Original Article

The prevalence of metabolic syndrome among adult patients with chronic kidney disease: an overlooked problem in Sudan

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Background: Chronic kidney disease (CKD) and metabolic syndrome (MetS) are two global public health problems. High waist circumference, high caloric nutrition, and sedentary lifestyle are known risk factors for CKD and MetS. CKD increases the risk of cardiovascular disease and end-stage renal disease. This work aimed to determine the prevalence of MetS and associated risk factors in adult Sudanese patients with CKD.

Methods: A descriptive cross-sectional hospital-based study enrolled 100 patients attending Ibn Sina specialized hospital in Khartoum, Sudan. A Comprehensive structured closed-ended questionnaire was applied. Anthropometric measurements were taken. Two readings of blood pressure (BP) were obtained. Blood samples were collected after overnight fasting for the measurement of fasting blood glucose (FBG), High-density lipoprotein (HDL) cholesterol and triglyceride (TG). Data were analyzed using SPSS version 25.0.

Results: The prevalence of MetS was 19%. Fifty-three percent of the patients aged more than 55 years and 56% were females. The estimated glomerular filtration rate (eGFR) of the patients was 60–89 mL/min in 24% of the patients. A significant association was found between MetS and high BP, high FBG, and high TG level.

Conclusions: The prevalence of MetS in patients with CKD was 19%. The main risk factors for MetS were hypertension, high FBG, and hypertriglyceridemia.

Keywords: Metabolic syndrome (MetS); chronic kidney disease (CKD); blood pressure (BP); waist circumference; prevalence

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Introduction

Chronic kidney disease (CKD) is a worldwide health problem ranging from mild to end-stage renal disease and is one of the leading causes of mortality. The prevalence of chronic kidney is about 15% worldwide (1-3). Older people are more prone to develop CKD due to aging related reduction in glomerular function and chronic illnesses such as hypertension and diabetes (4,5). Unfortunately, many patients are not aware of CKD

due to the long asymptomatic phase of the disease (6). Early treatment of CKD is important to slow disease progression (7). The prevalence of metabolic syndrome (MetS) increases with the growing prevalence of chronic renal disease (8).

MetS is a group of metabolic risk factors strongly associated with a greater risk of developing cardiovascular disease and type 2 diabetes mellitus. Components of MetS include central obesity, hypertension, insulin resistance, and atherogenic dyslipidemia (9,10). Both lifestyle factors and genetic factors are involved in the pathogenesis of MetS (11). There is an association between MetS and kidney damage (12). However, the mechanism by which components of MetS cause kidney damage is not yet elucidated. High caloric diet, unbalanced nutrition, sedentary lifestyle, and obesity which are now common in both developed and developing countries, are the main risk factors of MetS and CKD (13). Components of MetS might play an etiologic role in CKD (13-17). However, components of MetS do not have equal contribution to the risk of CKD (7). The prevalence of the MetS is growing in the Middle East and sub-Saharan Africa (18).

To our knowledge, there was no published study about MetS in CKD in the Sudanese population. This study aimed to determine the prevalence of MetS and associated risk factors in adult Sudanese patients with CKD. We present the following article in accordance with the STROBE reporting checklist (available at https://jphe.amegroups.com/article/view/10.21037/jphe-22-4/rc).

Methods

Study design

This was a descriptive cross-sectional hospital-based study.

Study area and duration

The study was conducted at Ibn Sina specialized hospital in Khartoum, Sudan from October 2020 to January 2021. Ibn Sina specialized hospital was selected because it is a tertiary healthcare hospital that attract patients with CKD.

Study population

All patients who came to the referred clinic of Ibn Sina specialized hospital during the study period.

Inclusion criteria

All patients who accepted to participate in the study were included in the study.

Exclusion criteria

Patients who refused to participate in the study.

Sampling technique and sample size

All study participants who fulfilled the inclusion criteria were selected as the representative study sample. The total coverage of patients presenting to the referred clinic in the present period was decided and the sample size of the patients was estimated to be about 100.

Study variables

Study variables include dependent variables: demographical characteristics, age, gender, body mass index (BMI), and independent variables, which are the laboratory investigations.

Data collection

The data was collected by a comprehensive, structured closed-ended questionnaire that covers the study's relevant aspects and variables. The data was collected by the authors themselves.

Anthropometric measurements

Weight and height were measured using calibrated equipment and standardized technique. Body mass index (BMI) was calculated by the following formula: weight in kilograms divided by height in meters squared. Waist circumference of the study participants was measured at the iliac crest highest point during minimal respiration.

Measurement of blood pressure (BP)

Two readings of BP were obtained using a mercury sphygmomanometer in the sitting position following rest for 10 minutes and the mean of the readings was used for analysis.

Measurement of fasting blood glucose (FBG), HDL-cholesterol and triglycerides (TG)

Blood samples were collected after overnight fasting for

Table 1 Sociodemographic factors of study participants

Population demographics	Study participants (N=100)	
	%	N
Age, years		
18–35	20	20
35–55	27	27
≥55	53	53
Gender		
Male	44	44
Female	56	56
Origin		
North Sudan	59	59
East Sudan	2	2
West Sudan	39	39
Residence		
Khartoum	61	61
Middle Sudan	19	19
North Sudan	7	7
West Sudan	3	3
Occupation		
Employee	16	16
Workers	28	28
Housewives	44	44
Jobeless/Retired	12	12

8–10 hours for the measurement of fasting blood glucose (FBG), HDL-cholesterol (HDL-C) and TG. All the biochemical parameters were assayed on a Biosystem BTS350.

Definition of CKD

CKD is defined as either urinary albumin-creatinine ratio more than 30 mg/gram or estimated glomerular filtration rate (eGFR) less than 60 mL/min per 1.73 m^2 body surface area (19).

Definition of MetS

Patients with CKD were diagnosed with MetS using the modified National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria (20). According to NCEP criteria, subjects who had three or more of the following were defined as having MetS: (I) abdominal obesity WC >102 cm in men and >88 cm in women; (II) systolic BP ≥130 mmHg or a diastolic BP ≥85 mmHg); (III) TG ≥1.7 mmol/L, (IV) HDL-C <1.03 mmol/L in men and <1.29 mmol/L in women; (V) FBG ≥5.6 mmol/L. The participants who currently reported using anti-diabetic or anti-hypertensive medication were counted as having diabetes or high BP respectively.

Data analysis

Data entered into the questionnaire and then transferred to SPSS version 25.0 for analysis. Descriptive analysis was performed for all study variables with mean and standard deviation for quantitative data and frequencies with proportions for qualitative data. These were presented in frequency tables with percentages and graphs.

Bi-variable analysis was done to determine the associations between the main outcome variable and the other relevant risk factors with Chi-square test (for categorical variables) and *t*-test (for quantitative variables) statistical tests. P value of 0.05 or less was considered significant.

Ethical approval

This study was approved by the Sudanese Medical Specialization Board (SMSB) and the Manager of Ibn Sina Teaching Hospital. Also, verbal consent was taken from the patients. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Results

Sociodemographic factors of study participants

More than half (53%) of the study participants were more than 55 years old; females were (56%) of the study participants. The majority of patients (61%) were from Khartoum State (*Table 1*).

Distribution of components of MetS among study participants.

Nineteen percent of the study participants had MetS, frequency of high blood pressure, high FBG, high TG, low HDL, and high WC were 48%, 39%, 43%,53%, and 9%,

Table 2 Components of metabolic syndrome distribution among study participants

Components of metabolic syndrome	Study participants (N=100)	
	%	N
MetS	19	19
High BP	48	48
High FBG	39	39
High TG	43	43
Low HDL	53	53
High WC	9	9

MetS, metabolic syndrome; BP, blood pressure; FBG, fasting blood glucose; TG, triglycerides; HDL, high-density lipoprotein; WC, waist circumference.

Table 3 Characteristics of study participants

Characteristics of metabolic syndrome	Study participants (N=100)	
	%	N
Fatigue	62	62
Anemia	63	63
Skin changes	7	7
HTN	55	55
DM	55	55
Family history of MetS	20	20
Smoking history	26	26
Alcohol consumption	7	7
Taking AHM	66	66
BMI >30 kg/m^2	15	15
eGFR, mL/min		
≥90	14	14
60–90	24	24
45–60	16	16
30–45	17	17
15–30	18	18
<15	11	11

HTN, hypertension; DM, diabetes mellitus; MetS, metabolic syndrome; AHM, antihypertensive medications; BMI, body mass index; eGFR, estimated glomerular filtration rate.

respectively (*Table 2*).

Characteristics of study participants

More than half (62%) of the study participants presented with fatigue, and also more than half (63%) were suffering from anemia (*Table 3*).

More than half (55%) of the study participants had a history of hypertension, and a similar percentage had a history of diabetes mellitus; less than a third (20%) of the study participants had a family history of a similar condition.

Twenty-six percent of patients were smokers, and 66% of them were using antihypertensive medications. BMI of more than 30 kg/m^2 was found in 15% of patients while eGFR between 60–89 mL/min was found in (24%) of the study participants (*Table 3*).

Test of associations

Using Chi-Square test, a statistically significant association was found between MetS and high blood pressure (with P=0.004), high TG (with P=0.000), high FBG (with P=0.000) (*Table 4*).

Discussion

Components of MetS are involved in CKD development (21). To the best of our knowledge, this is the first study in Sudan to assess the prevalence and associated risk factors of MetS in patients with CKD. In the present study, 19% of the participants had MetS. In the same direction, previous studies conducted by Ramli *et al.* (22), and Xiao *et al.* (23), reported that the percentages of the study participants with MetS were 23%and 25%, respectively. In contrast to our study, Poudel *et al.* (13) reported that 37.5% of their participants had MetS. The present study showed that more than a half (53%) of the study participants were more than 55 years old, similar to Ramli *et al.* (22) who reported that the mean age group of their participants was 40–60 years old. More than half (56%) of the study participants were females and male to female ratio was 1:1.3. In agreement with our study, Kurella *et al.* (24), revealed a male-to-female ratio of 1:1.2. Similar to Xiao

Table 4 Comparison between metabolic syndrome group and none metabolic syndrome group cross tabulation distribution among study participants

Factors	Patient without MetS	Patient with MetS	Total	P value
Age	47±12	55±10		0.083
Gender				0.785
Male	8	36	44	
Female	11	45	56	
High BP	14	34	48	*0.040
High FBG	17	22	39	*0.000
High TG	16	17	33	*0.000
Low HDL	8	45	53	0.054
High WC	2	7	9	0.795
Total	19	81	100	

*, significant P value. MetS, metabolic syndrome; BP, blood pressure; FBG, fasting blood glucose; TG, triglycerides; HDL, high-density lipoprotein; WC, waist circumference.

et al. (23), our study found that more than half of the study participants presented with fatigue, and less than one third (15%) of the study participants had BMI of more than 30 kg/m^2.

One interesting finding of our study is that more than half (59%) of study participants had a 88–100 cm waist circumference. Bener *et al.* estimated waist circumference in MetS to be 85–109 cm (25). In the present study, 61% of the participants had FBG level of less than 100 mg/dL, 57% of the study participants had a TG level of less than 150 mg/dL, and 53% of study participants had HDL level of less than 40 mg/dL, similar to Sawant *et al.* findings, which are components of MetS (26).

In agreement with Sheen *et al.*, who investigated the association between MetS and renal diseases (27), the present study documented that more than half of patients (60%) of the study participants had an eGFR less than 60 mL/min. This is similar to Xiao *et al.* (23), who showed that more than half of their participants had eGFR of 60–89 mL/min.

The present study showed that the risk factors for MetS in adult Sudanese patients with CKD were hypertension, high FBG level, and hypertriglyceridemia, similar to a recent study conducted by Xu *et al.*, which recruited 37,533 old Chinese individuals to investigate the association of components of MetS with CKD (28). Furthermore, Michishita *et al.* (29) and Lu *et al.* (7) reported that hypertension and hyperglycemia are associated with CKD. Zhao *et al.* showed that hypertriglyceridemia is associated with a higher risk of nephric microvascular damage and CKD (30). The main risk factor for MetS in our study was hypertension, while abdominal obesity was the main risk factor in Morocco and Nepal (13,21). It is worth mentioning that about one third of the population in the Middle East and sub-Saharan Africa is hypertensive (31). The high prevalence of hypertension in this study can be also explained by activation of the renin-angiotensin-aldosterone system and sympathetic nervous system, and inhibition of Atrial natriuretic peptide in patients with CKD (32).

This study is not without limitations. The sample size was relatively small and the cross-sectional design does not allow for identifying the temporal relationship between the risk factors and outcome. Variables that constitute the components of the MetS are associated with metabolic syndrome. The study might not truly represent all patients with MetS and CKD as the involvement of patients was not from all renal centers in Sudan. Despite all these limitations, this study is novel and reflects the prevalence and risk factors of MetS in adult Sudanese patients with CKD.

Conclusions

Nineteen percent of the study participants had MetS. The risk factors for MetS were hypertension, high FBG and high hypertriglyceridemia. The growing prevalence of MetS is expected to increase the prevalence of CKD. Components of MetS should be identified early and controlled in patients with CKD. Further clinical trials with bigger sample sizes should be conducted to establish whether the treatment of MetS or its components can improve the clinical outcomes in patients with CKD.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jphe.amegroups.com/article/view/10.21037/jphe-22-4/rc

Data Sharing Statement: Available at https://jphe.amegroups.

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jphe.amegroups.com/article/view/10.21037/jphe-22-4/coif). MHA serves as an unpaid editorial board member of *Journal of Public Health and Emergency* from August 2017 to July 2023. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was approved by the Sudanese Medical Specialization Board (SMSB) and the Manager of Ibn Sina Teaching Hospital. Also, verbal consent was taken from the patients. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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