BRIEF COMMUNICATION

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Comparison between general obesity and abdominal adiposity to estimate cardiovascular disease prevalence in individuals with chronic kidney disease: results from NHANES 2005–2016

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Abdominal obesity, regardless of overall obesity, is associated with metabolic abnormalities and with direct impact on cardiovascular risk. The aim of this study was to compare body mass index (BMI), waist circumference (WC), and waist-to-height ratio (WHtR) to estimate cardiovascular disease (CVD) prevalence in individuals with chronic kidney disease (CKD). The data analyzed is from 2005–2016 cycles of the NHANES. A total of 2,825 participants with CKD were included in this study, and most of them had a high BMI, 66.1%, to be exact (BMI ≥ 25.0 kg/m^2 if age <65 or >27.0 if age ≥ 65). The prevalence rates of high WC (≥102 cm for men or ≥88 cm for women) and high WHtR (WHtR>0.5) in the study population were 70.0% and 91.0%, respectively. The results of this study suggest that BMI is a good indicator of the risk of CVDs in individuals with CKD. In addition, the results show that WC and WHtR are associated with CVDs in non-overweight individuals of both sexes. These results indicate that the assessment of abdominal fat is essential even in non-overweight patients because the risk of CVDs cannot be identified in this subpopulation using only BMI.

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INTRODUCTION

Abdominal obesity, regardless of overall obesity, is associated with metabolic abnormalities. Despite this, in practice, the association of waist circumference (WC) with cardiometabolic risk beyond body mass index (BMI) depends on the population sampled and the outcome measured [1]. In healthy adults, the relationship between WC and clinical outcomes is consistently stronger than that between BMI and the risk of diabetes [2]. Regarding other cardiovascular diseases (CVDs), their associations with WC, regardless of BMI, remain unclear [1]. A systematic review of 58 cohort studies (221,934 participants) revealed that WC and BMI, whether assessed individually or together, have a similar strength of association with coronary disease and stroke [1]. The authors of another systematic review and meta-analysis concluded that the improved WC measure including height, waist-to-height ratio (WHtR), is significantly better than WC for assessing the risk of diabetes, hypertension, and all-cause mortality [3].

Individuals with chronic kidney disease (CKD) are acknowledged as a group at high risk for cardiovascular events and diseases that require special attention. The factors responsible for the association between obesity, CKD and CVD involve pathophysiological mechanisms, including renal hemodynamic changes, neurohumoral pathways that activate the sympathetic and renin-angiotensin-aldosterone systems, proinflammatory and profibrotic effects of various adipokines, and insulin resistance may explain the excessive risk of CKD development and progression in obese patients [4]. However, obesity is recognized as a heterogeneous condition in which individuals with similar BMI may have distinct metabolic and CVD risk profiles [5]. Therefore, the aim of this study was to compare BMI, WC, and WHtR to estimate cardiometabolic risk factors and CVD prevalence in individuals with CKD.

METHODS

Data from the 2005–2016 cycles of the NHANES was analyzed (https://www.cdc.gov/nchs/nhanes/index.htm). The study population included participants with CKD aged 20 or older. The glomerular filtration rate (eGFR) of each participant was calculated [6], and those with an eGFR<60 ml/min/1.73 m^2 were classified as having CKD. The exclusion criteria were participants with missing weight, height, WC or pregnancy data.

Cholesterol and triglyceride were evaluated as cardiometabolic risk factors. Hypertension, diabetes, coronary heart disease and stroke were defined by self-reported medical diagnosis at the time of the interview, or the use of prescribed medication to treat these CVDs [7].

Regarding anthropometric data, all the methods utilized are described in the Anthropometry Procedures Manual [8]. The cutoff points for high BMI were ≥25 kg/m^2 for adults and >27 kg/m^2 for elderly participants. The cutoff point for high WC were >102 cm for males and >88 cm for females [7]. To calculate WHtR, WC was divided by height [3]. WHtR >0.5 was considered high [3].

Logistic regression analysis was performed to estimate the associations among BMI, WC, WHtR, and outcomes. Area Under

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Table 1. Associations of overall obesity and abdominal adiposity with cardiometabolic risk factors and cardiovascular diseases in population with chronic kidney disease.

	High BMI[a]			High WC[b]			High WHtR[b]		
	OR	95% CI	p	OR	95% CI	P	OR	95% CI	p
Total cholesterol ≥200 mg/dL	0.89	0.72–1.10	0.324	1.12	0.84–1.48	0.945	0.66	0.58–1.28	0.463
Triglyceride ≥150 mg/dL	2.51	2.03–3.11	<0.001	2.58	1.98–3.38	0.002	3.74	2.28–6.14	<0.001
Blood pressure ≥130/ ≥ 85 mmHg	1.27	1.01–59	0.038	1.08	0.86–1.36	0.508	1.14	0.76–1.76	0.517
Hypertension	1.94	1.51–2.48	<0.001	1.11	0.83–1.49	0.081	1.88	1.21–2.91	0.005
Fasting glucose ≥110 mg/dL	1.64	1.29–2.09	<0.001	1.82	1.38–2.39	0.001	2.61	1.59–4.29	<0.001
Diabetes mellitus	2.77	2.14–3.58	<0.001	1.44	1.02–2.04	0.035	2.72	0.97–7.65	0.056
Coronary heart disease	1.42	1.08–1.85	0.010	1.26	0.91–1.72	0.155	1.48	0.68–3.22	0.311
Stroke	1.05	0.74–1.49	0.772	1.13	0.75–1.68	0.537	1.30	0.61–2.78	0.492

OR odds ratio. *CI* confidence interval, *BMI* body mass index; WC: waist circumference, *WHtR* waist to height ratio, *High BMI* BMI ≥ 25.0 kg/m² if age <65 or >27.0 if age≥65; high WC: ≥102 cm for men or ≥88 cm for women, high WHtR: WHtR>0.5. Logistic regression test was performed. [a]Models were adjusted for sex, age, education level, estimated glomerular filtration rate (eGFR), smoking status, alcohol consumption and dietary markers of unhealthy consumption. [b]Models adjusted for sex, age, education level, estimated glomerular filtration rate (eGFR), smoking status, alcohol consumption, dietary markers of unhealthy consumption and BMI(kg/m²).

the ROC Curve (AUC) was determined. The adjusted variables were sex, age, education level, estimated glomerular filtration rate (eGFR), smoking status, alcohol consumption, self-reported unhealthy food consumption (answers “fair” and “poor” to the question ‘How healthy is your diet?’ were considered unhealthy consumption) and BMI. Statistical analyses were corrected for the complexity of the sample, using the SVY command set in STATA version 15.0. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 2,825 participants with CKD were included in this study, most of them (66.1%) had a high BMI. Regarding CVDs, 61.5% of the participants had hypertension, whereas 18.0% had diabetes (Supplementary Table 1). The prevalence rates of a high WC and a high WHtR were 70.0% and 91.0%, respectively.

High BMI was associated with hypertriglyceridemia, hypertension, diabetes mellitus, and coronary heart disease. High WC was associated only with hypertriglyceridemia and diabetes mellitus. In addition, high WHtR was associated with hypertriglyceridemia, hypertension, and fasting glucose ≥110 mg/dL (Table 1). According to the Area Under the ROC Curve (AUC), BMI, WHtR, and WC showed better performance in predicting diabetes. However, in general, these indices showed poor performance in predicting cardiometabolic risk factors and CVD (Supplementary Table 2).

BMI showed better performance than WC and WHtR in models of the association between CVD and CKD in the entire study population. However, high WC and high WHtR were associated with hypertriglyceridemia and diabetes in the non-overweight participants. In addition, high WHtR was associated with hypertension (Table 2).

Table 2. Associations of overall obesity and abdominal adiposity with cardiometabolic risk factors and cardiovascular diseases only in individuals without overweight.

Dependent variables	Without high BMI (*n* = 964)		
	OR	95% CI	P
Total cholesterol ≥ 200 mg/dL			
High WC	1.26	0.88–1.79	0.206
High WHtR	1.07	0.69–1.68	0.752
Triglycerides ≥ 150 mg/dL			
High WC	2.28	1.54–3.40	<0.001
High WHtR	2.85	0.66–4.88	<0.001
Hypertension			
High WC	1.46	1.02–2.11	0.039
High WHtR	2.54	1.63–3.96	<0.001
Diabetes mellitus			
High WC	1.84	1.02–3.30	0.040
High WHtR	3.52	1.29–9.60	0.014
Coronary heart disease			
High WC	1.45	0.79–2.65	0.222
High WHtR	1.61	0.72–3.60	0.240
Stroke			
High WC	0.90	0.55–1.46	0.677
High WHtR	1.67	0.75–3.73	0.204

OR odds ratio, *CI* confidence interval, *BMI* body mass index, *WC* waist circumference, *WHtR* waist to height ratio. High BMI: BMI ≥ 25.0 kg/m² if age <65 or >27.0 if age≥65; high WC: ≥102 cm for men or ≥88 cm for women, high WHtR: WHtR>0.5. Logistic regression test was performed. Models were adjusted for sex, age and race.

DISCUSSION

Similar to the present study, studies of other populations have identified the importance of assessing abdominal obesity in non-overweight individuals. In a cross-sectional study of 662 patients with coronary artery lesions and BMI ≤ 25 kg/m^2, in which WC was evaluated in tertiles, the authors found that the prevalence of diabetes (43.2% in tertile 3 vs. 29.3% in tertile 1) and dyslipidemia (85.1% in tertile 3 vs. 58.6% in tertile 1) was significantly higher in men in tertile 3 than in those in tertile 1 [9].

These findings indicate that WC and WHtR measurements could be effective clinical tools for identifying metabolically non-obese or ‘lean’ patients with CKD who have a risk for CVDs and may benefit from therapy but would not have been considered for treatment because they have a normal BMI. Notably, WHtR predicted CVDs better than WC. Results, like those of the present study regarding the associations between CVD and normal BMI and abdominal obesity, were identified in a cross-sectional study on the prevalence of cardiovascular risk factors in women (*n* = 53, 961; age 50–64) categorized into different BMI and WC groups. In addition, a normal WC was associated with higher high-density lipoprotein cholesterol (HDL-C) levels and lower systolic blood pressure. This result shows that lipid profile (especially lower HDL-C level) is more strongly associated with higher WC values than BMI [10].

Few studies have been conducted to compare the differences in performance between overall and abdominal fat in individuals with CKD. A cross-sectional study conducted in southern China (1834 participants) identified that among BMI, WC, and WHtR, only WHtR is significantly associated with C-reactive protein (CRP) level after adjustments of age and sex (OR = 7.79; 95% CI:6.76–8.38) [11].

This study has some limitations, such as its cross-sectional design and use of less sophisticated anthropometric and clinical parameters. However, it presents as a strength of the innovative character for the population with CKD, using more accessible parameters for cardiometabolic risk factors. We believe that our work brings important results for emerging countries so that patients with CKD are acknowledged as a group at high risk for cardiovascular events and diseases that require special attention.

In conclusion, this study showed that BMI is a good indicator of risk in individuals with CKD. In addition, WC and WHtR are associated with CVDs in non-overweight individuals of both sexes with CKD. Thus, the assessment of abdominal fat (using WC or WHtR) in non-overweight patients with CKD is essential because the risk of CVDs cannot be identified in this subpopulation using only BMI. Furthermore, this study showed that WHtR is more strongly associated with CVDs than WC in non-overweight patients with CKDs. Thus, we believe that the measurement of BMI should be complemented with the assessment of abdominal fat in patients with CKD.

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AUTHOR CONTRIBUTIONS

CSAS, MRGP conceived and designed research; CSAS, LLSS, MRGP analyzed the data; CSAS, LLSS, ATVSF, NAC, LCCL, MRGP data interpretation; CSAS wrote the paper. All authors read, reviewed and approved the final manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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