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Research Article

Association between Cardiometabolic Index and Increased Urinary Albumin Excretion: Evidence from NHANES 2017-2020

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ABSTRACT

Background: Obesity negatively affects kidney health, which is quite concerning. It has recently been determined that the Cardiometabolic Index (CMI), a freshly created metabolic index, may be useful for screening for renal insufficiency. Few research has found a correlation between albuminuria and CMI, nevertheless. Thus, this study set out to look at the relationship between albuminuria and CMI.

Methods: The National Health and Nutrition Examination Survey (NHANES) for the period between 2017–2020 provided the data for this cross-sectional investigation. Triglyceride (TG) (mmol/L)/ High density lipid-cholesterol (HDL-C) (mmol/L) × Waist height ratio (WHtR) was the formula used for calculating CMI. Using multifactorial logistic regression, the independent connection between albuminuria and CMI was investigated. The threshold effect was determined by means of a two-stage linear regression model. Additionally, subgroup analysis and interaction tests were carried out.

Results: A total of 3,408 participants were included, and 12.38% of them had albuminuria. As the CMI quartiles grew (quartile 1: 7.86%, quartile 2: 12.69%, quartile 3: 12.68%, quartile 4: 16.31%), so did the probability of albuminuria. The results of adjusted model 3 showed that a greater probability of albuminuria prevalence was strongly correlated with CMI (OR = 1.86, 95% CI: 1.29-2.68). This association held true for all subgroups (all P for trend > 0.05). Furthermore, with a two-stage linear regression model with an inflection point of 0.72, we discovered a nonlinear relationship between albuminuria and CMI.

Conclusion: Our results imply that CMI levels are related to the probability of albuminuria prevalence risk, indicating that CMI may be applied to albuminuria risk assessment.

INTRODUCTION

The prevalence of Chronic Kidney Disease (CKD) is as high as 9.1% worldwide, according to JAMA intern Med 2023. Approximately 10% of CKD patients will eventually develop End Stage Renal Disease (ESRD) [1], while more than 2 million patients will pass away each year as a result of not receiving treatment [2]. It is now a global public health issue that poses a major threat to human health. As a result, early identification of renal disease is crucial [3]. Since increased urine albumin excretion is the most sensitive and accurate diagnostic indication for early renal disease, it has been widely employed [4].

One issue facing global health is obesity. According to a study that investigated adult obesity rates across several states in the United States, adult obesity rates are expected to rise further and about one in two adults would be obese by 2030 [5]. Nonetheless, it is challenging to differentiate between the accumulation of subcutaneous and visceral fat using only a few conventional body assessment metrics, such as Body Mass Index (BMI) [6]. Consequently, the degree of obesity and cholesterol levels can be more accurately reflected by the Cardiometabolic Index (CMI), a novel metabolic index created by Ichiro Wakabayashi et al. and made up of clinical indicators like TG, HDL-C, and WHtR [7]. The clinical utility of CMI in metabolically linked disorders such hypertension, ischemic stroke, and hyperuricemia has been shown in a number of investigations [8-10]. Obesity has been shown in several studies to negatively impact renal function [11,12]. Lorcaserin was also found to be helpful in reducing albuminuria and the progression of CKD in obese individuals enrolled in the CAMELLIA-TIMI 61 clinical trial [13]. However, no pertinent research has looked at the connection between CMI and anomalies in urine albumin across the board in the US.

Thus, using NHANES data, this study aimed to investigate the relationship between elevated urine albumin excretion and CMI in the US population across all age groups.

MATERIALS AND METHODS

Survey Description

The NHANES provided the authors with the data. The National Center for Health Statistics (NCHS) carried out the population-based cross-sectional NHANES research to look at health and nutrition in the US. Because it is a sophisticated, multistage, stratified probability sample that is carried out every two years, it is representative [14]. All NHANES research methods were approved by the NCHS Research Ethics Review Board, and informed consent forms were signed by all investigators or, in the case of individuals under 16, by their parents or legal guardians. The following website offers all comprehensive NHANES research designs and data that are open to the public: https://www.cdc.gov/nchs/nhanes/.

Study population

3, 408 participants were selected for this study based on the screening criteria, out of 15, 560 individuals from the NHANES 2017–2020 survey cycle, in order to investigate the connection between CMI and microalbuminuria (Fig. 1). Lack of CMI, Urine Albumin Creatinine Ratio (UACR), inadequate laboratory testing, and general clinical data were the exclusion criteria for this study.

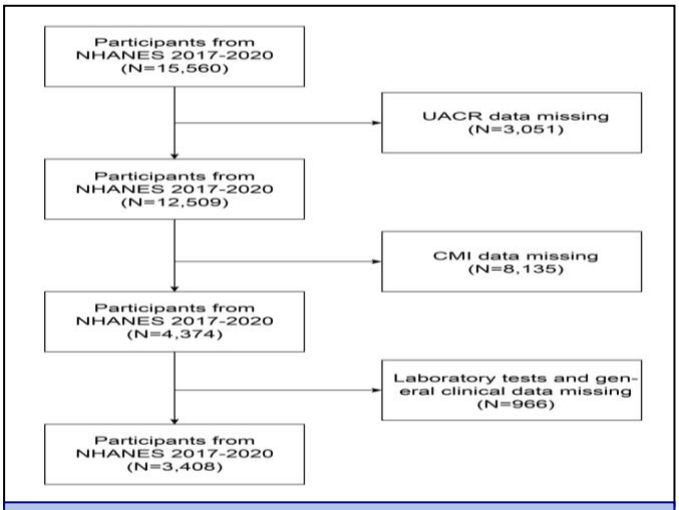

Figure 1: Flowchart of the sample selection from NHANES 2017–2020.

Definition of cardiometabolic index and albuminuria

An anthropometric measure called the CMI is used to gauge a person's amount of lipid and obesity. The rise in obesity is indicated by higher CMI scores. Health technicians with training gathered groups of clinical indications related to TG, WHtR, and HDL-C at mobile examination centers (MECs). CMI was further calculated: WHtR = WC (cm) / Height (cm); CMI = TG (mmol/L)/HDL-C (mmol/L) × WHtR, and rounded to two decimal places after that. For analytic purposes, we categorized the participants based on their CMI quartiles, using CMI as a continuous variable. CMI was chosen as the exposure variable in our investigation. NHANES participants provided urine samples, urinary albumin concentration, and urinary creatinine data. urine albumin concentration divided by urine creatinine concentration yielded the UACR. A UACR >30 mg/g was used to indicate albuminuria based on previous research [15,16]. Albuminuria was intended to be an outcome variable in our investigation.

Selection of covariates

Age (years), gender (male/female), smoking status, Waist Circumference (WC, cm), Body Mass Index (BMI, kg/m^2), history of hypertension and diabetes, Systolic Blood Pressure (SBP, mmHg), Diastolic Blood Pressure (DBP, mmHg), Fasting Blood Glucose (FPG, mg/dl), TG (mg/dl), Total Cholesterol (TC,

mg/dl), HDL-C (mg/dl), Low Density Lipoprotein Cholesterol (LDL-C, mg/dl), Serum Creatinine (Scr, mg/dL), Blood Urea Nitrogen (BUN, mg/dl), and Serum Uric Acid (SUA, mg/dl) were among the covariates in this study. There were three age groups: under 20, 20–60, and over 60. The individuals' BMIs were classified as < 25, 25-29.9, and ≥ 30 kg/m^2, corresponding to normal weight, overweight, and obese groups. The NHANES database has detailed measurements of every variable used in this investigation.

Statistical analysis

The Centers for Disease Control and Prevention (CDC) recommendations were followed in the execution of all statistical analyses. All analyses were performed using R version 4.1.2 and the EmpowerStats package (http://www.R-project.org). Categorical data were reported as proportions, while continuous variables were summarized as means with Standard Deviations (SD). Student's t-tests (for continuous variables) or chi-square tests (for categorical variables) were used to evaluate differences across individuals classified into CMI quartiles. Three separate multivariable regression models that took into consideration the NHANES complex sample design were used to investigate the relationship between CMI and albuminuria. In Model 1, no factors were altered. Model 2 underwent age, gender, and smoking status adjustments. Gender, age, smoking status, SBP, DBP, BMI, ALT, AST, Scr, and BUN were all corrected for in Model 3. Multivariate tests were created by fitting smoothed curves and controlling for variables using the three models. Using a threshold effect analysis model, the relationship and inflection points between CMI and albuminuria were examined. Subgroup analyses were then carried out based on the relationship between CMI and albuminuria, taking into account factors such as gender (male or female), age (< 20, 20-60, ≥ 60 years), BMI (normal weight/overweight/obese), diabetes (yes/no), and hypertension (yes/no). Additionally, these stratification factors were also considered as prespecified potential effect modifiers, and an interaction term was added to test for heterogeneity of associations between subgroups. p values < 0.05 were considered statistically significant.

RESULTS

Baseline Characteristics of Participants

The research involved 3, 408 participants who met the inclusion criteria with a mean age of 48.99 ± 18.02 years and 49.33% were male. The prevalence of albuminuria was 12.38%.

The clinical characteristics of the participants according to albuminuria as a column-stratified variable are shown in Table 1.

Table 1: Characteristics of the study population based on albuminuria.

Parameters	UACR<30 mg/g (*n* = 2985)	UACR≥30 mg/g (*n* = 422)	*P* value
Age (year)	47.78 ± 17.81	57.56 ± 17.19	<0.001
Gender (%)			0.418
Male	1465 (49.08%)	216 (51.18%)	
Female	1520 (50.92%)	206 (48.82%)	
Smokers (%)	1215 (40.70%)	195 (46.21%)	0.032
Diabetes (%)	352 (11.79%)	172 (40.76%)	<0.001
Hypertension (%)	978 (32.76%)	262 (62.09%)	<0.001
BMI (kg/m^2)	29.52 ± 7.17	30.77 ± 8.00	0.002
WC (cm)	99.65 ± 17.28	104.08 ± 18.24	<0.001
SBP (mmHg)	121.78 ± 17.79	135.92 ± 23.67	<0.001
DBP (mmHg)	74.28 ± 11.33	77.61 ± 13.72	<0.001
FPG (mg/dl)	108.64 ± 29.12	136.45 ± 63.61	<0.001
TC (mg/dl)	183.52 ± 40.34	177.51 ± 45.02	<0.001
TG (mg/dl)	102.25 ± 62.38	113.34 ± 65.99	<0.001
LDL-C (mg/dl)	109.09 ± 35.45	102.93 ± 38.05	<0.001
HDL-C (mg/dl)	53.98 ± 15.46	51.93 ± 17.18	<0.001
ALT (IU/L)	22.23 ± 21.20	22.51 ± 17.26	0.671
AST (IU/L)	21.80 ± 15.66	23.31 ± 17.39	0.236
BUN (mg/dl)	14.13 ± 4.92	17.73 ± 8.58	<0.001
Scr (mg/dl)	0.85 ± 0.21	1.09 ± 1.06	<0.001
SUA (mg/dl)	5.39 ± 1.39	5.75 ± 1.72	<0.001
CMI	1.36 ± 1.21	1.65 ± 1.34	0.028

Data are presented as means ± SD, medians (inter-quantile range (IQR)), and number (percentages).

Abbreviations: BMI: Body Mass Index; WC: Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; FPG: Fasting Plasma Glucose; TG: Triglyceride; TC: Total Cholesterol; LDL-C: Low-Density Lipoprotein Cholesterol; HDL-C: High-Density Lipoprotein Cholesterol; ALT: Aspartate Aminotransferase; AST: Aspartate Aminotransferase; BUN: Blood Urea Nitrogen; SCR: Serum Creatinine; SUA: Serum Uric Acid; CMI: Cardiometabolic Index.

The albuminuria group exhibited significantly higher age, smoking proportion, diabetes prevalence, hypertension prevalence, BMI, WC, SBP, DBP, FPG, TG, BUN, Scr, SUA, and CMI (p < 0.05) in comparison to the normal albuminuria group. Additionally, the albuminuria group had lower levels of TC, LDL-C, and HDL-C. According to the quartiles of CMI, four groups were categorized from low to high: Quartile 1 (CMI ≤

0.56), Quartile 2 (0.56 < CMI ≤ 1.01), Quartile 3 (1.01 < CMI ≤ 1.79), and Quartile 4 (CMI > 1.79). When compared to the Quartile I-CMI group, the following characteristics were significantly lower: female and HDL-C were significantly lower, and age, male, smoking proportion, diabetes prevalence, hypertension prevalence, BMI, WC, FPG, TC, TG, LDL-C, ALT, BUN, Scr, and SUA were significantly higher in the Quartile II-CMI, Quartile III-CMI, and Quartile IV-CMI groups. Remarkably, the risk of developing albuminuria increased with progressively higher CMI levels (67 (7.86%) vs. 108 (12.69%) vs. 108 (12.68%) vs. 139 (16.31%), $P < 0.001$). The clinical characteristics of the participants are shown in Table 2.

Table 2: Baseline characteristics of the study population according to cardiometabolic index quartiles.

CMI	Quartile 1	Quartile 2	Quartile 3	Quartile 4	*P* valu e
Age (year)	43.82 ± 19.10	49.04 ± 18.07	51.16 ± 17.38	51.93 ± 16.32	<0.001
Gender (%)					<0.001
Male	354 (41.55%)	406 (47.71%)	426 (50.00%)	495 (58.10%)	
Female	498 (58.45%)	445 (52.29%)	426 (50.00%)	357 (41.90%)	
Smokers (%)	305 (35.80%)	335 (39.37%)	354 (41.55%)	416 (48.83%)	<0.001
Diabetes (%)	39 (4.58%)	102 (11.99%)	153 (17.96%)	230 (27.00%)	<0.001
Hypertension (%)	203 (23.83%)	292 (34.31%)	348 (40.85%)	397 (46.60%)	<0.001
BMI (kg/m^2)	25.03 ± 5.22	28.71 ± 6.48	31.39 ± 6.86	33.58 ± 7.45	<0.001
WC (cm)	86.79 ± 13.31	98.07 ± 15.32	104.94 ± 14.88	111.01 ± 16.21	<0.001
SBP (mmHg)	119.84 ± 19.27	123.31 ± 19.08	125.18 ± 19.84	125.79 ± 18.00	<0.001
DBP (mmHg)	71.67 ± 11.65	74.40 ± 11.90	75.66 ± 11.26	77.02 ± 11.33	<0.001
FPG (mg/dl)	99.64 ± 14.35	107.08 ± 28.42	113.02 ± 32.60	128.58 ± 52.76	<0.001
TC (mg/dl)	174.64 ± 38.04	179.63 ± 38.86	185.92 ± 42.17	190.92 ± 42.87	<0.001
TG (mg/dl)	48.24 ± 14.63	75.28 ± 19.26	106.35 ± 25.40	184.60 ± 64.64	<0.001
LDL-C (mg/dl)	96.55 ± 30.42	108.00 ± 33.49	115.65 ± 37.55	113.10 ± 38.32	<0.001
HDL-C (mg/dl)	68.44 ± 16.62	56.56 ± 12.02	49.00 ± 9.78	40.90 ± 7.59	<0.001
ALT (IU/L)	17.99 ± 19.10	19.92 ± 13.62	23.67 ± 27.52	27.48 ± 19.05	<0.001
AST (IU/L)	21.96 ± 17.91	21.14 ± 12.73	21.96 ± 19.78	22.89 ± 11.65	<0.001
BUN (mg/dl)	13.82 ± 4.86	14.30 ± 5.15	14.51 ± 5.26	15.66 ± 6.89	<0.001
Scr (mg/dl)	0.86 ± 0.41	0.88 ± 0.33	0.87 ± 0.24	0.92 ± 0.64	0.007
SUA (mg/dl)	4.77 ± 1.26	5.29 ± 1.29	5.67 ± 1.41	5.99 ± 1.51	<0.001
UCAR (%)	67 (7.86%)	108 (12.69%)	108 (12.68%)	139 (16.31%)	<0.001

Data are presented as means ± SD, medians (inter-quantile range (IQR)), and number (percentages).
Abbreviations: BMI: Body Mass Index; WC: Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; FPG: Fasting Plasma Glucose; TG: Triglyceride; TC: Total Cholesterol; LDL-C: Low-Density Lipoprotein Cholesterol; HDL-C: High-Density Lipoprotein Cholesterol; ALT: Aspartate Aminotransferase; AST: Aspartate Aminotransferase; BUN: Blood Urea Nitrogen; SCR: Serum Creatinine; SUA: Serum Uric Acid; CMI: Cardiometabolic Index; UACR: Urinary Albumin Creatinine Ratio.

Association between CMI and Albuminuria

The association between CMI and albuminuria can be seen in Table 3. According to the present data, albuminuria prevalence is more likely to occur with higher CMI. Adjusted model 3 showed a positive correlation between CMI and albuminuria (OR = 1.14, 95% CI: 1.04-1.24), meaning that there was a 14% increase in the probability of albuminuria prevalence in participants for each unit increased in CMI. In order to perform a sensitivity analysis, the authors further transformed the CMI from a continuous variable to a categorical variable (quartiles). Comparing the highest CMI quartile to the lowest, the probability of albuminuria prevalence rose as CMI increased. 86% greater risk was associated with participants in the highest CMI quartile compared to those in the lowest quartile (OR = 1.86, 95% CI: 1.29-2.68; *P* for trend = 0.0066).

Table 3: The relationship between cardiometabolic index and albuminuria.

CMI	OR (95%CI), *P* value		
	Crude model 1	Adjusted model 2	Adjusted model 3
Continuous	1.18 (1.10, 1.27) <0.0001	1.16 (1.07, 1.25) 0.0002	1.14 (1.04, 1.24) 0.0041
Categories			
Quartile 1	1	1	1
Quartile 2	1.70 (1.24, 2.35) 0.0011	1.50 (1.08, 2.08) 0.0143	1.55 (1.10, 2.20) 0.0126
Quartile 3	1.70 (1.23, 2.34) 0.0012	1.42 (1.02, 1.97) 0.0361	1.43 (1.00, 2.05) 0.0498
Quartile 4	2.28 (1.68, 3.11) <0.0001	1.90 (1.38, 2.60) <0.0001	1.86 (1.29, 2.68) 0.0010
P for trend	<0.0001	0.0003	0.0066

In sensitivity analysis, the cardiometabolic index was converted from a continuous variable to a categorical variable (quartiles).
95% CI: 95% confidence interval.
OR: Odds Ratio.
Model 1: No covariates were adjusted.
Adjusted Model 2: Adjusted for Gender, Age, and Smokers.
Adjusted Model 3: Adjusted for Gender, Age, Smokers, BMI, SBP, DBP, ALT, AST, BUN, and Scr.

Subgroup analysis

Subgroup analyses were performed to assess whether the association between CMI and albuminuria was stable. For the association between CMI and albumin, the authors observed a positive correlation between subjects by age less than 20 years. In subjects younger than 20 years (OR=2.27, 95%CI 1.07-4.81), the risk of albuminuria prevalence increased by

127% for each unit rise in CMI. The interaction term did not report the influence of age on the association between CMI and albuminuria (*P* for interaction = 0.1412). Furthermore, there was no significant difference suggested by the interaction test in the association of CMI with albuminuria different stratifications, indicating that there was no significant dependence of gender, BMI, smokers, hypertension, and diabetes on this positive association (all *p* for interaction > 0.05) (Figure 2).

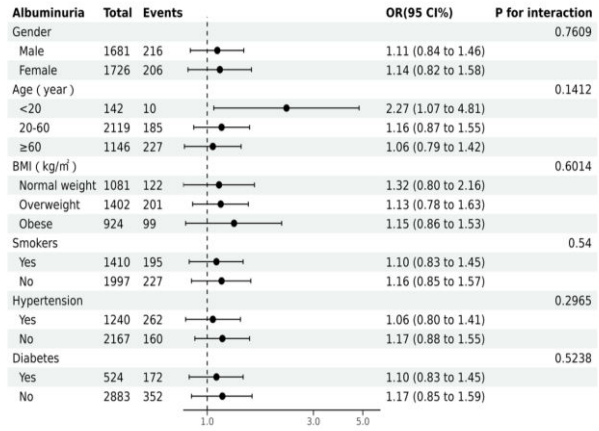

Figure 2. Forest plot of the effect of CMI on albuminuria according to different variables.

Smoothed curve fitting and threshold effect analysis

Using smoothed curve fitting, we examined the connection between albuminuria and CMI in more detail. According to the findings, there was a linear relationship between CMI and the probability of developing albuminuria (OR = 1.18, 95% CI: 1.10-1.27) (Figure 3A). Smoothed curve fitting revealed a nonlinear association between CMI and the likelihood to develop albuminuria (OR = 1.12, 95% CI: 0.85-1.48) after controlling for covariates (Figure 3B). Subsequently threshold effects were then analyzed using a two-stage linear regression model with a calculated inflection point of 0.72. A significant correlation between albuminuria and CMI was established to be to the left of the inflection point (OR = 6.85, 95% CI: 1.46-32.15). On the right side of the inflection point, however, no statistically significant connection was observed (OR = 1.36, 95% CI: 1.00-1.85) (Table 4).

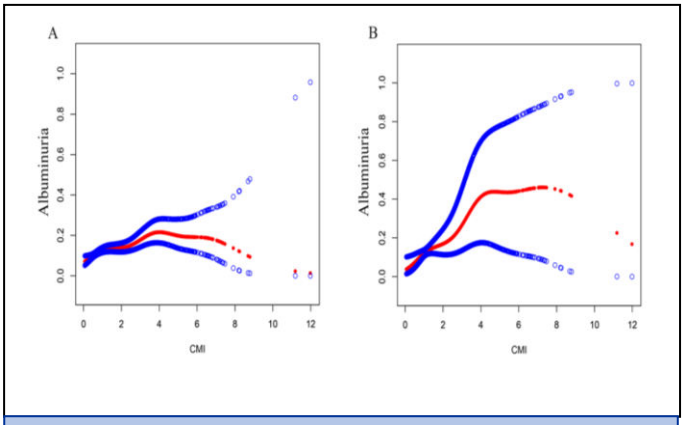

Figure 3: The relationship between CMI and albuminuria was analyzed by smoothed curve fitting.

A, Smoothed curve fitting analysis of the relationship between CMI and albuminuria without correction for any factor. B, after adjusting for Age, Gender, Smokers, Diabetes, Hypertension, BMI, WC, SBP, DBP, FPG, TC, TG, LDL-C, HDL-C, ALT, AST, BUN, Scr, and SUA, the relationship between CMI and albuminuria was analyzed by smooth curve fitting.

Table 4: Threshold effect analysis of CMI on albuminuria using a linear regression model.

CMI	Crude OR (95% CI), *p* Value	Adjusted OR (95%CI), *p* Value
Standard linear model	1.18 (1.10, 1.27) <0.0001	1.12 (0.85, 1.48) 0.4129
Two-piecewise linear model		
Inflection point	0.72	0.72
OR1 (CMI <0.72)	3.98 (1.76, 9.04) 0.0009	6.85 (1.46, 32.15) 0.0147
OR2 (CMI >0.72)	1.11 (1.02, 1.21) 0.0115	1.36 (1.00, 1.85) 0.0529
OR2 /OR1	0.28 (0.12, 0.66) 0.0034	0.20 (0.05, 0.78) 0.0203
Log likelihood ratio	0.002	0.019

95% CI: 95% confidence interval.
OR: Odds Ratio.

DISCUSSION

The authors of a cross-sectional research with 3, 408 participants discovered a positive correlation between CMI and albuminuria, indicating a steady rise in albuminuria likelihood with rising CMI levels. The similarity of this connection was demonstrated by subgroup analysis and interaction tests in various demographic contexts. After controlling for a number of variables, regression analysis revealed a nonlinear positive correlation with an inflection point of 0.72 between CMI and albuminuria. According to the aforementioned findings, when the CMI is less than 0.72, it appears to be an independent risk factor for albuminuria. This suggests that the CMI can be used to predict albuminuria early on.

To the greatest of our knowledge, this is the first study in the United States to assess the relationship between albuminuria and CMI in a population of all ages. Sun et al. conducted a prospective study including 401 patients with acute pancreatitis and found that patients with a higher CMI exhibited an increased density and incidence of acute pancreatitis [17]. Zha et al. determined that CMI was positively correlated with the incidence of DM in cohort research involving 15,453 individuals in Japan. The data suggests that CMI may serve as a predictor of diabetes risk in the Japanese population [18]. A retrospective research by Gu et al. with 6, 107 individuals found that there may be an independent relationship between MAFLD and higher CMI quartiles [19]. Wang et al. found that CMI was positively associated with the prevalence of hypertension in Chinese adults and determined that hypertensive participants were at high risk for future cardiovascular disease [9]. Previous studies have shown that high lipid accumulation, abdominal obesity can induce renal inflammation and oxidative stress and promote proteinuria [20,21]. The authors in this study observed a positive correlation between CMI and increased UACR, while CMI as the best measure of visceral obesity and UACR used as a means of assessing the presence or absence of albuminuria support the strong association between CMI and the risk of developing albuminuria.

Obesity may be a risk factor for both CKD and ESRD, according to epidemiologic studies [22,23]. Of them, subcutaneous adipose tissue is regarded as benign or protective, but visceral fat accumulation is the primary pathogenic state of obesity [24,25]. BMI and WC are easy to examine and have been widely used to define obesity and abdominal obesity [26]. The Look AHEAD study demonstrated that compared with the lowest quartile, BMI (OR = 1.72, 95% CI: 1.40-2.11) and WC (OR = 1.75, 95% CI: 1.42-2.15) in the highest quartile were significantly associated with albuminuria [27]. Postorino et al. discovered that WC was a direct predictor of both cardiovascular and all-cause mortality in ESRD patients, indicating that abdominal obesity is the root cause of a high risk of a bad prognosis [28]. Nevertheless, it is not possible to distinguish between visceral and subcutaneous fat mass using BMI or WC [29]. Because subcutaneous and visceral adipose tissue differ greatly in functional significance, anthropometric data alone are insufficient for accurate risk assessment of obesity [30]. As a result, quicker obesity diagnosis will be possible using image-based body fat evaluation. Computed Tomography (CT) and Magnetic resonance imaging (MRI) can accurately measure visceral fat area, generate high-resolution images, and have high reproducibility [31,32]. However, CT is expensive and exposes patients to radiation, and there is a lack of research on related techniques to assess visceral fat. It has been stated that CMI, a recently created tool for evaluating a patient's fat distribution (a model that incorporates anthropometrics and blood metabolic data), is being investigated in a number of domains, particularly in connection to disorders linked to metabolism. We found a substantial association between albuminuria and CMI in the current research. In adjusted model 3, subjects in the highest CMI quartile had a higher risk of developing albuminuria than the lowest quartile (OR=1.86, 95% CI: 1.29-2.68), suggesting that visceral obesity has a negative effect on albuminuria. Subgroup analyses and interaction tests also showed that gender, age, BMI, smokers, hypertension, and diabetes were not dependent on this positive association between CMI and albuminuria (all P for interactions > 0.05), suggesting that these positive associations are similar across populations. Furthermore, we found a nonlinear relationship between CMI and albuminuria after adjusting for a variety of confounders, and further concluded that the inflection point for CMI was 0.72, implying that the correlation between CMI and albuminuria was meaningful when subjects did not reach this threshold.

There are several advantages to our study. As a result of the study's reliance on data from NHANES, a nationwide population-based sample collected in accordance with defined procedures, the study sample is more representative. Confounding factors were also taken into account by the authors to make the present results more trustworthy. It is impossible to overlook this study's shortcomings, though. First, even after adjusting for a variety of potential confounders, urine albumin excretion is still influenced by a wide range of parameters, and the effect of other potential confounding factors cannot be totally ruled out. Second, because this study was cross-sectional, it was not possible for us to establish a definitive causal link between CMI and albuminuria. Therefore,

more research is required to confirm if CMI can be used as a screening tool for preventing early-stage renal disease.

CONCLUSION

This study demonstrates that elevated CMI levels are associated with an increased likelihood of albuminuria, emphasizing the importance of visceral fat management, as assessed by CMI, in kidney health and promising as a potential screening marker for the prevention of early kidney disease. However, further large-scale prospective studies are still needed to validate the authors' findings.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: www.cdc.gov/nchs/nhanes/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Review Board of the NCHS. The patients/participants provided their written informed consent to participate in this study.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Qiming Xu: software, data analysis, and writing – original draft. Junyan Lin: writing – original draft, formal analysis, and methodology. Lin Liao: data analysis, and formal analysis. Jing Hu: methodology and funding acquisition. Jianrao Lu: conceptualization, funding acquisition, and writing – reviewing and editing. All authors approved the final version.

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PUBLISHER'S NOTE

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