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Original Article

The Prevalence and Risk Factors of Metabolic Syndrome in Patients with Hemodialysis

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Abstract

Introduction: Metabolic syndrome is a common disorder that puts patients at high risk for cardiovascular disease (CVD) and mortality. To our knowledge, there is no published study in Pub Med which evaluated both lifestyle and metabolic syndrome in hemodialysis patients. This study aimed to estimate the prevalence of metabolic syndrome and investigate the potential risk factors in hemodialysis patients.

Methods: This was a cross-sectional study conducted on 204 patients enrolled conveniently. National Cholesterol Education Program Adult Treatment Panel III criteria considered for Metabolic Syndrome. Demographics, lifestyle, and disease characteristics were gathered. The relationship between metabolic syndrome and its severity with independent variables was investigated through multivariable multivariate logistic and linear regressions.

Results: The mean (SD) age was 55 (14) years and 42% were women. 42.6% had metabolic syndrome. Low high-density lipoprotein (HDL), high fasting blood sugar, high blood pressure (BP), increased waist circumference (WC), and high triglyceride were observed in decreasing order of frequency in 54.4%, 44.1%, 38.7%, 33.3% 28.9% of patients, respectively. The logistic regression model revealed significant associations between metabolic syndrome and physical activity (OR = 0.85, 95% CI : 0.74-0.97), mood (OR = 1.04, 95% CI : 1.002-1.078), age (OR = 1.023, 95% CI : 1.001-1.046), and missed work (OR = 0.86, 95% CI : 0.76-0.97). The linear regression model revealed significant associations between metabolic syndrome severity score and physical activity (B = -0.12, 95% CI : -0.21-0.02) and sleep quality (B = 0.017, 95% CI : 0.001-0.033).

Conclusion: Poorer sleep quality, lower physical activity, lower mood status, and older age were associated with higher odds of metabolic syndrome/metabolic syndrome severity score in hemodialysis patients.

Introduction

Hemodialysis is a lifesaving treatment for patients with end-stage renal disease (ESRD) or late-stage chronic kidney diseases (CKDs). Those with CKD are at a high risk for eventually developing ESRD, and importantly, the prevalence of CKD is increasing making both CKD and ESRD prominent public health issues.[1,2] In fact, some estimates put the global prevalence of CKD around 10%.[3] Importantly, patients with CKD are at a much higher risk of cardiovascular mortality than those without CKD; for individuals undergoing hemodialysis it is estimated that cardiovascular disease (CVD), is responsible nearly half of all mortalities.[4]

Metabolic syndrome is a group of conditions that when occurring simultaneously increase the risk of CVD, kidney disease, stroke, and type II diabetes. These conditions include hypertension, hyperlipidemia, hyperglycemia, and obesity. It is believed that dyslipidemia, glucose intolerance, increased proinflammatory cytokines such as tumor necrosis factor-alpha (TNF-alpha) and interleukin-6 (IL-6), and decreased levels of anti-inflammatory cytokines like adiponectin are possible

contributors to the development of metabolic syndrome.[5] The prevalence of metabolic syndrome among US adults is estimated to be at least 33%; importantly, its prevalence also increases significantly with age.[6] Its prevalence is similar among where estimates range from 2.2% on the low end in Turkey all the way up to 63% on the high end in Pakistan.[7]

Notably, one of the defining characteristics of metabolic syndrome is increasing the risk of kidney disease. Additionally, considering the increased risk of cardiovascular mortality associated with both CKD and metabolic syndrome, it is important to investigate the relationship, if any, that exists between CKD and metabolic syndrome. It is possible that when CKD and metabolic syndrome co-occur the risk of cardiovascular mortality may be even more worrisome. Understanding the dynamics between metabolic syndrome and patients undergoing hemodialysis for kidney disease will better enable physicians to proactively monitor high risk patients with the hopes of reducing cardiovascular or other health consequences.

Interestingly, the prevalence of metabolic syndrome has been reported to be high among dialysis patients, in fact Young et al found it to be almost 70%.[8] Importantly, some of the causes of metabolic syndrome can also cause kidney damage; for example, obesity one of the conditions of metabolic syndrome is an independent risk factor for kidney disease.[9,10] Metabolic syndrome has been shown to be common among ESRD and CKD patients undergoing dialysis, and more importantly it is associated with hemodialysis-related outcomes.[11]

Because of the many connections between kidney disease and metabolic syndrome, including both causes (obesity) and consequences (CVD mortality), as well as the importance of metabolic syndrome in the incidence of many diseases and the increasing prevalence of ESRD, it is important to investigate the factors at play in this relationship. This study aims to evaluate the prevalence of metabolic syndrome in hemodialysis patients and carefully examine the risk factors of metabolic syndrome in these patients. Using this information, we hope physicians can work to proactively identify these risk factors in order to reduce the mortality and financial burden associated with the presence of metabolic syndrome in kidney patients.

Materials and Methods

This was a cross-sectional study that enrolled patients undergoing dialysis, consecutively and conveniently sampled from all dialytic patients coming from the Dialysis Clinic affiliated with Qom University of Medical Sciences during 2022. The university's IRB committee approved the protocol of study. Participants were asked to provide a written consent form prior to their enrolment. Demographics, lifestyle, and laboratory data were recorded. Mini-Sleep Questionnaire was employed to assess sleep quality (Table 1).[12] Gallup Well-being Index was used to evaluate mood.[13] Gallup Diet Questionnaire was applied to estimate their diets.[14] Brunel lifestyle physical activity questionnaire was used to measure pre-planned physical activity.[15] The validity and reliability of the questionnaires have been confirmed before.[12-15] National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria were applied to assess the presence of metabolic syndrome. The calculation of metabolic syndrome severity score was accomplished according to the formulae introduced by Lee et al.[16]

Descriptive analyses were done to measure the frequency distributions of the variables. A t-test was used to compare continuous variables, while chi-square was applied to compare categorical variables. The normality of residuals, homoscedasticity, and residual symmetry were investigated. Regression models were built to assess the relationship of outcome with other patient characteristics. Metabolic syndrome in clinical practice is a binary variable. It is either present or not. That's why we built the logistic regression model for it. In order to have a more delineate picture of the relationship, we also used metabolic syndrome severity score which is a continuous variable to build the linear regression model. Metabolic syndrome was the outcome in the logistic regression models, whereas metabolic syndrome severity score was the outcome in the linear regression models. Both univariable and multivariable models were built. Backward elimination process was executed in the multivariable regression models to determine the most important factors associated with the outcomes and to reduce the likelihood of overfitting and to make the regression models more interpretable. Multivariable models were adjusted for confounders including age, sex, sleep, diet, mood, physical activity, social activity, smoking, and disease characteristics. We included several lab values in the multivariable models as surrogate indices of severity and duration of disease. Data analyses were conducted using R software (Foundation for Statistical computing, Vienna, Austria). A P value of <0.05 was considered significant.

Results

204 patients were studied, and 42% were women. The age range was 21-86 years and the mean (SD) age was 55 (14) years. Various characteristics of patients categorized by the presence or absence of metabolic syndrome are presented in Table 2. 87 (42.6%) patients had metabolic syndrome, which was more common in women than in men (Table 2). Those with metabolic syndrome were significantly different than patients without metabolic syndrome in terms of age, disease duration, physical activity, body mass index (BMI), metabolic syndrome components (systolic & diastolic blood pressure [BP], waist circumference [WC], fasting blood glucose [FBG], high-density lipoprotein [HDL], and triglycerides), and

Table 1. Lifestyle Questionnaire and the Calculating Method of Corresponding Scores

Lifestyle factors	Question	Time or days per week
Quantity of sleep	What time did you usually go to bed on weekdays?	
	How long did it take to fall asleep?	
	What time did you usually go to bed on weekends?	
	What time did you usually get out of bed on weekdays?	
	What time did you usually get out of bed on weekends?	
	How many hours did you sleep every night on weekdays?	
	How many hours did you sleep every night on weekends?	
	How many hours did you get a nap on weekdays?	
	How many hours did you get a nap on weekends?	
Sleep quality	How many days per week do you have difficulties falling asleep?	/Out of 7 days
	How many days per week do you wake up too early?	/Out of 7 days
	How many days per week do you use Hypnotic medications (sleep aids)?	/Out of 7 days
	How many days per week do you fall asleep during the day?	/Out of 7 days
	How many days per week do you feel tired upon waking up in the morning?	/Out of 7 days
	How many days per week do you snore?	/Out of 7 days
	How many days per week do you experience mid-sleep awakenings?	/Out of 7 days
	How many days per week do you experience headaches on awakening?	/Out of 7 days
	How many days per week do you experience excessive daytime sleepiness?	/Out of 7 days
	How many days per week do you experience excessive movement during sleep?	/Out of 7 days
Total score of sleep quality out of 70		/70
Mood	How many days per week do you experience no energy to get things done?	/Out of 7 days
	How many days per week do you experience sadness?	/Out of 7 days
	How many days per week do you experience worry?	/Out of 7 days
	How many days per week do you experience anger?	/Out of 7 days
	How many days per week do you experience physical pain?	/Out of 7 days
Total score of mood status out of 35		/35
Diet	How many days per week do you eat fast food?	/Out of 7 days
	How many days per week did you eat red meat?	/Out of 7 days
	How many days per week do you eat fish/omega 3?	/Out of 7 days
	How many days per week do you eat 4-5 servings of fruits/vegetables?	/Out of 7 days
	How many days per week did you take vitamin D tablet?	/Out of 7 days
	How many days per week did you take Magnesium tablet?	/Out of 7 days
Total score of diet out of 42		/42
Physical activity	How many days per week in a normal week do you engage in at least 30- minute pre-planned physical activity?	/Out of 7 days
Social activity	How many days per week did you participate in a social, cultural, or support group that you belong to?	/Out of 7 days
Smoking behavior	Do you smoke?	
	If yes, how many cigarettes do you smoke per day?	
Self-rated Wellness & Health	How much do you rate your wellness and health out of 10; 10 being the healthiest and 0 being the unhealthiest?	/10

metabolic syndrome severity score. All other features were not significantly different between the two groups (Table 2). High triglyceride, high WC, high BP, and high fasting blood sugar, and low HDL were observed in increasing order of frequency among 59 (28.9%), 68 (33.3%), 79 (38.7%), 90 (44.1%), 111 (54.4%) all 204 patients, respectively (Table 3). WC on average was over 12 cm larger in those with metabolic syndrome than in those without it (Table 2). Another notable difference was in BMI; those without metabolic syndrome had a mean BMI that fell within the healthy rage (24), whereas those with metabolic syndrome had a mean BMI that was considered overweight (27.4) (Table 2). Interestingly, those without metabolic syndrome had a significantly longer disease duration than those with metabolic syndrome by 1.5 years on average. Different combinations of metabolic syndrome components are presented in Table 3. Nearly 40% of patients with metabolic syndrome had at least four

Table 2. Comparison of the patients stratified by metabolic syndrome

Participants' characteristics	Metabolic syndrome		
	No. (%)		*P*
Gender			
Male	57 (48%)	62 (52%)	0.07
Female	30 (35%)	55 (65%)	
	Mean (SD)		
	No, n = 117	Yes, n = 87	
Age (y)	52 (14.5)	57 (13.5)	0.01
Sleep duration, weekdays (h)	7.1 (1.9)	7.3 (2.1)	0.94
Sleep duration, weekends (h)	7.2 (1.9)	7.5 (2.3)	0.91
Time to bed, weekdays, PM	23:50	23:40	0.54
Time to bed, weekends, PM	23:52	23:42	0.56
Time to fall asleep (min)	45 (51)	44 (49)	0.86
Time to get out of bed, weekdays (AM)	6:55	6:57	0.97
Time to get out of bed, weekends (AM)	7:03	7:07	0.83
Nap duration, weekdays (min)	42 (57)	61 (72)	0.06
Nap duration, weekdays (min)	48 (58)	60 (70)	0.25
Sleep quality score	19.8 (14)	21 (14)	0.67
Mood score	11.45 (9.8)	13.71 (11.1)	0.13
Diet score	19 (5.7)	18.8 (5.1)	0.84
no pre-planned physical activity, days per week	5.4 (2.6)	6.2 (2)	0.01
Sociocultural activity	0.1 (0.7)	0.12 (0.9)	0.93
Smoking, pack-year	1.7 (6.9)	3.8 (16.5)	0.37
Diastolic blood pressure (mm Hg)	79 (9.4)	81.9 (9.4)	0.03
Systolic blood pressure (mm Hg)	125.3 (17.9)	133.8 (19.5)	0.002
Waist circumference (cm)	86.9 (13.2)	99.8 (16)	0.0001
Body mass index, kg/m^2	24 (4.7)	27.4 (7.8)	0.001
Metabolic syndrome severity score	0.1 (0.82)	1.59 (1.64)	0.0001
Disease duration (y)	6.5 (5.9)	5 (4.3)	0.04
Laboratory Findings			
Fasting blood glucose (mg/dL)	98 (45)	150 (87)	0.0001
High density lipoprotein (mg/dL)	35 (15)	31 (12)	0.04
Triglyceride (mg/dL)	108 (50)	165 (95)	0.0001
Hemoglobin (mg/dL)	11.3	11.5	0.57
White blood cells, cells/L	6.24	9.94	0.43
Lymphocytes, cell/L	3.10	3.05	0.79
C-reactive protein, mg/L	4	3	0.41
Albumin	4.1	4.4	0.43
Blood urea nitrogen before dialysis (mg/dL)	132	130	0.78
Blood urea nitrogen after dialysis (mg/dL)	41.5	44	0.28
Parathyroid hormone	398	427	0.64
Phosphorus (mg/dL)	5.3	5.5	0.52
Vitamin D (IU/L)	61	70	0.51
Calcium (mg/dL)	8.5	8.6	0.33

Table 3. Frequency distribution of components of metabolic syndrome

Number of patients (%)	High FBG (n = 90)	High triglyceride (n = 59)	Low HDL (n = 111)	High blood pressure (n = 79)	High waist circumference (n = 68)
11 (9.5%)	√	√	√	√	√
3 (2.5%)		√	√	√	√
14 (12%)	√		√	√	√
4 (3.5%)	√	√		√	√
8 (7%)	√	√	√		√
5 (4%)	√	√	√	√	
9 (7.5%)	√	√	√		
0 (0%)	√	√		√	
1 (0.85%)	√	√			√
25 (21.5%)	√		√	√	
12 (10.25%)	√		√		√
1 (0.85%)	√			√	√
10 (8.5%)		√	√	√	
8 (7%)		√	√		√
0 (0%)		√		√	√
6 (5%)			√	√	√

components of metabolic syndrome (Table 3). The most frequently seen component was low HDL followed by high FBG, high BP, high WC, and high triglyceride (Table 3).

Logistic regression models are presented in Table 4. Presence of metabolic syndrome was the dependent variable. The multivariable logistic regression model with backward elimination was controlled for age, sex, lifestyle factors, smoking, and important laboratory data. Age, physical activity, mood status and missed work were the significant factors associated with metabolic syndrome (Table 4).

Linear regression models are presented in Table 5. Metabolic syndrome severity score was the dependent variable. The multivariable linear regression model with backward elimination was controlled for age, sex, lifestyle factors, smoking, and essential laboratory data. Sleep quality and physical activity were significant factors associated with the metabolic syndrome severity score.

Discussion

The objectives of this study were to evaluate the prevalence of metabolic syndrome among dialysis patients and to identify the risk factors for both its occurrence and its severity. With the help of these findings, physicians can more proactively identify risk factors in their dialysis patients and work to mitigate the risk of developing metabolic syndrome or prevent progression into severe manifestation of it. We found that more than 42.6% of patients undergoing hemodialysis have metabolic syndrome and that it is more prevalent in women (Table 2). This is corroborated by other studies that have reported a high prevalence of metabolic syndrome

Table 4. Association of metabolic syndrome and patients' characteristics assessed by multivariable logistic regression model ($R^2 = 0.29$)

Patients' characteristics	Univariate logistic association				Multivariable logistic model			
	OR	(95% CI)		*P*	OR	(95% CI)		*P*
Age	1.02	1.005	1.04	0.01	1.02	1.001	1.04	0.04
Physical activity	0.85	0.75	0.96	0.01	0.85	0.74	0.97	0.01
Mood status score (out of 35)	1.02	0.99	1.04	0.13	1.04	1.002	1.07	0.03
Missed work (out of 5 days)	1.001	0.92	1.09	0.97	0.86	0.76	0.97	0.01
Gender, Male	1.68	0.95	2.98	0.07	Removed by backward elimination			
Married	1.4	0.59	3.28	0.44				
Smoking (Pack-Years)	1.01	0.98	1.04	0.29				
Sleep quality score (Out of 70)	1.006	0.98	1.02	0.59				
Time to go to bed on weekdays	0.94	0.80	1.11	0.52				
Falling sleep time, minutes	0.99	0.99	1.005	0.79				
Time to go to bed on weekends	0.94	0.80	1.11	0.52				
Wake-up time on weekdays	1.005	0.88	1.14	0.94				
Wake-up time on weekends	1.01	0.89	1.14	0.84				
Night sleep duration on weekdays	0.99	0.88	1.11	0.89				
Night sleep duration on weekends	0.99	0.88	1.11	0.93				
Diet score (out of 49)	0.99	0.94	1.04	0.84				
Social activity	1.02	0.72	1.44	0.88				
Albumin	1.07	0.84	1.35	0.56				
Hb	1.05	0.89	1.26	0.51				
WBC	1.05	0.93	1.20	0.38				
PTH	1	0.99	1.001	0.57				
Ca	1.22	0.84	1.76	0.28				
P	1.06	0.88	1.27	0.49				
Vitamin D	1.001	0.99	1.004	0.57				

Ca, calcium; P, phosphate; Hb, hemoglobin; PTH, parathyroid hormone; WBC, white blood cell.
Note: The Hosmer–Lemeshow goodness-of-fit test for the model was $\chi^2 = 5.717$ ($P = 0.422$).

among these patients. For example, in a study among European patients, the prevalence of metabolic syndrome was found to be 68.5%, although the disease was more common among men, in contrast with our results.[17] Another study found the prevalence to be 56.25% during the first year of hemodialysis, but this number steadily declines as duration on dialysis increases.[18] Likewise, the patients within our study that had metabolic syndrome demonstrated a significantly shorter mean duration of disease than those without metabolic syndrome (Table 2). Additionally, Tsangalis et al found an overall prevalence of metabolic syndrome to be about 40%, which is similar to our finding of 42.6% (Table 2).[18] Therefore, differences in prevalence may be partially due to the duration of time spent on dialysis across different studies. We suggest more investigation into this topic.

Here we found metabolic syndrome to be more common among women. Jalalzadeh et al found the prevalence of metabolic syndrome in hemodialysis patients to be over 58% for men but under 50% for women and that the potential mechanisms behind metabolic syndrome may vary by gender; they saw low HDL more frequently in women and more trouble with glucose metabolism more frequently in men.[19] The findings with regards to gender differences presents an interesting area of study that still needs more clarification. We suggest studying both the prevalence of metabolic syndrome by gender, but also investigating which components of metabolic syndrome are seen at consistently higher rates according to gender.

Tsangalis et al identified high BP, abdominal obesity, and high triglycerides as the most common combination of risk factors in dialysis patients with metabolic syndrome.[18] Within our study the most frequent combination was high fasting blood sugar, low HDL, and high BP (Table 3). High BP seems to be a common denominator here, which is unsurprising considering the prevalence of hypertension among dialysis patients is estimated to be as high as 86%.[20] Additionally, it is estimated that only 30% of these patients have their hypertension well controlled.[20] Sodium and volume excess are thought to be the primary mechanisms contributing to the high prevalence of hypertension within this patient population due to the significantly diminished excretory capacity of ESRD patients.[21] Considering the prevalence of hypertension within dialysis patients and its involvement with metabolic syndrome, both of which increase the

Table 5. Association of metabolic syndrome severity score and patients' characteristics assessed by multivariable linear regression model ($R^2 = 0.36$)

Patients' characteristics	Univariate linear association				Multivariable linear model			
	β	95% CI		*P*	β	95% CI		*P*
Sleep quality score (out of 70)	0.02	0.005	0.03	0.009	0.01	0.001	0.03	0.03
Physical activity	-0.13	-0.22	-0.04	0.003	-0.12	-0.21	-0.02	0.01
Age	0.01	-0.005	0.02	0.17				
Sex, Male	0.34	-0.09	0.77	0.12				
Married	0.01	-0.64	0.68	0.95				
Smoking (Pack-Years)	-0.00	-0.01	0.01	0.67				
Time to go to bed on weekdays	-0.09	-0.22	0.03	0.13				
Falling sleep time (min)	0.001	-0.003	0.006	0.56				
Time to go to bed on weekends	-0.1	-0.22	0.02	0.12				
Wake-up time on weekdays	-0.06	-0.16	0.02	0.16				
Wake-up time on weekends	-0.05	-0.14	0.03	0.25				
Night sleep duration on weekdays	-0.07	-0.16	0.01	0.10				
Night sleep duration on weekends	-0.08	-0.17	0.004	0.06	Removed by backward elimination			
Diet score (out of 49)	-0.02	-0.06	0.01	0.27				
Social Activity	0.11	-0.15	0.37	0.40				
Albumin	-0.02	-0.09	0.04	0.54				
Hb	-0.07	-0.21	0.05	0.24				
WBC	0	-0.007	0.008	0.90				
PTH	0	-0.001	0	0.36				
Ca	0.14	-0.13	0.42	0.31				
P	0.02	-0.11	0.1	0.71				
Vitamin D	8.77E-05	-0.002	0.002	0.92				
Mood status score (out of 35)	0.01	-0.004	0.03	0.11				
Missed work (out of 5 days)	0.04	-0.02	0.11	0.17				

Ca, calcium; P, phosphate; Hb, hemoglobin; PTH, parathyroid hormone; WBC, white blood cell.

risk of CVD mortality in this vulnerable population, we recommend more investigation into optimal management strategies for this common problem.

The existence of a relationship between metabolic syndrome and ESRD has been established. For example, Navaneethan et al is one of the studied that has demonstrated a link between metabolic syndrome and ESRD as many of the components of metabolic syndrome are independent risk factors for the development of ESRD for those with CKD.[22] Additionally, certain components of metabolic syndrome can be associated with mortality in CKD patients: low HDL and high FBG.[22] The association of metabolic syndrome with CKD has been reported in other studies, even in the absence of classical risk factors for renal failure.[23]

Independent of kidney disease or hemodialysis, age and female gender have been identified as predisposing factors for metabolic syndrome.[24] The most apparent pathology associated with age is an increase in insulin resistance. For older women, hyperandrogenism, increased abdominal obesity, decreased HDL, and the physiological responses to stress increase their risk (more than for older men) of developing metabolic syndrome.[24] While our results on gender conflicted with some studies focused on metabolic syndrome within dialysis patients, they agree with the studies focused on metabolic syndrome alone.

Here we demonstrated that less planned days involving physical activity is associated with metabolic syndrome in dialysis patients. Myers et al explains how physical activity has been proven to help manage each of the contributing conditions of metabolic syndrome and is effective in preventing its development altogether.[25] Importantly, undergoing hemodialysis is very physically stressful and demanding, and it is not surprising that research has demonstrated that dialysis patients are less physical active when compared even with healthy individuals who live sedentary lifestyles.[26] According to Zhang et al increased physical activity levels are associated with reduced mortality in hemodialysis patients.[27] Therefore, we recommend incorporating light exercise as part of the treatment regimen for dialysis patients. This could be accomplished by having exercise equipment such as stationary bikes or fitness professionals at dialysis centers.

Mood was another factor associated with metabolic syndrome among dialysis patients. However, in a study on hemodialysis patients with metabolic syndrome

investigating the association of this syndrome on quality of life (QOL) and mood among patients, no significant relationship was found.[28] However, in the general population study, metabolic syndrome has been shown to be associated with symptoms of anxiety and depression.[29] While metabolic syndrome was not shown to affect QOL or mood in hemodialysis patients, it is important to note that QOL is greatly reduced for this patient population.[30,31] The prevalence of certain psychiatric disorders like depression among dialysis patients is reported to be nearly 40%.[32] Taken together with our results, these findings suggest that poor mood may contribute to the development of metabolic syndrome in hemodialysis patients, but the reverse relationship still requires more investigation.

We found sleep quality score to be significantly associated with the severity of metabolic syndrome in dialysis patients. It is well known that sleep insufficiency in both quality and quantity is a risk factor for the development of metabolic syndrome.[33,34] Jennings et al examined this relationship and saw that the Pittsburgh Sleep Quality Index global score was related to WC, body mass index, body fat percentage, serum insulin and glucose levels, and insulin resistance.[34] A number of other studies have corroborated this relationship by studying sleep disturbances like obstructive sleep apnea.[34-36] Sleep insufficiency has been shown to increase insulin resistance, which is one mechanism by which sleep insufficiency is thought to contribute to metabolic syndrome.[37,38]

Importantly, sleep disturbances are extremely common among the dialysis patient population. Its prevalence has been reported to be as high as 73%.[39] Additionally, both short and long sleep duration is associated with worsening of disease including progression from CKD to ESRD.[40] Therefore, sleep issues are clearly a prominent and worrying symptom among dialysis patients that has been associated with the development of metabolic syndrome even in the general population. It may be possible that by addressing struggles with sleep early in dialysis patients, physicians can help to mitigate the risk of developing severe metabolic syndrome. Additionally, in dialysis patients who do report sleep insufficiency, the conditions of metabolic syndrome should be more closely monitored so they can be managed proactively.

Strengths and Limitations

The strengths of our study were the comprehensive review and evaluation of possible risk factors in hemodialysis patients who have a significant financial burden for the health system and are prone to mortality and disability. In addition, the study of psychological and social issues has made this study unique as its coverage in existing literature is limited.

Our study's limitations are as follows: failure to examine more laboratory data such as other vitamins, hormones, and common medications used by patients. Additionally, we were unable to consider the relationship between the onset of the metabolic syndrome, the duration of dialysis and the prevalence of metabolic syndrome. Additionally, our results are not well generalizable because subjects were taken from only one medical center. Our study cannot completely answer whether there is an existence of a causal relationship.

Further studies with a larger group of subjects are needed to generalize the results of this study to the general public. As mentioned, metabolic syndrome requires special attention from researchers due to its significant prevalence and high risks. Better understanding the pathology of each risk factor can help prevent and reduce the prevalence of this syndrome. Other studies must look at the effectiveness of available therapies that can be implemented to fit into the treatment regimen of dialysis patients.

Conclusion

Given the high prevalence of metabolic syndrome in hemodialysis, several lifestyle elements emerged as its risk factors in the current study which included poor sleep quality, lower physical activity, lower mood status, and older age.

Authors' Contribution

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Research Highlights

What is the current knowledge?

- The prevalence of metabolic syndrome in hemodialysis patients is high however the lifestyle risk factors are unknown.

What is new here?

- In hemodialysis patients, the risk of metabolic syndrome is increased by poor sleep quality, lower physical activity, lower mood status, and older age.

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Competing Interests
The authors declared that they have no conflict of interest.

Data Availability Statement
Data are available upon reasonable request.

Ethical Approval
The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of Qom University of Medical Sciences.

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