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Original Article

Quality of sleep and health-related quality of life in haemodialysis patients

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Abstract

Background. Sleep complaints are common in haemodialysis patients. In the general population, insomnia impacts negatively on health-related quality of life (HRQoL). The objective of this study was to examine the association between quality of sleep and HRQoL in haemodialysis patients independent of known predictors of HRQoL.

Methods. Quality of sleep was measured using the Pittsburgh Sleep Quality Index (PSQI) and HRQoL was measured using the Medical Outcomes Study 36-item Short Form (SF-36) in 89 haemodialysis patients.

Results. Sixty-three (71%) subjects were 'poor sleepers' (global PSQI >5). The SF-36 mental component summary (MCS) and physical component summary (PCS) correlated inversely with the global PSQI score (MCS, $r=-0.28$, $P<0.01$; PCS, $r=-0.45$, $P<0.01$). The PCS score also correlated with age ($r=-0.24$, $P=0.02$), haemoglobin ($r=0.21$, $P=0.048$) and comorbidity ($r=-0.40$, $P<0.01$), and mean PCS was lower in depressed subjects (26.2 *vs* 35.9, $P=0.02$). Subjects with global PSQI >5 had a higher prevalence of depression, lower haemoglobin and lower HRQoL in all SF-36 domains. The global PSQI score was a significant independent predictor of the MCS and PCS after controlling for age, sex, haemoglobin, serum albumin, comorbidity and depression in multivariate analysis.

Conclusions. Poor sleep is common in dialysis patients and is associated with lower HRQoL. We hypothesize that end-stage renal disease directly influences quality of sleep, which in turn impacts on HRQoL.

Keywords: chronic renal failure; comorbidity; haemodialysis; quality of life; sleep

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Introduction

Sleep complaints are common in patients with end-stage renal disease (ESRD) on dialysis and include delayed sleep onset, frequent awakening, restlessness and daytime sleepiness [1–3]. Polysomnographic studies have documented a high prevalence of sleep disturbance in dialysis patients including obstructive sleep apnea (OSA), periodic movement of the legs during sleep (PMLS) and spontaneous arousals [4–6]. In the general population, insomnia and OSA are associated with decreased health-related quality of life (HRQoL) [7–9]. The onset of ESRD and dialysis impacts significantly on functional state and HRQoL [10]. Factors that have been shown in various studies to be associated with HRQoL in dialysis patients include haemoglobin, socio-economic level, education level, dialysis schedule, race, physical exercise, comorbidity, diabetes, intermittent claudication, previous failed transplant, sex, depression and nutritional status [10]. Previous studies have demonstrated an association between sleep disturbance and physical and mental well-being in dialysis patients [3].

The objectives of the present study were to determine the prevalence of 'poor sleep' in patients with ESRD on maintenance haemodialysis using a validated sleep quality questionnaire and to examine the association between quality of sleep and HRQoL while controlling for known predictors of HRQoL in this population.

Subjects and methods

This was a cross-sectional study of prevalent patients undergoing haemodialysis in the haemodialysis units associated with Kingston General Hospital. The subjects were recruited from a population of haemodialysis patients already enrolled in a 2 year longitudinal study of HRQoL. Quality of sleep was measured concurrently with the evaluation of HRQoL

and the other variables at the 6 month mark of the longitudinal study. All of the variables were measured concurrently. Patients were excluded if they were <18 years of age, had been on dialysis for <6 months, if they were unable to understand English or if they were not competent to give informed consent. The Queen's University Research Ethics Board approved the protocol.

Quality of sleep

Quality of sleep was measured using the Pittsburgh Sleep Quality Index (PSQI) [11]. This self-administered questionnaire assesses quality of sleep during the previous month and contains 19 self-rated questions yielding seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications and daytime dysfunction. Each component is scored from 0 to 3, yielding a global PSQI score between 0 and 21, with higher scores indicating lower quality of sleep. The PSQI is useful in identifying good and poor sleepers. A global PSQI score >5 indicates that a person is a 'poor sleeper' having severe difficulties in at least two areas or moderate difficulties in more than three areas [11].

Quality of life

HRQoL was measured with the Medical Outcomes Study 36-item Short Form (SF-36) [12,13]. This instrument has been used extensively in populations of patients with renal disease [10]. The SF-36 is a 36-item self-administered questionnaire that yields scores for eight domains of HRQoL (physical functioning, role limitations physical, bodily pain, general health perceptions, vitality, social functioning, role limitations emotional and mental health) as well as two summary scores, a mental component summary score (MCS) and a physical component summary score (PCS). Each of the eight domains is scored out of 100, with higher scores indicating better functioning. The MCS and PCS scores are standardized to a mean (SD) of 50 [10], with scores above and below 50 indicating above and below average functioning, respectively.

Comorbidity

Comorbidity was measured using the modified Charlson Comorbidity Index (CCI) [14]. The CCI has been validated in dialysis patients and is a strong predictor of clinical outcomes in this population [14]. The CCI is a composite score of multiple comorbid conditions and age. Comorbid conditions are given a score ranging from 1 to 6 and a score of 1 is added for each decade above 40 years of age. For the purpose of this study the comorbid conditions were determined by chart review and scored accordingly; however, age was not included in the index in order to examine the influence of age on HRQoL independent of comorbidity.

Other variables

Age, sex, cause of renal disease, time on dialysis and presence of partner were determined by interview and chart review. Serum albumin (Bromcresol purple method), haemoglobin and single pool Kt/V (estimated from urea reduction ratio) were also measured. Depression was recorded as present if the subject was taking anti-depressant medication for depressed mood.

Analysis

The analysis was performed using statistical software SAS® System for Windows™ release 6.12 (SAS Institute Inc., Cary, NC, USA). Spearman correlation coefficients were used to examine associations between continuous variables. Student's t-test was used to compare the means of normally distributed variables between 'good sleepers' (global PSQI $\leqslant 5$) and 'poor sleepers' (global PSQI >5), and the Mann–Whitney U test was used for variables that were not normally distributed. Differences among categorical variables were analysed using the χ^2 test or two-tailed Fisher's exact test as appropriate. The level of significance was $\alpha = 0.05$ for all comparisons. Multiple linear regression with forward stepwise selection ($\alpha = 0.05$) was performed to identify factors independently associated with MCS and PCS scores. The multivariate analysis was repeated forcing age, sex, haemoglobin, serum albumin, comorbidity and presence of depression in the model to examine the association between the global PSQI score and PCS and MCS scores while controlling for these variables. The MCS and PCS were used as the outcome variables in preference to the individual domains of the SF-36 to limit the number of regressions.

Results

Univariate analysis

Of 155 patients available to enter the longitudinal study, 32 did not meet inclusion criteria. By 6 months, one subject left the study, and six subjects died. The remaining 116 subjects were invited to enter the cross-sectional study. Twenty subjects did not complete the PSQI and seven did not complete the SF-36. Eighty-nine subjects were included in the analysis.

The characteristics of the 89 subjects are shown in Table 1. Eighty-eight subjects were Caucasian, one was Native Canadian and five had failed renal allografts. The causes of renal disease were: glomerulonephritis 12, diabetic nephropathy 22, vascular/hypertension 25, obstruction eight, interstitial nephritis six, polycystic kidney disease five and unknown 11. The majority of subjects attended haemodialysis for 4 h three times weekly. One subject underwent slow nocturnal dialysis six times weekly.

The mean (SD) global and component PSQI scores are shown in Table 1. The global PSQI score ranged from 0 to 20, and 63 (71%) subjects were 'poor sleepers' (global PSQI >5). For subjects who recorded the cause of sleep disturbance, five described restless legs and one described trouble breathing. The mean PSQI component scores for the study population and for normal controls (from 11) are shown in Figure 1.

The mean (SD) scores for SF-36 MCS, PCS and HRQoL domains are shown in Table 1. The MCS ranged from 19.1 to 68.7, while the PCS ranged from 12.8 to 62.0. The mean PCS was statistically lower than the standardized average of 50 ($P<0.01$), while the MCS was not.

Table 1. Characteristics of the 89 subjects included in the study

Variable	*n* (%)	Mean (SD)
Age (years)		60.1 (16.8)
Females (*n*)	34 (38.2)	
Time on dialysis (months)		49.4 (48.1)
Living alone (*n*)	25 (28.1)	
Depressed (*n*)	11 (12.4)	
Haemoglobin (g/l)		115.6 (11.6)
Serum albumin (g/l)		37.4 (4.2)
Kt/V		1.79 (0.39)
Quality of sleep		
Global PSQI		8.7 (4.5)
Subjective sleep quality		1.21 (0.85)
Sleep latency		1.43 (1.16)
Sleep duration		1.10 (1.07)
Sleep efficiency		1.35 (1.28)
Sleep disturbance		1.45 (0.62)
Use of sleep medications		1.09 (1.35)
Daytime dysfunction		1.08 (0.69)
Quality of life		
MCS		48.8 (11.5)
PCS		34.7 (12.6)
Physical functioning		49.6 (31.5)
Role-physical		36.2 (42.6)
Bodily pain		60.2 (31.3)
General health		46.7 (25.1)
Vitality		43.1 (23.5)
Social functioning		63.5 (44.6)
Role emotional		63.7 (44.6)
Mental health		73.4 (20.1)

MCS, SF-36 Mental Component Summary. PCS, SF-36 Physical Component Summary. PSQI, Pittsburgh Sleep Quality Index.

The mean (SD) CCI was 4.45 (2.1) with a range of 2–11. The frequencies of comorbid conditions included in the CCI are shown in Table 2.

The age and sex distribution of the 27 subjects who did not complete the PSQI or SF-36 questionnaires were similar to the study population. The mean (SD) age was 61.4 (14.2) years, and eight (29.6%) were female.

Bivariate analysis

The correlations between MCS and PCS and the other continuous variables are shown in Table 3.

Table 2. Frequencies of comorbid conditions included in the modified Charlson Comorbidity Index among the 89 study subjects

Comorbidity score	Condition	Number (%)
1	Coronary artery disease	32 (36.0)
	Congestive heart failure	11 (12.4)
	Peripheral vascular disease	13 (14.6)
	Cerebrovascular disease	13 (14.6)
	Dementia	1 (1.1)
	Chronic pulmonary disease	9 (10.1)
	Connective tissue disorder	3 (3.4)
	Peptic ulcer disease	40 (44.9)
	Mild liver disease	2 (2.2)
	Diabetes	26 (29.2)
2	Hemiplegia	1 (1.1)
	Severe renal disease	89 (100)
	Diabetes with end-organ damage	26 (29.2)
	Any tumour, leukaemia, lymphoma	17 (19.1)
3	Moderate or severe liver disease	2 (2.2)
6	Metastatic solid tumour	0 (0.0)
	AIDS	0 (0.0)

Table 3. Correlation coefficients for the SF-36 MCS and PCS and the other continuous variables among the 89 study subjects

Variable	MCS		PCS	
	r	*P*	*r*	*P*
Age	−0.01	0.96	−0.24	0.02
Time on dialysis	−0.21	0.052	−0.13	0.24
Haemoglobin	0.12	0.27	0.21	0.048
Serum albumin	−0.01	0.95	0.18	0.08
Kt/V	−0.03	0.75	−0.10	0.33
CCI	−0.08	0.46	−0.40	<0.01
Global PSQI	−0.28	<0.01	−0.45	<0.01
Subjective sleep quality	−0.21	0.046	−0.20	0.06
Sleep latency	−0.06	0.56	−0.14	0.19
Sleep duration	−0.00	0.98	−0.08	0.43
Sleep efficiency	−0.10	0.36	−0.38	<0.01
Sleep disturbance	−0.27	<0.01	−0.48	<0.01
Use of sleep medications	−0.32	<0.01	−0.39	<0.01
Daytime dysfunction	−0.51	<0.01	−0.36	<0.01

r, correlation coefficient. *P*, *P*-value for the correlation. MCS, SF-36 Mental Component Summary. PCS, SF-36 Physical Component Summary. CCI, modified Charlson Comorbidity Index. PSQI, Pittsburgh Sleep Quality Index.

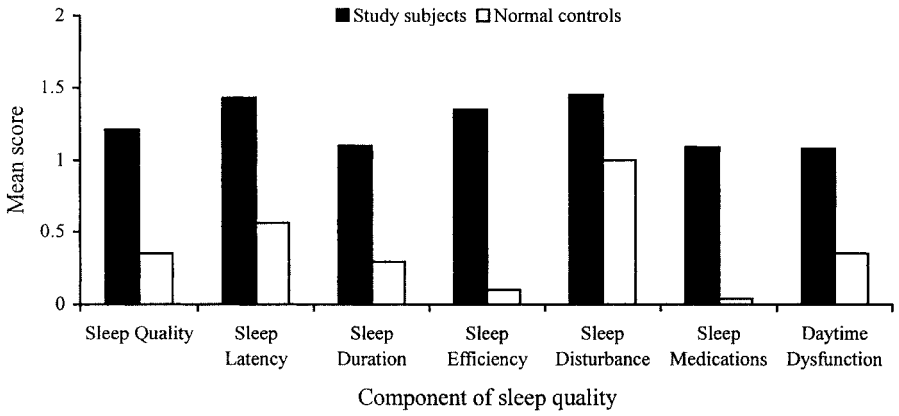

Fig. 1. Mean scores for components of the PSQI for the 89 study subjects and for normal controls. Data for normal controls is from Buysse *et al.* [11].

Table 4. Correlation coefficients for the PSQI and the other continuous variables in the 89 study subjects

Variable	Global PSQI	
	r	*P*
Age	−0.05	0.61
Time on dialysis	0.16	0.15
Haemoglobin	−0.27	<0.01
Serum albumin	−0.24	0.02
Kt/V	0.11	0.30
CCI	0.03	0.80
MCS	−0.28	<0.01
PCS	−0.45	<0.01
Physical functioning	−0.37	<0.01
Role-physical	−0.45	<0.01
Bodily pain	−0.54	<0.01
General health	−0.32	<0.01
Vitality	−0.36	<0.01
Social functioning	−0.34	<0.01
Role-emotional	−0.40	<0.01
Mental health	−0.31	<0.01

r, correlation coefficient. *P*, *P*-value. MCS, SF-36 Mental Component Summary. PCS, SF-36 Physical Component Summary. CCI, modified Charlson Comorbidity Index. PSQI, Pittsburgh Sleep Quality Index.

There was significant inverse correlation between MCS and global PSQI score. There was significant correlation between PCS and haemoglobin, and inverse correlations between PCS and age, CCI, and global PSQI score. For categorical variables, the mean PCS was lower in those with depression compared with those without (PCS 26.2 *vs* 35.9, $P=0.02$). The mean MCS and PCS were not different for females *vs* males, or for subjects who lived alone *vs* those with a partner.

The correlations between the global PSQI score and the other continuous variables are shown in Table 4. There were significant inverse correlations of global PSQI score with haemoglobin, serum albumin, MCS and PCS. For categorical variables, the mean global PSQI score was higher in those with depression compared with those without (12.36 *vs* 8.19, $P<0.01$). The mean global PSQI score was not different for females *vs* males, or for subjects who lived alone *vs* those with a partner.

The characteristics of 'good sleepers' (global PSQI $\leqslant 5$) compared with 'poor sleepers' (global PSQI >5) are shown in Table 5. Compared with 'good sleepers', 'poor sleepers' had a greater proportion of depressed subjects, lower haemoglobin and lower HRQoL in all domains. The mean SF-36 domain scores for 'good sleepers', 'poor sleepers' and age/sex matched Canadian norms (from 15) are shown in Figure 2.

Multivariate analysis

The only significant predictor of MCS was the global PSQI score ($\beta=-0.852$, $P<0.01$). The significant independent predictors of PCS were age ($\beta=-0.136$, $P=0.04$), CCI ($\beta=-2.02$, $P<0.01$) and the global PSQI score ($\beta=-1.24$, $P<0.01$). The global PSQI score remained a significant independent predictor of MCS and PCS after controlling for age, sex, haemoglobin, serum albumin, CCI and presence of depression as shown in Table 6.

Table 5. Characteristics of good sleepers compared to poor sleepers among the 89 study subjects

Variable	Good sleepers Global PSQI $\leqslant 5$ $n=26$	Poor sleepers Global PSQI >5 $n=63$	*P*
Age (years)	59.4 (19.1)	60.34 (16.0)	0.98
Females (*n*)	6	28	0.09
Time on dialysis (months)	50.0 (61.7)	49.1 (41.8)	0.36
Living alone (*n*)	6	19	0.61
Depressed (*n*)	0	11	0.03
Haemoglobin (g/l)	119.2 (11.1)	114.1 (11.6)	0.03
Serum albumin (g/l)	37.9 (4.0)	37.2 (4.3)	0.27
Kt/V	1.71 (0.17)	1.82 (0.45)	0.11
CCI	4.35 (2.31)	4.49 (2.02)	0.57
MCS	53.2 (8.9)	47.0 (12.0)	0.04
PCS	41.5 (11.2)	31.8 (12.1)	<0.01
Physical functioning	66.9 (29.6)	42.5 (29.7)	<0.01
Role-physical	57.7 (44.6)	27.4 (38.8)	<0.01
Bodily pain	78.6 (22.3)	52.6 (31.4)	<0.01
General health	56.1 (27.0)	42.8 (23.3)	0.046
Vitality	52.5 (26.9)	39.2 (21.0)	0.02
Social functioning	75.5 (28.4)	58.5 (31.3)	0.02
Role-emotional	88.5 (28.2)	53.4 (46.2)	<0.01
Mental health	80.8 (18.3)	70.3 (20.1)	0.01

Results are mean (SD) unless otherwise specified. MCS, SF-36 Mental Component Summary. PCS, SF-36 Physical Component Summary. CCI, modified Charlson Comorbidity Index. PSQI, Pittsburgh Sleep Quality Index.

Discussion

The prevalence of poor sleep in the present study was 71%, comparable with the 50–80% prevalence of sleep-wake complaints in dialysis patients reported in previous studies [1–3]. There was a strong association between quality of sleep and mental and physical HRQoL that persisted after controlling for known predictors of HRQoL. Williams *et al.* [3] examined the associations between seven specific sleep disturbances and a large number of mental, physical, functional and laboratory variables in 242 haemodialysis patients and found physical and mental well-being were related to the sleep disturbances. For example, functional status measured by the performance of activities of daily living was associated with waking up during the night, feeling tired in the morning and restless sleep, while perception and memory were associated with waking up too early. In the present study, mental HRQoL was associated with subjective sleep quality, sleep disturbance, use of sleep medications and daytime dysfunction, while physical HRQoL was associated with sleep efficiency, sleep disturbance, use of sleep medications and daytime dysfunction. Compared with 'good sleepers', 'poor sleepers' had

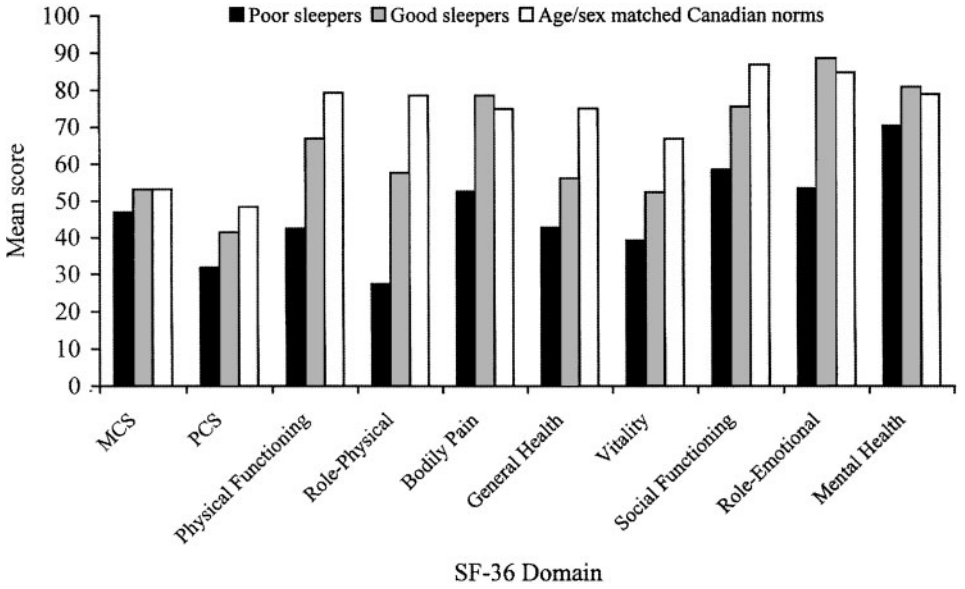

Fig. 2. Mean scores for the domains of the SF-36 for poor sleepers (global PSQI >5), good sleepers (global PSQI $\leqslant 5$), and age/sex matched Canadians from Hopman *et al.* [15]. MCS, SF-36 Mental Component Summary. PCS, SF-36 Physical Component Summary. PSQI, Pittsburgh Sleep Quality Index.

Table 6. Multiple linear regression models with outcome variables SF-36 MCS and PCS

Variable	Model 1 Outcome MCS Adj. $R^2=0.08$		Model 2 Outcome PCS Adj. $R^2=0.33$	
	β	P	β	P
Intercept	56.9	<0.01	54.3	<0.01
Age	-0.0228	0.76	-0.153	0.03
Sex	-0.0528	0.98	2.91	0.23
Haemoglobin	0.124	0.30	0.0331	0.76
Serum albumin	-0.266	0.43	0.112	0.72
CCI	-0.804	0.21	-2.01	<0.01
Depression	1.76	0.66	-0.935	0.80
PSQI	-0.885	<0.01	-1.21	<0.01

β, regression coefficient. P, P-value. MCS, SF-36 Mental Component Summary. PCS, SF-36 Physical Component Summary. CCI, modified Charlson Comorbidity Index. PSQI, Pittsburgh Sleep Quality Index.

lower HRQoL in all domains. The association between sleep quality and HRQoL may be explained by a direct influence of sleep quality on HRQoL (or vice versa), an association of both constructs with one or more confounding variables, an overlap in the instruments used to measure sleep quality and HRQoL, or a combination of these.

The best evidence that ESRD can directly influence quality of sleep, which in turn leads to reduced HRQoL, comes from studies of OSA in dialysis patients. OSA is common in dialysis patients [4,5]. Slow nocturnal dialysis and transplantation improve or reverse OSA [4,16]. In patients without renal disease, OSA is associated with reduced HRQoL measured by the SF-36, and HRQoL improves dramatically with treatment with nasal continuous positive airway pressure (nCPAP) [8,9]. We hypothesize that specific ESRD-related sleep disturbances such as OSA and PMLS impact directly on HRQoL and are responsible for a component of the association between sleep quality and HRQoL observed in the present study.

In the present study, HRQoL was associated with age, haemoglobin, comorbidity and depression in the bivariate analysis. These findings are consistent with previous studies [10]. Quality of sleep was associated with haemoglobin, serum albumin and depression in the bivariate analysis. Correction of anaemia with erythropoietin reduces PMLS, arousals from sleep and sleep fragmentation [17]. Previous studies have not found an association between serum albumin and quality of sleep; however, major depression has been associated with hypoalbuminaemia as part of an acute-phase response [18]. In the present study, quality of sleep remained a significant predictor of mental and physical HRQoL after controlling for age, sex, haemoglobin, serum albumin, comorbidity and depression, suggesting that the relationship between quality of sleep and HRQoL was independent of these potential confounding variables.

Dialysis adequacy measured by small solute clearance, Kt/V urea, was not associated with quality of sleep or HRQoL. These findings are consistent with previous studies. Holley *et al.* [1] measured sleep disturbance in 48 haemodialysis patients and 22 peritoneal dialysis patients and found Kt/V did not predict reported sleep disturbances. Williams *et al.* [3] found no association between the seven specific sleep disturbances and Kt/V. Morton *et al.* [19] measured HRQoL using the RAND 36 Item Health Survey in 115 dialysis patients and found no association between HRQoL and Kt/V. The authors hypothesized

that HRQoL is influenced by factors other than dialysis adequacy. It may not be possible to detect the influence of Kt/V on sleep quality and HRQoL within the narrow range of Kt/V achieved with thrice weekly dialysis. Alternatively, Kt/V may not be a suitable measure of dialysis adequacy in regards to quality of sleep or HRQoL, and frequency of dialysis may be more important than quantity of dialysis. Dialysis adequacy may have a significant influence on quality of sleep when thrice weekly dialysis is compared with daily or nocturnal dialysis. Hanly and Pierratos performed polysomnography in 14 haemodialysis patients on conventional intermittent haemodialysis before and after conversion to nocturnal haemodialysis. Before conversion to nocturnal dialysis, there was a high prevalence of OSA and PMLS [4]. In the seven subjects with OSA, conversion to nocturnal haemodialysis was associated with a dramatic reduction in respiratory arousals from 25 to 6/h accompanied by a significant rise in serum bicarbonate. The authors hypothesized that OSA in dialysis patients is due to central destabilization of ventilatory control and upper airway obstruction related to acidosis and airway oedema, respectively, both of which are improved with nocturnal dialysis.

In the present study, quality of sleep and HRQoL were measured using validated questionnaires. The PSQI and SF-36 evaluate quality of sleep and HRQoL during the preceding 4-week period. The SF-36 has been rigorously evaluated as a tool for the measurement of HRQoL in patients with OSA [8,9], and has been used to measure HRQoL in patients with insomnia [7]. The SF-36 and PSQI do not ask the same questions, however, some overlap is likely, particularly with regard to daytime dysfunction such as feeling tired. This would result in an overestimation of the relationship between this component of the PSQI and HRQoL. In contrast, PSQI components such as sleep efficiency and sleep disturbance are evaluated by specific questions regarding sleep times and disturbances. The strong associations between these PSQI components and physical HRQoL suggest that the relationship between sleep quality and HRQoL is not simply due to potential overlap between the two questionnaires in regard to daytime dysfunction.

The main limitation of this study is the absence of polysomonographic data without which it is not possible to ascertain the exact causes of insomnia and sleep disturbance. Because of the cross-sectional design it is not possible to establish cause and effect in the associations examined. The study aimed to control for known potential confounding variables of the relationship between quality of sleep and HRQoL. It is not possible to accurately measure all variables that may impact on quality of sleep and HRQoL, and the sample size of the study would limit the examination of numerous independent predictors of HRQoL. Comorbidity was measured with a validated index that is a strong predictor of clinical outcomes in dialysis patients. The advantage of using an index is the evaluation a large number of conditions while limiting comorbidity to only one independent variable. This does not necessarily mean that the index includes all conditions that are important in terms of HRQoL or that the value assigned to each condition based on clinical outcome data is appropriate for the outcome of HRQoL. Depression was recorded as present if the subject was taking anti-depressant medication for depressed mood. This definition would have misclassified subjects with new onset of depression and treated subjects who were no longer depressed. Despite the potential limitations in the evaluation of comorbidity and depression, both variables were associated with HRQoL in the bivariate analysis.

Further to the discussion of potential confounding variables in the association between quality of sleep and HRQoL, the reviewers commented that a number of other variables should be considered including lifestyle habits, income, education, diabetes independent of the CCI, nutrition, anti-hypertensive medications, functional status, psychiatric syndromes and daily life stress. To examine the influence of these variables on the results of this study, the analysis was repeated including variables for which prospective data was available. Forty-one subjects reported the perception that their income was sufficient, 34 had post-secondary education, 26 were diabetic, 20 were current smokers, 57 used anti-hypertensive medications. There were no statistical differences in the mean MCS, PCS and PSQI among the categories of these categorical variables. This may have been in part due to limited statistical power as there was a trend to higher MCS in subjects with post-secondary education compared with those without (51.4 *vs* 46.7, $P=0.07$). Forcing each of these variables into the final models in Table 6, individually or as a group, did not significantly change the regression coefficients or *P*-values for the PSQI. These results do not exclude the possibility that the relationship between quality of sleep and HRQoL is confounded by variables that were not measured (exercise, caffeine, alcohol, functional status, psychiatric syndromes, daily life stress), or by variables that were measured with limitations including comorbidity and depression.

The prevalent study population with little ethnic diversity limits the generalizability of the results of this study to other populations; however, the fact that the prevalence of 'poor sleep' in the present study is similar to the prevalence of sleep-wake complaints in previous studies suggests that the magnitude of sleep problems in haemodialysis patients is similar among different populations.

In conclusion, the results of this study suggest that 'poor sleep' is common in dialysis patients and that quality of sleep is an independent predictor of HRQoL. We hypothesize that a component of this association is due to a direct influence of ESRD on quality of sleep, which in turn influences HRQoL. OSA serves as feasible model for this hypothesis. In dialysis patients with low HRQoL, measurement of quality of sleep in conjunction with specific questions

about symptoms of OSA and PMLS may be useful in identifying patients who would benefit from formal polysomnography. Additional studies are needed to examine the influence of objective sleep disturbances on HRQoL in dialysis patients and to evaluate potential treatments such as more frequent dialysis, sleep medications, anaemia management and nCPAP. Longitudinal studies of quality of sleep in patients with progressive renal insufficiency not yet on dialysis are needed to determine at what stage of renal insufficiency quality of sleep declines and to examine the temporal sequence with the decrease in HRQoL.

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