A high triglyceride/ high-density lipoprotein ratio is associated with an increased risk of insulin resistance in the US population: a cross-sectional study from the US National Health and Nutrition Examination Survey, 2017–2018

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Abstract

Background Some previous studies have reported that the ratio of triglycerides to high-density lipoprotein may indicate insulin resistance, but the results suggest that there are differences between different ethnic groups. In this study, the NHANES 2017-2018 database was used to explore the relationship between TG/HDL-C and IR in the American population. Methods This trial comes from a cross-sectional study of NHANES (http://www.cdc.gov/nchs/nhanes/) conducted by the National Center for Health Statistics (NCHS) of the US Centers for Diseases and Control and Prevention. IR uses the homeostatic model assessment (HOMA) formula as an indicator: [fasting insulin (μU/mL)×fasting blood glucose (mmol/L)]/22.5, with ≥75th percentile of HOMA-IR as an indicator. Use logistic regression to explore the relationship between TG/HDL ratio and IR occurrence. Results In this study, a total of 450 participants (40%,450/1902) developed insulin resistance. Using logistic regression model of the association between TG/HDL-C and insulin resistance risk, after adjusting for potential confounding factors, as the TG/HDL ratio increases, the probability of insulin resistance increases significantly (OR: 1.91, 95% CI: 1.59-2.30, P<0.0001). At the same time, we performed a smooth curve fitting and found a non-linear relationship between TG/HDL and IR. Even if the adjusted covariate is deleted from the model, the association remains unchanged. The smooth curve of TG/HDL-C The inflexion point is 0.95. When TG/HDL-C<0.95, the effect value is very significant (OR: 27.34, 95%CI, 10.61-70.47, P<0.0001), when TG/HDL-C≥0.95, the effect value is relatively reduced (OR: 1.29, 95% CI, 1.03-1.61, P<0.0001). We grouped them by inflexion points. Multiple regression equations showed that after adjustment, the group's risk of insulin resistance greater than 0.95 increased by two times compared with the group less than 0.95. Conclusions In this study, we found that the increase of TG/HDL-C ratio in the American population was significantly related to IR. It is clinically acceptable and can save some extra costs for patients. However, in different situations, combining the TG/HDL-C ratio with other risk factors to predict whether IR will occur is worthwhile for the next step.

Introduction

Insulin resistance is the insensitivity to insulin in insulin-dependent organ tissues. Its clinical manifestation is nonresponse to the sugar load, which leads to the metabolic disorder of fat, protein, and other carbohydrates in the body.

Previous studies have shown that metabolic disorders can cause systemic toxicity and chronic diseases such as thrombosis, oxidative peroxidation, endothelial dysfunction, even they can cause diabetes in severe cases. In a 2014 study (1), Paul Welsh et al. found that older adults without insulin resistance had a much lower incidence of diabetes than those with insulin resistance. At the same time, another 13-year follow-up study (2) showed that patients with insulin resistance also had a significantly increased risk of cardiovascular disease. Gianluca et al. (3) conducted a 15-year cohort study analysis. They found that patients' mortality rate with insulin resistance was significantly different from those irrelevant to it in cancer cases. The mortality rate of cancer patients with insulin resistance was 5.6% higher than that of patients without insulin resistance. Therefore, insulin resistance (IR) can be considered a predictor of diabetes mellitus (DM), cardiovascular disease, and tumour.

As awareness of IR increases, we find that obesity often accompanies insulin resistance. Besides, smoking, hyperlipidemia, and hypertension have been affirmed and widely recognized as common risk factors for insulin resistance (IRRF). In Europe, a study of children found a 10.9% incidence of IR (4), suggesting that IR may occur with unrecognized IRRFs. Therefore, it is essential to find a model that can reduce the occurrence rate of IR.

At present, there are several methods to make a primary diagnosis of IR directly or indirectly (5). The gold standard diagnostic method is the high insulin regular blood sugar clamp test (HEC test), which is initially developed by DeFronzo(6). However, it is apparent defects, like high cost, fearful invasion, and long time required, so this method is not yet feasible in the clinical application (7).

Therefore, an easy mark of predicting IR helps clinicians identify whether patients have IR at an early stage and save patients' costs. Some studies have found that high triglyceridemia and low-density lipoprotein cholesterol plays a critical role in IR (8, 9), concluding the triglyceride/high-density lipoprotein cholesterol ratio as a simple clinical indicator of IR and a predictor of diabetes and coronary heart disease (10, 11). Various studies of potential clinical uses of triglyceride/HDL cholesterol ratios in adults and children have recently been investigated. Based on commonly used standardized measurements, the TG/HDL-C ratios index helps clinicians identify IR patients (10, 12-22). Based on data from the 2017-2018 National Health and Nutrition Examination Survey (NHANES), our study explored the role of the TG/HDL-C ratio in predicting IR in the general population. It suggests that early TG/HDL-C monitoring is of great significance in preventing insulin resistance and reducing the occurrence of chronic diseases related to insulin resistance.

Methods

Study design and study population

This trial comes from the CDC's National Center for Health Statistics (NCHS) cross-sectional study of NHANES(http://www.cdc.gov/nchs/nhanes/). Based on an intricate, layered, multistage probabilistic design, NHANES obtained a nationally representative sample of noninstitutionalized residents of the United States (23). The NHANES program began in the early 1960s as a series of surveys of different populations or health topics. The NHANES study program is described in detail elsewhere (National Center for Environmental Health, Centers for Disease Control and Prevention). The NHANES protocol has been reviewed and approved by the NCHS Research Ethics Committee. All participants provided written informed consent before participation. The survey is unique in its combination of interviews and medical examinations. In this study, a total of 9,254 subjects participated in THE NHANES during 2017-2018. Of those, 1,810 were excluded for lack of HIGH-density lipoprotein test information. Secondly, 1034 subjects were further excluded due to lack of routine laboratory examination information, 4499 subjects were further excluded due to lack of insulin, and a total of 1,902 subjects participated in this trial. These potential confounders were chosen on the basis of previous scientific literature, or a more than 10% change in effect estimates.

Data collection and measurement

Uniformly trained investigators collect all the information. These data include demographic data (gender, age, race/ethnicity, etc.), health-related behaviours (smoking and drinking), anthropometric measurements (such as height, waist circumference, weight, etc.), and biochemical tests (TC, TG, GLU, etc.). Insulin was determined using the AIA-PACK method on the Tosoh AIA System Analyzer. Subjects' height, weight, and WC were measured according to standardized protocols and techniques. BMI is calculated as follows: BMI= weight (Kg)/ height (M^2) (25). BMI cutoff point. Normal (18.5~24.9 kg/m^2), overweight (25.0~29.9 kg/m^2), obese (BMI≥30.0 kg/m^2).IR is defined by values equal to or greater than the 75th percentile.In this study, the value is 4.4, which represents the diagnostic value of IR to the study population as a whole rather than the general sample.

Assessment criteria

In this study, we classified smoking status into three levels. Never Smoker: Defined as having never smoked a cigarette in one's life or having smoked less than 100 cigarettes in total. Because the numbers are so small, we reduced quitters to never smokers. Recent nonsmokers smoked more than 100 cigarettes and smoked less than one cigarette per day for 30 days on average. Recent smokers had more than 100 cigarettes and an average of more than one cigarette per day for 30 days.

hypertension

Personal interview questionnaires were administered to NHANES participants to collect data on their knowledge, treatment, and hypertension control. This study defined patients who reported that they had hypertension and were taking antihypertensive drugs as hypertensive patients.

Statistical analysis

To make the samples more representative, we adopted the NHANES database, which has a complex, multistage probability sampling design. It looked at a nationally representative sample; Each year, 5,000 people were selected from a sampling framework of 15 different locations from all US counties. IR prevalence is a weighted percentage of IR in a complex sample, equal to the number of IR patients divided by the total number of IR patients. R 3.4.3 version was used for statistical analysis. Continuous variables are represented as detailed sample descriptions with averages and a 95% confidence interval. Categorical variables are represented by counts and weighted percentages, using complex sample frequencies. Continuous variables between groups were compared using student T-test or Mann-Whitney U test based on distributed normality, and classified variables were compared using the Fisher exact test. Since TG/HDL is a continuous variable, we used the generalized additive model (GAM) to identify the non-linear relationship and found that TG/HDL has a non-linear relationship. Considering the non-linear relationship between TG/HDL and insulin resistance, we also use the generalized additive and smooth curves to solve the non-linear problem. Besides, two binary logistic regression models are used to explain the nonlinearity further. A complex sample univariate Logistic regression analysis was used to assess whether baseline characteristics differed among IR participants. Multivariate logistic regression was used to analyze the relationship between TG/HDL and IR under multiple covariables. Model 1 is not adjusted; Model 2 was adjusted for age, race,

education, gender, and other factors. Model 3 was also adjusted for biochemical indicators, smoking status, diabetes and hypertension.

Consent to participate

All participants provided written informed consent, and the study was approved by the NCHS Research Ethics Review Board(https://wwwn.cdc.gov/nchs/nhanes/default.aspx)

Patient and public involvement

Patients and the public were not involved in developing the study question or measuring the outcome, study design or recruitment, and study's conduct. There are no plans to disseminate the results directly to participants.

Results

We selected the 2017-2018NHANES database to participate in this study, of which 1810 participants were excluded because they did not have HDL results, then 1034 participants were excluded because they did have basic biochemical test results. Finally, 4499 participants were excluded because they did not have insulin test results or BMI information. A total of 1,902 participants were enrolled in the study.Figure 1

Of the 1,902 eligible subjects, we divided them into two groups based on whether they developed insulin resistance. Four hundred fifty subjects with an IR value greater than 4.4 were assigned to the exposed group, and the remaining 1,452 subjects were assigned to the unexposed group. The age of the exposed group and the unexposed group were 53.19±16.80 and 50.42±17.79, respectively, and the difference in age distribution between the two groups was statistically significant (P < 0.001).BMI of the exposed group was higher than that of the unexposed group, and there was statistical significance (P<0.001). There was statistical significance in the race, smoking, waist circumference, hypertension, diabetes, and biochemical indexes such as ALT, ALP, BUN and other conventional biochemical indexes between the two groups (P<0.001). There was no statistical significance in annual income, marriage or gender (P<0.005).Table 1

It showed the relationship between insulin resistance and sex, smoking, education and diabetes mellitus and hypertension. Using men as the baseline, the risk of insulin resistance in women was reduced by 15%, P= 0.1246, because P>0.05 was not statistically significant. Based on recent non-smoking, the risk of recent smoking and recent non-smoking increased by 112% and 43%, respectively, P<0.0001, which was statistically significant. Participants with higher education had a 47% lower risk of developing insulin resistance than those without higher education (P<0.0001), which was statistically significant. The risk of insulin resistance without hypertension and diabetes was reduced by 52% and 79%, respectively, with statistical significance (P<0.0001).table 2

In the study, a total of 450 participants (40%) developed insulin resistance. A multivariate logistic regression model was used to analyze the association between TG/HDL-C and insulin resistance risk. After adjusting for age, gender, BMI, waist circumference, smoking and other factors, the probability of insulin resistance increased with the increase of TG/HDL ratio (OR: 1.91, 95%CI: 1.59-2.30, P<0.0001). At the same time, we

conducted a smoothing curve fitting. We found a non-linear relationship between TG/HDL and IR Even when the adjusted covariable was deleted from the model, and the correlation remained unchanged. The inflexion point of TG/HDL-C smoothing curve was 0.95. When TG/HDL-C < 0.95, the effect value was very significant (OR: 27.34, 95%CI, 10.61-70.47, P<0.0001), and when TG/HDL-C≥0.95, the effect value was relatively lower (OR: 1.29, 95%CI, 1.03-1.61, P<0.0001). We grouped them by inflexion points, and multiple regression equations showed a two-fold increase in the risk of developing insulin resistance after adjustment for groups greater than 0.95 compared with groups less than 0.95

At the same time, we conducted a smoothing curve fitting. We found that there was a non-linear relationship between TG/HDL and IR. Even when the adjusted covariable was deleted from the model, the correlation remained unchanged. The inflexion point of TG/HDL-C smoothing curve was 0.95. When TG/HDL-C < 0.95, the effect value was very significant (OR: 27.34, 95%CI, 10.61-70.47, P<0.0001), and when TG/HDL-C≥0.95, the effect value was relatively lower (OR: 1.29, 95%CI, 1.03-1.61, P<0.0001). We grouped them by inflexion points. Multiple regression equations showed a two-fold increase in the risk of developing insulin resistance after adjustment for groups greater than 0.95 compared with groups less than 0.95.figure 2table 4

Figure 3 showed associations between triglyceride/HDL cholesterol ratio and race, waist circumference, high blood pressure, BMI, diabetes, and ALT. In the non-Hispanic Black population, the increase of TG/HDL ratio had the most significant effect on insulin resistance. In the middle and old age of 42-60, the probability of insulin resistance increased by 177% for each increase of TG/HDL ratio by one unit. When waist circumference ranged from 63.2 to 92.3, the effect value was 2.83, suggesting that the risk of developing insulin resistance increased by 183% with each increase of TG/HDL ratio by one unit. Regardless of which factor and which group, TG/HDL-C was significantly associated with the occurrence of insulin resistance.

Discussion

In this study, we used data from the 2017-2018 National Health and Nutrition Examination Survey to determine a significant correlation between TG/HDL and IR (as measured by HOMA-IR) increased risk in the US population after adjusting for known confounders. After adjusting for potential confounding variables, the high TG/HDL-C ratio was positively correlated with HOMA-IR. The TG/HDL-C ratio in the HOMA-IR index ≥4.4 (IR positive) group was significantly higher than that in the HOMA-IR index < 4.4 (IR negative) group. The results show that the TG/HDL-C ratio is useful in detecting IR occurrence.

The TG/HDL ratio increase mechanism is adipose tissue trap, and only a small part of fatty acids will be retained in IR state (28). Therefore, relatively more free fatty acids will be transported to the liver to make more TG and TG containing very-low-density lipoprotein (VLDL). Also, VLDL-rich TG and HDL cholesterol esters are more likely to exchange with the increase of plasma TG concentration. This action makes THE HIGH-density lipoprotein TG prone to dissimilation. Therefore, IR patients often present high TG, high TG/HDL, and low HDL. In another study, a high TG/HDL ratio was found to play an essential role in the expansion of atherosclerosis in pre-diabetic and newly diagnosed type 2 diabetics (29). Murguia-Romero et al. examined more than 2,000 healthy young subjects and determined that TG/HDL-C ratios could be used to identify IR and increased cardiometabolic risk. There is also evidence that elevated TG/HDL-C ratio is

associated with morbidity and mortality associated with atherosclerotic disease and cardiovascular disease (12,30). It also predicts long-term mortality in high-risk patients (31). Therefore, our findings have implications for preventing diabetes, cardiovascular disease, cancer, and other new developments.

Our study adjusted waist circumference for confounders because previous studies have found a close correlation between waist circumference and insulin resistance (32). However, in previous studies, waist circumference and insulin resistance were not significant in younger adults, but only in older adults. Therefore, waist circumference was not a suitable predictor of IR in the population as a whole. In any case, TG and HDL-C are standard clinical parameters. They will be effective IR indicators to assess individual health status, which is of great significance for early intervention of IR and related diseases.

There are several advantages to be noted in this study. First, we used a nationally representative sample, and the general applicability of the results was enhanced. This was not the case in previous studies. Second, this time we included all the factors in the analysis instead of limiting the unique sample in the usual studies, which meant that our results were more representative of the general population. We hoped to show the correlation between TG/HDL-C and insulin resistance in the United States' general population, rather than in a specific population. After controlling for all other confounding effects, we hoped to derive an auxiliary effect representing the relationship between TG/HDL-C alone and insulin resistance.

However, there are still some deficiencies in this study. First, our data are derived from cross-sectional surveys; Therefore, further research is needed to explore the association's longitudinal context. Secondly, HOMA-IR has been used as an alternative method to diagnose IR, and its repeatability and reliability have certain limitations. Finally, we did not assess the genetic contribution to disease development, independent of TG/HDL.

Conclusion

To sum up, in the United States' general population, TG/HDL-C ratio is significantly correlated with insulin resistance under any circumstances. The correlation between TG/HDL-C ratio and insulin resistance seems to increase with the increase of TG/HDL-C ratio. In clinical practice, the significant correlation between TG/HDL-C ratio and insulin resistance can be well used as an important predictor of morbidity and mortality related to diabetes and cardiovascular diseases and as a basis for the prevention of diabetes and cardiovascular diseases.

Abbreviations

TG/HDL-C：triglyceride/ high-density lipoprotein

IR：insulin resistance CI: confidence interval OR: odds ratio

BMI：body mass index; BUN, blood urea nitrogen;LDH,Lactate dehydrogenase;TBIL,total bilirubin;TG,Triglyceride;HDL,high-density lipoprotein ALT: Alanine aminotransferase

ALP: alkaline phosphatase AST: Aspartate aminotransferase

Declarations

Authors' contributions

Rongpeng Gong and Xiaoxing Wei conceived the idea; Rongpeng Gong and Ya Liu wrote the manuscript; Zheng Li and Lixin Yang collected and read the literature and revised the article; Xiaoxing Wei read through and corrected the manuscript. All authors read and approved the final manuscript. Rongpeng Gong is the first author and Xiaoxing Wei is the corresponding author of this paper

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

Not applicable.

Consent for publication

Not applicable

Ethics approval and consent to participate

All participants provided written informed consent, and the study was approved by the NCHS Research Ethics Review Board(https://wwwn.cdc.gov/nchs/nhanes/default.aspx)

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Tables

Table 1. Baseline characteristics of the study participants

Characteristics	All participants （N=1902)	Patients with Insulin resistance(N=450)	Patients without Insulin resistance(N=1452)	*P*-value
Demographic				
Age(years),mean±SD	51.08±17.59	53.19±16.80	50.42±17.79	0.003
sex				0.124
male,no.(%)	912 (47.95%)	230 (51.11%)	682 (46.97%)	
female,no.(%)	990 (52.05%)	220 (48.89%)	770 (53.03%)	
BMI(kg/m2),mean±SD	29.73±7.11	35.19±7.22	28.03±6.16	<0.001
smoker				<0.001
never smoker	329 (17.30%)	56 (12.44%)	273 (18.80%)	
Current non-smoker,no.(%)	1095 (57.57%)	249 (55.33%)	846 (58.26%)	
Current smoker,no.(%)	478 (25.13%)	145 (32.22%)	333 (22.93%)	
Waist(cm),mean±SD	100.69±16.92	114.34±15.54	96.45±14.99	
race				<0.001
Mexican American	253 (13.30%)	86 (19.11%)	167 (11.50%)	
Other Hispanic	167 (8.78%)	47 (10.44%)	120 (8.26%)	
Non-Hispanic White	675 (35.49%)	145 (32.22%)	530 (36.50%)	
Non-Hispanic Black	439 (23.08%)	99 (22.00%)	340 (23.42%)	
Non-Hispanic Asian	258 (13.56%)	48 (10.67%)	210 (14.46%)	
Other Race - Including Multi-Racial	110 (5.78%)	25 (5.56%)	85 (5.85%)	
education, no.(%)				<0.001
Less than college , no.(%)	1438（75.60%）	369(82%)	1069(73.62%)	
College graduate or above, no.(%)	464 (24.40%)	81 (18.00%)	383(26.38%)	
Clinical characteristics				
Hypertension, no.(%)	667 (35.07%)	218 (48.44%)	449 (30.92%)	<0.001
Diabetes mellitus, no.(%)	316 (16.61%)	162 (36.00%)	154 (10.61%)	<0.001
Serum biomarkers				

Alanine aminotransferase(IU/L)，median（Q1-Q3）	17.00 (13.00-25.00)	23.00 (16.00-34.00)	16.00 (12.00-23.00)	<0.001
alkaline phosphatase(IU/L)，median（Q1-Q3）	74.00 (62.00-90.00)	80.00 (66.00-96.00)	73.00 (60.00-88.00)	<0.001
Aspartate aminotransferase(IU/L)，median（Q1-Q3）	19.00 (16.00-24.00)	20.00 (16.00-27.00)	19.00 (16.00-23.00)	<0.001
BUN(mmol/L)，median（Q1-Q3）	5.00 (3.93-6.43)	5.36 (4.28-6.43)	5.00 (3.93-6.07)	<0.001
globulin(g/L)，median（Q1-Q3）	31.00 (28.00-34.00)	32.00 (29.00-35.00)	30.00 (28.00-33.00)	<0.001
γ-glutamyl transpeptadase(U/L)，median（Q1-Q3）	21.00 (15.00-32.00)	27.00 (20.00-43.00)	19.00 (14.00-29.00)	<0.001
Fe，umol/L)，median（Q1-Q3）	15.60 (11.60-20.10)	14.50 (10.70-18.40)	15.90 (11.95-20.80)	<0.001
TBIL(umol/L)，median（Q1-Q3）	6.84 (5.13-10.26)	6.84 (5.13-8.55)	8.55 (5.13-10.26)	<0.001
TG/HDL，median（Q1-Q3）	0.88 (0.56-1.40)	1.30 (0.92-1.88)	0.77 (0.51-1.20)	<0.001
TG/HDL group				<0.001
<0.95, no.(%)	1019 (54.67%)	121 (27.25%)	898 (63.24%)	
>=0.95, no.(%)	845 (45.33%)	323 (72.75%)	522 (36.76%)	
Abbreviations：BMI，body mass index; BUN, blood urea nitrogen;LDH,Lactate dehydrogenase;TBIL,total bilirubin;TG,Triglyceride;HDL,high-density lipoprotein				

Table 2. Univariate analysis for Insulin resistance

Covariate	Statistics	OR(95%CI)	*P*-value
Age(years),mean±SD	51.08±17.59	1.01 (1.00, 1.02)	0.0036
BMI(kg/m2),mean±SD	29.73 ± 7.11	1.16 (1.14, 1.18)	<0.0001
Waist(cm),mean±SD	100.69 ± 16.92	1.07 (1.07, 1.08)	<0.0001
Alanine aminotransferase(IU/L)（median（Q1-Q3）	17.00 (13.00-25.00)	1.03 (1.03, 1.04)	<0.0001
alkaline phosphatase(IU/L)（median（Q1-Q3）	74.00 (62.00-90.00)	1.01 (1.01, 1.02)	<0.0001
Aspartate aminotransferase(IU/L)（median（Q1-Q3）	19.00 (16.00-24.00)	1.02 (1.01, 1.03)	<0.0001
sex			
male	912 (47.95%)	1	
Female	990 (52.05%)	0.85 (0.69, 1.05)	0.1246
education			
Less than college , no.(%)	1438（75.60%）	1	
College graduate or above, no.(%)	464 (24.40%)	0.61 (0.47, 0.80)	0.0003
smoker			
never smoker	329 (17.30%)	1	
Current non-smoker,no.(%)	1095 (57.57%)	1.43 (1.04, 1.98)	0.0272
Current smoker,no.(%)	478 (25.13%)	2.12 (1.50, 3.00)	<0.0001
TG/HDL（median（Q1-Q3）			
Hypertension			
NO,no.(%)	1235 (64.93%)	1	
YES,no.(%)	667 (35.07%)	2.10 (1.69, 2.60)	<0.0001
Diabetes mellitus, no.(%)			
NO,no.(%)	1580 (83.39%)	1	
Yes,no.(%)	316 (16.61%)	4.74 (3.67, 6.12)	<0.0001
TG/HDL group			
<0.95, no.(%)	1019 (54.67%)	1	
>=0.95, no.(%)	845 (45.33%)	4.59 (3.63, 5.81)	<0.0001

Table 3.The association between TG/HDL and insulin resistance in a multiple regression model

Outcome	Non-adjusted Model		Model1		Model2	
	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value	OR(95%CI)	*P*-value
TG/HDL	2.41 (2.09, 2.78)	<0.0001	2.53 (2.17, 2.95)	<0.0001	1.99 (1.67, 2.38	<0.0001
TG/HDL group						
<0.95	1		1		1	
>=0.95	4.59 (3.63, 5.81)	<0.0001	4.93 (3.83, 6.33)	<0.0001	3.05 (2.29, 4.04)	<0.0001

Non-adjusted model adjust for: None.Adjust I model adjust for: Gender; age; race; education. Adjust II model adjust for: BMI; HBP; Wasit; education; smoking; diabetes; ALT(IU/L); ALB(g/L); TBIL(umol/L); ALP(IU/L); Gender; age; BUN（mmol/L); GLB(g/L); GGT(IU/L); Fe(umol/L); TC(mmol/L)

Table 4. Threshold effect analysis of TG/HDL-C on insulin resistance

Outcome	OR(95%CI）	*P*-value
One-linear regression modle	1.89 (1.57, 2.27)	<0.0001
Two-piecewise linear regression model		
TG/HDL-C<0.95	27.34 (10.61, 70.47)	<0.0001
TG/HDL-C0.95	1.29 (1.03, 1.61)	0.0264

adjust（ALT(IU/L); Wasit; ALP(IU/L); AST(IU/L); BUN（mmol/L); Cl-（mmol/L）; GLB(g/L); GGT(IU/L); Fe(umol/L); LDH(IU/L); P(mmol/L); K(mmol/L); TBIL(umol/L); TP(g/L); UA(umol/L); age; race; education; smoking; diabetes; BMI; HBP

Figures

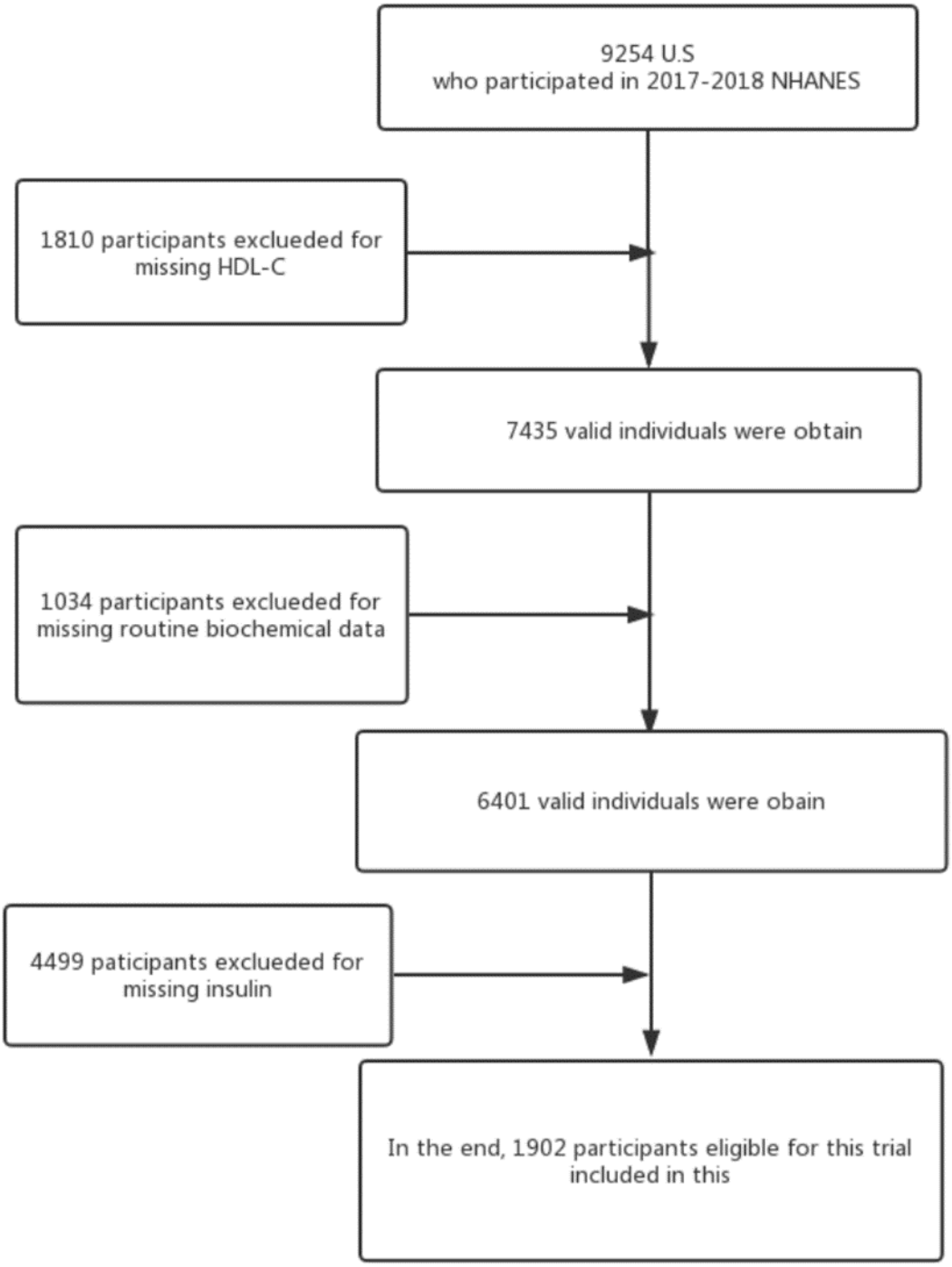

Figure 1

Flowchart of patient selection.

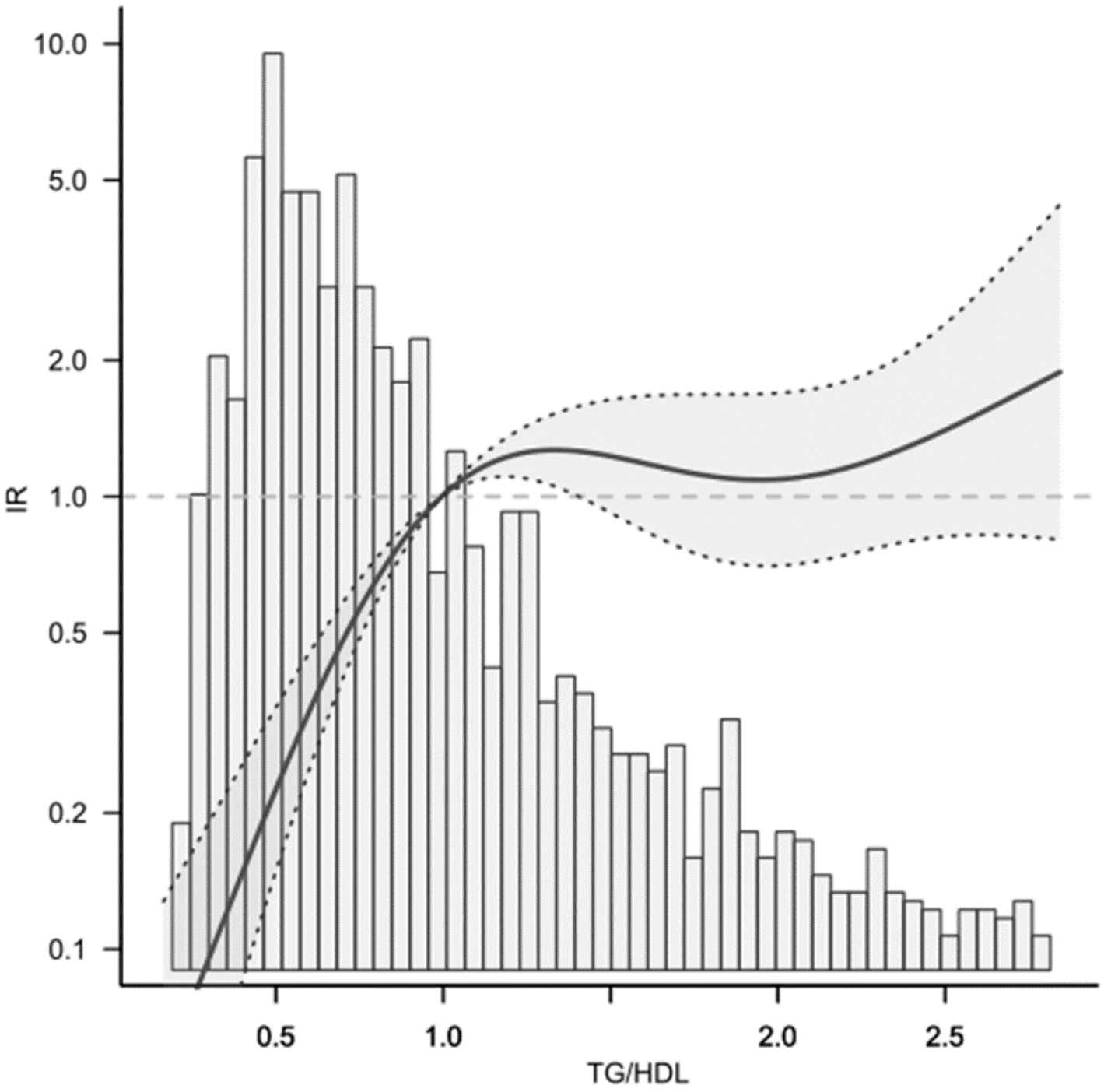

Figure 2

Association between TG/HDL-C and IR. Notes: The two blue lines represent estimates and their corresponding 95% confidence intervals.

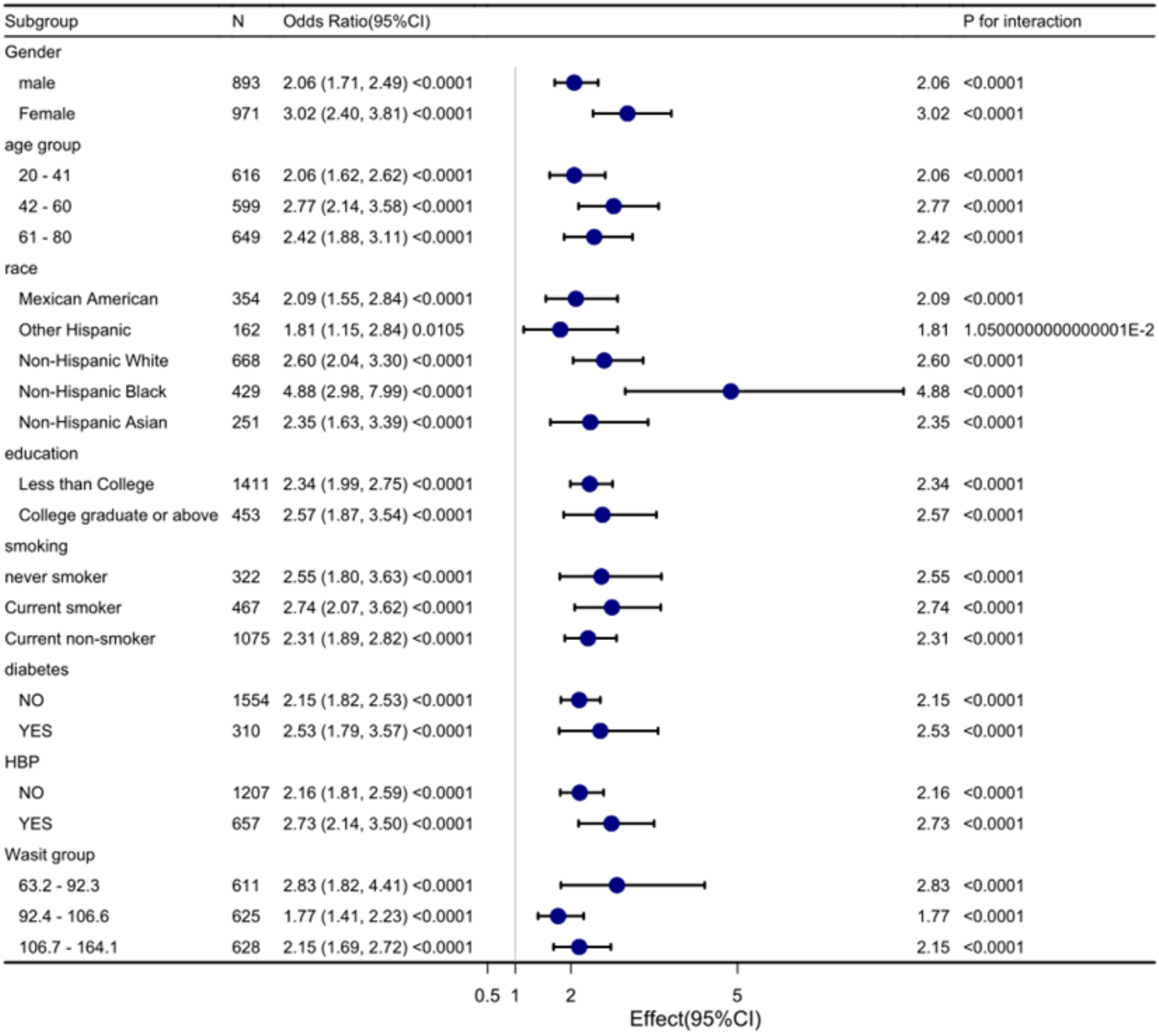

Figure 3

Association of triglycerides to high-density lipoprotein-cholesterol ratio with risk of incident