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Original Article

Predictors of sleep quality in hemodialysis patients

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ABSTRACT: Purpose: *Poor sleep quality (SQ) is common in hemodialysis (HD) patients. Factors associated with poor SQ are not well understood. The objectives of the present study were to determine the prevalence of poor SQ in HD patients in our region and to examine the association between SQ and health-related quality of life (HRQoL), depression, and certain clinical and laboratory parameters.* Methods: *A total of 233 HD patients at 5 centers in the city center of Konya, Turkey were included in this study. Their demographic data and biochemical parameters were analyzed. All patients were instructed to complete Turkish versions of three questionnaires, namely, a modified post-sleep inventory (PSI), Beck Depression Inventory (BDI) and a Short Form of Medical Outcomes Study (SF-36).* Results: *The mean age of the patients was 52.8±15.3 years and the male to female ratio was 1.33:1. The prevalence of poor sleepers, defined as those having a total sleep score (PSI-4 score) ≥ 4, was 60.9%. Compared with good sleepers, poor sleepers had higher BDI scores and as well as lower PCS and MCS domains of HRQoL. In addition, poor sleepers were older and more likely to be unemployed. There was a significant inverse correlation of PSI-4 score with PCS and MCS, and significant positive correlation of PSI-4 score with BDI and age ($p<0.001$). The significant independent predictors of PSI-4 score were BDI score, MCS score and employment status.* Conclusions: *Depression, MCS score and employment status were the most important predictors of sleep quality in HD patients. (Int J Artif Organs 2010; 33: 154-60)*

KEY WORDS: Depression, Hemodialysis, HRQoL, Sleep quality

INTRODUCTION

Poor sleep quality (SQ) is not uncommon in hemodialysis (HD) patients. The prevalence of poor SQ in HD patients ranges between 41% and 83% (1-3), depending on the assessment method and the type of population studied. In addition, factors asscociated with poor SQ are not well understood. The most frequently reported complaints of patients with sleep disorders are insomnia, restless leg syndrome, sleep disordered breathing and excessive daytime sleepiness. As with adequate nutrition, adequate sleep is a necessity for normal living. Unlike the attention given to adequate nutrition in dialysis patients, little or no attention is given to ensuring adequate sleep.

Prior studies have shown poor SQ in HD patients to be associated with female sex, older age, erythropoietin therapy, dialysis vintage, depression, cardiovascular disease, higher body mass index (BMI), exercise, dialysis adequacy, parathyroid hormone, serum creatinine and health related quality of life (HRQoL) (4, 5).

The objectives of the present study were to determine the prevalence of poor SQ in HD patients in our region and to examine the association between SQ and HRQoL, depression, and certain clinical and laboratory parameters.

MATERIALS AND METHODS

A total of 233 patients with end-stage renal disease (ESRD) receiving HD 3 times weekly for more than 3 mon-

ths at 5 centers in city center of Konya were included in this cross-sectional cohort study. Those who refused to join the study were excluded. Other exclusion criteria were as follows; severe cognitive impairment, unstable medical conditions that made the patients unable to answer the questionnaires, treatment with a sleep medication, chronic pain, presence of chronic obstructive pulmonary disease and a psychiatric disorder. Blood samples for biochemical and hematologic parameters were obtained by midweek predialysis session. The study was approved by our Institutional Local Ethics Committee and patients were included in the study after obtaining verbal consent of patients.

Evaluation of sleep quality

A modified post-sleep inventory (PSI), was applied to all patients for evaluating SQ. The PSI was developed by Webb et al to permit an adequate description of subjective responses to a preceding period of sleep. The PSI consists of a questionnaire with three groups of opposing statements separated by an analogic 0 to 1 rating scale. The aim is to classify the a patient's understanding about his or her SQ in terms of feelings at bedtime (PSI-1 score), quality of nocturnal sleep (PSI-2 score), and feelings at awakening (PSI-3 score). A total sleep score (PSI-4 score) was also arrived at as follows: (PSI-1 + PSI-2 + PSI-3). A PSI score of 0 reflects a positive opinion about the patient's sleep quality, while a score of 1 reflects a negative opinion. If PSI-4 is zero, this shows no sleep problem; if it is 1-3, this shows a small sleep problem; if it is 4-6, this shows a medium sleep problem; if it is 7-9, this shows a big sleep problem, and if it is 10-12 score, this shows a very big sleep problem (6).

Evaluation of depression

Depression was assessed by using the Beck Depression Inventory (BDI), which was validated and commonly used in patients with ESRD (7, 8). It is reported that 85% of Western dialysis patients with BDI scores of 11 or higher met DSM-IV criteria for diagnosis of major depression (8). The validation and reliability study in a Turkish population was made by Kapci EG et al (9) and a BDI score of 17 or greater was used as a cut-off value for diagnosis of depression.

Evaluation of health-related quality of life (HRQoL)

In order to evaluate HRQoL of the patients, a short form of Medical Outcomes Study (SF-36) was used, which was adapted to the Turkish population. The test consists of 36 items, which are assigned to 8 dimensions, namely, functional capacity (10 items), physical aspect (4 items), body pain (2 items), general health status (5 items), vitality (4 items), social aspect (2 items), emotional aspect (3 items) and mental health (5 items). Each scale was scored with a range from 0 to 100. The first 5 items constitute the physical component scale (PCS) and the last 5 items the mental component scale (MCS). It has been shown that these 2 summary scales adequately represent the values of their individual scale components with 80% and 85% variability (10). The higher the scale, the better is the QOL. This scale has been commonly used and validated in patients with ESRD (11).

Statistical analysis

The patients' characteristics were presented as the mean ± SD. The prevalence of poor sleepers was determined by the proportion of subjects with PSI 4 score ≥ 4. Student's t-test for independent samples was used for normally distributed continuous variables, and the Mann-Whitney U test was used for variables that were not normally distributed. Differences among categorical variables were analyzed using the chi-square test or two-tailed Fisher's exact test as appropriate. Spearman correlation coefficients were used to examine associations between continuous variables. Multiple linear regression with forward stepwise selection (p=0.05) was performed to identify factors independently associated with sleep quality score. The level of significance was p = 0.05 for all comparisons. All calculations were performed using a standart statistical package (SPSS 15.0 for Windows).

RESULTS

The mean age of the patients was 52.8±15.3 (range 18 to 84) years; mean dialysis vintage was 63.5±48.2 months. The male to female ratio was 1.33:1.0. The causes of renal disease were: chronic glomerulonephritis in 55 patients, diabetic nephropathy in 47, hypertension in 41, chronic

pyelonephritis in 17, polycystic kidney disease in 15, amiloidosis in 9, and unknown in 49 patients. Other clinical characteristics of the study population are listed in Table I.

The mean and median PSI-4 score of the patients was 5.07±3.50 and 4.0, respectively. The prevalence of poor sleepers which was defined as those having PSI-4 scores ≥ 4 was 60.9% (142/233). Sociodemographic characteristics of good sleepers compared with poor sleepers are shown in Table II. Compared with good sleepers, poor sleepers had higher BDI scores and lower PCS and MCS domain of HRQoL. In addition, poor sleepers were older and more likely to be unemployed. The difference of diabetes was partially significant (p=0.05), with a higher prevalence of diabetes (23.9%) in poor sleepers compared to good sleepers (14.3%). The mean BDI score, PCS and MCS scores were 12.9±9.4, 51.9±22.2 and 59.6±21.9 in poor sleepers compared to 6.8±6.2, 64.2±21.2 and 74.3±18.3 in good sleepers, respectively.

The correlations between the PSI-4 score and other continuous variables are shown in Table III. There was a significant inverse correlation of PSI-4 score with PCS and MCS ($r = -0.490$, $p<0.001$; $r = -0.542$, $p<0.001$, respectively). In addition, there was a significant positive correlation of PSI 4 score with BDI score and age ($r=571$, $p<0.001$; $r=0.285$, $p<0.001$, respectively). We did not find a significant correlation of PSI-4 score with dialysis vintage, BMI and any of the studied laboratory parameters.

In multivariate analysis, the significant independent predictors of PSI-4 score were BDI score ($\beta=0.202$, $p=0.014$), MCS ($\beta=-0.171$, $p=0.036$) and employed ($\beta=0.129$, $p=0.044$) (Tab. IV).

DISCUSSION

To our knowledge, this is one of the largest survey of self-reported SQ and its correlates in HD patients. The prevalence of poor sleep in the present study was 60.9%, similar to the 41% to 83% prevalence range of poor SQ reported by other studies made in HD patients with various kinds of surveys (1–3).

Our study is the first study to evaluate the effect of occupational status on SQ in chronic HD patients. The difference of occupational status was significant between the groups (p=0.003), with a higher prevalence of the employed (40.7%) in good sleepers compared with poor sleepers (22.5%). The positive effect of employed status may be related to better income and being free of the depressive effects of an unemployed status.

We observed that poor sleepers had a higher BDI sco-

TABLE I - SOCIO-DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF THE PATIENTS (N =233)

Characteristics	Number (%)	Mean + SD
Age (years)		52.8±15.3
Sex (male: female)	133:100	
Diabetes number (%)	47 (20.2%)	
Depression (BDI score ≥ 17)	44 (18.9%)	
Cigarette smoking	61 (26.2%)	
Employed		69 (29.6%)
Dialysis vintage (months)		63.5±48.2
Body Mass Index (kg/m^2)		23.46±4.32
Predialysis SBP (mmHg)		129.2±21.4
Predialysis DBP (mmHg)		76.2±11.2
Albumin (mg/dL)		4.20±0.5
Hemoglobin (g/dL)		10.95±1.22
Total cholesterol (mg/dL)		172.8 ±60.1
Triglyceride (mg/dL)		158.3±76.6
Serum calcium (mg/dL)		9.05±0.7
Serum phosphorus (mg/dL)		4.94±1.18
Calcium x phosphorus product (mg^2/dL^2)		44.94±11.70
Parathyroid hormone (pg/mL)		325.8±303.0
Single-pool Kt/V		1.31±0.21

SBP = Sistolic Blood Pressure; DBP = Diastolic Blood Pressure; BDI = Beck Depression Inventory.

re and lower PCS and MCS domain scores of HRQoL; in addition, poor sleepers were older and more likely to be unemployed. Futher analysis of SQ showed BDI score, MCS, and age to be the independent predictors of the PSI-4 score.

A remarkable relationship between sleep alterations and depression has been reported by numerous studies conducted on the general population. However, this relation has been less studied in the hemodialysis population. Elder et al (in DOPPS) (1) reported a history of depression to be the only predictor of poor sleepers. In addition, Pai et al (2) reported that poor sleepers had a higher BDI score than good sleepers and BDI score was found to be the factor that could predict whether a patient would be a poor sleeper. Our study is one of the few studies to evaluate the relationship between SQ and depression. We also found a positive correlation between PSI-4 score and BDI score ($r=0.571$, $p<0.001$). Moreover, we found that one of the significant independent predictors of PSI-4 score was BDI score ($\beta=0.366$, $p<0.001$) in multiple linear regression analysis. Thus, when assessing the SQ of hemodialysis patients, one should bear in mind that depression is prevalent and adversly affects sleep quality and should be addressed adequately to improve sleep.

Contradictory results were reported for the relationship between SQ and age in HD patents. Some researchers

TABLE II - SOCIO-DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF GOOD SLEEPERS COMPARED WITH POOR SLEEPERS

	Good sleepers PSI-4 score < 4 (n = 91)	Poor sleepers PSI-4 score ≥ 4 (n = 142)	P
Age (years)	49.6±15.7	54.9±14.6	0.009
Female (n)	37 (40.7%)	63 (44.4%)	0.337
Diabetes Mellitus (n)	13 (14.3%)	34 (23.9%)	0.05
CCI	1.46±1.37	1.64±2.09	0.034
Depression (n)	5 (5.5%)	39 (27.5%)	< 0.001
Marital Status		0.728	
Married	69(75.8%)	111 (78.1%)	
Unmarried	12 (13.2%)	14 (9.9%)	
Widowed	10 (11%)	17 (12%)	
Education level			0.531
High school or above	9 (9%)	17 (12%)	
Other*	82(91%)	125 (88%)	
Employed (n)	37 (40.7%)	32 (22.5%)	0.003
Cigarette smoking (n)	27 (29.7%)	34 (23.9%)	0.220
Dialysis vintage (months)	71.4±52.0	58.5.1±45.0	0.053
Body Mass Index (kg/m^2)	23.19±4.49	23.64±4.21	0.441
Predialysis SBP (mmHg)	128.7±23.0	129.5±20.4	0.772
Predialysis DBP (mmHg)	76.4±11.9	76.1±10.8	0.839
Hemoglobin (g/dL)	11.0±1.3	10.93±1.17	0.720
Albumin (mg/dL)	4.24±0.52	4.17±0.42	0.242
C-reactive protein	7.45±13.33	11.91±23.72	0.897
Single-pool Kt/V	1.33±0.21	1.29±0.21	0.187
Total cholesterol (mg/dL)	173.8±58.7	172.2±61.2	0.841
Triglyceride (mg/dL)	165.2±95.8	153.8±61.0	0.271
Serum calcium (mg/dL)	9.02±0.74	9.08±0.67	0.508
Serum phosphorus (mg/dL)	4.90±1.15	4.97±1.21	0.669
Parathyroid hormone (pg/mL)	335.4±366.1	319.5±255.0	0.43
Calcium x phosphorus product	44.5±11.8	45.2±11.7	0.643
BDI score	6.8±6.2	12.9±9.4	< 0.001
PCS	64.2±21.2	51.9±22.2	< 0.001
MCS	74.3±18.3	59.6±21.9	< 0.001

PSI-4 score = Total Sleep Score; SBP = Sistolic Blood Pressure; DBP = Diastolic Blood Pressure; BDI = Beck Depression Inventory; PCS = Physical Component Scale; MCS = Mental Component Scale; CCI = Charlson Comorbidity index; *Illiterate; elementary school.

found that there was no relationship between SQ and age (1, 2, 4, 12), while others reported that patients with insomnia were more elderly (4, 13). In the present study, poor sleepers were older and there was a significant positive correlation between PSI-4 score and age. The incidence of comorbidities and depression increases with aging in the dialysis population (14). Thus, the finding that the elderly had poorer sleep quality may be due to this indirect relationship between older age and comorbidities and depression.

Sleep quality was shown previously to be associated with HRQoL among those who undergo maintenance dialysis (1, 3, 15). Patients with better SQ are significanly more likely to have higher MCS and PCS scores of HRQoL. Iliescu et al found significant and independent associations between SQ, determined using PSQI (Pittsburgh Sleep Quality Index), and MCS and PCS in dialysis patients even when controlling for a variety of confounding factors (3). In the present study, poor sleepers had lower MCS and PCS scores and there was a significant negative correlation of PSI-4 score with both MCS and PCS. In addition, we found that one of the significant independent predictors of PSI-4 score was only the MCS domain of HRQoL (β=–0.291, $p<0.001$) in multiple linear regression analysis. SQ and HRQoL have many determinants, some of which overlap. End-stage kidney disease affects sleep quality at least by increasing the incidence of some specific sleep disorders (16). Treatment of obstructive sleep apnea improved sleep quality and HRQoL in patients without renal disease. Therefore, SQ and HRQoL are closely interrelated in the hemodialysis population and treatment of specific types of sleep disorders in hemodialysis patients may improve both SQ and HRQoL.

TABLE III - CORRELATION COEFFICIENTS FOR PSI-4 SCORE AND OTHER CONTINUOUS VARIABLES IN 233 PATIENTS

Variables	PSI-4 score	
	r	P
Age (years)	0.285	< 0.001
BDI score	0.571	< 0.001
MCS	- 0.542	< 0.001
PCS	- 0.490	< 0.001
Body Mass Index (kg/m^2)	0.008	0.902
Dialysis vintage (months)	- 0.121	0.066
Hemoglobin (g/dL)	- 0.094	0.152
Albumin (mg/dL)	- 0.103	0.118
Serum phosphorus (mg/dL)	- 0.095	0.147
Serum calcium (mg/dL)	- 0.006	0.932
Single-pool Kt/V	0.018	0.784

PSI-4 score = Total Sleep Score; BDI = Beck Depression inventory; PCS = Physical Component Scale; MCS = Mental Component Scale

TABLE IV - MULTIPLE LINEAR REGRESSION MODELS WITH OUTCOME VARIABLE PSI-4 SCORE

Variables	0utcome PSI-4 score Adj. R^2 = 0.135	
	β	*P*
BDI score	0.202	0.014
MCS	- 0.171	0.036
Employed	0.129	0.044
PCS		0.776
Age		0.593
CCI		0.629

PSI-4 score = Total Sleep Score; BDI = Beck Depression inventory; MCS = Mental Component Scale; PCS = Physical Component Scale; CCI = Charlson Comorbidity Index.
Age, employed, Charlson Comorbidity Index, BDI score, and PCS and MCS scores were included in the regression analysis.

The role of anemia in sleep disturbance has been a controversial topic in the previous literature concerning dialysis patients. Iliescue et al reported a negative correlation between the PSQI scores and the hemoglobin (Hb) levels (3). Benz et al (5) reported that raising Hb levels by intensive erythropoietin therapy might improve SQ. In addition, Pai et al (2) found that Hb levels did predict global PSQI scores in a multivariate analysis of the poor sleepers alone. However, in a large survey of insomnia in 694 dialysis patients using a different questionnaire (4), no correlation between Hb concentrations and sleep disorders was found. In another large study that examined the SQ in 909 dialysis patients (15), there was no difference in SQ by Hb levels. In the present study, we did not find a significant association between SQ and Hb levels by bivariate or multivariate analysis. This lack of difference may be due to intensive treatment of anemia by pursuit of K/DOQI guidelines in the whole study population. Actually, 81.5% of the study population was at target in terms of hemoglobin values.

Although it was shown in a prospective study that serum intact parathyroid hormone (iPTH) levels were not significantly different between good and poor sleepers (17), the case is different in hemodialysis patients with secondary hyperparathyroidism. Chou et al and Esposito et al showed that parathyroidectomy significantly improved SQ in hemodialysis patients with secondary hyperpa-

rathyroidism (18, 19). It should be emphasized that both these studies evaluated SQ in patients with secondary hyperparathyroidism so severe that it required surgical treatment. At these levels, hyperparathyroidism can cause generalized pruritus and bone pain (20), factors that interfere with sleep. However, effects of milder forms of secondary hyperparathyroidism on SQ were not studied well. This study also showed no significant difference between good and poor sleepers with respect to serum iPTH concentrations.

Hypertension (only systolic) was also reported to be associated with SQ in hemodialysis patients (21). This association may be due to a close association between obstructive sleep apnea and hypertension. In contrast to the previous study, this current study did not find a significant association between hypertension and SQ.

The role of sex, smoking status and comorbidity in sleep disturbance has also been a controversial topic in previous literature on dialysis patients. Some studies (1, 2, 4) reported that prevalence of females was higher in poor sleepers, while in other studies (3, 12-15, 22), there was no significant differences in SQ by sex. Merlino et al (13) and Elder et al (1) reported that one of the independent risk factors for sleep disorders was cigarette smoking, but in other studies (4, 12), this association was not reported. Some researchers found that there was no relationship between SQ and comorbidity (1, 3, 15), however De Santo et al (23) reported that the average Charlson Comorbidity Index in patients without sleep disorders was 4.10, while scores in patients with subclinical and clinically overt sleep disorders were 6.10 and 6.81, respectively. In the present study, there were no significant differences in SQ by sex, smoking status, coronary artery disease, or diabetes. There were no differences in SQ by serum albumin, serum phosphorus, calcium and calcium-phosphorus product, iPTH, Kt/V, BMI, or dialysis vintage, either.

Renal transplantation improves sleep quality, however, it does not entirely normalize the condition. When compared with normal subjects, transplant patients had poorer sleep quality (24). This may be due to incomplete resolution of severe bone pain, the adverse effects of immunosuppressants on sleep, and other psychosocial factors. Thus, renal transplantation is not a definitive treatment for impaired sleep in ESRD patients and should be adequately addressed in these patients.

This study has a few limitations. Firstly, we used a kind of patient questionnaire for the detection of sleep problems. This is not the best form to detect sleep disorders when compared with polysomnographic and/or neurophysiologic data. Secondly, this is a cross-sectional cohort study. Thus, we can only show associations between the study parameters rather than suggesting cause-and-effect relationships. Lastly, we did not exclude obese patients (BMI>30 kg/m^2). This may have had an impact on results because obese patients have a higher likelihood of having sleep problems, in particular obstructive sleep apnea.

In conclusion, the results of this study suggest that poor sleep is common in dialysis patients and that poor sleepers had higher rates of deppressive symptoms and lower HRQoL; in addition, poor sleepers were older and more likely to be unemployed. Depression, the mental domain of HRQoL, and age were the most important predictors of SQ. Assessment of SQ and bystander factors such as depression and HRQoL as well as appropriate interventions to relieve poor sleep, although rarely considered by nephrologists, should become an everyday practice when dealing with dialysis patients.

Conflict of interest statement: None reported.

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