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Contents

Original Articles

Brief Communication

Case Report

The Prevalence and Impact of Insomnia in Multiple Sclerosis

Multipl Sklerozda İnsomnia Prevalansı ve Etkisi

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Abstract

Objective: In this study, the prevalence of insomnia and the effects of factors such as depression, anxiety, and fatigue on sleep and quality of life in patients with relapsing-remitting multiple sclerosis (RRMS) were investigated.

Materials and Methods: One hundred and five RRMS patients and 105 healthy control groups were examined. Insomnia, depression, anxiety, sleep and life qualities and fatigue were evaluated with scales.

Results: The insomnia prevalence was higher in MS patients than in the control group (31.7% vs. 17.1%, p = 0.014). Fatigue, anxiety and depression levels increased in MS patients, and sleep and life qualities were significantly impaired (p < 0.001). Fatigue, anxiety and depression levels were higher in female patients than in males, while quality of life was lower (p < 0.001). It has shown an increasing effect on depression and anxiety levels, insomnia and deterioration in sleep quality.

Conclusion: Factors that adversely affect sleep and quality of life, especially depression, anxiety and fatigue, should be carefully evaluated in RRMS patients. This emphasizes the importance of individual approaches in clinical management.

Keywords: Multiple sclerosis, insomnia, sleep quality, anxiety, depression

Öz

Amaç: Bu çalışmada, relapsing-remitting multipl skleroz (RRMS) hastalarında insomnia prevalansı ile depresyon, anksiyete, yorgunluk gibi faktörlerin uyku ve yaşam kalitesi üzerinde etkileri araştırıldı.

Gereç ve Yöntem: Yüz beş RRMS hastası ve 105 sağlıklı kontrol grubu incelendi. İnsomnia, depresyon, anksiyete, yorgunluk, uyku ve yaşam kalitesini ölçen ölçeklerle değerlendirildi.

Bulgular: RRMS hastalarında insomnia prevalansı, kontrol grubuna göre daha yüksekti (%31,7 vs. %17,1, p = 0,014). RRMS hastalarında depresyon, anksiyete ve yorgunluk düzeyleri artmış, uyku ve yaşam kalitesini belirgin şekilde bozulmuştu (p < 0,001). Kadın hastalarda yorgunluk, anksiyete ve depresyon seviyeleri erkeklere göre daha yüksek bulunurken yaşam kalitesi daha düşüktü (p < 0,001). Depresyon ve anksiyete düzeyleri, insomnia ve uyku kalitesindeki bozulmayı artırıcı etki göstermiştir.

Sonuç: RRMS hastalarında uyku ve yaşam kalitesini olumsuz etkileyen faktörler, özellikle depresyon, anksiyete ve yorgunluk, dikkatle değerlendirilmelidir. Bu durum, klinik yönetimde bireysel yaklaşımların önemini vurgulamaktadır.

Anahtar Kelimeler: Multipl skleroz, insomnia, uyku kalitesi, anksiyete, depresyon

Introduction

Multiple sclerosis (MS) is a chronic neurological disease. The most frequent subtype of MS is relapsing–remitting MS (RRMS) form (1). MS patients exhibit a diverse array of symptoms. Additionally, clinical manifestations such as sleep abnormalities, depression, anxiety, fatigue and cognitive decline, which are often overshadowed, are commonly observed. These symptoms negatively impact the quality of life (2).

Insomnia is defined as difficulty in initiating or maintaining sleep, a reduction in sleep duration or quality, and consequent impairments in daytime physical and/or cognitive activities (2).

While comprehensive epidemiological studies exploring the precise insomnia prevalence in patients with MS are limited, it affects roughly 40–50% of patients (3). Other factors, such as drug–related side effects and lesion burden, such as with immunotherapy, may contribute to disruption of normal sleep patterns (4). Psychiatric manifestations such as depression and anxiety are also more common in MS than in the general population and are linked to a reduced life quality, cognitive dysfunction, and higher risk of suicide (5).

Clinicians' focus on the primary manifestations of MS often leads to the neglect of secondary disability conditions. The

prevalence of symptoms like sleep disturbances, fatigue, anxiety and depression in MS patients is well–documented; however, their impact on life quality remains insufficiently explored. In our study, we aimed to investigate the association between these symptoms and the prevalence of insomnia with current diagnostic criteria (6), which is common in MS, and its effects on patients.

Materials and Methods

Consecutively 105 patients with RRMS followed in Neuroimmunology Clinic of University of Health Sciences Türkiye, Antalya Training and Research Hospital between 01/07/2022 and 01/03/2023 were included into the study. The diagnoses were made according to the 2017 McDonald criteria (7). One hundred–five sex– and age– matched participants with no prior history of psychiatric or neurological conditions except for sleep disorders were included as control group.

Demographic information (age, gender and marital status) and clinical details including MS–related medications of the patient group were recorded.

Both patients and control groups were evaluated for insomnia. Symptoms of urinary dysfunction were also assessed in the patients. The Expanded Disability Status Scale (EDSS) was used for evaluating disease severity (8). Patients were administered the MS quality of life–54 instrument (MSQOL–54) (9), Fatigue Severity Scale (FSS) for fatigue (10), Beck Anxiety Inventory for severity of anxiety symptoms (11), Beck Depression Inventory for severity of depression symptoms (12), Pittsburgh Sleep Quality Index (PSQI) for sleep quality (13) and Epworth Sleepiness Scale (ESS) for daytime sleepiness (14).

University of Health Sciences Türkiye, Antalya Training and Research Hospital Clinical Research Ethics Committee (decision number: 16/13, date: 25/08/2022). An informed consent form was signed by each participant prior to the enrollment in the study. Each participant received a comprehensive explanation of the entire procedure and participation in the study was entirely voluntary.

Statistical Analysis

A priori sample size calculation was performed based on the assumption of medium effect size (d = 0.50), an alpha level of 0.05, and a statistical power of 95%. Given that the study involves comparisons of scales between MS and control groups, the calculations were conducted for independent samples. Based on these parameters, a minimum of 105 participants per group was required to achieve adequate statistical power. The sample size determination was conducted using a two–tailed t–test model (t–tests means: difference between two independent means), with the following parameters: non–centrality parameter δ = 3.6228, critical t = 1.9714, degrees of freedom = 208, and actual power = 0.9501.

Continuous variables were expressed as mean ± standard deviation or median and minimum–maximum values, while categorical variables were reported as frequency and percentage. The Shapiro–Wilk test was used to assess normal distribution. The categorical variables were analyzed using the Fisher's exact and Pearson chi–square tests. For continuous variables the Mann–Whitney U test and Kruskal–Wallis test were applied for non–normally distributed data, while the one–way analysis of variance test and independent t–test were used for normal distributions. Spearman correlation test was employed to analyze the relationship between disease duration, EDSS and other study parameters in patient group. The data was analyzed using IBM SPSS 23.0 software, with p–values <0.05 considered statistically significant.

Results

In Table 1 the clinical and demographic features of the MS patients and the control groups were summarized. There were no statistically significant differences between the groups regarding gender, age, marital status, or ESS scores. However, MS patients had significantly higher scores for Beck anxiety, Beck depression, FSS, PSQI, while their MSQOL–54 physical, MSQOL–54 cognitive and MSQOL–54 total scores were statistically lower. The median disease duration among MS patients was 7.5 years with a range of 1 to 34 years. Insomnia prevalence was higher in MS patients compared to control group (31.7% vs. 17.1%; p = 0.014) and 25.7% of the MS patients reported bladder dysfunction. Table 2 provides comparisons of MS patients' demographic and clinical characteristics based on insomnia presence. Accordingly, age (p = 0.786), gender (p = 0.451), marital status (p = 0.419), duration of illness (p = 0.908), EDSS score (p = 0.364), type of medication used (p = 0.718), ESS score (p = 0.464), and presence of bladder dysfunction (p = 0.242) did not differ significantly according to the presence of insomnia. Beck anxiety and depression scores were significantly higher in patients with MS with insomnia (p < 0.001 and p = 0.008). In addition, FSS (p = 0.028) and PSQI (p < 0.001) scale levels were found to be higher in the MS group with insomnia. MS patients with insomnia had significantly lower MSQOL–54 scale physical, cognitive and total scores.

When the distribution of patients according to the used MS medication was examined, it was observed that 65 patients (62.5%) used first–line drugs and 39 patients (37.5%) used second–line drugs. Dimethyl fumarate (20%) and teriflunomide (16.2%) were the highest in the first–line drug group, while ocrelizumab (11.4%) and natalizumab (9.5%) were the highest in the second–line drug group.

In the patient group with MS, the demographic and clinical characteristics of the patients according to gender are indicated in Table 3. No significant difference in terms of age (p = 0.864), marital status (p = 0.410), duration of illness (p = 0.741), EDSS score (p = 0.752), PSQI (p = 0.182), ESS score (p = 0.159), presence of insomnia (p = 0.451) and of urinary dysfunction (p = 0.630) according to gender was found. Beck's anxiety and depression levels in the female MS patients were statistically higher than in men (p = 0.010 and p = 0.008). It was determined that the FSS score of the female MS patient group was higher (p = 0.020). MSQOL–54 physical (p = 0.003), MSQOL–54 cognitive (p = 0.002) and MSQOL–54 total (p = 0.002) scale scores were significantly lower in female patients with MS.

Table 1. Demographic and clinical characteristics of the patient and control groups.

	Controls (n=105)	MS patients (n=105)	p
Age (years), mean ± SD	40.18 ± 10.18	41.65 ± 11	0.317
Gender, n (%)			
Female	73 (69.5)	78 (74.3)	0.443
Male	32 (30.5)	27 (25.7)	
Marital status			
Single	28 (26.7)	25 (23.8)	0.634
Married	77 (73.3)	80 (76.2)	
Disease duration (years), median (min–max)	–	7.5 (1–34)	–
Insomnia, n (%)	18 (17.1)	33 (31.7)	**0.014**
Urinary dysfunction	–	27 (25.7)	–
Beck depression, median (min–max)	5 (0–22)	8 (0–39)	**<0.001**
Beck anxiety, median (min–max)	3 (0–35)	8 (0–55)	**<0.001**
FSS, median (min–max)	2.78 (1–7)	4.4 (1–7)	**<0.001**
PSQI, median (min–max)	3 (0–12)	5 (0–18)	**<0.001**
ESS, median (min–max)	3 (0–10)	3 (0–24)	0.226
MSQOL–54 physical, median (min–max)	79.64 (30.05–97.35)	66.51 (17.03–98.67)	**<0.001**
MSQOL–54 cognitive, median (min–max)	74.87 (33.64–94.44)	65.34 (5.8–99.1)	**0.001**
MSQOL–54 total, median (min–max)	152.02 (63.7–186.76)	129.6 (28.43–196.29)	**<0.001**

Independent t–test, Mann–Whitney U test, Pearson chi–square test.

EDSS: Expanded Disability Status; FSS: Scale Fatigue Severity Scale, PSQI: Pittsburgh Sleep Quality Index, ESS: Epworth Sleepiness Scale, MSQOL–54: Multiple Sclerosis Quality of Life–54 Instrument, MS: Multiple sclerosis, SD: Standard deviation, Min: Minimum, Max: Maximum.

In the MS patients, depression, Beck anxiety, FSS, PSQI, MSQOL–54 physical, MSQOL–54 cognitive, MSQOL–54 total scores and presence of insomnia and urinary dysfunction of the patients were compared according to the disease modifying medication used as first– and second– line, and no significant relationship was found between the 2 groups (p > 0.05) (Table 4).

In Table 5, the results of the correlation analysis between EDSS score and disease duration and other variables in the patient group with MS are presented. A weak positive correlation was observed between disease duration and FSS (r = 0.206; p = 0.036). It was found that there was a significant positive correlation between EDSS score and FSS (r = 0.325; p = 0.001), and PSQI (r = 0.219; p = 0.025), and a weak negative correlation with MSQOL–54 physical (r = –0.291; p = 0.003) subscale score and MSQOL–54 total score (r = -0.223; p = 0.022).

Discussion

MS is characterized by a wide range of symptoms and signs that impair physical, psychological functions (2). Psychiatric comorbidities including sleep disturbances, depression and fatigue contribute to increased disability in MS patients and remain insufficiently addressed in clinical practice. Understanding the impact of these conditions on the quality of life of MS patients is crucial to fostering more comprehensive discussions about their underlying causes and treatment options. Our study

contributes to the existing literature by providing a detailed analysis of the impact of insomnia on fatigue, depression, anxiety, and quality of life in MS patients. While previous research has explored these associations, our study strengthens the evidence by utilizing multiple validated scales and conducting comprehensive statistical analysis. Importantly, we found that insomnia significantly exacerbates MS–related fatigue and psychiatric symptoms, emphasizing the need for routine sleep assessments in clinical practice. These findings suggest that insomnia should be recognized as a crucial factor influencing overall disease burden in MS patients, rather than a secondary symptom. Identifying and managing these comorbidities not only enhances the overall quality of life of the patients but also helps mitigate the risk of developing serious health complications. Insomnia is one of the most prevalent sleep disorders in both the adult and pediatric MS population. The prevalence of insomnia in MS is roughly 40–50% of patients (2). In our study, the prevalence of insomnia among MS patients was higher than in the healthy population. It was also observed that the sleep quality of the patients was significantly worse than the healthy controls [PSQI; 5 (0–18), p < 0.001].

Our study demonstrated no significant difference in the insomnia prevalence among MS patients based on gender. This finding is supported by several studies in the literature (15). Nevertheless, some studies have indicated that the prevalence of sleep disorders is higher in female MS patients (16-18).

Table 2. Demographic and clinical features according to the presence of insomnia in the MS patients.

	Insomnia - (n = 72)	Insomnia + (n = 33)	p
Age (years), mean ± SD	41.82 ± 10.97	41.18 ± 11.36	0.786
Gender, n (%)			
Female	51 (71.8)	26 (78.8)	0.451
Male	20 (28.2)	7 (21.2)	
Marital status			
Single	18 (25.4)	6 (18.2)	0.419
Married	53 (74.6)	27 (81.8)	
Disease modifying therapy, n (%)			
First line	45 (64.3)	20 (60.6)	0.718
Second line	25 (35.7)	13 (39.4)	
Disease duration (years), median (min–max)	7 (1–34)	8 (1–26)	0.908
EDSS >3, n (%)	8 (11.3)	6 (18.2)	0.364
Beck depression, median (min–max)	7 (0–32)	17 (1–39)	**<0.001**
Beck anxiety, median (min–max)	6 (0–44)	10 (0–55)	**0.008**
FSS, median (min–max)	4.1 (1–7)	4.7 (2.1–7)	**0.028**
PSQI, median (min–max)	4 (0–16)	9 (2–18)	**<0.001**
ESS, median (min–max)	3 (0–24)	2 (0–15)	0.464
MSQOL–54 physical, median (min–max)	73.8 (17.03–98.67)	52.8 (22.63–84.18)	**<0.001**
MSQOL–54 cognitive, median (min–max)	70.43 (14.46–99.1)	58.63 (5.8–92.09)	**0.005**
MSQOL–54 total, median (min–max)	143.1 (31.49–196.29)	112.04 (28.43–175.55)	**<0.001**
Urinary dysfunction, n (%)	16 (22.5)	11 (33.3)	0.242

Independent t–test, Mann–Whitney U test, Pearson chi–square test, Fisher's Exact test.

EDSS: Expanded Disability Status; FSS: Scale Fatigue Severity Scale, PSQI: Pittsburgh Sleep Quality Index, ESS: Epworth Sleepiness Scale, MSQOL–54: Multiple Sclerosis Quality of Life–54 Instrument, SD: Standard deviation, MS: Multiple sclerosis, Min: Minimum, Max: Maximum.

Insufficient sleep can worsen patients' life quality and cause problems often experienced in MS, including neurocognitive dysfunction and fatigue. Interrupted sleep may also potentially contribute to the progression of MS disease. Symptoms such as pain, cramps, bladder dysfunction, or anxiety also contribute to sleep disturbance in MS patients (19). In our study, there was no statistically significant relationship between the presence of bladder dysfunction and insomnia in patients, but it was observed that the sleep quality of patients with bladder dysfunction was much worse as expected (p = 0.018). In previous studies, it has been stated that the likelihood of developing depression is elevated in MS patients with insomnia, and the prevalence of insomnia is very low in patients without depression (2). Similarly, in our study, as the severity of depression increased, an increase in the incidence of insomnia and a deterioration in sleep quality evaluated by PSQI were observed. As expected, the physical and cognitive health scores of quality of life assessed by MSQOL–54 were significantly lower in the MS patient group with insomnia.

In a study, Stanton et al. (20) examined the sleep patterns of 60 MS patients. The 2 most common causes of insomnia were anxiety (27.5%) and pain (22.5%). In our study, anxiety and depression rating scores were significantly higher in patients with MS with insomnia (p = 0.008 and p < 0.001).

Although the MS patient group reported poor sleep quality in general, there was no significant increase in daytime sleepiness in this group as an expected result. This situation, which has been noted in previous studies, may be the result of patients using fatigue and sleepiness symptoms interchangeably (17). Patients suffering from insomnia often tend to complain of fatigue rather than sleepiness or a tendency to fall asleep.

Fatigue is a very debilitating symptom that MS patients frequently complain about, with an estimated prevalence of up to 83% (20). Fatigue in MS is known to be multifactorial and negatively affect mental health, physical activity, mobility and quality of life in MS patients. In our study, the relationship between disease severity, disease duration, insomnia, depression and anxiety with fatigue were evaluated. MS patients reported more fatigue symptoms than healthy controls. The severity of fatigue, as assessed by FSS, was found to be significantly higher in MS patients with anxiety than in those without, and in those with moderate–to–severe depression than those with minimal depression (p < 0.001). FSS scores were higher in MS patients complaining of insomnia (p = 0.028). In addition, fatigue was found to be associated with disease severity (p = 0.001) and duration (p = 0.036). A recent large nationwide study on fatigue in MS in the UK found that fatigue is a common problem in MS patients; depression, longer duration of illness, higher EDSS

Table 3. Demographic and clinical features according to the gender in the MS patients.

	Female (n = 78)	Male (n = 27)	p
Age (years), mean ± SD	41.76 ± 10.28	41.33 ± 13.06	0.864
Marital status			
Single	17 (21.8)	8 (29.6)	0.410
Married	61 (78.2)	19 (70.4)	
Disease duration (years), median (min–max)	7.25 (1–27)	8 (1–34)	0.741
EDSS >3, n (%)	10 (12.8)	4 (14.8)	0.752
Insomnia, n *(%)*	26 (33.8)	7 (25.9)	0.451
Urinary dysfunction	21 (26.9)	6 (22.2)	0.630
Beck depression, median (min–max)	10 (0–39)	4 (0–28)	**0.008**
Beck anxiety, median (min–max)	9.5 (0–44)	4 (0–55)	**0.010**
FSS, median (min–max)	4.55 (1–7)	3.25 (1–6.1)	**0.020**
PSQI, median (min–max)	5 (0–18)	4 (0–15)	0.182
ESS, median (min–max)	3 (0–24)	2 (0–9)	0.159
MSQOL–54 physical, median (min–max)	62.23 (17.03–98.67)	75.73 (33.11–97.27)	**0.003**
MSQOL–54 cognitive, median (min–max)	62 (5.8–99.1)	75.3 (29.18–96.78)	**0.002**
MSQOL–54 total, median (min–max)	122.17 (28.43–196.29)	151.05 (77.74–191.23)	**0.002**

Independent t–test, Mann–Whitney U test, Pearson chi–square test, Fisher's Exact test.
EDSS: Expanded disability status, FSS: Scale Fatigue Severity Scale, PSQI: Pittsburgh Sleep Quality Index, ESS: Epworth Sleepiness Scale, MSQOL–54: Multiple Sclerosis Quality of Life–54 Instrument, SD: Standard deviation, Min: Minimum, Max: Maximum.

Table 4. Clinical characteristics according to the drug used in the MS patient group.

	First–line drugs (n = 65)	Second–line drugs (n = 39)	p
Beck depression, median (min–max)	9 (0–39)	8 (0–32)	0.770
Beck anxiety, median (min–max)	8 (0–55)	8 (0–44)	0.872
FSS, median (min–max)	4.45 (1–6.5)	4.4 (1–7)	0.436
PSQI, median (min–max)	4 (0–18)	5 (1–14)	0.166
ESS, median (min–max)	3 (0–15)	3 (0–24)	0.657
MSQOL–54 physical, median (min–max)	67.2 (22.63–98.67)	63.74 (17.03–97.45)	0.172
MSQOL–54 cognitive, median (min–max)	65.6 (5.8–99.1)	65.34 (14.46–98.84)	0.401
MSQOL–54 total, median (min–max)	135.51 (28.43–195.44)	128.25 (31.49–196.29)	0.306

Mann–Whitney U test.
EDSS: Expanded disability status, FSS: Scale Fatigue Severity Scale, PSQI: Pittsburgh Sleep Quality Index, ESS: Epworth Sleepiness Scale, MSQOL–54: Multiple Sclerosis Quality of Life–54 Instrument, MS: Multiple sclerosis, Min: Minimum, Max: Maximum.

score, and SPMS have been shown to predict fatigue (21). When we looked at the literature, we found similar results with our study; In a 2005 study, a model illustrating the relationship between disease severity, sleep disturbances, fatigue and depression. In this study, the relationships between disease severity, depression, and sleep disturbance in MS and their possible roles in predicting fatigue were investigated and four models were proposed to explore these relationships. In the optimal model, all three have been shown to contribute significantly independently to fatigue in MS, with sleep disturbance making the largest contribution (22).

Our results indicated that MS patients had a notably lower quality of life compared to healthy controls. This finding is similar to a recently published study (23). Psychiatric disorders, especially depression, are common in MS and have a considerable effect on life quality. In a study conducted by Lobentanz et al. (24) in 2004, different factors affecting the life quality in a group of MS patients were examined, and it was determined that the main determinant of low quality of life was depression, followed by fatigue and sleep disorders. Similarly, our findings demonstrated that MS patients with mild and moderate–to–severe depression symptoms had a lower quality of life than patients with minimal symptoms (p < 0.001). A study in the Italian population also showed that depression affects quality of life, consistent with our results (25). In a study by Spain et al. (26), the perception of illness itself was found to be an independent predictor of quality of life in patients with MS.

Disease severity and duration have been shown to affect patients' quality of life in MS patients (23,25). In our study, it was observed that there was a decrease in MSQOL–54 physical

Table 5. Correlation between EDSS, disease duration and other parameters in the MS patient group.

	Disease duration		EDSS	
	r	p	r	p
Beck depression	0.001	0.996	0.081	0.409
Beck anxiety	-0.008	0.938	0.172	0.080
FSS	0.206	**0.036**	0.325	**0.001**
PSQI	0.126	0.201	0.219	**0.025**
ESS	-0.079	0.422	0.018	0.855
MSQOL-54 physical	-0.102	0.300	-0.291	**0.003**
MSQOL-54 cognitive	0.118	0.231	-0.124	0.207
MSQOL-54 total	0.013	0.894	-0.223	**0.022**

Spearman's correlation coefficient.

EDSS: Expanded disability status, FSS: Scale Fatigue Severity Scale, PSQI: Pittsburgh Sleep Quality Index, ESS: Epworth Sleepiness Scale, MSQOL-54: Multiple Sclerosis Quality of Life-54 Instrument, MS: Multiple sclerosis.

health score with an increasing EDSS score (r = -0.291; p = 0.003). However, no significant relationship was observed between disease duration and quality of life. This can be explained by the fact that the majority of our patients with long disease duration have benign MS.

While the EDSS was weakly correlated with the physical health score, it did not correlate with the cognitive health score, the other component of the MSQOL–54 that was measured. Similarly, in the literature, it has been observed that EDSS reflects physical health better than mental health (27,28). In our study, EDSS was not one of the best predictors of quality of life. Given that the EDSS does not assess key aspects of MS, such as pain, sleep quality and fatigue, this finding is not surprising. While life quality reflects patients' perceptions of their condition from an internal perspective; EDSS is a clinician's assessment based on an external evaluation of the patient's status. Most of the published literature has shown that the level of disability is somewhat related to quality of life (25,29). Nevertheless, other studies have reported no impact of disability on life quality (30). In a small number of studies carried out in recent years; it has been reported that in MS patients the life quality is worse than the normal population, and this is especially seen in patients with low EDSS scores (31). The disability level is undoubtedly a clinically important factor, and it is necessary to measure and follow. However, it should not be forgotten that there are other symptoms that should be evaluated by clinicians.

Our results revealed that the quality of life of women MS patients was significantly lower. Anxiety, depression and fatigue scores were also higher in women. However, in MS patients there is no definitive agreement on how gender impacts the life quality. Some studies indicate that women with MS experience a better quality of life, whereas others suggest the opposite (23). These conflicting findings may arise from sociocultural variations in the studied populations. Further studies are essential to explore the influence of diverse cultural backgrounds on the factors affecting quality of life in MS patients.

Patients classified as mild and moderate–to–severe depression in our study suffered from poorer sleep quality than those with minimal depressive symptoms. The group of patients with moderate–to–severe anxiety constituted the group with the worst sleep quality. It has also been emphasized in previous studies that sleep disturbance is closely related to depression and anxiety, and that poor sleep quality worsens the aforementioned psychiatric comorbidities (17,32). In earlier studies it was observed that there was a relationship between the duration of the disease and the severity of depression, but in our study, there was no significant relationship between the duration of the disease and the EDSS score and depression (23,33).

The use of interferon–β has been associated with worsening of depression (5). In our study, the relationship between first– and second–line MS drugs and depression, anxiety, fatigue, sleep quality, increased daytime sleepiness and quality of life was examined, but no statistically significant relationship was found. Sleep disorders, fatigue, depression, and anxiety are key factors affecting quality of life. Therefore, it should be evaluated in patient follow–up. Assessing and managing these factors is important in MS patients. Necessary arrangements should be provided by health systems to provide the necessary time and environment for the evaluation of patients in all aspects in polyclinics, and to ensure that the physician–patient relationship can be carried out under safe and sustainable conditions.

Study Limitations

This study has several limitations. First, it was conducted at a single center with a relatively small sample size (n = 105 per group), which may affect the generalizability of the findings. Second, the cross–sectional design does not allow for causal inferences. Future multicenter studies with larger cohorts and longitudinal design are warranted to evaluate causality and the longitudinal impact of insomnia in MS–related outcomes.

Conclusion

In our study, MS patients had poorer sleep and life quality compared to healthy controls, and insomnia, fatigue, depression and anxiety were more common in MS patients. In particular, it was noted that female patients were more tired, their

depression and anxiety symptoms were more severe, and their life quality was worse. Depression and anxiety in MS patients; it was noted that it worsens sleep and quality of life, increases the severity of fatigue, and increases the incidence of insomnia. Insomnia significantly affects the sleep and quality of life of MS patients; it was seen to increase symptoms of fatigue, depression and anxiety. Our findings highlight the need for routine sleep disorder screening in MS patients. Given the strong association between insomnia, fatigue, and psychiatric symptoms, clinicians should incorporate sleep assessments into routine MS management to improve patient outcomes. Future studies should further explore targeted interventions for managing sleep disturbances in MS patients. Bladder dysfunction was more prevalent among elderly patients with higher EDSS scores and was found to have a negative impact on both sleep quality and overall quality of life.

There is a need for more large–scale and multicenter studies investigating the prevalence and effects of insomnia in MS patients. Further research should focus on developing targeted interventions for managing insomnia in MS evaluating their effectiveness in clinical practice.

Ethics

Ethics Committee Approval: University of Health Sciences Türkiye, Antalya Training and Research Hospital Clinical Research Ethics Committee (decision number: 16/13, date: 25/08/2022).

Informed Consent: An informed consent form was signed by each participant prior to the enrollment in the study. Each participant received a comprehensive explanation of the entire procedure and participation in the study was entirely voluntary.

Footnotes

Authorship Contributions

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

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

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Advanced Model Approach for the Progression and Early Diagnosis of Insomnia

İnsomnia Seyri ve Erken Teşhisinin Tahminine Yönelik Gelişmiş Model Yaklaşımı

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Abstract

Objective: Insomnia is a common psychiatric condition characterized by persistent difficulties falling or staying asleep despite having adequate opportunities and conditions. Seven core parameters, as measured by the Insomnia Severity Index, determine the risk of insomnia. A cubic polynomial regression model was developed based on the baseline parameters to forecast insomnia severity.

Materials and Methods: The model incorporates quadratic and cubic terms to enhance accuracy by capturing nonlinear dependencies between variables. Least squares regression and ridge regularization improve stability and avoid overfitting.

Results: The model's performance was evaluated using mean squared error (MSE) and coefficient of determination R-squared (R^2), achieving an accuracy that effectively represents trends in insomnia severity. The results indicate that the cubic polynomial model significantly enhances prediction reliability, reducing the MSE value from simpler polynomial approaches to 0.0018 and increasing the R^2 value to 0.98.

Conclusion: The performance results demonstrate that the model's prediction of insomnia severity largely aligns with the actual observation data. This demonstrates that the model can accurately analyze sleep disorders and make dependable predictions. These findings suggest that advanced polynomial regression may be a valuable tool in sleep analysis, enabling the prediction of insomnia severity.

Keywords: Insomnia, Insomnia Severity Index, sleep disorder, predicting algorithm, cubic polynomial regression

Öz

Amaç: İnsomnia, uygun fırsat ve koşulların varlığına rağmen uykuya dalma veya uykuda kalma konusunda kalıcı güçlüklerle karakterize edilen ve yaygın görülen psikiyatrik bir durumdur. İnsomnia riskini belirlemek için yedi temel parametreden oluşan bir İnsomnia Şiddet İndeksi kullanılır. Temel parametrelere dayalı olarak insomnia şiddetini tahmin etmek için kübik bir polinom regresyon modeli geliştirilmiştir.

Gereç ve Yöntem: Model, değişkenler arasındaki doğrusal olmayan bağımlılıkları yakalayarak doğruluğu artırmak için kuadratik ve kübik terimleri entegre etmektedir. Kararlılığı artırmak ve aşırı uyumu önlemek için en küçük kareler regresyonu ve ridge düzenlemesi kullanılmıştır.

Bulgular: Modelin performansı ortalama karesel hata (MSE) ve determinasyon katsayısı R-kare (R^2) kullanılarak değerlendirilmiş ve insomnia şiddetindeki eğilimleri etkili bir şekilde temsil eden bir doğruluk neticesine ulaşılmıştır. Ulaşılan sonuçlar, kübik polinom modelinin tahmin güvenilirliğini önemli ölçüde arttırdığını ve daha basit polinom yaklaşımlarından elde edilen MSE değerini 0.0018 seviyelerine düşürdüğünü ve R^2 değerini 0,98 seviyesine ulaştırdığını göstermiştir.

Sonuç: Performans sonuçlarına göre, model tarafından tahmin edilen insomnia şiddeti, gerçek gözlem verileriyle büyük ölçüde örtüşmektedir. Bu da modelin, uyku bozukluklarını doğru bir şekilde analiz edebildiğini ve güvenilir tahminler yapabildiğini kanıtlamaktadır. Bu bulgular, gelişmiş polinom regresyonunun uyku analizinde değerli bir araç olabileceğini ve insomnia şiddetini daha iyi anlamak ve tahmin etmek için veri odaklı bir yaklaşım sağlayabileceğini göstermektedir.

Anahtar Kelimeler: İnsomnia, İnsomnia Şiddet İndeksi, uyku sorunları, tahmin algoritması, kübik polinom regresyonu

Introduction

Insomnia is a common sleep disorder that significantly impacts an individual's daily life and can lead to persistent disruptions in sleep patterns. People with insomnia often experience symptoms such as difficulty falling asleep and frequent awakenings during the night, or waking up earlier than usual in the morning. Such insomnia symptoms are frequently associated with stress, excessive mental arousal or emotional dysregulation (1).

In modern societies, especially in industrialised countries, this disorder is quite common, with more than one–third of the population reported to experience this problem at some point in time. Sleep is a physiological process that is not limited to rest, but is also considered essential for maintaining mental and physical well–being (2).

Deterioration of sleep quality, particularly during childhood, may predispose individuals to develop problems such as attention deficit, learning difficulties, and behavioural disorders later in life. Therefore, recognising cases of insomnia as early as possible is crucial. When diagnosed early, patients generally respond more quickly to treatment, and the likelihood of the disorder becoming chronic is greatly reduced. For children especially, early identification of symptoms can be vital in preventing developmental delays (3-6).

Insomnia can not only disrupt individual sleep patterns but also impact overall health. Research indicates that prolonged sleep disturbances weaken the immune system, increase stress levels and may contribute to the development of diseases such as depression, diabetes or hypertension (7,8). Sleep is essential for brain homeostasis and brain resilience, as well as for maintaining mental and physical health. Insomnia is associated with changes in sleep architecture and function and can occur as a stressor contributing to mental and physical disorders. Therefore, the assessment and treatment of insomnia are essential factors for mental and physical health (9-12).

Early diagnosis of insomnia is vital for enhancing both individual health and quality of life. Patients who receive treatment promptly after an early diagnosis tend to recover more quickly and are less likely to develop chronic insomnia. Additionally, early diagnosis aims to minimise other disorders that may be caused by insomnia (13,14).

However, this traditional approach faces several limitations, including the limited reliability of subjective data, the lengthy duration of the diagnostic process, and the difficulty of maintaining continuous follow–up (15,16).

Devices such as actigraphy and polysomnography measure objective data, which clinicians use in conjunction with self–reports obtained directly from the patient. Actigraphy is a measurement technique that usually involves the use of a device to collect physiological data and objectively track a person's sleep patterns. Polysomnography is a more comprehensive test that measures brain waves, eye movements, heartbeat and muscle activity during sleep (17,18).

The existing methods for diagnosing insomnia assess an individual's sleep patterns, medical history, and symptoms within a broad framework (19). In diagnosing insomnia, no biomarker is incorporated into clinical practice. Experts' observations rely on the accurate interpretation of patient information. However, human error always presents a potential risk (20,21). Moreover, difficulties in precisely describing sleep problems, as well as underestimating or overestimating one's sleep patterns, are also limitations in diagnosing insomnia. These traditional methods have limitations, such as relying on subjective data, the difficulty of applying many objective measurements in daily life, and the absence of long–term follow–up (22-24).

In this context, it has become possible to offer more accurate, faster, and individualised solutions by utilising the opportunities provided by technological advancements. Wearable devices, mobile tracking systems, and artificial intelligence (AI)–enabled models have promising potential to detect insomnia symptoms early and predict the severity of the disorder. This study aims to develop a prediction model that can aid in the early diagnosis of insomnia and its progression, providing a more robust health monitoring process beyond traditional methods (25-27).

The regression and AI–based modelling techniques developed are widely used for early diagnosis, monitoring disease progression, and creating personalised treatment recommendations not only for insomnia but also for many chronic health conditions, such as diabetes, hypertension, depression, Parkinson's, obesity, and cardiovascular diseases (28,29). The primary advantages of such modelling are:

• Enables early diagnosis: Compared to traditional methods, it can predict risky situations before symptoms appear.

• Offers process automation, reducing clinical assessment time and the burden on healthcare professionals.

• Offers personalised intervention: Individualised treatment recommendations can be produced by taking into account the patient's historical data.

• Based on objective data, it reduces human error and helps make data–driven decisions.

• Enables long–term follow–up: Clinicians' dynamic monitoring tracks disease progression or recovery.

The model developed in this study offers a more accurate, rapid, and personalised approach. It also addresses the limitations of subjective data, enabling more reliable results and more effective health management. Such algorithms can enhance the quality of healthcare in both clinical practice and research (30,31).

Materials and Methods

Methodology

This study developed a cubic polynomial model to represent the key parameters that influence the severity of insomnia. While multiple factors contribute to sleep disturbances, this study focuses on five key variables that have the most significant impact: sleep duration (SD), time to fall asleep, time to wake, time to return to sleep after waking, sleep efficiency and impaired daytime functioning (DI). The study selected these parameters based on their clinical relevance and measurable impact on sleep quality. The formulation of a cubic polynomial aims to capture the complex, nonlinear relationships between these factors and the severity of insomnia. The model strikes a balance between accuracy and computational efficiency, providing a reliable data representation while avoiding excessive complexity. The main parameters and threshold values in the literature are listed below.

Basic Parameters Signalling Insomnia

1. Sleep Duration:
• Sleeping less than 6–7 hours a night.

• Difficulty falling asleep in 30 minutes or more.

2. Sleep Quality:

• Frequent awakenings during the night.

• Not feeling rested or refreshed when waking up.

3. Sleep Delay:

• Taking longer than 30 minutes to fall asleep.

4. Waking After Sleep Onset (WASO):

• Staying awake for more than 20–30 minutes during the night.

5. Early Morning Awakening:

• Waking up 1 hour or more before the scheduled time and not being able to fall back asleep.

6. Impaired DI:

• Fatigue or excessive daytime sleepiness.

• Difficulty concentrating or memory problems.

• Mood disorders such as irritability, anxiety or stress.

7. Trigger Factors:

• Stress, emotional distress or sudden life changes.

• Travel, jet lag or shift work.

• Environmental disturbances (noise, light, temperature).

In natural conditions, if the symptoms listed above persist for more than three months, it is usually classified as chronic insomnia rather than acute insomnia (1). The developed cubic polynomial model reflects the severity of insomnia based on threshold values of key parameters and predicts the future course of the disease. The model includes numerous parameters; however, to reduce computational complexity, the study disregarded two of the seven basic parameters that indicate insomnia, as they contributed minimally.

The developed model considers the five basic parameters and threshold values listed below.

Step 1: Defining Parameters

Affecting parameters and their threshold values:

1. SD: Hours of sleep per night (threshold: 6–7 hours)

2. Sleep Latency (SL): Time taken to fall asleep in minutes (threshold: >30 minutes)

3. WASO: Total time awake during sleep in minutes (threshold: >20–30 minutes)

4. Early Awakening (EA): Minutes awake before the intended wake–up time (threshold: >60 minutes)

5. Impaired DI: Fatigue, concentration problems, mood swings (scale: 0–10)

Step 2: Defining the Cubic Polynomial Model

Using the five parameters (SD, SL, WASO, EA, DI), the study defines a function in Equation (1) to indicate the severity of insomnia.

$$Y = \beta_0 + \beta_1 SD + \beta_2 SL + \beta_3 WASO + \beta_4 EA + \\ \beta_5 DI + \beta_6 SD^2 + \beta_7 SL^2 + \beta_8 WASO^2 \tag{1}$$

Equation (1) presents the cubic polynomial model, to which least absolute shrinkage and selection operator (LASSO) optimisation

regression is applied to estimate all β values. To support this, Equation (2) includes the variable error (ε).

$$Y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \sum_{i=1}^{n} \beta_{ii} X_i^2 + \sum_{i=1}^{n} \beta_{iii} X_i^3 + \varepsilon \tag{2}$$

Where:

Y = Insomnia severity

X_i = Input variables (SD, SL, WASO, EA, DI)

β_0 = Initial value

β_i, β_{ii}, β_{iii} = Determined model coefficients

ε = The error variable captures the residual ε component, which includes randomness and unmodeled effects.

The variable β_0 denotes the constant term that allows the model to make significant predictions when all input parameters are zero. It explains the endogenous severity of insomnia not explained by the predictors. Without β_0, the model would be forced to pass through the origin ($Y = 0$ when all $X_i = 0$), which may not be realistic.

In practical application, if β_0 is significantly positive, indicating an initial level of insomnia severity, even without the influence of other factors such as SD, SL, and waking up after sleep onset). If the coefficient β_0 is close to zero or negative, which indicates that insomnia severity is due to the selected predictors rather than a natural baseline level.

Step 3: Normalise Parameters Using Thresholds

Using the developed model, inputs were normalized according to predefined threshold intervals to ensure comparability among various parameters:

$$x_1 = \frac{SD - 6}{1}, x_2 = \frac{SL - 30}{30}, x_3 = \frac{WASO - 20}{10}, x_4 = \frac{EA - 60}{60}, x_5 = \frac{DI}{10} \tag{3}$$

"The normalized values in Equation (1) can be expressed as follows:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \\ \beta_6 x_1^2 + \beta_7 x_2^2 + \beta_8 x_3^2 + \beta_9 x_4^2 + \beta_{10} x_5^2 + \beta_{11} x \tag{4}$$

Step 4: Multi-Objective Optimization Approach

The LASSO optimisation regression method includes a regularisation term L that encourages sparsity by forcing some coefficients to be exactly zero. This aids feature selection and prevents overfitting.

• Objective Functions:

The original Objective Function (before regulation) can be defined as follows:

$$Y \min_{\beta} J(\beta) = \frac{1}{m} \sum_{j=1}^{m} \left(Y_j - \beta_0 - \sum_{i=1}^{n} \beta_i X_{ij} - \sum_{i=1}^{n} \beta_{ii} X_{ij}^2 - \sum_{i=1}^{n} \beta_{iii} X_{ij}^3 \right)^2 \tag{5}$$

Modified Objective Function with LASSO (L–Regulation)

$$\min_{\beta} J(\beta) = \frac{1}{m} \sum_{j=1}^{m} \left(Y_j - \beta_0 - \sum_{i=1}^{n} \beta_i X_{ij} - \sum_{i=1}^{n} \beta_{ii} X_{ij}^2 - \sum_{i=1}^{n} \beta_{iii} X_{ij}^3 \right)^2 + \lambda \sum_{i=1}^{n} (|\beta_i| + |\beta_{ii}|) \tag{6}$$

Where:

Modified Objective Function with LASSO (L–Regulation) Y_j actual observed value for the jth sample, $J(\beta)$ represents the objective function that measures the error between predicted and actual values in a regression model.

• **Constraints:**

Depending on the specific optimisation method, constraints may include LASSO (L1 Regulation) constraints:

$$\sum_{i=1}^{n} |\beta_i| \leq \lambda$$

Ridge (L2 Regulation):

$$\sum_{i=1}^{n} \beta_i^2 \leq \lambda$$

These constraints prevent over–fitting and ensure sparsity in feature selection.

• **Physical or Site-Specific Constraints on Implementation:**

If certain parameters must be non–negative (for example, sleep time cannot be negative):

$$\beta_i \geq 0, \forall i$$

If the parameters need to be within a known range:

$$\beta_{min} \leq \beta_i \leq \beta_{max}$$

• **Monotony Constraints:**

If the model needs to implement monotonic relationships (e.g., severity should increase as sleep parameters worsen), constraints such as:

$$\frac{\partial Y}{\partial X_i} \geq 0 \tag{7}$$

The condition in Equation (7) ensures that a factor such as sleep delay or waking up after sleep onset increases its severity.

Exact Formulation of the Optimisation Problem:

$$\min_{\beta} \frac{1}{m} \sum_{j=1}^{m} \left(Y_j - \beta_0 - \sum_{i=1}^{n} \beta_i X_{ij} - \sum_{i=1}^{n} \beta_{ii} X_{ij}^2 - \sum_{i=1}^{n} \beta_{iii} X_{ij}^3 \right)^2 + \lambda \sum_{i=1}^{n} |\beta_i| \tag{8}$$

Equation (8) is defined provided that.

1. $\beta_{min} \leq \beta_i \leq \beta_{max}, \forall i$

2. $\sum_{i=1}^{n} |\beta_i| \leq \lambda$

3. $\beta_i \geq 0$ (for physically meaningful parameters)

This optimisation problem allows the minimisation of the estimation error while applying realistic constraints on the parameter values.

The β values are obtained from the measured data using a Least Squares Regression solution, but some modifications have been made using LASSO (L regularisation) which forces some β values set to zero, which leads to feature selection. If some polynomial terms are redundant, LASSO improves generalisation by removing them. The least squares regression method determines β values using the design matrix X as follows.

1. Solution Generating Matrix Layout

The model constructs the cubic polynomial regression by organising input variables into constant, linear, quadratic, and cubic terms. Matrix X can be defined as follows:

$$X = [1 \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad x_5 \quad x_1^2 \quad x_2^2 \quad x_3^2$$
$$x_4^2 \quad x_5^2 \quad x_1^3 \quad x_2^3 \quad x_3^3 \quad x_4^3 \quad x_5^3]$$

Where each row represents a data sample and the columns represent the polynomial properties.

2. Least Squares Regression Solution

Given the set of observed severity scores, the model coefficients β

$$\beta = (X^T X)^{-1} X^T Y \tag{9}$$

Where:

X^T: is the transpose of X,

$(X^T X)^{-1}$: Inverse of the Gram matrix,

$X^T Y$: generates the β parameter using the output values.

Ridge Regression defines a regularisation term to prevent overfitting and numerical instability:

$$\beta = (X^T X + \lambda I)^{-1} X^T Y \tag{10}$$

Where λ is the regulation parameter, and I is the identity matrix.

3. Prediction and Model Evaluation

The predicted severity score $\hat{Y}$ is calculated using Equation (11) with the coefficients β computed according to Equation (10).

$$\hat{Y} = X\beta \tag{11}$$

The model accuracy was evaluated using the Mean Squared Error (MSE) and the Coefficient of Determination (R^2):

$$MSE = \frac{1}{N} \sum_{i=1}^{N} (Y_i - \hat{Y}_i)^2$$

$$R^2 = 1 - \frac{\sum_{i=1}^{N} (Y_i - \hat{Y}_i)^2}{\sum_{i=1}^{N} (Y_i - \bar{Y})^2} \tag{12}$$

Where, N represents the number of samples, and $\hat{Y}$ denotes the mean of the actual values.

The goodness of fit of the developed model is evaluated using the MSE and R^2 methods. A high MSE value indicates poor model fit and greater error, whereas an R^2 value close to 1 signifies that the model fits the data well and demonstrates high performance.

Pseudocode: Cubic Polynomial Regression for Predicting Insomnia Severity.

Step 1: Upload Data

Input: SD, SL, WASO, EA, DI, Insomnia Severity Scores (Y)

Step 2: Normalized Data

For all parameters X_i {SD, SL, WASO, EA, DI}:
Calculate the average (X_i) and the standard deviation (X_i)
Normalize X_i : $X_{inormalized} = (X_i$ - average (X_i)) / standard deviation (X_i)

Step 3: Solution Matrix (Cubic Polynomial Parameters)

$$X = \begin{bmatrix} 1, x_1, x_2, x_3, x_4, x_5, \# \text{ Constant and Linear Terms} \\ x_1^2, x_2^2, x_3^2, x_4^2, x_5^2 \ \# \text{ Second-Order Terms} \\ x_1^3, x_2^3, x_3^3, x_4^3, x_5^3 \ \# \text{ Cubic Terms} \end{bmatrix}$$

Step 4: Solving Model Coefficients Using Ridge Regression

lambda = 0.1 # Regulation Parameter

$\text{beta} = (X^T * X + \text{lambda} * I)^\wedge(-1) * X^T * Y$

Step 5: Prediction

$Y_{prediction} = X * beta$

Step 6: Compute Model Accuracy (MSE, R²)

MSE = (1/N) * sum((Y - Y_{tahmin})²)

SST = Sum((Y - $Average_Y$)²)

R–squared (R²) = 1 - (MSE / SST)

Step 7: Output Results

Print "Model Constraints (beta):", beta
Print "MSE:", MSE
Print "R²:", R²

Step 8: Plot Actual and Predicted Severity Scores

Plot Y (actual values) vs. $Y_{prediction}$ (predicted values)

Z–score normalization was applied to the input variables to ensure numerical stability and prevent ill–conditioning:

$$X_i' = \frac{X_i - \mu_i}{\sigma_i}$$

Where μ_i and σ_i; respectively, X_i denotes the mean and standard deviation values.

Statistical Analysis

This study applies a custom analysis method developed by the authors for statistical analyses. The study utilises MATLAB R2021 b software (The MathWorks, Inc., Natick, MA, USA) to perform the analyses. Cubic polynomial regression analysis examined the relationships within the data, and the model's performance was measured using MSE and the coefficient of determination (R²). The study set the significance level at $p < 0.05$. The data in this study are from the Kaggle (32) open–access library. As the data are publicly available, ethical approval was not required. Throughout the research process, the team adhered to ethical guidelines and maintained the principles of data confidentiality. In this study, a prediction model is developed based on key sleep parameters that affect insomnia severity. The dataset used is a global sleep health dataset titled "Sleep Health and Lifestyle Dataset" obtained from the Kaggle (32) open data platform. The dataset includes health, lifestyle, and sleep information for 500 individuals, with the following variables recorded for each participant:

• Demographic information: Age, gender
• Health indicators: Body mass index, physical activity levels, stress levels, medical history
• Sleep information: SD, sleep quality, wake time, weekday/weekend sleep patterns

• Lifestyle factors: Caffeine intake, screen time, smoking and alcohol consumption, occupation, and marital status.

The study chose five parameters that directly influence insomnia prediction: SD, time to fall asleep, nighttime wakefulness time (WASO), EA time, and DI impairment score. The literature recognizes these parameters as biomarkers linked with insomnia, and the study used them as input variables in the model.

The study generated a data sample of around 500 rows based on these five parameters. Each row details the observation data of an individual.

The study applied Z–score normalisation to statistically scale the data and then trained the cubic polynomial regression model. It evaluated the model's performance using MSE and coefficient of determination (R²). The model, programmed in MATLAB R2021b environment, aims to accurately represent multivariate relationships affecting insomnia severity.

Table 1 lists the scoring system equivalents of the received data According to Table 1, each parameter is scored on a 0–4 scale and evaluated as follows.

• 0: No problem at all.
• 1: Mild.
• 2: Moderate.
• 3: Severe.
• 4: Very severe.

The calculation of insomnia severity involves evaluating five fundamental sleep parameters on a 0–4 point scale. The overall score, which ranges from 0 to 20, is obtained by adding up the individual parameter scores. Each parameter is weighted according to its clinical significance (for example, SD is multiplied by 1.5, and DI by 2).

Comparison with standard Insomnia Severity Index (ISI) values is as follows;

• 0–7 point: No clinical evidence.
• 8–14 point: Mild insomnia.
• 15–21 point: Moderate insomnia.
• 22–28 point: Severe insomnia.

If the total score exceeds 20, the formula below adjusts it to align with the standard ISI range (0-28).

Table 1. Scoring of parameters.	
Parameters	**Scoring**
Sleep duration (<6 hours)	0–4 point (by duration: 6 hours = 0, 4 hours = 4)
Sleep latency (>30 minutes)	0–4 point (30 minutes = 1, 60 minutes = 3)
WASO (nighttime awakenings)	0–4 point (20 minutes = 2, 40 minutes = 4)
Early awakening (>60 minutes)	0–4 point (30 minutes = 2, 60+ minutes = 4)
Daytime functioning	0–4 point (subjective report)
WASO: Waking after sleep onset.	

$$\text{Standard ISI} = \left(\frac{\text{Total Score}}{20}\right) \times 28$$

Implementation Results

The study utilised a dataset comprising 500 values for each parameter influencing insomnia severity. The predictive model, formulated as cubic polynomial regression, was employed to investigate the relationship between these parameters and the severity of the condition.

The actual severity obtained from the data, along with the comparison with the developed model, is shown in Figure 1.

Figure 1 compares the actual insomnia severity data (blue circles) with the model–predicted severity values (red dashed line). The predicted values of the developed model are generally quite close to the actual data.

The developed model accurately predicts insomnia severity, showing no significant deviations. The intrinsic severity values in the resulting graph range from 0 to 60, showing the variation in initial severity levels across different conditions.

Figure 2 illustrates the distribution of the total ISI.

Figure 2 presents the data used to understand the distribution of insomnia severity at different levels. In the graph, the ISI ranges from 0 to 28. This index is a metric used to measure the severity of insomnia symptoms.

The horizontal axis of the graph (x–axis) represents the severity index, while the vertical axis (y–axis) shows the number of individuals with these index values. Most cases concentrate on severity values ranging from 0 to 5. The data show an exceptionally high number of cases in the 0–1 range. This may mean that most individuals have very mild or no apparent symptoms of insomnia. When the severity index rises above 10, the number of cases decreases considerably, i.e. there are fewer cases of severe insomnia. When most of the index values fall within a certain range, insomnia severity is more prevalent in that range.

During the training and evaluation of the developed model,

analysing this distribution helps assess how accurately the model can predict insomnia cases of different severity levels. Furthermore, researchers can use the data to develop treatment or intervention strategies for insomnia.

Figure 3 illustrates the distribution of the ISI and shows the number of cases classified according to different levels of insomnia severity.

Figure 3 shows the distribution of samples by severity, categorised as negative (0–7), milf insomnia (8–14), moderate insomnia (15–21), and severe insomnia (22–28). According to the graph, the number of individuals with no symptoms of insomnia (i.e., negative individuals) was approximately 340, representing the largest group of the total cases. The number of individuals with mild insomnia was approximately 75, with about 30 having moderate insomnia, and approximately 35 experiencing severe insomnia.These results indicate that the majority of the individuals analysed do not experience insomnia. However,
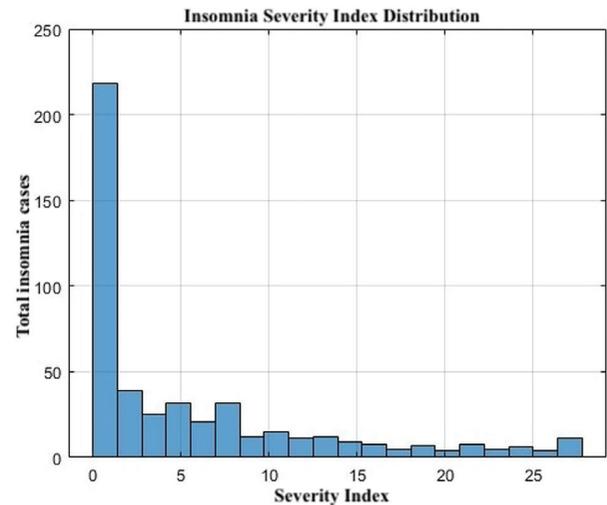
Figure 2. Number of cases by insomnia severity level.

Figure 1. Comparison of insomnia severity.
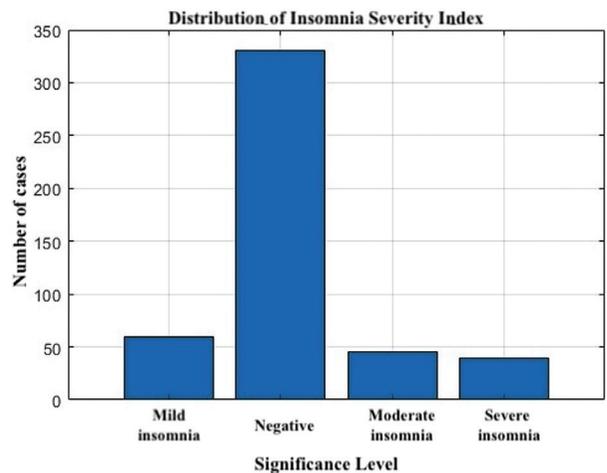
Figure 3. Number of cases according to ISI distribution. ISI: Insomnia Severity Index.

the data reveal a considerable number of mild insomnia cases, suggesting that insomnia symptoms are common but often not severe. The incidence of moderate and severe insomnia is relatively low and close to each other.

This distribution should be considered when evaluating the model's prediction performance. Particularly, the model's ability to detect mild and moderate insomnia cases will be a key factor. Additionally, the small number of samples in the "severe insomnia" group in the dataset may hinder the model's ability to learn this category. From a clinical perspective, early identification and treatment of individuals with mild to moderate insomnia symptoms present a vital opportunity to prevent severe insomnia.

Figure 4 shows the predicted severity of insomnia in future periods.

The highest insomnia severity observed in the graph is approximately 32–34 levels, and this maximum value occurs in the 2nd, 11th, and 17th periods. There are sudden increases at these points. The average insomnia severity is around 7–10, with a few periods where the minimum level is 0.

There is high variance in the dataset, as insomnia severity fluctuates from 0–5 at specific points in time to as high as 30 at others. These fluctuations suggest that specific periods exacerbate insomnia, resulting in its irregular variation over time.

To predict insomnia severity in future periods, time series analysis helps identify whether insomnia exhibits periodic increases or decreases. Sudden jumps, trend shifts, or anomalies enable the detection and investigation of potential triggering factors. These sudden jumps aid in forecasting future episodes of heightened insomnia severity.

Conclusion

This model provides greater practicality than traditional AI solutions and easily integrates with Internet of Things devices, requiring minimal processing power. The model's autonomous prediction ability enables continuous monitoring of disease progression and the timely recommendation of necessary interventions. This approach improves healthcare efficiency by preventing unnecessary delays for specialists.
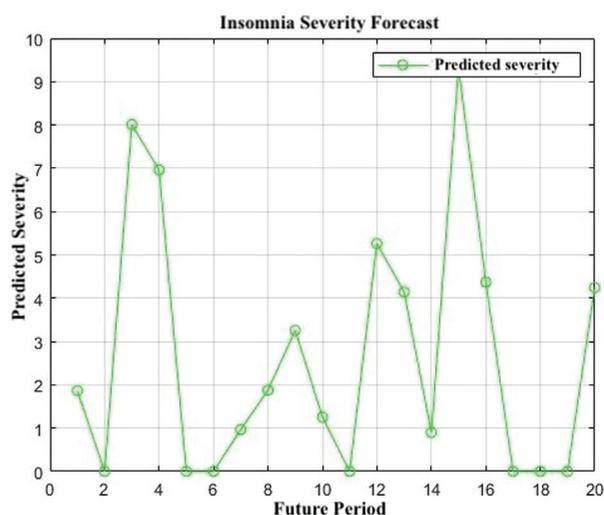
This study develops a cubic polynomial regression model to predict insomnia severity based on basic sleep parameters. The model, which includes quadratic and cubic terms, effectively captured the nonlinear relationships between the variables and provided a more accurate representation and prediction of the course of insomnia. The MSE value of 0.0018 indicated that the model's performance was relatively high. The study also evaluated the model's performance using the R^2 metric. According to the performance results, the model's R^2 value of 0.998 also demonstrates its high accuracy. These performance results emphasised the model's ability to predict insomnia severity more reliably.

Comparing different polynomial representations, the classical cubic model exhibits a significantly higher error, despite using fewer coefficients. The developed parametric cubic model with more coefficients significantly improved the fit and reduced the margin of error. These results highlight the importance of selecting a model that strikes a balance between accuracy and computational efficiency.

The findings suggest that advanced polynomial regression techniques can enhance sleep disorder assessments and provide a data–driven approach to understand Insomnia patterns.

Future studies could explore additional impact factors and further optimise the model for clinical applications. At the same time, using data from smartwatches can provide objective and continuous follow–up. Since smartwatches can be used comfortably by adults and children, data collection becomes easier and more reliable. Smartwatch data enables early diagnosis, especially in children, allowing doctors or parents to prevent insomnia before it progresses. The model offers a significant advantage in diagnosing insomnia by eliminating the need for direct feedback from individuals who have difficulty expressing themselves in childhood.

Ethics

Ethics Committee Approval: The data used in this study were obtained from an open–access repository. Since the data are publicly available, ethical approval was not required. All analyses were conducted in accordance with data privacy and ethical guidelines.

Informed Consent: This study utilized publicly available data from an open–access repository. No direct interaction with human participants was involved, and therefore, informed consent was not required.

Footnotes

Authorship Contributions

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

Figure 4. Insomnia severity prediction.

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Prevalence and Epidemiology of Restless Leg Syndrome (RLS) Among the Residents of Quetta Pakistan: A Cross-Sectional Study

Quetta Pakistan'da Yaşayanlar Arasında Huzursuz Bacaklar Sendromunun (RLS) Prevalansı ve Epidemiyolojisi: Kesitsel Bir Çalışma

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Abstract

Objective: Restless legs syndrome (RLS) is a prevalent neurological disorder characterized by an irresistible urge to move the legs. Mostly, the condition is associated with other health problems such as sleep disorders or any other health problems, thus making it an underdiagnosed condition among general population in a developing country like Pakistan including its local regions.

Materials and Methods: The study consisted of 350 participants from different regions of Quetta to evaluate the prevalence of RLS in the region. To achieve the desired aim, a well-designed questionnaire was made using Google Form which was distributed through different social media platforms from March 2023 to October 2023. The international diagnostic criteria for diagnosis of RLS was used.

Results: The prevalence of RLS among 350 individuals was calculated to be 43 (12.1%). According to the Epworth Sleepiness Scale, 20 (46.5%) of the 43 participants with an RLS diagnosis had severe sleepiness, followed by moderate (23.3%), very severe (20.9%), and mild (9.3%). Age, gender, sleeping difficulties, and other health conditions were not substantially correlated with RLS ($p > 0.05$), however smoking was ($p = 0.036$). Neither the severity of RLS nor the degree of sleepiness were significantly correlated with gender ($p = 0.683$ and $p = 0.858$, respectively).

Conclusion: The RLS prevalence found in our study was less than that of another prevalence study in Pakistan. To have a better understanding of the variables of RLS in distinct populations, it is imperative that additional prevalence studies be conducted in various regions of the country.

Keywords: Restless leg syndrome, prevalence, epidemiology, general population

Öz

Amaç: Huzursuz bacaklar sendromu (RLS), bacakları hareket ettirme konusunda karşı konulamaz bir istekle karakterize edilen yaygın bir nörolojik hastalıktır. Çoğunlukla, bu durum uyku bozuklukları veya diğer sağlık problemleriyle ilişkilindirmekte ve bu da onu Pakistan gibi gelişmekte olan bir ülkede ve yerel bölgelerinde genel popülasyonda tanı konulmamış bir durum haline getirmektedir.

Gereç ve Yöntem: Çalışma, Quetta'nın farklı bölgelerinden 350 katılımcıdan oluşmuş ve bölgedeki RLS prevalansını değerlendirmeyi amaçlamıştır. İstenilen amaca ulaşmak için iyi tasarlanmış sorulardan oluşan bir anket formu Google Form ile oluşturulmuş, formlar Mart 2023 ile Ekim 2023 arasında farklı sosyal medya platformları aracılığıyla dağıtılmıştır. RLS tanısı için uluslararası tanı kriterleri kullanılmıştır.

Bulgular: Yapılan çalışmada 350 birey arasında RLS prevalansı %12,1 (43 kişi) olarak belirlendi. Epworth Uykululuk Ölçeğine göre, RLS tanısı alan 43 katılımcıdan 20'si (%46,5) şiddetli uykululuk yaşarken, bunları orta derecede (%23,3), çok şiddetli (%20,9) ve hafif (%9,3) uykululuk takip etmiştir. Yaş, cinsiyet, uyku sorunları ve diğer sağlık sorunları RLS ile anlamlı ölçüde ilişkili değildi ($p > 0,05$), ancak sigara içme ile ilişki bulunmuştur ($p = 0,036$). RLS şiddeti ve uykululuk derecesi cinsiyetle anlamlı bir şekilde ilişkili değildi (sırasıyla $p = 0,683$ ve $p = 0,858$).

Sonuç: Çalışmamızda bulunan RLS prevalansı, Pakistan'da başka bir prevalans çalışmasına göre daha düşüktür. RLS'nin farklı popülasyonlardaki değişkenlerini daha iyi anlayabilmek için ülkenin çeşitli bölgelerinde ek prevalans çalışmalarının yapılması gerekmektedir.

Anahtar Kelimeler: Huzursuz bacaklar sendromu, prevalans, epidemioloji, popülasyon tabanlı çalışma

Introduction

Despite increased awareness of its detrimental effects on life quality, restless legs syndrome (RLS) is still not well understood and underdiagnosed condition, especially in developing countries. It's also known as Willis–Ekbom disease, a common and chronic movement disorder that significantly affects the limbs (1,2). People suffering from this illness have an uncontrollable need to move their legs and often experience strange and painless feelings of tingling and cramping. These sensations occur when the person is at rest, particularly in the evening and during the night and can decrease with body movements or physical activities (3,4). Symptoms tend to worsen at night, especially involuntary leg movements can disrupt the sleeping pattern, leading to periodic leg movement of sleep (5). RLS is mostly diagnosed based on the following five factors: (1) an urge to move the legs, frequently accompanied by uncomfortable leg sensations; (2) initiation or worsening of symptoms by rest; (3) relief from symptoms upon activity; (4) regular changes of symptoms with worsening in the evening and at night; and (5) excluding additional medical and behavioral conditions that can mimic RLS (6-9).

There are very limited studies that tend to assess the prevalence and epidemiology of RLS among the general population in recent years. A prevalence study was conducted in Saudi Arabia with almost 10,106 sample size, reported that a total of 11.9% of participants had persistent RLS. The study revealed associations between RLS with factors such as younger age, tobacco smoking, anxiety, and moderate to severe depressive symptoms (10). Similarly, the epidemiology of RLS has been the subject of numerous descriptive studies, but in the past ten years, it has become more well–known. The fact that RLS prevalence varies greatly around the globe is among the most significant conclusions drawn from these epidemiological studies. Another discovery is that RLS, which was before thought to be a rare disease, is now acknowledged as a prevalent ailment with notable clinical diversity.

Several studies in Pakistan evaluated the prevalence of RLS among different populations, such as pregnant women, medical students, madrasa students, and IT students (11-14). Other studies reported on its prevalence among patients with diabetes and obesity, spinal cord injuries, sleep disorders, and hemodialysis patients (15-18). So, the gap was felt regarding its prevalence and epidemiology in non–clinical setting specially in underprivileged area like Quetta, Pakistan which has an estimated population of 1.57 million according to 2023 Census of Pakistan. While local statistics on literacy and internet penetration are not available, national data indicates that 78 percent of people subscribe to mobile broadband and 45.7% of people use the internet. This lends credence to the utilization of an online poll among urban dwellers who are interested in technology. Online surveys can be a useful instrument for collecting health–related data from a sizable portion of the population in cities like Quetta, where internet access is increasingly expanding. Such approaches can non–etheless give a fairly accurate prevalence estimate among the population that is digitally active, even though they might not include people who do not have internet access or digital literacy.

Materials and Methods

Study Design

The current research study aimed to investigate the prevalence and severity of RLS among the residents of Quetta, Pakistan. To achieve this objective, a cross–sectional study design was employed using an online questionnaire distribution method through Google Forms during March 2022 to December 2022. It was content validated, and pilot tested before its application in the present study. The data were collected by sharing the questionnaire link through WhatsApp and Email among the general population of different regions of Quetta.

Ethical Approval

Throughout the study, ethical considerations were meticulously observed, including informed consent, anonymity, and data confidentiality. Participants were assured that their responses would remain confidential and be used solely for research purposes.

Sample Size

The following presumptions guided the calculation of the study's sample size, which was determined using a standard formula for prevalence studies:

$$n = [Z^2 \times P \times (1 \times P)]/d^2$$

P is the expected prevalence or proportion (if the expected prevalence is 20%, then p = 0:2), d is the precision (if the precision is 5%, then d = 0:05), n is the sample size, and Z is the Z statistic for a level of confidence. The anticipated sample size, assuming a prevalence of 23.6% (16), maintaining a 95% confidence level, and allowing for a 5% margin of error, came to 278. We require 300 individuals, plus an additional 10% for non–response, missing values, and dropouts. According to a prior study carried out in Karachi, Pakistan, the predicted prevalence was 23.6% (19). However, after careful consideration and to enhance the study's statistical power, the final selected sample size was increased to 350 participants.

Study Tool and Data Collection Method

The participants were thus recruited for this study through a non–random sampling method. Those participants aged 18 years and above were considered in this study. Participants below 18 years of age and those who did not give consent to participate were excluded from this study.

The questionnaire comprised four sections. The first section gathered demographic information, including age and gender, to provide a comprehensive characterization of the study population. The second section consisted of diagnostic criteria of the RLS set by: (9)

1) A strong desire to move one's legs, usually accompanied by leg discomfort.

2) Symptoms getting worse when at rest or inactivity.

3) Symptoms getting better when moving around.

4) Symptoms are more bothersome at night and in the evening than during the day.

5) Unpleasant feelings and sensations get worse after certain activities, such as long periods of sitting or inactivity.

Subjects fulfilling a maximum of five criteria were considered positive for RLS.

The third section consisted of sleep patterns and sleep disturbances using Epworth Sleepiness Scale (ESS). For participant convenience, the ESS was converted to a binary response format and the responses to the seven ESS questions were scored, and the total scores were categorized as follows:

• 0–2: Mild sleepiness

• 3–4: Moderate sleepiness

• 5–6: Severe sleepiness

• 7: Very severe sleepiness

The fourth section contained eight items about the frequency, severity, and impact of RLS symptoms on sleep and everyday activities that were used to measure the severity of their conditions. Due to the high percentage of illiteracy in the area, all answers were entered in the form of binary "Yes" or "No" format. Severity was classified as mild (0–2), moderate (3–4), severe (5–6), or very severe (7–8) based on the sum of the responses. While capturing important elements of RLS, like its onset, duration, alleviation through activity, and related sleep problems, our method guaranteed ease of use and accessibility.

Data Analysis

Data analysis encompassed descriptive statistics, including frequencies and percentages, to summarize the prevalence and severity of RLS within the Quetta population. Chi–square tests were also used to find the association between the categorical data in the study.

Results

In the study cohort comprising 350 individuals, 275 (77.50%) were identified as females, while 80 (22.50%) were males. Most participants were below the age of 40, 326 (91.8%), while a smaller portion was above 40, 29 (8.2%). In terms of smoking status, only 13 (3.7%), were reported smoking, while the rest 342 (96.3%), were non–smokers.

Among the total subjects (n = 355), 43 (12.10%) met all the diagnostic criteria and were RLS positive. The condition was observed to be more prevalent among females 32 (74.4%), than males 11 (25.6%). Within this subgroup of positive RLS cases (n = 43), 32 (74.42%) were females, and 11 (25.58%) were males (Figure 1).

The participants diagnosed with RLS (n = 43), had severe sleepiness among 20 (46.5%) followed by moderate 10 (23.3%), very severe 9 (20.9%), and mild 4 (9.3%) with minimal percentage on the ESS. As given by the RLS severity score, out of the 43 participants, there were 2 (4.6%) with mild, 9 (16.3%) moderate, 9 (20.9%) having a severe level of the condition, and the major number, 25 (58.1%), with very severe RLS.

Almost half of diagnosed participants, 48.8% were facing other health problems, and 39.5% had sleeping problems. In terms of treatment, more participants opted for homeopathy 25 (55.8%) than medical treatment 12 (27.9%), and a considerable number 31 (72.1%) did not seek medical treatment (Table 1).

The chi–square tests were applied to find out the association of RLS with gender, smoking, other health conditions and other sleeping disorders. The table indicates that smoking status is significantly associated with increased risk of RLS (p–value = 0.036). However, the participants with other health problems and sleeping disorders are not significantly associated with RLS, as their (p–values = 3.3395 and 9.0202), respectively, are greater than 0.05. The age and gender did not show significant associations with RLS, as p–values are greater than 0.05 (Table 2).

To find out the association between RLS severity scale and ESS with gender, the chi–square test was applied. The p–value for both the factors with gender were p = 0.683 and 0.858 respectively. The reason could be the high differences in both the genders among our sample size (Table 3).
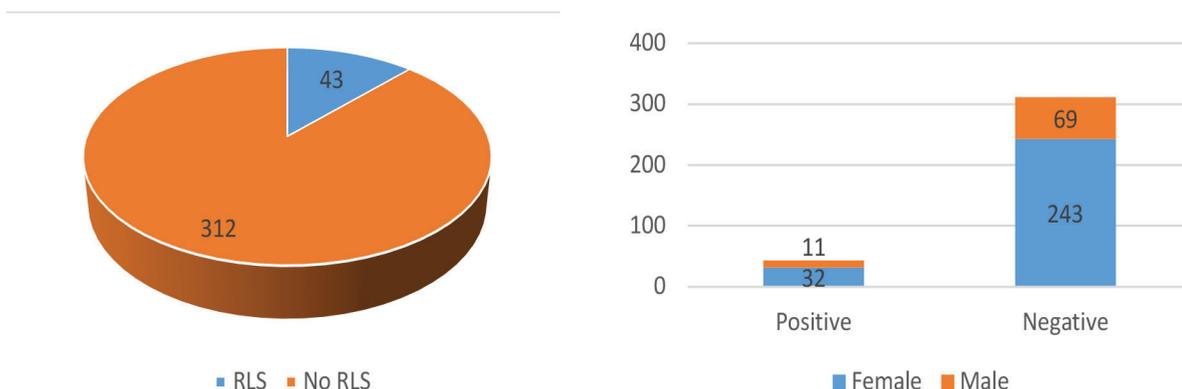
Figure 1. Prevalence of RLS among the residents of Quetta with distribution in gender with five diagnostic criteria (n = 355)
RLS: Restless legs syndrome

Table 1. Characteristics of participants of the study		
Characteristics	Numbers	Percentages
Total	355	100.0
Female	275	77.5
Male	80	22.5
Age (n = 355)		
Below 40	326	91.8
Above 40	29	8.2
Smoking status (n = 355)		
Yes	13	3.7
No	342	96.3
IRLSS diagnostic criteria (n = 355)		
Met all 5 diagnostic criteria	43	12.1
Female (n = 43)	32	74.4
Male	11	25.6
Epworth Sleepiness Scale (n = 43)		
Mild	4	9.3
Moderate	10	23.3
Severe	20	46.5
Very severe	9	20.9
RLS severity scale (n = 43)		
Mild	2	4.6
Moderate	7	16.3
Severe	9	20.9
Very severe	25	58.1
Diagnosed with other health conditions (n = 43)		
Yes	21	48.8
No	22	51.2
Diagnosed with Sleeping problems (n = 43)		
Yes	17	39.5
No	26	53.5
Type of treatment (n = 43)		
Homeopathy		
Yes	24	55.8
No	19	44.2
Medical		
Yes	12	27.9
No	31	72.1

RLS: Restless legs syndrome, IRLSS: International Restless Legs Syndrome Study Group

Discussion

To the best of our knowledge, after going through number of studies, this was the second attempt to classify RLS among the general population of Pakistan and identify its effects and consequences on the sleeping patterns. The first study was conducted in Karachi in 2015 and reported a prevalence up to 23% among general Pakistani population (20).

Other Asian countries came up with a prevalence of 32.9% (21) 16.2%, (22) 11.9%, (23) 8.36% (24). 8.5–14.2% is the documented prevalence of RLS in Western countries, making it one of the most prevalent movement disorders (25). In the current study, the prevalence of RLS among the general residents of Quetta city is (12.10%).The prevalence in the current study is almost similar to most of the other studies around the world. The consistency in prevalence can be due to the use of standardized diagnostic methods, similar lifestyles and genetic predispositions. The higher variation with the previous prevalence study in Pakistan is due the differences in participant selection and data collection methods. In the current study, the data were collected through online forms and covered a wider population compared to their study, whereas their participants were recruited from hospitals. This hospital–based recruitment probably included people with higher comorbidity rates, which could result in a higher prevalence being reported in their study. Our study did not find any association between RLS and gender unlike other studies who reported higher prevalence in females as compared to males, similar results were found by (20,21,23,26-29). Similar to our study, another study among medical students in Pakistan, also reported its high prevalence among females but could not find any significant association between both (19). This is because our study had significant differences between the two genders.

RLS can appear at any age, the majority of individuals with RLS are older than 40, and prevalence of RLS rises with age (30). Many research studies reported that prevalence of RLS increases with age and others reported similar results to our study that is maximum peak between 30 and 40 years of age (31). Further, the association with advancing age is greater among North American and European compared with Asian countries. Smoking acts as an independent risk factor for RLS, (19,32,33) as observed in the current study.

A study with a larger sample size was carried out in Iran, looking into individuals with a variety of comorbid conditions. It found that smoking and any neurological comorbidity were major contributors to the incidence (34). Further research can be done to examine this topic in the future. A study conducted in Türkiye revealed a generally low occurrence, although those who lived at high elevations were more likely to have this illness. Additionally, this study reaffirmed the link between smoking and developing RLS like another study in Pakistan (19). One of the most significant strength of this study was that the diagnosis was made based on IRLSSG diagnostic criteria.

Study Limitations

There are various restrictions on this study. Initially, it employed non–probability convenience sampling via online mediums (E–mail and WhatsApp), which would have left out people who lacked digital literacy or internet access. As a result, the results could not accurately reflect Quetta's overall population, but rather the city's tech–savvy and urban–literate citizens.

Second, a customized sleep scale created to enhance local

Table 2. Association of age, gender, smoking status and other health or sleeping problems with RLS

Characteristics	RLS positive (%)	RLS negative (%)	OR (95% CI)	p–value
Age				
>40	37 (10.4%)	289 (81.4%)	0.491 (0.188–1.284)	0.1396
<40	6 (1.7%)	23 (6.5%)		
Gender				
Female	32 (9.0%)	243 (68.5%)	0.826 (0.396–1.723)	0.6101
Male	11 (3.1%)	69 (19.4%)		
Smoking status				
Smoker	4 (1.1%)	9 (2.5%)	3.453 (1.015–11.74)	0.0357
Non-smoker	39 (11.0%)	303 (85.4%)		
Diagnosed with other health problems				
Yes	21 (5.9%)	20 (5.6%)	13.936 (6.582–29.51)	3.3395
No	22 (6.2%)	292 (82.3%)		
Diagnosed with other sleeping disorder				
Yes	17 (4.8%)	15 (4.3%)	12.946 (5.807–28.86)	9.0202
No	26 (7.3%)	297 (83.7%)		
RLS: Restless legs syndrome, OR: Odds ratio, CI: Confidence interval				

Table 3. Association of RLS severity and Epworth Sleepiness Scale with gender

Characters	Female	Male	p–value
Epworth Sleepiness Scale (n = 43)			
Mild	3 (6.9%)	1 (2.3%)	0.858
Moderate	8 (18.6%)	2 (4.6%)	
Severe	9 (20.9%)	5 (11.6%)	
Very severe	11 (25.6%)	4 (9.3%)	
RLS Severity Scale (n = 43)			
Mild	2 (4.6%)	0 (0.0%)	0.683
Moderate	4 (9.3%)	3 (11.6%)	
Severe	6 (13.9%	3 (11.6%)	
Very severe	18 (41.9%)	7 (16.3%)	
RLS: Restless legs syndrome			

comprehension was used to measure sleep disruption, even though RLS was diagnosed using the established IRLSSG criteria. The reliability and comparability of sleep–related outcomes may be impacted by the fact that this modified tool was not fully validated in the research population.

Finally, using self–reported data raises the possibility of subjective misinterpretation and recall bias, particularly when done online and without supervision.

Conclusion

It has been established that the prevalence of RLS in the general population of Quetta cannot be underestimated. Moreover, our research indicates that this condition is often overlooked, as a significant number of individuals do not actively seek medical assistance or investigate the underlying factors due to their lack of awareness regarding the cause of their symptoms. By educating the public about RLS, the project aims to enhance

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people's understanding of this ailment and its potential ramifications.

Ethics

Ethics Committee Approval: Strict adherence to ethical principles, such as informed permission, anonymity, and data confidentiality, was maintained throughout the investigation. Participants received assurances that their answers would be kept private and used only for study.

Informed Consent: Not availible.

Footnotes

Authorship Contributions

Concept: N.T., Design: N.E.A., N.T., Data Collection or Processing: N.E.A., N.T., Analysis or Interpretation: N.E.A., Literature Search: N.E.A., M.J.J., Writing: N.E.A., M.J.J.

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Evaluation of the Relationship Between Sleep Quality and Obesity, MEDFICTS Diet, and Social Media Addiction in Young Adults

Genç Yetişkinlerde Uyku Kalitesinin Obezite, MEDFICTS Diyet ve Sosyal Medya Bağımlılığı ile İlişkisinin Değerlendirilmesi

Halime Selen

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Abstract

Objective: Poor sleep quality is common among young adults, and there are many modifiable factors associated with it. The aim of this study is to evaluate the relationship between sleep quality, obesity, the MEDFICTS (meats, eggs, dairy, fried foods, in baked goods, convenience foods, table fats, and snacks) diet, and social media addiction in young adults.

Materials and Methods: This descriptive cross-sectional study was conducted with 200 young adults aged 18-25. The study data were collected using the Pittsburgh Sleep Quality Index (PSQI), the MEDFICTS diet assessment questionnaire, and the social media addiction scale (SMAS). A PSQI score of >5 was interpreted as poor sleep quality, while a score of ≤5 was considered good sleep quality.

Results: Seventy percent of the young adults participating in the study had poor sleep quality. According to the results of simple linear regression analysis, body mass index (β = 0.095, p = 0.031), the MEDFICTS diet score (β = 0.076, p = 0.000), and the SMAS score (β = 0.076, p = 0.000) were found to have a statistically significant and positive effect on the PSQI score. In the results of multiple linear regression analysis, the MEDFICTS diet score (β = 0.070, p = 0.000) and SMAS score (β = 0.053, p = 0.000) were also observed to have a statistically significant and positive effect on the PSQI score.

Conclusion: This study demonstrates that obesity, the MEDFICTS diet, and social media addiction are associated with poor sleep quality. Considering the close relationship between sleep and overall health, public health initiatives are needed to reduce obesity and social media use among young adults and to promote healthy eating habits.

Keywords: MEDFICTS diet, nutrition, obesity, sleep quality, social media addiction, young adulthood

Öz

Amaç: Genç yetişkinler arasında kötü uyku sorunu yaygındır ve bununla ilişkili değiştirilebilir birçok faktör vardır. Bu çalışmanın amacı genç yetişkinlerde uyku kalitesinin obezite, MEDFICTS (etler, yumurta, süt ürünleri, kızartılmış besinler, unlu mamullerdeki yağlar, hazır yiyecekler, sofrada eklenen yağlar ve atıştırmalıklar) diyet ve sosyal medya bağımlılığı ile ilişkini değerlendirmektir.

Gereç ve Yöntem: Tanımlayıcı kesitsel tipteki bu çalışma 18-25 yaş aralığındaki 200 genç yetişkin ile yürütülmüştür. Çalışma verileri Pittsburgh Uyku Kalite İndeksi (PUKİ), MEDFICTS diyet değerlendirme anketi ve sosyal medya bağımlılığı ölçeği (SMBÖ) kullanılarak toplanmıştır. PUKİ skorunun >5 olması kötü uyku kalitesi, ≤5 olması ise iyi uyku kalitesi olarak yorumlanmaktadır.

Bulgular: Çalışmaya katılan gençlerin %70'i kötü uyku kalitesine sahiptir. Basit doğrusal regresyon analiz sonuçlarında vücut kitle indeksi (β = 0,095, p = 0,031), MEDFICTS diyet (β = 0,076, p = 0,000) ve SMBÖ (β = 0,076, p = 0,000) değerinin PUKİ üzerinde istatistiksel olarak anlamlı ve pozitif yönlü bir etkisi olduğu gözlenmiştir. Çoklu doğrusal regresyon analiz sonuçlarında MEDFICTS diyet (β = 0,070, p = 0,000) ve SMBÖ (β = 0,053, p = 0,000) değerinin PUKİ üzerinde istatistiksel olarak anlamlı ve pozitif yönlü bir etkisi olduğu gözlenmiştir.

Sonuç: Bu çalışma obezite, MEDFICTS diyet ve sosyal medya bağımlılığın kötü uyku kalitesi ile ilişkili olduğunu göstermektedir. Uykunun genel sağlıkla yakından ilişkisi bilindiğinden genç yetişkinlerde obezite ve sosyal medya kullanımını azaltmaya yönelik girişimler ve sağlıklı beslenme alışkanlıklarının kazandırılmasına yönelik halk sağlığı çalışmaları gerekmektedir.

Anahtar Kelimeler: MEDFICTS diyet, beslenme, obezite, uyku kalitesi, sosyal medya bağımlılığı, genç yetişkinlik

Introduction

Sleep quality is closely related to human health (1). In young adults, sleep quality affects growth, development, academic achievement, cognitive development, a strong immune system, metabolic diseases, and mental health (2,3). However, there is a global conceptual confusion about how exactly good sleep quality should be defined (4). While sleep quality is related to sleep duration, it is a more complex phenomenon. Good sleep quality refers to satisfaction with sleep efficiency, sleep latency, sleep duration and wakefulness after sleep onset (4). Physiological, psychological, environmental, familial, and social factors form the basis of good sleep quality (4). The best assessment of sleep quality includes both subjective and objective measurements (5,6).

Good sleep quality allows individuals to feel rested and exhibit normal reflexes during the day, while poor sleep quality leads to issues such as fatigue, irritability, and dysfunction (4). A study evaluating the bidirectional relationship between sleep quality and multimorbidity in Chinese adults found that individuals with poor sleep quality were more likely to develop multimorbidity in the future. Additionally, individuals with multimorbidity exhibited worse sleep quality (7). Similar studies report that sleeping more or less than necessary increases the risk of developing chronic diseases such as stroke, cancer, obesity, depression and diabetes (8,9).

Sleep disorders among young adults are a global public health issue (10). While the outcomes of sleep quality are well–known, the factors affecting good sleep quality are highly diverse and complex. It is recognized that sleep quality has a bidirectional cause–and–effect relationship with obesity (11,12). Additionally, some authors have reported that sleep quality is associated with certain dietary patterns and nutrient profiles (13,14). The silent pandemic of recent times, social media addiction, is also closely linked to sleep quality (15), though further research on this topic is necessary. This study aims to evaluate the relationship between sleep quality, obesity, the MEDFICTS (meats, eggs, dairy, fried foods, in baked goods, convenience foods, table fats, and snacks) diet, and social media addiction in young adults.

Materials and Methods

This study is a descriptive cross–sectional study conducted between December 1–31, 2024. The study population and sample consisted of 200 young adults aged 18–25, studying in the Department of Nutrition and Dietetics at Ağrı İbrahim Çeçen University Faculty of Health Sciences in Ağrı, Türkiye. Participants were included if they did not have a chronic or metabolic disease diagnosed by a physician, were not using medication, and met the age criteria. All questions regarding the participants were asked directly by the researcher and recorded on questionnaire forms using a face–to–face interview technique. Written and verbal consent was obtained from all participants who agreed to participate in the study. In addition, the ethical approval of the study was approved by Ağrı İbrahim Çeçen University Scientific Research Ethics Committee (decision number: 428, date: 28.11.2024).

Data Collection Tools

The data for the study were collected using the Pittsburgh Sleep Quality Index (PSQI), the MEDFICTS diet assessment questionnaire, and the social media addiction scale (SMAS), in addition to a sociodemographic information questionnaire prepared by the researcher based on a relevant literature review.

Sociodemographic Information Questionnaire

The questionnaire included questions about participants' age, gender, body weight, height, marital status, place of residence, employment status, income level, smoking habits, alcohol consumption, and social media accounts used. Body mass index (BMI = kg/m^2) values were calculated from the participants' weight and height measurements and classified according to World Health Organization criteria: <18.5 kg/m^2 as "Underweight", 18.5–24.9 kg/m^2 as "normal weight", 25.0–29.9 kg/m^2 as "overweight," and ≥30 kg/m^2 as "obese"(16).

Pittsburgh Sleep Quality Index

The PSQI, used to assess participants' sleep quality, was developed by Buysse et al. (6) and its validity and reliability for the Turkish population were established by Yücel Ağargün et al. (17). The index consists of seven components, each scored between 0 and 3. The scores of all components are summed to calculate the sleep quality index. The PSQI yields a total score ranging from 0 to 21, with higher scores indicating poorer sleep quality. In general, a score >5 is interpreted as poor sleep quality, while a score ≤5 is considered good sleep quality (6,17).

MEDFICTS Diet Assessment Questionnaire

The MEDFICTS diet assessment, developed by Srinath et al. (18) to evaluate individuals' intake of total fat, saturated fat, and cholesterol, was validated and adapted for the Turkish population by Mermer et al. (19). The MEDFICTS diet questionnaire comprises eight main food categories: meats, eggs, dairy, fried foods, in baked goods, convenience foods, table fats, and snacks. The total score is determined by calculating the frequency and amount of consumption of foods in each category as specified in the guideline. An increase in the total score is interpreted as an increase in the intake of fat, saturated fat, and cholesterol in the individual's diet (18,19).

Social Media Addiction Scale

The SMAS was developed by Şahin and Yağcı (20) to evaluate social media addiction among adults in the Turkish population. The scale consists of 20 items in a five–point Likert format, with response options to be marked as "not suitable for me at all (1 point)", "not suitable for me (2 point)", "undecided (3 point)", "suitable for me (4 point)", and "completely suitable for me (5 point)". The scale does not have a cut–off point; instead, higher scores indicate that the individual perceives themselves as being "addicted to social media". Additionally, items 5 and 11 on the scale are reverse scored (20).

Statistical Analysis

The collected data were analyzed using SPSS for Windows 25.0. Descriptive statistical methods were used in data evaluation.

The normality of the data distribution was examined using Q–Q plot analysis, and normal distribution was defined as skewness and kurtosis values within the range of ±3. To investigate relationships among numerical variables and to examine the effects of independent variables on the dependent variable, simple and multiple linear regression analyses were applied. A p–value of <0.05 was considered statistically significant.

Results

The distribution of the sociodemographic characteristics of the participants is presented in Table 1. The participants were aged between 18–25 years, with a mean age of 21.51±1.58 years. Among the young adults, 80.5% were female, and 19.5% were male. When the distribution of the participants according to BMI classification was analyzed, it was seen that 11.0% were underweight, 73.0% were normal, 13.0% were overweight, and 3.0% were obese. 100.0% of the participants were single and the majority of them lived in student dormitories (76.0%). Most of the participants stated that they were not employed (92.0%), had a moderate income (70.0%), did not smoke (81.0%) and did not consume alcohol (89.0%). The five most commonly used social media platforms among the participants, all of whom owned smartphones, were WhatsApp (99.5%), Youtube (90.0%), Instagram (89.0%), Snapchat (60.5%) and Twitter (44.0%).

The distribution of participants based on their PSQI scores is presented in Table 2. According to the results, only 30% of the young adults had good sleep quality, while the majority, 70%, had poor sleep quality.

The results of the simple linear regression analysis conducted to estimate the predictive value of BMI, MEDFICTS diet, and social media addiction scores using PSQI as the dependent variable are presented in Table 3. The model established to investigate the effect of BMI on PSQI was found to be statistically significant (F = 4.728, p = 0.031). BMI had a statistically significant and positive effect on PSQI (β = 0.095, p = 0.031). The model explained 2.3% of the variance (R^2 = 0.023). Additionally, there was no autocorrelation problem in the model, as the Durbin–Watson (DW) value was between 1.5 and 2.5 (DW = 1.791). The model established to investigate the effect of MEDFICTS diet values on PSQI was found to be statistically significant (F = 286.933, p = 0.000). The MEDFICTS diet value had a statistically significant and positive effect on PSQI (β = 0.076, p = 0.000). The model explained 59.2% of the variance (R^2 = 0.592). Additionally, there was no autocorrelation problem in the model, as the DW value was between 1.5 and 2.5 (DW = 1.781). The model established to examine the effect of social media addiction scores on PSQI was statistically significant (F = 52.978, p = 0.000). Social media addiction scores had a statistically significant and positive effect on PSQI (β = 0.076, p = 0.000). The model explained 21.1% of the variance (R^2 = 0.211). Additionally, there was no autocorrelation problem in the model, as the DW value fell between 1.5 and 2.5 (DW = 2.039).

The results of the multiple linear regression analysis, in which PSQI was used as the dependent variable to estimate the predictive value of BMI, MEDFICTS diet, and social media addiction scores, are presented in Table 4. The model established to investigate the effect of BMI, MEDFICTS diet, and social media addiction scores on PSQI was found to be statistically significant (F = 153.760, p = 0.000). It was observed that MEDFICTS diet (β = 0.070, p = 0.000) and social media addiction (β = 0.053, p = 0.000) scores had a statistically significant and positive effect on PSQI. The model explained 70.2% of the variance (R^2 = 0.702). There was no autocorrelation problem in the model, as the DW

Table 1. Distribution of participants according to sociodemographic characteristics (n=200).			
Variables		n	%
Age (years) ($\overline{X}$ ± SD = 21.51 ± 1.58)	21 years and under	101	50.5
	Over 21 years old	99	49.5
Sex	Female	161	80.5
	Male	39	19.5
BMI ($\overline{X}$ ± SD = 22.08 ± 3.34)	Underweight	22	11.0
	Normal weight	146	73.0
	Overweight	26	13.0
	Obese	6	3.0
Marital status	Married	0	0.0
	Single	200	100.0
Place of worship	Student dormitory	152	76.0
	Family home	35	17.5
	Private home	13	6.5
Working status	Working	16	8.0
	Not working	184	92.0
Income status	Good	35	17.5
	Average	140	70.0
	Poor	25	12.5

Table 1. Continued.				
Variables			**n**	**%**
Smoking status		Yes	38	19.0
		No	162	81.0
Alcohol consumption		Yes	22	11.0
		No	178	89.0
Social media accounts used	Facebook	Yes	20	10.0
		No	180	90.0
	Instagram	Yes	178	89.0
		No	22	11.0
	Twitter (X)	Yes	88	44.0
		No	112	56.0
	LinkedIn	Yes	18	9.0
		No	182	91.0
	TikTok	Yes	44	22.0
		No	156	78.0
	Snapchat	Yes	121	60.5
		No	79	39.5
	Youtube	Yes	180	90.0
		No	20	10.0
	Pinterest	Yes	54	27.0
		No	146	73.0
	Twitch	Yes	8	4.0
		No	192	96.0
	WhatsApp	Yes	199	99.5
		No	1	0.5
	Telegram	Yes	17	8.5
		No	183	91.5
SD: Standard deviation, BMI: Body mass index.				

Table 2. Distribution of participants according to PSQI scores.		
PSQI score assessment	**n**	**%**
Good sleep quality	60	30.0
Poor sleep quality	140	70.0
Total	200	100.0
PSQI: Pittsburgh Sleep Quality Index.		

Table 3. The results of the simple linear regression analysis, in which PSQI was used as the dependent variable to estimate the predictive value of BMI, MEDFICTS diet, and social media addiction scores (n=200).

Model	Dependent variable	Independent variable	β	Standard error	Beta	t	p	F	p	R^2	Durbin-Watson
1	PSQI	Constant	4.507	0.978	-	4.608	0.000*	4.728	0.031*	0.023	1.791
		BMI	0.095	0.044	0.153	2.174	0.031*				
2	PSQI	Constant	2.022	0.287	-	7.050	0.000*	286.933	0.000*	0.592	1.781
		MEDFICTS diet	0.076	0.004	0.769	16.939	0.000*				
3	PSQI	Constant	2.606	0.566	-	4.607	0.000*	52.978	0.000*	0.211	2.039
		Social media addiction	0.076	0.010	0.459	7.279	0.000*				

*p<0.05.

BMI: Body mass index, MEDFICTS: Meats, eggs, dairy, fried foods, in baked goods, convenience foods, table fats, snacks, PSQI: Pittsburgh Sleep Quality Index.

Table 4. The results of the multiple linear regression analysis, in which PSQI was used as the dependent variable to predict the predictive values of BMI, MEDFICTS diet, and social media addiction scores (n=200).

Model	Dependent variable	Independent variable	β	Standard error	Beta	t	p	F	p	R²	Durbin-Watson
1	PSQI	Constant	-1.370	0.632	-	-2.169	0.031*	153.760	0.000*	0.702	1.890
		BMI	0.043	0.024	0.069	1.757	0.080				
		MEDFICTS diet	0.070	0.004	0.705	17.747	0.000*				
		Social media addiction	0.053	0.007	0.324	8.136	0.000*				

*p<0.05.

BMI: Body mass index, MEDFICTS: Meats, eggs, dairy, fried foods, ın baked goods, convenience foods, table fats, snacks, PSQI: Pittsburgh Sleep Quality Index.

value was between 1.5 and 2.5 (DW = 1.890).

Discussion

The relationship between good sleep quality and health is important across all age groups, from childhood to old age (21,22). However, it is particularly significant for young adults attending university, as sleep quality not only supports their overall health (23) but may also contribute to their academic success, although there is no complete consensus in the literature (24,25). Therefore, it is crucial to understand and control modifiable risk factors that impact sleep quality. This study evaluates the relationship between sleep quality and well–known factors such as high BMI, nutrition (fat and cholesterol intake), and social media addiction.

Poor sleep quality is common among young people, and it was observed that 70% of the young participants in this study had poor sleep quality (Table 2). In a study conducted with young individuals aged 18-29 in Jordan, 62.66% of the participants reported poor sleep quality (26). Similarly, in a study evaluating 462 women aged 23, nearly half of the participants reported poor sleep quality (27). A study conducted in Saudi Arabia reported that 72.5% of the general population experienced poor sleep quality, with the highest prevalence observed among young adults aged 18-28 (81.7%) (28). Furthermore, the recent Coronavirus Disease 2019 pandemic is also known to be associated with poor sleep quality (29). Young adulthood, often coinciding with university years, is a period marked by high levels of future anxiety and social pressure. During this time, the time spent on social media and unhealthy food choices in social settings may directly or indirectly impact sleep quality.

Although BMI values did not show a statistically significant effect on PSQI in the results of the multiple linear regression analysis, the simple linear regression analysis results indicated a statistically significant and positive effect (Table 3 and Table 4). This suggests that young individuals with higher BMI tend to have poorer sleep quality. There is a bidirectional relationship between obesity and sleep quality (11). Obesity can impair sleep quality by increasing the risk of sleep disorders (30). Researchers who consider obesity as a factor that can disrupt sleep quality often focus on obstructive sleep apnea (OSA) (31). OSA is a type of sleep disorder in which respiratory functions suddenly stop during sleep. OSA, which is particularly observed in individuals with high BMI, narrows the airway by reducing the activity of

upper airway muscles due to excessive fat accumulation around the neck, leading to sleep deprivation with hypoxic attacks (32). Another critical point in OSA is the reduction in serum lipoprotein lipase (LPL) concentrations (33). The decrease in LPL, which hydrolyzes fatty acids from circulating chylomicrons and VLDL, is a well–defined mechanism for hyperlipidemia associated with OSA (34). This represents the adverse effect of obesity on sleep quality. Researchers have also presented evidence that poor sleep can lead to obesity and negatively affect weight loss. A study involving 2,100 young adult university students demonstrated that poor sleep quality is associated with obesity status (35). A study involving 14,471 participants revealed that individuals with poor sleep quality have a significantly higher likelihood of being obese compared to those with good sleep quality (36). In a similar study, it was reported that obesity rates were significantly higher in adults who reported an average of less than 7 hours of night sleep per day (37). This situation can be linked to circadian rhythm disruption in individuals with poor sleep quality, an increase in the hunger–regulating hormone ghrelin, and a decrease in leptin levels, leading to increased consumption of high–fat and high–carbohydrate foods, thereby causing obesity (38). Excessive food intake associated with insufficient sleep can be considered a mechanism that increases obesity risk. All these factors may turn obesity into a vicious cycle in individuals with poor sleep quality.

Both simple and multiple linear regression analysis results revealed that the MEDFICTS diet score had a statistically significant and positive effect on PSQI (Tables 3 and Table 4). This indicates that young individuals with higher MEDFICTS diet scores tend to have poorer sleep quality. The MEDFICTS diet assessment questionnaire evaluates individuals' total fat, saturated fat, and cholesterol intake (18,19). This study is the first in the literature to evaluate the relationship between the MEDFICTS diet and sleep quality. A randomized controlled study assessing the effects of specific dietary patterns on sleep quality demonstrated that adults with high saturated fat intake experienced slower wave sleep and longer sleep latency (39). The same study reported that higher sugar intake increased nighttime awakenings in participants, while higher fiber intake was associated with fewer wake–up problems during sleep (39). This study provides significant insights into the potential impact of low–quality carbohydrates (low fiber, high starch) or high saturated fat intake on sleep quality (39). In a study evaluating

the relationship between adherence to the Mediterranean diet—characterized by the consumption of whole grains, fruits, vegetables, legumes, nuts, fish, and olive oil, while limiting red meat and high–saturated–fat dairy products–and sleep quality, it was reported that better adherence to the Mediterranean diet improved sleep quality (13). In a recent study, it was determined that an increase in the cholesterol/saturated fat index was associated with a higher likelihood of experiencing sleep problems (40). However, there are also authors in the literature who argue that food or fat intake is not related to sleep quality. In their study, Oliveira and Marques–Vidal (41) reported no significant relationship between various foods and nutrients and sleep quality, and that fat intake did not impair sleep quality. Similarly, a review evaluating 4,155 publications also concluded that no specific diet had a marked effect on sleep quality (42). Although the underlying mechanisms of how high–fat diets affect sleep quality have not yet been fully understood, studies generally focus on the potential of high–fat diets to cause weight gain, which may reduce the sensitivity of orexin neuropeptides responsible for regulating the body's sleep schedule, or disrupt the dopaminergic system, thereby impairing sleep quality (43,44).

Both simple and multiple linear regression analysis results showed that social media addiction had a statistically significant and positive effect on PSQI (Table 3 and Table 4). This indicates that young adults who are more addicted to social media tend to have poorer sleep quality. Social media addiction is progressing as a silent pandemic among young adults. Although social media addiction is not officially recognized in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders by the American Psychiatric Association, (45) it can be defined as excessive preoccupation with social media, acting with an uncontrollable urge to access and use social media, and spending so much time on social media that other important aspects of life are adversely affected. A study conducted among Chinese young adults aged 18–27 reported that social media addiction not only led to poor sleep quality but also resulted in a decline in executive functions (46). Another study evaluating Chinese undergraduate students found that more than half of those who used social media, particularly those spending 0.5–2 hours on social media before bedtime, experienced poorer sleep quality (47). These findings are significant for young adults, as social media usage has been shown to impair the ability to fall and stay asleep by increasing cognitive and emotional stimulation, thereby negatively affecting sleep quality (48,49). Additionally, excessive emotional investment in social media and frequent social media use can heighten pre–sleep cognitive arousal, leading to poor sleep outcomes (50). All these findings provide important clues that social media use can disrupt sleep quality.

Although limited in number, there are also studies in the literature that evaluate the combined relationship of nutrition and social media addiction with sleep quality. A study conducted among university students demonstrated that as digital addiction increased, there was a parallel rise in nighttime eating and consumption of processed foods, which negatively affected both sleep duration and quality (51). In a similar study conducted among Chinese university students, a bidirectional relationship was reported between internet addiction and unhealthy dietary habits, with both factors directly influencing insomnia (52). These findings, which are consistent with the current study, suggest that increasing social media addiction—particularly screen exposure late at night—may trigger late–night snacking behaviors. This may explain the increase in unhealthy eating habits, as assessed by MEDFICTS scores, and the negative impact on sleep quality.

Study Limitations

The main limitation of this study is the relatively small sample size and the limited age range of the participants. Additionally, other confounding factors that could influence sleep quality, such as dietary intake records, physical activity levels, the average time spent on social media daily, the specific hours of day when participants are more active on social media, and factors like stress, were not assessed. This could also be regarded as another limitation of the study. However, considering the lack of studies in the literature that evaluate the relationship between MEDFICT diet and sleep quality, and the limited number of studies on the relationship between social media addiction and sleep quality in young adults, this study may provide a valuable contribution to the literature.

Conclusion

The young adulthood period is a time when significant steps are taken for later stages of life. During this period, especially for young adults studying at university, maintaining good sleep quality is associated with living a healthy life. Seventy percent of the young participants in this study reported poor sleep quality. This can lead to chronic diseases in later years or decrease the quality of life. The findings of this study indicate that young people's sleep quality is closely related to BMI, MEDFICTS diet, and social media addiction. Social media addiction is particularly prevalent among young people. The foods often recommended on social media platforms are unfortunately low in nutritional value and high in simple carbohydrates and fats, typically fast food. Especially among young people who stay awake late into the night, exposure to advertisements for these foods on social media platforms and subsequent consumption can lead to obesity. This, in turn, can create a vicious cycle that negatively affects sleep quality.

In conclusion, public health interventions and policies should be developed to promote good sleep quality in young adults by ensuring weight control, encouraging healthy eating habits, and promoting moderate social media usage. Furthermore, larger–scale longitudinal studies are needed to fully understand the factors that affect sleep quality in young adults.

Ethics

Ethics Committee Approval: The ethical approval of the study was approved by Ağrı İbrahim Çeçen University Scientific Research Ethics Committee (decision number: 428, date: 28.11.2024).

Informed Consent: Written and verbal consent was obtained from all participants who agreed to participate in the study.

Footnotes

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

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Association Between Sleep Quality and Clinical-Cognitive Parameters in Multiple Sclerosis: A Multidisciplinary Cross-Sectional Study

Multipl Sklerozda Uyku Kalitesi ile Klinik-Bilişsel Parametreler Arasındaki İlişki: Multidisipliner Kesitsel Bir Çalışma

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Abstract

Objective: Sleep disturbances are a common symptom among patients with multiple sclerosis (MS). The Pittsburgh Sleep Quality Index (PSQI) is a reliable and practical tool for assessing sleep quality. The present study examined the association between sleep quality and clinical and radiologic characteristics in individuals with MS.

Materials and Methods: In this retrospective study, 137 patients with MS (PwMS) were included following stringent clinical, radiologic, and psychiatric exclusion criteria. Demographic, clinical, cognitive, and neuroimaging data were extracted from medical records. Sleep quality was assessed using the PSQI, with a global score ≥5 indicating poor sleep quality.

Results: Among the 137 PwMS, no significant differences were observed in demographic, clinical, cognitive, or radiologic parameters between those with good and poor sleep quality. However, walking speed was significantly slower in poor sleepers (p = 0.005). Sleep onset latency and subjective sleep quality were strongly correlated with overall PSQI scores. In contrast, lesion location, corpus callosum index, and measures of brainstem or spinal cord atrophy showed no association with sleep quality.

Conclusion: Sleep quality is adversely affected in PwMS and correlates with lower-limb physical performance. Patients' self-assessments of sleep quality appear consistent. Prolonged sleep onset latency is an important factor, while the effects of sleep duration and disturbance are less significant.

Keywords: Multiple sclerosis, sleep quality, Pittsburgh Sleep Quality Index, magnetic resonance imaging, physical performance, cognitive function, sleep latency

Öz

Amaç: Uyku bozuklukları, multipl skleroz (MS) hastalarında sık görülen bir semptomdur. Pittsburgh Uyku Kalitesi Endeksi (PSQI), uyku kalitesini değerlendirmek için güvenilir ve pratik bir araçtır. Bu çalışma, MS hastalarında uyku kalitesi ile klinik ve radyolojik özellikler arasındaki ilişkileri incelemiştir.

Gereç ve Yöntem: Bu retrospektif çalışmada, sıkı klinik, radyolojik ve psikiyatrik dışlama kriterleri doğrultusunda 137 MS hastası (PwMS) dahil edildi. Demografik, klinik, bilişsel ve nörogörüntüleme verileri tıbbi kayıtlardan çıkarıldı. Uyku kalitesi PSQI kullanılarak değerlendirildi ve genel puan ≥5 olanlar kötü uyku kalitesine sahip olarak kabul edildi.

Bulgular: Yüz otuz yedi MS hastası arasında, iyi ve kötü uyku kalitesine sahip olanlar arasında demografik, klinik, bilişsel veya radyolojik parametrelerde anlamlı bir fark gözlenmedi. Ancak, kötü uyuyanlarda yürüme hızı anlamlı olarak daha yavaştı (p = 0,005). Uykuya dalma süresi ve öznel uyku kalitesi, genel PSQI puanları ile güçlü bir korelasyon gösterdi. Buna karşın, lezyonun yeri, korpus kallosum indeksi ve beyin sapı veya omurilik atrofisi ölçümleri uyku kalitesi ile herhangi bir ilişki göstermedi.

Sonuç: MS hastalarında uyku kalitesi olumsuz etkilenir ve alt ekstremite fiziksel performansı ile ilişkilidir. Hastaların uyku kalitesine ilişkin öz değerlendirmeleri tutarlı görünmektedir. Uykuya dalma süresinin uzaması önemli bir faktördür, ancak uyku süresi ve uyku bozukluğunun etkileri daha az önemlidir.

Anahtar Kelimeler: Multipl skleroz, uyku kalitesi, Pittsburgh Uyku Kalitesi Endeksi, manyetik rezonans görüntüleme, fiziksel performans, bilişsel işlev, uyku latansı

Introduction

Multiple sclerosis (MS), a chronic inflammatory and neurodegenerative disease of the central nervous system (CNS), is a multifaceted condition that has a profound impact on individuals, caregivers, and the healthcare system (1). MS is characterized by various clinical symptoms in the CNS, including gait changes, spinal cord symptoms, motor and sensory deficits, cranial nerve dysfunction, speech disorders, cognitive deficits, fatigue, and sleep disturbances (2). Sleep disturbance is one of the factors that can affect the quality of life of patients with MS (PwMS) (3-8). Many factors probably contribute to sleep disorders. They may be due to other comorbidities or medications, as well as the involvement of brain nuclei that regulate sleep.

The Pittsburgh Sleep Quality Index (PSQI) questionnaire, which reflects an overall assessment of sleep quality over the past month, is convenient and valuable for PwMS. This study aimed to investigate the relationship between sleep quality and its components and demographic, clinical, and radiologic characteristics in PwMS.

Materials and Methods

Patient Selection

In this study, we retrospectively reviewed 628 medical records of patients with a definitive diagnosis of MS, according to the revised McDonald 2017 diagnostic criteria, who were evaluated for sleep quality using the PSQI at our center between December 2022 and May 2024. This study was conducted with the approval of the Bursa Uludağ University Clinical Research Ethics Committee (approval number: 2025/700–11/10, date: 11.06.2025). The date on which sleep quality was assessed was used as the baseline. The presence of incidental lesions unrelated to MS on magnetic resonance imaging (MRI), contrast–enhancing demyelinating lesions, a demyelinating relapse or steroid use within the previous month, use of medications that could affect sleep quality, comorbid conditions, the presence of clinically significant depressive symptoms determined by the Geriatric Depression Scale (GDS) or Beck Depression Inventory (BDI) administered concurrently. Patients with progressive MS were excluded from the study. Data from 137 eligible patients were included; see the patient selection flowchart for details (Figure 1).

Clinical and Radiologic Assessments

Demographic data, disease duration, number of attacks, average annual relapse [relapse count/year(s)], Expanded Disability Status Scale (EDSS) score, and most recent disease modifying treatments (DMTs) and their duration were obtained from clinical records based on assessments by three independent neurologists with experience in MS. Results of the montreal cognitive assessment (MoCA) and its components, the symbol–digit modalities test (SDMT), BDI, GDS, the nine–hole–peg test (9HPT), and the timed 25–foot walk test (T25–FW), administered by the same psychologist with experience in neurology, were obtained from patient records. Global PSQI

scores and subscale scores (administered intermittently during routine patient follow–up) were retrospectively evaluated by a neurologist who was experienced in sleep disorders.

All examinations were performed on a 1.5T MRI scanner (Aera®, Siemens, Erlangen, Germany). MRI included fluid attenuated inversion recovery, T1–, T2–, diffusion–weighted images in the axial and sagittal planes, with and without contrast, were obtained using standard parameters (repetition time: 576 ms, echo time: 8 ms, slice thickness: 5 mm, slice spacing: 6 mm, flip angle: 90º). The localization of demyelinating lesions (cortical/subcortical, periventricular, infratentorial, temporal, corpus
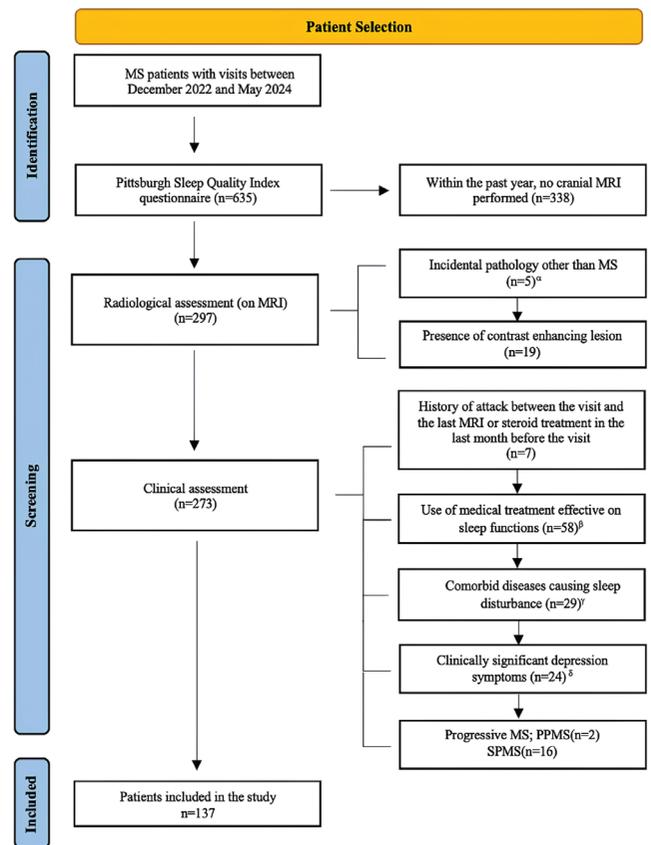
Figure 1. Patient selection flowchart.
†Venous anomaly (n = 1), hemangioma (n = 1), hydrocephalus (n = 1), syrinx (n = 2).
‡Use of any dose of sleeping pills, antidepressants, psychotropic or gabapentanoids.
§Thyroid disease (n = 8), psychiatric disorders (n = 7), cardiovascular diseases (n = 5), diabetes (n = 3), hematologic diseases (n = 2), epilepsy (n = 1), asthma (n = 1), rheumatologic disease (n = 1), lumbar disc herniation (n = 1).
¶Determined by administering the Geriatric Depression Scale (GDS) or the Beck Depression Inventory (BDI) simultaneously with assessing sleep. Clinically significant depression (≥17 for BDI, ≥5 for GDS) on the BDI (for patients aged <65 years) and the GDS (for patients aged ≥65 years).
MS: Multiple sclerosis MRI: Magnetic resonance imaging, PPMS: Primary progressive multiple sclerosis, SPMS: Secondary progressive multiple sclerosis.

callosum, spinal cord), the presence of coalescing lesions, and measurements of atrophy of the corpus callosum, brainstem, and spinal cord were performed and recorded by two research assistants at sites determined by the joint decision of two radiologists experienced in neurology (see Appendices 1 and 2 for measurement methods and examples).

Patients with global PSQI scores of ≥5 were grouped as those with poor sleep quality. The results were analyzed using demographic, clinical, and radiologic parameters.

Statistical Analysis

Whether the data showed normal distribution was analyzed using the Shapiro–Wilk test. Descriptive statistics are expressed as means and standard deviations or medians (minimum–maximum) for quantitative data, and frequencies and percentages for qualitative data. For normally distributed data, one–way analysis of variance was used in the comparison of more than two groups, and the Kruskal–Wallis test was used for non–normally distributed data. The Mann–Whitney U test was used for non–normally distributed data in two independent group comparisons. Categorical data were analyzed using Pearson's chi–square test, the Fisher–Freeman–Halton test, and Fisher's exact chi–square test. In case of significance, the Bonferroni test, one of the multiple comparison tests, was used. The relationships between variables were analyzed using the Pearson or Spearman correlation coefficient. The significance level was set as $\alpha = 0.05$. Statistical data analysis was performed using the IBM SPSS 28.0 (IBM Corp. Released 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp.) statistical package program and graphs were generated using Minitab® Statistical Software v.19.

Results

The mean age of the 137 patients, 106 females and 31 males, was 38.51 (range, 18–67) years, and the mean duration of the disease was 6.68 (range, 0–25) years. Of the patients enrolled in the study, 106 were measured for body mass index (BMI), 135 were measured for cervical MRI, and 55 were measured for thoracic MRI. The SDMT was performed concurrently in 110 patients. MoCA, T25–FW, and 9HPT results were available for 111 patients. The mean BMI was 24.79 (range, 16.6–42.8) kg/m², the mean duration of DMT use 3.54 (range, 0–18) years, the mean EDSS score was 1.28 (range, 0–6), and the average annual relapse rate was 0.45 (range, 0.07–2). Platform and second–line DMTs were used in most patients.

According to the global PSQI, there were no significant differences between patients with good and poor sleep quality regarding age, sex, BMI, disease or DMT use duration, DMTs used, average annual relapse rates, and EDSS MoCA, and SDMT scores. There was no significant difference in upper extremity function. However, walking speed was slower in those with poor sleep quality (p = 0.005) (Table 1, Figure 2).

Fifty–three patients did not have a roommate according to the PSQI. Twelve patients reported long intervals between breaths during sleep, 15 reported at least one twitching or jerking of the legs while sleeping, and one reported disorientation or confusion. There was no difference in global PSQI scores and sleep quality between those who reported snoring, restless legs symptoms, and sleep apnea in the PSQI questionnaire (p = 0.441, p = 0.524, and p = 0.406, respectively). All seven subscales of the PSQI, especially sleep onset latency and subjective sleep quality r = 0.786 and r = 0.767, respectively, showed a positive correlation with an increase in total PSQI scores in all patients. However, sleep duration and sleep disturbances were not correlated with the global score in patients with poor sleep quality (p = 0.249 and p = 0.051, respectively) (Figure 3).

No association was found between lesion location, corpus callosum index (CCI), brainstem or spinal cord atrophy measures, and poor sleep quality (Tables 2 and 3).

Discussion

Sleep disturbance is one of the factors that can affect the quality of life in PwMS. They are more common in PwMS than in the general population, with no significant difference between the sexes (about 40% vs. 60–75%) (3–8). Sleep disturbances are commonly reported in secondary progressive MS. The frequency and severity of sleep disturbances may increase with age, disease duration, number of relapses, and disability levels (5,9-11). Sleep disturbances in MS are likely multifactorial. They may be due to the involvement of brain nuclei, which regulates sleep, as well as pain, fatigue, depression/anxiety, intrinsic sleep disturbances, and pharmacologic treatments (8). The presence of other comorbidities (especially depression) or an increased number of comorbidities is associated with poorer sleep quality and a higher global PSQI scores (12).

This study found no statistically significant relationship between demographic characteristics, basic clinical characteristics of the disease, and sleep quality in PwMS. This situation confirms that the main confounding factors were excluded, in line with the aim of our study to identify the main components that might affect sleep quality in PwMS and the effect of lesion localization and characterization.

Sleep disturbances in PwMS may result from a common biologic link that affects sleep homeostasis, such as circadian rhythm disruption, decreased melatonin secretion, and increased levels of proinflammatory cytokines. Reduced sleep quality and sleep–related disorders may reflect underlying biologic and molecular changes associated with neuroinflammation, neurodegeneration, and white matter lesion burden (5,13–15) sleep disorders have been associated with increased lesion burden (16). Patients with neuromyelitis optica spectrum disorder with more severe demyelination have poorer sleep quality and use more sleeping pills than PwMS (10). In our study, we found no significant differences in the sleep quality in PwMS. Average annual relapses, another clinical indicator of inflammation, also showed no differences. These results may have been influenced by excluding patients with inflammatory activity (new relapses or contrast–enhancing demyelinating lesions) during patient selection. More light will be shed on this issue in studies with larger numbers of patients that also assess relapses.

Table 1. The relationship between clinical characteristics, cognitive and physical function tests

Demographic and clinical characteristics		Total	Good	Poor	p
Sex, n (%)	female male	106 (77.4) 31 (22.6)	73 (78.5) 20 (21.5)	33 (75) 11 (25)	0.649
Age		38.51 (10.98), 38 (18-67)	37.7 (10.42), 36 (19-61)	40.22 (12.02), 42 (18-67)	0.212
BMI		24.79 (4.76), 23.9 (16.6-42.8)	24.72 (4.6), 23.98 (16.6-37.5)	24.94 (5.14), 23.69 (17.7-42.8)	0.879
Disease duration, years		6.68 (5.49), 5 (0-25)	6.36 (5.58), 5 (0-25)	7.36 (5.28), 6.5 (0-22)	0.320
Duration of DMT use, years		3.54 (3.56), 2 (0-18)	3.38 (3.47), 2 (0-17)	3.89 (3.8), 3 (0-18)	0.322
EDSS		1.28 (1.01), 1 (0-6)	1.17 (0.91), 1 (0-5)	1.5 (1.19), 1 (0-6)	0.075
Average annual relapse		0.45 (0.35), 0.33 (0.07-2)	0.47 (0.39), 0.33 (0.07-2)	0.4 (0.23), 0.33 (0.1-1)	0.703
DMTs	Naive	8 (5.8)	7 (7.5)	1 (2.3)	0.901
	Interferon beta 1	14 (10.2)	10 (10.8)	4 (9.1)	
	Glatiramer acetate	18 (13.1)	11 (11.8)	7 (15.9)	
	Teriflunomide	37 (27)	23 (24.7)	14 (31.8)	
	Dimethyl fumarate	23 (16.8)	16 (17.2)	7 (15.9)	
	Fingolimod	26 (19)	20 (21.5)	6 (13.6)	
	Cladribine	7 (5.1)	3 (3.2)	4 (9.1)	
	Azathioprine	1 (0.7)	1 (1.1)	-	
	Natalizumab	1 (0.7)	-	1 (2.3)	
	Alemtuzumab	1 (0.7)	1 (1.1)	-	
	Rituximab	1 (0.7)	1 (1.1)	-	
MoCA	Visuospatial & executive (/5)	4.42 (2.79), 4 (1-30)	4.57 (3.28), 5 (1-30)	4.1 (0.96), 4 (1-5)	0.356
	Naming (/3)	2.64 (0.48), 3 (2-3)	2.62 (0.49), 3 (2-3)	2.67 (0.48), 3 (2-3)	0.681
	Attention (/6)	4.71 (1.38), 5 (1-6)	4.68 (1.42), 5 (1-6)	4.77 (1.3), 5 (2-6)	0.840
	Language (/3)	1.6 (1.12), 2 (0-3)	1.62 (1.13), 2 (0-3)	1.53 (1.14), 2 (0-3)	0.711
	Abstraction (/2)	1.73 (0.59), 2 (0-2)	1.75 (0.55), 2 (0-2)	1.67 (0.66), 2 (0-2)	0.571
	Delayed recall (/5)	2.98 (1.31), 3 (0-5)	3 (1.28), 3 (0-5)	2.93 (1.39), 3 (0-5)	0.987
	Orientation (/6)	5.97 (0.17), 6 (5-6)	5.97 (0.17), 6 (5-6)	5.97 (0.18), 6 (5-6)	0.908
	Total	23.53 (4.05), 24 (11-30)	23.53 (4.11), 24 (11-30)	23.55 (3.96), 24 (13-29)	0.918
SDMT		33 (13.48), 35 (1-57)	32.81 (13.15), 35 (1-57)	31.06 (14.24), 34 (4-54)	0.330
9HPT	Right	19.98 (3.81), 19 (13-34)	20.03 (4.02), 20 (13-34)	19.89 (3.32), 19 (15-29)	0.854
	Left	21.59 (4.28), 21 (16-36)	21.73 (4.39), 21 (16-36)	21.27 (4.05), 20 (16-31)	0.641
T25-FW		7.79 (1.59), 6.5 (3.5-12)	6.52 (1.54), 6.5 (3.5-12)	7.45 (1.56), 7.5 (4.5-11.5)	**0.005**

Mean (SD), Median (min-max), or n (%).

DMT: Disease-modifying treatment, EDSS: Expanded Disability Status Scale, MoCA: Montreal cognitive assessment, SDMT: Symbol-digit modalities test, 9HPT: Nine-hole-peg test, SD: Standard deviation.
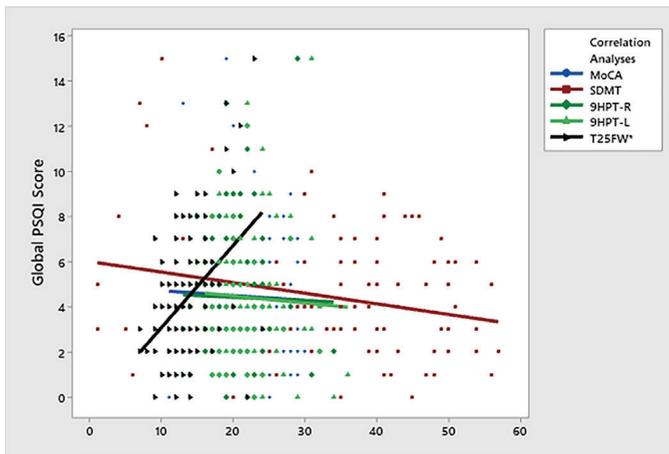
Figure 2. Correlation analysis between sleep quality index score and cognitive, and upper and lower extremity functions. *p < 0.05.
9HPT: Nine-Hole Peg Test (R:right, L:left), T25FW: Timed 25-foot walk test, MoCA: Montreal Cognitive Assessment, SDMT: the Symbol-digit modalities test and PSQI: Pittsburgh Sleep Quality Index PHPT-L: sor
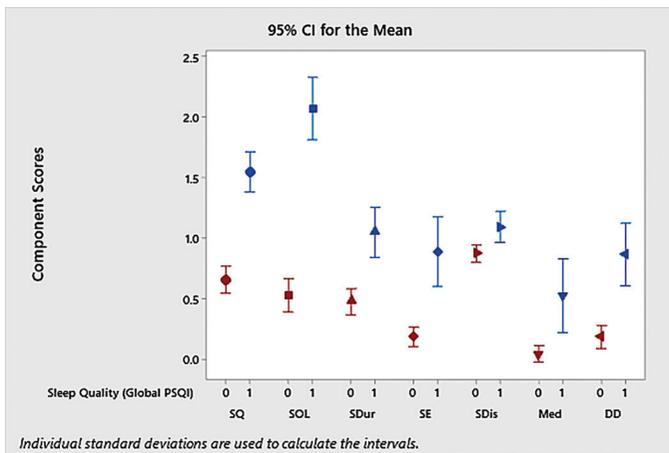

Figure 3. Changes in PSQI components according to sleep quality. When analyzing the correlation between the total score and the lower PSQI components in patients with poor sleep quality, all parameters showed a high correlation with the total score (p < 0.001). In descending order, the parameters were SOL (r = 0.786), SQ (r = 0.767), SD (r = 0.539), DD (r = 0.528), SE (r = 0.480), Med (r = 0.440), and SDis (r = 0.377). However, when analyzing patients with poor sleep quality, there was no significant correlation for SDur and SDis. For the other parameters, in descending order: Med (r = 0.696, p<0.001), SQ (r = 0.541, p < 0.001), SOL (r = 0.402, p = 0.007), SE (r = 0.320, p = 0.034), and DD (r = 0.302, p = 0.046). Sleep Quality (Global PSQI); poor: 0 (red) and good: 1 (blue).
SQ: Sleep quality, SOL: Sleep onset latency, SDur: Sleep duration, SE: Sleep efficiency, SDis: Sleep disturbance, Med: Use of sleeping medications, DD: Daytime dysfunction,
PSQI: Pittsburgh Sleep Quality Index, SD: Standard deviation CI: Confidence interval.

Sleep is closely associated with fatigue, mood, cognitive function, and physical performance (17). Poor sleep reduces the ability to perform daily activities and impairs social communication skills, negatively impacting quality of life (18). A correlation has been reported between sleep efficiency and number of awakenings after falling asleep, and stride length, stride speed, and stride duration (19). The exact mechanism by which sleep affects walking is still not fully understood. However, one possible mechanism is degeneration in neuroanatomic regions that regulate sleep and walking, including the pontine tegmentum and pedunculopontine nuclei (20,21). In addition, inadequate removal of metabolic waste from the brain due to sleep disturbances and creating a catabolic environment in skeletal muscles may reduce the effect of cognitive decline on gait mechanics and postural control, thereby worsening outcomes (19,22,23). Most studies examining the relationship between sleep quality parameters and objective walking measurements have been conducted on healthy individuals, and the results vary (24,25). Some studies found a positive correlation between sleep efficiency and walking speed, gait performance, and physical activity. However, other studies detected no such relationship, and the results vary (24,26–28). The general consensus is that sleep quality is associated with walking speed, especially among older individuals. Further studies on the younger population are needed (25).

Studies on PwMS have shown that sleep efficiency is related to step length. Additionally, walking speed and step duration are related to other sleep parameters independently of age (19). Research on this topic in our country is quite limited. Some data exist on the connection between sleep quality and more indirect indicators, such as physical activity level and number of steps taken. One study of the general Turkish population found no significant relationship between sleep quality and daily step count or physical activity level (29). A recent study of a small group of PwMS found an association between sleep quality and the six–minute walk test (30). In our study, no difference was found in SDMT or MoCA scores in cognitive assessment based on sleep quality. In terms of physical performance, no difference was observed in finger dexterity scores (9HPT). In contrast, lower extremity performance (T25–FW) was worse in those with poor sleep quality, consistent with the literature cited above. Our demonstration of this result in a much larger cohort of PwMS, after thorough pre–screening and filtering out potentially confounding factors, is a valuable contribution to the literature.

No significant association has been reported between the use or non–use of DMT, the type of use, the timing of use, or compliance problems and sleep quality in PwMS (10,31,32). However, DMTs with different activity levels and mechanisms may have differences in sleep quality. Natalizumab and ocrelizumab may positively affect sleep quality, whereas interferon beta and glatiramer acetate may have a negative effect (33-36). It is known that reducing systemic inflammation by suppressing NF–κB signaling, which dimethyl fumarate has a mild effect on, has an impact on sleep quality (13,37). We found no difference in DMT distribution according to sleep

Table 2. The relationship between lesion localization and sleep quality.

Lesion localization			Total, n	Sleep quality		p
				Good, n (%)	Poor, n (%)	
Periventricular		Yes	130	87 (93.5)	43 (97.7)	0.301
		No	7	6 (6.5)	1 (2.3)	
Temporal		Yes	53	36 (38.7)	17 (38.7)	0.993
		No	84	57 (61.3)	27 (61.4)	
Cortical/juxtacortical		Yes	112	78 (83.9)	34 (77.3)	0.352
		No	25	15 (16.1)	10 (22.7)	
Corpus callosum		Yes	45	26 (28)	19 (43.2)	0.078
		No	92	67 (72)	25 (56.8)	
Infratentorial	Infratentorial	Yes	54	36 (38.7)	18 (40.9)	0.806
		No	83	57 (61.3)	26 (59.1)	
	Bulbus	Yes	14	10 (10.8)	4 (9.1)	0.765
		No	123	83 (89.2)	40 (90.9)	
	Pons	Yes	27	21 (22.8)	6 (13.6)	0.210
		No	109	71 (77.2)	38 (86.4)	
	Pontocerebellar peduncle	Yes	18	15 (16.1)	3 (6.8)	0.133
		No	119	78 (83.9)	41 (93.2)	
	Mesencephalon	Yes	13	9 (9.7)	4 (9.1)	0.913
		No	124	84 (90.3)	40 (90.9)	
	Cerebellum	Yes	29	18 (19.4)	11 (25.6)	0.411
		No	107	75 (80.6)	32 (74.4)	
	Thalamus	Yes	5	5 (5.5)	-	0.123
		No	128	86 (94.5)	42 (100)	
Spinal cord	Cervical	Yes	89	62 (67.4)	27 (62.8)	0.601
		No	46	30 (32.6)	16 (37.2)	
	Thoracic	Yes	19	15 (38.5)	4 (25)	0.345
		No	36	24 (61.5)	12 (75)	
Other	Coalescing lesions	Yes	16	11 (11.8)	5 (11.4)	0.937
		No	121	82 (88.2)	39 (88.6)	

There were no statistically significant differences between patients with good and poor sleep quality based on the location of the demyelinating lesion(s), n (%).

quality. Further studies evaluating a larger cohort are needed in this regard.

Studies evaluating sleep architecture and components of sleep quality in PwMS have shown that patients with longer disease duration or greater disability tend to have lower sleep efficiency, shorter total sleep time, less nocturnal restfulness, longer sleep latency, and greater sleep fragmentation (38,39). In this study, the most effective components were found to be the subjective sleep quality and sleep latency. In PwMS with poor sleep quality, these components were again found to have the most significant impact on the sleep quality outcome. This situation shows that PwMS have difficulty falling asleep and are more sensitive to disturbances in the quality of their sleep.

Sleep disorders in PwMS may be caused by lesions in areas such as the diencephalon or brainstem that directly regulate the sleep–wake cycle of neurons (40). However, there is limited research on this topic. Our study found no difference in sleep quality between patients with combined lesions, brainstem atrophy, cervical spinal cord atrophy, or CCI, another atrophy indicator.

Study Limitation

The PSQI provides a cross–sectional assessment. Cross–sectional studies may not be sufficient to prove causality. Therefore, factors that may affect sleep quality, such as relapse duration, comorbidities, medication use, depressive mood, and disease progression, were excluded from our study. This allowed our results to show a more realistic clinical–radiologic correlation.

Table 3. Differences in corpus callosum index, brainstem, and spinal cord atrophy measurements according to sleep quality.

Radiologic measurements		Total	Good	Poor	p	Correlation analysis
						All
Corpus callosum index		0.36 (0.06), 0.36 (0.12-0.5)	0.36 (0.07), 0.36 (0.12-0.5)	0.36 (0.06), 0.36 (0.17-0.46)	0.761	r = 0.092 p = 0.286
Brainstem	Cerebral peduncle thickness, mm	15.3 (1.35), 15.2 (12-18)	15.29 (1.38), 15.3 (12-18)	15.3 (1.29), 15.2 (12.5-18)	0.835	r = 0.037 p = 0.664
	Interpeduncular angle, (°)	67.73 (10.41), 69 (16-86)	67.22 (10.82), 68 (16-86)	68.82 (9.5), 70.5 (48-86)	0.409	r = 0.027 p = 0.756
	Middle cerebellar peduncle thickness, mm	16.63 (1.48), 17 (12-21)	16.52 (1.45), 17 (12-21)	16.87 (1.52), 17 (12-20)	0.190	r = 0.127 p = 0.140
	Midbrain thicness, mm	11.55 (1.57), 11 (9-17.4)	11.54 (1.65), 11 (9-17.4)	11.56 (1.39), 11.15 (10-14.8)	0.925	r = 0.083 p = 0.335
	Pons thickness, mm	21.88 (1.53), 22 (16-26)	21.8 (1.56), 22 (16-26)	22.04 (1.49), 22 (19-24.3)	0.334	r = 0.062 p = 0.473
	Medulla thickness, mm	12.45 (1.24), 12.4 (9.7-15)	12.48 (1.32), 12.4 (9.7-15)	12.40 (1.06), 12.3 (10.6-15)	0.745	r = 0.052 p = 0.544
	Mamillopontine distance, mm	6.68 (1.25), 6.5 (4-12)	6.76 (1.24), 7 (5-12)	6.53 (1.26), 6.2 (4-10)	0.404	r = -0.052 p = 0.543
	Midbrain height, mm	12.54 (1.57), 12.6 (9-16.6)	12.63 (1.52), 13 (9-16.6)	12.35 (1.66), 12.05 (9-15)	0.327	r = -0.016 p = 0.854
	Pontomesencephalic angle, (°)	50.23 (10.02), 50 (25-85)	49.72 (8.8), 50 (26-76)	51.32 (12.11), 51 (25-85)	0.438	r = 0.166 p = 0.052
Cervical cord diameter, mm	C2 sagittal	7.65 (1.1), 7.4 (5-10.5)	7.62 (1.09), 7.4 (5-10.5)	7.71 (1.11), 7.45 (6-10)	0.767	r = 0.061 p = 0.479
	C3 axial	12.07 (1.03), 12 (8-16)	12.05 (1.11), 12 (8-16)	12.14 (0.86), 12 (10.3-14.3)	0.450	r = 0.047 p = 0.586
	C3 sagittal	7.5 (0.7), 7.5 (6-9.2)	7.52 (0.68), 7.6 (6-9)	7.47 (0.75), 7.1 (6-9.2)	0.618	r = -0.045 p = 0.607
	C7 axial	10.93 (1.02), 11 (6-14)	10.83 (1.07), 11 (6-13)	11.13 (0.88), 11 (10-14)	0.168	r = 0.111 p = 0.200
	C7 sagittal	6.5 (0.78), 6.25 (5-8.7)	6.48 (0.76), 6.2 (5-8.7)	6.54 (0.82), 6.3 (5-8.6)	0.717	r = -0.010 p = 0.913

There was no statistically significant difference in the measurements obtained from cranial and spinal MRIs between patients with good and poor sleep quality. Additionally, no correlation was found between the measurements and the GPSQI score for all patients. Mean (SD), median (min-max).

SD: Standard deviation, CCI: Corpus callosum index, MRI: Magnetic resonance imaging, GPSQI: Global Pittsburgh Sleep Quality Index.

This study did not assess fatigue, restless legs syndrome, or sleep apnea. However, no difference in sleep quality was found between patients reporting long intervals between breaths during sleep and twitching or jerking of the legs while sleeping on the PSQI component questions. This finding suggests that these two factors are not significant for this cohort. In addition to the sleep quality index, prospective studies are needed to evaluate changes in physical performance and other sleep parameters in PwMS. In this context, our multicenter studies lay an important foundation for generalizing our results.

Conclusion

Sleep quality is negatively affected in PwMS. This impairment appears to be associated with lower extremity physical performance, although no clear relationship was observed with lesion location, atrophy, or cognitive status in the early stages of the disease. Among the PSQI subcomponents, subjective sleep quality and sleep latency emerged as the main determinants of poor outcomes, possibly reflecting patients' heightened sensitivity to their own perception of sleep quality. These findings underscore the importance of routinely evaluating sleep quality during clinical follow–up of PwMS. Furthermore, interventions specifically targeting sleep latency may hold therapeutic potential in this population. From a clinical standpoint, systematic assessment and timely management of sleep disturbances should be regarded as integral components of MS care. Addressing sleep–related problems has the potential to improve quality of life and preserve mobility and functional independence. In this context, even relatively simple interventions such as sleep hygiene counseling or non–pharmacologic strategies may serve

as valuable adjuncts to conventional treatment approaches. Finally, it should be noted that the PSQI is a cross–sectional, self–reported tool reflecting the preceding month. Prospective longitudinal studies employing objective methods such as actigraphy or polysomnography are warranted to strengthen clinical–radiologic correlations, while still accounting for patient–reported outcomes.

Ethics

Ethics Committee Approval: This study was conducted with the approval of the Bursa Uludağ University Clinical Research Ethics Committee (approval number: 2025/700–11/10, date: 11.06.2025).
Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Concept: F.S., A.B.D., Design: F.S., B.H., A.B.D., Data Collection or Processing: F.S., F.H., R.Ö., S.N.M., A.D., Analysis or Interpretation: F.S., R.Ö., Y.D., E.O.A., A.D., E.R.K., B.H., Literature Search: F.S., F.H., R.Ö., Y.D., E.O.A., S.N.M., E.R.K., A.B.D., Writing: F.S., Y.D., E.O.A., A.B.D.

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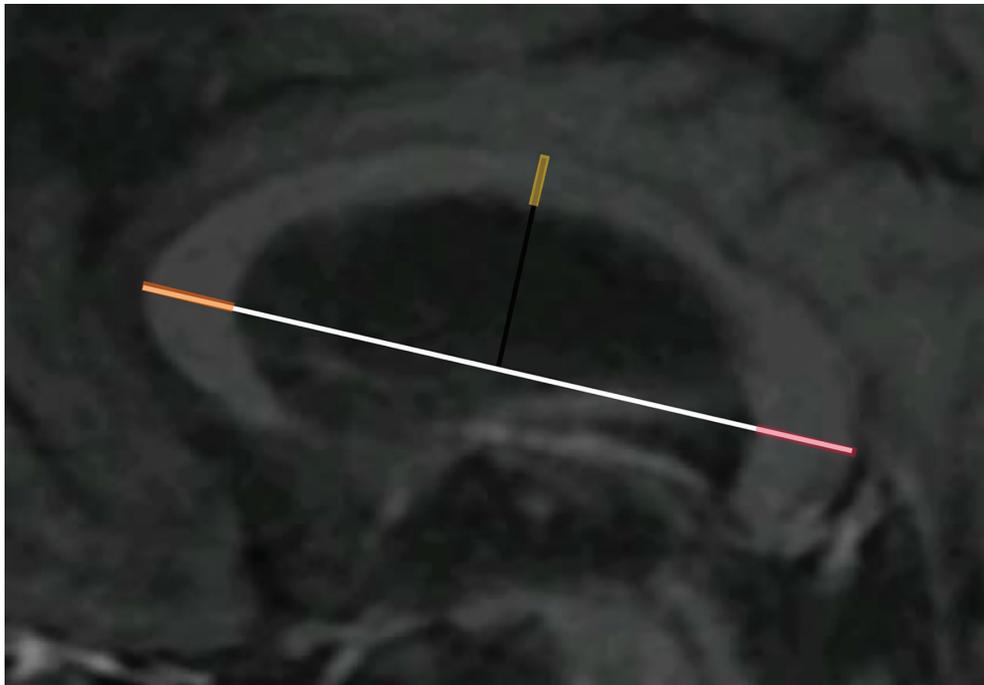
Appendix 1. Corpus callosum index measurement method: Using a simple orthogonal semi-automated system, a straight line (white-opaque) was obtained on the conventional best mid-sagittal T1W image with the largest anteroposterior diameter of the corpus callosum and a perpendicular drawn on the midline. It was normalized to the anterior (aa, orange-translucent), middle (cc, yellow-translucent), posterior (bb, red-translucent), and anteroposterior diameter (ab, white-opaque) of the corpus callosum (anterior + middle + posterior)/anteroposterior diameter; (aa + cc + bb) / ab).
For more information, see doi: 10.1016/j.mjafi.2022.06.002 and doi:10.36516/jocass.1109857
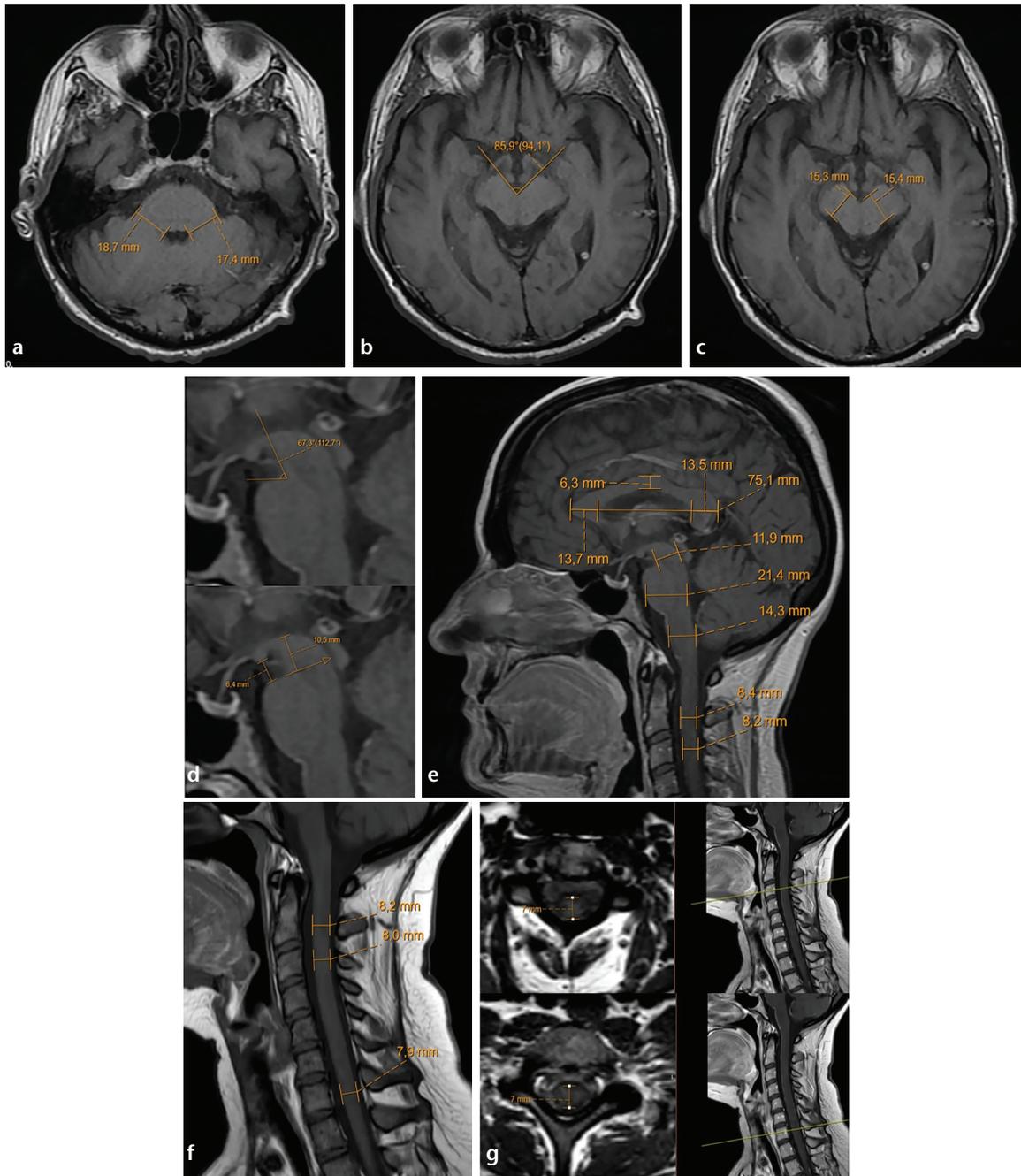
Appendix 2. Brain stem and spinal cord measurement methods: a: mid–cerebellar peduncle transverse thickness; the maximum thickness of each middle cerebellar peduncle perpendicular to its long axis was noted on both sides. b: interpeduncular angle formed between the cerebral peduncles. c: cerebral peduncle transverse thickness; the maximum thickness of the cerebral peduncle perpendicular to its long axis was noted on both sides. d: Pontomesencephalic angle; angle between the anterior surface of the midbrain and posterosuperior surface of pons at the pontomesencephalic junction (67.3°). Mamillopontine distance: distance from the inferior surface of the mammillary body to the highest point of convexity of the superior surface of the pons (6.4 mm). Midbrain height: maximum height from the ponto–mesencephalic junction level up to the midbrain roof (10.5 mm). e: Corpus callosum index measurements (13.7+6.3+13.5)/75.1 mm, see Appendix 1. Ventral midbrain anteroposterior thickness; the maximum thickness of the ventral midbrain was measured from the anterior surface up to the anterior wall of the aqueduct perpendicular to its long axis (11.9 mm). Pontine anteroposterior thickness (21.4 mm). Medullary anteroposterior thickness; the maximum thickness of the medulla was measured at its midpoint (14.3 mm). f: C2, C3, and C7 spinal cord anteroposterior sagittal diameter (C2T–S, C3T–S, C7T–S) (8.2, 8, 7.9 mm). g: C3 and C7 spinal cord anteroposterior axial diameter (C3T–A, C7T–A) (7.7 mm).

Assessing Sleep in Late Life: Validation of the Turkish Jenkins Sleep Scale and Identification of Older Population-Specific Cut-Off

Yaşlılıkta Uyku Değerlendirmesi: Türkçe Jenkins Uyku Ölçeği'nin Validasyonu ve Yaşlı Nüfusa Özgü Kesme Noktasının Belirlenmesi

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Abstract

Objective: Sleep disturbances frequently affect older adults and are linked to geriatric issues such as frailty, cognitive decline, and depression. This study assessed the psychometric properties and diagnostic value of the Turkish version of the Jenkins Sleep Evaluation Scale (JSS-TR) in individuals aged 65 years and above.

Materials and Methods: One hundred thirty-two community-dwelling older adults completed the JSS-TR along with the Pittsburgh Sleep Quality Index (PSQI), the Basic Scale on Insomnia Complaints and Quality of Sleep, and a comprehensive geriatric assessment. Analyses included internal consistency, test-retest reliability, correlation with related measures, group comparisons, and receiver operating characteristic (ROC) curve analysis to identify the most appropriate cut-off score for poor sleep quality.

Results: The median participant age was 80 years (interquartile range: 9.75). The JSS-TR demonstrated good internal consistency (Cronbach's alpha: 0.68) and excellent stability over time (intraclass correlation coefficients: 0.92). It showed a moderate correlation with PSQI scores (r = 0.62, p < 0.001). ROC analysis indicated an optimal cutoff of ≥15, yielding 54% sensitivity and 87% specificity. Higher JSS-TR scores were significantly associated with frailty and history of falls (p < 0.05), supporting predictive validity.

Conclusion: The JSS-TR is a reliable and valid instrument for detecting poor sleep quality among older adults. A population-specific cut-off score of ≥15 improves diagnostic precision in this group.

Keywords: Sleep, aged, insomnia

Öz

Amaç: Uyku bozuklukları, yaşlı yetişkinlerde sık görülmekte ve kırılganlık, bilişsel gerileme ve depresyon gibi geriatrik sorunlarla ilişkilendirilmektedir. Bu çalışma, 65 yaş ve üzerindeki bireylerde Jenkins Uyku Değerlendirme Ölçeği'nin Türkçe versiyonunun (JSS-TR) psikometrik özelliklerini ve tanısal değerini değerlendirmiştir.

Gereç ve Yöntem: Bu kesitsel çalışmada, toplumda yaşayan 132 yaşlı yetişkin JSS-TR'nin yanı sıra Pittsburgh Uyku Kalitesi İndeksi (PSQI), Uykusuzluk Şikayetleri ve Uyku Kalitesi Temel Ölçeği ve kapsamlı bir geriatrik değerlendirme tamamlamıştır. Analizler; iç tutarlılık, test-tekrar test güvenilirliği, ilişkili ölçümlerle korelasyon, grup karşılaştırmaları ve zayıf uyku kalitesi için en uygun kesme noktasını belirlemek amacıyla alıcı işletim karakteristiği (ROC) eğrisi analizini içermiştir.

Bulgular: Katılımcıların ortanca yaşı 80 (çeyrekler arası açıklık: 9,75) idi. JSS-TR, iyi düzeyde iç tutarlılık (Cronbach's alpha: 0,81) ve mükemmel düzeyde zamansal kararlılık (sınıf içi korelasyon katsayısı: 0,92) göstermiştir. PSQI puanları ile orta düzeyde korelasyon saptanmıştır (r = 0,62, p < 0,001). ROC analizi, %54 duyarlılık ve %87 özgüllük ile en uygun kesme noktasını ≥15 olarak belirlemiştir. Daha yüksek JSS-TR puanları, kırılganlık ve düşme öyküsü ile anlamlı şekilde ilişkili bulunmuş (p < 0,05) ve bu da yordayıcı geçerliliği desteklemiştir.

Sonuç: JSS-TR, yaşlı yetişkinlerde kötü uyku kalitesini saptamak için güvenilir ve geçerli bir ölçektir. Nüfusa özgü ≥15 kesme noktası, bu grupta tanısal kesinliği artırmaktadır.

Anahtar Kelimeler: Uyku, yaşlılık, uykusuzluk

Introduction

Sleep is a basic physiological need essential for maintaining physical and mental health. However, sleep quality tends to decline with aging. Nearly one in five older individuals is estimated to have insomnia disorder, often linked to gender, mental health, or somatic conditions (1). Worldwide, the most prevalent sleep–related disorder is obstructive sleep apnea, followed by inadequate sleep quality, other sleep problems, insomnia, and excessive daytime sleepiness (2,3). Among community–dwelling older adults, poor sleep quality affects roughly 40% of individuals, and this prevalence may rise to 65% in institutional care (2,3).

Sleep disturbances in older adults have multifactorial causes, including medical conditions like benign prostatic hyperplasia (through nocturia) and psychological factors such as depression and anxiety (4,5). Sleep disturbance is closely related to geriatric syndromes as well as quality of life. For instance, poor sleep is a well–established predictor of late–life depression, conferring a 66% greater risk (4). Sleep duration shows a U–shaped relationship with frailty and depression, with both short (<6 hours) and long (>8 hours) durations, long sleep duration, in particular, has been linked to a 29% increased risk of dementia (5-8). Additionally, measures such as sleep latency, continuity, and architecture have demonstrated significant associations with cognitive performance (8). Disrupted sleep architecture is observed in individuals with mild cognitive impairment, and excessive daytime sleepiness increases the risk of cognitive decline by 26% (9,10).

Although sleep can be measured objectively with polysomnography, it is time–consuming and impractical in most outpatient settings (6). For practical reasons, subjective tools are frequently used. Instruments such as the Pittsburgh Sleep Quality Index (PSQI) and sleep diaries are well known but may be too lengthy or complex for rapid clinical screening in geriatric practice. The Jenkins Sleep Scale (JSS) is a concise four–item questionnaire using a six–point Likert scale to assess difficulty falling asleep, waking during the night, early morning awakening, and morning tiredness (11). It has been validated in specific populations, such as cardiac and rheumatologic patients (12).

The present study aimed to assess the validity, reliability, and predictive ability of the Turkish version of the JSS in adults aged 65 years and older. Establishing its psychometric properties will support its use as a rapid, reliable, and clinically meaningful tool in geriatric practice and research.

Materials and Methods

Study Design and Participants

This cross–sectional study was conducted in geriatric outpatient clinics of two tertiary care hospitals between March and June 2025. Exclusion criteria were absence of written informed consent; communication barriers (e.g., language limitations, significant hearing loss); inability to cooperate with assessment; and neurologic or psychiatric disorders likely to affect evaluation (e.g.,

cerebrovascular disease, dementia, major depression, delirium). In addition, we excluded patients with acute conditions liable to cause transient sleep disturbance or whose sleep was primarily disrupted by pain or breathing difficulty at the time of assessment (e.g., acute pain exacerbation, febrile illness/infection, decompensated cardiopulmonary disease with dyspnea/orthopnea). Stable chronic comorbidities documented within the Comprehensive Geriatric Assessment (CGA) (e.g., hypertension, diabetes, osteoarthritis/chronic pain, benign prostatic hyperplasia/urinary symptoms, chronic lung disease, coronary artery disease) were permitted. Sociodemographic characteristics (age, sex, marital status, and education) were obtained via interviewer–administered questionnaires.

Sample Size

Sample size estimation followed the participant–to–item ratio described by Hogarty et al. (13), using a 20:1 ratio. For the 4–item JSS, a minimum of 80 participants was required. To account for potential data loss, 10 additional participants were recruited, resulting in a planned sample size of 90.

Instruments

Jenkins Sleep Scale (JSS)

The JSS consists of four items evaluating sleep difficulties over the preceding four weeks. Each is rated on a 6–point scale (0 = never to 5 = 22–28 days), producing a total score from 0 to 20; higher scores indicate greater disturbance (11). Scores of ≥11 suggest frequent problems. The Turkish version was previously translated and validated by Duruöz et al. (12) and permission for use was obtained.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a 19–item measure covering seven components of sleep quality, with total scores ranging from 0 to 21. A cut–off score of ≥5 is indicative of poor sleep quality. We employed the Turkish version validated by Ağargün et al. (14).

Basic Scale on Insomnia Complaints and Quality of Sleep (BaSIQS)

BaSIQS contains seven items assessing aspects such as sleep onset latency, fragmentation, and perceived quality. Each item is rated from 0 to 4, yielding total scores of 0–28. Values above 15 indicate frequent sleep disturbances. The Turkish version validated by Ağar et al. (15) was used in the present study.

Comprehensive Geriatric Assessment (CGA)

Frailty status was determined by the Clinical Frailty Scale (CFS), with scores ≥5 defining frailty (16). Disability was defined as activities of daily living (ADL) <5 or instrumental activities of daily living (IADL) <8 (17,18). Sarcopenia risk was screened using the SARC–F questionnaire, with scores ≥4 indicating increased risk (19). Cognitive performance was measured with the Standardized Mini–Mental State Examination, using a cut–off of <24 for impairment (20). Additional CGA components included assessments for urinary incontinence, falls within the past year, visual or hearing impairments, and nutritional status via the Mini Nutritional Assessment, with scores ≤7 indicating malnutrition (21).

Assessment of Anxiety, Depression and Stress

Anxiety symptoms were measured with the Generalized Anxiety Disorder–2 (GAD–2) scale, using a threshold of ≥3 (22). Perceived stress was assessed with the four–item Perceived Stress Scale (PSS–4), where higher scores indicate greater stress (23). Depressive symptoms were screened using the Patient Health Questionnaire–2 (PHQ–2), with a cut–off of ≥3 (24).

Cross-Cultural Adaptation

The JSS–TR, previously translated into Turkish by Duruöz et al. (12). The previously validated article employed the translation–back translation method. It was reviewed by three geriatricians to confirm its suitability for older adults. No further adaptation was deemed necessary.

Reliability Assessment

Internal consistency was examined using Cronbach's alpha, with values above 0.6 considered acceptable. Test–retest reliability was evaluated using a two–week interval in 20 participants. Agreement for categorical items was quantified using Cohen's kappa, interpreted as: >0.90 (almost perfect), 0.80–0.90 (strong), 0.60–0.79 (moderate), 0.40–0.59 (weak), 0.21–0.39 (minimal), and <0.20 (none). For continuous scores, intraclass correlation coefficients (ICC) were calculated using a two–way mixed–effects model (absolute agreement), with >0.90 considered excellent, 0.75–0.90 good, 0.50–0.75 moderate, and <0.50 poor.

Validity Assessment

Content validity was explored through cognitive interviews with 10 older participants to confirm clarity and relevance of items. Construct validity was tested by examining correlations between the JSS–TR and BaSIQS (convergent validity), and between JSS–TR and GAD–2, PHQ–2, and PSS–4 (discriminant validity). Concurrent validity was assessed by correlation between JSS–TR and PSQI scores. Predictive validity was evaluated by comparing JSS–TR scores across subgroups with and without selected geriatric syndromes, including frailty, falls, disability, cognitive impairment, malnutrition, hearing or vision problems, and sarcopenia risk.

Agreement analysis between the JSS–TR and PSQI classifications was performed using Cohen's kappa.

Diagnostic Accuracy

The PSQI served as the reference standard, with ≥5 indicating poor sleep quality (12). Receiver operating characteristic (ROC) curves were generated, and area under the curve (AUC) values ≥0.7 were regarded as acceptable sensitivity (Se), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), likelihood ratios (LR+/LR-), and overall accuracy were calculated with 95% confidence intervals (CIs). Three scoring approaches were examined: continuous JSS–TR score, the existing ≥11 cut–off, and the optimal cut–off (>15) determined by the Youden index. Diagnostic indices (Se, Sp, PPV, NPV, LR+/LR-, AUC) were reported across plausible thresholds; results are summarized at ≥11 (screening–oriented) and ≥15 (confirmation–oriented) to reflect different clinical use cases.

Ethics approval was granted by the Clinical Research Ethics Committee of University of Health Sciences Türkiye, İzmir Tepecik Training and Research Hospital (approval number: 2025/01–14, date: 05.02.2025).

All participants provided written informed consent, and study procedures complied with the Declaration of Helsinki.

Statistical Analysis

Data analysis was performed using SPSS version 25. Normality was assessed by the Shapiro–Wilk test. Variables with normal distribution were expressed as mean ± standard deviation; non–normally distributed data were expressed as median (interquartile range [IQR]). Categorical variables were summarized as frequencies and percentages, and comparisons were made using chi–square or Fisher's exact tests. Group differences for continuous variables were examined using independent samples t–tests or Mann–Whitney U tests, depending on distribution. Spearman's correlation coefficients assessed associations between JSS–TR scores and other measures, with rho values interpreted. Kappa statistics were used to interpret agreement categories. ROC curve results were interpreted. The Youden index was calculated to identify optimal cut–off values. Permission to use all scales was obtained from the original authors.

Results

Participant Characteristics

A total of 132 older adults took part in the study. The median age was 80 years (IQR: 9.75), and 64.4% (n = 85) were women. Of the participants, 12.9% (n = 17) were illiterate, and 17.4% (n = 23) lived alone. The median score of CFS, ADL and IADL were 4, 6, and 8, respectively. The median score of JSS–TR, PSQI and BaSIQS were 12, 6, and 12, respectively. Sleep disturbance was identified in 52.3% (n = 69) according to the JSS–TR and in 60.6% (n = 80) based on the PSQI, as shown in Table 1.

Reliability

The JSS–TR demonstrated strong stability over time, with a kappa value of 0.806 (p < 0.001) for dichotomized scores and an ICC of 0.906 (p < 0.001) for the total score. Internal consistency reliability was acceptable for a brief 4–item multidomain screener, with a Cronbach's alpha of 0.683.

Validity

Content Validity

Feedback from cognitive interviews with 10 older participants indicated that items were clear and relevant, with no changes required.

Construct Validity

JSS–TR scores correlated strongly with BaSIQS scores (rs = 0.624, p < 0.001). Weak but significant correlations were observed with GAD–2 (rs = 0.273, p = 0.002), PSS–4 (rs = 0.188, p = 0.03), and PHQ–2 (rs = 0.172, p = 0.05).

Predictive Validity

Higher JSS–TR scores were recorded in participants with frailty (p = 0.012), history of falls (p = 0.026), and hearing impairment (p = 0.004), as shown in Table 2. No significant associations were found for disability, sarcopenia risk, malnutrition, vision impairment, urinary incontinence, or cognitive impairment.

Concurrent Validity

JSS–TR and PSQI scores showed a moderate correlation (rs = 0.425, p < 0.001) and fair to moderate agreement (Cohen's kappa = 0.342, p < 0.001). Agreement with BaSIQS was moderate (kappa = 0.407, p < 0.001). Table 3 presents detailed correlation results between JSS–TR and PSQI components.

Group Comparisons and Discrimination

When participants were divided into poor (n = 80) and good (n = 52) sleepers using a PSQI cut–off ≥5, total and most item scores of the JSS–TR were significantly higher in the poor sleep group (p < 0.001 for total, item 1, and item 4) (Table 4).

Diagnostic Accuracy

The ROC analysis indicated that the JSS–TR total score had an AUC of 0.706 (95% CI: 0.617–0.794) for identifying poor sleep quality (PSQI ≥5). The >15 cut–off (the confirmation–oriented threshold) demonstrated superior specificity (86.54%) and PPV (86.0%) compared to the previously recommended >11 cut–off (relative to the screening–oriented threshold), though sensitivity was lower (53.75% vs. 66.25%) [AUC = 0.701 (95% CI: 0.612–0.791), AUC = 0.677 (95% CI: 0.583–0.772), respectively]. Choice of threshold should reflect clinical intent (screening vs. confirmation), noting that NPV was modest in this cohort. Table 5 presents the full diagnostic accuracy indices, and Figure 1 shows the ROC curves for both cut–offs.

Table 1. Demographics of participants.	
Variables	**All participants**
Age, years	80 (9.75) (65–95)
Female sex, n (%)	85 (64.4)
Education level, n (%)	
Illiterate	17 (12.9)
Literate	22 (16.7)
5–8 years	61 (46.3)
9–11 years	16 (12.1)
11 years	16 (12.1)
Marital status, n (%)	
Single	1 (0.8)
Married	73 (55.3)
Widow	58 (43.1)
Living alone, n (%)	23 (17.4)
Comprehensive geriatric assessment	
CFS	4 (2) (1–7)
ADL	6 (1) (1–6)
IADL	8 (1) (1–8)
SARC-F	3 (3.75) (0–10)
MNA-SF	13 (2) (2–14)
S-MMSE	25 (5) (9–30)
Fall history, n (%)	57 (43.2)
Presence of incontinence, n (%)	66 (50)
Vision impairment, n (%)	110 (83.3)
Hearing impairment, n (%)	71 (53.8)

Continuous variables were expressed as median (interquartile range) (minimum-maximum), and categorical variables were presented as frequencies (percentages).

CFS: Clinical Frailty Scale, ADL: Activities of daily living, IADL: Instrumental activities of daily living, MNA-SF: Mini Nutritional Assessment-Short Form, S-MMSE: Standardized Mini-Mental State Examination.

Table 2. The predictive validity of the JSS-TR.					
Variables		**n (%)**	**Median JSS –TR (IQR)**	**p–value**	**z-score**
Frailty	Frail	44 (33.3)	8 (10.75)	**0.012**	-2.525
	Non-frail	88 (66.7)	13 (6.75)		
Falls history	Yes	57 (43.2)	13 (9.5)	**0.026**	-2.230
	No	75 (56.8)	10 (10)		
ADL disability	Yes	8 (6.1)	15 (12.25)	0.306	-1.024
	No	124 (93.9)	11 (9)		
IADL disability	Yes	39 (29.5)	10 (11)	0.423	-0.801
	No	93 (70.5)	12 (7)		
Urinary incontinence	Yes	66 (50)	14 (8.5)	0.155	-1.421
	No	66 (50)	10 (9.25)		
Hearing impairment	Yes	71 (53.8)	10 (10)	**0.004**	-2.871
	No	61 (46.2)	15 (9.5)		
Vision impairment	Yes	110 (83.3)	12 (8.25)	0.587	-0.542
	No	22 (16.7)	8 (13.75)		

Table 2. Continued.					
Variables		**n (%)**	**Median JSS–TR (IQR)**	**p–value**	**z-score**
Malnutrition	Yes	7 (5.3)	9 (7)	0.498	-0.678
	No	125 (94.7)	12 (9)		
Sarcopenia risk	Yes	63 (47.7)	11 (9)	0.862	-0.174
	No	69 (52.3)	12 (8)		
Cognitive impairment	Yes	51 (38.6)	9 (11)	0.321	-0.992
	No	81 (61.4)	12 (7)		

JSS–TR: The Turkish version of Jenkins Sleep Scale, ADL: Activities of daily living, IADL: Instrumental activities of daily living.

Table 3. Spearman rho correlations value between the JSS–TR overall and components scores score and the PSQI overall and components scores.

	JSS–TR score	1. Trouble falling asleep	2. Waking up several times per night	3. Trouble falling asleep again	4. Waking up feeling tired and worn out
C1-Subjective sleep quality	0.377**	0.516**	0.166	0.224*	0.148
C2-Sleep latency	0.454**	0.692**	0.054	0.229*	0.262*
C3-Sleep duration	0.195*	0.305**	0.015	0.025	0.164
C4-Sleep efficiency	0.241*	0.303**	0.003	-0.044	0.335**
C5-Sleep disturbances	0.273**	0.254*	0.121	0.118	0.316**
C6-Use of sleeping medication	-0.031	-0.099	-0.099	-0.077	0.058
C7-Daytime dysfunction	0.203*	0.126	-0.040	0.042	0.406**
PSQI overall score	0.425**	0.585**	0.036	0.123	0.401**

*$p<0.05$, **$p<0.001$.
JSS–TR: Turkish version of Jenkins Sleep Scale, PSQI: Pittsburgh Sleep Quality Index.

Table 4. JSS-TR scores comparisons between PSQI sleep quality groups.

	Poor sleep quality n = 80	Good sleep quality n = 52	p–value
	Median (IQR)	**Median (IQR)**	**Mann-Whitney U**
JSS-TR scores	15 (10)	10 (7)	<0.001
1. Trouble falling asleep	4 (3)	0 (1)	<0.001
2. Waking up several times per night	5 (3)	5 (2)	0.698
3. Trouble staying asleep	4 (4)	4 (5)	0.519
4. Waking up feeling tired and worn out	3 (5)	0 (2)	0.001

PSQI ≥5 indicates poor sleep quality (reference standard). Minumum-maximum value of all items of JSS–TR were 0–5. Minimum-maximum value of JSS-TR total score were 0–20. JSS–TR: Turkish version of Jenkins Sleep Scale, PSQI: Pittsburgh Sleep Quality Index, IQR: Interquartile range.

Table 5. Test accuracy results of the JSS-TR to predict sleep distribution based on PSQI score.

Cut-off value	Se % (95% CI)	Sp % (95% CI)	PPV % (95% CI)	NPV % (95% CI)	LR+	LR-	Youden index
≥11*	66.25 (54.81–76.45)	69.23 (54.90–81.28)	76.81 (68.16–83.68)	57.14 (48.28–65.57)	2.15 (1.39–3.33)	0.49 (0.34–0.70)	0.355
≥15**	53.75 (42.24–64.97)	86.54 (74.21–94.41)	86 (74.97–92.65)	54.88 (48.41–61.19)	3.99 (1.95–8.19)	0.53 (0.41–0.69)	0.403

*The previously recommended value.

**The optimal cut-off value.

Threshold interpretation: ≥11 prioritizes sensitivity for screening; ≥15 prioritizes specificity/PPV for confirmation. NPV depends on prevalence and was modest in this cohort; positive results should be confirmed (e.g., PSQI/clinical evaluation).

Se: Sensitivity, Sp: Specificity, PPV: Positive predictive value, NPV: Negative predictive value, LR: Likelihood ratio, JSS–TR: Turkish version of Jenkins Sleep Scale.
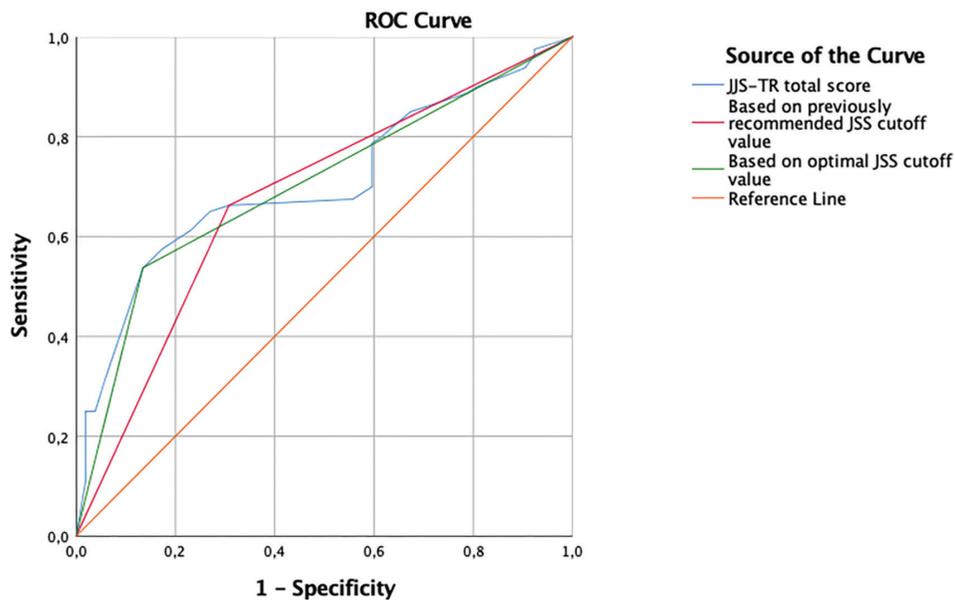
Figure 1. The receiver operating characteristic (ROC) curve annotates the ≥11 (screening-oriented) and ≥15 (confirmation-oriented) thresholds. ROC curve for the Turkish version of Jenkins Sleep Scale score, the previously recommended value and the optimal cut-off value in detecting sleep distrubition based on the Pittsburgh Sleep Quality Index (poor sleep quality vs. good sleep quality). The red diagonal represents the line of no discrimination (area under the curve = 0.5), corresponding to a non-informative classifier.

Discussion

The JSS–TR demonstrated moderate sensitivity and specificity, with a relatively high PPV, supporting its utility as a screening tool for identifying sleep disturbances among older adults. Importantly, our findings highlight the value of using a population–specific cutoff of ≥15, which provided greater specificity and PPV than the previously recommended cutoff of ≥11. The population–specific cut–off yielded a more precise identification of individuals with objectively poor sleep, as defined by the PSQI. This enhanced diagnostic accuracy is especially meaningful in geriatric care settings, where avoiding unnecessary interventions and focusing on those truly in need is a clinical priority. Our findings support the integration of the JSS–TR with the ≥15 cut–off as part of routine sleep assessments in older populations.

The predictive validity analysis highlighted that poor sleep, as measured by JSS–TR, was associated with frailty, falls, and hearing problems. The absence of an association with sarcopenia risk aligns with evidence indicating that while both poor sleep and reduced muscle strength are important geriatric issues, their link is likely mediated through broader health decline (6,25). Meta–analytic data indicate that insomnia nearly doubles the risk of frailty, particularly when sleep onset and maintenance are impaired (26).

Convergent validity was supported by significant correlations with PSQI subdomains, except for "use of sleep medication," which may be influenced by prescribing habits rather than actual sleep quality. Items related to difficulty initiating sleep and morning tiredness appeared to be the most discriminating. Psychosocial influences on sleep in later life are well documented, with studies showing that cumulative stressors contribute to worsening sleep patterns over time (27). Our weak correlations with depression and anxiety measures suggest that JSS–TR primarily reflects sleep disturbance rather than emotional distress; however, longitudinal evidence shows a bidirectional relationship between poor sleep and depressive symptoms, underlining the importance of monitoring both in clinical care (28). Network analyses also suggest that certain JSS subdomains, such as "feeling tired in the morning," may act as key connectors between insomnia and depression (29).

No significant association emerged between JSS–TR scores and cognitive impairment in this sample, although other research points to complex and sometimes subtle links between sleep and cognitive performance. Recent meta–analysis showed that short sleep latency and better sleep efficiency correlate with stronger executive function, while non–restorative sleep and early morning awakenings may impair cognitive flexibility and working memory (8). Differences in findings may reflect the use of self–report measures and cross–sectional design in our study. Finally, given the simplicity, brevity, and psychometric strength of the JSS–TR, it appears suitable for routine use in geriatric outpatient settings. As sleep quality is a vital determinant of physical and psychological health in older adults (30), incorporating the JSS–TR into clinical workflows may enhance the detection and management of sleep–related problems.

Given its brevity and multidomain content, the JSS–TR is most suitable for triage and case–finding. For initial screening/

triage (prioritizing sensitivity), ≥11 may be preferred. For case–finding/confirmation in geriatric clinics (prioritizing specificity and PPV), ≥15 is preferable (specificity ~87%, PPV ~86) with lower sensitivity (~54). Because NPV is modest in our sample, consistent with relatively high prevalence of poor sleep, the JSS–TR is not optimal for ruling out poor sleep on its own; positive results should be followed by confirmatory assessment (e.g., PSQI/clinical evaluation).

Study Limitations

This study has some constraints. First, its cross–sectional design limits our ability to examine changes in sleep patterns over time or to determine the scale's sensitivity to treatment effects. Second, although we excluded individuals with diagnosed psychiatric or neurological conditions, unrecognized or subthreshold symptoms may still have influenced sleep and introduced residual bias. Third, sleep disturbances were assessed through self–report measures rather than objective tools such as actigraphy or polysomnography, which may reduce measurement precision. Fourth, while the study sample was derived from two tertiary geriatric clinics, limiting generalizability to other settings, especially community–dwelling or institutionalized older adults, future multicenter or population–based studies could provide broader validation. Finally, residual confounding from unmeasured or undiagnosed sleep–specific conditions (e.g., obstructive sleep apnea) cannot be excluded.

Conclusion

Sleep disturbances in older adults may signal underlying depression or contribute directly to symptoms such as fatigue and repeated hospital visits. Therefore, the ability to assess sleep quality rapidly and practically is essential in geriatric clinical practice. The JSS–TR proved to be a valid, reliable, and efficient screening tool for adults aged 65 years and older. The population–specific cutoff of ≥15 improved diagnostic precision, making it more suitable for geriatric settings than the previously recommended threshold. Future research should focus on the responsiveness of the JSS–TR to therapeutic interventions, including cognitive behavioral therapy for insomnia and pharmacologic treatments, to further establish its utility in both clinical and research settings.

Ethics

Ethics Committee Approval: Ethics approval was granted by the Clinical Research Ethics Committee of University of Health Sciences Türkiye, İzmir Tepecik Training and Research Hospital (approval number: 2025/01–14, date: 05.02.2025).

Informed Consent: All participants provided written informed consent.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.Ö.K., N.S.G., S.Ç., Concept: F.Ö.K., S.Ç., Design: F.Ö.K., N.S.G., S.Ç., F.U.E., Data Collection or Processing: F.Ö.K., N.S.G., F.U.E., Analysis or Interpretation: F.Ö.K., Literature Search: F.Ö.K., Writing: F.Ö.K., N.S.G., S.Ç., F.U.E.

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Psychological Inflexibility and Its Associations with Chronotype and Sleep Quality in Spanish Adults

Psikolojik İnfleksibilite ile Kronotip ve Uyku Kalitesi Arasındaki İlişki: İspanyol Yetişkinlerde Bir İnceleme

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Abstract

The primary objective of this study was to analyze self-reported sleep perception in relation to psychological inflexibility traits in adults. A total of 705 adults (65.2% women) participated, with a mean age of 27.21 years standard deviation = 10.67. The instruments used were the Pittsburgh Sleep Quality Index, the Composite Scale of Morningness, and the Acceptance and Action Questionnaire. Results showed that participants with high psychological inflexibility had a significantly greater risk of reporting poor sleep quality [odds ratio (OR) = 2.632] and identifying with an evening chronotype (OR = 2.825) than those with lower inflexibility scores. Higher inflexibility scores were positively associated with sleep disturbances, daily dysfunction due to poor sleep quality, use of sleep medication, and other sleep-related issues. Targeting behaviors associated with psychological inflexibility could help improve sleep-related outcomes.

Keywords: Chronotype, subjective sleep, sleep quality, psychological flexibility, sleep perception

Öz

Bu çalışmanın temel amacı, yetişkinlerde psikolojik esneklik özellikleri ile öz bildirimle belirtilen uyku kalitesi arasındaki ilişkinin incelenmesidir. Toplam 705 yetişkin (%65,2'si kadın) çalışmaya katılmış ve bu katılımcıların yaş ortalaması 27,21 (standart sapma = 10,67) olarak saptanmıştır. Kullanılan ölçüm araçları Pittsburgh Uyku Kalitesi İndeksi, Sabahçıllık-Birleşik Ölçeği ve Kabul ve Kararlılık Anketi'dir. Sonuçlar, psikolojik esnekliği düşük olan katılımcıların, yüksek olanlara kıyasla, kötü uyku kalitesi bildirme [odds ratio (OR) = 2,632] ve akşam kronotipiyle kendini tanımlama (OR = 2,825)açısından anlamlı derecede daha yüksek eğilimde oldukları bulundu. Düşük psikoloji esneklik puanları; uyku bozuklukları, kötü uyku kalitesine bağlı günlük işlev bozukluğu, uyku ilacı kullanımı ve diğer uyku ile ilgili sorunlarla pozitif yönde ilişkili olduğu görüldü. Bu sonuçlar ışığında, psikolojik esneklik ile ilişkili davranışların klinik uygulamalarda hedef alınmasının, uyku sorunlarının iyileştirilmesine katkı sağlayabileceği düşünülmektedir.

Anahtar Kelimeler: Kronotip, öznel uyku, uyku kalitesi, psikolojik infleksibilite, uyku algısı

Introduction

Psychological inflexibility has been conceptualized as a process of engaging with the present experience. It involves experiencing the present fully and consciously, without unnecessary defenses, and accepting it as it is, not as it is said to be. It also involves the ability to persist or change behavior based on freely chosen values (1). Individuals with higher cognitive flexibility are better equipped to solve problems as an adaptive response to situational changes. They typically do so through the following skills or processes: acceptance, cognitive defusion, flexible attention to the present moment, a sense of self–as–context, values, and committed action (2).

Within the framework of Acceptance and Commitment Therapy, psychological inflexibility has been characterized as a transdiagnostic etiological factor, playing a central and significant role in the development and maintenance of problems of an emotional and psychological nature with maladaptive consequences (3,4). An individual who copes with distressing situations through any of the six basic processes increases the risk of progressively developing psychological inflexibility, which manifests as experiential avoidance. This, in turn, can contribute to the emergence of emotional disorders (5).

Psychological inflexibility is closely linked to a wide range of psychological disturbances characterized by avoidant response

patterns (5,6), including sleep–related problems (4). According to Lundh and Broman (7), two types of processes are involved in sleep–related cognitions: those that interfere with sleep and those that interpret sleep experiences. In this context, psychological inflexibility emerges as a key factor in managing or mediating these processes (4). By examining the interaction between sleep problems and emotional dysregulation, researchers have proposed psychological inflexibility as a transdiagnostic factor that mediates this relationship (4).

The relationship between psychological inflexibility and chronotype has been less extensively studied (7-9). Psychological inflexibility has been linked to a range of difficulties and lower psychological well–being (4-6). Similarly, an evening–type chronotype has been associated with a greater psychological problems and poor sleep quality (10,11). These findings suggest the possibility of a relationship between high psychological inflexibility scores and evening chronotypes. Indeed, existing studies indicate that individuals with higher psychological flexibility are more likely to report morningness and alertness–oriented patterns typical of healthier lifestyles (9,10-13).

The present study examines the relationship between psychological inflexibility and perceived sleep characteristics in Spanish adults. The first hypothesis proposes that individuals with high psychological inflexibility will report poorer sleep quality compared to those with greater psychological flexibility. The second hypothesis predicts that psychological inflexibility will be associated with evening chronotype patterns, which are commonly linked to a higher incidence of behavioral problems.

Materials and Methods

Participants

The sample consisted of 705 individuals, of whom 65.2% were women. Participants ranged in age from 18 to 62 years. Regarding educational attainment, 10.5% had completed primary education, 28.2% had completed secondary education, and 61.3% had completed university studies.

Instruments

An ad hoc interview was administered to collect sociodemographic and educational information. Subjective sleep quality was measured using the Spanish version of the Pittsburgh Sleep Quality Index; Buysse et al. (14) in the version adapted to Spanish by Macías and Royuela. (15) Higher scores indicate poor sleep quality. In the present study, internal consistency was acceptable (Cronbach's α = 0.85).

Chronotype was evaluated using The Composite Scale of Morningness [CSM; Smith et al. (16,17), Spanish adaptation by Díaz–Morales and Sánchez–López (18)]. This questionnaire assesses the evening chronotype type, a general morningness factor, and an alertness factor. Internal consistency in this study was acceptable for the CSM–total (α = 0.82), CSM–general (α = 0.79), and CSM–alert (α = 0.75).

Psychological inflexibility was measured using the Acceptance and Action Questionnaire [Bond et al. (19), Spanish adaptation by Ruiz et al. (20)]. Higher scores indicate greater psychological

inflexibility. In the present sample, internal consistency was high (Cronbach's α = 0.93).

Procedure

A non–probabilistic sampling method was employed using a cross–sectional design. Data were collected online, with survey links distributed via social media and email to the administrations of various social centers, clubs, and adult groups to reach potential participants. Additionally, in–person visits were conducted at several universities, where information about the study was further disseminated among students through social networks, the Moodle platform, and other university–related channels.

This research was approved by the This research was approved by the Andalusian Ethics Committee of Biomedical Research (Evaluation Committee of Huelva. Internal Code: 0423–N–23. Date of approval: 20/06/2023; Act: 06/23). All participants provided informed consent. Data generated in this study are available from the corresponding author upon reasonable request. The authors declare no conflicts of interest.

Statistical Analysis

Descriptive analyses [means, standard deviations (SDs), etc.] were used to characterize the main variables. Internal consistency of the instruments was assessed using Cronbach's alpha (α). For comparisons involving quantitative variables with more than two categories, analysis of variance (ANOVA) was performed using Snedecor's F statistic, followed by Bonferroni post hoc tests. Effect sizes were estimated with eta–squared (η^2), classified as small ($0.01 \leq \eta^2 < 0.06$), medium ($0.06 \leq \eta^2 < 0.14$), or large ($\eta^2 \geq 0.14$). For categorical variables, chi–square tests (χ^2) were used, with effect sizes estimated using Cramer's V: small (<0.20), moderate (0.20–0.60), and large (>0.60). Odds ratios were also calculated. Cluster analyses were conducted to group participants according to psychological inflexibility. All statistical analyses were performed with the SPSS software package (IBM SPSS Statistics, Version 25.0; IBM Corp., Armonk, NY, USA).

Results

The sample included 705 individuals, of whom 245 (34.8%) were men and 460 (65.2%) women. The mean age of the sample was 27.21 years (SD = 10.67). Regarding educational level, 10.5% reported only basic education, 28.2% had completed secondary education, and 61.3% held a university degree.

When participants were grouped into three clusters based on psychological inflexibility scores (low, medium, and high; see Table 1), significant differences were found in sleep quality, with a medium effect size (η^2 = 0.13). Post-hoc comparisons indicated that group a < b (p < 0.001), a < c (p < 0.001), and b < c (p < 0.001). Differences were also observed in self–reported sleep duration, with a small effect size (η^2 = 0.01); group a > c (p = 0.002) and b > c (p = 0.046). Finally, significant differences emerged regarding medication use, with a medium effect size (Cramér's V = 0.173): participants in the high inflexibility group

were more likely to report using sleep medication, whereas those in the low inflexibility group were more likely to report not using it. No significant differences were found in sleep efficiency, although minor residual differences were observed in reported time spent in bed.

When analyzing the three clusters based on chronotype scores (Table 2), the total scale score showed statistically significant differences among the groups, with a small effect size (η^2 = 0.04). Post–hoc comparisons revealed that Group a scored higher than Group b (p < 0.001) and Group c (p < 0.001), whereas no significant differences were found between Groups b and c (p = 0.791).

For the morningness subscale, significant differences were observed with a small effect size (η^2 = 0.03). Post–hoc comparisons indicated that Group a scored higher than Group b (p = 0.002) and Group c (p = 0.006), whereas no significant difference was observed between Groups b and c (p = 1.0). On the alertness subscale, the low inflexibility group again differed from the other two groups, with a medium effect size (η^2 = 0.06): Group a > b (p < 0.001), a > c (p < 0.001), and b = c (p = 0.103).

Finally, when participants were grouped into just two clusters

(high vs. low psychological inflexibility), the high inflexibility group showed a significantly greater risk of reporting poor sleep quality, the presence of sleep disturbances, daytime dysfunction due to sleep problems, use of sleep medication, longer sleep latency, and a higher risk of sleeping fewer than six hours per night compared to the low inflexibility group (Table 3).

Discussion

This study examined the relationship between perceived sleep characteristics and psychological inflexibility traits in Spanish adults.

The first hypothesis predicted that individuals with high psychological inflexibility would report poorer sleep quality than those with greater psychological flexibility. The findings supported this hypothesis and are consistent with previous research showing that psychological inflexibility is linked to difficulties in coping with and managing sleep–related issues (3,21,22).

According to Lundh (23), certain sleep disturbances arise from the interaction between arousal–inducing processes and dysfunctional cognitive processes related to the perception

Table 1. Subjective sleep quality characteristics by psychological inflexibility clusters

	Total 705	C1 low PI (a) 322 (45.7)	C2 medium PI (b) 269 (38.2)	C3 high PI (c) 114 (16.2)	Test statistic	p
PSQI	8.70 (4.23)	7.36 (3.79)	9.07 (4.15	11.64 (3.95)	$F_{(2,702)}$=51.25	<0.001
Category PSQI					$Chi^2_{(2,705)}$=31.437	<0.001
Poor quality	526 (74.61)	211 (65.5)	212 (78.8)	103 (90.4)		
Good quality	179 (25.39)	111 (34.5)	57 (21.2)	11 (9.6)		
Time in bed (hrs)	7.51(1.26)	7.57 (1.27	7.55 (1.19)	7.26 (1.37)	$F_{(2,702)}$=2.85	0.059
Sleep duration (hrs)	6.52 (1.15)	6.63 (1.19)	6.52 (1.12)	6.21 (1.09)	$F_{(2,702)}$=5.76	0.003
Sleep efficiency (%)	87.52 (11.88)	88.28 (11.89)	86.98 (11.74)	86.65 (12.14)	$F_{(2,702)}$=1.24	0.290
Medication use					$Chi^2_{(2,705)}$=21.089	<0.001
Yes	137 (19.43)	44 (13.7)	55 (20.4)	38 (33.3)		
No	568 (80.57)	278 (86.3)	214 (79.6)	76 (66.7)		

For categorical variables, values are presented as n (%); for quantitative variables, as M (SD). Poor quality = PSQI >5; Good quality = PSQI ≤5. C1, Low PI; C2, Medium PI; C3, High PI.

SD: Standard deviation, PSQI: Pittsburgh Sleep Quality Index, C: Cluster, PI: Psychological inflexibility.

Table 2. Chronotype characteristics by psychological inflexibility clusters

	Total 705	C1 low PI (a) 322 (45.7)	C2 medium PI (b) 269 (38.2)	C3 high PI (c) 114 (16.2)	$F_{(2,704)}$	p
CSM	33.98 (60.40)	35.34 (6.27)	33.07 (6.01)	32.29 (6.90)	14.463	<0.001
Morningness	26.09 (5.12)	26.91 (5.10)	25.49 (4.79)	25.20 (5.59)	7.844	<0.001
Alertness	7.89 (2.15)	8.43 (2.06)	7.58 (2.09)	7.09 (2.17)	21.955	<0.001
Category CSM					$Chi^2_{(4, 705)}$=19.613	0.001
Morning type	64 (9.08)	40 (12.4)	14 (5.2)	10 (8.8)		
Intermediate type	548 (77.73)	251 (78.0)	218 (81.0)	79 (69.3)		
Evening type	93 (13.19)	31 (9.6)	37 (13.8)	25 (21.9)		

For categorical variables, values are presented as n (%); for quantitative variables, as M (SD). C1, Low Psychological Inflexibility; C2, Medium Psychological Inflexibility; C3, High Psychological Inflexibility.

SD: Standard deviation, PSQI: Pittsburgh Sleep Quality Index, C: Cluster, CSM: Composite Scale of Morningness, PI: Psychological inflexibility.

Table 3. ORs of sleep–related problems comparing high vs. low psychological inflexibility clusters					
	High PI cluster vs. low PI cluster				
	OR	$\chi^2_{(1,157)}$	p	Phi	95% CI
Poor sleep quality	2.632	23.333	<0.001	1.182	1.762–3.933
Presence of sleep disturbances	2.199	11.381	0.001	0.127	1.380–3.459
Daytime dysfunction	2.267	14.919	<0.001	0.145	1.486–3.459
Use of sleep medication	2.319	19.517	<0.001	0.166	1.588–3.387
Sleep latency ≥31 minutes	1.654	7.862	0.005	0.106	1.162–2.356
Sleep Duration <6 h	1.642	9.773	0.002	0.118	1.202–2.243
CSM–evening chronotype	2.825	9.024	0.003	0.240	1.420–5.619
High PI Cluster: Cluster of high psychological inflexibility, Low PI Cluster: Cluster of low psychological inflexibility.					
OR: Odds ratio, CI: Confidence interval, PSQI: Pittsburgh Sleep Quality Index, CSM: Composite Scale of Morningness, PI: Psychological inflexibility					

of sleep. Specifically, factors that interfere with sleep include stressful life events and maladaptive cognitive patterns that influence how individuals interpret arousal, sleep difficulties, and the consequences of insufficient sleep (7). These factors may help to explain the role of psychological inflexibility in sleep problems.

The second hypothesis proposed that psychological inflexibility would be associated with evening–type chronotype patterns. The results supported this prediction, indicating that higher psychological inflexibility is linked to an evening chronotype, an outcome consistent with previous research (17-20).

In this context, chronotype has been associated with the ways in which individuals seek, regulate, internalize, and process information about their environment and themselves (cognitive styles), as well as how they engage in social interactions (behavioral styles), including the emotions that drive them and the cognitions they have developed (10,11).

Morning–type individuals tend to retain knowledge grounded in tangible and concrete realities, relying on direct experience and observable phenomena (realistic/sensing). They process information primarily through logical analysis and integrate new knowledge in line with established understanding. In contrast, evening–type individuals are more inclined to draw on symbolic and abstract data, often embracing uncertainty and engaging in imaginative reinterpretation of their experiences. Their cognitive style relies more on symbolic and unfamiliar inputs than on concrete and observable evidence (10,24-27).

Study Limitations

This study has several limitations that should be addressed in future research. First, the correlational design does not allow for causal inferences. Second, although the questionnaires used demonstrated acceptable validity and reliability, self–report measures are subject to inherent limitations such as response bias. Third, longitudinal studies are needed, as sleep problems may vary depending on contextual factors (e.g., academic or occupational demands, health conditions). Finally, future research should control for potentially relevant variables (e.g., mental and physical health, socio–occupational and family circumstances) and include more representative samples to

strengthen the external validity of the findings.

Conclusion

In conclusion, higher psychological inflexibility is associated with poorer sleep quality, a greater number of sleep–related problems, and a tendency toward evening–type sleep patterns —often linked to additional behavioral and health issues. These findings underscore the potential for interventions aimed at reducing experiential avoidance, cognitive fusion, and attentional rigidity, which constitute core features of psychological inflexibility and may, in turn, improve sleep outcomes.

Ethics

Ethics Committee Approval: All procedures were conducted following the ethical standards of the institutional and national research committees and with the 1975 Helsinki Declaration, as revised in 2013. This research was approved by the Andalusian Ethics Committee of Biomedical Research (Evaluation Committee of Huelva. Internal code: 0423–N–23, date: 20.06.2023, Act: 06/23).

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.A., A.L.F, A.S.P., J.D.A., Concept: F.A., J.D.A., Design: F.A., A.L.F, J.D.A., Data Collection or Processing: F.A., A.L.F, A.S.P., J.D.A., Analysis or Interpretation: F.A., A.L.F, A.S.P., J.D.A., Literature Search: F.A., A.L.F, A.S.P., J.D.A., Writing: F.A., A.L.F, A.S.P., J.D.A.

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

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Prader–Willi Syndrome and Obstructive Sleep Apnea Syndrome: A Case Series from Türkiye

Prader–Willi Sendromu ve Obstrüktif Uyku Apne Sendromu: Türkiye'den Bir Olgu Serisi

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Abstract

Prader–Willi syndrome (PWS) is a rare genetic disorder that is frequently associated with sleep-disordered breathing, particularly obstructive sleep apnea syndrome (OSAS). We present a case series of five Turkish children with PWS who underwent overnight polysomnography. OSAS was identified in three patients (60%), one of whom had severe disease. Ear, nose, and throat evaluations revealed adenoid hypertrophy in two patients and tonsillar hypertrophy in one child. These findings suggest that OSAS is clinically relevant in PWS, and underscore the importance of routine polysomnographic assessment before and during growth hormone therapy.

Keywords: Prader-Willi syndrome, obstructive sleep apnea syndrome, polysomnography, growth hormone

Öz

Prader–Willi sendromu (PWS), özellikle obstrüktif uyku apne sendromu (OSAS) ile ilişkili olan nadir bir genetik bozukluktur. Bu çalışmada, gece boyunca polisomnografi uygulanan beş Türk PWS'li çocuğa ait bir olgu serisini sunuyoruz. Beş hastanın üçünde (%60) OSAS saptandı; bunlardan birinde hastalık ağır düzeydeydi. Kulak, burun ve boğaz değerlendirmelerinde iki çocukta adenoid hipertrofisi, bir çocukta ise tonsil hipertrofisi tespit edildi. Bu bulgular, OSAS'ın PWS'de klinik açıdan önemli olduğunu göstermekte ve büyüme hormonu tedavisinden önce ve tedavi sırasında rutin polisomnografik değerlendirmenin önemini vurgulamaktadır.

Anahtar Kelimeler: Prader–Willi sendromu, tıkayıcı uyku apne sendromu, polisomnografi, büyüme hormonu

Introduction

Prader–Willi syndrome (PWS) is a rare neurodevelopmental disorder that occurs due to the loss of paternally inherited genes on chromosome 15q11–q13. Its core features are hypotonia, hyperphagia, short stature and cognitive impairment (1), along with excessive daytime sleepiness (EDS) that reflects frequent sleep–disordered breathing (SDB) (2). Obstructive sleep apnea syndrome (OSAS), a form of SDB, is associated with significant morbidity and worsens the quality of life (3). OSAS is recurrent upper airway obstruction that occurs during sleep, and causes intermittent hypoxemia, hypercapnia, and sleep fragmentation (4). The prevalence of OSAS in children is 1–4%

and linked to cardiovascular, metabolic, and neurocognitive consequences (5). It is also highly prevalent in PWS patients due to obesity, craniofacial anomalies, hypotonia, and adenotonsillar hypertrophy (3,6). While there is substantial data on PWS from international studies, Turkish reports are scarce. Herein, we present the cases of five children with PWS undergoing polysomnography (PSG), with focus on the prevalence, ear, nose and throat (ENT) findings, and clinical implications.

Case Report

Children with genetically or clinically confirmed PWS who underwent overnight PSG in our sleep laboratory between 2018 and 2025 were included in the study. The exclusion criteria were

the lack of confirmed PWS diagnosis, incomplete PSG data, or missing ENT evaluation. The indications were snoring, EDS, or pre–growth hormone (GH) assessment. PSGs were scored using the Embla system per American Academy of Sleep Medicine pediatric criteria (4). The apnea–hypopnea index (AHI), oxygen saturation, and arousal index were evaluated. The severity of OSAS was categorized as normal (AHI <1), mild (1-5), moderate (5-10), and severe (>10). Indirect ENT examinations were performed by a pediatric otolaryngologist, and the adenoid and tonsil size were recorded. Written informed consent was obtained from the parents or legal guardians of all children, and the study was conducted in accordance with the principles of the Declaration of Helsinki (2013 revision).

Five children, including three males and two females (mean age 6.8 ± 5 years), were enrolled in the study. The mean body mass index was 19.6 ± 9.2 kg/m². Neonatal hypotonia was common, and craniofacial anomalies and obesity were also noted. ENT evaluation revealed adenoid hypertrophy in two children and tonsillar hypertrophy in one (Table 1). The mean AHI was 10.5 ± 17.2 events/h, and three patients (60%) had OSAS. Minimum oxygen saturation ranged from 72–84% (Table 2).

Discussion

SBD is a major cause of morbidity in patients with PWS, and is driven by hypotonia, craniofacial anomalies, and obesity (3,6). Disrupted sleep worsens neurocognitive, behavioral, and cardiometabolic outcomes (2,5,7). Over half of children with PWS have OSAS, often moderate to severe, leading to EDS, cardiovascular risk, and reduced quality of life (5-7). Other sleep disorders, such as central apnea, narcolepsy–like sleepiness, insomnia, and periodic limb movements, are related to hypothalamic dysfunction (8,9). These mechanisms may explain persistent sleepiness despite OSAS treatment, thereby underscoring the need for comprehensive sleep evaluation.

Three of the five patients (60%) in this study had OSAS, including one severe case. This proportion falls within international ranges, although severe cases may reflect small sample size, referral bias, or variability in obesity, hypotonia, or craniofacial features. ENT evaluation identified upper–airway hypertrophy in three patients, which is consistent with the involvement of adenotonsillar obstruction but also indicates that anatomical factors alone do not explain OSAS severity in PWS patients (6). The patient with severe OSAS was obese, which supports obesity as an additional risk factor. Moreover, age–related differences may also contribute, as younger children tend to present with adenotonsillar obstruction, whereas obesity and hypotonia become more prominent determinants with increasing age.

PSG showed reduced rapid–eye movement (REM) sleep and frequent arousals. Likewise, previous studies have reported

Table 1. Clinical, genetic, AHI, and ENT findings in children with PWS.								
Case	Age (years)	Sex	BMI (kg/m²)	Symptoms	Genetics	AHI (events/h)	ENT findings	Treatment
1	5	F	13.8	Snoring, EDS, apnea	Negative	0.9	Tonsillar hypertrophy, Grade 3	Follow-up
2	5	F	13.9	Snoring, EDS, apnea, neck flexure (ESAP)	Chromosome 15q11–13 deletion	0.2	Adenoid hypertrophy, Grade 3	Follow-up
3	8	M	32.9	Hypotonic birth, snoring	Chromosome 15: 11–13q deletion	41.7	Micrognathia, Mallampati Class IV	CPAP 7 mbar
4	1	M	16.4	EDS, apnea, pre-GH control	Negative	8.7	Adenoid vegetation, adenoid hypertrophy, Grade 3	CPAP 6 mbar
5	15	M	31.1	Pre-GH control	Chromosome 15: 11–13q deletion	2.9	Normal	CPAP 5 mbar

AHI: Apnea–hypopnea index, BMI: Body mass index, CPAP: Continuous positive airway pressure, EDS: Excessive daytime sleepiness, ENT: Ear–nose–throat, ESAP: Excessive short/anteriorly positioned neck (short and thick neck morphology predisposing to obstructive sleep apnea syndrome), GH: Growth hormone, F: Female, M: Male, Mallampati classification: Method for airway assessment, PWS: Prader–Willi syndrome.

Table 2. Polysomnographic findings of children with PWS.								
Case	TST (min)	Sleep efficiency (%)	REM (%)	NREM (%)	Mean SpO$_2$ (%)	Min SpO$_2$ (%)	AHI (events/h)	Arousal index (events/h)
1	462	86.6	13.2	86.8	92	84	0.9	5.8
2	470	97.0	16.7	83.3	96	72	0.1	11.6
3	412	94.6	20.1	79.9	95	72	48.1	66.5
4	337	79.3	33.5	66.5	96	82	8.7	15.0
5	410	77.4	17.0	83.0	95	80	2.9	11.2

TST: Total sleep time, REM: Rapid eye movement, NREM: Non-rapid eye movement, SpO$_2$: Peripheral oxygen saturation, AHI: Apnea–hypopnea index, PWS: Prader–Willi syndrome.

altered sleep architecture in PWS patients, such as reduced REM and fragmented sleep (2,3). O'Donoghue et al. (6) linked these changes to neurobehavioral problems, and a review confirmed disrupted continuity and reduced REM as a characteristic of PWS (8). Such abnormalities may contribute to persistent EDS and cognitive impairment beyond OSAS.

The relevance of OSAS screening is heightened by GH therapy. Although GH improves stature, body composition, and quality of life, it has been linked to worsening OSAS in children with obesity or adenotonsillar hypertrophy (2,3). Accordingly, PSG prior to and during GH therapy is recommended (7). Our cohort supports this practice, as most patients underwent PSG before GH initiation.

Conclusion

Recently, a study conducted in Türkiye reported PSG–based findings in PWS (10). Our case series contributes to the current evidence, but is limited by sample size and follow–up. Nevertheless, our findings underscore the need for routine PSG and multidisciplinary care for PWS patients, especially with GH therapy.

Ethics

Informed Consent: The written informed consent was obtained from all patients included in the study.

Footnotes

Authorship Contributions

Data Collection or Processing: G.A., Analysis or Interpretation: G.A., T.Y., U.O.A., Literature Search: G.A., T.Y., Writing: G.A., T.Y., U.O.A.

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

Financial Disclosure: The authors declared that this study received no financial support.

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Erratum

Nalbantoğlu Y, Türkarslan KK. Workaholism and sleep disorders in employees: the moderator roles of workaholism in the relationships between insomnia and affective symptoms. J Turk Sleep Med. 2025;12(3):176-185

On page 176 of the manuscript, it has been stated that the affiliation of one of the authors, "Ankara Medipol University Faculty of Administrative and Social Sciences, Department of Psychology, Ankara, Türkiye," should be corrected to "Atılım University, Graduate School of Social Sciences, Department of Psychology, Ankara, Türkiye." Accordingly, the necessary correction has been indicated in bold within the text.

The uncorrected version is as follows:

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