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Correlation between TG/HDL-C Ratio and Sarcopenia in Middle-Aged and Elderly People in Southwest China

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Abstract

Objective: To study the correlation between TG/HDL-C ratio and sarcopenia in middle-aged and elderly people in southwest China. **Methods:** Body mass index (BMI) and serum of middle-aged and elderly people aged 50 - 70 years in Southwest China were collected, grip strength was measured by grip strength meter, muscle mass and fat mass of upper, lower limbs and trunk were measured by body composition analyzer based on bioelectrical impedance method, and TG and HDL-C in serum were determined by enzymatic method. **Results:** Pearson correlation analysis showed that TG/HDL-C ratio (r = 0.246, p < 0.05) was positively correlated with skeletal muscle index, linear regression analysis showed that TG/HDL-C ratio (B = 0.103, Partial correlation value = 0.123, p < 0.05) was an independent predictor of skeletal muscle index, and logistic regression analysis showed that TG/HDL-C was a protective factor for sarcopenia (OR = 1.245, 95% CI = 0.750~2.065, p > 0.05). **Conclusion:** TG/HDL-C ratio is a predictor of skeletal muscle mass, and TG/HDL-C ratio is a protective factor for sarcopenia in middle-aged and elderly people in southwest China, and it can be used as a potential evaluation indicator for sarcopenia.

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Keywords

Muscular Atrophy, Blood Lipids, Skeletal Muscle Mass, Triglycerides, HDL Cholesterol

1. Introduction

Sarcopenia (SP) refers to the syndrome caused by continuous loss of skeletal muscle mass, strength and function, which mostly occurs in middle-aged and elderly people [1] [2]. With the increasing trend of global population ageing, the prevalence of sarcopenia is increasing, posing a serious threat to the quality of life of the elderly and placing a heavy burden on healthcare systems [3]-[5]. Studies have shown that sarcopenia is associated with increased morbidity, disability and mortality [6]-[9], and effective prevention and treatment strategies are urgently needed.

Insulin resistance is considered to be a key pathophysiological mechanism in the development of sarcopenia [10] [11]. When insulin resistance occurs, there is a decrease in insulin secretion and an imbalance in glycaemic homeostasis, leading to a decrease in glucose utilisation and a significant reduction in energy supply to muscles, which are the body's main organs for glucose uptake and utilisation [12] [13]. In addition, insulin resistance leads to increased catabolism in limb skeletal muscle and impairs the function of small muscle blood vessels, which significantly affects skeletal muscle function and status, leading to reduced skeletal muscle mass and sarcopenia [14] [15].

Dyslipidaemia is an important indicator of insulin resistance and is also associated with the risk of cardiovascular disease [16] [17]. However, there is a lack of studies investigating the direct relationship between TG/HDL-C ratio and sarcopenia, and TG/HDL-C ratio as a combined indicator of insulin resistance and dyslipidaemia [18] [19], may be a potential predictor of sarcopenia risk.

The aim of this study was to investigate the correlation between TG/HDL-C ratio and sarcopenia in middle-aged and elderly population in Southwest China, and to verify the feasibility of TG/HDL-C ratio as a predictor of sarcopenia risk. This study will help to provide new ideas and methods for the prevention and treatment of sarcopenia in the middle-aged and elderly population.

2. Research Objects and Methods

2.1. Research Design

From July 2016 to November 2016, with informed consent, people aged 50 - 70 years in southwest China were selected using the random cluster sampling method as subjects [20] [21]. These subjects did not have tumors or use drugs that would cause abnormal muscle and bone metabolism. After exclusion, a total of 365 eligible subjects were included in the study.

2.2. Research Methods

2.2.1. Determination of Serum TG and HDL-C

Fasting venous blood from subjects is centrifuged at 4˚C and 3000 rpm for 15 minutes to separate the serum, which is then used for the determination of blood lipids (including HDL-C), and the remainder is kept in the refrigerator at −80˚C.

Using the TG assay kit and the HDL-C assay kit (Zhong Sheng Bei Kong, China), in strict accordance with the operating procedures provided by the manufacturer, the levels of TG and HDL-C were determined by enzymatic method using the automatic biochemical analyzer 7600 (Hitachi, Japan) and the chemiluminescence immunoassay analyzer e601(Roche, Switzerland).

2.2.2. Height and Weight Measurement

The subject stood naturally, and the height and weight were measured by a height gauge (cm) and a weight scale (kg), accurate to two decimal places. Body mass index (BMI) is calculated by dividing the weight in kilograms by the height in meters squared (kg/m^2).

2.2.3. Determination of Grip Strength

The muscle strength of the subjects was evaluated by grip strength test: The WCS-10,000 grip strength meters (Shanghai Wanqing Electronics, China) were calibrated using a certified weight set to verify the accuracy of the force measurement. Each grip strength meter was zeroed and then tested with known weights to ensure the readings were within an acceptable range of error (±0.5 kg). This process was repeated bi-weekly throughout the study to maintain the precision of the grip strength measurements. This calibration process was conducted by certified technicians and followed the manufacturers' recommended protocols. The unit of measurement was kg. Before testing the grip strength, the grip distance is adjusted within a suitable range. The measured arm of the subject is abducted but not more than 30˚, and the upper arm is at a 90˚ angle to the forearm. When sitting upright, the subject holds the grip of the instrument with maximum strength and pulls it down, holding it with both hands twice, and the maximum value is taken for statistical analysis.

2.2.4. Measurement of Muscle Mass and Fat Mass of Limbs and Calculation of Skeletal Muscle Mass Index

The body composition analyzer (TANITA MC-180, Japan), based on bioelectrical impedance analysis (BIA), was used to measure the muscle mass and fat mass of body limbs, and the units of measurement were kg. The skeletal muscle mass (ASM) of limbs is the sum of the individual limb skeletal muscle masses, and the unit of measurement is kilograms (kg). The skeletal muscle mass index (SMI) is calculated as the skeletal muscle mass of limbs divided by the square of the height, and the unit of measurement is kg/m^2. The instrument was calibrated by following a strict procedure outlined by the manufacturer. This included a thorough cleaning of the electrodes and ensuring that the device's software was updated to the latest version. The calibration was performed using a phantom device with known resistance and

reactance values to verify the accuracy of the muscle mass and fat mass measurements. The calibration process was conducted at the beginning of the study and then repeated monthly to ensure the reliability of the body composition data.

To ensure the reliability of the skeletal muscle mass index (SMI) and fat mass measurements obtained through bioelectrical impedance analysis (BIA), the following measures were implemented: Standardization of Hydration and Food Intake: Participants were instructed to follow a standardized protocol regarding hydration and food intake before their measurements. They were asked to: Avoid excessive fluid intake or dehydration, maintaining a normal hydration status. Refrain from consuming any food or beverages containing caffeine or alcohol for at least 4 hours prior to the test, as these can affect hydration status. Have a light meal no later than 4 hours before the test to ensure that the body is in a post-absorptive state, but not in a fasting state that could affect muscle hydration. Test Environment Control: All BIA measurements were conducted in a controlled environment to minimize external factors that could influence the results: The room temperature was maintained at a comfortable level (approximately 22˚C - 24˚C) to avoid thermal stress. Participants were asked to rest for at least 10 minutes in a seated position before the measurements to allow for stabilization of their physiological state. Participant Preparation: To further standardize the testing conditions, participants were prepared as follows: They were asked to void their bladder just before the test to minimize the impact of fluid in the bladder on the BIA measurements. Participants were instructed to remove any metal objects, as these could interfere with the electrical current. Technician Training: All technicians performing the BIA measurements were trained to ensure they followed a consistent and standardized procedure.

2.2.5. Diagnosis of Sarcopenia

The assessment of sarcopenia was based on the diagnostic criteria of the Asian Working Group of Sarcopenia (AWGS) [22]: (1) Male SMI < 7.0 kg/m^2, female SMI < 5.7 kg/m^2), (2) Muscle strength is based on the grouping standard of grip strength: referring to Asian standards, the grip strength of men is less than 26 kg and that of women is less than 18 kg. When it satisfies both (1) and (2), it is judged as sarcopenia. Subjects were divided into the sarcopenia group (n = 53) and normal group (n = 337).

2.3. Statistical Method

The data were processed by SPSS 26.0 statistical software. The Kolmogorov-Smirnov test was used to determine whether the subjects' index followed a normal distribution. Measurement data that obey the normal distribution is represented by the mean ± standard deviation ($\overline{x} \pm s$), otherwise it is described by the median (M) and interquartile interval (P25 - P75). If the data follows a normal distribution, an independent sample T-test is used to analyze differences in numerical indicators, otherwise, the Wilcoxon rank sum test is used. The Pearson correlation test is used for data that follow a normal distribution, otherwise, the Spearman correlation test is used.

Count data were expressed as frequency and rate, and rates were compared by the chi-square test. Linear regression was used to analyze whether TG/HDL-C ratio was a predictor of the skeletal muscle mass index, and binary logistic regression was used to analyze whether TG/HDL-C ratio was a risk factor of sarcopenia in middle-aged and elderly people in southwest China. Differences were considered statistically significant at $p < 0.05$.

3. Result

3.1. Baseline Data of Middle-Aged and Elderly People in Southwest China

This study included 390 middle-aged and elderly people in Southwest China, including 144 males and 246 females. The overall age ranged from 51.0 to 71.0 years, including 53.0 to 73.0 years for males and 49.0 to 69.0 years for females. According to the diagnostic criteria of AWGS, this study mainly analyzed the age, height, weight, BMI, grip strength, muscle mass SM, SMI, fat mass, TG, HDL-C and TG/HDL-C. The results show that height, weight, grip strength, limb muscle mass, and skeletal muscle mass index (SMI) were significantly smaller in women compared to men ($p < 0.001$), whereas fat content was significantly greater in women than in men ($p < 0.001$) (Table 1).

3.2. Comparison of TG/HDL-C Levels between Sarcopenia Group and Non-Sarcopenia Group

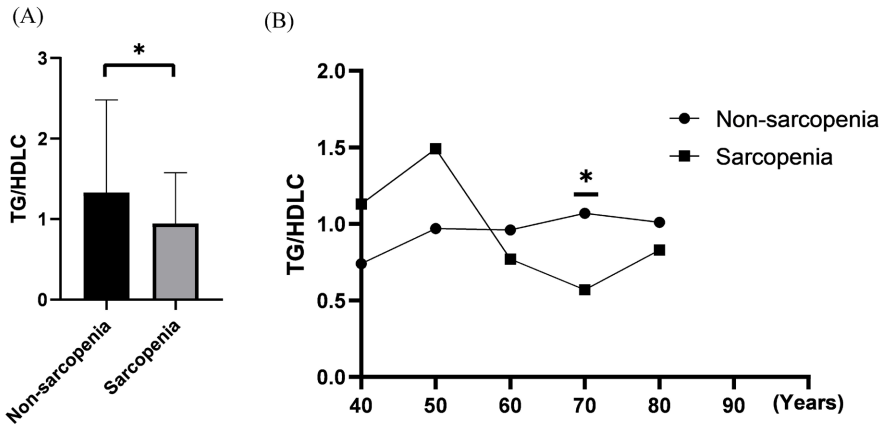
The TG/HDL-C ratio of non-sarcopenia group was significantly higher than that of sarcopenia group (Figure 1(A)), The TG/HDL-C ratio of sarcopenia group gradually increased after 40 years old, reached its highest at about 50 years old and then gradually decreased, while the TG/HDL-C ratio of non-sarcopenia group gradually increased, and the TG/HDL-C ratio of non-sarcopenia group gradually increased after 60 years old (Figure 1(B)).

3.3. Correlation between TG/HDL-C and Skeletal Muscle Index

Pearson correlation analysis showed that TG/HDL-C was positively correlated with skeletal muscle mass index ($r = 0.246$, $p < 0.01$).

Table 1. Population baseline data.

	Age (yr)	Height (cm)	Body mass(kg)	BMI (kg/m^2)	The power of gripping (kg)	SM (kg)	SMI (kg/m^2)	Fat mass (kg)	TG (mmoL/L)	HDL-C (mmoL/L)	TG/ HDL-C
Total (390)	61.01 ± 10.72	153.70 ± 8.04	53.30 [47.50 - 60.70]	23.07 ± 3.30	20.25 [15.30 - 26.40]	16.50 [14.50 - 19.40]	7.07 [6.49 - 7.80]	13.56 ± 6.40	1.30 [0.91 - 2.01]	1.48 ± 0.41	0.93 [0.56 - 1.65]
p-value	0.001	<0.001	<0.001	0.274	<0.001	<0.001	<0.001	<0.001	0.124	0.185	0.092
Male (144)	63.25 ± 10.17	160.28 ± 6.39	58.25 [51.75 - 65.70]	22.93 ± 3.52	27.95 [21.10 - 35.15]	20.55 [18.25 - 23.45]	7.98 [7.30 - 8.84]	10.57 ± 5.97	1.44 [0.91 - 2.42]	1.44 ± 0.42	1.02 [0.56 - 1.90]
Female (246)	59.70 ± 10.84	149.85 ± 6.20	50.95 [46.40 - 58.30]	23.15 ± 3.18	17.85 [13.80 - 21.70]	15.20 [13.90 - 16.70]	6.80 [6.24 - 7.18]	15.31 ± 6.00	1.29 [0.90 - 1.83]	1.50 ± 0.41	0.88 [0.58 - 1.44]



Note: (A) Overall comparison of TG/HDL-C between sarcopenia group and non-sarcopenia group. (B) Comparison of TG/HDL-C levels between sarcopenia group and non-sarcopenia group at different ages. The experimental results were obtained by independent samples T-test. Compared with non-sarcopenia group *$p < 0.05$.

Figure 1. Comparison of TG/HDL-C levels between sarcopenia group and non-sarcopenia group.

3.4. TG/HDL-C Is a Predictor of Skeletal Muscle Index

With skeletal muscle index as the dependent variable and age, BMI and TG/HDL-C ratio as the independent variables, linear regression was used for analysis. The results showed that age was negatively correlated with skeletal muscle index (Beta = −0.230, $p < 0.001$), while BMI was positively correlated with skeletal muscle index (Beta = 0.471, $p < 0.001$), and TG/HDL-C ratio was positively correlated with skeletal muscle index (Beta = 0.103, $p < 0.05$) (Table 2).

Table 2. Linear regression was used to analyze the predictive factors of skeletal muscle index.

Variable	Beta	t	*p*	95% CI	Partial correlation
Constant		10.052	<0.001	3.856 - 5.731	
BMI (kg/m^2)	0.471	10.928	<0.001	0.136 - 0.196	0.486
Year	−0.230	−5.521	<0.001	−0.034 - −0.0160	−0.271
TG/HDL-C	0.103	2.431	0.015	0.021 - 0.198	0.123

Note: Dependent variable: SMI (kg/m^2).

3.5. TG/HDL-C Is a Predictor of Sarcopenia in Middle-Aged and Elderly People in Southwest China

With sarcopenia as the dependent variable and age and TG/HDL-C ratio as the independent variables, binary Logistic regression was used for analysis. The results show that age (OR = 1.134, $p < 0.001$) and TG/HDL-C ratio (OR = 0.598, $p < 0.05$) are one of the influencing factors of sarcopenia in middle-aged and elderly people in southwest China (Table 3).

Table 3. Risk factors of TG/HDL-C on sarcopenia in middle-aged and elderly people after age adjustment.

Variable	B	Se	ward	*p*	OR	95% CI
Year	0.125	0.019	45.600	<0.001	1.134	1.093 - 1.176
TG/HDL-C	−0.514	0.252	4.176	0.041	0.598	0.365 - 0.979
Contest	−9.535	1.321	52.131	<0.001	0.000	

Note: The input variables include age, TG/HDL-C. Because BMI was not statistically significant between non-sarcopenia group and sarcopenia group, it was not included in the correction analysis.

4. Discussion

Our findings suggest that the TG/HDL-C ratio is significantly associated with sarcopenia in middle-aged and older adults in southwest China. This association provides new insights into the complex interactions between lipid metabolism and muscle health, an area of increasing interest in geriatrics research [23] [24].

The positive correlation between TG/HDL-C ratios and skeletal muscle index (SMI) suggests that higher TG/HDL-C ratios may be associated with better maintenance of muscle mass. In clinical practice, this may imply that by adjusting lipid levels, especially by raising HDL-C and/or lowering TG levels, may help prevent or slow down the loss of muscle mass, which is particularly important in the middle-aged and elderly population. Our findings are consistent with recent studies that have also identified lipid metabolism as a key factor influencing muscle health and function [25] [26]. However, the exact mechanism of this relationship remains to be elucidated and may involve a variety of pathways, including inflammation, insulin resistance and cellular energy metabolism. Meanwhile, the TG/HDL-C ratio was found to be a significant predictor of SMI by linear regression analysis, suggesting a positive correlation between the TG/HDL-C ratio and SMI after accounting for the effects of age and BMI. Specifically, for each unit increase in the TG/HDL-C ratio, SMI was expected to increase by 0.103 units (with age and BMI held constant). This finding is clinically relevant as it suggests that maintaining a higher TG/HDL-C ratio may help maintain skeletal muscle mass, which is critical for physical function and overall health in middle-aged and older populations. We have highlighted the statistical significance of the TG/HDL-C ratio as a predictor of SMI, which highlights the importance of lipid metabolism in muscle health. Although higher TG/HDL-C ratios are commonly associated with metabolic disorders, our results suggest that in the context of sarcopenia, this ratio may reflect a complex interaction between lipid metabolism and muscle biology, which warrants further investigation.

Previous studies have demonstrated a strong association between sarcopenia and traditional risk factors such as age, physical inactivity and malnutrition [27] [28]. Our study further enriches this finding by highlighting the role of lipid metabolism (specifically TG/HDL-C ratio) as a modifiable risk factor.

It is important to note that our sample had specific demographic and geographic

characteristics, and the generalisability of our findings may be limited. Future research should aim to replicate these findings in longitudinal studies and explore the biological mechanisms underlying the association between lipid metabolism and sarcopenia.

5. Conclusion

TG/HDL-C ratio appears to be associated with skeletal muscle quality in middle-aged and elderly individuals in Southwest China. Additionally, the TG/HDL-C ratio may serve as a potential protective factor against sarcopenia in this population. However, the wide confidence intervals observed in the logistic regression analysis indicate that the protective effect of TG/HDL-C ratio on sarcopenia is not statistically significant. Therefore, further research is needed to confirm this association and explore the underlying mechanisms.

6. Limitations

Because of the cross-sectional nature of our research, it is impossible to clarify the causal relationship, and there is the possibility of reverse causal bias. The population we studied is limited to middle-aged and elderly people in southwest China. Because of the different living environment, food culture and other factors, the result may not be applicable to other populations.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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