Association between the triglyceride-glucose index-a body shape index and kidney stones in adults: A large-scale, cross-sectional study in China

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Abstract. Insulin resistance and visceral obesity jointly drive the pathogenesis of kidney stones. However, the epidemiological utility of the composite triglyceride-glucose index-a body shape index (TyG-ABSI) remains unclear. To clarify its utility, the present cross-sectional study investigated the association between the TyG-ABSI and the prevalence of kidney stones in a large Chinese population. Data collected from 89,546 participants who presented for health check-ups at the Affiliated Hospital of Yangzhou University (Yangzhou, China) in 2023 were analyzed using logistic regression models, subgroup analyses and smooth curve fitting, with full adjustment for confounding factors. Receiver operating characteristic (ROC) curves were developed to evaluate the discriminative ability of the indices. In the fully adjusted model, the TyG-ABSI was positively associated with the prevalence of kidney stones [odds ratio (OR)=1.17; 95% CI: 1.12-1.22; P<0.001]. Smooth curve analysis demonstrated a positive, strictly linear, continuous association with no threshold effect. Participants in the highest tertile exhibited significantly higher odds of developing kidney stones compared with those in the lowest tertile (OR=1.25; 95% CI: 1.16-1.36; P<0.001). Subgroup analyses revealed that this positive association was highly consistent across all strata. ROC analysis of the TyG-ABSI yielded a modest area under the ROC curve of 0.595 (95% CI: 0.588-0.603), indicating that the TyG-ABSI did not provide significant incremental discriminative value compared with the TyG index alone. Overall, the present findings demonstrated that the TyG-ABSI exhibited a significantly positive, strictly linear association with the prevalence of kidney stones in a large Chinese population. Therefore, the TyG-ABSI may serve as a valuable epidemiological indicator rather than as an isolated diagnostic tool, reflecting the underlying pathophysiological association between metabolic disorders and the likelihood of developing kidney stones.

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Introduction

Contemporary lifestyle and dietary shifts have markedly increased the prevalence of kidney stones, also known as nephrolithiasis, affecting up to 11% of men and 7% of women in the United States, posing a notable global public health challenge (1). Kidney stones often lead to severe complications, including acute renal colic, urinary tract infections and long-term renal dysfunction, which can severely compromise the quality of life of patients (2). In addition, the recurrence rate of nephrolithiasis reaches up to 50% within 5 years after the initial episode (3,4). Given this marked disease burden, identifying the metabolic indicators associated with nephrolithiasis is key in designing effective secondary prevention and management strategies.

The triglyceride-glucose (TyG) index has emerged as a reliable alternative marker for insulin resistance, a known pathophysiological driver of lithogenesis (5). Recent epidemiological studies have integrated the TyG index with a number of obesity-associated parameters, such as BMI and waist circumference (WC), to further capture the synergistic effects of metabolic abnormalities and adiposity (6,7). However, traditional metrics such as WC and waist-to-height ratio remain highly collinear with BMI, limiting their capacity to assess visceral adipose tissue independently (8). To address this limitation, Krakauer *et al* (9) developed a body shape index (ABSI), which standardizes WC relative to BMI and height, enabling this index to serve as a more specific surrogate for visceral fat volume. Notably, an elevated ABSI value has been independently associated with an increased prevalence of nephrolithiasis (10,11).

As insulin resistance and visceral obesity frequently coexist and mutually exacerbate metabolic syndrome, combining the TyG index and ABSI into a single metric, defined as the triglyceride-glucose index-a body shape index (TyG-ABSI), may capture this metabolic-structural interplay more effectively than either index alone. However, whether this novel composite index is associated with the prevalence of kidney stones remains unexplored. The objective of the present cross-sectional study was therefore to evaluate the epidemiological association between the TyG-ABSI and kidney stone prevalence within a large Chinese population.

Materials and methods

Study design and population. This retrospective cross-sectional study was approved by the Ethics Committee of the Affiliated Hospital of Yangzhou University (approval no. 2025-YKL06-K05), and the requirement for written informed consent was waived. Within the present cross-sectional study, data collected from individuals who underwent comprehensive health check-ups at the Health Management Center, Affiliated Hospital of Yangzhou University (Yangzhou, China) between January and December 2023, was analyzed. The main inclusion criteria were adults aged ≥20 years who underwent routine health check-ups with complete abdominal ultrasound and laboratory data. As illustrated in Fig. 1, the initial cohort comprised 120,197 individuals. At their check-up, trained health promotion professionals collected their demographic data and medical histories. After the individuals had fasted for 12 h overnight, the health professionals collected venous blood samples for analysis using standardized dry chemical methods in the central laboratory of the hospital. The 120,197 potential participants were then sequentially excluded if they met any of the following exclusion criteria: i) Aged <20 years (n=5458); ii) missing abdominal ultrasound examination for kidney stone assessment (n=11,813); iii) missing data required to calculate the TyG index and ABSI, including data on triglyceride level, fasting plasma glucose level, BMI, WC and height (n=8119) and; iv) missing data on key covariates, including serum creatinine (Cr) level, serum uric acid (SU) level, total cholesterol (TC) level, high-density lipoprotein cholesterol (HDL-C) level, low-density lipoprotein cholesterol (LDL-C) level, hypertension and diabetes (n=5261). After these criteria were applied, 89,546 adult participants were included in the final analysis, consisting of 51,894 males (57.95%) and 37,652 females (42.05%), with a mean age of 48.11±14.64 years. The present cross-sectional study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (12).

Assessment of TyG index, ABSI and TyG-ABSI. TyG indexes were calculated using fasting triglyceride and fasting glucose levels. The ABSI was calculated using WC, BMI and height. The three indices were calculated as follows: i) TyG index=ln [fasting triglyceride (mg/dl) x fasting glucose (mg/dl)/2] (5); ii) ABSI=WC (cm)/[$(BMI^{2/3}$ (kg/m^2)] x [$height^{1/2}$ (cm)] (11) and; iii) TyG-ABSI=TyG x ABSI (13).

Kidney stone diagnosis. Kidney stones were diagnosed through abdominal ultrasonography using a 3.5-5 MHz convex probe (LOGIQ E9; GE Healthcare). All scans and interpretations were performed by certified sonographers with >5 years of clinical experience. To minimize bias, all sonographers were blinded to the laboratory and metabolic profiles of the participants. Findings were documented and subsequently reviewed by a senior sonographer to ensure inter-observer reliability. To strictly differentiate true kidney stones from nephrocalcinosis or renal parenchymal calcifications, kidney stones were defined as echogenic foci ≥2 mm located within the renal collecting system and exhibiting clear posterior acoustic shadowing (14).

Covariates. Covariates were selected based on clinical relevance and the >10% change-in-estimate criterion (15-18). Despite smoking status and alcohol consumption being initially assessed, they were excluded from the final adjusted multivariable models as their inclusion did not alter the effect estimates of the primary exposure by >10%. The final covariates included age, sex, hypertension, diabetes and serological parameters. Hypertension was defined as a resting systolic blood pressure 140 mmHg, diastolic blood pressure 90 mmHg, a self-reported history of hypertension or current use of antihypertensive medications. Diabetes was defined as a self-reported physician diagnosis, current use of glucose-lowering agents or insulin administration.

Statistical analysis. Continuous variables are presented as the mean ± SD for normally distributed data and as the median with the interquartile range (IQR) for skewed data. Categorical variables are expressed as frequencies and percentages and were compared using the χ^2 test (Fisher's exact test was used when expected frequencies were <5). Group differences were compared using an unpaired Student's t-test for normally distributed data. Data normality was initially evaluated using the Kolmogorov-Smirnov test. No post-hoc tests were conducted, as only the overall significance across groups was assessed.

To investigate the association between the TyG-ABSI and kidney stones, multivariable logistic regression models were employed to calculate odds ratios (ORs) and 95% CIs. The TyG-ABSI was analyzed both as a continuous variable and categorized into tertiles. Multicollinearity was assessed using the variance inflation factor criterion <5. Consistent with the covariate selection strategy, three models were constructed: i) An unadjusted model; ii) Model 1, adjusted for age, sex, hypertension and diabetes and; iii) Model 2, fully adjusted for age, sex, hypertension, diabetes, serum Cr level, serum SU level, HDL-C level and LDL-C level. Generalized additive models (GAMs) with smooth curve fitting were used to evaluate potential nonlinear associations between the TyG-ABSI and kidney stone prevalence.

To analyze threshold effects, a two-piecewise linear regression model was applied. The inflection point (breakpoint) was identified using a recursive algorithm and maximum likelihood estimation and its robustness was validated using a bootstrap resampling method. A likelihood ratio test was performed to compare the one-line linear regression model with the piecewise model. Subgroup analyses stratified by age, sex, BMI, hypertension and diabetes were conducted using the fully adjusted model. Interaction terms were included to test for effect modification across strata.

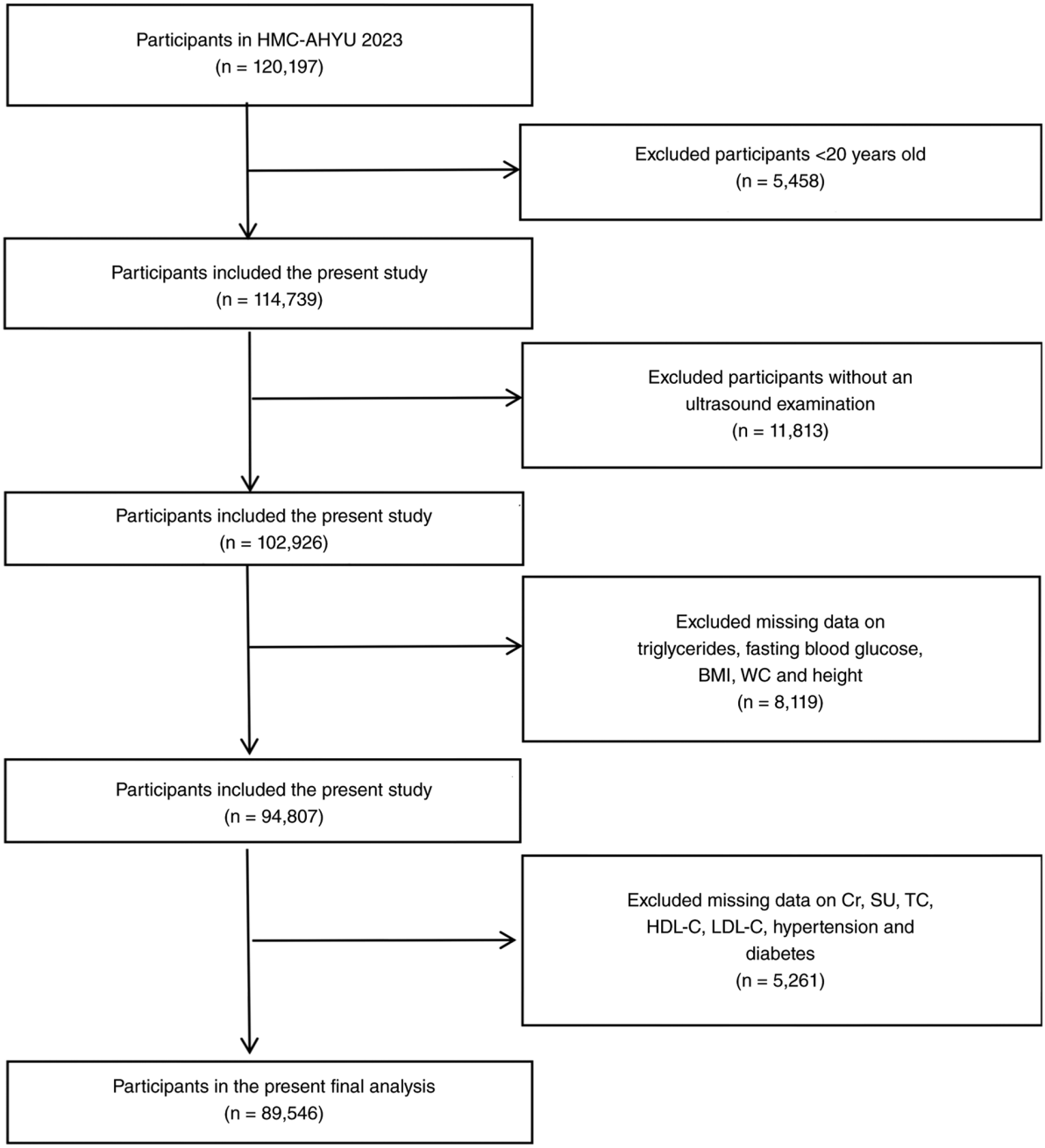


Figure 1. Flow diagram of the screening of participants. A total of 120,197 participants from the HMC-AHYU 2023 cohort were initially assessed and 89,546 participants were included in the present final analysis after exclusions. HMC-AHYU, Health Management Center of the Affiliated Hospital of Yangzhou University; WC, waist circumference; Cr, serum creatinine; SU, serum uric acid; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

Receiver operating characteristic (ROC) curves were generated to evaluate the discriminative ability of the TyG index, ABSI and the TyG-ABSI for identifying kidney stones. The areas under the ROC curves (AUCs) were calculated and optimal cut-off values were determined using the Youden index. In addition, DeLong's test was employed to formally compare the AUCs and evaluate the incremental statistical value of the TyG-ABSI compared with the TyG index or ABSI alone. All statistical analyses were performed using R software (version 4.4.2; Posit Software, PBC) and EmpowerStats (version 5.2; X&Y Solutions, Inc.). A two-sided $P<0.05$ was considered to indicate a statistically significant difference.

Results

Baseline characteristics of the study participants. Significant differences were identified between the baseline characteristics of participants with and without kidney stones. As shown in Table I, compared with the non-kidney stone group, the kidney stone group exhibited a higher proportion of male patients and a higher mean age. Furthermore, participants with kidney stones consistently exhibited significantly higher TyG-ABSI, BMI and WC values, as well as fasting glucose levels, triglyceride levels and prevalence of hypertension and diabetes (all, $P<0.001$).

Table I. Characteristics of Chinese participants.

Variables	Total	No-kidney stones	Kidney stones	P-value
No.	89,546	83,883	5,663	
Sex				<0.001
Male	51,894 (57.95)	47,479 (56.60)	4,415 (77.96)	
Female	37,652 (42.05)	36,404 (43.40)	1,248 (22.04)	
Age, years	48.11±14.64	47.98±14.72	49.95±13.28	<0.001
Hypertension				<0.001
No	73,181 (81.72)	68,344 (81.48)	4,837 (85.41)	
Yes	16,365 (18.28)	15,539 (18.52)	826 (14.59)	
Diabetes				<0.001
No	85,683 (95.69)	80,398 (95.85)	5,285 (93.33)	
Yes	3,863 (4.31)	3,485 (4.15)	378 (6.67)	
Cr, umol/l	72.07±22.08	71.72±22.08	77.2±21.49	<0.001
SU, mg/dl	5.14±1.37	5.13±1.37	5.30±1.37	<0.001
TC, mmol/l	4.96±0.97	4.95±0.97	5.03±1.02	<0.001
Weight, kg	69.47±13.49	69.12±13.41	74.69±13.66	<0.001
Height, cm	168.44±8.23	168.31±8.24	170.35±7.80	<0.001
BMI, kg/m^2	24.34±3.57	24.25±3.55	25.61±3.65	<0.001
WC, cm	84.48±10.13	84.21±10.08	88.54±10.05	<0.001
HDL-C, mmol/l	1.33±0.33	1.34±0.33	1.25±0.30	<0.001
LDL-C, mmol/l	2.70±0.73	2.70±0.73	2.75±0.74	<0.001
Fasting glucose, mg/dl	102.33±25.25	102.01±24.81	107.19±30.64	<0.001
Triglyceride, mg/dl	155.61±153.45	153.39±151.19	188.54±180.57	<0.001
ABSI	0.78±0.04	0.78±0.04	0.79±0.04	<0.001
TyG	8.74±0.69	8.72±0.69	8.96±0.72	<0.001
TyG-ABSI	6.79±0.72	6.78±0.72	7.02±0.73	<0.001

Continuous variables are presented as the mean ± SD and categorical variables are presented as counts (percentages). P-values were calculated using the χ^2 test for categorical variables, and the unpaired Student's t-test or Mann-Whitney U test for continuous variables. ABSI values were scaled by a factor of 10 for analytical presentation. Cr, serum creatinine; SU, serum uric acid; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; WC, waist circumference; ABSI, a body shape index; TyG, triglyceride-glucose index; TyG-ABSI, triglyceride-glucose index-a body shape index.

Table II. Association between TyG-ABSI and the prevalence of kidney stones.

	OR (95% CI); P-value		
Variables	Non-adjusted	Adjusted I (Model 1)	Adjusted II (Model 2)
TyG-ABSI, continuous	1.54 (1.49-1.59); P<0.001	1.22 (1.17-1.27); P<0.001	1.17 (1.12-1.22); P<0.001
TyG-ABSI tertile			
Tertile 1	1.0	1.0	1.0
Tertile 2	1.53 (1.42-1.65); P<0.001	1.15 (1.07-1.24); P<0.001	1.08 (1.00-1.17); P=0.051
Tertile 3	2.18 (2.03-2.33); P<0.001	1.38 (1.28-1.49); P<0.001	1.25 (1.16-1.36); P<0.001
P-value for trend	P<0.001	P<0.001	P<0.001

Model 1 was adjusted for age, sex, hypertension and diabetes. Model 2 was adjusted for Model 1 plus serum creatinine, serum uric acid, high-density lipoprotein cholesterol and low-density lipoprotein cholesterol. P-values were derived from logistic regression analysis. OR, odds ratio; TyG-ABSI, triglyceride-glucose index-a body shape index.

TyG-ABSI is significantly associated with an increased risk of kidney stones. Associations between TyG-ABSI and the prevalence of kidney stones are presented in Table II. When TyG-ABSI was evaluated as a continuous variable, each

Table III. Subgroup analysis for the associations of TyG-ABSI with kidney stones.

TyG-ABSI	OR (95% CI)	P-value	P-value for interaction
Sex			0.867
Male	1.16 (1.10-1.22)	<0.001	
Female	1.15 (1.03-1.28)	0.014	
Age, years			0.467
<40	1.22 (1.12-1.33)	<0.001	
40-60	1.15 (1.08-1.21)	<0.001	
≥60	1.17 (1.08-1.27)	0.003	
BMI, kg/m^2			0.522
<25	1.16 (1.09-1.24)	<0.001	
25-30	1.11 (1.04-1.19)	0.002	
≥30	1.19 (1.05-1.34)	0.007	
Hypertension			0.901
No	1.17 (1.12-1.23)	<0.001	
Yes	1.16 (1.02-1.31)	0.020	
Diabetes			0.301
No	1.18 (1.12-1.23)	<0.001	
Yes	1.08 (0.93-1.26)	0.289	

All models were fully adjusted for age, sex, hypertension, diabetes, serum creatinine, serum uric acid, high-density lipoprotein cholesterol and low-density lipoprotein cholesterol, except for the stratification variable itself. P-values were derived from logistic regression analysis. OR, odds ratio; TyG-ABSI, triglyceride-glucose index combined with a body shape index.

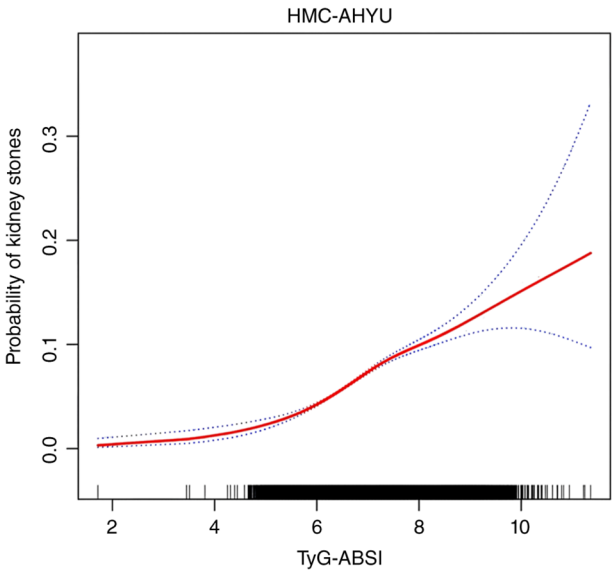


Figure 2. Smooth curve analysis of the association between TyG-ABSI and the prevalence of kidney stones. The solid red line represents the estimated smooth curve fit and the dotted blue lines represent the 95% CIs. The model was fully adjusted for age, sex, BMI, waist circumference, serum uric acid, creatinine, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, hypertension and diabetes (Model 2). The dose-response association reflects a strictly linear association without a threshold effect. HMC-AHYU, Health Management Center of the Affiliated Hospital of Yangzhou University; TyG-ABSI, triglyceride-glucose index-a body shape index.

unit increase was associated with higher odds of developing kidney stones across all three models (all, P<0.001). In the fully adjusted model (Model 2), the OR for kidney stones was 1.17 (95% CI: 1.12-1.22) per unit increase in the TyG-ABSI. This positive association persisted when the TyG-ABSI was categorized into tertiles. In the fully adjusted model, compared with participants in the lowest tertile (Tertile 1), those in the middle tertile (Tertile 2) did not exhibit a statistically significant increase in OR (OR=1.08; 95% CI: 1.00-1.17; P=0.051). However, individuals in the highest tertile (Tertile 3) exhibited a significantly higher fully adjusted OR of 1.25 (95% CI: 1.16-1.36; P<0.001) in Model 2. The P-values for the trend across tertiles were consistently significant (P<0.001 for trend). GAMs with smooth curve fitting revealed a continuously positive association between the TyG-ABSI and kidney stone prevalence (Fig. 2). Following full adjustment for covariates in Model 2, the log-likelihood ratio test indicated that the association was strictly linear (P=0.574), indicating no significant threshold effect.

Subgroup analyses demonstrate a consistent association between TyG-ABSI and kidney stones. To evaluate the robustness of the association between the TyG-ABSI and the prevalence of kidney stones, subgroup analyses were conducted using the fully adjusted model (Model 2). The results revealed that the positive association between TyG-ABSI and kidney stones was highly consistent across various subgroups, including those for sex, age, BMI, hypertension and diabetes (Table III). Notably, no significant effect modification was observed across any of the stratification variables (for interaction, all P>0.05). The association was statistically significant in nearly all strata. Although the association did not reach statistical significance within the small subset of participants with diabetes (OR=1.08; 95% CI: 0.93-1.26; P=0.289), likely due to the limited sample size of this subgroup. The non-significant interaction term (P=0.301) demonstrated that the overall epidemiological trend of the TyG-ABSI remained stable regardless of diabetic status.

TyG-ABSI demonstrates superior discriminative ability for kidney stones compared with the TyG index and ABSI alone. ROC curves were generated to evaluate the discriminative ability of the TyG index, ABSI and TyG-ABSI for identifying kidney stones (Fig. S1 and Table S1). The TyG index yielded an AUC of 0.598 (95% CI: 0.591-0.606), with the composite TyG-ABSI yielding a comparable AUC of 0.595 (95% CI: 0.588-0.603), while ABSI exhibited the lowest AUC of 0.542 (95% CI: 0.535-0.550). The cut-off values for the indices varied, with the TyG index attaining a value of 8.667, the TyG-ABSI attaining a value of 6.900 and ABSI attaining a value of 0.756. ABSI exhibited the highest sensitivity (0.725), while the TyG-ABSI achieved the highest specificity (0.594). Formal comparison using DeLong's test revealed that although the TyG-ABSI significantly outperformed ABSI (P<0.001), its AUC was not significantly greater compared with that of the TyG index alone (P=0.1426).

Discussion

To the best of our knowledge, the present study was the first investigation conducted regarding the association between the composite TyG-ABSI and the prevalence of kidney stones in a large sample of Chinese adults. It is therefore the first to have demonstrated that a higher TyG-ABSI was significantly associated with higher odds of developing kidney stones. Smoothing curve analysis, following full adjustment for covariates, revealed a positive, strictly linear, continuous association between the TyG-ABSI and kidney stones. Subsequent subgroup analysis showed that these associations were highly consistent across various demographic and clinical subgroups, with no significant effect modification observed across any stratification variables. With regard to discriminative performance, the AUC of the TyG-ABSI was higher compared with that of ABSI but comparable to that of the TyG index. Furthermore, despite the TyG-ABSI having demonstrated a robust epidemiological and statistical association with the prevalence of kidney stones at a population level, DeLong's test demonstrated that it did not provide a statistically significant incremental discriminative benefit over the TyG index alone (P=0.1426). Consequently, its utility as an isolated predictive tool for individual clinical diagnosis appears highly limited.

In contrast with traditional obesity-associated parameters, including BMI and WC, ABSI is currently the only parameter that does not exhibit the 'obesity paradox' (a counterintuitive finding where obesity may appear protective in some disease contexts) (19) and is linearly associated with kidney stone prevalence, consistent with the findings of the present study (10). Despite the advantages of ABSI, to the best of our knowledge, no previous studies have combined this indicator of visceral obesity with the TyG index to evaluate the ability of the combined index to identify the likelihood of developing kidney stones. In a previous study, Qin *et al* (20) found that elevated TyG index values were notably associated with a higher prevalence of kidney stones. Similarly, Lin *et al (*21) found that elevated ABSI values were notably associated with kidney stones. Elevated TyG-ABSI values have also been markedly associated with cardiovascular incidents (12) and hyperuricemia (22). The findings of the present study highlight the value of the TyG-ABSI as an integrative epidemiological indicator that captures the combined pathophysiological impact of insulin resistance and visceral adiposity on kidney stone formation rather than as an isolated tool for clinical screening.

Severe obesity (BMI ≥30) has been associated with elevated mortality and morbidity, as well as a range of comorbidities including cardiovascular disease, type 2 diabetes mellitus and kidney stones (23). Consequently, the present study combined ABSI, an indicator reflecting visceral obesity, with the TyG index to evaluate its association with kidney stones. Participants with kidney stones in the present study exhibited baseline characteristics consistent with metabolic syndrome, including a significantly larger WC, higher fasting glucose levels, a poorer lipid profile (elevated triglyceride and reduced HDL-C levels) and a higher prevalence of diabetes, compared with the participants without kidney stones. This dyslipidemic state has been associated with increased urinary excretion of calcium, oxalate and uric acid (24). Obesity-associated chronic inflammation, particularly the accumulation of visceral fat, has been shown to exacerbate systemic inflammation and disrupt renal calcium handling, thereby facilitating stone formation (25,26). Hyperuricemia has also been notably associated with high TyG-ABSI values (20) through two mechanisms, namely promoting urinary calcium and oxalate deposition, as well as reducing urinary pH to enhance urate crystal formation; as high uric acid levels can influence kidney stone pathogenesis (27).

Subgroup analyses further highlighted the statistical robustness of the TyG-ABSI. The positive association between the TyG-ABSI and the prevalence of kidney stones remained highly consistent across numerous demographic and clinical strata. In addition, no significant effect modification was observed for any stratification variable. Despite the association not reaching statistical significance within the small subset of participants with diabetes, the non-significant interaction term demonstrated that the overall epidemiological trend remained stable regardless of diabetic status. Previous studies have suggested that specific medications, such as thiazide diuretics or sodium-glucose cotransporter 2 inhibitors, may influence stone recurrence (28-30). However, the consistent results across subgroups in the present fully adjusted model suggest that the pathophysiological association between the TyG-ABSI and kidney stones broadly persists across the general population without being markedly distorted by baseline hypertension or diabetes.

In the present fully adjusted smoothing curve analysis, the TyG-ABSI exhibited a positive, strictly linear and continuous association with the prevalence of kidney stones rather than a threshold effect. This continuous linear pattern indicated that even moderate elevations in the TyG-ABSI corresponded to markedly higher odds of developing kidney stones, reinforcing the cumulative pathophysiological burden of insulin resistance and central obesity. With regard to the discriminative capacity of these indices, ROC analysis yielded modest AUC values (0.542-0.598), reflecting the multifactorial nature of kidney stone disease, which is driven by the complex interplay of metabolic derangements (such as insulin resistance and dyslipidemia that alter urine pH and solute supersaturation), environmental influences (including inadequate fluid intake and dietary habits) and genetic susceptibility (such as inherited variations in renal tubular transporters) (31). Notably, a number of key factors are not captured by this index, such as daily water intake, dietary oxalate and sodium consumption, urinary pH and specific mineral metabolism parameters, all of which serve a key role in stone pathogenesis (32). Consequently, the TyG-ABSI should be regarded as an epidemiological marker for assessing population-level associations rather than as an autonomous predictive tool for individual clinical diagnosis. Future longitudinal studies incorporating the TyG-ABSI with other well-established clinical and dietary variables are warranted to comprehensively evaluate the likelihood of kidney stone formation.

Overall, the present study identified the TyG-ABSI as a valuable epidemiological indicator for identifying metabolic phenotypes associated with a higher prevalence of kidney stones, a notable contribution to the field. However, a number of study limitations must be acknowledged. First, as the present study used a cross-sectional observational design, it could not

establish a causal association between the TyG-ABSI and kidney stones. Second, since the present study population was recruited from a single health management center, potential selection bias cannot be completely ruled out. Therefore, the present conclusions should be restricted strictly to the studied Chinese health check-up population. Third, despite the present study having made rigorous adjustments for numerous clinical covariates, the potential influence of unmeasured confounders cannot be fully ruled out. Finally, due to the lack of detailed dietary, socioeconomic and urinary metabolic data, the impact of these variables, which are known to interact with metabolic syndrome in stone formation, could not be assessed in the present study.

In conclusion, the present study demonstrates a significant, strictly linear and positive association between the TyG-ABSI and the prevalence of kidney stones within a large Chinese population. Rather than serving as an isolated clinical diagnostic tool, the TyG-ABSI functions as a valuable epidemiological indicator that reflects the combined pathophysiological burden of insulin resistance and visceral obesity on stone formation. Future longitudinal cohort studies incorporating comprehensive lifestyle, dietary and genetic variables are warranted to validate these epidemiological findings and to elucidate potential causal mechanisms.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

JW wrote the original manuscript draft, conceptualized the present study, was responsible for the methodology used (designing the statistical analysis plan) and conducted project administration. SZ performed data curation, wrote the original manuscript draft, provided validation (verifying the reproducibility of the statistical results) and was responsible for the software used (writing and executing R scripts for data cleaning and model building). XG also performed data curation, was responsible for the resources used (coordinating data access from the Health Management Center), wrote the original manuscript draft and conducted the investigation. ZS and SM conducted formal analysis, provided validation (cross-checking data integrity) and wrote, reviewed and edited the manuscript. YL acquired the funding, supervised the entire research project, contributed to the overall study design and the clinical interpretation of the results, was responsible for projection administration and critically revised the manuscript for important intellectual content. JW and YL confirm the authenticity of all the raw data. All authors read and approved the final version of the manuscript.

Ethics approval and consent to participate

Ethical oversight was provided by the Institutional Review Board of the Affiliated Hospital of Yangzhou University (Yangzhou, China; approval no. 2025-YKL06-K05). Given that the present analysis used retrospectively assembled cohort records, the Ethics Committee waived the requirement for written informed consent. Identifiers were removed before analysis and all procedures were consistent with the Declaration of Helsinki.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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