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Relationship Between Metabolic Syndrome and Cognitive Function: A Population-Based Study of Middle-Aged and Elderly Adults in Rural China

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Introduction: To explore the relationship between metabolic syndrome (MetS) and cognitive impairment in a low-income and low-education population.

Methods: All residents aged ≥45 years in a low-income population in Tianjin, China, were eligible to participate in this study. The Mini-Mental State Examination (MMSE) scale was used to conduct a preliminary screening and assessment of the participants' cognitive statuses. The MMSE components are orientation, registration, attention and calculation, recall, and language.

Results: In this population, the prevalences of MetS and cognitive impairment were 54.1% and 44.5%, respectively. In the overall population, the registration score was 0.105 points lower in the elevated triglycerides (TG) group than in the normal TG group (β, −0.105; 95% confidence interval [CI]: −0.201, −0.010; P=0.030). In men, high TG was associated with registration scores that were 0.152 points lower than those in the normal TG group (95% CI: −0.281, −0.022; P=0.022), while larger WC and lower HDL-C had positive effects on cognitive scores (all P<0.05). However, in women, there were no significant differences between cognitive scores and MetS or its components.

Conclusion: In this population, first, TG had a great impact on cognition, even greater than the impact of MetS on cognition. Second, the impact of MetS components on cognition was more obvious in men, and not all of the effects were negative. Therefore, the effect of MetS on cognition may need to be analyzed separately for different populations, and it may be that the effect of a single component is greater than the overall effect. When formulating prevention strategies for cognitive impairments, population differences must also be taken into consideration.

Keywords: cognitive impairment, MMSE, metabolic syndrome, aging, population-based study

Introduction

The burden of dementia is huge for society and individuals. It is estimated that there were 43.8 million people with dementia worldwide in 2016, with numbers expected to increase to 100 million by 2050.[1] China has 165.58 million people aged 65 years and older, accounting for 12.6% of the total population,[2] far exceeding the aging society definition of the United Nations.[3] Thus, the burden of dementia may be heavier in China than in other parts of the world. As the early stage of dementia, cognitive impairment has been considered the main intervention stage for preventing dementia. A recent study reported that the prevalence of mild cognitive impairment in China exceeded 15.5%, representing 38.77 million people nationwide.[4] Moreover, compared with that in urban areas, the burden of cognitive impairment in rural areas of China is heavier.[5] Thus, it is necessary to observe, identify, and manage more closely cognitive dysfunction and its potential risk factors in residents of rural China.

Old age, sex, and genetic factors have been shown to be non–modifiable risk factors for cognitive impairment.[6–8] Previous studies have also shown that hypertension, diabetes, and hyperlipidemia were independent risk factors for cognitive impairment.[9–11] As a clinical syndrome, metabolic syndrome (MetS) is a combination of metabolic risk factors, and its impact on cognition has recently attracted more and more attention. However, the impact of MetS on cognition is currently controversial. Some studies have indicated that MetS was an independent risk factor for cognitive impairment,[12–14] while other studies reported that there were no significant relationships between MetS and global cognitive function, especially in low-income people.[15,16] Therefore, this study's purpose was to explore the associations between MetS and its components with cognition among low-income adults in Northern China.

Methods

Participants and Study Design

This study was a cross-sectional survey conducted between April 2014 and January 2015 in 18 rural administrative villages in Tianjin, China. The population enrolled in this study was a sub-cohort of the Tianjin Brain Study.[17] Briefly, approximately 95% of the individuals in this study were low-income farmers with low educational attainment and with a 2014 disposable per capita income of <1600 USD.[18] All residents aged ≥45 years without previous histories of dementia or mental disease were invited to participate in the study.

Information Collection and Risk Factor Definition

A pre-designed questionnaire was used to collect participants' information by uniformly trained investigators through face-to-face interviews. Demographic information included sex, age, educational level, and history of disease. Cognitive function was assessed with the Chinese version of the Mini-Mental State Examination (MMSE).

Each participant underwent a physical examination to determine blood pressure, height, and weight; body mass index (BMI) was calculated as the individual's weight (kg) divided by the square of the individual's height (m^2). Serum fasting blood glucose (FBG), total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) concentrations were measured.

Definition of Variables

Hypertension was defined as a history of hypertension, systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg, or taking antihypertensive drugs.[19] Diabetes mellitus (DM) was defined as FBG ≥7.0 mmol/L or 2-hour postprandial glucose (2h-PG) ≥11.1 mmol/L, a previous diagnosis of DM, or having a prescription for insulin or oral antidiabetic drugs.[20]

BMI was classified into the following groups: low weight, BMI <18.5 kg/m^2; normal weight, BMI 18.5–23.9 kg/m^2; overweight, BMI 24.0–27.9 kg/m^2; and obese, BMI ≥28.0 kg/m^2).[21]

MetS was defined by the presence of three or more of the following criteria: (1) waist circumference (WC) ≥90 cm for men and ≥80 cm for women; (2) TG ≥1.7 mmol/L (150 mg/dL) (hypertriglyceridemia) or using medications for hypertriglyceridemia; (3) HDL-C <1.03 mmol/L for men, HDL-C <1.30 mmol/L for women, or using medications to reduce HDL–C; (4) SBP ≥130 mmHg or DBP ≥85 mmHg (hypertension) or using antihypertensive medications; and (5) FBG ≥5.6 mmol/L (hyperglycemia) or using antidiabetic medications.[22] Cognitive impairment was defined by MMSE scores <17 for the group with no formal education, <22 for the group with 1–6 years of education, and <26 for the group with >6 years of education.[23] According to the definition of MetS components, participants' TG, FBG, HDL-C, blood pressure, and WC values were defined as normal or elevated.

The participants were grouped into two age categories: <65 years and ≥65 years. Participants were also classified into three groups on the basis of length of formal education: the group with no formal education (0 years), 1–6 years, and >6 years. Cigarette smoking was defined as smoking more than 1 cigarette/day for ≥1 year; participants were categorized as non-smokers, current smokers, or previous smokers. Alcohol consumption was defined as drinking >500 g of alcohol/week for ≥1 year; participants were categorized as non-drinkers, past drinkers, or current drinkers.[24]

Statistical Analyses

Continuous variables, including age, educational level, BMI, SBP, DBP, WC, FBG, TC, TG, HDL-C, and LDL-C, were presented as means and standard deviations (SDs). Continuous variables were analyzed using Student's t-tests. MMSE scores were presented as medians and interquartile ranges (IQs). Categorical variables, including age group, BMI group, educational level group, smoking status, alcohol consumption, hypertension, DM, and MetS and its components, were counted as numbers and frequencies, and between-group comparisons were performed using chi-squared tests.

Multiple linear regression analyses were used to evaluate the associations between MMSE scores with MetS and its components (ie, orientation, registration, attention and calculation, recall, and language). The relationships were presented as standard partial regression coefficients (β) with 95% confidence intervals (CIs). Multiple linear regression analyses were run for each MetS component by age group adjusted for age, education level, smoking status, and the other four MetS components.

All analyses were conducted using SPSS for Windows (version 25.0; SPSS Inc., Chicago, IL, USA). Reported probabilities were two-sided; all tests were set at the 0.05 level of statistical significance.

Results

Participant Characteristics

This study recruited 1286 individuals aged ≥50 years (mean age, 66.84 years), including 595 men (46.3%) and 691 women (53.7%). The average number of years of education in this study population was 4.15 years. Moreover, 27.8% of participants (8.1% of men and 44.7% of women) had not received any formal education. The prevalences of MetS, cognitive impairment, hypertension, DM, and obesity were 54.1%, 44.5%, 80.0%, 29.8%, and 17.9%, respectively. The prevalences of current smoking and current alcohol consumption were 26.4% and 22.6%, respectively. Moreover, the median MMSE score (22) was low in this population (Table 1).

The Effects of MetS and Its Components on Cognition

Table 2 shows that there were no significant differences between participants with and without MetS in the median scores for total MMSE, orientation, registration, attention and calculation, recall, and language (all P>0.05).

This study also compared the prevalences of MetS and its components in the cognitively impaired group with those in the cognitively normal group. There were no significant relationships between MetS and cognitive status (P=0.962). However, the prevalence of high TG was higher in the normal cognitive status group than in the cognitive impairment group (51.6% vs 48.4%, P=0.032). In the age <65 years group, the prevalence of MetS was higher in the group with cognitive impairment than in the normal cognition group (56.3% vs 49.1%, P=0.170). Additionally, in the age ≥65 years group, the prevalence of MetS was lower in the cognitive impairment group than in the normal cognition group (52.7% vs 60.3%, P=0.266). There were no significant differences between the cognitive impairment group and the normal cognition group in the prevalences of MetS components (all P>0.05) (Table 3).

Influence of MetS and Its Components on Cognitive Scores in the Multivariate Analysis

In the overall population, there were no significant associations between MetS components and cognitive status after adjusting for age, education level, smoking history, and the other four MetS components (P>0.05). The registration score was 0.105 points lower in the elevated TG group than in the normal TG group (β, −0.105; 95% CI: −0.201, −0.010; P=0.030), while there were no correlations between other MetS components and cognitive status (all P>0.05).

Among men in the study population, compared with those in the normal TG group, the registration scores in the elevated TG group were 0.152 points lower (95% CI: −0.281, −0.022; P=0.022). The orientation scores and language scores were 0.228 points (95% CI: 0.023, 0.433; P=0.029) and 0.331 points (95% CI: 0.061, 0.600; P=0.016) higher, respectively, in the elevated WC group than in the normal WC group. The attention and calculation score was 0.480 points (95% CI: 0.083, 0.878; P=0.018) lower in the decreased HDL group than in the normal HDL group.

However, in women, there were no significant relationships between cognitive status and MetS and its components (all P>0.05) (Table 4).

Discussion

This population-based study aimed to explore the associations between MetS components and cognitive function

Table 1 Characteristics of Demography Among All Participants in This Study

Category	Men	Women	Total
Total:	595 (46.3)	691 (53.7)	1286
Age, means (SD), years	67.19 (6.62)	66.53 (6.56)	66.84 (6.59)
Age group, n (%)			
45–65years	256 (43.0)	333 (48.2)	589 (45.8)
≥65 years	339 (57.0)	358 (51.8)	697 (54.2)
Education, means (SD), years	5.74 (2.85)	2.79 (3.16)	4.15 (3.36)
Education group, n (%)			
0 years	48 (8.1)	309 (44.7)	357 (27.8)
1~6 years	378 (63.5)	314 (45.4)	692 (53.8)
≥ 6 years	169 (28.4)	68 (9.8)	237 (18.4)
Smoking status, n (%)			
Never smoking	180 (30.3)	643 (93.1)	823 (64.0)
Ever smoking	117 (19.7)	7 (1.0)	124 (9.6)
Current smoking	298 (50.1)	41 (5.9)	339 (26.4)
Alcohol consumption, n (%)			
Never drinking	284 (47.7)	677 (98.0)	961 (74.7)
Ever drinking	34 (5.7)	1 (0.1)	35 (2.7)
Current drinking	277 (46.6)	13 (1.9)	290 (22.6)
Hypertension, n (%)			
Yes	468 (78.7)	561 (81.2)	1029 (80.0)
No	127 (21.3)	130 (18.8)	257 (20.0)
Diabetes, n (%)			
Yes	147 (24.7)	236 (34.2)	383 (29.8)
No	448 (75.3)	455 (65.8)	903 (70.2)
BMI, n (%)			
Low weight	18 (3.0)	14 (2.1)	32 (2.5)
Normal	266 (45.0)	260 (38.1)	526 (41.3)
Overweight	217 (36.7)	270 (39.6)	487 (38.3)
Obesity	90 (15.2)	138 (20.2)	228 (17.9)
MetS, n (%)			
No	315 (52.9)	275 (39.8)	590 (45.9)
Yes	280 (47.1)	416 (60.2)	696 (54.1)
Cognitive impairment, n (%)			
No	352 (59.2)	243 (52.4)	595 (55.5)
Yes	362 (40.8)	329 (47.6)	691 (44.5)
SBP, means (SD), mmHg	155.20 (24.47)	159.17 (24.06)	157.34 (24.32)
DBP, means (SD), mmHg	90.22 (12.47)	89.79 (12.61)	89.99 (12.54)
BMI, means (SD), kg/m^2	24.43 (3.41)	25.09 (3.66)	24.78 (3.56)
FBG, means (SD), mmol/L	5.70 (1.33)	6.07 (1.95)	5.90 (1.70)
TC, means (SD), mmol/L	4.72 (1.36)	4.88 (1.19)	4.80 (1.27)
TG, means (SD), mmol/L	1.68 (1.49)	1.71 (1.00)	1.69 (1.25)
HDL-C, means (SD), mmol/L	1.46 (0.48)	1.44 (0.47)	1.45 (0.48)
LDL-C, means (SD), mmol/L	2.69 (0.89)	2.72 (0.87)	2.71 (0.88)
MMSE scores, median (IQ)	23 (6)	20 (9)	22 (8)

Abbreviations: SD, standard deviation; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; FBG, fasting blood glucose; TC, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

Table 2 The Difference in Cognitive Scores in the Different MetS Groups Under the Age Stratification

Category	No-MetS	MetS	Total
Total			
MMSE	16 (14–21)	18 (13–21)	0.520
Orientation	8 (7–9)	8 (7–9)	0.820
Registration	2 (1–3)	2 (1–3)	0.495
Attention and calculation	1 (1–3)	1 (0–3)	0.688
Recall	0 (0–0)	0 (0–1)	0.253
Language	5 (3–6)	5 (4–7)	0.088
< 65 years			
MMSE	18 (14–21)	18 (14–21)	0.939
Orientation	8 (7–9)	8 (7–9)	0.611
Registration	2 (1–3)	3 (1–3)	0.649
Attention and calculation	2 (1–4)	1 (1–3)	0.054
Recall	0 (0–1)	0 (0–1)	0.113
Language	5 (4–6)	5 (4–7)	0.459
≥65 years			
MMSE	16 (13–20)	16 (13–20)	0.504
Orientation	8 (7–9)	8 (6–9)	0.876
Registration	2 (1–3)	2 (1–3)	0.680
Attention and calculation	1 (0–3)	1 (0–3)	0.482
Recall	0 (0–0)	0 (0–0)	0.952
Language	5 (3–6)	5 (4–7)	0.130

among adults aged ≥45 years in rural Northern China. In this study, the prevalences of MetS and cognitive impairment were 54.1% and 44.5%, respectively. In the overall population, there was a significant negative relationship between high TG and registration. In men, registration scores were significantly lower in the elevated TG population than in the normal TG group, while there was a positive relationship between cognitive status and lower HDL and elevated WC. In women, there was no significant association between MetS and its components with cognitive status.

The impact of MetS on cognitive impairment remains controversial. A Korean study of elderly people over age 65 years pointed out that MetS was an independent risk factor for cognitive impairment.[14] A systematic review of prospective population-based studies reported that, compared with individuals without MetS, the risk of cognitive decline was increased 1- to 2-fold in patients with MetS.[25] A study in Northeast China also reported that MetS was inversely associated with cognitive function.[26] Another study reported that the prevalence of MetS exceeded 50% among Australians with severe mental illness.[27]

Table 3 The Prevalence of Metabolic Syndrome and Its Components in Different Cognitive Function

Category	Cognitive Normal	Cognitive Impairment	P
Total			
MetS	386 (55.5)	310 (44.5)	0.962
Raised TG	242 (51.6)	227 (48.4)	0.032
Raised FBG	362 (53.7)	312 (46.3)	0.170
Reduced HDL-C	147 (57.2)	110 (42.8)	0.545
Raised BP	637 (55.2)	518 (44.8)	0.429
Raised WC	409 (57.0)	309 (43.0)	0.242
< 65 years			
MetS	207 (63.9)	117 (36.1)	0.305
Raised TG	138 (61.3)	87 (38.7)	0.079
Raised FBG	183 (62.0)	112 (38.0)	0.060
Reduced HDL-C	86 (67.2)	42 (32.8)	0.690
Raised BP	339 (65.3)	180 (34.7)	0.590
Raised WC	230 (65.0)	124 (35.0)	0.646
≥65 years			
MetS	179 (48.1)	193 (51.9)	0.496
Raised TG	104 (42.6)	140 (57.4)	0.096
Raised FBG	179 (47.2)	200 (52.8)	0.856
Reduced HDL-C	61 (47.3)	68 (52.7)	0.925
Raised BP	298 (46.9)	338 (53.1)	0.918
Raised WC	179 (49.2)	185 (50.8)	0.211

Meanwhile, a recent study also reported that patients with first-episode psychosis and those with schizophrenia had an increased prevalence of MetS.[28] However, there have also been some studies that reported no significant association between global cognitive function and MetS.[15,16] In this study, MetS had no effect on global cognition status in the overall population. The mechanism for this relationship is not clear, but it may be related to the nutritional and metabolic status of the population. Perhaps in low–income people, nutritional status has a greater impact on cognition, and metabolic syndrome does not reflect the nutritional status of this population well.

The obesity paradox has attracted increasingly more attention. Although obesity is a risk factor for many diseases,[29,30] with respect to tumors, cardiovascular disease, and the entire life course, the impact of obesity on health cannot be generalized.[31–33] In this study, large WC, as an indicator of abdominal obesity, had a significant positive relationship with registration and language scores.

Table 4 MMSE Score in Metabolic Syndrome and Its Components Using Multivariate Regression Analysis [β (95% CI)]

MetS Components	MMSE	Orientation	Registration	Attention and Calculation	Recall	Language
Total						
MetS	0.097 (−0.343, 0.537)	−0.008 (−0.151, 0.134)	0.038 (−0.053, 0.128)	0.053 (−0.114, 0.219)	0.005 (−0.104, 0.114)	0.026 (−0.149, 0.200)
Raised TG	−0.390 (−0.854, 0.073)	−0.124 (−0.274, 0.025)	−0.105 (−0.201, −0.010)*	−0.117 (−0.293, 0.058)	0.013 (−0.102, 0.129)	0.012 (−0.172, 0.195)
Raised FBG	−0.189 (−0.633, 0.256)	−0.138 (−0.281, 0.006)	0.024 (−0.067, 0.116)	−0.012 (−0.180, 0.156)	−0.047 (−0.158, 0.063)	−0.066 (−0.242, 0.110)
Reduced HDL-C	0.096 (−0.465, 0.658)	0.070 (−0.111, 0.251)	0.049 (−0.066, 0.165)	0.041 (−0.171, 0.254)	0.025 (−0.115, 0.164)	−0.106 (−0.329, 0.116)
Raised BP	−0.156 (−0.901, 0.589)	0.086 (−0.155, 0.326)	0.059 (−0.094, 0.213)	−0.141 (−0.422, 0.141)	0.142 (−0.043, 0.327)	−0.276 (−0.571, 0.018)
Raised WC	0.337 (−0.119, 0.794)	0.141 (−0.006, 0.288)	0.034 (−0.060, 0.127)	0.089 (−0.084, 0.262)	−0.017 (−0.131, 0.096)	0.128 (−0.053, 0.308)
Men						
MetS	0.326 (−0.298, 0.950)	0.022 (−0.173, 0.217)	0.087 (−0.032, 0.207)	0.146 (−0.093, 0.384)	0.009 (−0.149, 0.167)	0.140 (−0.116, 0.396)
Raised TG	−0.602 (−1.280, 0.077)	−0.185 (−0.397, 0.027)	−0.152 (−0.281, −0.022)*	−0.179 (−0.439, 0.081)	0.069 (−0.104, 0.242)	−0.036 (−0.316, 0.243)
Raised FBG	−0.075 (−0.704, 0.553)	−0.104 (−0.301, 0.092)	0.066 (−0.054, 0.187)	−0.015 (−0.256, 0.226)	0.029 (−0.131, 0.190)	−0.096 (−0.355, 0.162)
Reduced HDL-C	0.751 (−0.286, 1.789)	0.132 (−0.192, 0.457)	0.150 (−0.048, 0.349)	0.480 (0.083, 0.878)*	0.057 (−0.208, 0.321)	0.082 (−0.345, 0.509)
Raised BP	−0.157 (−1.190, 0.877)	0.117 (−0.206, 0.440)	0.036 (−0.162, 0.234)	0.035 (−0.361, 0.431)	0.090 (−0.174, 0.354)	−0.290 (−0.715, 0.136)
Raised WC	0.893 (0.239, 1.548)	0.228 (0.023, 0.433)*	0.117 (−0.008, 0.243)	0.193 (−0.058, 0.444)	−0.021 (−0.188, 0.146)	0.331 (0.061, 0.600)*
Women						
MetS	0.049 (−0.565, 0.664)	−0.020 (−0.227, 0.186)	0.014 (−0.122, 0.149)	0.051 (−0.180, 0.283)	−0.012 (−0.167, 0.142)	−0.011 (−0.250, 0.228)
Raised TG	−0.256 (−0.884, 0.373)	−0.060 (−0.271, 0.151)	−0.068 (−0.206, 0.071)	−0.08 (−0.317, 0.156)	−0.041 (−0.199, 0.116)	0.035 (−0.210, 0.279)
Raised FBG	−0.341 (−0.952, 0.270)	−0.183 (−0.388, 0.022)	−0.018 (−0.153, 0.116)	−0.015 (−0.246, 0.215)	−0.112 (−0.265, 0.041)	−0.056 (−0.293, 0.182)
Reduced HDL-C	−0.027 (−0.705, 0.650)	0.039 (−0.188, 0.267)	0.016 (−0.133, 0.166)	−0.046 (−0.301, 0.209)	−0.002 (−0.171, 0.168)	−0.119 (−0.382, 0.145)
Raised BP	0.297 (−0.760, 1.354)	0.136 (−0.218, 0.491)	0.117 (−0.116, 0.350)	−0.127 (−0.525, 0.271)	0.220 (−0.045, 0.485)	−0.129 (−0.540, 0.282)
Raised WC	−0.088 (−0.713, 0.536)	0.071 (−0.139, 0.280)	−0.032 (−0.17, 0.105)	0.026 (−0.209, 0.261)	−0.025 (−0.182, 0.131)	−0.028 (−0.271, 0.215)

Notes: Adjusted with age, education, smoking history, and other four MetS components; *presented that P< 0.05.

The possible mechanism may be that the relationship between obesity and disease is not only dependent on adiposity but also on endocrine function and adipocyte leptin secretion.[34] Therefore, some low-leptin lifestyles independent of obesity (such as health status) may confuse the relationship between obesity and disease. Moreover, an important factor is the development of frailty, which was not considered in the relationship between obesity and disease.[31] The average age of this population was older, and the overall population may be more fragile, so the increase in WC may indicate a better nutritional status.

There was a significant negative correlation between high TG and memory score, especially in men, in this study. This is consistent with previous research results. A previous study reported that MMSE scores for men were significantly negatively correlated with TG.[15] Another follow-up study also reported that high TG was associated with deterioration in memory and learning ability.[13]

In this study, MetS and its components had different effects on cognitive function in different age groups. A previous study reported that the prognostic role of the overall MetS score in the elderly was not greater than the sum of its components.[35] Moreover, age seems to change the association between MetS and cognitive decline.[12] Thus, it is necessary to explore the relationship between MetS and cognition in all age groups.

The score for attention and calculation was higher in the reduced HDL-C group than in the normal HDL-C group, which is contrary to previous research results. HDL-C has always been considered good cholesterol.[36] A recent study showed that white matter volume was positively correlated with HDL-C levels, suggesting that elevated that HDL-C levels have a positive effect on brain cognitive function.[37] Although a previous study reported that there may be a U-shaped relationship between HDL-C and cardiovascular disease,[38] there is no evidence that reduced HDL-C protects cognition. In this study, the mechanism of the positive correlation between reduced HDL-C and cognition is unclear, but it is possible that the quality of HDL-C may be more important than its quantity, because HDL-C loses its antioxidant effect because of changes in its composition, which may reduce the predictive ability of HDL-C.[36]

There were several limitations in this study. First, an inherent limitation of a cross-sectional study is that it cannot validate causal links between significant variables and MMSE score; thus, further longitudinal studies are needed to determine causality. Second, in this study, the MMSE scale was used to assess the cognitive function of the participants. Because the MMSE scale is so simple, it is easy to miss impaired cognitive function in patients with higher educational levels. However, the research population in this study was a low-income population with low educational attainment; the average education length was 4.15 years. Thus, the assessment of cognitive impairment was likely more accurate. Third, this study did not distinguish the causes of cognitive impairment. In a follow-up study, the scope of information collection of the participants will be expanded, and a deeper analysis of different types of cognitive impairment will be done. Finally, this study did not collect relevant information to assess the frailty of participants; however, age adjustment and the exclusion of participants with severe cardiovascular and cerebrovascular diseases and who are unable to take care of themselves were also excluded. Thus, the influence of frailty on the results can be decreased to a certain extent.

Conclusions

In this study, the prevalence of cognitive impairment was as high as 44.5% among middle-aged and elderly adults, suggesting that the burden of cognitive impairment for people in low-income areas remains heavy in rural Tianjin. Elevated TG was associated with reduced cognitive scores in overall population. Moreover, larger WC and lower HDL-C was associated with increased cognitive scores in men, while there were no significant differences between MetS and cognitive scores in women. Therefore, the influence of MetS on cognition cannot be generalized and must be based on a specific analysis of different populations. When formulating prevention strategies for related cognitive impairments, population differences must also be taken into consideration.

Data Sharing Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Tianjin Medical University General Hospital; all participants received information on the study and provided written informed consent. This study was conducted in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no competing interests.

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