The impact of depression and anxiety on sleep quality in hemodialysis patients: A single-center study in Türkiye

Hemodiyaliz hastalarında depresyon ve anksiyetenin uyku kalitesi üzerindeki etkisi: Türkiye'de tek merkezli bir çalışma

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Abstract

Aim: This study was conducted to investigate the effects of depression and anxiety on sleep quality in patients receiving hemodialysis treatment and to evaluate these relationships.

Methods: The study was conducted in a cross-sectional design in a training and research hospital in Turkey. The study included 101 hemodialysis patients and 100 healthy control participants. The sample size was calculated using G*Power software (effect size = 0.48, α = 0.05, power = 0.95), requiring a minimum of 180 participants. Hospital Anxiety and Depression Scale (HADS), Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), and Epworth Sleepiness Scale (ESS) were used as data collection tools. Independent samples t-tests and Pearson correlations were used for group comparisons and associations. Multiple linear regression was employed to identify predictors of sleep quality.

Results: Depression and anxiety scores were significantly higher in the hemodialysis group compared to the control group (p<0.001). Poor sleep quality was detected in 79.2% of hemodialysis patients, and PSQI scores were significantly higher compared to the control group (p<0.001). Multiple regression analysis showed that anxiety, depression, and marital status were significant predictors of PSQI scores, explaining 56.8% of the variance (adjusted R^2 = 0.568, p < 0.001).

Conclusion: The study showed that depression and anxiety significantly negatively affected sleep quality in hemodialysis patients. These results highlight the importance of incorporating psychosocial interventions within the care of this population and emphasize the need for healthcare providers to address psychological factors when managing sleep disturbances.

Keywords: Anxiety; depression; hemodialysis; sleep

Öz

Amaç: Bu çalışma hemodiyaliz tedavisi alan hastalarda depresyon ve anksiyetenin uyku kalitesi üzerine etkilerini araştırmak ve bu ilişkileri değerlendirmek amacıyla yapılmıştır.

Yöntem: Çalışma Türkiye'de bir eğitim ve araştırma hastanesinde kesitsel bir tasarımla yürütüldü. Çalışmaya 101 hemodiyaliz hastası ve 100 sağlıklı kontrol grubu dahil edilmiştir. Örneklem büyüklüğü G*Power yazılımı kullanılarak hesaplandı (etki büyüklüğü = 0,48, α = 0,05, güç = 0,95) ve en az 180 katılımcıya ihtiyaç duyuldu. Veri toplama aracı olarak Hastane Anksiyete ve Depresyon Ölçeği (HADS), Pittsburgh Uyku Kalitesi İndeksi (PSQI), Uykusuzluk Şiddeti İndeksi (ISI) ve Epworth Uykululuk Ölçeği (ESS) kullanılmıştır. Elde edilen veriler SPSS yazılımı ile analiz edilmiş, gruplar arası karşılaştırmalar için bağımsız örneklem t-testi ve değişkenler arasındaki korelasyon analizi için Pearson testi kullanılmıştır. Uyku kalitesinin öngörücülerini belirlemek için çoklu doğrusal regresyon kullanıldı.

Bulgular: Hemodiyaliz grubunda depresyon ve anksiyete skorları kontrol grubuna göre anlamlı derecede yüksekti (p<0,001). Hemodiyaliz hastalarının %79.2'sinde kötü uyku kalitesi saptandı ve PSQI skorları kontrol grubuna göre anlamlı derecede yüksekti (p<0,001). Çoklu regresyon analizi, anksiyete, depresyon ve medeni durumun PSQI puanlarının anlamlı yordayıcıları olduğunu ve varyansın %56,8'ini açıkladığını gösterdi (R^2 = 0,568, p < 0,001).

Sonuç: Çalışma, hemodiyaliz hastalarında depresyon ve anksiyetenin uyku kalitesini önemli ölçüde olumsuz etkilediğini göstermiştir. Bulgular, bu hasta grubunda psikososyal müdahalelerin önemini vurgulamakta ve sağlık profesyonellerine uyku sorunlarının yönetiminde psikolojik faktörleri dikkate almaları gerektiğini hatırlatmaktadır.

Anahtar Sözcükler: Anksiyete; depresyon; hemodiyaliz; uyku

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INTRODUCTION

End-stage renal disease (ESRD) is a common and growing chronic condition worldwide (1). Treatment options for ESRD include hemodialysis (HD), peritoneal dialysis, and kidney transplantation (2). HD is the most commonly used treatment for patients with ESRD, particularly in cases requiring regular and long-term management. Globally, millions of individuals receive HD, which imposes significant physical, emotional, and psychological burdens on patients (3).

Sleep quality encompasses factors such as sleep efficiency, time to fall asleep, wake time after sleep, and subjective perceptions of sleep. Research consistently reports a high prevalence of poor sleep quality in HD patients, with 40–85% experiencing sleep problems (4, 5). Poor sleep is associated with increased morbidity, mortality, cardiovascular risks, infections, and reduced overall quality of life (6). Furthermore, 50% of HD patients suffer from anxiety, while 44.7% experience depression, both of which are known to impair sleep quality and negatively affect all aspects of life (7). Studies have shown that addressing depression and anxiety can improve sleep quality and overall well-being (8, 9). Although sleep disturbances have been frequently reported in patients undergoing hemodialysis, the specific impact of anxiety and depression on sleep quality has not been adequately explored in the existing literature. Few studies in Turkey have evaluated how depression and anxiety specifically influence sleep among HD patients.

The present study aims to examine the relationship between depression, anxiety, and sleep quality in patients undergoing HD, compared with healthy controls. It is hypothesized that higher levels of depression and anxiety are significantly associated with poorer sleep quality in this population.

METHOD

Study design and sample

This cross-sectional study was conducted in the HD unit of Recep Tayyip Erdoğan University Training and Research Hospital in Turkey in January and December 2022. The sample size was calculated using G*Power (V. 3.1.9.2), with α = 0.05, 95% power, and an effect size of 0.48 (Cohen's d), based on Pawar et al.'s study, determining a minimum sample size of N = 180 (10). The study included 101 HD patients (≥3 months of treatment) and 100 healthy controls matched on age, sex, and marital status.

The inclusion criteria were that the individuals who will participate in the study must be 18 years of age or older, the participants in the HD group must have been receiving regular hemodialysis treatment for at least 3 months, and the individuals in the healthy control group must not have any history of chronic physical or psychiatric diseases. Obtaining written informed consent from all participants before participating in the study was also determined as a basic requirement for participation. The exclusion criteria included individuals with a history of cognitive impairment or neurological disease that could prevent communication, those with acute psychotic disorders or serious psychiatric diagnoses. These criteria were determined in order to keep external variables that could affect sleep quality under control.

Participants completed sociodemographic forms, the Hospital Anxiety and Depression Scale, Pittsburgh Sleep Quality Index, Epworth Sleepiness Scale, and Insomnia Severity Index. Written informed consent was obtained, and inclusion/exclusion criteria were applied.

Ethical approval

Before being allowed to participate in the study, participants were informed about the purpose, meaning, and data security of the study. In addition, participation was voluntary and anonymous. Participants were informed about their rights and responsibilities and were told that they had the right to withdraw from participation at any time. Ethics committee approval for the study was obtained from Recep Tayyip Erdoğan University Non-Interventional Research Ethics Committee (date: 06.01.2022, decision no: 2022/01).

Data collection tools

1. **Sociodemographic Form:** This questionnaire, designed by the researcher, collected data on participants' age, gender, marital status, education level, employment, and dialysis-related details.
2. **Hospital Anxiety and Depression Scale (HADS):** A 14-item self-report scale assessing anxiety

(HADS-A) and depression (HADS-D) symptoms in non-psychiatric patients. Each subscale contains seven items scored on a 4-point Likert scale. Scores are categorized as normal (0–7), mild (8–10), moderate (11–15), and severe (16–21), with scores ≥8 indicating clinically significant anxiety or depression (11). The internal consistency (Cronbach's alpha) was 0.85 for HADS-A and 0.83 for HADS-D. The Turkish validity and reliability study was conducted by Aydemir et al. (12).

3. **Pittsburgh Sleep Quality Index (PSQI):** This tool evaluates sleep quality, duration, and disorders over the past month. It includes 24 items scored across seven components such as sleep efficiency, sleep latency, and daytime dysfunction. Total PSQI scores range from 0–21, with scores ≥6 indicating poor sleep quality (13). Cronbach's alpha was 0.81. Turkish adaptation and validation were performed by Agargün et al. (14).
4. **Epworth Sleepiness Scale (ESS):** This self-report scale assesses daytime sleepiness through eight scenarios. Each item is rated from 0 (no chance of dozing) to 3 (high chance of dozing), with a total score range of 0–24 (15). Cronbach's alpha was 0.86. The Turkish validation was conducted by Boysan et al. (16).
5. **Insomnia Severity Index (ISI):** A seven-item scale examining insomnia symptoms over the past two weeks, including sleep problems, daytime functioning, and distress. Scores range from 0–28, classified as mild (0–7), moderate (8–14), or severe insomnia (15–28) (17). Cronbach's alpha was 0.79. The Turkish version was validated by Ağargün et al. (18).

Statistical analysis

Data were analyzed using the SPSS Statistics for Windows (Statistical Package for the Social Sciences package program version 26.0, IBM Corp., Armonk, N.Y., USA).. Descriptive statistics included frequency, percentage, mean, and standard deviation. Normality was tested with the Kolmogorov-Smirnov test. Group comparisons used chi-square and independent t-tests. Pearson correlation assessed variable relationships, and multiple regression analyzed sleep quality factors. Significance was set at $p < 0.05$.

RESULTS

Demographic and clinical characteristics of participants

The mean age of the total sample was 57.5 ± 16.7 years. The mean age was 58.5 ± 16.1 in the poor sleep quality group and 53.8 ± 19.1 in the normal sleep quality group, with no statistically significant difference between the two groups ($p = 0.258$, Cohen's $d = 0.26$). Of the patients, 46.5% were female, and 53.5% were male. Poor sleep quality was observed in 76.6% of women and 81.5% of men, with no significant gender difference ($p = 0.359$, Cramér's $V = 0.06$). Married individuals constituted 57.4% of the sample, while 42.6% were single. Poor sleep quality was significantly lower among married participants (70.7%) compared to singles (90.7%, $p = 0.012$, Cramér's $V = 0.24$). Smokers (48.5%) had significantly poorer sleep quality compared to non-smokers (63.5%, $p < 0.001$, Cramér's $V = 0.41$). Dialysis frequency also influenced sleep quality; those receiving dialysis three times a week had poorer sleep (83.3%) compared to those undergoing dialysis twice a week (58.8%, $p = 0.031$, Cramér's $V = 0.24$) (Table 1).

Comparison of scale scores between hemodialysis and control groups

Significant differences were observed between hemodialysis (HD) and control groups in psychological and sleep parameters. The HD group had significantly higher HADS total scores (22.79±8.75 vs. 8.67±1.8, $p < 0.001$, Cohen's $d = 2.03$), HADS-A scores (11.17±4.58 vs. 3.9±1.32, $p<0.001$), and HADS-D scores (11.61±4.72 vs. 4.77±1.43, $p<0.001$) than the control group. Sleep quality, assessed by PSQI, was significantly poorer in the HD group (8.83±3.51 vs. 3.56±1.25, $p < 0.001$, Cohen's $d = 2.00$). Similarly, ISI (15.00±3.95 vs. 6.72±2.47, $p < 0.001$, Cohen's $d = 2.18$) and ESS (11.68±3.42 vs. 6.98±2.31, $p < 0.001$, Cohen's $d = 1.49$) scores were higher in the HD group. All PSQI subcomponents, including sleep duration, efficiency, latency, and daytime dysfunction, were worse in the HD group ($p<0.001$) (Table 3).

The effect of anxiety and depression on sleep quality

Patients with poor sleep quality had significantly higher HADS total scores (24.93±7.27) compared to those

Table 1. Comparison of demographic of hemodialysis patients according to sleep quality

Variable		Normal Sleep 21 (20.8) n (%)	Poor Sleep 80 (79.2) n (%)	Total n (%)	Statistics	p value
Age		53.81 (19.07)	58.49 (16.13)	57.5 (16.7)	t=-1.138[a]	p=0.258[a]
Gender	Female	11 (23.4)	36 (76.6)	47 (46.5)	X^2=0.364[b]	p=0.359[b]
	Male	10 (18.5)	44 (81.5)	54 (53.5)		
Marital status	Single	4 (9.3)	39 (90.7)	43 (42.6)	X^2=6.002[b]	p=0.012[b]
	Married	17 (29.3)	41 (70.7)	58 (57.4)		
Education level	Primary education	7 (18.4)	31 (81.6)	38 (37.6)	X^2=1.417[b]	p=0.702[b]
	Secondary Education	10 (26.3)	28 (73.7)	38 (37.6)		
	High school	3 (14.3)	18 (85.7)	21 (20.8)		
	University	1 (25)	3 (75)	4 (4)		
Occupational status	Unemployed	21 (22.1)	74 (77.9)	95 (94.1)	X^2=1.674[b]	p=0.237[b]
	Employed	0 (0)	6 (100)	6 (5.9)		
Etiology of Dialysis	Idiopathic	7 (33.3)	14 (66.7)	21 (20.8)	X^2=3.546[b]	p=0.315[b]
	DM	3 (11.1)	24 (88.9)	27 (26.7)		
	HT	9 (20.9)	34 (79.1)	43 (42.6)		
	Diğer	2 (20)	8 (80)	10 (9.9)		
Dialysis access site	Arteriovenous fistula	12 (18.8)	52 (81.3)	64 (63.4)	X^2=0.442[b]	p=0.337[b]
	Catheter	9 (24.3)	28 (75.7)	37 (36.6)		
Smoking	No	19 (36.5)	33 (63.5)	52 (51.5)	X^2=16.137[b]	p<0.001[b]
	Yes	2 (4.1)	47 (95.9)	49 (48.5)		
HD session frequency	2 sessions per week	7 (41.2)	10 (58.8)	17 (16.8)	X^2=5.157[b]	p=0.031[b]
	3 sessions per week	14 (16.7)	70 (83.3)	84 (83.2)		

DM: Diabetes mellitus HT: Hypertansion HD: Hemodialysis, n: Number, %: Percent, a: Student's t test for the comparison between study groups, b: Chi-square test for the comparison between study groups

Table 2. Psychological and sleep scale comparisons of hemodialysis patients according to sleep quality

Variable	Normal Sleep 21 (20.8) Mean (SD)	Poor Sleep 80 (79.2) Mean (SD)	Total Mean (SD)	Statistics	p value
HADS-Total	14.67 (9.32)	24.93 (7.27)	22.79 (8.75)	t=-5.413	<0.001
HADS-A	6.67 (3.67)	12.36 (4.04)	11.17 (4.58)	t=-5.854	<0.001
HADS-D	8.00 (5.77)	12.56 (3.92)	11.61 (4.72)	t=-4.268	<0.001
ISI	11.3 (2.62)	15.95 (3.69)	15.00 (3.95)	t=-5.329	<0.001
ESS	9.14 (1.46)	12.35 (3.48)	11.68 (3.42)	t=-4.114	<0.001
PSQI-Total	4.33 (0.48)	10.01 (2.96)	8.83 (3.51)	t=-8.725	<0.001
PSQI-SQ	0.71 (0.64)	1.66 (0.76)	1.47 (0.83)	t=-5.228	<0.001
PSQI-SL	0.29 (0.46)	1.27 (0.91)	1.07 (0.93)	t=-4.79	<0.001
PSQI-SD	0.86 (0.36)	1.39 (0.74)	1.28 (0.71)	t=-3.189	<0.01
PSQI-SE	0.48 (0.51)	1.10 (0.79)	0.97 (0.78)	t=-3.431	<0.001
PSQI-SDİ	0.81 (0.81)	1.68 (0.71)	1.50 (0.81)	t=-4.834	<0.001
PSQI-USM	0.71 (1.31)	1.69 (1.50)	1.49 (1.51)	t=-2.716	<0.01
PSQI-DTD	0.48 (0.87)	1.23 (1.02)	1.06 (1.03)	t=-3.082	<0.01

HADS-Total: Hospital Anxiety and Depression Scale HADS-A: Hospital Anxiety and Depression Scale-Anxiety subscale; HADS-D: Hospital Anxiety and Depression Scale Depression subscale ISI: Insomnia Severity Index ESS: Epworth Sleep Scale PSQI: Pittsburgh Sleep Quality Index PSQI-SQ: Sleep quality PSQI-SL: Sleep latency PSQI-SD: Sleep duration PSQI-SE: Sleep efficiency PSQI-SDİ: Sleep disturbance PSQI-USM: Use of sleeping medication PSQI-DTD: Daytime dysfunctiona, Student's t test for the comparison between study groups, n: Number, SD: Standard Deviation

Table 3. Psychological and sleep scale comparisons between HD and control groups

Variables	HD Group Mean (SD)	Control Group Mean (SD)	Statistics	p value
HADS-Total	22.79 (8.75)	8.67 (1.8)	t=-14.122	<0.001
HADS-A	11.17 (4.58)	3.9 (1.32)	t=-7.278	<0.001
HADS-D	11.61 (4.72)	4.77 (1.43)	t=-6.843	<0.001
ISI	15.00 (3.95)	6.72 (2.47)	t=-8.28	<0.001
ESS	11.68 (3.42)	6.98 (2.31)	t=-4.703	<0.001
PSQI-Total	8.83 (3.51)	3.56 (1.25)	t=-5.271	<0.001
PSQI-SQ	1.47 (0.83)	0.69 (0.46)	t=-0.775	<0.001
PSQI-SL	1.07 (0.93)	0.65 (0.48)	t=-0.419	<0.001
PSQI-SD	1.28 (0.71)	0.53 (0.5)	t=-0.747	<0.001
PSQI-SE	0.97 (0.78)	0.47 (0.5)	t=-0.5	<0.001
PSQI-SDİ	1.50 (0.81)	0.61 (0.49)	t=-0.885	<0.001
PSQI-USM	1.49 (1.51)	0.00 (0.00)	t=-1.485	<0.001
PSQI-DTD	1.06 (1.03)	0.61 (0.49)	t=-0.459	<0.001

HADS-Total: Hospital Anxiety and Depression Scale HADS-A: Hospital Anxiety and Depression Scale-Anxiety subscale; HADS-D: Hospital Anxiety and Depression Scale Depression subscale ISI: Insomnia Severity Index ESS: Epworth Sleep Scale PSQI: Pittsburgh Sleep Quality Index PSQI-SQ: Sleep quality PSQI-SL: Sleep latency PSQI-SD: Sleep duration PSQI-SE: Sleep efficiency PSQI-SDİ: Sleep disturbance PSQI-USM: Use of sleeping medication PSQI-DTD: Daytime dysfunctiona, Student's t test for the comparison between study groups, SD: Standard Deviation

Table 4. Multiple regression analysis of PSQI

Variables	b	SE	ß	t	p value	95% CI		Tolerance	VIF
						Lower	Upper		
Constant	1.480	1.183		1.252	0.214	-0.868	3.828		
Age	0.010	0.015	0.047	0.660	0.511	-0.020	0.039	0.860	1.163
Gender	-0.712	0.467	-0.102	-1.525	0.131	-1.640	0.215	0.973	1.028
Marital status	1.542	0.542	0.218	2.845	0.005	0.466	2.618	0.735	1.360
Duration of HD	-0.002	0.004	-0.027	-0.385	0.701	-0.010	0.007	0.910	1.099
HADS-A	0.806	0.086	1.051	9.354	<0.001	0.635	0.977	0.342	2.922
HADS-D	-0.226	0.081	-0.304	-2.803	0.006	-0.386	-0.066	0.368	2.719

HD: Hemodialysis HADS-A: Hospital Anxiety and Depression Scale-Anxiety subscale; HADS-D: Hospital Anxiety and Depression Scale-Depression subscale CI: confidence interval, F(4,195)=22.899 p=0.000; Adj. R^2:0.568; Durbin-Watson=1.994

with normal sleep quality (14.67±9.32, p<0.001, Cohen's d = 1.27). HADS-A (12.36±4.04 vs. 6.67±3.67, p < 0.001, Cohen's d = 1.52) and HADS-D (12.56±3.92, p < 0.001, Cohen's d = 0.91) scores were also higher in the poor sleep quality group. ISI (15.95±3.69) and ESS (12.35±3.48) scores were significantly higher as well (p < 0.001, Cohen's d = 1.45). PSQI scores were higher in the poor sleep quality group (10.01±2.96 vs. 4.33±0.48, p < 0.001, Cohen's d = 2.33). These results highlight the impact of depression and anxiety on sleep quality in hemodialysis patients (Table 2).

Multiple regression analysis on PSQI

Multiple regression analysis revealed that various factors significantly affect sleep quality. The model, including age, gender, marital status, dialysis duration, and HADS-A and HADS-D scores, explained 56.8% of the variance in PSQI scores (Adj. R^2=0.568, p<0.001). HADS-A (b=0.806, ß=1.051, p<0.001) and HADS-D (b=-0.226, ß=-0.304, p=0.006) had significant effects on sleep quality, with higher anxiety and depression levels negatively impacting sleep. Marital status also influenced sleep quality, with married individuals hav-

ing better sleep quality (b=1.542, ß=0.218, p=0.005). Age, gender, and dialysis duration had no significant effect (p>0.05) (Table 4). To identify predictors of sleep quality, a multiple linear regression analysis was conducted with Pittsburgh Sleep Quality Index (PSQI) scores as the dependent variable. Independent variables included age, gender, marital status, duration of dialysis, HADS-Anxiety (HADS-A), and HADS-Depression (HADS-D) scores. The overall model fit was evaluated using the adjusted R^2, F-statistic, and Durbin-Watson test, with the latter assessing autocorrelation of residuals. A Durbin-Watson value close to 2.0 (observed = 1.994) indicated no serious autocorrelation.

An unexpected negative regression coefficient for HADS-D was noted, despite its positive correlation with poor sleep. This counterintuitive finding may be explained by multicollinearity, as anxiety and depression scores were highly correlated. To address this, collinearity diagnostics were conducted, including Variance Inflation Factor (VIF) and tolerance values. VIF values for all predictors were below 3.0 and tolerance values above 0.3, indicating acceptable levels of multicollinearity. Although both HADS-A and HADS-D were significantly correlated with poor sleep in univariate analyses, their shared variance likely influenced the direction and magnitude of regression coefficients in the multivariable model.

DISCUSSION AND CONCLUSION

Chronic diseases often burden individuals with multifaceted symptoms and complications. ESRD exemplifies this, as patients undergoing HD, the most common treatment, experience physiological, psychological, sociological, economic, and sexual challenges. A growing body of evidence indicates that hemodialysis patients are particularly vulnerable to depression, anxiety, and significant disturbances in sleep quality. (19). Our study examined the interaction between psychological symptoms and sleep disturbances in patients undergoing hemodialysis. According to our results, 63.4% of patients met the criteria for anxiety (HADS-A), and 75.2% for depression (HADS-D). These rates are comparable to previous findings in similar populations. For example, Al-Shammari et al. (20) reported anxiety in 50% and depression in 44.7% of ESRD patients in a multicenter study. Similarly, Kose and Mohamed (19) observed comparable rates among Somali HD patients. The slightly higher prevalence observed in our sample may reflect contextual differences such as cultural perceptions of illness, access to psychosocial support, or underlying socioeconomic stressors in the Turkish setting. These findings reinforce the notion that psychological distress is a central feature of the HD experience and highlight the need for routine mental health screening in dialysis units.

One possible explanation is the lower likelihood of men seeking psychosocial support, exacerbating their vulnerability to depression. Anxiety levels, on the other hand, were higher in unmarried patients and those with a greater frequency of HD sessions, a trend supported by Peng et al., who found increased anxiety risk in patients undergoing more than eight dialysis sessions monthly (21).

Our study revealed poor sleep quality in 79.2% of HD patients, a finding consistent with national and international research, reporting rates of 82.5% and 84.8%, respectively (11). The causes of poor sleep quality in this population are multifactorial, encompassing physiological disruptions, such as altered circadian rhythms and hormonal imbalances, as well as psychological stressors like anxiety and depression (22). HD patients often experience reduced nocturnal melatonin and altered cortisol rhythms, contributing to fragmented sleep and excessive daytime sleepiness (23). Older age emerged as a significant factor associated with deteriorated sleep quality, echoing findings that aging increases the risk of serious sleep disorders and daytime sleepiness in HD patients (19).

Our finding that smokers reported significantly poorer sleep quality is consistent with previous research identifying smoking as an independent predictor of sleep disturbances in hemodialysis patients. For instance, Liao et al. and Merlino et al. both reported higher rates of sleep problems among HD patients who smoked, suggesting a potential biological and behavioral link between nicotine use and impaired sleep architecture in this population (24,25).

Our study also identified a significant association between unmarried status and poorer sleep quality, a finding that contrasts with some previous studies re-

porting either no association or better sleep among single individuals (26, 27). This discrepancy may be explained by differences in social support structures, as married individuals in collectivist societies like Turkey may benefit more from emotional and practical support, which in turn buffers psychological distress and improves sleep.

One of the key findings in this study was the strong association between anxiety and poor sleep quality, confirmed through both group comparisons and regression analysis. However, the regression model revealed a counterintuitive negative coefficient for HADS-D, despite its positive correlation with PSQI in bivariate analysis. This result may be attributed to multicollinearity between anxiety and depression scores. As confirmed by our collinearity diagnostics, the high intercorrelation between HADS-A and HADS-D likely caused statistical suppression, where the unique contribution of HADS-D to sleep quality appears negative when HADS-A is controlled in the same model. This highlights the complexity of the interplay between emotional states and sleep in clinical populations.

Regression analysis demonstrated that anxiety (HADS-A), depression (HADS-D), and marital status were significant predictors of sleep quality, explaining 56.8% of the variance in PSQI scores. Anxiety's impact on sleep stems from prolonged sleep onset latency and reduced sleep efficiency due to heightened autonomic nervous system activity (22). Depression exacerbates sleep disturbances, including early morning awakenings and nonrestorative sleep (19). Marital status also influenced sleep, with married individuals showing better quality, likely due to enhanced social support, which reduces psychosocial stress (28). Contrary to some findings, variables like age, gender, and dialysis duration had limited effects on sleep quality (29). This aligns with Xu et al., who reported minimal influence of age on PSQI scores, suggesting psychological and social factors play a more significant role (23). Another noteworthy and novel finding of this study is the independent effect of marital status on sleep quality. After controlling for psychological variables and demographic factors, being married was associated with better sleep. This may be explained by increased social and emotional support in married individuals, which could buffer stress and mitigate the psychological impact of chronic illness. Few previous studies in Turkey have explored this relationship, making this a potentially important contribution to the literature. Additionally, the regression model explained a high proportion of variance in sleep quality (Adjusted $R^2 = 0.568$). This suggests that depression, anxiety, and social factors such as marital status play a substantial role in determining sleep outcomes in HD patients. In clinical terms, this level of explanatory power is notable and indicates the utility of integrating psychosocial assessments into routine nephrology care.

This study has several limitations that should be acknowledged. First, the sample size was relatively small and drawn from a single center, which may limit the generalizability of the findings to broader hemodialysis populations. Larger, multicenter studies are needed to validate and expand upon these results. Second, all measures were based on self-reported questionnaires, which are subject to recall bias and social desirability bias. Objective assessments such as polysomnography or actigraphy could provide more accurate data on sleep patterns. Third, the cross-sectional design of the study precludes any causal inferences. While significant associations were found between psychological symptoms and sleep quality, it is not possible to determine whether depression and anxiety lead to poor sleep, or vice versa. Longitudinal studies are necessary to explore these temporal relationships. Fourth, the study did not collect detailed socioeconomic information, such as income level, housing conditions, or family support, all of which may influence both psychological well-being and sleep. In addition, medication use, including sedatives, antidepressants, or antihypertensives, was not systematically recorded and may have confounded some of the associations observed. Finally, although multicollinearity diagnostics were performed in regression models, the psychological constructs of anxiety and depression remain closely intertwined, which may have influenced the individual weight of these variables in multivariate analysis. Despite these limitations, the study contributes valuable insight into the psychological and sleep-related challenges faced by HD patients and highlights the need for integrated psychosocial assessment in nephrology settings. Integrating psychological assessment and psychosocial support into routine nephrology

care may not only improve sleep quality but also enhance overall treatment adherence and quality of life. Future research should focus on longitudinal designs and include objective sleep measurements and broader biopsychosocial variables to further elucidate these relationships.

Author Contribution: Research design DS, CH; Collection of data SD, AD, DS; Analysis of data AÖ, KS; Literature screening DS, AÖ; Writing and presenting the research DS, CH.

Ethical Declaration: The ethics committee approval of the research was obtained from Recep Tayyip Erdoğan University Non-Interventional Ethics Committee (Ethics Committee Decision Approval Date: 06.01.2022 Decision No: 2022/01). In addition, all practices in the study were conducted in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its subsequent revisions or comparable ethical standards.

Conflict-of-interest and financial disclosure

The authors declare that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study.

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