

# Excessive daytime sleepiness and risk of sleep apnea in non-obese kidney transplant and chronic dialysis patients

**Introduction:** Sleep disorders are common across all stages of chronic kidney disease and more often related to non-conventional than to conventional risk factors such as obesity. We compared the quality of sleep, daytime sleepiness and obstructive sleep apnea (OSA) risk in non-obese dialysis patients and kidney transplant (KTx) recipients.

**Patients and methods:** Surveys assessing OSA risk and daytime sleepiness - Berlin Questionnaire (BQ) and Epworth Sleepiness Scale (ESS), respectively, were conducted among 108 dialysis patients and 46 KTx. **Results:** 31.5% of dialysis patients, 37.3% and 22% of hemodialysis (HD) and peritoneal dialysis (PD) patients, respectively, and 32.6% of KTx recipients had high OSA risk. BQ revealed the high risk of OSA in normal body mass dialysis patients and overweight KTx recipients. Excessive daytime sleepiness (EDS) measured by means of ESS occurred in about 47% of interviewees in both groups and was most common in normal body mass KTx and overweight dialysis patients. Waking up at night was most common sleep-related problem reported by 77% dialysis patients and 82% KTx recipients. The most prevalent cause of waking up in KTx was nocturia, dialysis patients were mostly unable to identify the cause.

**Conclusions:** Obstructive sleep apnea and excessive daytime sleepiness remain a serious problems in both kidney transplant and dialysis patients. The lack of a positive relation between BMI values and OSA risk in dialysis patients may be another example of a reverse epidemiology observed in this population.

(NEPROL DIAL POL. 2021; 25: 21-25)

## Ocena senności w ciągu dnia oraz ryzyka bezdechu sennego wśród nieotyłych chorych po przeszczepieniu nerki i pacjentów przewlekłe dializowanych

**Wstęp:** Zaburzenia snu są powszechne we wszystkich stadiach przewlekłej choroby nerek i częściej są związane z niekonwencjonalnymi niż konwencjonalnymi czynnikami ryzyka, takimi jak otyłość. Celem niniejszej pracy było porównanie jakości snu, senności w ciągu dnia i ryzyka obturacyjnego bezdechu sennego (OBS) u nieotyłych pacjentów dializowanych i chorych po przeszczepieniu nerki (KTx).

**Pacjenci i metody:** Ankietę, składającą się z dwóch zwalidowanych kwestionariuszy oceniających ryzyko OBS i senność w ciągu dnia, odpowiednio - Berlin Questionnaire (BQ) i Epworth Sleepiness Scale (ESS) - przeprowadzono wśród 108 pacjentów dializowanych i 46 chorych po KTx.

**Wyniki:** 31,5% pacjentów dializowanych, odpowiednio 37,3% i 22% pacjentów poddawanych hemodializie (HD) i dializie otrzewnowej (PD) oraz 32,6% pacjentów po KTx miało duże ryzyko wystąpienia OBS. Duże ryzyko OBS dotyczyło najczęściej dializowanych pacjentów z prawidłową masą ciała i chorych po KTx z nadwagą. Nadmierna senność w ciągu dnia (EDS) wystąpiła u około 47% ankietowanych w obu grupach i najczęściej dotyczyła pacjentów dializowanych z nadwagą i chorych po przeszczepieniu z prawidłową masą ciała. Budzenie się w nocy było najczęstszym problemem związanym ze snem zgłaszanym przez 77% pacjentów dializowanych i 82% biorców KTx. Najczęstszą przyczyną wybudzenia się w grupie pacjentów po KTx była nokturia, pacjenci dializowani najczęściej nie byli w stanie zidentyfikować przyczyny.

**Wnioski:** Obturacyjny bezdech senny i nadmierna senność w ciągu dnia pozostają poważnymi problemami zarówno u pacjentów po przeszczepieniu nerki, jak i u chorych dializowanych. Brak związku między wartościami BMI a ryzykiem OBS u pacjentów dializowanych może być kolejnym przykładem tzw. odwrotnej epidemiologii obserwowanej w tej populacji.

(NEFROL DIAL POL. 2021; 25: 21-25)

Ewa PAWŁOWICZ<sup>1</sup>  
Ewa BUDZISZ<sup>2</sup>  
Mateusz ADAMKIEWICZ<sup>3</sup>  
Maciej R. MAZURKIEWICZ<sup>4</sup>  
Ilona KURNATOWSKA<sup>5</sup>  
Michał NOWICKI<sup>1</sup>

<sup>1</sup>Department of Nephrology, Hypertension and Kidney Transplantation, Medical University of Lodz; Klinika Nefrologii, Hipertensjologii i Transplantologii Nerek, Uniwersytet Medyczny w Łodzi

<sup>2</sup>2<sup>nd</sup> Department of Anaesthesiology and Intensive Care, Central Teaching Hospital, Medical University of Warsaw, II Klinika Anestezjologii i Intensywnej Terapii, Centralny Szpital Kliniczny, Warszawski Uniwersytet Medyczny

<sup>3</sup>Department of Urology, Medical University of Silesia, Zabrze; Klinika Urologii, Śląski Uniwersytet Medyczny, Zabrze

<sup>4</sup>Hospice Care Association of the Pabianice District, Pabianice; Stowarzyszenie Opieki Hospicyjnej Powiatu Pabianickiego; Pabianice

<sup>5</sup>Department of Internal Medicine and Transplantation Nephrology, Medical University of Lodz; Klinika Chorób Wewnętrznych i Nefrologii Transplantacyjnej, Uniwersytet Medyczny w Łodzi

### Key words:

- daytime sleepiness
- hemodialysis
- kidney transplantation
- obstructive sleep apnea
- peritoneal dialysis

### Słowa kluczowe:

- dializoterapia otrzewnowa
- hemodializoterapia
- obturacyjny bezdech senny
- przeszczepienie nerki
- senność w ciągu dnia

Autorzy nie deklarują konfliktu interesów.

**Adres do korespondencji:**  
Prof. dr hab. med. Michał Nowicki  
Klinika Nefrologii, Hipertensjologii i Transplantologii Nerek, Uniwersytet Medyczny w Łodzi  
ul. Pomorska 251, 92-213 Łódź  
fax: +48 42 201 44 01  
e-mail: nefro@wp.pl

## Introduction

Sleep disorders comprise a range of clinically relevant problems – from insomnia and excessive daytime sleepiness (EDS) to obstructive sleep apnea (OSA). They are among the most common medical problems in the general population contributing to decreased quality of life and increased morbidity and mortality [1].

Obstructive sleep apnea is a condition, in which pauses in breathing occur during sleep because the airway became narrowed, blocked or floppy. It occurs despite normal respiratory muscles activity, thereby resulting in hypoxia and interruption of sleep which patient is unaware of [2, 3].

Excessive daytime sleepiness is an objective or subjective state in which inclination to sleep or naps occur during daytime activity while intending to stay awake. Causes of the EDS are multifarious and can be divided into four main groups: intrinsic disorders (narcolepsy, OSA), extrinsic disorders linked to poor sleep hygiene, circadian rhythm disruptions (shift-work disorder) and other lifestyle and health factors (age, obesity, diabetes) [4].

Polysomnography remains the “gold standard” for diagnosis of sleep disorders [5]. The use of this method is limited since it is expensive, time-consuming and not readily available. Therefore there is a need to use simpler methods for the assessment of sleep disorders. The risk of OSA could be reliably estimated in many patients based only on an anamnesis and clinical symptoms. The questionnaires, including the most popular Berlin Questionnaire [6] and Epworth Sleepiness Scale for OSA risk and EDS assessment, respectively, are commonly used for screening of sleep disorders.

Berlin Questionnaire (BQ) estimates the risk of sleep apnea, taking into account both anthropometric indices and comorbidities, such as arterial hypertension. In contrast, Epworth Sleepiness Scale (ESS) takes into consideration likelihood of fall asleep during a daytime functioning and can be used to assess the level of sleep apnea indirectly. Sleep disorders are highly prevalent at each stage of chronic kidney disease (CKD) with variable intensity [7, 8]. They also frequently affect the subjects on renal replacement therapy irrespective of dialysis modalities [1, 3, 9]. It should be emphasized, that sleep disorders adversely affect overall quality of life and mental abilities. They

also significantly increase a risk of depression and other mental disorders [10]. Kidney transplantation leads to improved general quality of life and lower mortality compared to chronic dialysis but so far little has been known about the prevalence and risk factors of sleep disturbances in that population. The aim of this study was to assess and compare the risk of sleep apnea and excessive day-time sleepiness among non-obese dialysis patients and kidney transplant recipients.

## Patients and methods

The study group included 108 dialysis patients (42 women and 66 men, mean age 49.7±11.8 years) and 46 kidney transplant recipients (20 women and 26 men, mean age 46.3±12.5 years). Among dialysis patients 67 were treated with intermittent HD and 41 with PD (Table 1.). Two surveys assessing sleep quality and likelihood of sleep apnea as well as excessive daytime sleepiness, i.e. Berlin questionnaire (BQ) and Epworth Sleepiness Scale (ESS) were conducted among all subjects. All the patients were also asked to answer 11 supplemental questions focused on specific causes of sleep interruption, snoring and morning headache. The study protocol was approved by the local ethics committee.

The dialysis patients were included according to the following criteria: at least 3 months of the renal replacement therapy with unchanged type and modality of dialysis, age 18-65 years. Inclusion criteria in the KTx group were as follows: at least 12 months after transplant surgery, age 18-65 years.

Exclusion criteria in both groups were as follows: lack of informed consent, acute illness, obesity (BMI≥30 kg/m<sup>2</sup>), mental disorders and cognitive disorders which made patients unable to answer the questions.

The results of the surveys were analyzed with respect to anthropometric indices, comorbidities and time on renal replacement therapy. The risk of sleep apnea was evaluated with Berlin Questionnaire and excessive daytime sleepiness with Epworth Sleepiness Scale.

Berlin Questionnaire includes three categories of questions. The first category concerns snoring and pauses in breathing during sleep, the second – excessive daytime sleepiness, and the third – prevalence of obesity and arterial hypertension. Positive answers in two or three categories were recognized as

a high risk of sleep apnea. One positively answered category or lack of positive answers were recognized as a low risk of sleep apnea [6].

The Epworth Sleepiness Scale is based on the assessment of patients' subjective evaluation of daytime sleepiness, which can be also considered independently as risk factor for mortality in older adults [11]. Subjects were asked to rate on a scale from 0 (fall asleep impossible) to 3 (fall asleep the most possible) how likely they would fall asleep in the eight situations, while e.g.: reading, watching television, sitting and talking to someone or when stopped for a few minutes in traffic while driving a car. The number selected for particular situations in ESS was added for each subject. Participants selection for a certain risk group of sleep apnea was based on ESS score [12].

The results of the study are presented as a mean ± standard deviation. Chi<sup>2</sup>-test was for categorical data comparisons. To compare the groups, the independent samples t-test or U Mann-Whitney test in case of a non-normal distribution were used. Statistical significance was set at p<0.05.

## Results

Seventy seven percent of the patients in the whole study group were hypertensive and 35% were overweight (BMI 25-29.9 kg/m<sup>2</sup>) including 40% of dialysis patients and 24% of kidney transplant recipients (p=0.06). The HD and PD patients reported sleeping equally long with the mean sleep duration of 7.8 hours a day, whereas KTx patients slept 6.9 hours a day (p=0.0015). The results of the Berlin Questionnaire showed similar risk of sleep apnea in dialysis patients and patients after kidney transplantation (31.5% and 32.6% of patients, respectively). 37.3% of HD patients and 22% of PD patients were at high risk of sleep apnea (p=0.13).

ESS revealed the excessive daytime sleepiness in about half of dialysis patients and kidney transplant recipients (46.5% and 47.8%, respectively).

The risk of sleep apnea assessed with BQ and ESS was analyzed with respect to BMI categories.

BQ indicated that the significant risk of OSA occurred most often in normal body mass dialysis patients and in overweight transplant recipients (Fig. 1). The EDS was most common in normal body mass KTx and in overweight dialysis patients (Fig. 2).

Table 1  
General characteristics of the study group

	Number of patients	Age (mean±SD)	Sex (F/M)	BMI (mean±SD)	Type of dialysis therapy	
					HD	PD
dialysis patients	108	49.7±11.8	42 (38.9%)/ 66 (61.1%)	24.2±3.4	67	41
kidney transplant recipients	46	46.3±12.5	20 (43.5%)/ 6 (56.5%)	23.0±2.8	-	-

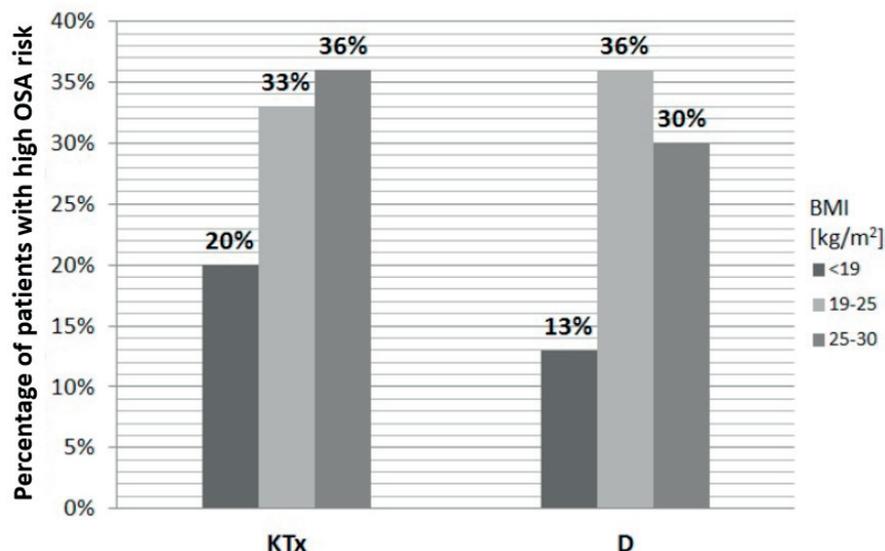


Fig. 1. Prevalence of high risk of sleep apnea according to Berlin Questionnaire ( $\geq 2$  points) in the groups divided into BMI categories and type of renal replacement therapy (kidney transplant recipients – KTx and dialysis patients – D).

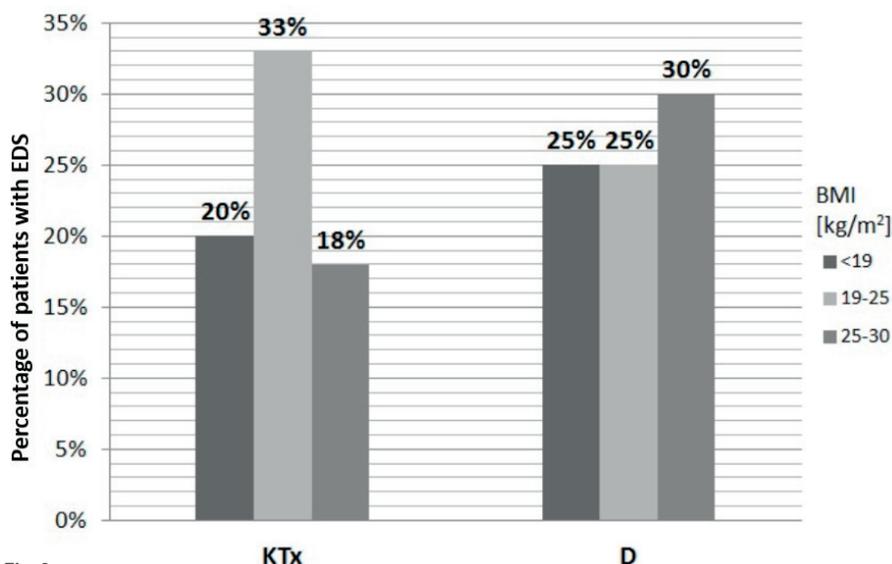


Fig. 2. Prevalence of excessive daytime sleepiness according to Epworth Sleepiness Scale ( $\geq 10$  points) in the groups divided into BMI categories and type of renal replacement therapy (kidney transplant recipients – KTx and dialysis patients – D).

BQ revealed that 47% of chronic dialysis patients snored while sleeping, whereas in KTx patients that symptom was found in 34% ( $p=0.25$ ). A significant difference in snoring was however demonstrated between dialysis patients on different modalities since it was reported by 58% of HD and 22% of PD patients ( $p=0.001$ ).

The influence of waking up at night on the quality of patients' sleep was analyzed with BQ that revealed that 77% of dialysis patients and 82% of kidney transplant recipients woke up at night. Snoring was an unlikely cause of waking up at night since that answer was selected by only 3.6% dialysis patients and 2.7% KTx recipients. The feeling of shortage of air caused waking up in 12.7% dialysis patients and 2.7% KTx recipients ( $p=0.14$ ). Sixty three percent of dialysis patients and 46% of patients after kidney trans-

plantation had difficulties in establishing the cause of sleep interruption. In KTx group the most often cause of waking up was nocturia (Fig. 3).

Morning headache occurred 3-5 times a week in about 2% of both dialysis and KTx patients. 17.8% of KTx and 9.6% dialysis patients suffered from headaches 1-2 times a week, and 8.9% and 20.2% 1-3 times a month, respectively.

### Discussion

We compared the risk of sleep apnea and the daytime sleepiness in dialysis patients treated with different modalities (HD and PD) and in patients after kidney transplantation. According to previous studies, chronic kidney disease has been recognized as a population with exceedingly high risk of sleep apnea [13].

The information regarding the sleep problems were collected using three commonly used and well-validated surveys, i.e. Berlin Questionnaire and Epworth Sleepiness Scale. [14, 15]. A clear advantage of such screening methods is that they give an opportunity of self-contained filling of the survey. This secures patients' privacy and increases reliability of their responses. The patients were able to ask for help while answering the questions and that was the case in most of our dialysis patients. On one hand our help in completing the survey may decrease the percentage of unanswered or wrong understood questions, but on the other it might have diminished privacy and patients might have not answered all the questions truthfully.

Although the surveys used in our study are most widely used, we have to realize that both BQ and ESS were initially created to assess the risk of OSA and EDS in the general population. Therefore they may not take into consideration many specific factors present in patients with chronic kidney disease like the circadian variations caused by dialysis shift, general deterioration of health affecting nutrition and physical activity, lack of

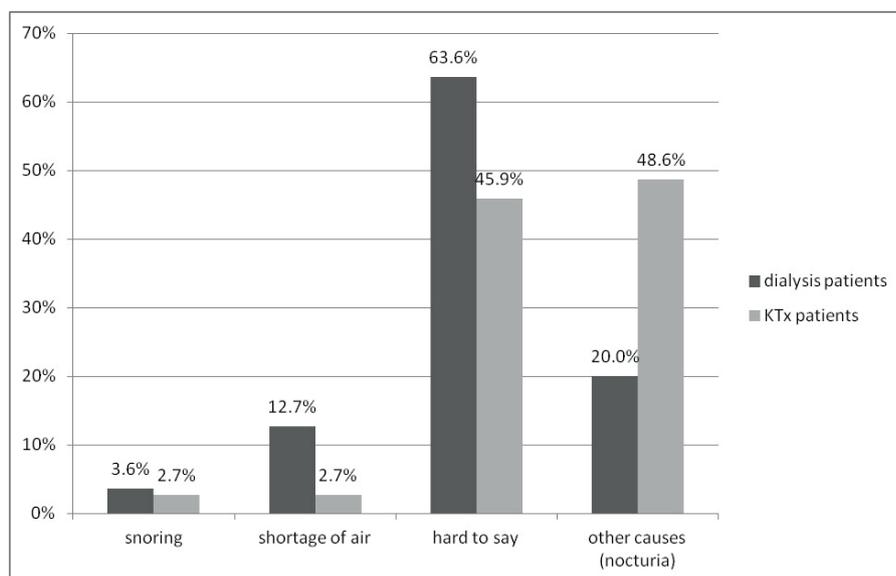


Fig. 3. The causes of waking up at night in dialysis patients and kidney transplant recipients (KTx)

professional activity, sedentary lifestyle and many comorbidities. That is why, the authors added several questions to the survey addressing the specific reasons of waking up at night, morning headache, and sleeping position, in which snoring occurs most often.

The best way to validate the assessments based on the surveys would be to compare their results with the polysomnographic examination, which remains the gold standard in the diagnosis of sleep disorders [8, 16, 17]. Its use would have allowed direct assessment of the prevalence of breathing problems while sleeping and subjective feelings reported in surveys. Unfortunately we were unable to make such a comparison because of limited availability of polysomnography. Polysomnography remains gold standard in sleep investigation, but there are still some limitations, which have to be taken into consideration. The greatest limitation seems to be differences between examination conditions and conditions present in patient's home. They have highest effect during the first night of testing – a "first-night effect". The importance of two consecutive nights of polysomnographic examination has been examined in many studies [18]. Its use, however, is too costly to study larger populations and with limited availability.

It is of note that we did not find any significant differences in terms of OSA risk and sleep quality between the patients on chronic dialysis and after kidney transplantation. Nevertheless the significant differences appeared, when a type of dialysis therapy was taken into account. OSA risk was significantly higher in HD than in PD patients. We may speculate that it could be the result of the differences in the baseline characteristics of these two populations because the patients, who are treated with peritoneal dialysis, are more often able to self-care, more active, better educated and their physical condition is better [19].

Overweight and obesity are recognized as the most important modifiable factors of OSA [18, 20]. Therefore, we decided to assess the risk of OSA after dividing the patients into BMI categories. Patients with high BMI values  $\geq 30$  kg/m<sup>2</sup> were excluded from the study that allowed us to overcome a bias of most studies comparing HD and PD patients as the patients from the latter group are more frequently obese. According to expectations we found that in KTx patients the higher was BMI value, the more common high risk of OSA. Interestingly the same association was not observed in dialysis patients as in that group high risk of OSA was noted in patients with normal body mass. The likely explanation of that relation comes from the concept of so called "reverse epidemiology" that has been well described in chronic dialysis patients in relation to cardiovascular pathologies [21]. High BMI is a predictor of increased mortality in the general population [22]. It was however observed that in dialysis patients such

the relation was reversed as an increased BMI but not normal-range BMI was linked to longer survival and improved quality of life. Similar phenomenon of reversed relations was observed in the elderly population [23].

No significant difference between study groups in EDS prevalence was revealed. Since there are many risk factors, with the most important factor of circadian rhythm disruptions, of EDS in dialysis patients, the high prevalence of EDS in KTx is quite unexpected finding, especially that EDS is most common in normal body mass transplant recipients. According to Bixler et al. EDS is commonly considered the important sign of OSA, however the underlying association is still unclear. In compliance with his results depression was the most significant risk factor of EDS in general population followed by body mass, age, typical sleep duration, diabetes, smoking and, finally, sleep apnea [24]. Further investigations are necessary to reveal underlying cause of EDS in kidney transplant recipients and chronic dialysis patients.

There is an urgent need to modify the tools that are currently used as screening for sleep disturbances in order to tailor them to populations with different epidemiology [25]. This is particularly relevant since BQ and ESS are the methods widely used for preliminary diagnostics of sleep problems and their results are taken into account when deciding which patients are qualified for polysomnography and which are not.

Snoring is an important warning sign of OSA [26]. It is related to lower sleep quality and may also adversely affect people sleeping in the same room. Unfortunately an important caveat of a self-administered questionnaire like BQ or ESS is that the patient cannot make a self assessment of his/her snoring. According to BQ, which was completed only by the patients about one third of those interviewed snored. Many patients had difficulties in establishing a precise cause of waking up at night. It was easiest to recognize for patients who woke up because of nocturia that was a frequent cause of disturbed sleep among KTx patients but for obvious reasons was not prevalent in dialysis population.

The main limitation of our study was the lack of an objective assessment of symptoms reported by the patients and a follow-up. That is why we estimated only the risk of sleep disorders and not its presence in a direct way. The studies which are based on surveys are almost always subject to errors and biases caused by unreliability of patients' opinions and improperly understood questions.

Despite of the difficulties we tried to compare the daytime sleepiness and the risk of sleep apnea using two surveys in dialysis patients and kidney transplant recipients. Comparison of their results with polysomnographic examination could be first step into their validation for use in a population of patients with renal func-

tion impairment. Paired observation of the same patients before and after renal transplantation could also give better view on changes of sleep disorders depending of the type of replacement therapy in this population.

To best of our knowledge our study is the first that demonstrated that sleep disturbances are other aspect of the so called "reverse epidemiology" phenomenon observed in the dialysis population.

## References

1. **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: 922-930.
2. **Gacjong Z, Wolf J, Narkiewicz K.** Obstructive sleep apnea and systemic hypertension. *Pneumon Alergol Pol.* 2007; 75: 57-61.
3. **Molnar MZ, Novak M, Mucsi I.** Sleep disorders and quality of life in renal transplant recipients. *Int Urol Nephrol.* 2009; 41: 373-382.
4. **Hayley AC, Williams LJ, Kennedy GA, et al.** Prevalence of excessive daytime sleepiness in a sample of Australian adult population. *Sleep Med.* 2014; 15: 348-354.
5. **Mannarino MR, Di Filippo F, Pirro M.** Obstructive sleep apnea syndrome. *Eur J Intern Med.* 2012; 23: 586-593.
6. **Netzer NC, Stoohs RA, Netzer CM, et al.** Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. *Ann Intern Med.* 1999; 131: 485-491.
7. **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: 184-190.
8. **Rai M, Rustagi T, Rustagi S, et al.** Depression, insomnia and sleep apnea in patients on maintenance hemodialysis. *Indian J Nephrol.* 2011; 21: 223-239.
9. **Harris TJ, Nazir R, Khetpal P, et al.** Pain, sleep disturbance and survival in hemodialysis patients. *Nephrol Dial Transplant.* 2012; 27:758-765.
10. **Batterham PJ, Glozier N, Christensen H.** Sleep disturbance, personality and the onset of depression and anxiety: prospective cohort study. *Aust N Z J Psychiatry.* 2012; 46: 1089-1098.
11. **Gooneratne NS, Richards KC, Joffe M, et al.** Sleep disordered breathing with excessive daytime sleepiness is a risk factor for mortality in older adults. *Sleep.* 2011; 34: 435-442.
12. **Johns MW.** A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep.* 1991; 14: 540-545.
13. **Molnar MZ, Szentkiralyi A, Lindner A, et al.** High prevalence of patients with a high risk for obstructive sleep apnea syndrome after kidney transplantation-association with declining renal function. *Nephrol Dial Transplant.* 2007; 22: 2686-2692.
14. **Araujo SM, Bruin VM, Daher EF, et al.** Quality of sleep and day-time sleepiness in chronic hemodialysis: a study of 400 patients. *Scand J Urol Nephrol.* 2011; 45: 359-364.
15. **Pedrosa RP, Lima SG, Drager LF, et al.** Sleep quality and quality of life in patients with hypertrophic cardiomyopathy. *Cardiology.* 2010; 117: 200-206.
16. **Keenan SA.** Polysomnography: technical aspects in adolescents and adults. *J Clin Neurophysiol.* 1992; 9: 21-31.
17. **Pereira EJ, Driver HS, Stewart SC, Fitzpatrick MF.** Comparing a combination of validated ques-

- tionnaires and level III portable monitor with polysomnography to diagnose and exclude sleep apnea. *J Clin Sleep Med*. 2013; 9: 1259-1266.
18. **Newell J, Mairesse O, Verbanck P, Neu D.** Is a one-night stay in the lab really enough to conclude? First-night effect and night-to-night variability in polysomnographic recordings among different clinical population samples. *Psychiatry Res*. 2012; 200: 795-801.
  19. **Chanouzas D, Ng KP, Fallouh B, Baharani J.** What influences patient choice of treatment modality at the pre-dialysis stage? *Nephrol Dial Transplant*. 2012; 27: 1542-1547.
  20. **Lurie A.** Obstructive sleep apnea in adults: epidemiology, clinical presentation and treatment options. *Adv Cardiol*. 2011; 46: 1-42.
  21. **Kalantar-Zadeh K, Abbott KC, Salahudeen AK, et al.** Survival advantages of obesity in dialysis patients. *Am J Clin Nutr*. 2005; 81: 543-554.
  22. **Sankri-Tarbichi AG.** Obstructive sleep apnea-hypopnea syndrome: Etiology and diagnosis. *Avicenna J Med*. 2012; 2: 3-8.
  23. **Veronese N, De Rui M, Toffanello ED, et al.** Body mass index as a predictor of all-cause mortality in nursing home residents during a 5-year follow-up. *J Am Med Dir Assoc*. 2013;14:53-70.
  24. **Bixler EO, Vgontzas AN, Lin HM et al.** Excessive daytime sleepiness in general population sample: the role of sleep apnea, age, obesity, diabetes and depression. *J Clin Endocrinol Metab*. 2005; 90: 4510-4515.
  25. **Pillar G, Shehadeh N.** Abdominal fat and sleep apnea: the chicken or the egg? *Diabetes Care*. 2008; 31(Suppl. 2): S303-S309.
  26. **Parekh R, Green E, Majeed A.** Obstructive sleep apnea: quantifying its association with obesity and snoring. *Prim Care Respir J*. 2012; 21: 361-362.