METS-IR, a novel score to evaluate insulin sensitivity, is associated with the urinary albumin–creatinine ratio in Chinese adults: A cross-sectional REACTION study

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Abstract

Background: The metabolic score for insulin resistance (METS-IR) is a novel noninsulin-based metabolic index used as a substitution marker of insulin resistance and for cardiovascular disease evaluation. However, whether METS-IR is associated with the urinary albumin–creatinine ratio (UACR) is not well known. Therefore, we explored the age- and sex-related associations between METS-IR and UACR and compared the discriminative ability of the METS-IR index and its components for elevated UACR.

Methods: This study included 37,290 subjects from the REACTION study (Risk Evaluation of cAncers in Chinese diabeTic Individuals: a lONgitudinal study). METS-IR was calculated as follows: (Ln [2 × fasting blood glucose {mg/dL} + fasting triglyceride level {mg/dL}] × body mass index)/(Ln [high-density lipoprotein cholesterol {mg/dL}]). Participants were divided into four groups on the basis of METS-IR: <25%, 25%–49%, 50%–74%, and ≥75%. Logistic regression analyses were conducted to determine the associations between METS-IR vs. its components{(fasting blood glucose（FBG), fasting triglyceride level, body mass index, and high-density lipoprotein cholesterol} with UACR.

Results: Participants with the highest quartile METS-IR, particularly men,

presented a more significant trend towards elevated UACR than towards its components (odds ratio [OR]: 1.260, 95% confidence interval [CI]: 1.152–1.378, P < 0.001 in all subjects; OR: 1.321, 95% CI: 1.104–1.579, P = 0.002 in men; OR: 1.201, 95% CI: 1.083–1.330, P < 0.001 in women). There were significant associations between METS-IR and UACR in younger participants (<65 years for women and 55–64 years for men) and those with an estimated glomerular filtration rate ≥ 90 mL/min/1.73 m^2. Increased METS-IR was significantly associated with UACR in men with FBG ≥ 5.6 mmol/L or postprandial blood glucose ≥ 7.8 mmol/L and systolic blood pressure ≥ 120 mmHg or diastolic blood pressure ≥ 80 mmHg. The relationships were significant in women with diabetes and hypertension.

Conclusions: Increased METS-IR was significantly associated with elevated UACR, and its discriminative power for elevated UACR was superior to that of its components. The findings support the clinical significance of METS-IR for evaluating the cardiometabolic risk and renal function damage among Chinese adults.

Keywords: urinary albumin–creatinine ratio; metabolic score for insulin resistance; cardiovascular disease; age; sex.

Background

Driven by population growth and ageing, cardiovascular disease (CVD) has become the leading cause of death worldwide.[1] Increased urinary albumin–creatinine ratio (UACR) has been regarded a marker of early kidney dysfunction and an independent factor for CVD risk.[2] An elevated UACR is more closely associated with increased CVD risk than with the estimated glomerular filtration rate (eGFR) in patients with diabetes.[3] In addition, microalbuminuria (MAU) is independently related to the all-cause mortality of CVD not only in people with diabetes people but also in people without diabetes.[4] Elevated fasting blood glucose (FBG) level, hyperlipidaemia, and obesity are not only associated with CVD but also with chronic kidney disease (CKD).[5–9] Compelling evidence confirmed that dyslipidaemia, including high levels of low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglycerides (TG) and low levels of high-density lipoprotein cholesterol (HDL-C), is the cornerstone of arteriolosclerosis and is an important risk factor for the progression of CKD and CVD.[10–14] Moreover, both diabetes and albuminuria are risk factors for CVD, and the morbidity of MAU remarkably increased in people with diabetes.[15,16]

Insulin resistance (IR) plays roles in the pathophysiology of dyslipidaemia, obesity, type 2 diabetes mellitus (T2DM), and MAU.[17–20] Many studies found that IR is a major risk factor for CVD events and has strong relationships

with other risk factors for CVD (inflammation, dyslipidaemia, and hypertension) via various pathophysiologic mechanisms.[21–23] The routine assessment of IR may probably hold great significance in preventing a global pandemic and reducing the socioeconomic burden. The homeostatic model assessment of the IR index has been widely used for IR evaluation in clinical practice.[24] However, this index has limitations, including variability depending on the utilised technique, low practicality, and invasiveness.

Compared with other noninsulin-based IR indices, the novel surrogate of IR, namely, the metabolic score for IR (METS-IR),[5] demonstrates a higher concordance with the euglycemic–hyper-insulinemic clamp and its components, including the TG, HDL-C, and FBG levels and body mass index (BMI), and has strong predictive abilities for CVD risk.[6,7] However, information is limited on the association of METS-IR with UACR. Therefore, the current study evaluated the association between METS-IR and UACR and compared it with the associations between FBG level, BMI, and HDL-C level with UACR in the Chinese population.

Methods

Participants

This study was a sub-study of the REACTION study (“Risk Evaluation of cAncers in Chinese diabeTic Individuals: a lONgitudinal” study), which was

designed to investigate the association of prediabetes and T2DM with the risk of cancer among Chinese adults.[25] The REACTION study was conducted on individuals aged over 40 years in centres across mainland China from 2011 to 2012. A total of 47,808 participants from seven regional centres (Guangzhou, Zhengzhou, Dalian, Luzhou, Lanzhou, Shanghai, and Wuhan) were included in this study. We excluded participants (1) diagnosed with primary kidney disease at baseline (n = 4,050), (2) who used lipid-lowering drugs or angiotensin-converting enzyme inhibitors/angiotensin receptor blockers (n = 2,174), (3) had incomplete clinical or demographic data (n = 873), or (4) used hypoglycaemic drugs and insulin (n = 3,421). Finally, 37,290 subjects were included in the present study.

Social, clinical, and biological parameters

All participants were administered a detailed questionnaire on their lifestyle, medical history, and medication use and subsequently underwent anthropometric assessments according to standardised procedures. Medical history included history of T2DM, hypertension, kidney disease, CVD (including stroke, myocardial infarction, and coronary artery disease), and drug use. Smoking habits were categorised as a history of never smoking, currently smoking (frequently: smoking one or more cigarettes daily; occasionally: smoking less than seven cigarettes weekly), or formerly smoking (had already quit smoking for at least half a year). Drinking habits were categorised as a

history of never drinking, currently drinking (frequently: drinking more than once a week; occasionally: drinking less than once a week), or formerly drinking (had already quit drinking for at least half a year).

Height (cm), weight (kg), and waist circumference (WC; cm) were measured by trained nurses. Subjects were required to take off their shoes during height measurements. WC was measured between the inferior margin of the 12th rib and the top of the iliac crest in the horizontal plane. BMI was calculated as the ratio of the body weight in kilograms and the squared body height in meters (kg/m^2). Blood pressure (BP) and resting heart rate (RHR) were measured sequentially three times with 1 min intervals each. The three measurement results of diastolic BP (DBP) and systolic BP (SBP) were averaged for analysis.

Blood samples were collected by venepuncture after a 10 h overnight fast. A 75 g oral glucose tolerance test was then performed. Biochemical parameters included FBG, 2 h postload blood glucose (PBG), TC, LDL-C, HDL-C, TG, aspartate transaminase (AST), gamma-glutamyl transferase (GGT), alanine transaminase (ALT), serum creatinine, and glycosylated haemoglobin (HbA1c). The biological parameters were assayed by quality control procedures. The eGFR ($mL/min/1.73\ m^2$) was calculated according to the following formula: eGFR = 186 × (serum creatinine × 0.011) − 1.154 × (age) − 0.203 × (0.742 if female) × 1.233, where serum creatinine was presented in μ mol/l. The

procedure used the Modification of Diet in Renal Disease, which was recalibrated for the Chinese population.[26]

Definition of variables

According to the self-reported questionnaires, history of hypertension and history of diabetes were defined as documented hypertension at baseline and documented diabetes at baseline, respectively. Urinary albumin and creatinine concentrations were determined in the first-void sterile urine specimens collected early in the morning. UACR was defined as the ratio of the urinary albumin concentration to the urinary creatinine concentration, which was divided into two groups: UACR ≥ 30 mg/g or UACR < 30 mg/g. METS-IR was calculated using the following formula: (Ln [2 × FBG {mg/dL} + TG0 {mg/dL}] × BMI) / (Ln [HDL-C {mg/dL}]), where TG0 is the fasting triglyceride level.[27] The METS-IR index was divided by quartiles.

Statistical analysis

All statistical analyses were performed using SPSS 24.0 (IBM, Chicago, IL, USA). We used one-way analysis of variance to compare the distinctions among the continuous variables of the four groups. The least significant distinction was compared using the multiple comparison test, and continuous variables were expressed as means ± standard deviations. Continuous variables with non-normal distributions were expressed as medians (interquartile range [IQR]). Categorical variables were described as

percentages (%). The odds ratios (ORs) and 95% confidence intervals (CIs) were estimated to explore the associations between METS-IR and UACR via logistic regression analyses. Model 1 was a non-adjusted model. Model 2 was adjusted for centre, age, and sex. Model 3 was further adjusted for education status, smoking habits, drinking habits, and previous diagnosis of CVD. Model 4 was further adjusted for history of diabetes and hypertension and use of hypotensive drugs. Model 5 was further adjusted for eGFR, WC, SBP, DBP, LDL-C, TC, AST, ALT, GGT, HbA1c, and RHR. The relationships between METS-IR and UACR were also explored in subgroups that were stratified by age (<55, 55–64, and ≥65 years), eGFR (<60, 60–90, and ≥90 mL/min/1.73 m^2), blood glucose (BG) status (normal: FBG < 5.6 and PBG < 7.8 mmol/L; prediabetes: 5.6 ≤ FBG < 7.0 or 7.8 ≤ PBG < 11.1 mmol/L; and diabetes: FBG ≥ 7.0 or PBG ≥ 11.1 mmol/L), and BP status (normal BP: SBP < 120 and DBP < 80 mmHg; prehypertension: 80 ≤ DBP < 90 or 120 ≤ SBP < 140 mmHg; and hypertension: DBP ⩾ 90 or SBP ⩾ 140 mmHg). This study also investigated the interactions between METS-IR and the stratified variables among subjects with increased risk of UACR. Two-tailed P < 0.05 was considered statistically significant.

Results

Clinical characteristics of the participants

Among the 37,290 subjects included in this study, 10,909 were men, and 26,381 were women. Table 1 shows the characteristics of the study subjects, who were divided into four groups on the basis of the quartiles of the METS-IR index. The mean age of the Q4 group was 58.72 ± 9.13 years. The mean age of the Q1, Q2, and Q3 groups were 56.77 ± 9.29, 57.49 ± 8.01, and 58.30 ± 9.13 years. The proportions of men and women were the highest in the highest and lowest quartile METS-IR groups, respectively (men: Q1, 19.3%; Q2, 21.4%; Q3, 26.8%; Q4, 32.5%; women: Q1, 27.3%; Q2, 26.5%; Q3, 24.3%; Q4, 21.9%). The highest quartile METS-IR group was characterised by significantly higher WC, BMI, UACR, SBP, DBP, RHR, and TC, TG, ALT, AST, GGT, FBG, and HbA1c levels. Moreover, the eGFR and HDL-C levels were lower because METS-IR was higher.

Association between UACR and METS-IR quartiles

Logistic regression analyses were performed to examine the association between the METS-IR quartiles and UACR. As presented in Table 2, only the highest quartile METS-IR group had a positive relationship with UACR after adjusting for confounding factors among all subjects (OR: 1.260, 95% CI: 1.152–1.378, P < 0.001).

As shown in Table 3, in the non-adjusted model, Q1–Q4 were all associated with UACR; however, after adjusting for various confounding factors, only the

highest quartile of METS-IR was associated with UACR in both men and women in Model 5 (for men: OR: 1.321, 95% CI: 1.104–1.579, P = 0.002; for women: OR: 1.201, 95% CI: 1.083–1.330, P < 0.001). The association in men was more significant than that in women.

Association between METS-IR and UACR according to different levels of age, BG, BP, and eGFR

Stratified analyses were performed for the subgroups of age, BG level, BP, and eGFR to further investigate whether the relationships between METS-IR and UACR were still significant (Tables 4 and 5). Moreover, to better discuss the sex hormone–related associations between METS-IR and UACR, we divided women into two groups, namely, the postmenopausal women group and premenopausal women group (Additional Table 1). Significant interactions were found in the BP and age subgroups (all subjects: age [P for interaction = 0.136] and BP [P for interaction = 0.016]; men: age [P for interaction = 0.593] and BP [P for interaction = 0.336]; women: age [P for interaction = 0.028] and BP [P for interaction = 0.035]; postmenopausal women: age [P for interaction = 0.028] and BP [P for interaction = 0.024]). Significant associations between the fourth METS-IR quartile and UACR years were found among all subjects and women younger than 65 years. The relationship between the third METS-IR quartile and UACR was also significant in women (55–64 years subgroup).

However, among men, a significant association was only observed in men aged 55–64 years (OR: 1.494, 95% CI: 1.114–2.004, P = 0.007). Moreover, we also analysed the association between UACR and METS-IR in BG subgroup. A significant association was found in all subjects and men with critical BG levels and diabetes, whereas a significant association was only observed in women with diabetes (Tables 4 and 5). In addition, similar results were found according to BP, the risk of elevated UACR occurrence in the Q4 METS-IR group was increased in the prehypertension and hypertension groups among all subjects and men. Among women, this risk was only increased in the hypertension group. We also explored the subgroup associations in postmenopausal and premenopausal women (Additional file 1), and the findings for postmenopausal women were similar to those for men.

To better explore the relationship between UACR and METS-IR according to the kidney function level, we divided the participants into three groups on the basis of eGFR (<60, 60–90, and ≥90 mL/min/1.73 m^2). When eGFR $\geqslant$ 90 mL/min/1.73 m^2, the positive relationships between the fourth METS-IR quartile and UACR were significant regardless of sex (all subjects: OR: 1.289, 95% CI: 1.172–1.417, P < 0.001; men: OR: 1.316, 95% CI: 1.089–1.589, P = 0.004; women: OR: 1.268, 95% CI: 1.135–1.417, P < 0.001).

Discussion

Main findings

To the best of our knowledge, this study is the first to explore the association between the METS-IR and UACR among a nationwide community-based population of Chinese adults. The main findings of our study were as follows: (1) UACR was significantly associated with the METS-IR index after controlling for confounding factors, and the association was more significant for the METS-IR index than for its components (FBG, TG, BMI, and HDL-C). (2) Differences among the subgroups were observed on the basis of sex. Among men, the association between METS-IR and UACR was significant in those aged 55–64 years with prediabetes or diabetes, prehypertension or hypertension, and eGFR $\geqslant$ 90 mL/min/1.73 m^2. Among women, the association between METS-IR and UACR was significant among those aged < 65 years with diabetes, hypertension, and eGFR $\geqslant$ 90 mL/min/1.73 m^2.

Components of METS-IR and UACR

Although previous studies found that the components of METS-IR, including BMI, TG, FBG, and HDL-C, could be treated as predictors of CVD and hypertension,[5–7] our study showed that BMI, FBG, and TG in men and HDL-C in women were not significantly associated with UACR. However, METS-IR remained strongly associated with UACR among all subjects and both sexes. Moreover, the assessment of these METS-IR components has

potential limitations. An increased FBG level is a less competent indicator of cardiovascular outcomes.[28] The role of BMI remains debatable because different studies have presented conflicting results.[29–31] Although lower HDL-C and higher TG levels were significantly associated with a risk of elevated UACR among the conventional parameters of dyslipidaemia, the individual lipid profile have been found to be more predictive of CVD.[32–34] This study indicated that METS-IR may be regarded a more reliable predictor of elevated UACR than BMI or TG, FBG, and HDL-C levels. Thus, the combination of TG, BMI, FBG, and HDL-C may lead to a better vigilant value for CVD detection.

Association of age and sex with the METS-IR index and UACR

Few studies have investigated sex- or age-stratified associations between UACR and METS-IR. In our study, we found age- and sex-based differences. In this population-based study of middle-aged and older participants, the results showed that an elevated UACR was significantly associated with an increased METS-IR index among men (55–64 years) and women (<65 years). However, in all subjects, the relationships were only found in younger people (<65 years). A previous study has found that BMI, which is a component of METS-IR, is significantly associated with CKD, and this association becomes weaker with increasing age (particularly among women).[35] Similar findings of

another study showed that the influence of lipid variability on unfavourable outcomes was greater in younger adults.[36] Our findings support the fact that younger adults exhibit greater sensitivity to increasing the variability of cholesterol than older adults. UACR has been reported to be predictive of CVD.[3] It has a negative association with the risk of CVD and is independent of sex and age.[37] Likewise, mortality risk ratios for coronary artery disease among men were halved between the age of 55–64 years and 65–74 years.[38] The findings of our study were not fully consistent with those of the abovementioned studies. In our study, there are some elderly people in retirement to a certain extent; we speculated that such people have possibly more time to exercise to reduce inflammation, which could lead to renal dysfunction.[39]

In the subgroup analyses, it was noticeable that the different associations were significant in men with diabetes and prediabetes, prehypertension, and hypertension and in women with hypertension and diabetes. However, we found that the interaction between BP and METS-IR was only significant among women, particularly premenopausal women. Therefore, our findings indicated that the independent association of METS-IR with UACR was more significant in men. Moreover, the proportion of men was higher in the highest METS-IR quartile group, and the OR for elevated UACR was higher in men than in women. Our findings disagree with those of some previous studies that

indicated that being female seems to intensify the progression of diabetic renal disease [40] or that being male could be considered a risk for the disease.[41] The possible reasons for the conflicting findings are unclear. However, data from a review study confirmed that the risk of incidence of nondiabetic renal disease was higher among men than among age-matched women without diabetes. It suggested that a possible mechanism for the deficiency of the distinct sex discrepancy in the status of diabetes may be due to the imbalance of sex hormone levels with diabetes.[42] This finding was consistent with that of the current study. A sex-stratified study had similar conclusions and showed that the components of METS-IR in men were more impaired than that in women and that the values of TG or TG/HDL ratios were higher in men.[43] Further evidence could come out in support of the role of endogenous oestrogen in the metabolic homeostasis and the decrease of visceral lipid accumulation.[44] Our results may be due to the latent lipid distribution differential based on sex and the different levels of steroid hormone. An animal study showed that oestrogen therapy may have a beneficial impact on proteinuria.[45] Therefore, further analysis among postmenopausal and premenopausal women is essential. Similar results to those in men were found in the population of postmenopausal women. Simultaneously, the results of premenopausal women were distinct from those of men, which provided evidence for the hypothetic mechanism and indicated the higher accumulation

of risk factors with gradual elevation of UACR in postmenopausal women and men.

Association of eGFR with the METS-IR index and UACR

In our analysis, there was a significant association between higher eGFR values and METS-IR and UACR. Recent observations showed that glomerular hyperfiltration (GH) was a possible predictor of obesity-related CKD or diabetic renal disease.[46,47] The aforementioned study found that excess lipids aggravate inflammation by producing adipokines, thus inducing the alteration of the renal glomerular feedback; this results in elevated glomerulus capillary pressure and causes a secondary increase in the glomerular filtration rate, which was detected as GH. The potential mechanism has not been fully explored, but a study found that the renin–angiotensin–aldosterone system could be blocked to protect the renal function via ameliorating GH. Moreover, the relationship of all-cause mortality with eGFR is U-shaped, which shows the significance of the low and high eGFR levels.[48,49] Interestingly, the relationship between UACR and METS-IR in low eGFR levels was insignificant in the current study. The possible interpretation of this discrepancy may be the small sample size of the low eGFR level. Further large-scale investigations are essential to clarify the associations between UACR and MEST-IR according to different eGFR values.

Potential pathophysiological mechanisms underlying the association between UACR and METS-IR

The underlying pathophysiological mechanism linking UACR to METS-IR and its constituents are not fully established. A cross-sectional study indicated that the contribution of dyslipidaemia, higher TG levels, and lower HDL-C levels was significant for the development of albuminuria.[50] Several studies found that IR was the kernel pathological trait of metabolic syndrome, and the constituents of the METS-IR index (TG, FBG, HDL-C, BMI) have been indicated as risk factors for hypertension.[5–6,51–53] Moreover, diabetes and hypertension have significant relationships with MAU.[15,54,55] However, in the current study, the interaction between METS-IR and the BG level was not significant, and METS-IR was still significantly associated with UACR after controlling the stratified factor. The possible reason may be attributed to visceral obesity. The relationship between IR and visceral adipose tissue (VAT) has long been recognised.[56,57] Given that METS-IR has a particularly stronger association with visceral adiposity than insulin-based indexes,[5] it could be a predictor for ectopic lipid accumulation and visceral fat, which were confirmed risk factors for hypertension and CVD.[58,59] Furthermore, recent studies have proposed that visceral adiposity may be pivotally involved in UACR excretion and albuminuria may be a manifestation of VAT.[60–62] It is presumptive that adiponectin's role in renal dysfunction may be an underlying

factor of the association between albuminuria and VAT.[63] Elevated VAT and increased albuminuria have both been reported to have inverse associations with adiponectin.[64–66] Adiponectin had a positive correlation with age, and the concentration levels of adiponectin were different based on sex. Intra-abdominal fat was less in women than in men. These findings are concordant with our findings. An adiponectin-deficient animal-based model showed that glomerular damage was promoted by lower levels of adiponectin.[67] Furthermore, the adipocytokines of VAT, such as IL-6 and TNF-α, could exacerbate renal vascular damage via inflammation and lead to the development of albuminuria owing to increased GFRs.[68–71] The findings of these studies are consistent with our findings. Taken together, the above findings confirm that the relationship between UACR with METS-IR could be explained by the increased VAT associated with both adiponectin and IR.

Strengths and limitations

The major strength of this study was that the study benefited from a relatively large multicentre investigation of the Chinese population. However, a few limitations should be considered. First, no inference of causality can be drawn owing to the cross-sectional design; a follow-up analysis should be performed to determine whether METS-IR is a predictor of elevated UACR. Second, the measurement of UACR was based on a single morning spot urine specimen.

Despite its recommendation as a reliable method in large epidemiological studies, misestimations of urinary albumin egestion owing to intra-individual variance cannot be eliminated. Third, although the population who used lipid-lowering drugs or angiotensin-converting enzyme inhibitors/angiotensin receptor blockers was excluded, the use of other medications that were not investigated might have influenced the findings of this study. Finally, despite regulating a series of confounding factors, some remnants or unmeasured confounders could not be excluded.

Conclusions

METS-IR was significantly associated with an elevated UACR among Chinese adults and was superior to its components. Moreover, not only men or postmenopausal women with diabetes and hypertension but also those with critical BG and critical BP levels, particularly those aged below 65, needed specific supervision when screening for the METS-IR index. Clinicians may detect this timely to intervene and improve the mentioned risk factors in practice. Our study provided proof to support that age and sex should be an essential consideration when referring to the METS-IR index.

List of abbreviations

AST, aspartate transaminase;

ALT, alanine transaminase;

BMI, body mass index;

BP, blood pressure;

BG, blood glucose;

CI, confidence interval;

CKD, chronic kidney disease;

CVD, cardiovascular disease;

DBP, diastolic blood pressure;

eGFR, estimated glomerular filtration rate;

FBG, fasting blood glucose;

GGT, gamma-glutamyl transferase;

GH, glomerular hyperfiltration;

HbA1c, glycosylated haemoglobin;

HDL-C, high-density lipoprotein cholesterol;

IQR, interquartile range;

IR, insulin resistance;

LDL-C, low-density lipoprotein cholesterol;

MAU, microalbuminuria;

METS-IR, metabolic score for insulin resistance;

OR, odds ratio;

PBG, 2 h postload blood glucose;

RHR, resting heart rate;

SBP, systolic blood pressure;

TC, total cholesterol;

TG, triglycerides;

T2DM, type 2 diabetes mellitus;

UACR, urinary albumin–creatinine ratio;

VAT, visceral adipose tissue;

WC, waist circumference.

Declarations

Data Availability

The datasets used to support this study are not freely available to protect the privacy of participants.

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Competing interests

The authors declare no competing interests.

Consent for publication

Not applicable

Ethics approval and consent to participate

The study protocol was approved by the Committee on Human Research at Rui-Jin Hospital affiliated with the School of Medicine, Shanghai Jiao Tong University. Written informed consents were obtained from all participants before data collection.

Authors' contributions

Wanlu Su and Jie Wang contributed equally to this article. Wanlu Su and Yiming Mu designed the conception of the manuscript. Wanlu Su performed the statistical analysis, interpreted the data, and drafted and revised the manuscript. Jie Wang interpreted the data and drafted and revised the manuscript. Yiming Mu assisted in data collection and acquisition and revised the manuscript. Songyan Yu, Wenhua Yan, Zhengnan Gao, Xuelei Tang, Qin Wan, and Zuojie Luo offered advice and assistance, recruited the subjects, and supervised the study. Each author contributed to the final approval of the

485 version to be published and ensured that questions related to the accuracy or
486 integrity of any part of the work are appropriately investigated and resolved.
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Tables

Table 1. Characteristics of the study subjects by METS-IR quartiles

Variable	METS-IR				P value
	Q1 (n = 9,322)	Q2 (n = 9,323)	Q3 (n = 9,323)	Q4 (n = 9,322)	
Age, y	56.77 ± 9.29	57.49 ± 8.01	58.30 ± 9.13	58.72 ± 9.13	<0.001a,b,c,d,e
Male sex, no. (%)	2,107 (19.3)	2,336 (21.4)	2,923 (26.8)	3,543 (32.5)	<0.001
Female sex, no. (%)	7,215 (27.3)	6,987 (26.5)	6,400 (24.3)	5,779 (21.9)	<0.001
WC, cm	76.37 ± 7.89	83.05 ± 7.13	87.77 ± 7.24	94.23 ± 8.51	<0.001a,b,c,d,e,f
Triglycerides, mmol/L	0.96 (0.76–1.25)	1.23 (0.92–1.63)	1.51 (1.10–2.05)	1.93 (1.35–2.80)	<0.001a,b,c,d,e,f
BMI, kg/m²	20.62 ± 1.73	23.31 ± 1.50	25.24 ± 1.74	28.45 ± 3.74	<0.001a,b,c,d,e,f
TC, mmol/L	4.88 ± 1.24	5.10 ± 1.13	5.06 ± 1.14	5.12 ± 1.07	<0.001b,c,d,e,f
LDL-C, mmol/L	2.93 ± 0.87	3.06 ± 0.90	3.04 ± 0.89	2.82 ± 0.92	<0.001a,b,c,e,f

HDL-C, mmol/L	1.60 ± 0.34	1.38 ± 0.28	1.24 ± 0.26	1.08 ± 0.26	<0.001a,b,c,d,e,f
UACR, mg/g	8.28 (5.65–16.47)	9.39 (5.57–17.68)	10.07 (5.85–19.07)	11.56 (6.21–21.52)	<0.001c,e,f
ALT, U/L	15.16 ± 12.62	16.34 ± 12.26	18.83 ± 13.79	21.90 ± 16.72	<0.001a,b,c,d,e,f
AST, U/L	21.68 ± 10.57	21.28 ± 11.29	22.15 ± 12.41	23.12 ± 13.37	<0.001c,d,e,f
SBP, mmHg	122.17 ± 19.30	128.17 ± 20.31	133.07 ± 20.95	137.51 ± 20.93	<0.001a,b,c,d,e,f
DBP, mmHg	72.79 ± 10.68	75.89 ± 10.88	78.51 ± 11.09	81.03 ± 11.29	<0.001a,b,c,d,e,f
RHR, (beat/min)	78.81 ± 12.60	78.45 ± 12.35	78.66 ± 12.13	79.12 ± 12.25	<0.001a,f
HbA1c, %	5.7 (5.5–6)	5.8 (5.5–6.1)	5.9 (5.6–6.2)	6 (5.7–6.4)	<0.001a,b,c,d,e,f
GGT, U/L	22.84 ± 35.30	25.91 ± 31.99	30.96 ± 42.74	35.38 ± 40.05	<0.001a,b,c,d,e,f
FBG, mmol/L	5.29 ± 0.78	5.55 ± 1.07	5.82 ± 1.34	6.25 ± 1.74	<0.001a,b,c,d,e,f
eGFR, mL/min/1.73 m^2	119.29 ± 21.73	119.84 ± 22.87	119.98 ± 24.84	122.11 ± 29.62	<0.001b,c,d,e,f
High-school education, no. (%)	6,830 (73.3)	4,717 (50.6)	4,428 (47.5)	3,938 (42.2)	<0.001
Current smoker, no. (%)	1,110 (12.0)	1,096 (11.8)	1,325 (14.2)	1,631 (17.5)	<0.001

Former smoker, no. (%)	902 (9.68)	980 (10.51)	1,286 (13.8)	1,547 (16.6)	<0.001
Current alcohol drinker, no. (%)	2,170 (23.3)	2,195 (23.5)	2,420 (26.0)	2,513 (27.0)	<0.001
Former alcohol drinker, no. (%)	2,041 (21.9)	2,045 (22.0)	2,318 (24.9)	2,432 (26.1)	<0.001
History of hypertension, no. (%)	757 (0.08)	1,246 (13.4)	1,839 (19.7)	2,511 (27.0)	<0.001
History of diabetes, no. (%)	85 (0.91)	145 (1.56)	238 (2.55)	366 (3.93)	<0.001
Previous MI, no. (%)	6 (0.06)	16 (0.17)	25 (0.27)	56 (0.60)	<0.001
Previous stroke, no. (%)	68 (0.73)	83 (0.89)	95 (1.02)	137 (1.47)	<0.001
Previous CAD, no. (%)	201 (2.16)	223 (2.39)	332 (3.56)	431 (4.62)	<0.001
Taking hypertension drugs, no. (%)	103 (1.10)	148 (1.59)	181 (1.94)	242 (2.60)	<0.001

759 METS-IR, metabolic score for insulin resistance; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein
760 cholesterol; UACR, urinary albumin–creatinine ratio; AST, aspartate transaminase; ALT, alanine transaminase; DBP, diastolic blood
761 pressure; HbA1c, glycosylated haemoglobin; SBP, systolic blood pressure; eGFR, estimated glomerular filtration rate; FBG, fasting

762 blood glucose; GGT, gamma-glutamyl transferase; MI, myocardial infarction; CAD, coronary artery disease.

763

764 Table 2. Association of the METS-IR index and its components with UACR in total subjects

METS-IR	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
METS-IR										
Q1 (17.75–31.63)	Reference		Reference		Reference		Reference		Reference	
Q2 (31.64–36.03)	1.180 (1.075–1.296)	0.001	1.168 (1.061–1.286)	0.002	1.152 (1.047–1.267)	0.004	1.106 (1.005–1.217)	0.039	1.084 (0.978–1.023)	0.124
Q3 (36.04–41.03)	1.310 (1.195–1.435)	<0.001	1.284 (1.167–1.412)	<0.001	1.175 (1.085–1.271)	<0.001	1.107 (1.022–1.199)	0.013	1.028 (0.940–1.124)	0.548
Q4 (41.04–137.55)	1.787 (1.637–1.951)	<0.001	1.857 (1.693–2.037)	<0.001	1.524 (1.423–1.632)	<0.001	1.399 (1.304–1.500)	<0.001	1.260 (1.152–1.378)	<0.001
TG, mmol/L										
<1.7	Reference		Reference		Reference		Reference		Reference	
⩾1.7,<2.3	1.443 (1.331–1.564)	<0.001	1.254 (1.153–1.364)	<0.001	1.239 (1.138–1.348)	<0.001	1.183 (1.086–1.289)	<0.001	1.033 (0.944–1.131)	0.476

⩾2.3	1.702 (1.574–1.840)	<0.001	1.385 (1.276–1.503)	<0.001	1.523 (1.402–1.624)	<0.001	1.303 (1.198–1.417)	<0.001	1.158 (1.058–1.268)	0.001
FBG, mmol/L										
<5.6	Reference		Reference		Reference		Reference		Reference	
⩾5.6,<7.0	1.235 (1.156–1.321)	<0.001	1.140 (1.079–1.182)	<0.001	1.035 (1.023–1.038)	<0.001	1.135 (0.968–1.332)	0.067	1.142 (1.032–1.265)	0.010
⩾7.0	1.602 (1.506–1.705)	<0.001	1.225 (1.153–1.301)	<0.001	1.196 (1.113–1.285)	<0.001	1.148 (1.068–1.233)	<0.001	1.051 (0.959–1.152)	0.287
BMI, kg/m^2										
<18.5	Reference		Reference		Reference		Reference		Reference	
⩾18.5,<24	0.986 (0.812–1.197)	0.887	1.229 (0.993–1.522)	0.059	1.042 (0.853–1.272)	0.687	0.989 (0.808–1.211)	0.916	0.828 (0.664–1.032)	0.094
⩾24,<28	1.108 (0.912–1.345)	0.303	1.220 (0.998–1.491)	0.052	1.174 (1.047–1.316)	0.006	1.083 (0.965–1.215)	0.174	0.908 (0.796–1.035)	0.150
⩾28	1.447 (1.182–1.771)	<0.001	1.421 (1.259–1.502)	<0.001	1.513 (1.389–1.568)	<0.001	1.280 (1.427–1.591)	<0.001	0.912 (0.701–1.187)	0.493
HDL, mmol/L										
⩾1	Reference		Reference		Reference		Reference		Reference	

<1	1.291 (1.192–1.397)	<0.001	1.249 (1.146–1.360)	<0.001	1.237 (1.134–1.349)	<0.001	1.178 (1.079–1.286)	<0.001	1.133 (1.020–1.259)	0.020

765 METS-IR, metabolic score for insulin resistance; TG, triglycerides; BMI, body mass index; FBG, fasting blood glucose; HDL-C,

766 high-density lipoprotein cholesterol; CI, confidence interval; OR, odds ratio; UACR, urinary albumin–creatinine ratio.

767 Model 1: Unadjusted

768 Model 2: Adjusted for centre, age, sex

769 Model 3: Further education status, smoking habits, drinking habits, CVD status

770 Model 4: Further diabetes history, hypertension history, hypotensive drugs

771 Model 5: Further eGFR, LDL-C, TC, AST, ALT, GGT, HbA1c, SBP, DBP, WC, HR

772

773 Table 3. Association of the METS-IR index and its components with UACR by sex

METS-IR	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value

Men										
Q1 (18.98–32.95)	Reference		Reference		Reference		Reference		Reference	
Q2 (32.96–37.78)	1.129 (0.910–1.400)	0.270	1.165 (0.935–1.452)	0.175	1.131 (0.930–1.376)	0.218	1.045 (0.858–1.273)	0.661	0.991 (0.735–1.129)	0.395
Q3 (37.79–42.71)	1.348 (1.155–1.573)	<0.001	1.389 (1.131–1.707)	<0.001	1.365 (1.166–1.598)	<0.001	1.258 (1.073–1.476)	0.005	1.058 (0.882–1.269)	0.544
Q4 (42.72–115.22)	1.878 (1.559–2.263)	<0.001	2.092 (1.722–2.540)	<0.001	1.745 (1.525–1.970)	<0.001	1.591 (1.387–1.824)	<0.001	1.321 (1.104–1.579)	0.002
TG, mmol/L										
<1.7	Reference		Reference		Reference		Reference		Reference	
⩾1.7,<2.3	1.182 (0.998–1.401)	0.053	1.175 (0.988–1.398)	0.068	1.173 (0.985–1.398)	0.074	1.473 (1.256–1.728)	<0.001	0.929 (0.768–1.124)	0.451
⩾2.3	1.667 (1.426–1.949)	<0.001	1.531 (1.319–1.777)	<0.001	1.547 (1.323–1.808)	<0.001	1.100 (1.002–1.113)	0.009	1.166 (0.952–1.426)	0.137
FBG, mmol/L										
<5.6	Reference		Reference		Reference		Reference		Reference	
⩾5.6,<7.0	1.359 (1.184–1.560)	<0.001	1.051 (1.008–1.326)	<0.001	1.033 (1.025–1.041)	<0.001	1.051 (0.877–1.259)	0.589	1.060(0.909–1.237)	0.459
⩾7.0	1.696 (1.529–1.882)	<0.001	1.187 (1.065–1.324)	0.002	1.353 (1.170–1.563)	<0.001	1.296 (1.120–1.499)	<0.001	1.229(0.960–1.573)	0.101

BMI, kg/m^2										
<18.5	Reference		Reference		Reference		Reference		Reference	
⩾18.5,<24	0.912 (0.621–1.340)	0.640	1.026 (0.694–1.516)	0.899	1.023 (0.687–1.522)	0.911	0.953 (0.640–1.421)	0.815	0.679 (0.433–1.065)	0.092
⩾24,<28	1.152 (0.786–1.687)	0.469	1.345 (1.080–1.674)	0.008	1.360 (0.914–2.023)	0.129	1.196 (0.954–1.499)	0.120	0.637 (0.393–1.032)	0.067
⩾28	1.502 (1.009–2.235)	0.045	1.675 (1.448–1.976)	<0.001	1.649 (1.285–1.955)	0.002	1.534 (1.242–1.895)	<0.001	0.747 (0.435–1.282)	0.289
HDL, mmol/L										
⩾1	Reference		Reference		Reference		Reference		Reference	
<1	1.391 (1.211–1.598)	<0.001	1.249 (1.146–1.360)	<0.001	1.340 (1.157–1.553)	<0.001	1.280 (1.103–1.485)	<0.001	1.243 (1.040–1.485)	0.017
Women										
Q1 (17.75–31.18)	Reference		Reference		Reference		Reference		Reference	
Q2 (31.19–35.37)	1.205 (1.086–1.337)	0.001	1.181 (1.061–1.315)	0.002	1.163 (1.041–1.299)	0.007	1.123 (1.005–1.255)	0.041	1.041 (0.989–1.245)	0.077
Q3 (35.38–40.27)	1.356 (1.222–1.504)	<0.001	1.266 (1.136–1.411)	0.001	1.152 (1.052–1.262)	0.002	1.103 (1.006–1.209)	0.037	1.064 (0.960–1.180)	0.234
Q4 (40.28–137.55)	1.877 (1.697–2.077)	<0.001	1.797 (1.614–2.000)	<0.001	1.410 (1.302–1.526)	<0.001	1.340 (1.233–1.456)	<0.001	1.201 (1.083–1.330)	<0.001

TG, mmol/L										
<1.7	Reference		Reference		Reference		Reference		Reference	
⩾1.7,<2.3	1.540 (1.405–1.689)	<0.001	1.278 (1.160–1.407)	<0.001	1.262 (1.144–1.391)	<0.001	1.214 (1.101–1.340)	<0.001	0.996 (1.106–1.228)	0.060
⩾2.3	1.817 (1.657–1.992)	<0.001	1.325 (1.203–1.459)	<0.001	1.466 (1.329–1.617)	<0.001	1.245 (1.128–1.375)	<0.001	1.152 (1.023–1.297)	0.020
FBG, mmol/L										
<5.6	Reference		Reference		Reference		Reference		Reference	
⩾5.6,<7.0	1.234 (1.143–1.333)	<0.001	1.142 (1.107–1.212)	<0.001	1.036 (1.031–1.041)	<0.001	1.114 (0.964–1.288)	0.142	0.981 (0.898–1.072)	0.671
⩾7.0	1.640 (1.515–1.774)	<0.001	1.220 (1.134–1.312)	<0.001	1.153 (1.061–1.252)	0.001	1.108 (1.019–1.205)	0.016	1.001 (0.999–1.003)	0.246
BMI kg/m^2										
<18.5	Reference		Reference		Reference		Reference		Reference	
⩾18.5,<24	0.995 (0.795–1.246)	0.965	1.036 (0.821–1.307)	0.767	1.030 (0.814–1.303)	0.806	0.993 (0.785–1.257)	0.954	0.854 (0.662–1.102)	0.224
⩾24,<28	1.098 (0.876–1.377)	0.417	1.147 (1.006–1.309)	0.041	1.121 (0.981–1.281)	0.094	1.049 (0.917–1.199)	0.489	0.781 (0.595–1.024)	0.074
⩾28	1.427 (1.128–1.806)	0 .003	1.373 (1.290–1.481)	<0.001	1.353 (1.246–1.533)	<0.001	1.397 (1.230–1.586)	<0.001	0.934 (0.690–1.265)	0.659

HDL, mmol/L										
⩾1	Reference		Reference		Reference		Reference		Reference	
<1	1.390 (1.258–1.537)	<0.001	1.345 (1.080–1.474)	<0.001	1.200 (1.077–1.337)	0.001	1.143 (1.024–1.275)	0.017	1.068 (0.935–1.220)	0.334

774 METS-IR, metabolic score for insulin resistance; TG, triglycerides; BMI, body mass index; FBG, fasting blood glucose; HDL-C,
775 high-density lipoprotein cholesterol; CI, confidence interval; OR, odds ratio; UACR, urinary albumin–creatinine ratio.
776 Model 1: Unadjusted
777 Model 2: Adjusted for centre, age
778 Model 3: Further education status, smoking habits, drinking habits, CVD status
779 Model 4: Further diabetes history, hypertension history, hypotensive drugs
780 Model 5: Further eGFR, LDL-C, TC, AST, ALT, GGT, HbA1c, SBP, DBP, WC, HR

781

782 Table 4. Association of the METS-IR index with UACR for different levels of age, BG, BP, and eGFR in total subjects

METS-IR

Variable	Q1	Q2		Q3		Q4		P-values for
	Reference	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	interaction
All subjects								0.136
Age, year a								
<55 (n = 14,788)	1	1.099 (0.924–1.307)	0.288	0.943 (0.801–1.110)	0.483	1.313 (1.114–1.547)*	0.001	
⩾55,<64 (n = 14,026)	1	0.991 (0.829–1.185)	0.920	1.118 (0.962–1.300)	0.146	1.208 (1.027–1.574)*	＜0.001	
⩾65 (n = 7,387)	1	1.206 (0.989–1.470)	0.064	0.988 (0.838–1.164)	0.885	1.034 (0.879–1.217)	0.685	
Blood glucose, mmol/L b								0.869

FBG < 5.6 and PBG < 7.8 (n = 15,996)	1	1.029 (0.886–1.196)	0.706	0.974 (0.836–1.135)	0.736	1.082 (0.946–1.239)	0.250
5.6 ⩽ FBG < 7.0 or 7.8 ⩽ PBG < 11.1 (n = 15,837)	1	1.128 (0.953–1.336)	0.160	0.955 (0.832–1.095)	0.509	1.330 (1.121–1.578)*	0.001
FBG ⩾ 7.0 or PBG ⩾ 11.1 (n = 5,457)	1	1.066 (0.780–1.457)	0.688	1.084 (0.871–1.349)	0.469	1.381 (1.025–1.698)*	0.038
BP, mmHg c							0.016
SBP < 120 and DBP < 80 (n = 11,520)	1	1.146 (0.955–1.376)	0.143	1.049 (0.865–1.272)	0.629	1.094 (0.939–1.275)	0.247
120 ⩽ SBP < 140 and/or 80 ⩽ DBP < 90 (n = 14,145)	1	0.981 (0.820–1.175)	0.838	1.255 (0.686–1.565)	0.404	1.356 (1.165–1.579)*	<0.001
SBP ⩾ 140 or DBP ⩾ 90 (n = 11,625)	1	1.069 (0.929–1.231)	0.351	1.127 (0.903–1.396)	0.302	1.282 (1.124–1.463)*	<0.001

eGFR, mL/min/1.73 m^2 d								0.120
eGFR ⩾ 90 (n = 34,691)	1	1.088 (0.976–1.212)	0.128	1.037 (0.943–1.141)	0.449	1.289 (1.172–1.417)*	<0.001	
60 ⩽ eGFR < 90 (n = 2,408)	1	1.189 (0.806–1.755)	0.384	0.959 (0.709–1.298)	0.788	1.042 (0.773–1.406)	0.785	
eGFR < 60 (n = 191)	1	1.010 (0.989–1.032)	0.359	1.011 (0.960–1.065)	0.676	1.052 (0.983–1.125)	0.144	

783 METS-IR, metabolic score for insulin resistance; UACR, urinary albumin–creatinine ratio; DBP, diastolic blood pressure; SBP,
784 systolic blood pressure; eGFR, estimated glomerular filtration rate; FBG, fasting blood glucose; PBG, 2 h postload blood glucose; CI,
785 confidence interval; OR, odds ratio.
786 a Age subgroup: adjusted for sex, centres, ALT, AST, GGT, LDL-C, TC, HbA1c, SBP, DBP, eGFR, WC, smoking habits, drinking
787 habits, CVD status, hypertension history, diabetes history, use of hypertension drugs.
788 b Blood glucose subgroup: adjusted for age, sex, centres, ALT, AST, GGT, LDL-C, TC, SBP, DBP, eGFR, WC, smoking habits,

drinking habits, CVD status, hypertension history, use of hypertension drugs.

c BP subgroup: adjusted for age, sex, centres, ALT, AST, GGT, LDL-C, TC, HbA1c, eGFR, WC, smoking habits, drinking habits, CVD status, diabetes history.

d eGFR subgroup: adjusted for age, sex, centres, ALT, AST, GGT, LDL-C, TC, HbA1c, SBP, DBP, WC, smoking habits, drinking habits, CVD status, hypertension history, diabetes history, use of hypertension drugs.

Table 5. Association of the METS-IR index with UACR for different levels of age, BG, BP, and eGFR by sex

	METS-IR								
Variable	Q1	Q2		Q3		Q4		P-values for	
	Reference	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	interaction	
Men								0.593	
Age, year a									
<55 (n = 3,477)	1	0.862 (0.504–1.475)	0.589	0.862 (0.571–1.300)	0.478	1.078 (0.748–1.555)	0.686		

⩾55,<64 (n = 4,361)	1	0.933 (0.631–1.381)	0.730	0.898 (0.652–1.236)	0.508	1.494 (1.114–2.004)*	0.007	
⩾65 (n = 3,071)	1	1.053 (0.719–1.543)	0.791	1.111 (0.820–1.505)	0.496	1.113 (0.820–1.511)	0.494	
Blood glucose, mmol/L b								
FBG < 5.6 and PBG < 7.8 (n = 3,995)	1	0.846 (0.582–1.231)	0.382	0.738 (0.521–1.045)	0.087	1.020 (0.709–1.469)	0.914	0.564
5.6 ⩽ FBG < 7.0 or 7.8 ⩽ PBG < 11.1 (n = 4,797)	1	1.040 (0.711–1.523)	0.839	0.816 (0.606–1.098)	0.179	1.231 (1.011–1.498)*	0.001	
FBG ⩾ 7.0 or PBG ⩾ 11.1 (n = 2,117)	1	1.040 (0.579–1.868)	0.896	1.380 (0.933–2.041)	0.107	1.511 (1.070–2.134)*	0.019	

BP, mmHg c								0.336
SBP < 120 and DBP < 80 (n = 2,612)	1	0.617 (0.410–1.128)	0.206	0.845 (0.602–1.186)	0.330	1.190 (0.865–1.639)	0.285	
120 ⩽ SBP < 140 and/or 80 ⩽ DBP < 90 (n = 4,256)	1	1.500 (0.915–2.460)	0.108	1.069 (0.663–1.724)	0.784	1.635 (1.020–2.622)*	0.041	
SBP ⩾ 140 or DBP ⩾ 90 (n = 4,041)	1	1.451 (0.984–2.140)	0.060	1.114 (0.848–1.464)	0.439	1.368 (1.070–1.750)*	0.012	
eGFR, mL/min per 1.73 m^2 d								0.116
eGFR ⩾ 90 (n = 10,057)	1	0.991 (0.772–1.273)	0.943	0.939 (0.766–1.151)	0.544	1.316 (1.089–1.589)*	0.004	
60 ⩽ eGFR < 90 (n = 792)	1	1.496 (0.588–3.804)	0.398	1.282 (0.690–2.384)	0.432	1.128 (0.620–2.051)	0.693	

eGFR < 60 (n = 60)	1	1.001 (0.788–1.379)	0.688	0.941 (0.849–1.044))	0.254	1.005 (0.998–1.012)	0.168	
Women								
Age, year a								0.198
<55 (n = 11,814)	1	1.159 (0.964–1.394)	0.117	0.977 (0.816–1.169)	0.799	1.378 (1.144–1.662)*	0.001	
⩾55,<64 (n = 10,048)	1	0.998 (0.816–1.220)	0.981	1.203 (1.014–1.429)*	0.034	1.319 (1.105–1.574)*	0.002	
⩾65 (n = 4,519)	1	1.250 (0.989–1.579)	0.061	0.921 (0.756–1.122)	0.414	0.991 (0.816–1.203)	0.927	
Blood glucose, mmol/L b								0.872
FBG < 5.6 and PBG < 7.8 (n = 12,837)	1	1.083 (0.746–1.572)	0.674	0.973 (0.745–1.270)	0.838	1.127 (0.884–1.436)	0.334	

5.6 ⩽ FBG < 7.0 or 7.8 ⩽ PBG < 11.1 (n = 9,368)	1	1.162 (0.962–1.403)	0.119	1.003 (0.858–1.171)	0.975	1.118 (0.853–1.465)	0.420	
FBG ⩾ 7.0 or PBG ⩾ 11.1 (n = 4,176)	1	1.162 (0.962–1.403)	0.119	1.003 (0.858–1.171)	0.975	1.630 (1.398–1.845)*	0.004	
BP, mmHg c								0.035
SBP < 120 and DBP < 80 (n = 8,908)	1	1.102 (0.905–1.342)	0.335	1.058 (0.856–1.308)	0.603	1.170 (0.907–1.509)	0.227	
120 ⩽ SBP < 140 and/or 80 ⩽ DBP < 90 (n = 9,889)	1	1.096 (0.897–1.340)	0.370	1.170 (0.985–1.390)	0.073	1.279 (0.999–1.638)	0.051	
SBP ⩾ 140 or DBP ⩾ 90 (n = 7,584)	1	1.055 (0.894–1.246)	0.524	1.182 (0.073–1.284)	0.220	1.242 (1.060–1.456)*	0.007	

eGFR, mL/min per 1.73 m^2 d								0.225
eGFR ⩾ 90 (n = 24,634)	1	1.115 (0.989–1.258)	0.076	1.073 (0.963–1.026)	0.199	1.268 (1.135–1.417)*	<0.001	
60 ⩽ eGFR < 90 (n = 1,616)	1	1.236 (0.799–1.914)	0.341	0.889 (0.620–1.275)	0.524	1.152 (0.806–1.646)	0.437	
eGFR < 60 (n = 131)	1	1.051 (0.952–1.162)	0.325	1.294 (0.916–1.294)	0.143	1.258 (0.395–2.167)	0.468	

METS-IR, metabolic score for insulin resistance; UACR, urinary albumin-to-creatinine ratio; DBP, diastolic blood pressure; SBP, systolic blood pressure; eGFR, estimated glomerular filtration rate; FBG, fasting blood glucose; PBG, 2 h postload blood glucose; CI, confidence interval; OR, odds ratio.

a Age subgroup: adjusted for centres, ALT, AST, GGT, LDL-C, TC, HbA1c, SBP, DBP, eGFR, WC, smoking habits, drinking habits, CVD status, hypertension history, diabetes history, use of hypertension drugs.

b BG subgroup: adjusted for age, centres, ALT, AST, GGT, LDL-C, TC, SBP, DBP, eGFR, WC, smoking habits, drinking habits, CVD status, hypertension history, use of hypertension drugs.

c BP subgroup: adjusted for age, centres, ALT, AST, GGT, LDL-C, TC, HbA1c, eGFR, WC, smoking habits, drinking habits, CVD status, diabetes history.

d eGFR subgroup: adjusted for age, centres, ALT, AST, GGT, LDL-C, TC, HbA1c, SBP, DBP, WC, smoking habits, drinking habits, CVD status, hypertension history, diabetes history, use of hypertension drugs.

Additional files

File name: Additional file 1

File format: PDF(.pdf)

Title of data: Additional Table 1

Description of data: Association of the METS-IR index with UACR for different levels of age, BG, BP, and eGFR by menopause status