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Effects of sleep disorders and sedative–hypnotic medications on health-related quality of life in dialysis patients

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Abstract

Purpose Sleep disorders are very common among dialysis patients, leading patients to frequently take sedative–hypnotic medications; however, the effects of sleep disorders and the use of such drugs on health-related quality of life (HRQOL) have rarely been investigated.

Methods The Pittsburgh Sleep Quality Index and Short Form-12 were used to assess sleep quality and patient health situations, respectively. Logistic regression was employed to identify factors associated with deterioration of the mental component summary (MCS) score and the physical component summary (PCS) score.

Results A total of 461 patients undergoing dialysis were recruited. The prevalence of sleep disorders was 67.0%. Among the study population, 30.4% of patients took sedative–hypnotic medications to improve their sleep quality. Both the PCS (81.25 vs. 71.88, $p < 0.001$) and MCS scores (78.63 vs. 74.63, $p < 0.001$), which indicate HRQOL, were decreased among patients with sleep disorders compared with good sleepers. However, neither the PCS nor MCS scores showed any significant difference between patients with sleep disorders who used sedative–hypnotic medications and those who did not.

Conclusion Sleep disorders were closely associated with deterioration of both mental HRQOL and physical HRQOL. Sedative–hypnotic medication use did not affect HRQOL among patients with sleep disorders undergoing dialysis.

Keywords Dialysis · MCS · PCS · Sedative–hypnotic medications · Sleep disorders · Quality of life

Introduction

Sleep disorders are well known as a common condition with a high prevalence of 30–80% among patients with end-stage renal disease receiving dialysis [1, 2]. This is a serious problem because dialysis patients with sleep disorders commonly complain of subjective daytime impairments including mood disturbances, concentration problems, sleepiness, and elevated fatigue [3, 4]. Furthermore, objective daytime impairments in working memory, motor control, and vigilance tasks have also been seen among these patients [5, 6]. These numerous daytime dysfunctions attributable to sleep disorders have been confirmed to reduce quality of life (QOL) [7, 8], which is considered a complex and multidimensional term, affecting the status of both lifestyle and health.

Because of the high prevalence of sleep disorders among patients undergoing dialysis, the use of sedative–hypnotic medications is common among these patients. However, few studies have examined the effect of these drugs on QOL in this vulnerable population. Among the general population, it has been reported that the use of sedative–hypnotic medications enhances both mental QOL and physical QOL [9].

Unlike the previous study, Sasai et al. [7] found that sleep medication was useful to improve mental QOL but degraded physical QOL because of the medication's adverse effects. In addition, several studies have revealed that there were no significant effects of treatment on QOL [10, 11].

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As we know, both the quality of sleep and the QOL among patients undergoing dialysis are much poorer than those of the general population. However, few studies have examined the effect of sedative–hypnotic medications on health-related QOL (HRQOL) in patients undergoing dialysis. In this study, the prevalence of patients undergoing dialysis with sleep disorders using sedative–hypnotic medications and the effects of those medications on QOL were investigated in Southern China.

Subjects and methods

Study population and follow-up

This was a cross-sectional study. Eligible patients of The First Affiliated Hospital of Wenzhou Medical University who were undergoing dialysis and had completed both the Pittsburgh Sleep Quality Index (PSQI) and the Short Form-12 (SF-12) were recruited from September to December 2017. Among patients undergoing HD, a dialysis schedule is three sessions per week, with 4 h per session. According to the dialysis schedule, all patients undergoing PD were divided into two groups: continuous ambulatory peritoneal dialysis (CAPD) and daytime ambulatory peritoneal dialysis (DAPD). Dialysis patients receiving therapy for 3 months or more and aged 18 years or older were included in this study. Patients with dementia, malignancy, active infection, psychotic disorder, or uncontrolled heart failure; who were using immunosuppressants, immunomodulators, or steroids; or who had been hospitalized in the previous month were excluded. Questionnaires concerning sleep quality and QOL were administered after enrollment. This study was approved by the Ethics Committee of The First Affiliated Hospital of Wenzhou Medical University. Before the study was carried out, informed consent documents were signed by participants.

Data collection

Patient medical history and medical information were obtained from their medical records. Data were collected on demographic characteristics including age, sex, body mass index (BMI), education, household type, income, marital status, and occupational status. Data on diabetes and cardiovascular disease (CVD) were obtained from the patients' records. CVD was defined as one of the following: myocardial infarction or cerebrovascular event. Laboratory parameters including serum creatinine, hemoglobin, albumin concentrations, calcium, phosphorus, intact parathyroid hormone (iPTH), and urea clearance index (Kt/V) were also collected.

Questionnaires

The PSQI is a standard tool that is commonly used to estimate sleep quality and has been applied widely in the clinic because of its high validity and reliability [12]. Currently, the Chinese version of the PSQI has also been widely used among dialysis patients [13–15]. As a self-administered questionnaire, the PSQI contains 18 questions describing 7 specific aspects of the patient's sleep quality during the previous month. The PSQI score ranges from 0 to 3 in 7 aspects, including subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime dysfunction, yielding a total PSQI score from 0 to 21. Higher and lower scores represent worse and better quality of sleep, respectively, and a total PSQI score > 5 can be indicative of sleep disorders [12].

The Short Form-12 (SF-12), which is derived from the Short Form-36 (SF-36) Health Survey, was used to evaluate the patients' health situation. The SF-36 contains 36 questions yielding eight domains: physical function, physical role limitations, bodily pain, vitality, social function, emotional role limitations, general mental health, and general health [16]. SF-36 scores can be divided into two main sections, the mental component summary (MCS) and physical component summary (PCS) scores [17], which are the primary dependent variables of the SF-12 survey. A total score of 50 indicates the average score for the general population, with higher scores representing better HRQOL. Twelve questions from the SF-36 addressing all eight domains were selected to create the SF-12, a shorter survey instrument that yields MCS and PCS scores consistent with the SF-36 [16].

Groupings

According to the PSQI, all the patients undergoing dialysis were divided into two groups: good sleepers and poor sleepers; the latter were defined as having sleep disorders. Furthermore, patients with sleep disorders were divided into two groups according to the use of sedative–hypnotic medications: sleep disorders without drugs and sleep disorders with drugs.

Statistical analyses

The patient characteristics were presented as the means ± SD or medians (interquartile range) for continuous variables and as percentages (frequencies) for categorical

variables. Descriptive statistics were calculated for the full sample. Comparisons were made using the independent samples *t* test (normally distributed continuous variables), the Mann–Whitney *U* test (non-normally distributed continuous variables), and the Chi square test (categorical variables). Subjects whose scores were below the population average (50 points) were defined as having poor PCS, which was also defined as poor MCS. Univariate logistic regression analysis was used to identify factors associated with PCS and MCS. In the multivariable logistic regression

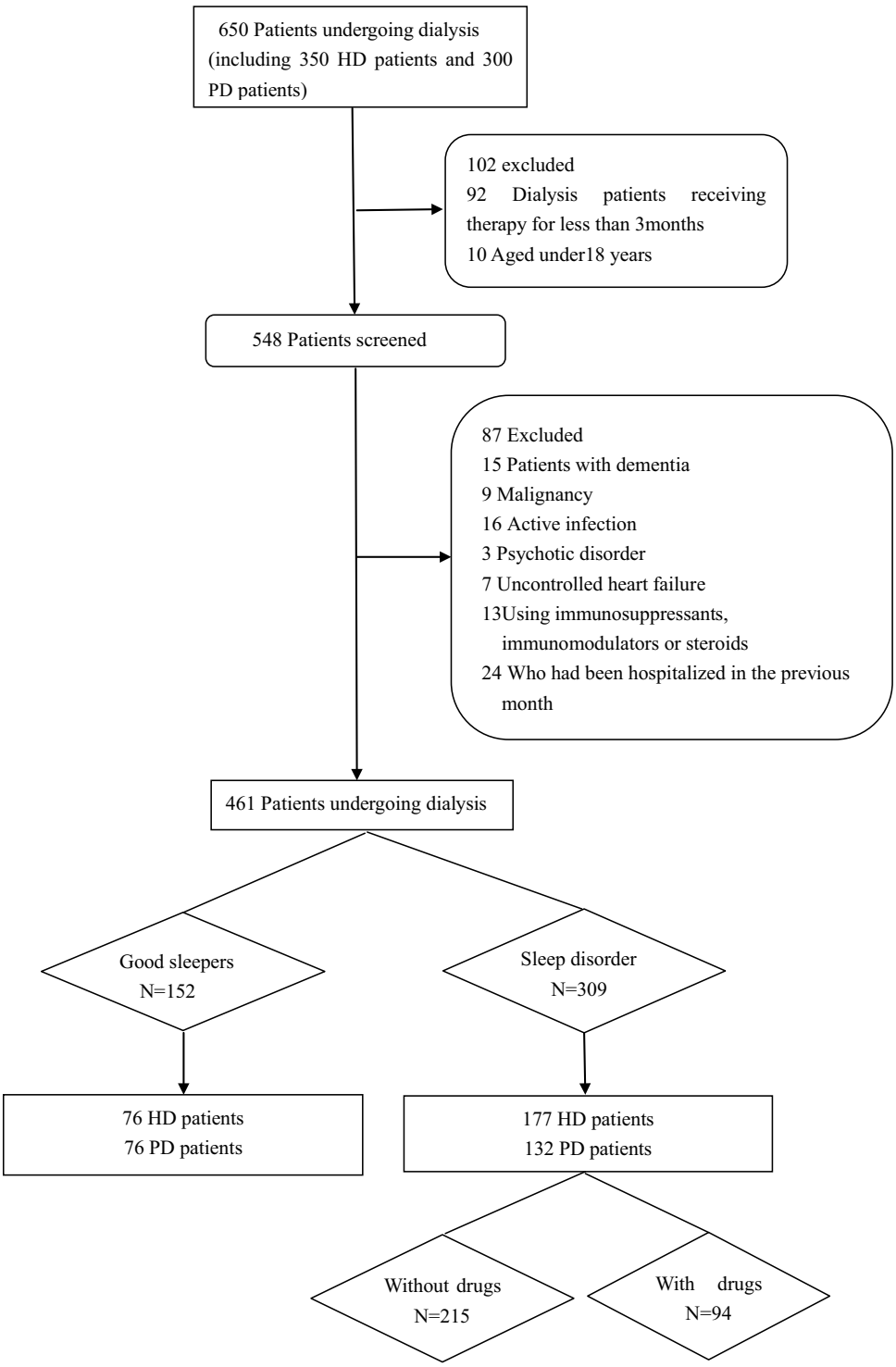

Fig. 1 A study flow diagram of patient enrollment

Abbreviations: *HD* hemodialysis, *PD* peritoneal dialysis

model, variables with $p < 0.05$ in the univariate analysis were forced into the model; other variables were selected by the forward entry method (entry: 0.1, removal: 0.2). We expressed results as odds ratios (ORs) and 95% confidence intervals (CIs). All the data were analyzed using SPSS 20.0 (SPSS Inc. Chicago, IL, USA). A p-value < 0.05 was considered to be statistically significant (Fig. 1).

Results

Characteristics of the study cohort

A total of 461 patients undergoing dialysis had finished the PSQI and the SF-12 during the period from September to December 2017. Overall, the prevalence of sleep disorders was 67.0%.

Among them, 94 patients (30.4%) took sedative–hypnotic medications to improve their sleep quality, and 215 patients (69.6%) did not take these drugs to control their sleep disorders. Of the total study population, the mean (SD) age was 54.96 ± 14.46 years, 56.6% were male, 25.9% had diabetes, 6.9% had CVD, and the median duration of CAPD was 40.00 months. Compared to the good sleepers, patients with sleep disorders were much older (57.76 ± 13.65 vs. 49.30 ± 14.45 years, $p < 0.001$), with lower levels of serum albumin (38.07 ± 4.38 vs. 39.66 ± 7.42 g/l, $p = 0.004$), higher levels of serum calcium (2.32 vs. 2.24 mmol/l, $p = 0.005$), lower levels of intact PTH (302.30 vs. 338.10 pg/ml, $p < 0.001$), higher PSQI scores (9.00 vs. 4.00, $p < 0.001$), higher rates of marriage (96.8% vs. 90.8%, $p = 0.007$), lower percentages of individuals having completed high school or above (22.3% vs. 42.1%, $p < 0.001$), and a lower employment rate (9.4% vs. 21.1%, $p = 0.001$). Again, the presence of comorbid conditions such as diabetes (28.8% vs. 19.7, $p = 0.033$) and CVD (9.4% vs. 2.0%, $p = 0.003$) was higher among patients with sleep disorders than among good sleepers. Both the PCS (71.88 vs. 81.25, $p < 0.001$) and MCS scores (74.63 vs. 78.63, $p < 0.001$) which indicated HRQOL, were decreased among poor sleepers compared with good sleeper. No significant difference was observed between the two groups regarding the patients' sex, BMI, duration of dialysis, dialysis modality, hemoglobin, serum creatinine, urine volume, serum phosphorus, or Kt/V (Table 1). Furthermore, compared to the patients with sleep disorders not taking sedative–hypnotic medications, patients with sleep disorders taking these drugs had a longer duration of dialysis (58.00 vs. 39.00 months, $p < 0.001$), with higher PSQI scores (12.00 vs. 8.00, $p < 0.001$), less urine volume (0.00 vs. 300.00 ml/day, $p < 0.001$), higher levels of intact PTH (346.20 vs. 281.15 pg/ml, $p = 0.009$), and lower levels of Kt/V (1.68 vs. 1.79, $p = 0.032$). Interestingly, the proportion of patients undergoing hemodialysis was higher in the sleep disorders with drugs group than in patients without drugs (77.7% vs. 48.4%, $p < 0.001$). The presence of comorbid conditions such as diabetes and CVD was not related to sedative–hypnotic medication use. No significant difference was observed regarding the patients' age, sex, marital status, educational level, occupational status, BMI, hemoglobin, serum creatinine, serum albumin, serum calcium, and serum phosphorus. HRQOL, which was indicated by the PCS and MCS scores, was the same in the two groups.

Factors associated with deterioration of the PCS scores

The median score of the PCS was 75.63 in the total dialysis patient population. We designated subjects whose scores were below those of the population median as having poor PCS. The results showed that the median score was 58.75 in the group with poor PCS; the value was 83.75 in the group with good PCS.

Univariate logistic regression analyses were performed for 19 independent variables: age, sex, marital status, educational level, occupational status, BMI, duration of dialysis, diabetes, CVD, sedative–hypnotic medication use, dialysis modality, urine volume, hemoglobin, serum creatinine, serum albumin, serum calcium, serum phosphorus, intact PTH, and Kt/V (Table 2). Among these variables, four items (older age, diabetes, CVD, and PD) were associated with PCS score deterioration, and four items (good education, employment, good sleep, and high levels of albumin) were associated with PCS score improvement in the univariate model. Multivariate logistic regression analysis revealed that PCS score deterioration was significantly associated with older age (OR 1.04, 95% CI 1.01–1.06), diabetes (OR 2.04, 95% CI 1.01–1.06), CVD (OR 4.69, 95% CI 1.75–12.59), and being on PD (OR 6.05, 95% CI 3.56–10.28) after adjustment for age, education, occupation, sedative–hypnotic medication use, diabetes, CVD, dialysis modality, albumin, phosphorus, and calcium (Table 3). In addition, more remarkably, compared with patients with sleep disorders who did not use sedative–hypnotic medications, dialysis patients without sleep disorders had the higher PCS score (OR 0.59, 95% CI 0.36–0.97); however, there was no difference between patients with sleep disorders who used sedative–hypnotic medications and those who did not.

Factors associated with MCS scores deterioration

The median score of the MCS was 76.13 in the total dialysis patient population. We designated those subjects whose scores were below those of the population median as having poor MCS. The results showed that the median score was 68.50 in the group with poor MCS; the value was 80.63 in the group with good MCS.

Table 1 Characteristics of all dialysis patients

Variable	Overall	Good sleepers	Sleep disorders		
			All sleep disorders	Without drugs	With drugs
	N = 461	*N* = 152	*N* = 309	*N* = 215	*N* = 94
Age	54.96 ± 14.46	49.30 ± 14.45	57.76 ± 13.65*	56.97 ± 13.69	59.58 ± 13.45
Male (%)	261 (56.6)	94 (61.8)	167 (54.0)	117 (54.4)	50 (53.2)
Married (%)	437 (94.8)	138 (90.8)	299 (96.8)*	208 (96.8)	91 (96.8)
High school or above (%)	133 (28.9)	64 (42.1)	69 (22.3)*	46 (21.4)	23 (24.5)
Employed (%)	61 (13.2)	32 (21.1)	29 (9.4)*	24 (11.2)	5 (5.3)
BMI	20.90 (18.71, 23.10)	20.55 (18.28, 22.81)	21.10 (19.03, 23.22)	21.24 (19.04, 23.44)	20.94 (18.93, 22.73)
Duration of dialysis (months)	40.00 (20.00, 65.75)	36.00 (19.00, 64.00)	40.00 (21.00, 67.00)	39.00 (19.00, 56.00)	58.00 (30.00, 100.50)▲
Diabetes (%)	119 (25.8)	30 (19.7)	89 (28.8)*	59 (27.7)	30 (31.9)
CVD (%)	32 (6.9)	3 (2.0)	29 (9.4)*	18 (8.5)	11 (11.7)
Hemodialysis (%)	253 (54.9)	76 (50.0)	177 (57.3)	104 (48.4)	73 (77.7)▲
PSQI scores	7.00 (5.00, 11.00)	4.00 (3.00, 5.00)	9.00 (7.00, 12.00)*	8.00 (7.00, 11.00)	12.00 (9.00, 15.00)▲
PCS scores	75.63 (58.75, 83.75)	81.25 (69.38, 87.50)	71.88 (53.75, 82.50)*	72.50 (54.22, 81.25)	70.00 (45.94, 83.75)
MCS scores	76.13 (68.25, 80.50)	78.63 (75.06, 83.06)	74.63 (64.00, 79.38)*	74.88 (64.69, 79.00)	74.25 (55.38, 80.38)
Hemoglobin (g/dl)	10.42 ± 1.37	10.48 ± 1.18	10.40 ± 1.46	10.38 ± 1.49	10.43 ± 1.39
Serum creatinine (mg/dl)	10.12 (8.38, 11.88)	10.49 (8.87, 12.29)	10.09 (8.27, 11.86)	10.07 (8.26, 11.82)	10.23 (8.24, 12.01)
Urine volume (ml/day)	200.00 (0.00, 500.00)	200.00 (0.00, 700.00)	200.00 (0.00, 500)	300.00 (0.00, 612.50)	0.00 (0.00, 200.00)▲
Albumin (g/l)	38.59 ± 5.61	39.66 ± 7.42	38.07 ± 4.38*	37.81 ± 4.60	38.65 ± 3.79
Calcium (mmol/l)	2.30 (2.16, 2.42)	2.24 (2.13, 2.39)	2.32 (2.17, 2.43)*	2.32 (2.17, 2.42)	2.31 (2.17, 2.49)
Phosphorus (mmol/l)	1.66 (1.37, 1.93)	1.66 (1.36, 1.92)	1.66 (1.40, 1.93)	1.64 (1.39, 1.92)	1.74 (1.44, 2.08)
Intact PTH (pg/ml)	306.80 (163.80, 530.85)	338.10 (170.90, 548.05)	302.30 (164.10, 531.20)*	281.15 (145.65, 493.95)	346.20 (215.25, 684.70)▲
Kt/V	1.76 (1.54, 2.02)	1.74 (1.53, 1.99)	1.76 (1.54, 2.03)	1.79 (1.57, 2.08)	1.68 (1.53, 1.92)▲

Mean ± SD or median (interquartile range) for continuous variables; percentages (frequencies) for categorical variables

CVD cardiovascular disease, *BMI* body mass index, *PSQI* Pittsburgh sleep quality, *PCS* physical component summary, *MCS* mental component summary, *PTH* parathyroid hormone, *Kt/V* urea clearance index

*$p < 0.05$ versus good sleepers; ▲$p < 0.05$ versus sleep disorders without drugs;

Table 2 Univariate logistic regression model for factors associated with PCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.03	1.02–1.05	< 0.001**
Sex (male vs. female)	0.94	0.65–1.36	0.738
Marital status (married vs. unmarried)	1.20	0.53–2.73	0.667
Education (high school or above vs. junior high school or below)	0.58	0.39–0.88	0.010*
Occupation (employed vs. unemployed)	0.56	0.32–0.97	0.039*
Sedative–hypnotic medications			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers without drug	0.40	0.26–0.62	< 0.001**
Sleep disorders with drug	1.06	0.65–1.72	0.831
Diabetes	2.38	1.54–3.68	< 0.001**
CVD	4.78	1.93–11.85	0.001**
Duration of dialysis (months)	1.00	0.99–1.00	0.162
Dialysis modality (PD vs. HD)	2.33	1.60–2.39	< 0.001**
BMI	1.03	0.97–1.09	0.298
Urine volume	1.00	1.00–1.00	0.160
Hemoglobin (g/dl)	0.93	0.82–1.07	0.299
Serum creatinine (mg/dl)	0.98	0.92–1.05	0.605
Albumin	0.96	0.92–1.00	0.041*
Phosphorus	0.76	0.51–1.13	0.762
Calcium	3.64	1.48–8.97	0.005**
iPTH	1.00	1.00–1.00	0.145
Kt/V	1.54	0.91–2.59	0.105

PCS physical component summary, *CVD* cardiovascular disease, *BMI* body mass index, *PD* peritoneal dialysis, *HD* hemodialysis, *iPTH* intact parathyroid hormone, *Kt/V* urea clearance index

*$p < 0.05$; **$p < 0.01$

Univariate logistic regression analyses were performed for 19 independent variables: age, sex, marital status, educational level, occupational status, BMI, duration of dialysis, diabetes, CVD, sedative–hypnotic medication use, dialysis modality, urine volume, hemoglobin, serum creatinine, serum albumin, serum calcium, serum phosphorus, intact PTH, and *Kt/V* (Table 4). Among these variables, six items (older age, diabetes, CVD, PD, higher levels of calcium, and *Kt/V*) were associated with MCS score deterioration, and three items (good education, employment, and good sleep) were associated with MCS score improvement in the univariate model. Multivariate logistic regression analysis revealed that MCS score deterioration was significantly associated with diabetes (OR 1.91, 95% CI 1.13–3.24), CVD (OR 6.28, 95% CI 2.21–17.81), and being on PD (OR 4.97, 95% CI 2.85–8.67) after adjustment for age, marital status, education, occupation, sedative–hypnotic medication use, diabetes, CVD, dialysis modality, and *Kt/V* (Table 5).

Table 3 Multivariate logistic regression model for factors associated with PCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.04	1.01–1.06	0.001**
Education (high school or above vs. junior high school or below)	0.98	0.55–1.73	0.977
Occupation (employed vs. unemployed)	0.78	0.39–1.53	0.462
Sedative–hypnotic medicines			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers	0.59	0.36–0.97	0.038*
Sleep disorders with drug	1.67	0.94–2.98	0.080
Diabetes	2.04	1.21–3.44	0.007**
CVD	4.69	1.75–12.59	0.002**
Dialysis modality (PD vs. HD)	6.05	3.56–10.28	< 0.001**
Albumin (g/l)	1.00	0.96–1.04	0.899
Phosphorus (mmol/l)	0.65	0.41–1.03	0.065
Calcium (mmol/l)	1.48	0.49–4.47	0.487

PCS physical component summary, *CVD* cardiovascular disease, *PD* peritoneal dialysis, *HD* hemodialysis

*$p < 0.05$; **$p < 0.01$

Furthermore, compared to unmarried patients, those who were married had a higher MCS score. Again, compared with patients with sleep disorders who did not use sedative–hypnotic medications, good sleepers had the higher MCS score (OR 0.45, 95% CI 0.27–0.74); however, there was no difference between patients with sleep disorders who used sedative–hypnotic medications and those who did not.

Differences in PCS and MCS scores among the three groups categorized by sleep disorders and sedative–hypnotic medication use

Table 1 presents a comparison of the PCS and MCS scores among the three groups categorized according to sleep disorders and sleep medication use: good sleepers, sleep disorders without sedative–hypnotic medications, and sleep disorders with sedative–hypnotic medications. Among the three groups, this value was significantly different. Compared to the good sleepers, both patients with sleep disorders who did not use sedative–hypnotic medications and those who did use these drugs had lower PCS scores (72.50 vs. 81.25, $p < 0.001$; 70.00 vs. 81.25, $p < 0.001$). Similarly, compared to the good sleepers, both patients with sleep disorders who did not use sedative–hypnotic medications and those who did use these drugs had lower MCS scores (74.88 vs. 78.63, $p < 0.001$; 74.25 vs. 78.63, $p < 0.001$); however, neither PCS scores nor MCS scores showed any significant difference between the two sleep disorder groups.

Table 4 Univariate logistic regression model for factors associated with MCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.01	1.00–1.03	0.028*
Sex (male vs. female)	0.76	0.53–1.11	0.153
Marital status (married vs. unmarried)	0.61	0.26–1.43	0.259
Education (high school or above vs. junior high school or below)	0.65	0.43–0.98	0.039*
Occupation (employed vs. unemployed)	0.49	0.28–0.86	0.012*
Sedative–hypnotic medications			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers	0.35	0.23–0.54	< 0.001**
Sleep disorders with drug	1.00	0.61–1.64	0.995
Diabetes	2.01	1.31–3.09	0.001**
CVD	5.69	2.15–15.04	< 0.001**
Duration of dialysis (months)	1.00	0.99–1.00	0.083
Dialysis modality (PD vs. HD)	2.68	1.84–3.92	< 0.001**
BMI	1.04	0.99–1.11	0.150
Urine volume	1.00	1.00–1.00	0.281
Hemoglobin (g/dl)	0.95	0.83–1.08	0.433
Serum creatinine (mg/dl)	0.98	0.92–1.05	0.605
Albumin	0.98	0.95–1.02	0.334
Phosphorus (mmol/l)	1.04	0.71–1.54	0.832
Calcium (mmol/l)	5.24	2.07–13.25	< 0.001**
iPTH (pg/ml)	1.00	1.00–1.00	0.098
Kt/V	2.15	1.26–3.68	0.005**

MCS mental component summary, *CVD* cardiovascular disease, *BMI* body mass index, *PD* peritoneal dialysis, *HD* hemodialysis, *iPTH* intact parathyroid hormone, *Kt/V* urea clearance index

*$p < 0.05$; **$p < 0.01$

Table 5 Multivariate logistic regression model for factors associated with MCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.02	1.00–1.04	0.073
Marital status (married vs. unmarried)	0.23	0.76–0.68	0.008**
Education (high school or above vs. junior high school or below)	0.78	0.44–1.37	0.382
Occupation (employed vs. unemployed)	0.57	0.29–1.15	0.574
Sedative–hypnotic medicines			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers	0.45	0.27–0.74	0.002**
Sleep disorders with drug	1.43	0.80–2.54	0.226
Diabetes	1.91	1.13–3.24	0.016*
CVD	6.28	2.21–17.81	0.001**
Dialysis modality (PD vs. HD)	4.97	2.85–8.67	< 0.001**
Calcium (mmol/l)	2.28	0.79–6.59	0.128
Kt/V	1.19	0.61–2.33	0.603

MCS mental component summary, *CVD* cardiovascular disease, *PD* peritoneal dialysis, *HD* hemodialysis, *Kt/V* urea clearance index

*$p < 0.05$; **$p < 0.01$

Discussion

In the present study, we found that the prevalence of sleep disorders was 67.0% among patients undergoing dialysis and, furthermore, that 30.4% of these patients with sleep disorders took sedative–hypnotic medications to improve their sleep quality. Sleep disorders were associated with low PCS and MCS scores. However, neither PCS nor MCS scores showed any significant difference between patients with sleep disorders who used sedative–hypnotic medications compared with those who did not.

The incidence rate of sleep disorders among dialysis patients (67.0%) in the present study was the same as reported before (30–80%) [1, 8]. However, the percentage of dialysis patients with sleep disorders using sedative–hypnotic medications (30.4%) was much higher than those reported in the United States (13.7%) [18]; it was, however, the same as we reported before among patients undergoing PD from the other PD center at the First Affiliated Hospital of Sun Yat-sen University [19]. A possible reason is that, in the previous studies, dialysis patients both with and without sleep disorders were recruited. However, both in this study and in our previous study from the other PD center, the percentage of such drug use was only assessed among dialysis patients with sleep disorders [19].

Previous studies confirmed that poor sleepers had significantly lower MCS and PCS scores among patients undergoing dialysis than did good sleepers [20–22]. Compatible with these results, we obtained the same result in that both the MCS scores and the PCS scores were significantly lower for poor sleepers than for good sleepers in dialysis patients. Sasai et al. [7] found that sleep medication was useful to improve MCS scores, but it might degrade PCS scores among the poor sleepers. However, in the present study, it was found that neither PCS nor MCS scores showed any significant difference between dialysis patients with sleep disorders who used sedative–hypnotic medications and those who did not. One possible reason is that the patients in our study who were undergoing dialysis were more vulnerable to sleep problems, while the previous study used the general population for the analysis.

The results of the multiple logistic regression analysis showed that older age was associated with the deterioration of PCS scores, which was the same as shown in previous studies [23, 24]. A possible reason is that the physiological function of the body was declining during aging. However, there was no association between older age and MCS score. The existence of complications such as diabetes and CVD were associated with lower PCS scores and MCS scores,

which made these patients suffer more. Based on previous studies, whether HD or PD provide a better QOL was still controversial [25]. In this study, patients undergoing PD had both lower PCS and MCS scores than those undergoing HD, even though patients with HD were older, had a longer duration of dialysis, a lower employment rate, a higher diabetes rate and a higher CVD rate, all of which would reduce QOL. The most likely cause was that patients undergoing HD had more leisure time to communicate with each other. Interestingly, being married was associated with a higher PCS score. One of the possible reasons was that married patients had spouses to take care of them, which made them feel less lonely and less stressed. In addition to these factors, good sleepers had significantly higher PCS and MCS scores.

The most remarkable finding of this study was the association of sedative–hypnotic medication use with mental QOL and physical QOL: multiple logistic analysis revealed that sedative–hypnotic medication use was not associated with PCS scores or with MCS scores among patients undergoing dialysis. To our knowledge, few reports have described the relevant evaluation of the association between sedative–hypnotic medication use and QOL, especially in dialysis patients. Furthermore, Zammit et al. [26] showed the same results in his study, finding no differences in both PCS scores and MCS scores between poor sleepers receiving treatment versus those who were not treated in the general population. On the other hand, another study showed that sleep medication was useful to improve MCS scores, but it might degrade PCS scores among poor sleepers in the general population [7]. In our study, the analysis was done among patients undergoing dialysis, while the two studies above performed their analyses on the general population. Inconsistent with Taeko Sasai's result, the present study showed that sedative–hypnotic medications did not affect the QOL of patients undergoing dialysis with sleep disorders. This fact might be reflected in the results showing that poor sleepers with sedative–hypnotic medication use had higher PSQI scores than did those without such drug use. Many reports have described that more severe the sleep disorders were associated with lower levels of HRQoL [10, 27, 28]. However, the quality of life when compared between these poor sleepers taking sedative–hypnotic medications and those not taking these drugs was the same. Therefore, sedative–hypnotic medications might improve quality of life, helping patients with lower sleep quality have the same quality of life as the patients with higher sleep quality. In our previous study, we found that there was no association between these agents and all-cause mortality in CAPD patients with sleep disorders [19]. According to the above analysis, sedative–hypnotic medication use is one treatment option for the patients undergoing dialysis with sleep disorders.

This study has several limitations. First, this was a cross-sectional study of dialysis patients from a single center, and the data on sleep quality and HRQOL were measured only once, when the dialysis patients were recruited. The PCS and MCS scores were not tracked, so we could not compare the quality of life between before and after sedative–hypnotics use. Second, sleep disorders in the patients undergoing dialysis were diagnosed only through the PSQI score, which is a semiquantitative and subjective measurement. Comprehensive polysomnography and the Multiple Sleep Latency Test, which are objective and quantitative tools, were not performed. Finally, it was impossible to obtain detailed information about medication usage, including the kind and dosage of medication or the duration of use.

Conclusively, the results of this study demonstrate that the incidence rate of sleep disorders among dialysis patients was 67.0% and that 30.4% of these patients with sleep disorders took sedative–hypnotic medications. Sleep disorders were associated with low scores of PCS and MCS. However, sedative–hypnotic medication use was neither associated with PCS nor with MCS scores among patients with sleep disorders undergoing dialysis.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix

See Tables 6, 7, 8, 9, 10 and 11.

Table 6 Type and dosage of sedative–hypnotic drugs use in dialysis patients with sleep disorders ($N=94$)

Generic substance	*N*	%
Alprazolam	11	11.7
Diazepam	3	3.2
Estazolam	57	60.6
Clonazepam	13	13.8
Zolpidem	4	4.3
Alprazolam or Estazolam▲	1	1.1
Eatazolam or Zolpidem▲	3	3.2
Estazolam and Zolpidem*	2	2.1

▲Patients took two sedative–hypnotic medicines successively, none of them took more than one of these drugs at a time

*Patients took two sedative–hypnotic medicines together

Table 7 Characteristics of all dialysis patients

Variable	Overall *N* = 461	Hemodialysis *N* = 253	Peritoneal dialysis *N* = 208
Age	54.96 ± 14.46	59.48 ± 14.17	49.49 ± 12.86*
Male (%)	261 (56.6)	158 (62.5)	103 (49.5)*
Married (%)	437 (94.8)	246 (97.2)	191 (91.8)*
High school or above (%)	133 (28.9)	51 (20.2)	82 (39.4)*
Employed (%)	61 (13.2)	22 (9.5)	39 (18.8)*
BMI	20.90 (18.71, 23.10)	20.90 (18.61, 23.05)	20.90 (18.86, 23.18)
Duration of dialysis (months)	40.00 (20.00, 65.75)	46.00 (28.00, 87.50)	34.00 (17.00, 50.00)*
Diabetes (%)	119 (25.8)	77 (30.4)	42 (20.2)*
CVD (%)	32 (6.9)	27 (10.7)	5 (2.4)*
PSQI scores	7.00 (5.00, 11.00)	7.00 (5.00, 11.00)	7.00 (5.00, 10.00)
Prevalence of sleep disorders (%)	309 (67.0)	177 (70.0)	132 (63.5)
PCS scores	75.63 (58.75, 83.75)	78.75 (59.38, 87.50)	71.25 (58.75, 80.00)*
MCS scores	76.13 (68.25, 80.50)	78.13 (71.44, 81.56)	74.63 (66.13, 78.38)*
Hemoglobin (g/dl)	10.42 ± 1.37	10.40 ± 1.33	10.46 ± 1.42
Serum creatinine (mg/dl)	10.12 (8.38, 11.88)	9.16 (7.92, 10.62)	11.60 (9.84, 13.30)*
Urine volume (ml/day)	200.00 (0.00, 500.00)	0.00 (0.00, 300)	500.00 (100.00, 900.00)*
Albumin (g/l)	38.59 ± 5.61	39.62 ± 4.05	38.56 ± 7.06
Calcium (mmol/l)	2.30 (2.16, 2.42)	2.24 (2.11, 2.36)	2.36 (2.23, 2.45)*
Phosphorus (mmol/l)	1.66 (1.37, 1.93)	1.64 (1.34, 1.93)	1.69 (1.43, 1.93)
Intact PTH (pg/ml)	306.80 (163.80, 530.85)	337.10 (164.70, 593.10)*	274.20 (166.50, 463.80)**
Kt/*V*	1.76 (1.54, 2.02)	1.63 (1.45, 1.81)	1.93 (1.74, 2.18)*

Mean ± SD or median (interquartile range) for continuous variables; percentages (frequencies) for categorical variables

CVD cardiovascular disease, *BMI* body mass index, *PSQI* Pittsburgh sleep quality, *PCS* physical component summary, *MCS* mental component summary, *PTH* parathyroid hormone, *Kt*/*V* urea clearance index

*$p < 0.05$ versus hemodialysis

Table 8 Univariate logistic regression model for factors associated with PCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.03	1.02–1.05	< 0.001**
Sex (male vs. female)	0.94	0.65–1.36	0.738
Marital status (married vs. unmarried)	1.20	0.53–2.73	0.667
Education (high school or above vs. junior high school or below)	0.58	0.39–0.88	0.010*
Occupation (employed vs. unemployed)	0.56	0.32–0.97	0.039*
Sedative–hypnotic medications			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers without drug	0.40	0.26–0.62	< 0.001**
Sleep disorders with drug	1.06	0.65–1.72	0.831
Diabetes	2.38	1.54–3.68	< 0.001**
CVD	4.78	1.93–11.85	0.001**
Duration of dialysis (months)	1.00	0.99–1.00	0.162
BMI	1.03	0.97–1.09	0.298
Urine volume	1.00	1.00–1.00	0.160
Hemoglobin (g/dl)	0.93	0.82–1.07	0.299
Serum creatinine (mg/dl)	0.98	0.92–1.05	0.605
Albumin	0.96	0.92–1.00	0.041*
Phosphorus	0.76	0.51–1.13	0.762

Table 8 (continued)

Variable	OR	95% CI	*p*-value
Calcium	3.64	1.48–8.97	0.005**
iPTH	1.00	1.00–1.00	0.145
Kt/V	1.54	0.91–2.59	0.105
Dialysis schedule and vascular access			
HD patients with arteriovenous fistulas	Ref	Ref	Ref
HD patients with a tunneled catheter	2.07	1.09–3.93	0.025*
CAPD	2.64	1.65–4.23	< 0.001**
DAPD	1.94	1.17–3.21	0.010*

PCS physical component summary, *CVD* cardiovascular disease, *BMI* body mass index, *PD* peritoneal dialysis, *HD* hemodialysis, *iPTH* intact parathyroid hormone, *Kt/V* urea clearance index, *DAPD* daytime ambulatory peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

*$p < 0.05$; **$p < 0.01$

Table 9 Univariate logistic regression model for factors associated with MCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.01	1.00–1.03	0.028*
Sex (male vs. female)	0.76	0.53–1.11	0.153
Marital status (married vs. unmarried)	0.61	0.26–1.43	0.259
Education (high school or above vs. junior high school or below)	0.65	0.43–0.98	0.039*
Occupation (employed vs. unemployed)	0.49	0.28–0.86	0.012*
Sedative–hypnotic medications			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers	0.35	0.23–0.54	< 0.001**
Sleep disorders with drug	1.00	0.61–1.64	0.995
Diabetes	2.01	1.31–3.09	0.001**
CVD	5.69	2.15–15.04	< 0.001**
Duration of dialysis (months)	1.00	0.99–1.00	0.083
BMI	1.04	0.99–1.11	0.150
Urine volume	1.00	1.00–1.00	0.281
Hemoglobin (g/dl)	0.95	0.83–1.08	0.433
Serum creatinine (mg/dl)	0.98	0.92–1.05	0.605
Albumin	0.98	0.95–1.02	0.334
Phosphorus (mmol/l)	1.04	0.71–1.54	0.832
Calcium (mmol/l)	5.24	2.07–13.25	< 0.001**
iPTH (pg/ml)	1.00	1.00–1.00	0.098
Kt/V	2.15	1.26–3.68	0.005**
Dialysis schedule and vascular access			
HD patients with arteriovenous fistulas	Ref	Ref	Ref
HD patients with a tunneled catheter	2.24	1.18–4.23	0.013*
CAPD	1.92	1.20–3.07	0.006**
DAPD	2.35	1.42–3.88	0.001**

MCS mental component summary, *CVD* cardiovascular disease, *BMI* body mass index, *PD* peritoneal dialysis, *HD* hemodialysis, *iPTH* intact parathyroid hormone, *Kt/V* urea clearance index, *DAPD* daytime ambulatory peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

*$p < 0.05$; **$p < 0.01$

Table 10 Multivariate logistic regression model for factors associated with PCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.03	1.01–1.06	0.003**
Education (high school or above vs. junior high school or below)	1.00	0.56–1.78	1.00
Occupation (employed vs. unemployed)	0.74	0.37–1.47	0.387
Sedative–hypnotic medicines			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers	0.58	0.35–0.96	0.033*
Sleep disorders with drug	1.67	0.94–2.98	0.082
Diabetes	2.07	1.23–3.51	0.007**
CVD	4.73	1.75–12.79	0.002**
Albumin (g/l)	1.00	0.96–1.05	0.842
Phosphorus (mmol/l)	0.65	0.41–1.03	0.069
Calcium (mmol/l)	1.72	0.57–5.34	0.346
Dialysis schedule and vascular access			
HD patients with arteriovenous fistulas	Ref	Ref	Ref
HD patients with a tunneled catheter	1.64	0.78–3.47	0.193
CAPD	5.42	2.90–10.13	< 0.001**
DAPD	7.86	4.14–14.90	< 0.001**

PCS physical component summary, *CVD* cardiovascular disease, *PD* peritoneal dialysis, *HD* hemodialysis, *DAPD* daytime ambulatory peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

*$p < 0.05$; **$p < 0.01$

Table 11 Multivariate logistic regression model for factors associated with MCS among patients undergoing dialysis

Variable	OR	95% CI	*p*-value
Age	1.02	1.00–1.04	0.118
Marital status (married vs. unmarried)	0.24	0.08–0.73	0.012*
Education (high school or above vs. junior high school or below)	0.78	0.44–1.38	0.385
Occupation (employed vs. unemployed)	0.56	0.28–1.13	0.563
Sedative–hypnotic medicines			
Sleep disorders without drug	Ref	Ref	Ref
Good sleepers	0.45	0.27–0.75	0.002**
Sleep disorders with drug	1.43	0.80–2.55	0.223
Diabetes	1.92	1.13–3.26	0.016*
CVD	6.29	2.21–17.93	0.001**
Calcium (mmol/l)	2.48	0.84–7.31	0.101
Kt/V	1.13	0.58–2.22	0.722
Dialysis schedule and vascular access			
HD patients with arteriovenous fistulas	Ref	Ref	Ref
HD patients with a tunneled catheter	1.53	0.73–3.21	0.266
CAPD	5.08	2.64–9.77	< 0.001**
DAPD	5.72	2.93–11.17	< 0.001**

MCS mental component summary, *CVD* cardiovascular disease, *PD* peritoneal dialysis, *HD* hemodialysis, *Kt/V* urea clearance index, *DAPD* daytime ambulatory peritoneal dialysis, *CAPD* continuous ambulatory peritoneal dialysis

*$p < 0.05$; **$p < 0.01$

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