

Table 1. Sociodemographic characteristics of participants.

		Teacher		Police officer		χ²; p
		n	%	n	%	
Gender	Female	62	59.6	15	20.8	χ^2 = 26.002; **p < 0.001**[a]
	Male	42	40.4	57	79.2	
Marital status	Single	22	21.2	24	33.3	χ^2 = 3.269; p = 0.71[a]
	Married	82	78.8	48	66.7	
Smoking	Yes	27	26.0	36	50.0	χ^2 = 10.697; **p = 0.001**[a]
	No	77	74.0	36	50.0	
Alcohol consumption	Yes	10	9.6	21	29.2	χ^2 = 11.207; **p = 0.001**[a]
	No	94	90.4	51	70.8	
Skipping meals	Yes	62	56.6	51	70.8	χ^2 = 2.330; p = 0.127[a]
	No	42	40.4	21	29.2	
History of dieting	Yes	11	10.6	6	8.3	χ^2 = 0.245; p = 0.620[a]
	No	93	89.4	66	91.7	
Does your work schedule affect your diet?	Never	11	10.6	2	2.8	χ^2 = 26.285; **p < 0.001**[a]
	Rarely	55	52.9	17	23.6	
	Usually	29	27.8	32	44.4	
	Always	9	8.7	21	29.2	
		$\bar{X}$/M	**SD/min-max**	**$\bar{X}$/M**	**SD/min-max**	**p**
Age (years)		40.3	8.20	34.0	6.25	**0.011**[c]
Professional experience (years)		3	1–4	2	1–4	**<0.001**[b]
Sleep duration (hours)		7	5–10	7	4–12	0.813[b]
Number of meals per day		3	2–5	3	1–7	0.791[b]
Height (cm)		167.8	8.68	176.9	8.74	0.540[c]
Body weight (kg)		71.3	13.29	77.8	13.14	0.716[c]
BMI (kg/m²)		25.2	3.52	24.8	3.16	0.382[c]
		n	%	n	%	
BMI classification	Normal	52	50.0	39	54.2	0.497[a]
	Overweight	43	41.3	30	41.6	
	Obese	9	8.7	3	4.2	

[a]Chi-square test; [b]Mann-Whitney U test; [c]Independent samples t-test. BMI: Body mass index, M: Median, Max: Maximum, Min: Minimum, SD: Standard deviation. $\bar{X}$: Mean, Significant results ($p < 0.05$) are in bold.

In morning-type and intermediate-type teachers, there were moderate to strong positive correlations among depression, anxiety, stress, and sleep quality ($p < 0.01$). These associations were stronger for evening-type teachers, with depression showing very strong correlation with anxiety and stress ($r = 0.964$; $p < 0.01$). Intermediate-type and evening-type police officers also exhibited moderate to strong positive correlations among depression, anxiety, and stress ($p < 0.05$). Additionally, sleep quality was moderately correlated with anxiety in intermediate-type police officers ($r = 0.464$; $p < 0.01$) (Figure 1).

Regression analyses of teachers' and police officers' mood, BMI, and sleep quality according to chronotype are presented in Table 4. Intermediate and evening types had significantly higher depression, anxiety, and stress scores compared to morning types (2- to 4-fold higher for teachers; 5- to 6-fold higher for police officers). Furthermore, evening-type police officers' sleep quality was approximately twice as poor as that of morning types.

Discussion

The present study examined the potential relationship between chronotype and nutrition attitudes, mood, and sleep quality in two occupational groups with different work schedules. The findings indicated that police officers' shift work schedule had a greater impact on their eating habits than teachers' daytime schedule, although there was no difference in nutrition attitudes between the two groups. According to the MEQ, the majority of teachers were morning types, whereas the majority of police officers were intermediate types. Teachers and police officers who were evening types reported significantly higher levels of depression, stress, and anxiety compared to other chronotypes. Furthermore, more than half of police officers had poor sleep quality, while both teachers and police officers who were

Table 2. Classification of teachers and police officers according to chronotype, depression, anxiety, and stress levels, sleep quality, and nutrition attitudes.

		Teacher		Police officer		χ^2; p
		n	%	n	%	
Chronotype	Morning	57	54.8	10	13.9	χ^2 = 14.433 **p = 0.001**
	Intermediate	40	38.5	50	69.4	
	Evening	7	6.7	12	16.7	
Depression level	Normal	35	33.7	18	25.0	χ^2 = 1.804; p = 0.614
	Mild	30	28.8	23	31.9	
	Moderate	31	29.8	23	31.9	
	Severe/very severe	8	7.7	8	11.1	
Anxiety level	Normal	38	36.5	20	27.8	χ^2 = 3.947; p = 0.267
	Mild	24	23.1	12	16.7	
	Moderate	20	19.2	19	26.4	
	Severe/very severe	22	21.2	21	29.2	
Stress level	Normal	88	84.6	57	79.2	χ^2 = 6.615; **p = 0.037**
	Mild/moderate	9	8.7	14	19.4	
	Severe/very severe	7	6.7	1	1.4	
Sleep quality	Good	57	54.8	34	47.2	χ^2 = 0.980; p = 0.322
	Bad	47	45.2	38	52.8	
Nutrition attitudes	Moderate	9	8.7	12	16.7	χ^2 = 2.600; p = 0.107
	Good	95	91.3	60	83.3	

Chi-square tests. Significant results ($p < 0.05$) are in bold.

Table 3. Comparison of teachers' and police officers' mood, sleep quality, and nutrition attitudes according to chronotype.

	Teacher				Police officer			
	Morning-type	Intermediate-type	Evening-type		Morning-type	Intermediate-type	Evening-type	
Depression	5.8 (3.55)^x	5.6 (2.72)^x	11.1 (20.00)^y	**p < 0.001**^{a}	4.5 (1.27)^x	6.2 (3.00)^x	9.1 (4.17)^y	**p = 0.002**^{a}
Anxiety	4.0 (21.00)	5.0 (12.00)	13.0 (21.00)	p = 0.099^b	3.0 (8.00)^x	6.0 (13.00)^y	8.0 (15.00)^y	**p = 0.017**^{b}
Stress	3.0 (21.00)^x	3.0 (13.00)^x	10.0 (20.00)^y	**p = 0.045**^{b}	2.0 (7.00)^x	4.5 (12.00)^y	6.0 (18.00)^y	**p = 0.022**^{b}
PSQI	4.7 (3.08)^x	5.8 (2.58)^x	7.3 (2.63)^y	**p = 0.037**^{a}	4.5 (1.84)	6.0 (3.06)	7.3 (1.78)	p = 0.062^a
ASHN total	67.6 (30.00)	67.6 (28.00)	67.6 (30.00)	p = 0.588^b	65.6 (39.00)	67.8 (36.00)	68.3 (20.00)	p = 0.155^b
ASHN subscales								
Nutrition knowledge	20.0 (4.03)	20.1 (5.03)	19.9 (0.03)	p = 0.810^b	19.2 (14.00)	19.9 (15.00)	19.6 (3.00)	p = 0.391^b
Attitudes toward nutrition	16.3 (4.81)	16.1 (7.00)	17.0 (5.81)	p = 0.122^b	15.2 (17.00)	16.1 (16.00)	16.7 (10.00)	p = 0.608^b
Positive nutrition	15.7 (4.00)	15.5 (7.00)	15.6 (0.39)	p = 0.524^b	15.9 (13.00)	15.5 (11.00)	15.5 (1.00)	p = 0.669^b
Poor nutrition	16.8 (5.55)	16.5 (8.00)	16.6 (1.55)	p = 0.327^b	15.4 (15.00)	16.3 (13.00)	16.3 (8.00)	p = 0.995^b

Data expressed as mean (standard deviation) or median (interquartile range). ^{a}Analiysis of variance, ^{b}Kruskal-Wallis H test. Significant results ($p < 0.05$) are in bold. There is a significant difference between x, y, z groups. PSQI: Pittsburgh Sleep Quality Index, ASHN: Attitude Scale for Healthy Nutrition.

morning types had good sleep quality. Positive correlations between mood and sleep quality were observed in morning- and intermediate-type teachers and intermediate-type police officers. Regression analyses revealed that depression, anxiety, and stress levels were 3- to 6-fold higher in evening and intermediate types compared to morning types for both occupational groups, although this association was more pronounced among police officers.

Circadian rhythm is described in terms of individual chronotypes (morningness/eveningness), which reflect a person's preferred timing for activity and sleep within a 24-hour period (27). The circadian rhythm plays a fundamental role in regulating biological functions, including sleep-wake preferences, body temperature, hormone secretion, food intake, and cognitive and physical performance. The timing and composition of food intake are important for synchronizing both the central and

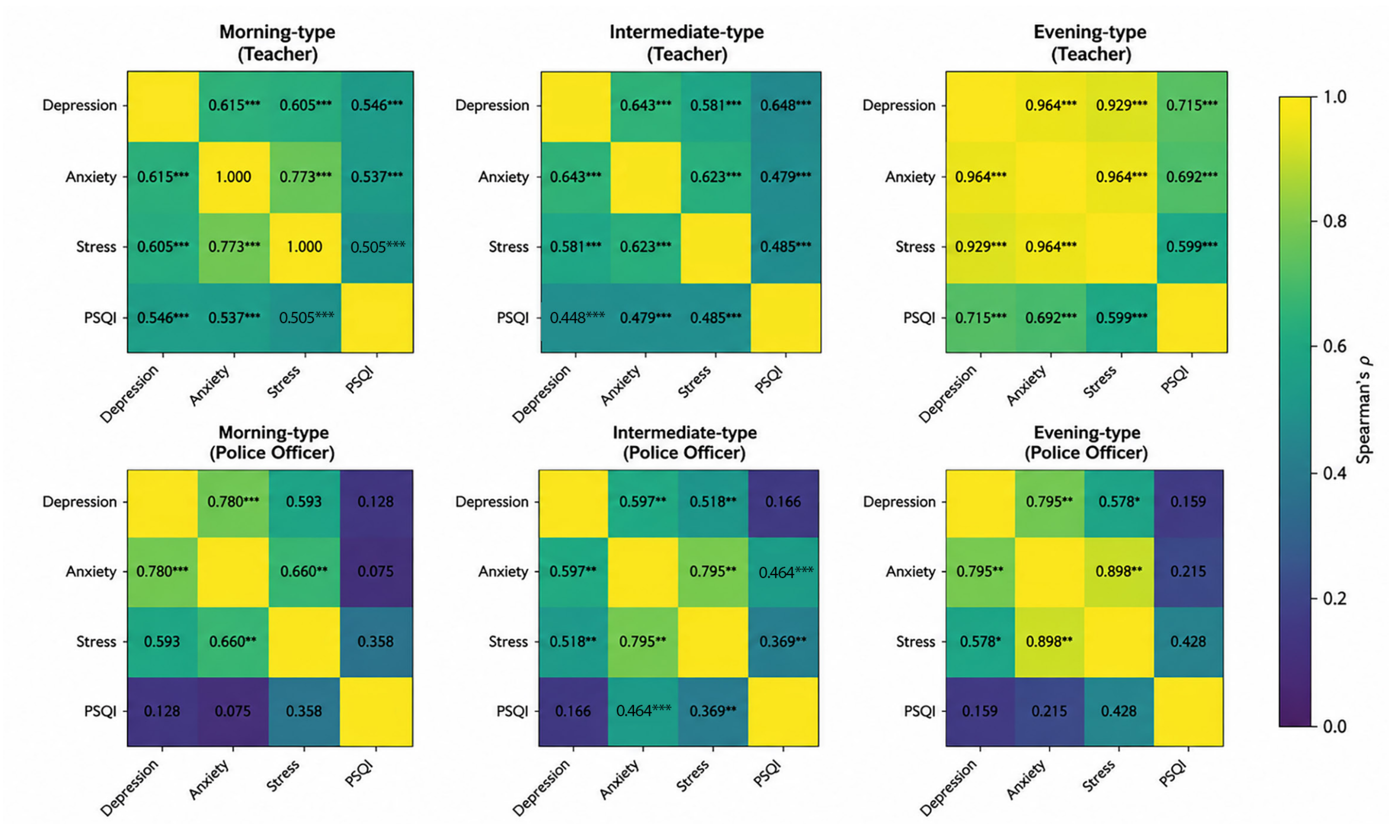

Figure 1. Relationship between mood and sleep quality according to chronotype in teachers and police officers heatmap. Heatmaps showing Spearman correlations among depression, anxiety, stress, and sleep quality scores, stratified by chronotype (morning, intermediate, evening) in teachers and police officers. Lighter colors indicate stronger associations. Correlation coefficients are displayed in each cell. Statistical significance is indicated by asterisks (*p < 0.05; **p < 0.01). PSQI: Pittsburgh Sleep Quality Index.

peripheral biological clocks in humans. These metabolic clocks coordinate the synthesis, breakdown, recycling, and disposal of metabolic substrates, ensuring that nutrients consumed at mealtimes can adequately meet our physiological needs (28). Furthermore, from a nutritional genomics perspective, genetic variants in "clock genes" can both affect metabolic health and alter an individual's response to diet (29). Therefore, a single food or specific combination of foods can lead to weight gain or loss in relation to chronotype and the hunger-satiety cycle (30). Having an evening or morning chronotype not only determines preferred sleep schedule but can also influence subsequent mealtimes, which in turn can affect the circadian rhythm (31). This is because the clocks within the hypothalamus (such as the suprachiasmatic nucleus) regulate the daily rhythm of food intake (32). Biological clocks outside the hypothalamus are sensitive to nutrients in the peripheral circulation, such as free fatty acids and glucose, and to nutrients-related hormones such as ghrelin, leptin, and insulin. Furthermore, biological clocks may also interact with dopaminergic motivation-reward circuits that influence eating behavior, effectively controlling food intake through both homeostatic and hedonic pathways (33).

A systematic review of 24 studies examining chronotype and body composition found that although evening and morning types had similar energy and macronutrient intakes, evening types were more likely to be overweight or obese (34). Another review reported that among Italian adults, intermediate and evening chronotypes were associated with lower adherence to the Mediterranean diet (35). Similarly, a meta-analysis by Zhang et al. (36) and a systematic review by Teixeira et al. (37) revealed that the evening chronotype was associated with unhealthy eating habits, obesity, and adverse metabolic parameters of glucose and lipid metabolism. Conversely, a study conducted among healthcare workers in Türkiye showed that morning types had higher BMI values compared to other chronotypes (38). In the present study, the majority of police officers and teachers had a normal BMI (54.2% and 50%, respectively). Although police officers working rotating shifts reported a greater impact of work schedule on diet and consumed tobacco and alcohol at higher rates than daytime-working teachers, there was no significant difference in BMI between the groups. This may be related to the higher prevalence of the intermediate chronotype among police officers, which may facilitate their adaptation to night shifts compared to morning types, or to their shift rotation every two weeks. Given the lack

Table 4. Regression analyses of teachers' and police officers' mood, BMI, and sleep quality according to chronotype.

	Chronotype	Model	Teacher β (95% CI), p	Police officer β (95% CI), p
Depression	Intermediate-type	Adjusted	-2.907 (-4.927, -0.886), **0.005**	-5.594 (-8.270, -2.918), **<0.001**
		Unadjusted	-2.843 (-4.806, -0.880), **0.005**	-5.529 (-8.297, -2.761), **<0.001**
	Evening-type	Adjusted	-4.889 (-7.668, -2.111), **<0.001**	-5.230 (-7.944, -2.516), **<0.001**
		Unadjusted	-4.583 (-7.198, -1.969), **<0.001**	-5.393 (-8.224, -2.561), **<0.001**
Anxiety	Intermediate-type	Adjusted	-3.362 (-5.503, -1.222), **0.003**	-6.357 (-9.488, -3.226), **<0.001**
		Unadjusted	-3.173 (-5.294, -1.053), **0.004**	-6.316 (-9.494, -3.137), **<0.001**
	Evening-type	Adjusted	-5.277 (-8.220, -2.333), **<0.001**	-5.988 (-9.163, -2.812), **<0.001**
		Unadjusted	-4.633 (-7.458, -1.809), **0.002**	-6.125 (-9.377, -2.873), **<0.001**
Stress	Intermediate-type	Adjusted	-3.155 (-5.389, -0.921), **0.006**	-6.288 (-9.428, -3.148), **<0.001**
		Unadjusted	-2.967 (-5.181, -0.752), **0.009**	-6.286 (-9.419, -3.153), **<0.001**
	Evening-type	Adjusted	-5.580 (-8.652, -2.509), **<0.001**	-5.845 (-9.030, -2.660), **<0.001**
		Unadjusted	-4.867 (-7.816, -1.917), **0.002**	-5.911 (-9.116, -2.706), **<0.001**
BMI	Intermediate-type	Adjusted	-0.035 (-1.780, 1.710), 0.968	0.903 (-1.732, 3.538), 0.498
		Unadjusted	0.172 (-1.873, 2.218), 0.867	0.375 (-2.449, 3.198), 0.793
	Evening-type	Adjusted	0.750 (-1.649, 3.150), 0.534	0.369 (-2.303, 3.041), 0.785
		Unadjusted	0.868 (-1.856, 3.593), 0.527	0.470 (-2.419, 3.358), 0.748
PSQI	Intermediate-type	Adjusted	-0.954 (-2.744, 0.835), 0.291	-1.688 (-3.905, 0.529), 0.134
		Unadjusted	-1.333 (-3.102, 0.436), 0.137	-1.522 (-3.743, 0.699), 0.177
	Evening-type	Adjusted	-2.109 (-4.568, 0.350), 0.092	-2.532 (-4.780, -0.285), **0.028**
		Unadjusted	-2.833 (-5.185, -0.482), **0.019**	-2.619 (-4.891, -0.348), **0.024**

Morning-type used as reference. Model was adjusted for age, gender, and professional experience (years). BMI: Body mass index, PSQI: Pittsburgh Sleep Quality Index. CI: Confidfencve interval.
Significant results ($p < 0.05$) are in bold.

of existing literature comparing police officers and teachers in terms of chronotype, obesity, or dietary patterns, these findings contribute novel insights to the literature.

According to WHO data, sleep disorders are very common among adults, with approximately 30–35% of the world's population reporting sleep problems and 9–11% suffering from chronic insomnia (39). According to 2022 U.S. Department of Health data, 31.1% of adults fail to get adequate sleep (40). An epidemiological study in Cyprus indicated the prevalence of circadian rhythm sleep-wake disorders (particularly delayed sleep phase and shift work disorder) in the general population was 10–13% (7). Studies on shift-working nurses have shown that chronotype and work schedules impact sleep quality (41,42). Similarly, night and rotating shift work has been associated with poorer sleep quality and higher depression and anxiety among police officers (43,44). In a study of primary and secondary school teachers in China, Xue et al. (45) found that teachers generally had poor sleep quality (69.3%) and high rates of anxiety (65.3%) and depression (74.7%). In the current study, we determined that over half (52.8%) of police officers had poor sleep quality, while morning types in both groups reported good sleep quality. Both the literature and the current findings suggest that the morning chronotype and a stable daytime work schedule are conducive to better sleep. To address the global prevalence of sleep problems, individuals should be encouraged to seek employment compatible with their chronotype, and shift systems should be regulated.

A meta-analysis of 14 studies involving approximately 50,000 employees reported that shift workers have a higher risk of poor mental health compared to daytime workers, with 1.47-fold greater risk in evening shift workers, specifically (46). Depression is a debilitating mental health disorder that affects millions of people worldwide, and evidence that chronotype is an important factor associated with depression is steadily mounting. Research indicates that evening types have a significantly higher risk of depression, an increased tendency toward suicide, and greater risk for substance use, whereas the morning chronotype may have a protective effect (47,48). Shift work can further compound the mental health risk by disrupting the circadian rhythm (49). Togo et al. (50) reported higher levels of depressive symptoms among shift workers compared to daytime workers. Consistent with this, we found that evening-type teachers and police officers had higher levels of depression, stress, and anxiety than other chronotypes. Additionally, mood and sleep quality were positively correlated in morning- and intermediate-type teachers, but only in intermediate-type police officers. Further analyses revealed that, although more apparent among police officers, evening and intermediate types in both occupational groups had 3- to 6-fold higher levels of depression, anxiety, and stress than morning types. In line with the literature, both the evening chronotype and shift work were found to negatively impact sleep quality and psychological well-being.

Study Limitations

This study has certain strengths and limitations. It is the first study in Türkiye to compare the effects of different work schedules on chronotype, nutrition attitudes, mood, and sleep quality among daytime-working teachers and police officers working rotating shifts. However, several limitations should be acknowledged. First, the data were obtained by self-report. Therefore, participants may have expressed perceived or desired states rather than their actual situation. Second, because the study was cross-sectional in nature, we cannot establish causal relationships between variables. Third, the frequent rotation of the police officers' shift schedule (every two weeks) may have obscured differences related to work schedule. Fourth, we did not assess exposure to natural and artificial light, which is an important regulator of circadian rhythm. Fifth, nutritional attitudes and behaviors were assessed using only the ASHN scale, which precludes generalizations about the participants' diet. Finally, work-related stress was not assessed. Incorporating this variable into future studies could provide clearer insight and allow more accurate interpretations.

Conclusions

In this study, the chronotypes of police officers working rotating shifts and teachers on a daytime schedule were strongly associated with mood and sleep quality. This association was particularly evident among police officers. These findings suggest that considering chronotype is important for the health of workers in shift-based occupations. Consequently, to promote overall health and well-being, it may be advantageous to regulate police officers' working hours and shift rotations to minimize circadian rhythm deviations. Future research should explore the potential benefits of chronotype-aware work assignments or shift scheduling.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the Ordu University Social and Human Sciences Research Ethics Committee (date: 29 April 2025; session no: 04; decision no: 2025-74).

Informed Consent: All participants were informed of the purpose of the study and provided written informed consent online, in accordance with the Declaration of Helsinki.

Footnotes

Authorship Contributions

Concept: N.Ö., Design: N.Ö., A.B., Data Collection or Processing: N.Ö., A.B., Analysis or Interpretation: N.Ö., A.B., Literature Search: N.Ö., Writing: N.Ö., A.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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Case Report / *Olgu Sunumu*

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Nocturnal Desaturation Due to Hereditary Thrombophilia: A Case Report

Nokturnal Desaturasyonun Ardındaki Kalıtsal Trombofili: Olgu Sunumu

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Abstract

Nocturnal hypoxemia is often attributed to obstructive sleep apnea syndrome (OSAS), but it may also reveal occult cardiopulmonary or thromboembolic disease. A 42-year-old woman with excessive daytime sleepiness and snoring underwent polysomnography, which showed mild OSAS. Despite her normal body mass index and absence of severe respiratory events she had nocturnal desaturation (mean SpO_2 88%). V/Q scintigraphy detected subsegmental defects indicating pulmonary embolism, and echocardiography revealed mild pulmonary hypertension. Genetic analysis demonstrated homozygous MTHFR C677T and PAI-1 (4G/4G) mutations. Anticoagulation and vitamin supplementation were initiated, resulting in normalized imaging. Nocturnal hypoxemia may be associated with thrombotic activity, especially in the presence of hereditary thrombophilia.

Keywords: Nocturinal hypoxia, OSAS, hereditary thrombophilia, chronic thromboembolic pulmonary hypertaension

Öz

Noktürnal hipoksemi genellikle obstrüktif uyku apne sendromu (OSAS) ile ilişkilendirilir; ancak altta yatan kardiyopulmoner ya da tromboembolik hastalıkların da göstergesi olabilir. Aşırı gündüz uykululuğu ve horlama yakınmasıyla başvuran 42 yaşında kadın hastada polisomnografide hafif OSAS saptandı. Normal vücut kitle indeksi ve belirgin solunumsal olayları olmamasına rağmen, noktürnal desaturasyon (ortalama SpO_2: %88) izlendi. Ventilasyon–perfüzyon sintigrafisinde pulmoner emboli ile uyumlu subsegmenter perfüzyon defektleri, ekokardiyografide hafif pulmoner hipertansiyon mevcuttu. Genetik analizde homozigot MTHFR C677T ve PAI-1 (4G/4G) mutasyonları tespit edildi. Antikoagülan tedavi ve vitamin desteği sonrası görüntüleme bulguları normale döndü. Noktürnal hipoksemi, özellikle kalıtsal trombofili varlığında, trombotik aktivite ile ilişkili olabilir.

Anahtar Kelimeler: Nokturinal hipoksi, OSAS, herediter trombofili, kronik tromboembolik pulmoner hipertansiyon

Introduction

Nocturnal hypoxemia is defined as a mean oxygen saturation level below 90% during sleep. While it is most frequently encountered in patients with obstructive sleep apnea syndrome (OSAS), it can also be observed in patients with chronic obstructive pulmonary disease (COPD), pulmonary hypertension (PH), obesity hypoventilation syndrome, congestive heart failure, neuromuscular disorders, or pregnancy, and in individuals living at high altitude (1).

Several mechanisms explain the relationship between OSAS and increased risk of thrombosis (2). Intermittent hypoxia induces oxidative stress and cellular injury, which in turn cause endothelial dysfunction, vascular inflammation, and enhanced platelet aggregation. Hypoxia-driven erythropoietin release results in elevated hematocrit and blood viscosity, ultimately promoting thrombosis. Recurrent episodes of desaturation also upregulate tissue factor, initiating the extrinsic coagulation cascade, while downregulating thrombomodulin, a cofactor required for activation of protein C in the anticoagulant pathway.

Beyond OSAS, nocturnal hypoxemia has also been described in patients with chronic thromboembolic pulmonary disease (CTEPD) and chronic thromboembolic PH (CTEPH). In these conditions, unresolved thromboembolic obstruction leads to persistent ventilation–perfusion mismatch, which may worsen during sleep and contribute to nocturnal desaturation independent of respiratory events (3). Importantly, nocturnal

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hypoxemia has been associated with right heart remodeling and impaired hemodynamics in patients with CTEPH, suggesting that sleep-related desaturation may serve not only as a clinical marker but also as a pathogenic driver of disease progression.

Taken together, nocturnal hypoxemia is a clinical finding that may either reflect the presence of established cardiopulmonary disease or reveal an undiagnosed condition. Here, we present a patient, after obtaining informed consent, initially evaluated for OSAS symptoms, in whom further investigation led to the diagnosis of pulmonary embolism and hereditary thrombophilia. This case highlights the importance of considering thromboembolic disease in the differential diagnosis of unexplained nocturnal desaturation.

Case Report

A 42-year-old hypertensive female smoker who did not live at high altitude presented with excessive daytime sleepiness, fatigue, and snoring. Polysomnography revealed mild OSAS [Apnea–Hypopnea Index (AHI): 13/h], a mean nocturnal oxygen saturation of 88%, and T90 (time below 90% oxygen saturation) of 45%. Despite a normal body mass index (24 kg/m^2) and absence of severe respiratory events, she exhibited marked nocturnal desaturation.

The patient's systemic physical examination and postero-anterior chest X-ray were normal. Pulmonary function testing of the patient showed no obstruction and hemoglobin was 13.7 g/dL. Echocardiography demonstrated preserved left ventricular ejection fraction (60%), mild PH (37 mmHg), and mild tricuspid regurgitation with a tricuspid annular plane systolic excursion (TAPSE) of 20 mm. V/Q scintigraphy revealed heterogeneous perfusion with subsegmental defects in the right lower lobe, consistent with pulmonary embolism (Figure 1).

The patient had no conventional risk factors for thrombosis; however, genetic testing revealed homozygous MTHFR C677T and PAI-1 (4G/4G) polymorphisms. Laboratory evaluation showed vitamin B12 of 208 ng/L, folate of 6.8 mg/L, and homocysteine of 11.8 µmol/L. Following B12 (1 mg/day) and folate (5 mg/day) supplementation, homocysteine decreased to 8 µmol/L in 12 weeks. Anticoagulation with warfarin was administered for 6 months. Follow-up imaging confirmed resolution of perfusion defects, while echocardiography showed mild improvement in right ventricular function (TAPSE 22

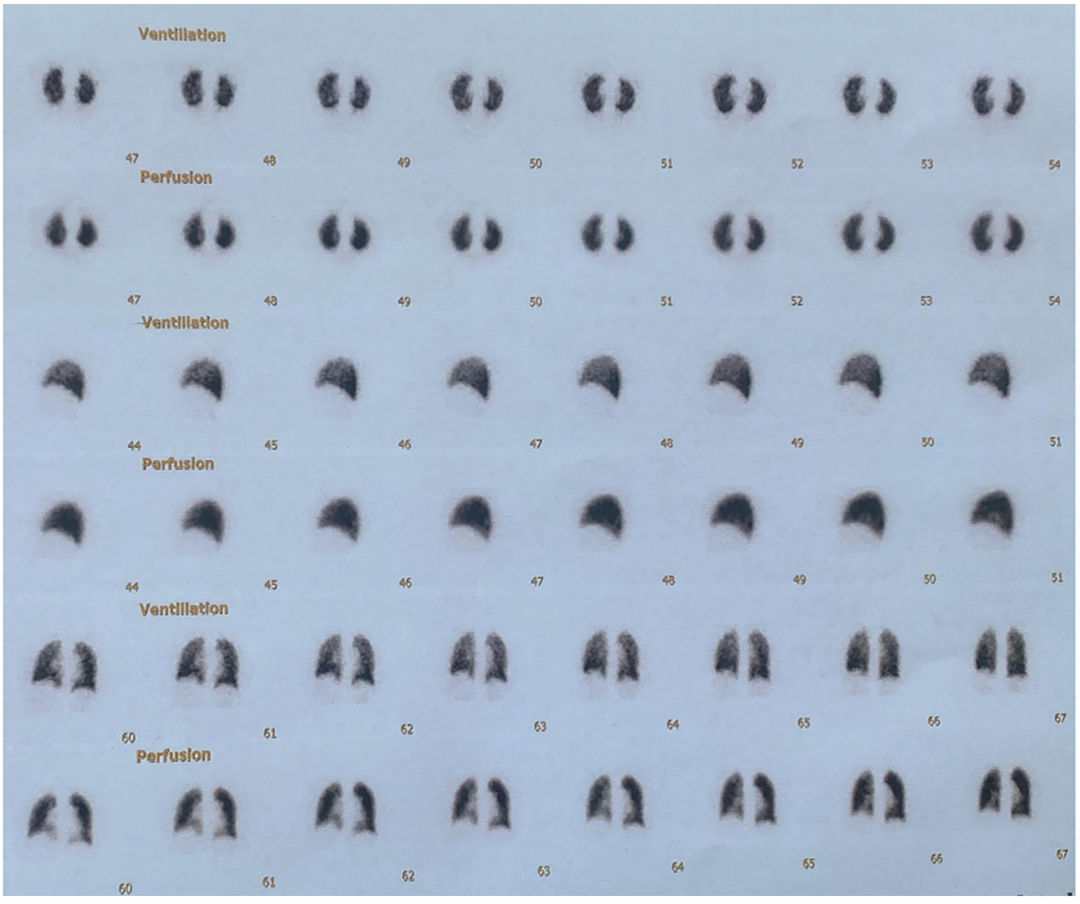

Figure 1. Perfusion images: partially heterogeneous involvement in both lungs; subsegmental hypoperfusion areas in the superior and posterior basal segments of the right lung's lower lobe. Ventilation images: hypoperfused areas are ventilated and compatible with high probability of pulmonary thromboembolism.

mm) and stable pulmonary pressure (35 mmHg). The patient remains under observation.

Discussion

Nocturnal hypoxemia is a multifactorial phenomenon most frequently caused by OSAS, but may also result from other causes. In COPD, hypoventilation and ventilation–perfusion mismatch contribute, while in heart failure, pulmonary congestion and Cheyne–Stokes respiration exacerbate desaturation.

The incidence of CTEPD following acute pulmonary embolism ranges from 0.5% to 9% (4). Risk factors include diagnostic delay, recurrent embolism, and right ventricular dysfunction. In CTEPD, indices such as mean SpO_2 and T90 are stronger predictors of PH than AHI (5). Importantly, nocturnal hypoxemia has been correlated with right heart structural changes and impaired hemodynamics, even in the absence of overt OSAS (6).

Pronounced nocturnal hypoxia in these patients may result from ventilation–perfusion mismatch due to organized thrombus and from hypoxia-related increases in tumor necrosis factor alpha, which may augment thrombophilia (7).

Methylenetetrahydrofolate reductase (MTHFR) C677T polymorphism decreases enzyme activity, leading to hyperhomocysteinemia in folate deficiency, predisposing individuals to venous thrombosis and cardiovascular disease (8). In patients carrying an MTHFR mutation, supplementation with vitamin B12 (0.5 mg/day) and folate (0.5–5 mg/day) is indeed a reasonable and evidence-based strategy to lower plasma homocysteine levels and to reduce the risk of hyperhomocysteinemia-related complications (9). Plasminogen activator inhibitor-1 (PAI-1) 4G/5G variant increases PAI-1 expression and inhibits fibrinolysis, further promoting thrombus formation (10). While systematic reviews suggest that these mutations alone may not consistently predict clinical thrombotic events (11), their coexistence with intermittent hypoxia, as in OSAS, may amplify thrombotic risk.

In the present case, the combination of OSAS-related intermittent hypoxia and genetic thrombophilia likely increased her thrombotic susceptibility, leading to pulmonary embolism. As reported by Han et al. (5), nocturnal hypoxemia, independent of AHI, has been identified as an independent determinant of elevated mean pulmonary artery pressure, as in our case. Although anticoagulation and vitamin supplementation normalized perfusion and homocysteine levels in 12 weeks, mild PH persisted, possibly due to delayed recognition. Current guidelines (12) do not support lifelong anticoagulation or antiplatelet therapy in such cases, emphasizing the importance of individualized follow-up.

Conclusion

Nocturnal hypoxemia should not be regarded solely as a marker of sleep-disordered breathing. It may indicate occult cardiopulmonary or thromboembolic disease and can contribute to disease progression if unrecognized. Patients with disproportionate nocturnal desaturation should undergo a thorough evaluation, including V/Q imaging and echocardiography. Early identification of underlying causes enables timely management and may prevent long-term complications.

Ethics

Informed Consent: Written informed consent was obtained from a 42-year-old female patient.

Footnotes

Conflict of Interest: No conflict of interest was declared by the authors.

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Letter to the Editor / *Editöre Mektup*

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A Common but Overlooked Problem in Adolescents: Poor Sleep Quality

Ergenlerde Sık Görülen Bir Sorun: Kalitesiz Uyku

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Keywords: Adolescents, sleep quality, mental health, neurodevelopment, public health
Anahtar Kelimeler: Ergenler, uyku kalitesi, ruh sağlığı, nörogelişim, halk sağlığı

Dear Editor,

I read with great interest your article titled "The Associations between Sleep Problems, Parental Attitudes, and Behavioral Problems in Preschool Children" (1). This study highlights the importance of effectively managing sleep anxiety and duration in children, given their significant behavioral and emotional consequences. Building on these findings, I would like to draw attention to sleep problems in adolescents, another age group that is often overlooked.

Adequate sleep is essential for healthy growth and development during both childhood and adolescence. It significantly contributes to physical health, immune function, mental well-being, and academic performance (1). Adolescence is marked by intense neurodevelopmental changes, especially in the prefrontal cortex, which governs executive functions. Sleep disturbances during this critical period can impair planning, decision-making, and emotional regulation, potentially leading to attention deficits, memory issues, and emotional instability (1). Numerous studies have demonstrated strong associations between poor sleep habits in adolescents and a wide range of psychological, behavioral, and physical problems (2).

Research consistently shows that sleep disturbances are highly prevalent among adolescents. Approximately 10% meet the diagnostic criteria for insomnia, while over 33% report at least one symptom of sleep disturbance (2). These problems are closely linked with mood disorders such as anxiety and depression. Adolescents with sleep difficulties often exhibit maladaptive emotional regulation strategies, including increased rumination and suppression, making them more vulnerable to these conditions (2). For instance, a large population-based study in Norway involving 10,220 adolescents aged 16–18 assessed multiple sleep parameters, alongside fatigue and daytime sleepiness. The study found that 65% had trouble falling asleep, and 18.5% met DSM-5 criteria for insomnia (3). Furthermore, insufficient sleep has been associated with risk-taking behaviors such as substance use and academic failure, underscoring the broad impact of sleep on adolescent well-being (4).

Poor sleep quality often hampers the management of other health-related behaviors in adolescents. Therefore, establishing a regular and restorative sleep routine should be a primary intervention. Once consistent sleep patterns are in place, addressing other issues becomes more feasible. Preventable sleep problems must be prioritized during adolescence, as many lifelong health habits are formed during this stage (5). Additionally, improving adolescent sleep behaviors may help prevent adult sleep disorders, which pose significant public health challenges.

Sleep disturbances are a modifiable risk factor crucial for improving adolescent health. Both sleep quality and regularity are vital in maintaining healthy circadian rhythms at physiological and behavioral levels (2). Therefore, healthcare providers, educators, and policymakers must collaborate to promote healthy sleep habits among adolescents. Strategies such as

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establishing regular sleep schedules, limiting screen time before bed, and raising awareness of sleep's importance can mitigate the adverse effects of sleep disturbances.

In conclusion, addressing sleep disorders in adolescence is not only about improving sleep quality; it is an essential step to safeguard cognitive and emotional development, ultimately enhancing overall quality of life.

Footnotes

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