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Association and Diagnostic Value of TyG-BMI for Hyperuricemia in Patients with Non-Alcoholic Fatty Liver Disease: A Cross-Sectional Study

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Purpose: This study aimed to investigate the association between TyG-BMI and hyperuricemia in NAFLD patients and assess its potential diagnostic value compared to the TyG index.

Patients and Methods: This study selected the patients diagnosed with fatty liver disease at the Affiliated Hospital of Chengde Medical University between September and December 2023. These patients were divided into NAFLD without HUA (NAFLD-NUA, n=1166) and NAFLD with HUA (NAFLD-HUA, n=844) groups. Baseline characteristics between the groups were compared. Patients were divided into quartiles (Q1–Q4) according to their TyG-BMI level; the lowest quartile (Q1) was used as the reference group. Multivariate logistic regression analysis was used to investigate the association between TyG-BMI and HUA. Receiver operating characteristics curve analysis and area under the curve (AUC) were used to evaluate the diagnostic accuracy.

Results: Patients in the NAFLD-HUA group had higher levels of TyG-BMI than patients in the NAFLD-NUA group(252.45 ±34.11VS 234.34±31.88, P<0.001). Pearson correlation analysis showed that TyG-BMI levels were positively correlated with serum uric acid (SUA) (r=0.309, P<0.001). After adjusting for potential confounders, logistic regression analysis revealed that TyG-BMI was a risk factor for HUA(OR:1.019 95% CI:(1.012, 1.027).) and shows superior diagnostic accuracy (AUC: 0.656) compared to the TyG index (AUC: 0.605).

Conclusion: TyG-BMI index is a risk factor for HUA in patients with NAFLD, and demonstrates acceptable diagnostic accuracy for NAFLD-HUA. But further prospective studies are needed to confirm these findings.

Keywords: triglyceride glucose-body mass index, hyperuricemia, non-alcoholic fatty liver disease, insulin resistance, metabolic syndrome

Introduction

In recent years, with the changes in lifestyle and diet, the incidence of hyperuricemia (HUA) has been increasing annually, and it has become the second most prevalent metabolic disease after diabetes mellitus. Increased serum uric acid levels not only cause gout, but are also independent risk factors for hypertension, metabolic syndrome, chronic kidney disease, and cardiovascular disease.[1]

However, most patients usually have no clinical symptoms in the early stages of the disease. Therefore, early detection and interventions against HUA are critical to improve the patients' quality of life and reduce pressure on the healthcare system.

Non-alcoholic fatty liver disease (NAFLD), as the liver manifestation of metabolic syndrome, is one of the most common metabolic diseases worldwide. The damage caused by NAFLD is not only attributable to the disease itself, but also to other metabolic diseases associated with it, such as HUA.[2] HUA and NAFLD are both important risk factors for

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cardiovascular disease. Their coexistence accelerates the occurrence and progression of cardiovascular disease, and increases cardiovascular mortality among patients with NAFLD.

Insulin resistance (IR), a state of reduced sensitivity and responsiveness to insulin, is one of the most important causes of NAFLD. Studies have shown that IR can lead to increased serum uric acid (SUA) production and decreased excretion, resulting in SUA accumulation.[3] There are many indicators of IR, such as insulin resistance index (HOMA-IR), triglyceride glucose (TyG) index, TyG-body mass index (BMI) index, triglyceride/high-density lipoprotein cholesterol (TG/HDL-C), and insulin resistance metabolic score (METS-IR). Recent studies have shown that there is a significant correlation between TyG index and HUA in patients with NAFLD.[4–6] Studies have also shown that the BMI partially mediates the relationship between TyG and NAFLD.[7] We speculated that TyG-BMI, as a composite index of TyG and BMI, might be more closely related to the occurrence of NAFLD and HUA. Therefore, this study aimed to explore the association between TyG-BMI and HUA in patients with NAFLD and its diagnostic value.

Patients and Methods

Study Population

This study was approved by the Ethics Committee of the Affiliated Hospital of Chengde Medical University and was performed according to the Declaration of Helsinki. The requirement for informed consent was waived due to the retrospective nature of the study. Patients who were examined in the Affiliated Hospital of Chengde Medical University of China from September to December, 2023 were included. The following inclusion and exclusion criteria were used to evaluate the eligibility of the patients.

Inclusion Criteria

1. The diagnosis of fatty liver disease was based on the following criteria[8]: Fatty liver was diagnosed in patients with more than two of the following abnormalities on abdominal ultrasonography: a) The near field echo of the liver was enhanced, while the far field echo was diminished; b) the echo of the liver parenchyma was dense and stronger than that of the kidney parenchyma; c) the structure of the blood vessels and biliary tract in the liver was unclear.
2. The diagnosis of HUA was based on the following criteria[9]: SUA >360 mmol/L (6.05 mg/dl) in women and 420 mmol/L (7.06 mg/dl) in men on a normal purine diet.

Exclusion Criteria

The following patients were excluded: 1. Patients with alcoholic liver disease, viral hepatitis, and aspartate aminotransferase (AST)/ alanine aminotransferase (ALT)≥2.0.[10] 2. Patients with diabetes mellitus (including type 1 and type 2 diabetes, gestational diabetes, and specific types of diabetes), and fasting blood glucose (FPG) ≥7.0mmol/L.[11] 3. Those with incomplete data at baseline.

Study Methods

The height, weight, and blood pressure were measured by a trained physician with a unified measurement tool. The BMI was calculated by the body weight (kg) divided by the square of the height (m^2). Biochemical parameters such as ALT, AST, gamma glutamyltranspeptidase (GGT), serum creatinine (Scr), SUA, blood urea nitrogen (BUN), total cholesterol (TC), triglyceride (TG), and FPG were measured using using the Au5800 analyzer from Beckman. The TyG index was calculated by the following formula =ln [fasting TG (mg/dL) * FPG (mg/dL)/2]. The TyG-BMI was calculated by the following formula =ln [fasting TG (mg/dl) *FPG (mg/dl) /2]*BMI.

Statistical Analysis

SPSS 26.0 (IBM, USA), GraphPad Prism, and MedCalc were used to analyze the data. Continuous variables are presented as means ± standard deviation (SD) or medians (25th and 75th percentiles: P25, P75) and differences between the two groups were examined by the independent-sample *t*-test or Mann–Whitney *U*-test depending on whether the data

had a normal or non-normal distribution, respectively. Categorical variables are expressed as counts and percentages, and inter-group comparisons were performed using the chi-square test. Pearson correlation analysis was employed to examine the associations between age, BMI, FPG, SBP, DBP, TC, Scr, BUN, TyG, TyG-BMI, and other normally distributed variables. For variables that were not normally distributed, such as TG, ALT, AST, and GGT, Spearman's rank correlation was utilized to assess their correlations. In order to better understand and analyze the distribution characteristics of the data, especially in terms of identifying the central tendency and variability of the data, we conducted a stratified analysis of TyG-BMI to further verify the association of TyG-BMI with HUA in NAFLD patients. TyG-BMI was categorized into four groups Q1 (TyG-BMI≤218.46, n=503), Q2 (218.46<TyG-BMI≤237.66, n=502), Q3 (237.66<TyG-BMI≤262.21, n=503), and Q4 (TyG-BMI>262.21, n=503) by quartiles. Binary logistic regression analysis was used to analyze the factors influencing HUA in patients with NAFLD. Moreover after adjusting for factors such as age, sex, BMI, SBP, DBP, AST, TC, Scr, GGT, and ALT, TyG-BMI was found to be an independent risk factor for HUA in patients with NAFLD. Receiver operating characteristic (ROC) curve analysis was used to analyze the predictive values of TyG-BMI, TyG index, and HUA, which were then compared. Statistical significance was defined as $P<0.05$.

Results

Comparison of the Clinical Characteristics of Patients with NAFLD with and without HUA

A total of 2010 patients with NAFLD were included in this study (Figure 1). There are 1313 men and 844 women. The prevalence of HUA was 49.58% in males and 27.69% in females. Patients with NAFLD with HUA had significantly higher levels of BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), TC, TG, ALT, AST, GGT, Scr, BUN, TyG, and TyG-BMI, and were younger in age compared to those with NAFLD without HUA (NAFLD-NUA; $P < 0.05$, Table 1). However, the FPG levels did not differ significantly between the two groups ($P >0.05$, Table 1). This could be attributed to the exclusion of individuals with fasting blood glucose levels exceeding 7 mmol/L, a measure taken to mitigate the influence of hyperglycemia on uric acid levels, resulting in a relatively modest absolute difference. Based

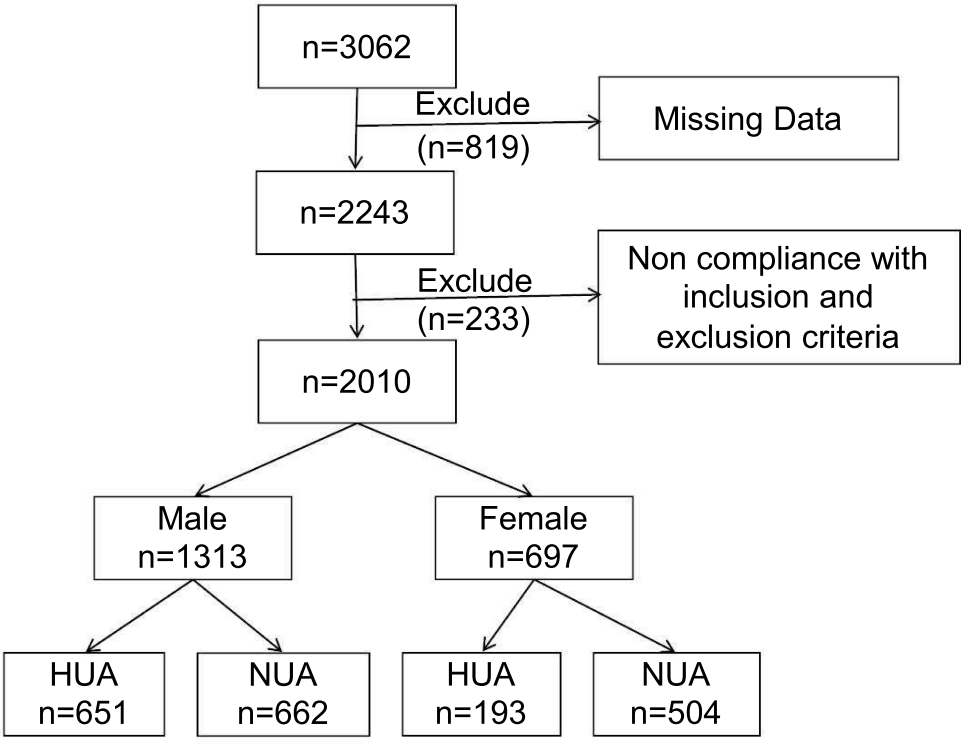

Figure 1 Flow chart of patient selection.

Table 1 Comparison of Various Parameters Between the Two Groups [$\overline{X}$±s, M(P_{25},P_{75})]

	All patients (n=2010)			Male (n=1313)			Female (n=697)		
	NAFLD-HUA (n=844)	**NAFLD-NUA (n=1166)**	**P value**	**NAFLD-HUA (n=651)**	**NAFLD-NUA (n=662)**	**P value**	**NAFLD-HUA (n=193)**	**NAFLD-NUA (n=504)**	**P value**
Age(year)	41.36±11.73	46.64±12.03	< 0.001	39.97±11.03	46.00±12.07	< 0.001	46.09±12.78	47.48±11.93	0.178
BMI(kg/m^2)	28.02±3.48	26.54±3.29	< 0.001	28.09±3.37	26.77±2.85	< 0.001	27.77±3.82	26.25±3.78	< 0.001
FPG(mmol/L)	5.21±0.57	5.21±0.59	0.965	5.21±0.57	5.25±0.61	0.106	5.23±0.56	5.15±0.54	0.072
SBP(mmHg)	131.28±15.94	129.44±15.94	0.011	131.52±14.95	130.13±15.65	0.100	130.48±18.92	128.54±16.31	0.180
DBP(mmHg)	86.86±12.36	84.58±11.32	< 0.001	87.92±12.08	86.45±11.15	0.022	83.41±12.70	82.14±11.08	0.194
TC(mmol/L)	5.37±0.97	5.20±0.97	< 0.001	5.31±0.91	5.16±0.95	0.005	5.56±1.13	5.25±1.00	< 0.001
TG(mmol/L)	1.95 (1.39, 2.76)	1.58 (1.17, 2.22)	< 0.001	2.00(1.44,2.85)	1.68 (1.23, 2.36)	< 0.001	1.84 (1.30, 2.40)	1.51 (1.12,2.02)	< 0.001
ALT(U/L)	29.60 (20.83, 43.50)	23.00 (17.20, 32.60)	< 0.001	31.40 (22.50, 46.50)	23.80 (19.70, 37.43)	< 0.001	22.50 (18.45, 27.20)	19.35 (14.53, 25.90)	< 0.001
AST(U/L)	24.10 (20.00, 30.00)	22.00 (18.40, 26.50)	< 0.001	24.60 (20.30, 30.60)	23.10 (19.70, 27.50)	< 0.001	22.40 (16.85, 32.55)	20.35 (17.10, 24.70)	< 0.001
GGT(U/L)	37.75 (27.00, 54.86)	28.35 (20.70, 41.53)	< 0.001	41.80 (30.40, 59.60)	35.50 (25.90, 51.20)	< 0.001	26.90 (21.10, 35.80)	21.60 (17.53, 28.90)	< 0.001
Scr (umol/L)	73.90±13.73	66.24±13.43	< 0.001	78.32±11.40	74.64±10.18	< 0.001	59.00±9.92	55.20±8.18	< 0.001
UA(umol/L)	475.24±68.42	329.84±54.10	< 0.001	494.72±62.12	356.84±46.62	< 0.001	409.53±43.15	294.38±41.26	< 0.001
BUN(mmol/L)	4.95±1.09	4.81±1.15	0.005	5.03±1.09	5.03±1.13	0.982	4.71±1.08	4.52±1.22	0.058
TyG-BMI	252.45±34.11	234.34±31.88	< 0.001	253.86±33.68	237.93±29.91	< 0.001	247.70±35.18	229.63±33.75	< 0.001
TyG	9.01±0.52	8.83±0.52	< 0.001	9.04±0.53	8.89±0.54	< 0.001	8.92±0.49	8.75±0.49	< 0.001

Abbreviations: BMI, Body mass index; FPG, Fasting plasma glucose; TC, Total cholesterol; TG, Triglycerides; HDL-C, triglyceride/high-density lipoprotein cholesterol; SBP, Systolic blood pressure; DBP, Diastolic blood Pressure; ALT, Alanine aminotransferase; AST, Aspartate aminotransferase aspartate; GGT, Gamma-Glutamyltranspeptidase; Scr, Serum creatinine; UA, blood Uric acid; BUN, Blood urea nitrogen.

on the sex, the participants were divided into two groups. Among men, the BMI, DBP, TC, TG, ALT, AST, GGT, Scr, and TyG index in the NAFLD-HUA group were significantly higher when those in the NAFLD-NUA group, whereas the age was significantly younger than that in the NAFLD-HUA group, and a statistically significant difference was observed between the two groups (P<0.05, Table 1). Among women, the BMI, TC, TG, ALT, AST, and TyG index were significantly higher in the NAFLD-HUA group compared to the NAFLD-NUA group, and the difference was statistically significant (P<0.05, Table 1).

Comparison of TyG-BMI Between the Two Groups

Compared with the NAFLD-NUA group, the TyG-BMI index in the NAFLD-HUA group was higher, and the difference was statistically significant (P< 0.001, Figure 2A). In addition, in both sexes, TyG-BMI in the NAFLD-HUA group was significantly higher than that in the NAFLD-NUA group (P<0.001, Figure 2B and C).

Correlations Between SUA and the Basic Clinical Indicators

In Pearson correlation analysis, SUA was positively correlated with TyG-BMI (r=0.302, P < 0.001), BMI (r=0.231, P < 0.001), Scr (r=0.488, P < 0.001), and TyG index (r=0.216, P< 0.001), and negatively correlated with age (r=−0.273, P< 0.001) (Figure 3). Spearman correlation analysis indicated positive correlations of SUA with TG (r=0.235, P < 0.001), AST (r=0.218, P < 0.001), ALT (r=0.329, P < 0.001), and GGT (r=0.413, P < 0.001). Furthermore, the correlation was higher in women (r=0.266 vs r=0.264, Figure 4).

Clinical Characteristics of Patients with NAFLD with Different Levels of TyG-BMI

The baseline characteristics of the participants according to TyG-BMI quartiles are shown in Table 2. Participants with higher TyG-BMI showed higher BMI, SBP, DBP, FPG, TC, TG, ALT, AST, GGT, Scr, and SUA, lower age, and included a higher proportion of men. In addition, the Q4 group had the highest SUA level (Figure 5).

Multivariate Logistic Regression Analysis of SUA and Associated Factors in Patients with NAFLD

Logistic regression analysis was employed to examine whether TyG-BMI was independently and significantly associated with the presence of HUA in patients with NAFLD. After adjusting for factors such as age, sex, BMI, SBP, DBP, AST, TC, Scr, GGT, and ALT, TyG-BMI was found to be an independent risk factor for HUA in patients with NAFLD. In addition, to ensure the robustness of the results, TyG-BMI was analyzed as a categorical variable in multivariate logistic regression separately (Table 3).

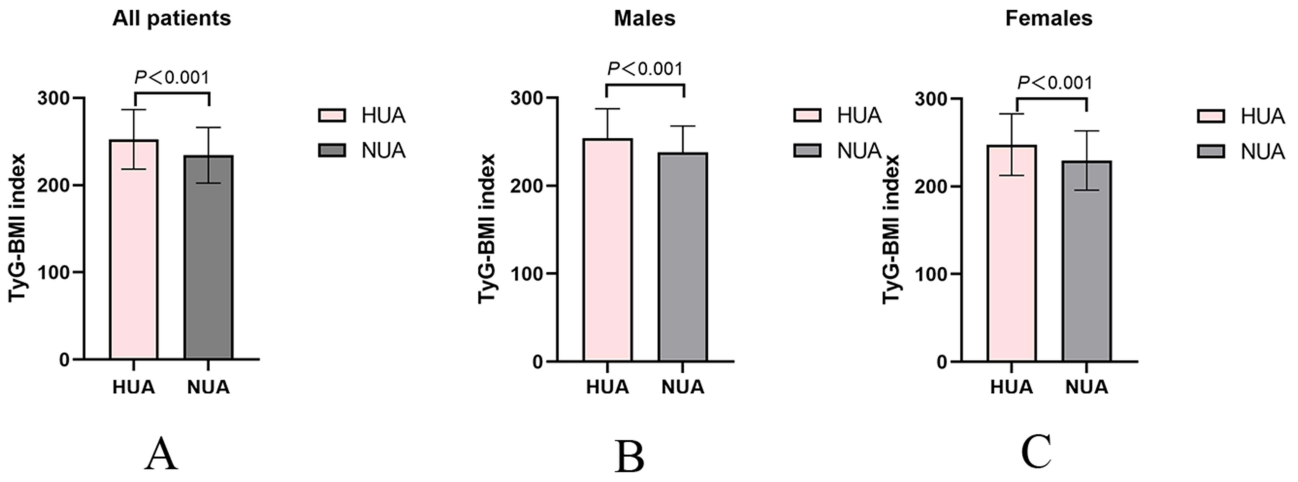

Figure 2 Comparison of TyG-BMI between the two groups: (**A**) all participants; (**B**) men; and (**C**) women.

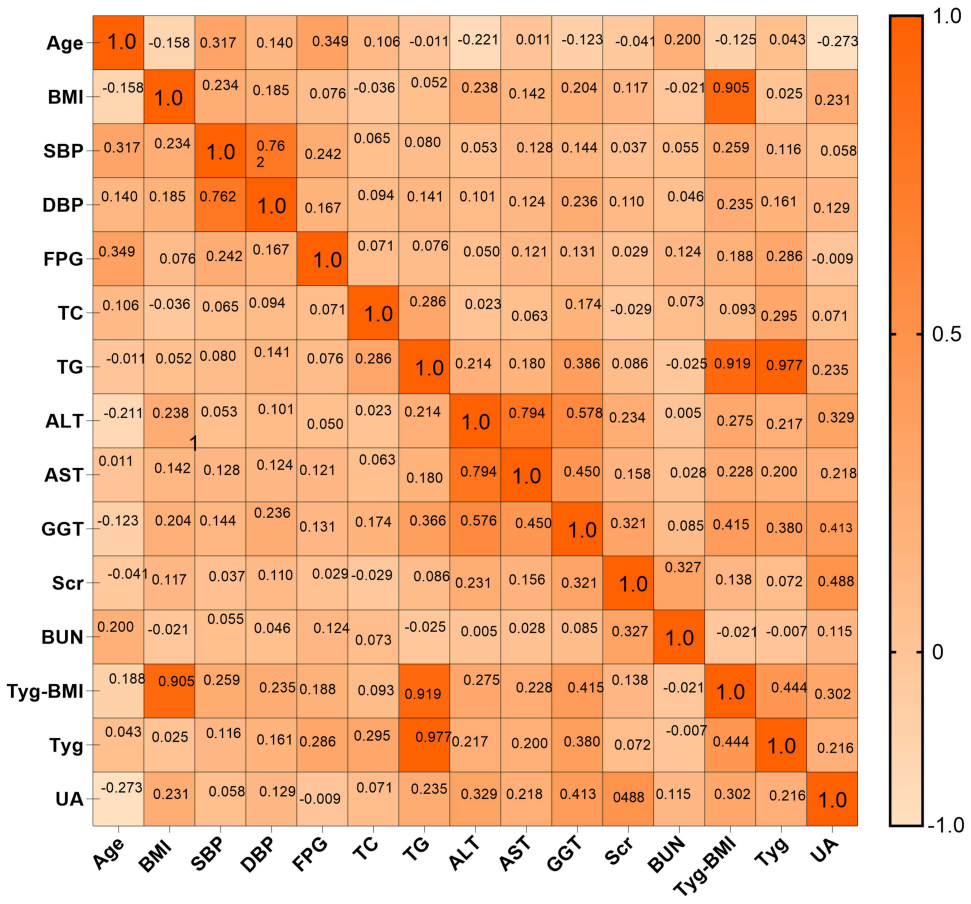

Figure 3 Correlations between SUA and the clinical basic indicators in patients with NAFLD *(r)*.

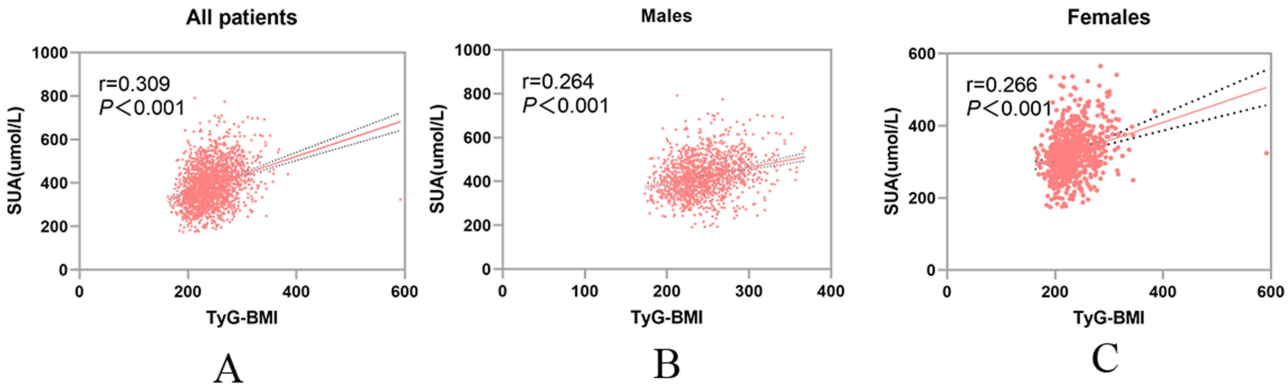

Figure 4 Correlation between uric acid level and TyG-BMI index: (**A**) All participants; (**B**) men; and (**C**) women.

Subgroup Analysis

To enhance the robustness of our research findings, we will conduct stratified analyses by gender, age levels. Table 4 has summarized the results of subgroup analysis results. The association between the TyG-BMI index and HUA in the NAFLD cohort was found to be less pronounced among individuals over 65 years of age. However, the correlation remained significant across different genders.

Table 2 Baseline Characteristics of the Participants Based on TyG-BMI Levels

	Q1	Q2	Q3	Q4	P
n	503	502	503	503	
Sex (men)	258 (51.3%)	328 (65.3%)	354 (70.4%)	373 (74.2%)	< 0.001
Age(Years)	46.23 ±12.12	45.19 ±12.33	44.54 ±12.10	41.75 ±11.75	< 0.001
BMI(kg/m^2)	23.71 ±1.49	25.97 ±1.38	27.81 ±1.57	31.18 ±3.34	< 0.001
SBP(mmhg)	125.12 ±16.41	128.62 ±14.94	132.05 ±15.84	135.07 ±14.92	< 0.001
DBP(mmhg)	82.01 ±11.51	84.07 ±10.63	87.39 ±11.89	88.74 ±12.02	< 0.001
FPG(mmol/L)	5.08 ±0.52	5.16 ±0.57	5.25 ±0.58	5.35 ±0.61	< 0.001
TC(mmol/L)	5.15 ±0.99	5.21 ±1.02	5.32 ±0.99	5.40 ±0.88	< 0.001
TG(mmol/L)	1.29 (1.02,1.67)	1.66 (1.18,2.15)	1.57 (1.43, 2.60)	2.43 (1.71, 3.40)	< 0.001
ALT(U/L)	21.00 (15.50,29.00)	24.55 (18.08, 32.45)	27.80 (19.60, 40.80)	31.30 (21.88, 47.83)	< 0.001
AST(U/L)	21.00 (17.9,25.40)	22.30 (19.10, 26.40)	24.00 (19.60, 29.00)	24.75 (20.20, 31.00)	< 0.001
GGT(U/L)	24.60 (18.80,34.90)	30.40 (22.58, 44.15)	36.20 (25.90, 52.40)	40.80 (28.10, 58.45)	< 0.001
Scr(umol/L)	65.94 ±13.49	69.17 ±14.13	70.93 ±13.49	71.79 ±14.48	< 0.001
BUN(mmol/L)	4.92 ±1.24	4.84 ±1.13	4.89 ±1.11	4.83 ±1.12	0.492
SUA(umol/L)	354.31 ±83.57	380.38 ±85.83	399.52 ±93.97	429.42 ±95.46	< 0.001

ROC Analysis of the TyG-BMI and TyG Indexes

To explore the predictive value of the TyG-BMI and TyG indexes for NAFLD-HUA, we analyzed the ROC curves of TyG-BMI and TyG indexes. DeLong test was used to compare the predictive value of the two indexes. The results showed that the TyG-BMI index had sufficient and better accuracy than the TyG index for HUA (Figure 6 and Table 5) and the AUROC for TyG-BMI was 0.656 with a cut-off value of 0.229.

Discussion

HUA is one of the most common metabolic disorders associated with oversecretion or reduced clearance of SUA, which is widely known to increase the risk of gout, cardiovascular disease, and type 2 diabetes.[12] A growing number of cross-sectional studies and some prospective studies have suggested that HUA is associated with increased prevalence, incidence, and disease severity of NAFLD. A case-control study conducted by Lonardo et al in 2002 was the first to show that SUA levels were higher in patients with NAFLD compared to those in controls.[13]

NAFLD is closely related to metabolic disorders, and IR is an important part of the reactive metabolism. Obesity, serving as a pivotal factor in the pathogenesis of insulin resistance, is recognized as a risk factor for the development of

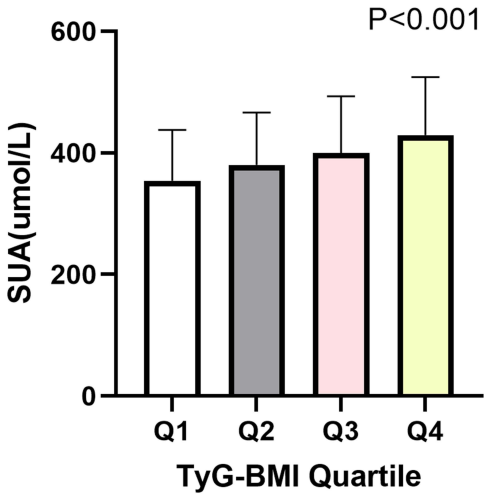

Figure 5 Comparison of the SUA levels according to different levels of the TyG-BMI index.

Table 3 Logistic Regression Analysis of NAFLD-HUA Related Factors

Outcomes	No-Adjust		ModelI		ModelII	
	OR(95% CI)	P	OR(95% CI)	P	OR(95% CI)	P
TyG-BMI	1.017 (1.014, 1.020)	< 0.001	1.024 (1.017, 1.031)	< 0.001	1.019 (1.012, 1.027)	< 0.001
TyG-BMI quartile						
Q1	Ref		Ref		Ref	
Q2	1.838 (1.398, 2.402)	< 0.001	1.595 (1.185, 2.147)	0.002	1.515 (1.117, 2.057)	0.008
Q3	2.435 (1.863, 3.181)	< 0.001	1.949 (1.395, 2.721)	< 0.001	1.588 (1.121, 2.248)	0.009
Q4	4.469 (3.413, 5.850)	< 0.001	3.155 (2.039, 4.881)	< 0.001	2.448 (1.550, 3.867)	< 0.001

Notes: Model I was adjusted for age, sex, BMI, SBP, and DBP. Model II was further adjusted for AST, TC, Scr, GGT, and ALT.

Table 4 Subgroup Analysis of TyG-BMI in NAFLD Patients with HUA

Characteristics	No. of Participants	OR(95% CI)	P-value
Age (years)			
≤65	1896	1.018(1.015,1.021)	<0.001
>65	114	1.004(0.995,1.013)	0.409
Sex			
Males	1313	1.016 (1.012,1,020)	<0.001
Females	697	1.016 (1.010,1.021)	<0.001

HUA. This condition may precipitate dysregulations in glucose and lipid metabolism. Prior research has indicated that the TyG-BMI index is associated with HUA in the general population and is linked to various factors including insulin resistance, metabolic dysfunction, and obesity.[14] The underlying mechanism of the association between TyG-BMI and HUA within the NAFLD cohort is likely to be interconnected with these same elements. Therefore, this study explored the correlation between TyG-BMI and HUA in patients with NAFLD. Previous studies have shown that AST/ALT≥2.0 indicates a high possibility of alcoholic steatohepatitis.[15] Since no data on the history of alcohol consumption could be obtained in this study, patients with AST/ALT≥2.0 were excluded. To reduce the effects of glucose metabolism disorders on SUA, we excluded people with FBG≥ 7.0mmol/L.

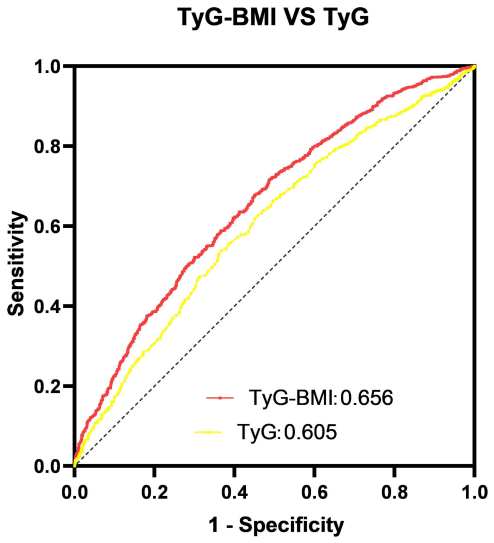

Figure 6 ROC curves of the TyG index and TyG-BMI indexes for predicting NAFLD-HUA.

Table 5 DeLong Test for Comparing the Predictive Values of the TyG-BMI and TyG Indexes for NAFLD-HUA

Difference Between Areas	Standard Error	95% CI	Z Statistic	P
0.0511	0.013	0.0255–0.0766	3.916	0.001

Several studies have shown a correlation between IR and HUA, as well as an independent correlation between TyG, TyG-BMI, and HUA in patients with Type 2 diabetes mellitus.[16] However, none of these studies were conducted in people with NAFLD. In this study, it was found that TyG-BMI in the NAFLD-HUA group was significantly higher than that in the NAFLD-NUA. As a marker of insulin resistance, TyG-BMI demonstrates a strong correlation between insulin resistance and hyperuricemia. In an experiment conducted by Toyoki et al, it was observed that the administration of insulin in rats resulted in decreased uric acid excretion, accompanied by an increase in the expression of uric acid reabsorption transporter (URAT1) and a decrease in the expression of uric acid secretion transporter (ABCG2). These findings indicate that insulin resistance impairs the excretion of uric acid from the proximal renal tubules, ultimately leading to elevated levels of uric acid.[17] Further analysis showed that TyG-BMI was an independent risk factor for HUA, which was not related to sex, age, BMI, serum creatinine, GGT, ALT and other factors. In addition, our study found that the prevalence of HUA was higher among men than among women in patients with NAFLD, consistent with previous findings that men were more likely to develop HUA compared to women.[18]

Our results also revealed that TG in the NAFLD-HUA group was significantly higher than that in the NAFLD-NUA group, which is consistent with the results of previous studies. Qiu et al found that the higher the TG level, the higher the risk of developing HUA.[19] This may be attributed to the frequent association between hyperuricemia and insulin resistance, which can enhance hepatic uric acid production while impairing its excretion, thereby resulting in elevated uric acid levels. Moreover, the elevation of TG levels might coincide with increased oxidative stress, leading to lipid peroxidation that can damage renal tubules and subsequently reduce uric acid excretion.

Although our study showed a negative correlation between age and occurrence of HUA, most previous studies have revealed a positive correlation between age and HUA, which may be due to the tendency of NAFLD to occur in younger individuals, as well as the impact of work, diet, alcohol consumption, and other activities.

Our study revealed that the predicted value of TYG-BMI (0.656) exceeded that of the TyG index (0.605), which aligns with findings from previous studies. Hao Wang et al demonstrated a positive correlation between hyperuricemia and indicators such as TyG and TYG-BMI, indicating that TyG-BMI exhibits promising potential in identifying HUA.[20] We postulate that this association may be attributed to the strong link between BMI, an obesity indicator, and insulin resistance, a crucial risk factor for HUA. Combining the TyG index with BMI allows for a more comprehensive understanding of this relationship.

Evidence from certain studies indicates that seasonal variations might influence the incidence of hyperuricemia.[21] Nonetheless, the conclusions of our current study are in harmony with the findings of research led by QJ and colleagues, which were conducted at various intervals throughout the year.[4] This alignment suggests that seasonal transitions exert a negligible effect on our findings. However, we entirely rule out the potential role of seasonal variables. As such, we are committed to undertaking parallel investigations during diverse seasons in the coming years to ascertain the robustness and universality of our results.

This study has some limitations. First, A major limitation of this study is that the diagnosis of NAFLD primarily relies on ultrasound, which has limited sensitivity in detecting mild steatosis. Therefore, our findings may not adequately reflect the true prevalence of mild NAFLD. Future studies should consider incorporating more advanced diagnostic methods such as magnetic resonance spectroscopy, liver biopsy, or blood biomarkers to enhance diagnostic accuracy. Second, the present study only encompassed a data collection period of 3 months, potentially introducing seasonal bias. In order to further validate our findings, long-term large-scale multi-center prospective studies are needed to verify the predictive ability of the TyG-BMI index for HUA risk in patients with NAFLD. Third, although

our model was adjusted for many covariates, there were no data on dietary habits and alcohol consumption, which can influence SUA levels.

Conclusions

After adjustments for confounders, an elevated TyG-BMI index level was found to be a risk factor for HUA in patients with NAFLD. Moreover, the predictive value of TyG-BMI was greater than that of the TyG index. Despite the limitations of this study, TyG-BMI has the potential to replace Tyg in assessing the prevalence of hyperuricemia. This study provides a reliable, sensitive, and convenient assessment tool for preventing hyperuricemic conditions.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Affiliated Hospital of Chengde Medical University (FYFYLL 2022120) and the requirement for informed consent was waived due to the retrospective nature of the study. This study was performed in adherence to the principles of the Declaration of Helsinki. All data collected was anonymised in accordance with the Personal Information Protection Law of the People's Republic of China. All patient data used is non-identifiable and confidential.

Consent for Publication

Consent for publication was obtained from all authors.

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The original data can be obtained by Email request at any time (lihaitao202302@163.com).

Author Contributions

All authors contributed significantly to the work that was reported, whether it is in the conception, study design, implementation, data collection, analysis, and interpretation, or in all of these areas. They also all participated in writing, revising, or critically evaluating the article, gave their final approval for the version that would be published, agreed on the journal to which the article would be submitted, and agreed to be responsible for all aspects of the work.

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Disclosure

The authors declare that no conflicts of interest in this work.

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