Journal of Taibah University Medical Sciences (2026) 21(4), 632–638

Taibah University

Journal of Taibah University Medical Sciences

www.sciencedirect.com

Original Article

Comparative analysis of excessive daytime sleepiness and sleep apnea symptoms in renal transplant recipients and a historical dialysis cohort

Turki Alharbi, MS [a], Salman Alahmadi, MS [a], Turki Almejaish, MS [a], Amer Alburodi, MS [a], Mohammed Alsaif, MS [a], Mohammed Albader, MS [a], Abdulrahman Altheaby, MD [a,b,c,e], Ziad AL-Jahdali, MS [f], Rajkumar Rajendram, MD [a,b,d,e] and Hamdan AL-Jahdali, MD [a,b,d,e,*]

[a] *College Of Medicine – King Saud University for Health Sciences, Riyadh, KSA*
[b] *King Abdullah International Medical Research Centre, Riyadh, KSA*
[c] *Organ Transplant Department, Riyadh, KSA*
[d] *Department of Medicine, Sleep Disorders Center, Riyadh, KSA*
[e] *King Abdulaziz Medical City, Ministry of National Guard Health Affairs, Riyadh, KSA*
[f] *College of Medicine - Dar Al Uloom University, Riyadh, KSA*

Received 11 November 2025; revised 19 April 2026; accepted 17 May 2026; Available online 9 June 2026

الملخص

أهداف البحث: اضطرابات النوم شائعة بين مرضى الفشل الكلوي في مراحله النهائية الذين يخضعون لغسيل الكلى. ورغم أن زراعة الكلى قد تُحسّن جودة النوم، إلا أن البيانات المقارنة محدودة. يهدف البحث إلى تقييم مدى انتشار انقطاع النفس الانسدادي النومي والنعاس المفرط أثناء النهار لدى متلقي زراعة الكلى مقارنةً بمرضى غسيل الكلى، والعوامل المرتبطة بهما.

طرق البحث: حللت هذه الدراسة المقطعية بيانات 159 متلقيًا لزراعة الكلى باستخدام مقياس ستوب-بانق، واستبيان برلين، ومقياس إبيوورث للنعاس. وقورنت هذه النتائج بمجموعة تاريخية تضم 227 مريضا يخضعون لغسيل الكلى. واستُخدمت نماذج الانحدار اللوجستي متعدد الحدود، مع ضبط المتغيرات الديموغرافية والسريرية المؤثرة، لاستكشاف الارتباطات.

النتائج: في المجموعة المُجمّعة، أبلغ 27.5% عن النعاس المفرط أثناء النهار (44.1% لدى مرضى غسيل الكلى مقابل 3.8% لدى مرضى زراعة الكلى)، وأبلغ 30.6% عن انقطاع النفس الانسدادي النومي (41.9% لدى مرضى غسيل الكلى مقابل 14.5% لدى مرضى زراعة الكلى). بعد ضبط النتائج وفقا للعمر، والجنس، ومؤشر كتلة الجسم، وحجم الرقبة، والتدخين، وتناول القهوة، والأمراض المصاحبة، ارتبطت زراعة الكلى بشكلٍ ملحوظ بانخفاض احتمالية الإصابة بالنعاس المفرط أثناء النهار (نسبة الأرجحية 0.014)، وانقطاع النفس الانسدادي النومي (نسبة الأرجحية 0.422)، وتزامنهما (نسبة الأرجحية 0.092). لم تتوفر بيانات تخطيط النوم.

الاستنتاجات: يُبلغ مرضى زراعة الكلى عن أعراض أقل للنعاس المفرط أثناء النهار واحتمالية أقل للإصابة بانقطاع النفس الانسدادي النومي مقارنة بمرضى غسيل الكلى، مما يُشير إلى فوائد محتملة لزراعة الكلى تتجاوز تحسين وظائف الكلى.

الكلمات المفتاحية: اضطرابات النوم؛ جودة النوم؛ انقطاع النفس الانسدادي النومي؛ أمراض الكلى المزمنة؛ الفشل الكلوي؛ غسيل الكلى؛ زراعة الكلى

Abstract

Objectives: Sleep disorders are prevalent in end-stage renal failure (ESRF) patients on dialysis. Renal transplantation may enhance the quality of sleep but comparative data are limited. The aim of our study was to assess the prevalence and factors linked to self-reported obstructive sleep apnea (OSA) and excessive daytime sleepiness (EDS) in kidney transplant recipients compared with dialysis patients.

Methods: This cross-sectional study analyzed 159 renal transplant recipients using the STOP-BANG questionnaire, Berlin Questionnaire, and Epworth Sleepiness Scale. These results were compared to those for a historical cohort of 227 dialysis patients. Multinomial logistic regression models adjusted for demographic and clinical confounders were used to explore associations.

* Corresponding address: King Saud University for Health Sciences, Head of Pulmonary Division, Medical Director of Sleep Disorders Centre, King Abdulaziz Medical City, Riyadh, KSA.
E-mail: Jahdalih@gmail.com (H. AL-Jahdali)

Peer review under responsibility of Taibah University.

ELSEVIER Production and hosting by Elsevier

1658-3612 © 2026 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/). https://doi.org/10.1016/j.jtumed.2026.05.005

Results: In the combined cohort, 27.5% reported EDS (44.1% in dialysis vs. 3.8% in transplant patients, $P < 0.001$) and 30.6% reported OSA risk (41.9% in dialysis vs. 14.5% in transplant patients, $P < 0.001$). After adjusting for age, sex, body mass index, neck size, smoking, coffee intake, and comorbidities, renal transplantation was significantly associated with lower adjusted odds of EDS (odds ratio (OR): 0.014), OSA (OR: 0.422), and co-occurrence (OR: 0.092). No polysomnography data were available.

Conclusion: Renal transplant patients reported fewer symptoms of EDS and OSA risk compared with dialysis patients, indicating potential benefits of transplantation beyond renal function.

Keywords: Obstructive Sleep Apnoea (OSA); Excessive Daytime Sleepiness (EDS); Sleep quality Dialysis; Renal transplant; Chronic renal disease

© 2026 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Sleep disorders are prevalent in patients with chronic kidney disease (CKD). Approximately two-thirds of individuals with end-stage renal failure (ESRF) on dialysis experience sleep impairments, where conditions such as insomnia, excessive daytime sleepiness (EDS), and obstructive sleep apnea (OSA) are often diagnosed.[1–6] These conditions are frequently linked to factors like dialysis, metabolic imbalances, uremia, medications, and mood disorders such as anxiety and depression.[1,7] In this population, poor sleep is distressing but also associated with increased morbidity and mortality.[8]

Kidney transplantation restores renal function and improves several physiological stressors that contribute to sleep disturbances.[9–12] Improvements in insomnia and OSA have been reported.[9–12] The estimated prevalence of OSA ranges from 6% to 13% in the general population, whereas it varies between 30% and 80% among patients with ESRF on dialysis.[12,13] Studies have indicated notable decreases in both the prevalence and severity of OSA after transplantation.[12,14] Other studies found that the prevalence of OSA remains considerable in kidney transplant recipients, with rates similar to those found in dialysis patients[15,16] Nevertheless, polysomnography studies reported post-transplant reductions in both severity and prevalence, but OSA persists in ~25–45% of recipients,[10,14,17–20] highlighting the need for ongoing surveillance.

EDS affects 40–68% of patients with ESRF on dialysis and is influenced by factors such as comorbidities, medication, poor sleep hygiene, cardiometabolic derangements, and concomitant sleep disorders.[3,21] Transplantation significantly reduces EDS in some patients, but the prevalence remains clinically significant.[22] Contributing factors include immunosuppressive medications, chronic pain, and psychological stress related to recovery and lifestyle adjustments.[23] Importantly, the sleep quality in transplant recipients does not match the levels reported in the general population.[24]

Polysomnography is the gold standard for diagnosing sleep disorders[12] but its feasibility is limited in large-scale clinical settings. Validated patient-reported outcome measures, including self-reported questionnaires, provide a practical alternative for assessing symptoms such as EDS, estimating the OSA risk, and evaluating the patient burden. These tools are especially valuable in large transplant populations where scalable approaches are essential. The primary aim of this cross-sectional study was to compare the prevalence of self-reported EDS and the OSA risk between kidney transplant recipients and in a historical cohort of dialysis patients. A secondary aim was to identify the association between the self-reported OSA risk and EDS within the transplant population.

Materials and Methods

This observational, cross-sectional survey study was conducted at King Abdulaziz Medical City (KAMC), Riyadh, KSA from May 2024 to October 2024. The study was conducted in adherence to the principles outlined in the Declaration of Helsinki and approval obtained from the Institutional Review Board (IRB) at the King Abdullah International Medical Research Center (KAIMRC) in Riyadh, KSA (IRB/0340/24). In accordance with regulations governing research involving human participants, informed consent before enrollment in the study was provided.

The study enrolled adult renal transplant recipients (aged 18 years or older) who attended routine follow-up at outpatient clinics. We included all renal transplant patients who attended the ambulatory outpatient clinic, unless they chose not to participate. The inclusion and exclusion criteria for dialysis patients were detailed in our previous study.[3] Data were collected in person using validated, structured sleep questionnaires, which were administered by trained personnel to ensure data integrity and address participant queries.

The historical comparison group consisted of 227 patients with ESRF on dialysis, and their data were obtained from a previous study conducted at the same institution.[3] Importantly, both studies employed a similar methodology and identical instruments to assess sleep symptoms, ensuring methodological consistency across cohorts, including factors such as age, sex, comorbidities, and medication usage.

Three validated Arabic-language tools were used to assess sleep symptoms. The Epworth Sleepiness Scale (ESS) was used, where scores greater than 10 are considered to indicate EDS.[25,26]

The STOP-BANG questionnaire is a widely used screening tool for identifying individuals at risk for OSA.[27] The validated Arabic STOP-BANG questionnaire was used to evaluate the risk of OSA based on eight binary (Yes/No) items related to common risk factors, including snoring, daytime tiredness, observed apneas, high blood pressure, body mass index (BMI), age, neck circumference measured at the cricoid cartilage (males: 40 cm; females: 38 cm), and gender. Higher STOP-BANG scores are associated with a greater likelihood of moderate to severe OSA (0–2: low risk of OSA; 3–4: intermediate risk of OSA; 5–8: high risk of OSA).[27,28]

The Berlin Questionnaire (BQ) was developed in 1996, and details of the questionnaire and its validity and accuracy in the Arabic language have been reported

previously.[3,29,30] A high-risk BQ score predicts a respiratory disturbance index (RDI) >5 with moderate sensitivity (86%) and specificity (77%).[29] Three categories are defined in BQ based on the information collected. In Category 1, a positive response is defined as frequent symptoms (>3 times per week) for the questions about snoring and witnessed apneas. In Category 2, a positive response is defined as frequent symptoms for two or more questions about fatigue, sleepiness, and/or drowsy driving. In Category 3, a positive response is defined as a self-report of hypertension and/or a BMI >30 kg/m^2. Based on the data collected, patients were stratified into high-risk for OSA and low-risk for OSA groups according to their responses. Positive scores for at least two of the three categories were scored as high risk for OSA. We screened depression using an Arabic validated self-administered depression questionnaire.[31]

Abbreviations

ESRD: End-stage renal disease; OSA: Obstructive Sleep Apnoea; BQ: Berlin questionnaires; EDS: Excessive Daytime Sleepiness.

Data analysis

Sample size was estimated to detect a 20% absolute difference in sleep disorder prevalence between groups (e.g., 40% in dialysis vs. 20% in transplant), with 80% power and $\alpha = 0.05$, where the requirement was estimated at 194 participants per group. To offset non-response, all eligible patients who attended outpatient clinics during the study period were invited. The final sample comprised 159 transplant recipients and 227 historical dialysis patients, approximating the targeted numbers.

Descriptive statistics were calculated for demographics, comorbidities, and sleep disorder symptoms, and expressed as counts, percentages, means, and standard deviations. The primary outcome was categorized into four mutually exclusive groups: no symptoms (reference category), EDS only, OSA only, and both. Associations between renal status and sleep disorder symptoms were analyzed using multinomial logistic regression adjusted for age, sex, BMI, neck size, smoking, coffee intake, and relevant comorbidities. Results were reported as odds ratios (OR) with corresponding 95% confidence intervals (95% CIs), and statistically significant differences were accepted at $P < 0.05$. We employed the Hosmer–Lemeshow test to assess the goodness of fit for the model. Statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Table 1: Demographic and clinical characteristics of study participants (ESRF on dialysis vs. renal transplant).

		Overall		Group				*P*-value
				Historical dialysis cohort		Renal transplant		
		n	%	n	%	n	%	
	Overall	386	100.0	227	58.8	159	41.2	
Variables								
Female sex	No	237	61.4	122	53.7	115	72.3	<0.001*
	Yes	149	38.6	105	46.3	44	27.7	
DM	No	205	53.1	108	47.6	97	61.0	0.009*
	Yes	181	46.9	119	52.4	62	39.0	
Depression	No	360	93.3	207	91.2	153	96.2	0.052
	Yes	26	6.7	20	8.8	6	3.8	
Smoking	No	293	75.9	162	71.4	131	82.4	0.013*
	Yes	93	24.1	65	28.6	28	17.6	
Coffee intake	No	96	24.9	55	24.2	41	25.8	0.728
	Yes	290	75.1	172	75.8	118	74.2	
EDS	No	280	72.5	127	55.9	153	96.2	<0.001*
	Yes	106	27.5	100	44.1	6	3.8	
OSA	No	268	69.4	132	58.1	136	85.5	<0.001*
	Yes	118	30.6	95	41.9	23	14.5	
Symptom subgroups	None	222	57.5	87	38.3	135	84.9	<0.001*
	EDS only	46	11.9	45	19.8	1	0.6	
	OSA only	58	15.0	40	17.6	18	11.3	
	OSA and EDS	60	15.5	55	24.2	5	3.1	
		Mean	SD	Mean	SD	Mean	SD	
Age (15–90), years		51.0	17.1	55.7	17.2	44.2	14.5	<0.001*
BMI (10.9–81.2), kg/m^2		36.0	12.8	41.3	11.3	28.0	6.3	<0.001*
Neck size (14.5–54), cm		38.6	4.6	38.3	4.5	39.1	4.7	0.070
ESS score (0–24)		7.9	6.1	9.7	6.2	5.2	4.8	<0.001*

Note. This table presents the demographics and clinical characteristics of study participants (N = 386). Abbreviations: BMI = body mass index; DM = diabetes mellitus; EDS = excessive daytime sleepiness; ESRF = end-stage renal failure on dialysis; OSA = obstructive sleep apnea. * Significant *P*-value at alpha = 0.05.

Results

In total, 159 patients with renal transplants participated, as well as 227 dialysis patients from the historical comparator group.[3] As shown in Table 1, renal transplant patients were younger, with a lower BMI, and lower prevalence of diabetes and smoking, and had substantially lower rates of EDS and OSA compared with the historical dialysis cohort. Differences in sleepiness and OSA were probably influenced by the younger age and lower BMI in the transplant group. The combined cohort comprised 386 patients with CKD (mean age 51.0 ± 12.5 years, 61.4% male), and their demographic and clinical characteristics are shown in Table 1. Overall, 27.5% reported EDS and 30.6% exhibited OSA symptoms (Table 1). When grouped into mutually exclusive categories, 11.9% had EDS only, 15.0% had OSA only, and 15.5% had both OSA and EDS.

Table 2: Unadjusted odds ratios (ORs) for sleep disorder symptoms (reference = none) by renal transplant status and demographics.

Variables	Category	EDS only	*P*-value	OSA only	*P*-value	OSA and EDS	*P*-value
		OR (95%CI)		OR (95%CI)		OR (95%CI)	
Group	Dialysis	Ref	<0.0001*	Ref	<0.0001*	Ref	<0.0001*
	Transplant	0.014 (0.002–0.106)		0.29 (0.156–0.538)		0.059 (0.023–0.152)	
Age per 1 year		1.05 (1.027–1.073)	<0.0001*	1.033 (1.014–1.053)	0.0005*	1.053 (1.033–1.074)	<0.0001*
BMI per 1 kg/m^2		1.054 (1.025–1.085)	0.0003*	1.073 (1.046–1.101)	<0.0001*	1.08 (1.053–1.108)	<0.0001*
Neck size, cm		0.991 (0.923–1.064)	0.8020	1.127 (1.053–1.207)	0.0006*	1.088 (1.018–1.163)	0.0124*
Female	No	Ref	0.1914	Ref	0.5117	Ref	0.0025*
	Yes	1.538 (0.806–2.936)		1.222 (0.671–2.226)		2.444 (1.368–4.366)	
DM	No	Ref	0.0774	Ref	0.6776	Ref	<0.0001*
	Yes	1.779 (0.939–3.371)		1.132 (0.631–2.032)		3.487 (1.887–6.443)	
Depression	No	1	0.4749	Ref	0.4737	Ref	0.1270
	Yes	1.531 (0.476–4.927)		0.574 (0.126–2.619)		2.123 (0.807–5.585)	
Smoking	No	Ref	0.6506	Ref	0.4641	Ref	0.9531
	Yes	1.183 (0.571–2.452)		1.277 (0.663–2.46)		1.02 (0.52–2.004)	
Coffee intake	No	Ref	0.7994	Ref	0.2677	Ref	0.0796
	Yes	1.098 (0.534–2.257)		1.485 (0.738–2.99)		1.937 (0.925–4.059)	

Note. This table presents the unadjusted odds ratios (OR) and corresponding 95% confidence intervals (95% CIs) for various self-reported excessive daytime sleepiness (EDS) and obstructive sleep apnea (OSA) risk, stratified by renal transplant status and key demographic characteristics. The ORs were calculated using univariate logistic regression models for each symptom. Demographic variables include age, sex, and body mass index (BMI). Renal transplant status was defined as either "post-transplant" or "dialysis" (reference group). Abbreviations: BMI = body mass index; CI = confidence interval; DM = diabetes mellitus; EDS = excessive daytime sleepiness; OSA = obstructive sleep apnea. * Significant *P*-value at alpha = 0.05.

Table 3: Adjusted odds ratios (aORs) for sleep disorder symptoms (reference = none) by renal transplant status and confounders.

Variables	Category	EDS only	*P*-value	OSA only	*P*-value	OSA and EDS	*P*-value
		aOR (95%CI)		aOR (95%CI)		aOR (95%CI)	
Group	**Dialysis**	Ref	<0.0001*	Ref	0.0380*	Ref	<0.0001*
	Transplant	0.014 (0.002–0.114)		0.422 (0.187–0.953)		0.092 (0.03–0.284)	
Age per 1 year		1.032 (1.008–1.058)	0.0097*	1.03 (1.006–1.053)	0.0125*	1.026 (1.001–1.051)	0.0391*
BMI per 1 kg/m^2		0.97 (0.929–1.012)	0.1582	1.022 (0.996–1.048)	0.1039	1.015 (0.982–1.048)	0.3755
Neck size, cm		1.056 (0.947–1.177)	0.3274	1.143 (1.054–1.24)	0.0012*	1.132 (1.03–1.245)	0.0102*
Female	**No**	Ref	0.8094	Ref	0.1911	Ref	0.0081*
	Yes	1.112 (0.469–2.635)		1.655 (0.778–3.521)		2.909 (1.319–6.415)	
DM	**No**	Ref	0.8403	Ref	0.1445	Ref	0.1581
	Yes	0.92 (0.408–2.073)		0.583 (0.283–1.203)		1.763 (0.802–3.873)	
Depression	**No**	Ref	0.6640	Ref	0.4782	Ref	0.5018
	Yes	1.339 (0.358–5.003)		0.556 (0.109–2.819)		1.494 (0.463–4.819)	
Smoking	**No**	Ref	0.8107	Ref	0.9449	Ref	0.8434
	Yes	0.895 (0.362–2.215)		1.029 (0.46–2.299)		0.914 (0.373–2.238)	
Coffee intake	**No**	Ref	0.9931	Ref	0.2745	Ref	0.0485
	Yes	1.004 (0.441–2.286)		1.523 (0.716–3.237)		2.359 (1.006–5.534)	

Note. This table presents the adjusted odds ratios (aOR) and corresponding 95% confidence intervals (95% CIs) for various self-reported excessive daytime sleepiness (EDS) and obstructive sleep apnea (OSA) risks, stratified by renal transplant status and key demographic characteristics. The ORs were derived from multivariable logistic regression models after adjusting for potential confounding variables. Renal transplant status was categorized as "post-transplant" or "dialysis" (reference group). These adjusted values represent the independent associations between the risks of sleep disorder symptoms after controlling for the influence of the other covariates in the model. Abbreviations: BMI = body mass index; CI = confidence interval; DM = diabetes mellitus; EDS = excessive daytime sleepiness; OSA = obstructive sleep apnea. * Significant *P*-value at alpha = 0.05.

Unadjusted multinomial logistic regression (Table 2) showed that renal transplantation was associated with significantly lower odds of EDS (OR = 0.014; 95% CI: 0.002−0.106), OSA (OR = 0.29; 95% CI: 0.16−0.54), and the co-occurrence of both symptoms (OR = 0.059; 95% CI: 0.023−0.152). Female gender, older age, larger neck circumference, and higher BMI were associated with increased risk of EDS symptoms (Table 2). Patients with diabetes were more likely to report symptoms of both OSA and EDS than patients without diabetes (OR = 3.487; 95% CI: 1.887−6.443).

After adjustment for potential confounders (Table 3), renal transplantation remained significantly associated with reduced odds of EDS (OR = 0.014; 95% CI: 0.002−0.114), OSA (OR = 0.422; 95% CI: 0.187−0.953), and the co-occurrence of both symptoms (OR = 0.092; 95% CI: 0.030−0.284). Female sex, older age, larger neck circumference, and coffee consumption were associated with increased risk of symptoms (Table 3). According to the Hosmer−Lemeshow test, the multinomial model had a good fit with the data ($P = 0.8377$).

Discussion

Our findings based on this single-center, cross-sectional study indicate that renal transplant recipients reported significantly fewer symptoms of sleep disorders (i.e., EDS, OSA risk, or both) compared with a historical cohort of patients on dialysis, even after adjusting for potential confounders (age, sex, BMI, and neck circumference). Validated Arabic-language instruments were used to assess symptoms across both groups, where this consistent methodology reduced the measurement bias. Thus, these data add to the existing literature suggesting that improvements in renal function post-transplantation may mitigate selected factors that contribute to sleep-related breathing disorders and daytime somnolence in patients with CKD.[32−34] The mechanism that underlies this effect may be related to metabolic changes and improvements in the regulation of fluid balance.[10]

EDS affects 40−68% of patients with ESRF on dialysis and is influenced by factors such as comorbidities, medication, poor sleep hygiene, cardiometabolic derangements, and concomitant sleep disorders.[3,21] EDS is one of the main clinical manifestations of OSA and is a treatment target. Approximately 20−50% of patients with OSA report EDS.[35,36] The presence of EDS with OSA indicates symptomatic OSA. In patients with OSA, EDS is associated with a worse quality of life, worse functional status, and more severe driving impairment.[37]

In the present study, we found a significant decrease in symptomatic OSA following renal transplantation, as assessed based on EDS and either the BQ or STOP-BANG questionnaires. However, its occurrence was significantly reduced in post-renal transplant patients.[14] Post-renal transplant EDS has several potential etiologies, including the effects of immunosuppressant medications, obesity, comorbidities, and OSA[14] In the present study, we observed significantly less self-reported EDS (3.8%) in the transplant cohort than the dialysis cohort (44.1%). Improvement in EDS is probably due to decreases in metabolic derangement and sleep disorders, including sleep quality, insomnia, OSA, and RLS[9,12,38,39]

However, some previous studies found no changes in sleep quality after renal transplantation, whereas others observed improvements that did not reach levels comparable to those in the general population[23,24,34,40,41] Indeed, in the present cohort, OSA and EDS symptoms were not eliminated, and their prevalence post-transplant remained clinically significant, as evidenced by the ESS, BQ, and STOP-BANG criteria. Our observations are consistent with other studies that reported persistent OSA symptoms in 25−45% of transplant recipients.[10,14,17−20,24] The improvement in OSA following transplantation is associated with enhancement of metabolic balance, the resolution of metabolic derangements in the form of uremia, acidosis, and hypervolemia, and alleviation of mood disorders such as anxiety and depression.[1,7] However, these improvements can be offset by the weight gain that often occurs after transplantation, which may result in the persistence of OSA in ∼25−45% of recipients.[10,14,17−20] The variable improvement in sleep quality is probably multifactorial, reflecting the tools used for assessing the sleep quality, age, education, marital condition, home environment, employment, and psychosocial issues of transplant recipients.[33,34,42]

Sleep disorders can negatively impact kidney allograft function and recipient outcomes, highlighting the critical importance of systematic screening for sleep disorders and their management to promote the health and longevity of both the graft and the recipient,[43,44] while also improving the quality of life post-transplant. Thus, reducing the EDS and OSA risk post-renal transplant is clinically important. Untreated OSA can cause cardiometabolic complications, and recurrent hypoxia during sleep may compromise graft survival.[17,33,45]

Limitations, strengths, and weaknesses

The present study had several limitations that should be acknowledged. The single-center design limits the generalizability of the findings, and the use of a historical control group introduces the possibility of bias due to variations in clinical practice and unmeasured confounders that may have changed over time. Another limitation is that recruitment was limited to clinic visitors who agreed to participate over a 6-month period. Extending recruitment to one year or longer would probably have increased the sample size and study power. Crucially, the reliance on questionnaire-based screening tools (BQ and STOP-BANG) rather than polysomnography, which is the gold standard for OSA diagnosis, was a major methodological limitation. Questionnaires are practical for large-scale studies, but are less sensitive and specific than objective measures of sleep apnea. Thus, the assessment of OSA risk was presumptive rather than diagnostic. Finally, in the present study, we did not specifically analyze the potential influence of different immunosuppressant regimens on sleep disorders, which could be an important area for future investigation. However, this study also had several strengths. The use of validated Arabic versions of the ESS and the STOP-BANG questionnaire increases the applicability of the findings within the study population. The inclusion of a historical control group of ESRF patients on dialysis provided a valuable comparison to help understand

the symptom burden in a similar patient population. Furthermore, the adjustment for multiple potential confounders in the regression analyses strengthened the confidence in the associations observed between renal transplantation and self-reported sleep disorders.

Conclusion

This single-center, cross-sectional study suggested that renal transplantation was significantly associated with a reduced likelihood of self-reported sleep disorder symptoms and improved sleep quality compared with a historical cohort of dialysis patients. These patient-reported symptomatic improvements highlight the potential benefits of transplantation for addressing sleep health in patients with chronic renal failure and improving their quality of life. Our results are relevant to screening-based identification of sleep disorders, rather than a formal clinical diagnosis. However, definitive conclusions regarding the prevalence of sleep disorders and direct causation require prospective longitudinal studies utilizing polysomnography as the diagnostic gold standard. The present study provides a strong foundation for future research, emphasizing the need for comprehensive sleep assessment in this vulnerable population.

Conflict of interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical approval

The study was conducted in adherence to the principles outlined in the Declaration of Helsinki and approval obtained from the IRB at the KAIMRC in Riyadh, Saudia Arabia (IRB/0340/24). Following regulations governing research involving human subjects, all participants provided informed consent before their enrollment in the study.

Authors contributions

HJ, T Alharbi, RR, and A Altheaby participated in the study concepts, design of the study, development of the questionnaire, and data acquisition and entry. T Almejaish, SA, RR, A Alburodi, M Alsaif and M Albader contributed to acquiring data analysis and statistical analysis of the data, participated in the intellectual content, reviewed and summarized the published literature and clinical studies, and participated in outlining the resulting themes and manuscript preparation, editing, and review. Corresponding author HJ takes responsibility for the integrity of the work as a whole. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript. All authors reviewed and approved the manuscript.

Acknowledgment

We would like to acknowledge the contributions of Anwar E. Ahmed, Department of Preventive Medicine and Biostatistics, Uniformed Services University of Health Sciences, Bethesda, MD, USA, who provided valuable assistance with the analysis and statistical evaluation of our data. His expertise greatly enhanced the quality of our research. We would like to acknowledge the support and fund received from King Abdullah International Medical research center (KAIMRC).

References

1. Lyons OD. Sleep disorders in chronic kidney disease. **Nat Rev Nephrol 2024**; 20(10): 690–700.
2. Zhang F, Huang X, Wang H, Bai Y, Huang L, Li Y, et al. Prevalence of obstructive sleep apnea in whole spectrum chronic kidney disease patients: a systematic review and meta-analysis. **Sleep Med 2024**; 119: 526–534.
3. Al-Jahdali H. Prevalence of sleep apnea and excessive day time sleepiness in patients with end-stage renal disease on dialysis. **Saudi J Kidney Dis Transpl 2012**; 23(2): 251–261.
4. Al-Jahdali HH, Al-Qadhi WA, Khogeer HA, Al-Hejaili FF, Al-Ghamdi SM, Al Sayyari AA. Restless legs syndrome in patients on dialysis. **Saudi J Kidney Dis Transpl 2009**; 20(3): 378–385.
5. Al-Jahdali HH, Khogeer HA, Al-Qadhi WA, Baharoon S, Tamim H, Al-Hejaili FF, et al. Insomnia in chronic renal patients on dialysis in Saudi Arabia. **J Circadian Rhythms 2010**; 8: 7.
6. Hanly P. Sleep apnea and daytime sleepiness in end-stage renal disease. **Semin Dial 2004**; 17(2): 109–114.
7. Tan LH, Chen PS, Chiang HY, King E, Yeh HC, Hsiao YL, et al. Insomnia and poor sleep in CKD: a systematic review and meta-analysis. **Kidney Med 2022**; 4(5):100458.
8. Koh JH, Lim CYJ, Yam KJM, Yeo BSY, Ng ACW, Loh SRH, et al. Bidirectional association of sleep disorders with chronic kidney disease: a systematic review and meta-analysis. **Clin Kidney J 2024**; 17(11): sfae279.
9. Molnar MZ, Novak M, Mucsi I. Sleep disorders and quality of life in renal transplant recipients. **Int Urol Nephrol 2009**; 41(2): 373–382.
10. Forni Ogna V, Ogna A, Haba-Rubio J, Nowak G, Venetz JP, Golshayan D, et al. Impact of kidney transplantation on sleep apnea severity: a prospective polysomnographic study. **Am J Transplant 2020**; 20(6): 1659–1667.
11. Hasanzamani B, Pourranjbar E, Rezaei Ardani A. Comparing sleep quality in patients before and after kidney transplantation. **Iran J Kidney Dis 2020**; 14(2): 139–144.
12. Mahajan S, Gupta K, Sinha S, Malhotra A, Mahajan S. Effect of kidney transplantation on sleep-disordered breathing in patients with end stage renal disease: a polysomnographic study. **Sleep Med 2018**; 45: 140–145.
13. Parker KP. Sleep disturbances in dialysis patients. **Sleep Med Rev 2003**; 7(2): 131–143.
14. Kanbay M, Ureche C, Copur S, Covic AM, Tanriover C, Esen BH, et al. Kidney transplantation: a possible solution to obstructive sleep apnea in patients with end-stage kidney disease. **Sleep Breath 2023**; 27(5): 1667–1675.
15. Fornadi K, Ronai KZ, Turanyi CZ, Malavade TS, Shapiro CM, Novak M, et al. Sleep apnea is not associated with worse outcomes in kidney transplant recipients. **Sci Rep 2014**; 4(1): 6987.

16. Rodrigues CJ, Marson O, Togeiro SM, Tufik S, Ribeiro AB, Tavares A. Sleep-disordered breathing changes after kidney transplantation: a polysomnographic study. **Nephrol Dial Transplant 2010**; 25(6): 2011–2015.
17. Szentkiralyi A, Czira ME, Molnar MZ, Kovesdy CP, Remport A, Szeifert L, et al. High risk of obstructive sleep apnea is a risk factor of death censored graft loss in kidney transplant recipients: an observational cohort study. **Sleep Med 2011**; 12(3): 267–273.
18. Tandukar S, Hou S, Yabes J, Ran X, Fletcher M, Strollo P, et al. Does kidney transplantation affect sleep and fatigue in patients with kidney disease? **Transplant Direct 2019**; 5(6):e461.
19. Beecroft JM, Zaltzman J, Prasad R, Meliton G, Hanly PJ. Impact of kidney transplantation on sleep apnoea in patients with end-stage renal disease. **Nephrol Dial Transplant 2007**; 22(10): 3028–3033.
20. Molnar MZ, Mucsi I, Novak M, Szabo Z, Freire AX, Huch KM, et al. Association of incident obstructive sleep apnoea with outcomes in a large cohort of US veterans. **Thorax 2015**; 70(9): 888–895.
21. Davydov GG, Nashat H, Ghali S, Afifi S, Suryadevara V, Habab Y, et al. Common sleep disorders in patients with chronic kidney disease: a systematic review on what they are and how we should treat them. **Cureus 2023**; 15(8):e44009.
22. Hoteit M, Al-Masry A, Elbejjani M, Aoun M, Abu-Dargham R, Medawar W, et al. Sleepiness and health-related quality of life among kidney transplant recipients in a low-middle income country: a cross-sectional study. **Transpl Int 2023**; 36:11547.
23. Silva DS, Andrade Edos S, Elias RM, David-Neto E, Nahas WC, Castro MC, et al. The perception of sleep quality in kidney transplant patients during the first year of transplantation. **Clinics (Sao Paulo) 2012**; 67(12): 1365–1371.
24. Xie J, Wang L, Tang X, Yi Y, Ding S, Yan J, et al. Sleep quality and related psychosocial variables among renal transplant patients. **Transplant Proc 2018**; 50(10): 3426–3433.
25. Ahmed AE, Fatani A, Al-Harbi A, Al-Shimemeri A, Ali YZ, Baharoon S, et al. Validation of the Arabic version of the Epworth sleepiness scale. **J Epidemiol Glob Health 2014**; 4(4): 297–302.
26. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. **Sleep 1991**; 14(6): 540–545.
27. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. **Anesthesiology 2008**; 108(5): 812–821.
28. BaHammam AS, Al-Aqeel AM, Alhedyani AA, Al-Obaid GI, Al-Owais MM, Olaish AH. The validity and reliability of an Arabic version of the STOP-bang questionnaire for identifying obstructive sleep apnea. **Open Respir Med J 2015**; 9: 22–29.
29. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin questionnaire to identify patients at risk for the sleep apnea syndrome. **Ann Intern Med 1999**; 131(7): 485–491.
30. Saleh AB, Ahmad MA, Awadalla NJ. Development of Arabic version of Berlin questionnaire to identify obstructive sleep apnea at risk patients. **Ann Thorac Med 2011**; 6(4): 212–216.
31. Kirkby R, Al Saif A, el-din Mohamed G. Validation of an Arabic translation of the Zung Self-Rating Depression scale. **Ann Saudi Med 2005**; 25(3): 205–208.
32. Burkhalter H, Denhaerynck K, Huynh-Do U, Binet I, Hadaya K, De Geest S. Change of sleep quality from pre- to 3 years post-solid organ transplantation: the Swiss transplant cohort study. **PLoS One 2017**; 12(10):e0185036.
33. Eryilmaz MM, Ozdemir C, Yurtman F, Cilli A, Karaman T. Quality of sleep and quality of life in renal transplantation patients. **Transplant Proc 2005**; 37(5): 2072–2076.
34. Kovacs AZ, Molnar MZ, Szeifert L, Ambrus C, Molnar-Varga M, Szentkiralyi A, et al. Sleep disorders, depressive symptoms and health-related quality of life–a cross-sectional comparison between kidney transplant recipients and waitlisted patients on maintenance dialysis. **Nephrol Dial Transplant 2011**; 26(3): 1058–1065.
35. Ulander M, Hedner J, Stillberg G, Sunnergren O, Grote L. Correlates of excessive daytime sleepiness in obstructive sleep apnea: results from the nationwide SESAR cohort including 34,684 patients. **J Sleep Res 2022**; 31(6):e13690.
36. Léger D, Stepnowsky C. The economic and societal burden of excessive daytime sleepiness in patients with obstructive sleep apnea. **Sleep Med Rev 2020**; 51:101275.
37. Tang Y, Li D, Yang M, Liu X, Mao Z, Zhang W, et al. Prevalence of excessive daytime sleepiness (EDS) and its association with quality of life in patients with obstructive sleep apnea (OSA): data from a sleep-center in Shenzhen, a single-center cross-sectional study. **J Thorac Dis 2024**; 16(12): 8216–8229.
38. Liaveri PG, Dikeos D, Ilias I, Lygkoni EP, Boletis IN, Skalioti C, et al. Quality of sleep in renal transplant recipients and patients on hemodialysis. **J Psychosom Res 2017**; 93: 96–101.
39. Vendeville N, Mucsi I, Molnar MZ. Sleep-related disorders in patients with CKD and kidney transplant recipients. **Clin J Am Soc Nephrol 2025**; 20(10): 1446–1460.
40. Cordoza M, Koons B, Perlis ML, Anderson BJ, Diamond JM, Riegel B. Self-reported poor quality of sleep in solid organ transplant: a systematic review. **Transplant Rev (Orlando) 2021**; 35(4):100650.
41. Liu HX, Lin J, Lin XH, Wallace L, Teng S, Zhang SP, et al. Quality of sleep and health-related quality of life in renal transplant recipients. **Int J Clin Exp Med 2015**; 8(9): 16191–16198.
42. Neipp M, Karavul B, Jackobs S, Meyer zu Vilsendorf A, Richter N, Becker T, et al. Quality of life in adult transplant recipients more than 15 years after kidney transplantation. **Transplantation 2006**; 81(12): 1640–1644.
43. Parajuli S, Tiwari R, Clark DF, Mandelbrot DA, Djamali A, Casey K. Sleep disorders: serious threats among kidney transplant recipients. **Transplant Rev (Orlando) 2019**; 33(1): 9–16.
44. Ekici M, Aksoy N. Sleep disorders in kidney transplant recipients. **Exp Clin Transplant 2024**; 22(Suppl 1): 192–194.
45. Kuznetsova A, Meyers KE, Dhanantwari P, Laney N, Frank R, Sethna CB. Sleep-related breathing disorders and cardiometabolic risk factors in pediatric kidney transplant recipients. **Pediatr Transplant 2022**; 26(8): e14355.

How to cite this article: Alharbi T, Alahmadi S, Almejaish T, Alburodi A, Alsaif M, Albader M, Altheaby A, AL-Jahdali Z, Rajendram R, AL-Jahdali H. Comparative analysis of excessive daytime sleepiness and sleep apnea symptoms in renal transplant recipients and a historical dialysis cohort. J Taibah Univ Med Sc 2026;21(4):632–638.