The Association of Healthy Behaviors and Metabolic Factors With Dyslipidemia Among Miao Adults: The China Multi-Ethnic Cohort (CMEC) Study

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Abstract

Background: Behavioral and metabolic risk factors will increase the risk of dyslipidemia, the association of behaviors and metabolic factors with dyslipidemia among Miao adults are still unclear.

Objective: To evaluate the association between behaviors, metabolic factors and dyslipidemia.

Methods: Based on the CMEC study, a representative samples of 5,559 Miao participants aged 30 to 79 years old who were included in the baseline survey from 2018 to 2019 were analyzed. A binary logistic regression model was utilized to evaluate the odds ratios (OR) and 95% confidence intervals (CI) of the associations of healthy behaviors and metabolic factors with dyslipidemia.

Results: In both sexes, only a small percentage of females with ideal levels of waist-to-hip ratio (WHR) (27.2%). However, participants were more likely to have ideal levels of fasting blood glucose (FBG). In addition, males with dyslipidemia had poor levels of body mass index (BMI) (60.3%), WHR (59.2%) and FBG (65.8%). While females with dyslipidemia had poor levels of FBG (60.0%). Notably, our study found that WHR, BMI, FBG, and blood pressure were major risk factors for almost all dyslipidemia components.

Conclusions: The rate of dyslipidemia cannot be ignored, particularly high TG levels. In addition, healthy behaviors and metabolic factors, especially WHR, BMI, FBG levels, and blood pressure were significantly associated with dyslipidemia, which may have become a major challenge to public health problems in the ethnic minority areas of Guizhou.

Background

Due to its high incidence, disability rates and mortality rates, CVD has become the leading cause of death in the global, and it has become a public health problem that urgently needs to be overcome. Studies have found that dyslipidemia is an independent risk factor for CVD ^[1]. Dyslipidemia characterized by elevated total cholesterol (TC) or LDL-C levels is generally considered to be a major risk factor for atherosclerosis ^[2]. According to the latest data from the WHO, more than 50% of the global incidence of coronary heart disease is related to the increased TC levels. The American Heart Association (AHA) has long recognized that elevated levels of certain lipid components are important markers of CVD risk. However, there are relatively few studies on lipid components among ethnic minorities in southwest China. Given the rapid prevalence trend of high TC levels, high TG levels and other lipid phenotypes in Chinese individuals, it is of great importance to explore the typical risk factors of lipid components in people with different characteristics for the control of CVD.

Recently, due to the prevalence of risk factors such as physical activity deficiency, smoking, obesity and hypertension, the incidence of dyslipidemia is increasing at an alarming speed and showing a younger trend ^[3]. Research reported that approximately 64.4% of persons in china have at least one type of dyslipidemia ^[4]. The increasing westernization of chinese dietary patterns (i.e., high cholesterol dietary intake) contributed to this phenomenon to a large extent. In china, the form of prevention and control of dyslipidemia is severe. The release of the Healthy China Action (2019-2030) will further strengthen the management of blood lipid levels in residents aged 35 and above. Therefore, it is a priority to put forward targeted prevention and control measures based on different characteristics of the population.

The blood lipid level is linearly related to the progression of atherosclerosis. The risk of cardiovascular events is reduced by 21% for every 1mmol/L decrease in LDL-C levels ^[5], which can effectively control dyslipidemia and identify potential modifiable risk factors of dyslipidemia that are essential to reducing the risk of CVD. The blood lipid level is closely related to behavior and metabolic factors, and the superposition and complex interaction of life behavior and metabolic factors are important reasons for the disorder of blood lipid metabolism ^[6, 7]. Several studies have pointed out that poor behaviors and metabolic factors can increase the levels of TC, TG, and LDL-C and reduce the concentration of high-density lipoprotein cholesterol (HDL-C) ^[8]. Healthy behaviors and metabolic factors are essential primary preventive measures for disease. Smoking cessation, weight loss and blood sugar reduction have a profound effects on dyslipidemia. Studies have shown that changing poor behaviors and metabolic factors can reduce dyslipidemia as effectively as clinical drug therapy ^[9]. However, although healthy behaviors and metabolic

factors were negatively correlated with the disease risk^[10, 11], but the proportions of healthy behaviors and metabolic factors that meet the ideal levels were extremely low^[12].

Guizhou is the main settlement of the Miao nationality in southwest China. In the Sixth Population Census, the Miao populations in Guizhou accounted for 42.1% of the national Miao populations^[13]. Due to the influence of many factors such as the natural geographical environment, ethnic beliefs, and traditional customs, the Miao residents still maintain simple and primitive customs and traditional cultural concepts, and have a unique way of lifestyles (such as drinking customs and dietary structure), which are obviously different from the Han and other ethnic minorities^[14]. Previous studies on lifestyle and dyslipidemia have been reported, but there have still been few large-scale studies of Miao adults in southwest China, and almost no studies had fully explored the abnormalities in lipid components. In addition, there had been few comprehensive studies on healthy behaviors and metabolic factors in recent years, and the evidence of their association with dyslipidemia is limited. Thus, the associations between healthy behaviors, metabolic factors and dyslipidemia in this special ethnic group remains to be clarified. Therefore, the purpose of this study is to systematically explore the relationships between healthy behaviors, metabolic factors and dyslipidemia by using baseline data from CMEC project sites in Guizhou, in order to provide more constructive information for the prevention and management of dyslipidemia and even CVD of ethnic minority areas in Southwest China.

Materials And Methods

Study participants

The CMEC study is a large-scale prospective cohort study based on community population in five provinces of southwest China, Guizhou, Yunnan, Sichuan, Chongqing and Tibet. From May 2018 to September 2019, 99,556 members aged 30 to 79 years old (Tibetan populations include those aged 18 to 30 years) were recruited from ethnic minority communities for a baseline survey. Further details are available elsewhere^[15].

In our study, participants has to meet following inclusion criteria: (i) aged 30~79 years on the day of the investigation; (ii) three generations of direct relatives who were permanent residents of the Miao nationality (duration of residence $\geq$ 6months); (iii) capability of completing baseline surveys and the follow-up study; (iv) no mental disorders and other related diseases. The exclusion criteria were as follows: the participants were excluded if they were pregnant or had missing data (smoking history, drinking history, blood pressure, etc), fasting time < 8 hours and those who taking any antihyperlipidemic drugs.

A multi-stage stratified cluster sampling method was used. According to the characteristics of ethnic minorities in Guizhou, the Miao and Dong Autonomous Prefecture of Qiandongnan and the Bouyei and Miao Autonomous Prefecture of Qiannan were selected from 3 minority autonomous prefectures as investigation areas. From the Qiandongnan and Qiannan Prefectures, Kaili City, Liping County, and Libo County were selected as secondary sampling units. Ultimately, 5,559 subjects were recruited in the present analyses.

Electronic questionnaire

An application (CMEC App) developed by the CMEC project team was used to collect questionnaire information through tablets. The questionnaire assessed personal identification information, social demographic characteristics, behaviour patterns (e.g., smoking, drinking and physical activity) and health status. The questionnaire information was collected by trained local medical college students using tablets through face-to-face interviews. Participants were required to bring a second- generation ID card or household register to the designated site to participate in the questionnaire survey.

Medical examinations

Measures included height (cm), weight (kg), waist circumference (cm), hip circumference (cm), and blood pressure (mmHg). Participants were required to fast before medical examinations. Blood pressure was measured by an ohmic electronic sphygmomanometer with an interval of 5 minutes between each measurement, and a total of 3 measurements. The analysis was based on the average values of the three blood pressure readings. For the height measurement, subjects were told to wear light clothes, with their hat off, standing barefoot and to keep their bodies upright when measured using an ultrasonic height

measuring instrument. For weight measurement, the subjects removed heavy clothes and stood barefoot in the centre of the weighing scales. Waist circumference was measured approximately 1 cm above the navel with a soft tape, and the hip circumference was measured at the maximum extension of the hip, circling the soft tape around the hip for a week and closing to the skin for reading.

Clinical laboratory tests

Fasting venous blood was collected by professional nurses from participants who had fasted for 8 hours. Next, the blood samples were centrifuged and sub-packaged, refrigerated at 4°C and sent to the JinYu Medical Laboratory Center, Guizhou Province. Finally, biochemical indexes, i.e., FBG, TC, TG, HDL-C and LDL-C, were assessed by an automatic biochemical instrument (Model: P800, Roche, Switzerland).

Definition of dyslipidemia

According to the guidelines for the prevention and treatment of dyslipidemia in Chinese adults^[16], dyslipidemia was defined as abnormality in any of the four indicators of blood lipids: TC $\geq$ 6.22mmol/L, TG $\geq$ 2.26mmol/L, LDL-C $\geq$ 4.14 mmol/L and HDL-C<1.04mmol/L.

Assessment of behavioral and metabolic factors

Based on the questionnaire assessment of smoking history, participants were divided into non-smoker, previous smoker (smoking cessation $\geq$ 1 year), and currently smoker (so far more than 100 cigarettes) groups. Based on the self-report of the frequency of alcohol consumption in participants over the past year, participants were divided into non-drinker or almost non-drinker, occasional drinker and regular drinker. Individual physical activity was assessed through the sum of the metabolic equivalents task (MET) of occupational and non-occupational physical activity. Sleep duration was assessed based on average daily sleep duration (excluding lunch break). WHR was calculated as a person's waist circumference divided by the hip circumference. BMI was defined as a person's weight in kilograms divided by the square of the height in meters (kg/m²).

Classification of healthy behaviors and metabolic factors

With reference to the healthy lifestyle behavior proposed by the AHA and combined with the characteristics of Chinese behavior, the definitions of healthy behavior and metabolic factors are shown in Table 1. A single index was respectively assigned the values 2, 1 and 0 for ideal, intermediate and poor, and a score of 0~16 was assessed for overall healthy behaviors and metabolic factors. Then, the scores were divided into three levels, including ideal (11~16), intermediate (9~10), poor (0~8).

Statistical analysis

Calculations of the distribution of participants' social demographic characteristics used descriptive statistical methods for the stratification of dyslipidemia. In addition, considering the characteristics of male and female behaviour patterns, we also described the dyslipidemia of participants with different healthy behaviors and metabolic factors based on gender stratification. The age-standardized rate of dyslipidemia was calculated according to the data of the sixth census of Guizhou in 2010. Categorical variables were expressed as n(%). The chi-square(χ^2) test was performed to assess the differences between the groups with each categorical variable.

Based on gender stratification, a binary logistic regression model was used to analyze the OR and 95% CI of different healthy behaviors and metabolic factors indicators associated with dyslipidemia. The dependent variables of binary logistic regression models respectively were high TC, high TG, high LDL-C or low HDL-C levels. The independent variables included smoking history, drinking of alcohol, physical activity, sleep duration, WHR, BMI, FBG levels, and blood pressure. Covariates for model adjustment included age, residence, educational, and occupation.

SPSS 22.0 and R 4.0.2 software were used for statistical analysis. A *P* value of less than 0.05 was considered to be significant.

Results

Baseline characteristics of the Miao participants

Among the 5,559 Miao participants recruited, 5,032 (90.5%) had a complete lifestyle assessment and completed a physical examination. Table 2 shows the social demographic characteristics of the participants. The average age of males and females was (53.3±12.0) years old, (50.9±11.0) years old. Except for marital status, the differences in dyslipidemia among different social demographic variables were statistically significant (all P value < 0.05). The dyslipidemia rate of the participants was 32.8% (age-standardized rate of 23.3%). In addition, individuals with dyslipidemia were more likely to be males, manager or professional technology fields, higher level of education and urban residents (all P value < 0.05).

Dyslipidemia in Participants with different healthy behaviors and metabolic factors by gender

Table 3 show, males were more likely to have poor levels of blood pressure, BMI, and become current smoker, and alcohol drinker. And males with dyslipidemia were had poor levels of blood pressure, WHR, FBG, BMI, especially with poor BMI (60.3%), poor FBG (65.8%) levels of dyslipidemia were more outstanding. Conversely, females tended to have poor levels of WHR and BMI. Females with dyslipidemia were had poor levels of FBG (60.0%). Moreover, the trend chi-square test showed that the rate of dyslipidemia increased with the decrease of the level in healthy behaviors and metabolic factors classification (P value ≤ 0.05), except for sleep duration, smoking history, drinking of alcohol, physical activity.

Figure 1 shows that the abnormal rate of blood lipid components according to the grading of overall healthy behaviors and metabolic factors scores. After stratification, the abnormal rate of blood lipid components increased with the decrease in overall healthy behaviors and metabolic factors score. And abnormal rate of blood lipid components in men fluctuated greatly with the score of overall healthy behaviors and metabolic factors.

Abnormal lipid components in participants with different healthy behaviors and metabolic factors

As shown in Table 4, the rate of abnormal TG levels in individuals with adverse healthy behaviors and metabolic factors was higher, followed by the rate of abnormal TC levels, among all the lipid components.

Relationship between healthy behaviors, metabolic factors and dyslipidemia components

Upon gender stratification, the associations of healthy behaviors and metabolic factors with dyslipidemia components are shown in Figure 2 and Figure 3. WHR was the major risk factor of dyslipidemia in men, with the strongest correlation between WHR and high LDL-C levels (adjusted OR=3.11, 95% CI=1.89-5.11). BMI was the main risk factor for abnormal TG and HDL-C levels, and the risk of high TG and low HDL-C levels increased as BMI increased. Participants with poor blood pressure levels were at higher risk of high TC (adjusted OR=1.82, 95% CI=1.11-3.00) and high TG levels (adjusted OR=1.78, 95% CI=1.27-2.50) than those with normal blood pressure levels. This study did not observe an association between FBG and LDL-C levels (P value > 0.05). Smoking history was independently associated with HDL-C, and men with poor smoking behaviors had a higher risk of low HDL-C (adjusted OR=1.48, 95% CI=1.08-2.03). Men who drank occasionally (adjusted OR=1.63, 95% CI=1.20-2.22) and who drank often (adjusted OR=1.73, 95% CI=1.29-2.32) had a higher risk of high TG levels. Notably, there was a negative correlation between alcohol consumption and LDL-C levels.

A similar phenomenon has been observed in women, in that BMI was independently associated with high TG and low HDL-C levels, and the risk of high TG and low HDL-C levels increased with the increased of BMI. However, FBG levels may be a typical risk factor for dyslipidemia in Miao women. With the exception of HDL-C levels, the increased risk of high TG, high TC and high LDL-C levels increased with the increase of FBG levels. With the increase of blood pressure, the risk of high TC and high TG gradually increased, while the risk of high LDL-C levels was found only in the adverse blood pressure level was found. WHR had the strongest correlation with HDL-C levels (adjusted OR=3.04, 95% CI=1.72-5.40). Furthermore, compared with ideal physical activity, those who with moderate physical activity had a higher risk of low HDL-C (adjusted OR=1.59, 95% CI=1.04-2.42).

Discussion

This study provided a systematic analysis of the association of healthy behaviors and metabolic factors with the risk of dyslipidemia. The results showed that Miao adults had a large proportions of poor levels of WHR and blood pressure, especially the WHR, which may be related to the tendency of body fat to accumulate in the abdomen. Furthermore, individuals with dyslipidemia had poor levels of WHR, BMI, FBG levels and blood pressure, which may be the reasons for the increased burden of CVD in minority populations in recent years, which deserves increased attention. Strikingly, BMI, WHR, FBG, and blood pressure showed strong associations with dyslipidemia. In contrast, certain behaviors (smoking, alcohol consumption and physical activity) were weakly associated with dyslipidemia. These results revealed that the management of obesity, hypertension and hyperglycemia should be important entry points for the intervention of dyslipidemia components.

Compared with the studies of Guangxi, Jiangsu, Beijing and other locations^[17-20], dyslipidemia and its abnormal lipid components among Miao adults were relatively low, the reasons for which may be due to differences in genetic background, socioeconomic level and lifestyle of the subjects. Guizhou belongs to a mountainous karst landform plateau, and the ethnic minority residents live in a special environment. Their diet culture has distinct regional characteristics (sour soup), a unique primitive lifestyle (manual batik and ethnic embroidery), and the level of economic development was limited, which may be one of the reasons for the low rate of dyslipidemia in this region. The abnormal rates of lipid components of Miao residents were significantly different: the main types were high TG (21.8%), which was consistent with other studies in China^[21, 22]. Epidemiological studies have suggested that elevated TG levels are associated with increased risk of CVD^[23]. Therefore, the monitoring of TG levels should be strengthened to reduce the burden of CVD in Miao adults.

We explored the relationship between healthy behaviors, metabolic factors and dyslipidemia components according to gender. In both sexes, the results showed that the influencing factors of dyslipidemia were not identical. Overall, after adjusting for potential confounding factors, BMI, WHR, FBG levels and blood pressure were the most typical risk factors for dyslipidemia components, as confirmed in many previous studies^[24, 25]. Obesity, diabetes and hypertension are prominent metabolic risk factors for lipid metabolic disorders. Dyslipidemia caused by these indicators has been demonstrated to be closely related to the progression of atherosclerotic diseases^[26]. At the same time, these metabolic factors have been identified as important biomarkers for the screening of dyslipidemia. Therefore, to further strengthen the management of dyslipidemia, individuals with adverse metabolic factors should be paid more attention, suggesting that prevention and control strategies for dyslipidemia should be formulated.

This study found that males with current smoking were at higher risk of low HDL-C levels, consistent with other findings^[27, 28]. Previous studies have reported that smoking increased TC and TG levels and decreased HDL-C level compared with non-smokers^[29], while our study only observed the association between smoking and HDL-C levels. Our study also found that males with regular drinking were at greater risk of high TG levels. However, similar result was not observed in women. The association may be underestimated because this study assessed that alcohol consumption was classified only according to the frequency of drinking and lacked a specific level of alcohol intake analysis. Furthermore, we found that alcohol consumption was negatively correlated with LDL-C in men, which may be because wine with rice and glutinous rice as raw materials was self-brewed by Miao residents. The low alcohol content of self-brewed wine had no significant effect on blood lipid levels, and it may also be related to the genetic susceptibility of ethnic minorities. In short, the association between alcohol consumption and blood lipids of Miao adults should be further explored.

Previous study reported that as physical activity decreased, the risk of dyslipidemia increased, and active physical activity was associated with improved blood lipid levels^[30]. Except for HDL-C, we did not observe that physical activity was significantly associated with any lipid components, which may be related the evaluations of individual physical activity through the metabolic equivalent of total physical activity in our study, and did not distinguish the correlation between physical activity in specific fields and blood lipids. Therefore, subsequent research can further explore the association between physical activity in specific fields and lipid components. Shigeki Kinuhata observed a positive correlation between sleep duration and high TG levels^[31]. Zhan found that sleep duration was significantly associated with risk of dyslipidemia in women, but not in men^[32]. However, in both sexes, there was no association of sleep duration with any lipid components was observed in our study (all *P* value >0.05). It may be that as the level of economic development in this region was limited, minority participants still followed the traditional habits of rest; thus, the vast majority of participants with normal sleep duration may have no obvious effect on lipid components. However, the explanation of this phenomenon remains to be further studied.

With the transformation of social and economic development, dyslipidemia is increasing at an alarming speed, and it has become a huge challenge for the health promotion. This study revealed that individuals with poor behaviors and metabolic factors have a relatively high risk for dyslipidemia. Thus, the prevention of dyslipidemia may benefit from interventions for behaviors and metabolic risk factors. Additionally, it is suggested that populations with unhealthy lifestyles should be continuously monitored and managed to control dyslipidemia as effectively as possible to improve the health level of ethnic minority groups.

Despite the following limitations, our study was unique. First, to our knowledge, this was the first large-scale cohort study focusing on ethnic minority groups in China. Second, medical examinations were conducted by professional medical staff according to strict criteria rather than self-reporting by participants. However, several limitations needed to be considered. First, considering the influence of potential confounding factors, this study adjusted more covariates as much as possible to control confounding factor interference. Second, studies on the genetic susceptibility to dyslipidemia in ethnic minorities were scarce, and further research support was needed. Furthermore, we excluded participants with aged beyond 30 to 79 who might have missed information on early life exposures. Thus, subsequent research may consider expanding the age range of participants. Finally, our study was based on cross-sectional data analysis to confirm that the causal capacity was limited, which needs to be further supplemented by follow-up data.

Conclusions

The dyslipidemia rate of Miao adults in Guizhou was lower than the national average (40.40%), but the overall situation was still not optimistic, especially regarding the high TG abnormal. Therefore, continuous monitoring of blood lipid levels among ethnic minorities are essential. Furthermore, this study has identified the typical risk factors for dyslipidemia components in Miao adults. These findings are extremely critical for identifying target groups with high risk factors to implement screening dyslipidemia. Given the worldwide prevalence of dyslipidemia, present findings have important public health significance for the prevention and control of dyslipidemia in ethnic minorities.

Abbreviations

CMEC: The China Multi-Ethnic Cohort Study; CVD: Cardiovascular diseases; OR: Odds ratios; CI: Confidence intervals; WHR: Waist-to-hip ratio; FBG: Fasting blood glucose; BMI: Body mass index; TG: Triglycerides; LDL-C: Low-density lipoprotein cholesterol; TC: Total cholesterol; AHA: American Heart Association; HDL-C: High-density lipoprotein cholesterol.

Declarations

Acknowledgements

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Authors' contributions

Each author has been involved in and contributed to this paper. F.N. carried out the statistical analysis, collected the data and wrote the manuscript. F.H., P.L. contributed to the study design of this paper. W.D., Y.W., H.G., Y.Y. and B.Z. participated in the data collection, study management and coordination. H.W. contributed to guide the paper and correcting the English. All author read and approved the final manuscript.

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Availability of data and materials

Currently, the database used to support this study are not freely available in view of participants' privacy protection but are available from the corresponding author on reasonable data request. Researchers interested in our study could contact the corresponding author Dr.Feng Hong (519490967@qq.com) who will review the data request.

Ethics approval and consent to participate

This study protocol was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Medical Ethical Committee of Sichuan University (K2016038) and the Ethics Committee of the Affiliated Hospital of Guizhou Medical University (2018[094]). And written informed consent was obtained from each subject.

Consent for publication

All authors read and approved to publication.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1 Definition of healthy behaviors and metabolic factors

Variables	Ideal	Intermediate	Poor
Smoking history	Non-smoker	Previous smoker (smoking cessation ≥ 1 year)	Current smoker
Drinking of alcohol	Never/nearly non-drinker	Occasional drinker	Regular drinker
Sleep duration, hr	7–8	5–6 or 9–10	< 5 or >10
BMI, kg/m ²	< 24	24–27.9	≥ 28
WHR	< 0.90 (Male) or < 0.85 (Female)	0.90–0.94 (Male) or 0.85–0.89 (Female)	≥ 0.95 (Male) or ≥ 0.90 (Female)
Blood pressure, mmHg	Non-drug therapy < 120/80	120–139/80–89 or taking anti-hypertensive drugs < 140/90	$\geq 140/90$
FBG, mmol/L	Non-drug therapy < 5.6	5.6–6.9 or taking anti-diabetic drugs < 5.6	≥ 7.0
Physical activity, (MET-hr/day)	$\geq$ P50	P25–P50	< P25
BMI body mass index, FBG fasting blood glucose, WHR waist-to-hip ratio, MET metabolic equivalent task.			

Table 2 Social demographic characteristics of participants

Variables	Total (n=5032)	Normal (n=3379)	Dyslipidemia (n=1653)	χ^2	P value
Gender (%)				114.7	< 0.001
Male	1845 (36.7)	1067 (57.8)	778 (42.2)		
		□□			
Female	3187 (63.3)	2312 (72.5)	875 (27.5)		
Age (years, %)				6.2	0.013
30 -39	862 (17.2)	647 (75.1)	215 (24.9)		
40 -49 ^{ac}	1478 (29.4)	994 (67.3)	484 (32.7)		
50 -59 ^{abde}	1396 (27.7)	849 (60.8)	547 (39.2)		
60 -69 ^{ac}	893 (17.7)	597 (66.9)	296 (33.1)		
70 -79 ^c	403 (8.0)	292 (72.5)	111 (27.5)		
Residence (%)				18.8	< 0.001
Rural	3584(71.2)	2472 (69.0)	1112 (31.0)		
Urban	1448(28.8)	907 (62.6)	541 (37.4)		
Educational level (%)				14.7	< 0.001
No formal school	2190 (43.5)	1504 (68.7)	686 (31.3)		
Primary school ^{acde}	687 (13.7)	475 (69.1)	212 (30.9)		
Middle school ^{bde}	1004 (20.0)	696 (69.3)	308 (30.7)		
High School or college ^{abc}	884 (17.5)	544 (61.5)	340 (38.5)		
University or above ^{abc}	267 (5.3)	160 (59.9)	107 (40.1)		
Occupation (%)				8.3	0.004
Farmers	1767 (35.1)	1255 (71.0)	512 (29.0)		
Workers ^{ade}	400 (7.9)	258 (64.5)	142 (35.5)		
Administration or manager ^{ae}	165 (3.3)	97 (58.8)	68 (41.2)		
Specialist ^{ae}	441 (8.8)	257 (58.3)	184 (41.7)		
Other occupations ^{abcd}	2259 (44.9)	1512 (66.9)	747 (33.1)		
Marital status (%)					
Married or cohabiting	4367 (86.8)	2917 (66.8)	1450 (33.2)	1.03	0.310
Separated or divorced	183 (3.6)	128 (69.9)	55 (30.1)		
Widowed	427 (8.5)	301 (70.5)	126 (29.5)		

Never married	55 (1.1)	33 (60.0)	22 (40.0)		
Family income (Yuan/year, %)				5.1	0.024
< 20,000	2101 (41.7)	1446 (68.8)	655 (31.2)		
20,000 -59,999	1650 (32.8)	1098 (66.5)	552 (33.5)		
60,000 -99,999	763 (15.2)	500 (65.5)	263 (34.5)		
≥100,000	518 (10.3)	335 (64.7)	183 (35.3)		
abcde, respectively, represent pairwise comparisons: compared with the first group, $P < 0.05$; compared with the second group, $P < 0.05$; compared with the third group, $P < 0.05$; compared with the fourth group, $P < 0.05$; compared with the fifth group, $P < 0.05$.					

Table 3 Different healthy behaviors and metabolic factors of dyslipidemia by gender

Healthy behaviors and	Male				Female			
metabolic factors	Total	Normal	Dyslipidemia	<i>P</i> value	Total	Normal	Dyslipidemia	<i>P</i> value
Smoking history (%)	0.604				0.212			
Ideal	780 (42.2)	454 (58.2)	326 (41.8)		3153 (98.9)	2284 (72.4)	869 (27.6)	
Intermediate	184 (10.0)	111 (60.3)	73 (39.7)		6 (0.2)	5 (83.3)	1 (16.7)	
Poor	881 (47.8)	502 (57.0)	379 (43.0)		28 (0.9)	23 (82.1)	5 (17.9)	
Drinking of alcohol (%)	0.008				0.130			
Ideal	541 (29.3)	351 (64.9)	190 (35.1)		1710 (53.7)	1212 (70.9)	498 (29.1)	
Intermediate	709 (38.4)	378 (53.3)	331 (46.7)		1172 (36.7)	882 (75.3)	290 (24.7)	
Poor	595 (32.3)	338 (56.8)	257 (43.2)		305 (9.6)	218 (71.5)	87 (28.5)	
Physical activity (%)	0.962				< 0.001			
Ideal	948 (51.4)	555 (58.5)	393 (41.5)		1568 (49.2)	1188 (75.8)	380 (24.2)	
Intermediate	445 (24.1)	243 (54.6)	202 (45.4)		813 (25.5)	579 (71.2)	234 (28.8)	
Poor	452 (24.5)	269 (59.5)	183 (40.5)		806 (25.3)	545 (67.6)	261 (32.4)	
WHR (%)	< 0.001				< 0.001			
Ideal	788 (42.7)	570 (72.3)	218 (27.7)		866 (27.2)	734 (84.8)	132 (15.2)	
Intermediate	462 (25.0)	254 (55.0)	208 (45.0)		722 (22.7)	550 (76.2)	172 (23.8)	
Poor	595 (32.3)	243 (40.8)	352 (59.2)		1599 (50.1)	1028 (64.3)	571 (35.7)	
BMI (%)	< 0.001				< 0.001			
Ideal	782 (42.4)	577 (73.8)	205 (26.2)		1239 (38.9)	1013 (81.8)	226 (18.2)	
Intermediate	776 (42.0)	376 (48.5)	400 (51.5)		1317 (41.3)	921 (69.9)	396 (30.1)	
Poor	287 (15.6)	114 (39.7)	173 (60.3)		631 (19.8)	378 (59.9)	253 (40.1)	
FBG (%)	< 0.001				< 0.001			
Ideal	1226 (66.5)	777 (63.4)	449 (36.6)		2475 (77.7)	1899 (76.7)	576 (23.3)	

Intermediate	458 (24.8)	235 (51.3)	223 (48.7)	577 (18.1)	359 (62.2)	218 (37.8)
Poor	161 (8.7)	55 (34.2)	106 (65.8)	135 (4.2)	54 (40.0)	81 (60.0)
Blood pressure (%)				< 0.001		< 0.001
Ideal	391 (21.2)	269 (68.8)	122 (31.2)	1292 (40.5)	1054 (81.6)	238 (18.4)
Intermediate	741 (40.2)	433 (58.4)	308 (41.6)	1121 (35.2)	783 (69.8)	338 (30.2)
Poor	713 (38.6)	365 (51.2)	348 (48.8)	774 (24.3)	475 (61.4)	299 (38.6)
Sleep duration (%)				0.642		0.047
Ideal	904 (49.0)	525 (58.1)	379 (41.9)	1675 (52.6)	1231 (73.5)	444 (26.5)
Intermediate	776 (42.1)	438 (56.4)	338 (43.6)	1304 (40.9)	945 (72.5)	359 (27.5)
Poor	165 (8.9)	104 (63.0)	61 (37.0)	208 (6.5)	136 (65.4)	72 (34.6)
<i>P</i> value was expressed as trend chi-square test.						
<i>BMI</i> body mass index, <i>FBG</i> fasting blood glucose, <i>WHR</i> waist-to-hip ratio.						

Table 4 The abnormal lipid components in different healthy behaviors and metabolic factors

Healthy behaviors and	TC		TG		LDL-C		HDL-C	
metabolic factors	≥ 6.22	<i>P</i> value	≥ 2.26	<i>P</i> value	≥ 4.14	<i>P</i> value	< 1.04	<i>P</i> value
Total	534 $\pm$ 10.6		1098 $\pm$ 21.8		385 $\pm$ 7.7		371 $\pm$ 7.4	
Smoking history (%)		0.902		< 0.001		0.804		< 0.001
Ideal	417 (10.6)		771 (19.6)		304 (7.7)		227 (5.8)	
Intermediate	23 (12.1)		52 (27.4)		12 (6.3)		20 (10.5)	
Poor	94 (10.3)		275 (30.3)		69 (7.6)		124 (13.6)	
Drinking of alcohol (%)		0.554		< 0.001		0.079		0.003
Ideal	248 (11.0)		412 (18.3)		191 (8.5)		143 (6.4)	
Intermediate	191 (10.2)		430 (22.9)		131 (7.0)		143 (7.6)	
Poor	95 (10.6)		256 (28.4)		63 (7.0)		85 (9.4)	
Physical activity (%)		0.006		0.067		0.014		0.017
Ideal	241 (9.6)		513 (20.4)		172 (6.8)		156 (6.2)	
Intermediate	136 (10.8)		302 (24.0)		99 (7.9)		115 (9.1)	
Poor	157 (12.5)		283 (22.5)		114 (9.1)		100 (7.9)	
WHR (%)		< 0.001		< 0.001		< 0.001		< 0.001
Ideal	110 (6.7)		196 (11.9)		58 (3.5)		68 (4.1)	
Intermediate	107 (9.0)		270 (22.8)		76 (6.4)		74 (6.3)	
Poor	317 (14.4)		632 (28.8)		251 (11.4)		229 (10.4)	
BMI (%)		< 0.001		< 0.001		< 0.001		< 0.001
Ideal	160 (7.9)		230 (11.4)		115 (5.7)		82 (4.1)	
Intermediate	242 (11.6)		550 (26.3)		174 (8.3)		185 (8.8)	
Poor	132 (14.4)		318 (34.6)		96 (10.5)		104 (11.3)	
FBG (%)		< 0.001		< 0.001		< 0.001		< 0.001
Ideal	321 (8.7)		645 (17.4)		234 (6.3)		224 (6.1)	
Intermediate	144 (13.9)		308 (29.8)		112 (10.8)		99 (9.6)	
Poor	69 (23.3)		145 (49.0)		39 (13.2)		48 (16.2)	
Blood pressure (%)		< 0.001		< 0.001		< 0.001		0.001
Ideal	96 (5.7)		210 (12.5)		84 (5.0)		92 (5.5)	
Intermediate	205 (11.0)		424 (22.8)		150 (8.1)		153 (8.2)	
Poor	233 (15.7)		464 (31.2)		151 (10.2)		126 (8.5)	
Sleep duration (%)		0.304		0.137		0.054		0.361
Ideal	267 (10.4)		544 (21.1)		189 (7.3)		179 (6.9)	
Intermediate	220 (10.6)		464 (22.3)		153 (7.4)		165 (7.9)	
Poor	47 (12.6)		90 (24.1)		43 (11.5)		27 (7.2)	

<i>P</i> value was expressed as trend chi-square test.
<i>BMI</i> body mass index, <i>FBG</i> fasting blood glucose, <i>WHR</i> waist-to-hip ratio.
<i>TC</i> total cholesterol, <i>TG</i> triglyceride, <i>LDL-C</i> low-density lipoprotein cholesterol, <i>HDL-C</i> high-density lipoprotein cholesterol.

Figures

Figure 1

Prevalence of dyslipidemia components by classification of overall healthy behaviors and metabolic factors score. Compared with ideal group, **meant $P < 0.01$, ***meant $P < 0.001$. TC total cholesterol, TG triglyceride, LDL-C low-density lipoprotein cholesterol, HDL-C high-density lipoprotein cholesterol.

Figure 2

Associations between risks of dyslipidemia components and healthy behaviors, metabolic factors in men. Ideal was considered as reference in the model; OR were adjusted for age, residence, education level, and occupation. BMI body mass index, FBG fasting blood glucose, WHR waist-to-hip ratio.

Figure 3

Associations between risk of dyslipidemia components and healthy behaviors, metabolic factors in women. Ideal was considered as reference in the model; OR was adjusted for age, residence, education level, and occupation. BMI body mass index, FBG fasting blood glucose, WHR waist-to-hip ratio.