The relationship between ratio of serum triglyceride to high-density lipoprotein cholesterol and frequency of sarcopenia in Chinese community adults

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Research

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Abstract

Background

In a previous study, the high ratio of serum triglyceride to high-density lipoprotein cholesterol (TG/HDL-C) was relevant to a high risk of sarcopenia in Korean old males. In this study, the purpose was to discover the association in Chinese community adults.

Methods

Chinese adults who had physical examinations from May 2016 to August 2017 at the First Affiliated Hospital of Wenzhou Medical University were involved in this study. The univariable and multivariable logistic regression analyses were applied to evaluate possible effect.

Results

In total, 2613 adults were involved in the study, with 13.85% presenting sarcopenia. The separate results for TG and HDL-C displayed that OR for TG was 0.67(95%CI: 0.51-0.87), and OR for HDL-C was 1.97(95%CI: 1.49-2.61). Additionally, the ratio of TG/HDL-C was independently associated with sarcopenia status(OR: 0.63; 95%CI: 0.49-0.81).

Conclusions

It was indicative that TG was negatively associated with the frequency of sarcopenia in Chinese community population, but HDL-C was positively associated with it. Besides, the negative association was discovered between sarcopenia and TG/HDL-C ratio.

Introduction

The reduction of muscle mass and function relevant to age, referred to "sarcopenia," has drawn public attention all over the world (1-5). The Asian Working Group for Sarcopenia (AWGS) put forward a concept of sarcopenia in 2014. It referred to reduction of muscle mass and function, or low physical capability relevant to age (5). In 2019, AWGS regarded either reduced muscle strength or reduced physical capability as "possible sarcopenia". Sarcopenia is incrementally general in the society, with a prevalence rate of 5.5%-25.7% (6-8). Sarcopenia has become a public health issue gradually.

Up to now, the potential mechanisms of sarcopenia have not yet been fully expounded. Many variables, such as aging, inflammation, hormonal changes, and cachexia, have been deemed to be risk factors of sarcopenia (9-15).

Serum lipid profile is commonly tested in a clinical setting, including fasting serum triglyceride (TG) and cholesterol. A meta-analysis by Jaekyung No *et al.* on sarcopenia and blood lipid profiles was recently published, which confirmed that TG had a positive relation with sarcopenia, whereas high-density

lipoprotein cholesterol (HDL-C) had a negative effect (16). Tae-Ha *et al.* demonstrated that the higher ratio of TG/HDL-C was relevant to an increased rate of sarcopenia in elderly Korean men (17). Given this finding, the purpose of this research was to discover a potential association between serum lipid profile and sarcopenia in Chinese community adults.

Methods

Study population

This cross-sectional study involved in individuals having routine health examinations from May 2016 to August 2017 at the First Affiliated Hospital of Wenzhou Medical University. Subjects with age≥18, having serum lipid profile and bioelectrical impedance analysis (BIA) measures were involved in our study. Exclusion criteria included individuals with aged<18 years; taking lipid-lowering medicine; with a history of stroke, malignant tumor, chronic kidney or liver disease, or thyroid disease.

The research was agreed by the Institutional Review Board (IRB) of the hospital. Given its cross-sectional nature, the consent was waived by the IRB and the medical privacy was protected. All data were reviewed complying with the Declaration of Helsinki.

Data collection

Data regarding the health examinations were collected, including questionnaires concerning to lifestyles and pre-existing conditions, and results of BIA, blood, biochemical and anthropometric measurements.

Living habits contained smoking and drinking. Alcohol drinking higher than 70 g per week for women and higher than 140 g per week for men were regarded as heavy drinking. The 3 kinds of smoking status were defined as follows: current smoker (currently smokes and has smoked for at least the past 6 months or who abandoned smoking <2 years ago), past smoker (smoked in the past and had quitted smoking for at least 2 years) and never (never smoked).

Pre-existing conditions included diabetes mellitus (DM), hypertension (HTN), and hyperuricemia. DM was referred to random plasma glucose(PG), fasting plasma glucose (FPG) or 2-h PG equal or greater than 200 mg/dL, 126 mg/dL, or 200 mg/dL, respectively (18). Every individual took a blood pressure measure at the morning of medical examination, containing systolic blood pressure (SBP) and diastolic blood pressure (DBP). HTN was referred to SBP ≥140 mmHg or DBP ≥90 mmHg (19). Hyperuricemia was referred to serum uric acid (UA) levels higher than 6 mg/dL in females and higher than 7.0 mg/dL in males (20). Additionally, past morbidities included medical histories of DM, HTN or hyperuricemia or taking corresponding medications from self-reports.

To monitor appendicular skeletal muscle mass (ASM; kg), every subject carried out BIA detection (InBody770; InBody Japan Inc., Tokyo, Japan). Then, skeletal muscle mass index (SMI; kg/m^2) was computed through following formula: ASM(kg)/height^2 (m^2). Additionally, according to the AWGS 2019

Consensus(1), males with SMI lower than 7.0kg/m^2 and females with SMI lower than 5.7kg/m^2 were diagnosed as sarcopenia. Subjects with Body mass index (BMI) higher than 25 kg/m^2 were regarded as with status of overweight.

The following parameters were measured at the morning of medical examination: TG, HDL-C, low density lipoprotein cholesterol (LDL-C), total cholesterol (TC), glycated hemoglobin (HbA1c), FPG, albumin, UA, hemoglobin (Hb), leukocyte count (WBC) and platelet (PLT).

Statistical analysis

Continuous and categorical factors were displayed as medians (ranges) and frequencies (percentages), respectively. Through receiver operating characteristic (ROC) curves, the diagnostic accuracies of lipid profile for sarcopenia were assessed. The optimal indicator was selected, based on area under curve (AUC) and Youden index. The subjects were grouped according to the selected indicator(high and low group). The differences of the continuous factors were compared with the Mann-Whitney test, while the differences of the categorical factors was compared with the χ2 test. Through univariate and multivariate logistic regression models, the effects of the factors on the risk of sarcopenia were evaluated, including separate logistic regression models for TG, HDL-C, and TG/HDL-C ratio. Backward stepwise selection with the Akaike information criterion(AIC) was performed to identify variables for the multivariable logistic regression models. Interaction term in the multivariable logistic regression analysis was also conducted to get rid of confound factor. In addition, individuals were stratified by quartiles, χ^2 test was utilized to compare the different rate of sarcopenia.

R version 3.6.1 was utilized to perform statistical analyses (https://www.r-project.org/). All analyses were 2-sided, and a *P* value <0.05 was regarded as significance level.

Results

Population features

In total, 2613 subjects were involved in the research. The medians of ASM and SMI were 20.14 (8.9-32.98) and 7.27 (4.35-11.50). The medians of TG and HDL-C were 127.44 (35.40-1896.56) and 45.23 (17.40-108.25). Other clinical features are shown in Table 1. Among 2613 subjects, 362 (13.85%) individuals were diagnosed with sarcopenia.

Cutoffs and clinical features according to grouping

By ROC curves, TG, diagnostic performances of lipid profile were evaluated (Supplementary Figure). The cutoff for TG was 138.50 mg/dL with AUC of 0.63 and Youden Index of 0.2(sensitivity: 0.72; specificity: 0.48; *P*<0.01). The cutoff for HDL-C was 42.72 mg/dL with AUC of 0.64 and Youden Index of 0.22(sensitivity: 0.78; specificity: 0.44; *P*<0.01). The cutoff for TG/HDL-C ratios was 2.78 with AUC of 0.64 and Youden Index of 0.22(sensitivity: 0.67; specificity: 0.55; *P*<0.01). Regarding to Youden index and AUC,

TG/HDL-C ratio was selected as the optimal indicator. Subjects were classified into TG/HDL^{low} group (TG/HDL-C ratio<2.78) and TG/HDL^{high} group (TG/HDL-C ratio≥2.78).

There were 1266 individuals in low group and 1347 in high group. In all, 243 (19.19%) in the low group and 119 (8.83%) in the high group were diagnosed with sarcopenia. The clinical features were displayed in Table 1. The high group showed higher ASM (p<0.01), SMI (p<0.01) and BMI (p<0.01), and a greater proportion of elderly (p<0.01) and male (p<0.01) subjects, compared to the low group.

Univariate and multivariate logistic regression analyses

Univariable and multivariable analyses were utilized to assess the possible effect of clinical variables on sarcopenia. As depicted in Table 2, factors including the ratio of TG/HDL-C (high *vs.* low, OR: 0.63, 95% CI: 0.49-0.81), overweight status (yes *vs.* no, OR: 0.04, 95% CI: 0.04-0.07) and age (>65 *vs.* ≤65, OR: 2.10, 95% CI: 1.43-3.10) kept independent effects, with C-index of 0.73. Separate results for TG and HDL-C were displayed in Table 3, and TG(>138.50 vs. ≤138.50, OR: 0.67, 95% CI: 0.51-0.87) and HDL-C(>42.72 vs. ≤42.72, OR: 1.97, 95% CI: 1.49-2.61) were also independently associated with status of sarcopenia.

When the TG/HDL-C ratio was a continuous predictor in multivariable logistic regression analysis(Table 4), it continued to exert an independent effect on sarcopenia (OR: 0.75, 95%CI: 0.63-0.89), with C-index of 0.75.

Association between rate of sarcopenia and the ratio of TG/HDL-C

Subjects were stratified by quartiles as Fig 1 showed. The rate of sarcopenia reduced as the TG/HDL-C ratio augmented (*p*<0.01). In addition, it was further validated by multivariate logistic regression model in TG/HDL-C quartiles that the exposure continued to be an independent factor (Q2 *vs.* Q1: OR: 0.77, 95%CI: 0.57-1.03; Q3 *vs.* Q1: OR: 0.65, 95%CI: 0.46-0.92 ; Q4 *vs.* Q1: OR, 0.55, 95%CI: 0.38-0.81; Table 5). There was no interaction with significant importance between age and TG/HDL-C ratio (OR:1.36, 95%CI: 0.62-2.98, p=0.45), though age-by-TG/HDL interaction term.

Discussion

The negative association between sarcopenia and the TG/HDL-C ratio was discover in Chinese community adults in this study. In a research by Tae-Ha *et al.*, the ratio of TG/HDL-C was positively relevant to the rate of sarcopenia in Korean old males, along with insulin resistance. However, this study was limited to older age and sex-based differences in general (17). A larger number of subjects were involved in our study, including men and women, with a median age of 48 years. Additionally, there were methodological differences existing between 2 studies. The prevalence risk of sarcopenia according to the TG/HDL-C ratio quartiles was identified by adjusting for age, cigarette smoking, alcohol intake, BMI and physical activity in the study by by Tae-Ha *et al.*. These adjusting factor was chosen via clinical importance. In our study, the adjusting factors was identified by backward stepwise selection with the Akaike information criterion(AIC) in univariable logistic regression models. And the selected adjusting

factors included the ratio of TG/HDL-C, overweight status and age. Genetic and lifestyle factors among different populations contribute to interindividual variations in serum cholesterol and triglyceride levels. Previous studies have verified some special loci in different populations. For instance, there were novel loci near MYL2 and HECTD2 associated with HDL-C in Korean individuals (21). The missense variants at PNPLA3 and PKD1L3 were discovered to be correlated to TG and LDL-C in the Chinese population (22). Although the different distribution of genetic polymorphism between Chinese and Korean have not been illustrated yet, the difference of lipid profile between Chinese and Korean adolescents have been demonstrated. Korean adolescents had higher levels of TC, LDL-C, TC/HDL-C, and LDL-C/HDL-C, compared to Korean-Chinese adolescents(18). Additionally, lifestyle factors, such as alcohol abuse, dietary habits, and physical activity, may have effect on lipid profiles(23).

The ratio of TG/HDL-C was negatively associated with the frequency of sarcopenia.

The separate results displayed that TG was negatively associated with the frequency of sarcopenia, but HDL-C was positively associated with it. It was corresponding with the result of TG/HDL-C ratio. However, it was defective that average association for the TG/HDL ratio cannot be estimated if one of components increases and the other one decreases the association.

The lipid profile, a widely used test, is a group of easy and economic parameters. Among lipid profile, it was found that medium-chain TG could be a feasible nutrient for sarcopenia, as medium-chain TG could enhance muscle strength through motivating ghrelin (24). Besides, it was proposed by Stella *et al.* that muscle loss could be attenuated by plasma TG, which was generated from omega 3 fatty acids. (25). HDL-C was discovered to be negatively relevant to muscle function improvement (26-28). According to these findings, a negative association between the ratio of TG/HDL-C and risk of sarcopenia should be took into account. Thus, appropriate supplementation of fatty foods could be good for building muscle function; however, further researches are needed to determine the degree of supplementation that is required.

Study strengths and limitations

This was a large cross-sectional study investigating in 2613 Chinese individuals, and provided new and opposite results compared to the Korean study (17). Our results indicate that the relationship may be relevant to different nationalities and territories.

However, there were some limitations. First, since its cross-sectional nature, causality could not be determined, and there is a possibility of reverse causality bias. Additionally, the study was not registered in a database of clinical studies. Second, due to the lack of data, the new definition was not taken into consideration, which proposed that the diagnosis of sarcopenia included 2 elements: low muscle mass and function (1). Third, many of the individuals involved in this study with age younger than 65 years and without any severe diseases. Thus, our results may not apply to older and critically ill patients. Finally, the cutoff was determined by the ROC curve, with restrictive sensitivity and specificity.

Conclusion

In general, a low ratio of TG/HDL-C was a potential risk marker for sarcopenia regardless of whether it is a continuous variable or a categorical variable. In clinical practice, to lessen the impact and frequency of sarcopenia, the supplementation of TG and control of HDL could be put into effect, especially in Chinese patients.

Prospective studies with more comprehensive data and a larger sample size are requisite to validate the relationship in the future.

Declarations

Ethics approval and consent to participate

The study was approved by the IRB of the First Affiliated Hospital of Wenzhou Medical University. Given its cross-sectional nature, the consent was waived by the IRB and the medical privacy was protected.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study will be provided by the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Na Wang, Mengjun Chen, and Danhong Fang contributed to the conception and design of the work. Na Wang and Mengjun Chen contributed to the acquisition, analysis, or interpretation of data. Na Wang drafted the manuscript. Danhong Fang critically revised the manuscript. All authors gave final approval and are accountable for all aspects of the work and its integrity and accuracy.

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Tables

Due to technological limitations, tables are only available as downloads in the supplementary files section.

Figures
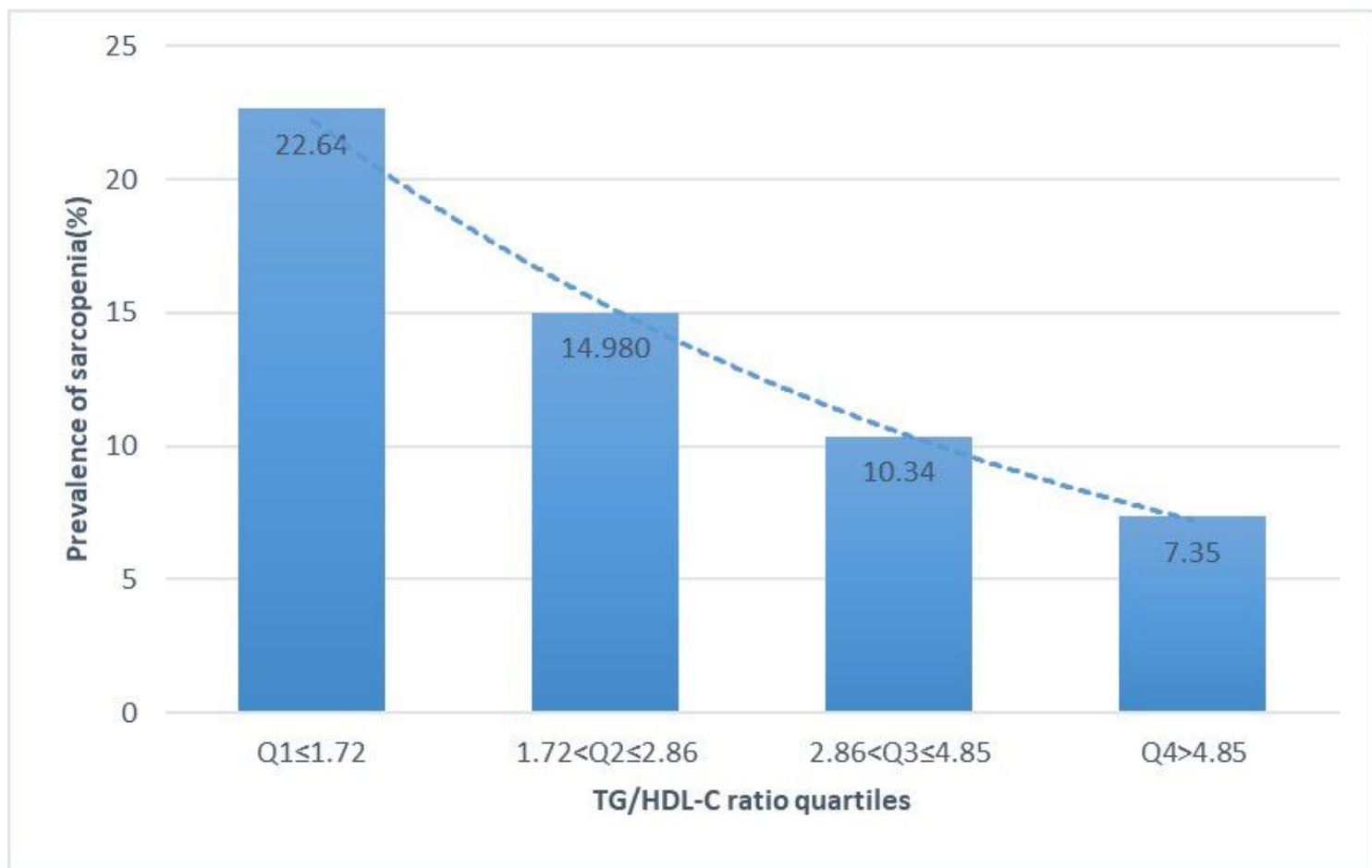
Figure 1

The prevalence of sarcopenia according to the TG/HDL ratio quartiles. Supplementary Figure. Receiver operating characteristic(ROC) curve analyses of the TG, HDL and TG/HDL ratio in sarcopenia status.