Dovepress

ORIGINAL RESEARCH

Subjective Assessment of Sleep Quality and Excessive Daytime Sleepiness in Conventional Hemodialysis Population: A Single-Center Experience

Shanmuganathan Velu, Arul Rajagopalan, Jegan Arunachalam, Arun Prasath, Rakesh Durai

Department of Nephrology, Madurai Medical College, Madurai, Tamil Nadu, India

Correspondence: Jegan Arunachalam, Department of Nephrology, Madurai medical college, Madurai, Tamil Nadu, India, Tel +91 9994373260, Email jeganmddm@gmail.com

Introduction: Sleep disturbances are common in patients with end-stage kidney disease on hemodialysis (hemodialysis population: HDP). Higher rates of primary sleep disorders, demographic characteristics, metabolic abnormalities, and the efficacy of treatment place HDP at higher risk. The pattern observed is delayed onset of sleep, frequent awakening episodes, insomnia, sleep apnoea, excessive daytime sleepiness, restless leg syndrome, abnormal limb movements, pain in limbs, confusion, and nightmares. Two commonly used subjective assessment scores are the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality and the Epworth Sleepiness Scale (ESS) to assess excessive daytime sleepiness.

Objective: Subjective assessment of sleep using PSQI and ESS scores in HDP and correlation with clinical and demographic characteristics.

Patients and Methods: A cross-sectional descriptive study of 148 patients with ESKD undergoing in-center hemodialysis. From June 2021 to October 2021 in Madurai medical college, Madurai, India. Subjective assessment with PSQI and ESS scores was done to identify sleep quality and daytime sleepiness, respectively.

Results: The median PSQI score was 6 (IQ:4–10), and as much as 68.24% scored >5 on the PSQI (poor sleepers). The median ESS score of the study participants was 4 (Iq range 3–7), and 19.59% had a total ESS score of more than 10 (excessive daytime sleepiness). The mean age of the participants was 44±14.5. Age more than 60, lower body mass index, unemployment, higher dialysis vintage of more than 2 years, lower hemoglobin, high calcium-phosphorus product are statistically significant for both PSQI and ESS scores.

Conclusion: The prevalence of poor sleep quality and excessive daytime sleepiness is high in HDP. Subjective assessment scores (PSQI and ESS) on the bedside are valuable tools in identifying sleep quality and EDS where objective assessment methods are not feasible and will help in the short time identification and management of sleep disturbances.

Keywords: sleep quality, excessive daytime sleepiness, PSQI, ESS, hemodialysis population, poor sleepers

Plain Language Summary

Sleep disturbances are common in patients with end-stage kidney disease on conventional hemodialysis. In various studies, the prevalence of poor sleep quality is around 20% to 80%. Therefore, identification and management of sleep disturbances will be helpful to improve the mental and physical well-being of these individuals. However, objective testing like actigraphy, polysomnography, and multiple sleep latency testing is time and resource-consuming. Hence, subjective assessment scores are commonly used, Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality and the Epworth Sleepiness Scale (ESS) to assess excessive daytime sleepiness. We had done a cross-sectional descriptive study of 148 HDP from June 2021 to October 2021 in our center. We had done a Subjective assessment with PSQI and ESS scores to identify sleep quality and daytime sleepiness, respectively, as a short time assessment method and correlated with clinical, demographic characteristics influencing sleep. We found a median PSQI score of 6; as much as 68.24% of the study population scored ≥5 on the PSQI (poor sleepers). The median ESS score of the study participants was 4, and 19.59% had a total ESS score of more than 10 (excessive daytime sleepiness). On statistical analysis, we found that age over 60, lower body mass index, low socioeconomic status, higher dialysis vintage, lower hemoglobin, high calcium-phosphorus product are significantly associated with poor sleep quality (PSQI ≥5) and

103

excessive daytime sleepiness (ESS >10). In addition, we found a statistically significant negative correlation of hemoglobin and a positive correlation between Self-reported sleep symptoms with PSQI and ESS scores.

Introduction

Sleep disturbances are common in patients with end-stage kidney disease on hemodialysis (hemodialysis population: HDP). Approximately 40% to 80% of the HDP have sleep disorders, much higher than the general population.[1–3] A large multicentre study, which included 1643 patients on either hemodialysis or peritoneal dialysis from 335 centers, reported that 50% had trouble falling asleep,59% woke during the night, and 49% woke early morning.[4] The factors such as the higher rate of primary sleep disorders, demographic characteristics, metabolic abnormalities, and the efficacy of treatment place patients at higher risk for sleep disturbances in HDP.[4,5] The pattern of sleep disorders observed in HDP is delayed onset of sleep, frequent awakening episodes, insomnia, sleep apnoea, excessive daytime sleepiness (EDS), restless leg syndrome (RLS), abnormal limb movements, pain in limbs, confusion, and nightmares.[4,6–8] The high prevalence of sleep disorders, poor sleep quality, and sleep apnoea significantly impact the quality of life2, mental well-being of the patients,[2] immune response,[4] and cardiovascular events.[9] Poor sleep quality and EDS lead to poor work performance and unemployment in HDP. The prevalence of insomnia among HDP ranges from 19% to 71%.[4,10,11] Causes of insomnia include central sleep apnoea, obstructive sleep apnoea,[10] periodic limb movement (PLM), restless leg syndrome (RLS),[11] metabolic factors like uremia, anemia, hypercalcemia, pruritus, anxiety, and depression.[8] Some studies have suggested that the time of the dialysis shift alters the severity of insomnia such that insomnia is worse among patients dialyzed in the morning[3,] whereas some studies had shown no impact.[12]

Excessive daytime sleepiness (EDS) is the third most reported sleep disease in patients with ESKD next to insomnia and day and night reversal of sleep.[13,14] EDS is one of the critical factors affecting the health and economy of HDP. Subjective standardized assessments using questionnaires have demonstrated a prevalence of daytime sleepiness in 52–67% of patients with ESKD.[15] EDS is associated with sleep apnoea, but it could also result from insomnia, restless leg syndrome, and medical problems. One explanation for the EDS in ESKD is the notion of day/night sleep reversal, which has more often been cited as a cardinal feature of uremia.[6,8] However, even in those patients who received adequate hemodialysis, sleep disturbance and EDS are found to be a higher degree when compared to the normal population.[15] Next, circadian rhythm disorders due to the disturbed diurnal rhythm of melatonin are reported in patients with ESKD, which results in delayed sleep phase syndrome and daytime sleepiness.[16] Elevated orexin levels, which promote wakefulness and systemic inflammation, may also contribute to poor sleep quality and EDS. Multiple hypotheses have been proposed for daytime sleepiness, including (1) subclinical uremic encephalopathy,[17] (2) abnormal metabolism and retention of melatonin,[18] 3) tyrosine deficiency leading to diminished neurotransmitters associated with arousal,[19] (4) alteration in body temperature rhythm resulting in a perturbation of the sleep-wakefulness cycle,[20] (5) the effects of dialysate temperature on sleep[21] (6) release of sleep-inducing inflammatory cytokines during dialysis,[22] and (7) co-existent sleep apnea syndrome (SAS).[5]

The factors which affect sleep quality and circadian rhythm in HDP are older age,[1–3] female sex, higher body mass index, anemia, low serum albumin, elevated serum phosphorus, elevated PTH, high calcium-phosphorus product, and malnutrition.[23] In addition, the factors related to renal replacement therapy are dialysis adequacy, dialysis shift, longer dialysis vintage, dialysis efficacy, mode of dialysis, and various middle molecule accumulation in chronic hemodialysis.[5,23] However, studies are controversial for the factors mentioned earlier except for dialysis adequacy.[5] Moreover, even in patients who were adequately dialyzed, sleep quality is poor when compared to the normal population;[15] Factors like gender, anemia, low albumin, dialysis shift, dialysis vintage, and comorbid conditions are still an area to be explored for causation of poor sleep quality and alteration of the circadian rhythm.

Objective and subjective measures are available to assess sleep quality and related sleep disturbances. The objective measures of sleep are home-based actigraphy which is very good in measuring rest and activity cycle. However, false positives are relatively high with sensitivity in detecting sleep periods: 0.965 and difficulties in detecting wake periods with specificity: 0.32923.[24] Next is in-lab Polysomnography (PSG), which is significantly costlier, time and human resources consuming than the in-home PSG, which is cheaper and more convenient. However, in-home-PSG is usually limited to diagnosing OSAS without comorbid conditions since it measures only heart rate, blood oxygen level, airflow, and breathing

patterns—not actual sleep time as in-lab study and the possibility of an accidental displacement of the sensor during sleep. Furthermore, the multiple sleep latency test (MSLT) also needs time and expert hands. The general subjective assessment of sleep quality can be obtained using the Pittsburgh Sleep Quality Index (PSQI) or the Patient-Reported Outcomes Measurement Information System (PROMIS). Finally, the Epworth Sleepiness Scale (ESS) and the Functional Outcomes of Sleep Questionnaire (FOSQ) are used to assess daytime sleepiness and functional impairments.[28] PSQI and ESS are commonly used among these four objective and four subjective assessment scores because of their easy availability, bedside testing, good reliability, and user-friendly nature, particularly where resources are limited.

Our study focused on evaluating the prevalence of sleep disturbances, sleep quality, and excessive daytime sleepiness in our hemodialysis population after adequate dialysis (as per KDIGO guidelines) using simplified subjective assessment scores (PSQI and ESS). The study also focused on the statistical significance of subjective scores in predicting sleep disturbances and their validity. These scores can be used in situations where the cumbersome objective testing methods are not feasible. Furthermore, to focus on the relationship of sleep quality and excessive daytime sleepiness with clinical, demographic, nutritional, and dialysis-related characteristics in our dialysis population.

Materials and Methods

Study Design
Cross-sectional descriptive study of 148 patients with ESKD undergoing in-center hemodialysis.

Study Population
We recruited the subjects from intermittent maintenance hemodialysis unit Madurai medical college, Madurai, India, from June 2021 to October 2021.

Objectives
Subjective assessment of sleep using PSQI and ESS scores in hemodialysis population (HDP) and correlation with clinical and demographic characteristics.

Sampling Procedure and Sample Size
The sample size required was determined by two methods: (1) using Epi info 7 software using our total hemodialysis population of 178, with a 50% expected response, a 5% error margin, and a 95% confidence interval. The calculated minimum number of participants needed for our study was 118. (2) With a previous pilot study done by samara et al, the median PSQI was taken to calculate the minimum sample size. With median PSQI 8(6–12), the standard deviation is calculated by range divided by 4 (ie, 1.5). The margin of error is fixed at 5% and 25% non-response rate, and then the minimum needed sample was found to be 64 by this method. However, we selected a larger sample of 148 to ensure more representativeness to the data. In addition, we used a convenience sample of HDP.

Inclusion and Exclusion Criteria
We included male and female patients with end-stage kidney disease over 18 years of age who were undergoing intermittent weekly thrice hemodialysis of four hours with weekly KT/V >1.2 for four consecutive weeks. Patients underwent hemodialysis for four hours three times a week in three shifts (7 am – 11 am, 12 noon – 4 pm, and 5 pm – 9 pm). All participants were subjected to ENT examination to rule out possible anatomical obstructive causes of sleep apnoea. All participants were counseled well about the interview and study. We evaluated all participants to have a sufficient cognitive level for understanding the procedures and agreed to participate by signing the informed consent.

We excluded those who were not adequately dialyzed (Weekly KT/V <1.2), those undergoing treatment for sleep apnoea, those who already diagnosed as obstructive sleep apnoea syndrome, those who had poor cardiac function (h/o paroxysmal nocturnal dyspnoea or EF <45), active psychiatric disease, active alcohol, and drug abuse or who refused to participate.

Study Methodology

The data for age, sex, marital status, residency, occupation, level of education, monthly income, BMI, smoking, and alcoholic habits were collected. In addition, the participants' clinical status, hemodialysis parameters like dialysis vintage, shift, duration, and biochemical parameters like hemoglobin urea, serum creatinine, electrolytes, and calcium-phosphorus product were measured. Then, all participants were taken for a questionnaire involving PSQI and ESS scales to assess the quality of sleep and daytime sleepiness, respectively ([Supplementary Materials](#)). The PSQI test is used to assess sleep quality by exploring seven areas: the subjective quality of sleep, sleep latency, duration, habitual efficiency, sleep disturbances, the use of sleep medication, and daytime dysfunction. The first question is an open-ended type, and there are four questions in this manner. The next type can be answered on a 0 to 3 scale, the frequency of troubled sleeping in the past week, answering with 0 indicates having no trouble; with 1, having trouble once weekly; with 2, having trouble twice weekly; and with 3 having trouble three times weekly. The tested subject is considered poor sleep quality when their total score is five or higher. ESS is used to assess daytime sleepiness by asking how likely it is for a person to doze off in various given situations (Johns 1991). Scale can be answered from 0 to 3 to indicate "not at all likely" to 'highly likely to doze. The subject's score is considered normal when the total sum is 0–10.

Human Participants Protection

The study does not involve any human or animal experiments, and no new therapeutic interventions were done. The study was a cross-sectional survey, and the methodology was approved by the Institutional ethical committee of Madurai medical college, Madurai, India. All participants had given informed written consent for participation in the study. This study was conducted in accordance with the Declaration of Helsinki.

Statistical Methods

The study results were shown as absolute numbers, percentage, or mean and standard deviation as appropriate. The normality of the distribution of variables was assessed by Kolmogorov–Smirnov's Z-value test before the analysis method was determined. For analyzing the data, we used the Statistical Package for the Social Sciences (SPSS), Version 21. The categorical variables were presented as frequency, and both the percentages and continuous variables were shown either as means and standard deviations or as median and inter-quartile {q1-q3} ranges. The Nonparametric Mann–Whitney test was used to compare two independent variables, and Kruskal–the Wallis test was used to compare multi-category variables (more than two independent variables), where appropriate. For continuous variables, an independent *t*-test and fisher extract test were performed. The Pearson Spearman correlations formula was used for correlation analysis for parametric continuous variables (biochemical parameters). Whereas contingency testing was used for nominal variables (self-reported sleep symptoms). Psychometric validity of both PSQI and ESS scales was tested with Cronbach's alpha and item correlation in our data.

Results

Subjective Assessment Scores

We initially assessed one hundred seventy-six (176) patients for eligibility and 148 patients included in the study. The Median PSQI score was 6 with an interquartile range of 4–10, and as much as 68.24% of participants scored five or more (≥5) points on the PSQI score (termed as poor sleepers). [Table 1](#) shows detailed scoring percentages of all seven compartments of PSQI. The median ESS score of our study participants was 4 with interquartile range 2–7, and 19.59% had more than 10 (>10) on ESS scoring (termed as excessive daytime sleepiness). The Cronbach's alpha based on standardized items for the PSQI questionnaire and ESS questionnaire in our study population was 0.951 and 0.912, respectively, reflecting the internal consistency and reliability of the scores in the study. The PSQI score and ESS score show a significant positive relationship with each other (Spearman rho correlation 0.689.)

Table 1 Components and Scoring in PSQI Scale*

Parameter*	Score*	Percentage
Subjective sleep quality	Very good	18.9
	Fairly good	46.6
	Fairly bad	25.0
	Very bad	9.5
Sleep latency	≤15 minutes	12.8
	16–30 minutes	53.4
	31–60 minutes	24.3
	>60 minutes	9.5
Sleep duration	>7 hours	18.9
	6–7 hours	50.0
	5–6 hours	20.9
	<5 hours	10.1
Habitual sleep efficacy	>85%	19.6
	75–84%	46.6
	65–74%	23.6
	<65%	10.1
Sleep disturbances	Not during past one month	30.4
	Less than once a week	48.0
	Once or twice a week	8.8
	Three or more a week	12.8
Sleep medications	Not during past one month	62.8
	Less than once a week	27
	Once or twice a week	5.4
	Three or more a week	4.7
Daytime dysfunction	Never	41.9
	Once or twice	33.8
	Once or twice each week	6.8
	Three or more each week	17.6

Notes: *PSQI scale items reproduced from: Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res.* 1989;28(2):193-213. doi:10.1016/0165-1781(89)90047-4.[35] Copyright © University of Pittsburgh 1989; Published by Elsevier Ltd. All rights reserved.

Self-Reported Sleep Symptoms

Of the symptoms reported, insomnia and sleep apnoea episodes are 19.5% and 18.2%, respectively. Rest being Snoring in 15.5%, EDS in 12.8%, pain in limbs 9.5%, RLS in 6.7% confusion with a nightmare in 6.0%, and all self-reported sleep disturbance were statistically correlated with poor sleeper quality and EDS (Table 2). All self-reported symptoms had a strong correlation with PSQI and ESS scores.

Table 2 Self-Reported Pattern of Sleep Disturbance

Type of Sleep Disturbance	Prevalence in Study Population (%)	PSQI score		ESS Score	
		Correlation Coefficient	p-value	Correlation Coefficient	p-value
Insomnia	19.5	0.580	0.000	0.562	0.000
Sleep Apnoea	18.2	0.489	0.001	0.414	0.006
Restless Leg Syndrome	6.7	0.533	0.000	0.481	0.000
Excessive Daytime Sleepiness	12.8	0.514	0.000	0.387	0.025
Snoring	15.5	0.558	0.000	0.566	0.000
Pain In Limbs	9.5	0.653	0.000	0.564	0.000
Confusion With Nightmare	6.0	0.558	0.000	0.558	0.000

Demographic and Clinical Parameters

The mean age of the participants was 44±14.5. Males were 68.2%, and 17.6% of the participants were more than 60 years old. Age more than 60 was statistically significant in both poor sleepers and EDS. In the study, the low, average, and high body mass index was around 8.1%, 57.4%, and 34.5%, respectively. The lower BMI group was significantly associated with poor sleeper quality and EDS when compared to the higher BMI. Low, middle, and higher socioeconomic status was around 14.9%, 69.5%, 15.6%, respectively, and the low socioeconomic group was significantly associated with poor sleep quality and EDS. Other demographic characters are given in Table 3 and are not statistically associated with either poor sleep quality or EDS. Comorbid conditions diabetes mellitus, hypertension, CAD were found in 48.6%, 49.3%,

Table 3 Demographic, Clinical and Dialysis Parameters

Variable	Category	Percentage	PSQI Median {Q1-Q3}	P-value	ESS Median {Q1-Q3]	P-value
Age	Less than 60	82.4	6 (4–9)	0.012	3 (2–5)	0.05
	More than 60	17.6	7 (5–18)		4 (2–14)	
Sex	Male	68.2	6 (4–10)	0.582	4 (2–7)	0.365
	Female	31.8	6 (4–11)		3 (1–7)	
BMI	< 18.5	8.1	9 (5–17)	0.001	4 (3–14)	0.001
	18.5–24.9	57.4	6 (4–7)		3 (2–4.5)	
	25.0–29.9	34.5	2 (0–5)		1.5 (0.25–3.75)	
Socio economic status	Low	14.9	7 (6–13)	0.009	4 (2.75–9.75)	0.045
	Middle	69.5	6 (3–8)		3 (1–5)	
	High	15.6	7 (5–18)		4 (2–14)	
Education	None	20.3	8 (5–17)	0.07	4 (2–14)	0.222
	School level	64.2	6 (4–9)		3 (2–5)	
	College	15.5	6 (3.5–10)		4 (2.5–8)	

(Continued)

Table 3 (Continued).

Variable	Category	Percentage	PSQI Median {Q1-Q3}	P-value	ESS Median {Q1-Q3]	P-value
Residence	Rural	74.3	6 (4–9)	0.475	3 (2–5)	0.17
	Urban	25.7	6.5 (3.5–14.25)		4 (2–11.25)	
Living status	Family	97.2	6 (4–10)	0.206	4 (2–7)	0.467
	Single	3.8	8 (6.25–15)		4.5 (1.75–13.25)	
Marital status	Married	84.3	6 (4–13)	0.356	4 (2–8.25)	0.27
	Unmarried	15.7	6 (3–9)		3.5 (1–5)	
Occupation	Unemployed	36.8	6 (3–15)	0.048	4 (2–11)	0.103
	Self employed	58.5	6 (4–7.25)		3 (2–5)	
	Public servant	4.7	2 (0–6)		2 (1–4)	
Dialysis Vintage	< 3 months	18.2	3 (0–5)	0.001	1 (1–4)	0.001
	3m- 1 year	41.8	5 (4–6)		3 (2–4)	
	1–2 years	27.7	7 (6–14.5)		6 (3–10)	
	> 2 years	12.3	17 (14.75–18)		14.5 (14–15.25)	
Dialysis Shift	First (7 am – 11am)	33.7	6 (4.75–13)	0.80	4 (1.75–9)	0.80
	Second (12 noon – 4 pm)	31.6	6 (4–9)		3 (2–5)	
	Third (5pm −9 pm)	34.5	6 (2–7)		4 (2–5)	
Diabetes Mellitus	Yes	48.6	6 (4–11.75)	0.751	3.5 (2–8)	0.905
	No	51.4	6 (4–10)		4 (2–7)	
Hypertension	Yes	49.3	6 (3.5–13)	0.931	4 (2–9)	0.989
	No	50.7	6 (3–9)		4 (2–5)	
Coronary artery disease	Yes	14.2	5 (2–7)	0.124	3 (1–4.5)	0.187
	No	85.8	6 (4–13)		4 (2–8)	
Smoking	Yes	10.1	6 (4–10.5)	0.69	4 (2–7.5)	0.977
	No	89.9	6 (2–7)		4 (2–4)	
Alcoholism	Yes	4.8	6 (4–10.5)	0.34	4 (2–7.5)	0.913
	No	95.2	6 (2–7)		4 (2–4)	
Hemoglobulin	<6 g/dl	1.4%	17 (14–17)	0.001	14 (3–14)	0.001
	6–8g/dl	27.0%	14.5 (7–17.75)		11 (3–15)	
	8–10g/dl	60.8%	6 (4–7)		3 (2–4)	
	>10g/dl	10.8%	1.5 (0–3.75)		1 (1–2.75)	
Calcium phosphorus product	≥54	12.2	14.5 (7–18.25)	0.007	10 (2.75–14.75)	0.002
	<54	87.8	6 (4–9)		3.5 (2–5)	

Table 4 Biochemical Parameters and Significance with PSQI and ESS

Parameters	Mean	Correlation Coefficient	PSQI P-value	Correlation Coefficient	ESS P-value
Hemoglobulin	8.61±1.21	−0.677	0.001	−0.555	0.001
Blood urea	81±16.2	0.075	0.364	0.07	0.399
Serum creatinine	6.5±2.43	0.179	0.13	0.175	0.121
Serum sodium	135±3.8	0.127	0.123	0.144	0.18
Serum potassium	4.1±0.47	0.017	0.833	0.025	0.765
Serum albumin	3.6±0.37	0.03	0.714	0.001	0.991

14.2%, respectively, and were not statistically significant (Table 3). Higher dialysis vintage is significantly associated with poor sleep quality and EDS. All three dialysis shifts first, second, third constitute 33.7%, 31.6%, and 34.5%, respectively, but are not significantly associated with sleep quality and EDS. The presence of low hemoglobulin and high calcium-phosphorus products are associated with poor sleep quality and EDS.

Biochemical Parameters

On biochemical analysis (Table 4), we found hemoglobin mean 8.61±1.21, blood urea 81±16.2, serum creatinine 6.5 ±2.43, serum sodium 135±3.8, serum potassium 4.1±0.47. Hemoglobulin was negatively correlated with PSQI and ESS scores and had statistical significance. Blood urea and serum creatinine have a positive correlation with scores but were not statistically significant with sleep quality and EDS.

Discussion

In our study, of 148 patients, PSQI and ESS scores were used to assess sleep quality and daytime sleepiness. In the PSQI scale, we found that 68.2% (n=101) had poor sleep quality (PSQI >5) and were termed "poor sleepers." In the ESS score >10, Excessive daytime sleepiness was 19.5%. According to Luyster et al, PSQI > 5 has a sensitivity (89%) and specificity (86.5%) for differentiating "poor" from "good" sleepers when compared with other objective assessment methods.[25] John M et al's study had shown that ESS Total score >10 excessive daytime sleepiness; ≥17 indicates pathological sleepiness had higher sensitivity and reliability in the prediction of the EDS when compared to objective measures.[26] On psychometric analysis, we found Cronbach's alpha and its item correlation for 19 items, 7 component PSQI score is 0.951 and 8-item ESS score is 0.912 (which is better than the previous study 0.84 by Krishnamoorthy Y et al[27]), reflecting the internal reliability of the scores in our data. The global PSQI and ESS scores are shown in Figures 1 and 2 respectively. Moreover, the PSQI score and ESS score show a significant positive relationship with each other.

In our study, the pattern of sleep disturbances self-reported by patients was insomnia (19.5%), sleep apnoea episodes (18.2%), RLS (13.5%), excessive daytime sleepiness (12.8%), history of snoring (15.5%), pain in limbs (9.5%), confusion and nightmare (6%) which was similar with the previous studies.[4,6–8] Furthermore, all the self-reported sleep disturbances (Table 2) had a very high statistical correlation with PSQI and ESS scores, reflecting the two scores' ability to predict the outcome within a short time in our study. The total prevalence of sleep disturbances in HDP was 68.2% (101 participants) by PSQI score ≥5, concordance with previous studies.[1–3,23] In addition, the prevalence of excessive daytime sleepiness (ESS > 10) among our patients was 19.59% (29 participants) which was less when compared to previous reports 28% by Bastos et al[12] and 44% by Al-Jahdali et al[15]

The mean age of participants was 44±14.5 years. The more than 60 years had a significant impact on sleep quality (PSQI median 7) which correlates with the previous studies.[1–3] Males were 68.2% with a male-female ratio of nearly 2:1, with median PSQI 6 in both, but sex has no statistical significance with sleep quality and EDS. The low body mass index was significantly correlated to poor sleepers (PSQI >5) and EDS, which contrasts to reports from a previous study by Elder et al[23] but is similar with Jehan et al,[28] probably due to malnutrition in the low BMI group. In our study, patients
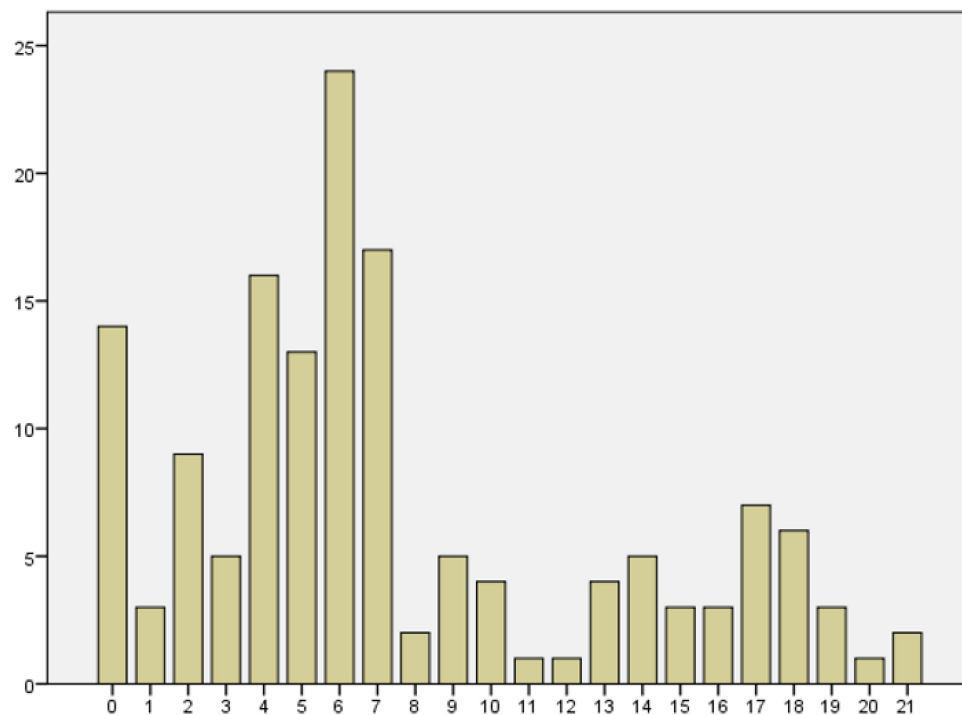
Figure 1 Global PSQI distribution among study population.
Notes: X axis: global PSQI score, Y axis: number of patients.

from low socioeconomic status (14.9%) had statistically significant (p-value 0.009 and 0.045) poor sleep quality and EDS when compared with the middle and upper class. However, education, residence, marital status, and living status were not significantly associated with poor sleep quality and EDS, similar to previous reports.[28,29] Those unemployed had
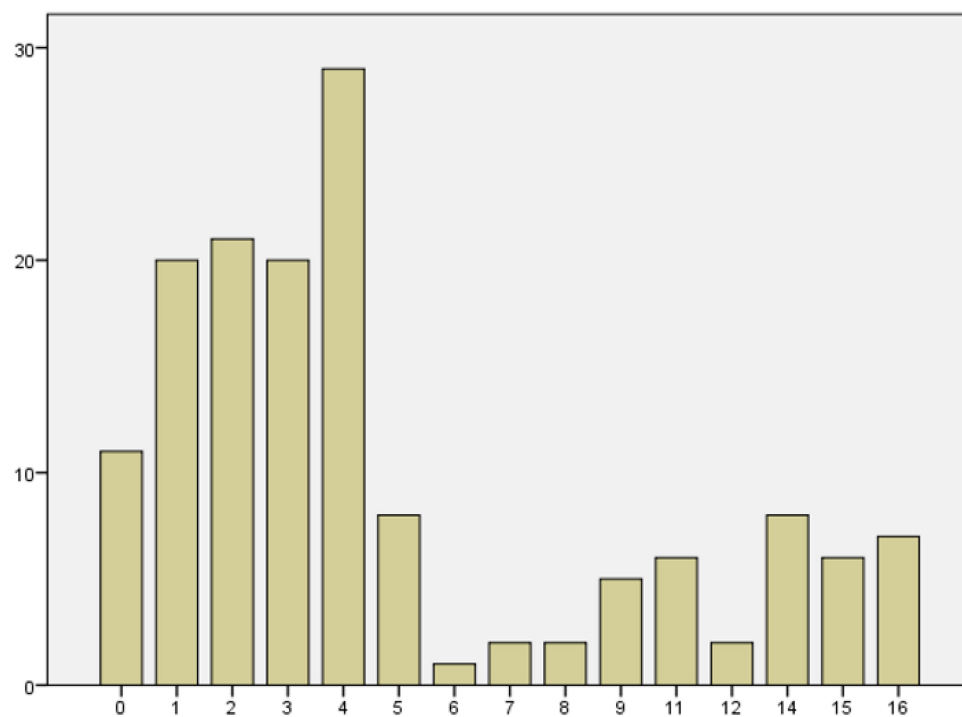
Figure 2 Epworth sleeps score distribution among the study population.
Notes: X axis: ESS score, Y axis: number of patients.

significantly associated with poor sleep quality probably due to psycho-social issues, and though 48.2% of them were with EDS, results were not statistically significant.[28] Though our study has more than half of patients with diabetes, hypertension, and 15.2% CAD, comorbidities were not significant with sleep quality and EDS.[5,29] In contrast to a previous report by Elder et al,[23] smoking and alcoholism were not significantly correlated with poor sleep quality and EDS. Probable reason may be due to minimal numbers; only 10.1% and 4.8% of patients had smoking and alcoholic habits due to our health education protocol in HDP, similar to the findings observed in peril et al.[5]

Patients with higher dialysis vintage were significantly associated with poor sleep quality and EDS, similar to Daniel V et al, other south Indian study.[30] The first, second, and third dialysis shifts constitute 33.7%, 31.6%, and 34.5%, respectively, but were not significantly correlated with sleep quality and EDS. The percentage of patients with EDS undergoing dialysis in the morning, afternoon, and evening were 35%, 27%, and 38%, respectively. EDS was not influenced by the dialysis shift, similar to studies by Fonacea et al[14] and Samara et al.[29] Moreover, in contrast to previous studies by Merlino et al[3] where morning sessions and AL-Jaldali et al,[15] where afternoon and evening sessions were associated with insomnia and EDS, respectively, our study has no statistical significance with dialysis shift. The reason probably reflects the in-center hemodialysis schedule timing (our schedule timing is from 7 am to 10 pm only). Furthermore, our center allows the afternoon shift rather than morning and evening for patients from remote places.

In our study, low hemoglobin was negatively correlated with PSQI and ESS scores and significantly associated with poor sleeper quality and EDS, similar to previous studies probably due to stress factors, poor diet, and lack of exercise.[31–33] In a study done by Indrarini et al,[32] the prevalence of anemia (98.6%) and poor sleep quality (94.3%) was high. The previous report by Iliescu et al.[2] Showed that 71% of ESKD in hemodialysis with low hemoglobin levels experienced poor sleep quality. In addition, Rompas et al[33] showed a significant relationship between the hemoglobin level and sleep quality of ESKD patients. On routine biochemical analysis with blood urea, serum creatinine, electrolytes sodium, and potassium had no significant difference between poor sleepers and good sleepers reflecting adequate dialysis clearance. Serum albumin was also not significantly different between poor sleepers and good sleepers. The higher calcium-phosphorus product was significantly associated with poor sleepers and EDS, probably due to the dysregulation of the calcium-phosphorus axis, PTH, and vitamin D roles in maintaining sleep quality.[34]

In short, PSQI and ESS scores in our study showed a significant correlation with self-reported sleep symptoms, very good internal reliability on psychometric analysis, and correlated well with each other. The poor sleep quality (PSQI >5) was statistically significant with age more than 60, low socioeconomic status, unemployment, low BMI, higher dialysis vintage, low hemoglobin, higher calcium-phosphorus product. Likewise, excessive daytime sleepiness (ESS >10) was statistically significant with age more than 60, low socioeconomic status, higher BMI, higher dialysis vintage, low hemoglobin, and higher calcium-phosphorus product.

Limitations of our study are the cross-sectional type of study with no comparison group, and objective assessment methods were not done.

Conclusion

The prevalence of sleep disturbances and poor sleep quality are high in HDP. In our study, 68.24% scored >5 on the PSQI (poor sleepers), and 19.59% had a total ESS > 10 (excessive daytime sleepiness). Subjective assessment scores (PSQI and ESS) correlated statistically with self-reported sleep symptoms and good internal reliability making these tools simple, practical bedside tools in identifying sleep quality and excessive daytime sleepiness where objective assessment methods are not feasible. Age more than 60, anemia, low BMI, low socioeconomic status. High calcium-phosphorus products' higher dialysis vintage is associated with poor sleep quality and EDS.

Ethical Statement

The study does not involve any human or animal experiments, and no new therapeutic interventions were done. The study was a cross-sec survey. The methodology was approved by the Institutional ethical committee of Madurai medical college, Madurai, India. Informed written consent was obtained from all patients who were taken in the study. This study was conducted in accordance with the Declaration of Helsinki.

Author Contributions

All authors made equal contributions to conception and design, acquisition of data, or analysis and interpretation of data; contributed in drafting the article or revising it critically for intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Funding

Disclosure

The authors report no conflicts of interest for this work.

References

1. Walker S, Fine A, Kryger MH. Sleep complaints are common in a dialysis unit. *Am J Kidney Dis*. 1995;26(5):751–756.
2. Iliescu EA, Coo H, McMurray MH, et al. Quality of sleep and health-related quality of life in haemodialysis patients. *Nephrol Dial Transplant*. 2003;18(1):126–132.
3. Merlino G, Piani A, Dolso P, et al. Sleep disorders in patients with end-stage renal disease undergoing dialysis therapy. *Nephrol Dial Transplant*. 2006;21(1):184–190.
4. Cukor D, Unruh M, McCurry SM, Mehrotra R. The challenge of insomnia for patients on haemodialysis. *Nat Rev Nephrol*. 2021;17(3):147–148. doi:10.1038/s41581-021-003965
5. Perl J, Unruh ML, Chan CT. Sleep disorders in end-stage renal disease: 'Markers of inadequate dialysis'. *Kidney Int*. 2006;70(10):1687–1693.
6. Parker KP, Bliwise DL, Bailey JL, Rye DB. Daytime sleepiness in stable hemodialysis patients. *Am J Kidney Dis*. 2003;41(2):394–402.
7. Anand S, Johansen KL, Grimes B, et al. Physical activity and self-reported symptoms of insomnia, restless legs syndrome, and depression: the comprehensive dialysis study. *Hemodial Int*. 2013;17(1):50–58.
8. Sabry AA, Abo-Zenah H, Wafa E, et al. Sleep disorders in hemodialysis patients. *Saudi J Kidney Dis Transpl*. 2010;21(2):300–305.
9. Leung RS, Bradley TD. Sleep apnea and cardiovascular disease. *Am J Respir Crit Care Med*. 2001;164(12):2147–2165.
10. Al-Jahdali H. A comparison of sleep disturbances and sleep apnea in patients on hemodialysis and chronic peritoneal dialysis. *Saudi J Kidney Dis Transpl*. 2011;22(5):922–930.
11. Aritake-Okada S, Nakao T, Komada Y, et al. Prevalence and clinical characteristics of restless legs syndrome in chronic kidney disease patients. *Sleep Med*. 2011;12(10):1031–1033.
12. Bastos JPC, Sousa RB, Nepomuceno LAM, et al. Sleep disturbances in patients on maintenance hemodialysis: role of dialysis shift. *Rev Assoc Med Bras*. 2007;53(6):492–496.
13. Cengić B, Resić H, Spasovski G, Avdić E, Alajbegović A. Quality of sleep-in patients undergoing hemodialysis. *Int Urol Nephrol*. 2012;44(2):557–567.
14. Fonsêca N, Santos I, Fernandes V, Fernandes V, Lopes V, Luis V. Excessive daytime sleepiness in patients with chronic kidney disease undergone hemodialysis. *Fisioterapia em Movimento*. 2014;27(4):653–660. doi:10.1590/0103-5150.027.004.ao17
15. 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.
16. Sharma U. On dialysis, sleep and melatonin. *Indian J Nephrol*. 2013;23(4):269–270. doi:10.4103/0971-4065.114490
17. Hughes JR. Correlations between EEG and chemical changes in uremia. *Electroencephalogr Clin Neurophysiol*. 1980;48(5):583–594.
18. Vaziri ND, Oveisi F, Wierszbiezki M, Shaw V, Sporty LD. Serum melatonin and 6-sulfatoxymelatonin in end-stage renal disease: effect of hemodialysis. *Artif Organs*. 1993;17(9):764–769.
19. Fürst P. Amino acid metabolism in uremia. *J Am Coll Nutr*. 1989;8(4):310–323.
20. Parker KP, Bliwise DL, Rye DB. Hemodialysis disrupts basic sleep regulatory mechanisms: building hypotheses. *Nurs Res*. 2000;49(6):327–332.
21. Parker KP, Bailey JL, Rye DB, Bliwise DL, Van Someren EJ. Lowering dialysate temperature improves sleep and alters nocturnal skin temperature in patients on chronic hemodialysis. *J Sleep Res*. 2007;16(1):42–50.
22. Entzian P, Linnemann K, Schlaak M, Zabel P. Obstructive sleep apnea syndrome and circadian rhythms of hormones and cytokines. *Am J Respir Crit Care Med*. 1996;153(3):1080–1086. doi:10.1164/ajrccm.153.3.8630548
23. Elder SJ, Pisoni RL, Akizawa T, et al. Sleep quality predicts quality of life and mortality risk in haemodialysis patients: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). *Nephrol Dial Transplant*. 2008;23(3):998–1004.
24. Marino M, Li Y, Rueschman MN, et al. Measuring Sleep: accuracy, Sensitivity, and Specificity of Wrist Actigraphy Compared to Polysomnography. *Sleep*. 2013;36(11):1747–1755.
25. Luyster FS, Choi J, Yeh CH, Imes CC, Johansson AE, Chasens ER. Screening and evaluation tools for sleep disorders in older adults. *Applied Nursing Res*. 2015;28(4):334–340.
26. Johns MW. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep*. 1991;14(6):540–545.
27. Krishnamoorthy Y, Sarveswaran G, Sakthivel M, Kalaiselvy A, Majella MG, Lakshminarayanan S. Construct Validation and Reliability Assessment of Tamil Version of Epworth Sleepiness Scale to Evaluate Daytime Sleepiness among Adolescents in Rural Puducherry, South India. *J Neurosci Rural Pract*. 2019;10(1):89–93.
28. Jehan S, Myers AK, Zizi F, et al. Sleep health disparity: the putative role of race, ethnicity and socioeconomic status. *Sleep Med*. 2018;2(5):127–133.
29. Samara AM, Sweileh MW, Omari AM, et al. An assessment of sleep quality and daytime sleepiness in hemodialysis patients: a cross-sectional study from Palestine. *Sleep Sci Practice*. 2019;3(4):635.

30. Daniel V, Meetha S, Jayakumar M, Sekar M. Quality and adequacy of sleep among dialysis patients. *Biomedicine*. 2021;40(4):543–546.

31. Pai MF, Hsu SP, Yang SY, Ho TI, Lai CF, Peng YS. Sleep disturbance in chronic hemodialysis patients: the impact of depression and anemia. *Ren Fail*. 2007;29(6):673–677.

32. Indrarini A, Noorana ZA, Yona S. The relationship between anemia, depression, duration of hemodialysis, and quality of sleep among end-stage renal disease patients. *Enfermería Clínica*. 2019;29(Suppl 2). doi:10.1016/j.enfcli.2019.05.002.

33. Rompas AB, Tangka J, Rotti J. Hubungan kadar hemoglobin dengan kualitas tidur pasien penyakit ginjal kronik di poli ginjal dan hipertensi BLU RSUP Prof DR. *Int J Med*. 2013;1:pp. 1–6.

34. Esposito MG, Cesare CM, De Santo RM, et al. Parathyroidectomy improves the quality of sleep in maintenance hemodialysis patients with severe hyperparathyroidism. *J Nephrol*. 2008;21(Suppl 13):S92–6.

35. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193–213. doi:10.1016/0165-1781(89)90047-4