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Original Article

Prevalence of dyslipidemia and its risk factors in the Chinese Maonan and Han populations

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Abstract: Chinese Maonan nationality is an isolated minority with a population of 107,166 in 2010. They mainly reside in several townships of Huanjiang Maonan Autonomous County in the Northwestern of Guangxi, China. The prevalence and epidemiological characters of dyslipidemia in this ethnic group have not been studied previously. The objective of the present study was to assess the difference in serum lipid levels, the prevalence of dyslipidemia and the risk factors in the Maonan and Han populations. A cross-sectional study of dyslipidemia was conducted in 1332 unrelated subjects of Maonan and 1344 participants of Han ethnic groups. Information on epidemiological survey was collected with standardized questionnaires. Anthropometric and biochemical data were obtained. Serum total cholesterol (TC), triglyceride (TG) and low-density lipoprotein cholesterol (LDL-C) levels were higher but high-density lipoprotein cholesterol (HDL-C), apolipoprotein (Apo) A1 and ApoB levels were lower in Maonan than in Han (P < 0.01-0.001). The prevalence of hypercholesterolemia (40.09% *vs*. 33.93%, P < 0.01), hypertriacylglycerolemia (29.13% *vs*. 16.52%, P < 0.001) and hyperlipidemia (51.95% *vs*. 41.07%, P < 0.001) was higher in Maonan than in Han. The anormal rates of HDL-C, LDL-C, and ApoA1 were also higher but the anormal rate of ApoB was lower in Maonan than in Han (P < 0.001 for all). The effects of sex, age, body mass index (BMI), hypertension, alcohol consumption, and cigarette smoking on serum lipid levels and the prevalence of dyslipidemia were different between the Maonan and Han populations. The prevalence of hyperlipidemia was positively correlated with BMI, hypertension and the intakes of total energy and total fat in Maonan (P < 0.01 for all), whereas it was positively associated with BMI, and the intakes of total energy and total fat in Han (P < 0.01). The difference in the serum lipid levels and the prevalence of dyslipidemia between the two populations might result from the combined effects of different BMI, hypertension, diet, lifestyle, and genetic background.

Keywords: Lipids, apolipoproteins, dyslipidemia, hyperlipidemia, cross-sectional studies, risk factors

Introduction

Dyslipidaemia, abnormal amounts of lipids and/or lipoproteins in the blood such as elevated levels of total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), and apolipoprotein (Apo) B, and reduced levels of high-density lipoprotein cholesterol (HDL-C) and ApoA1 is a global health problem [1-3]. It is also a major modifiable risk factor for cardiovascular disease accounting for an estimated 4 million deaths per year worldwide [4, 5]. With the development of national economy, improvement of living standards, progression of urbanization and industrialization, changes of associated lifestyle, and longer life expectancy, the prevalence of dylipidemia and its cardiovascular complications have increased dramatically over the past decade in China. The prevalence of dyslipidemia in adults aged 18 and older was 18.6% according to the Chinese National Nutrition and Health Survey in 2002 [6]. The results from the International Collaborative Study of Cardiovascular Disease in Asia

(InterAsia), conducted during 2000 to 2001, demonstrated that the prevalence of the combined borderline dyslipidemia and dyslipidemia in Chinese adults was 53.6% (aged 35-74 years) [7]. In a population-based study conducted in Shanghai, with 14,385 adults of both sexes, 36.5% of the population had dyslipidemia, 3.8% had mixed hyperlipidemia, 24.9% had isolated hypertriglyceridemia, 3.2% had isolated hypercholesterolemia, and 4.7% had low HDL-C [8]. In a population of 11,956 adults aged ≥ 35 years among rural areas in Liaoning Providence, 16.4% had high TC, 13.8% had low HDL-C, 7.6% had high LDL-C, and 17.3% had high TG concentrations. The prevalence of both borderline dyslipidemia and dyslipidemia was 47.8%, 13.8%, 25.7% and 30.7% for TC, HDL-C, LDL-C and TG, respectively. Detailed analysis indicated that 36.9% of this population had at least one type of dyslipidemia and 64.4% had at least one type of abnormal lipid levels [9]. A recent cross-sectional study in the general population aged > 18 years in China showed that the overall prevalence of dyslipidemia was 34.0% (35.1% in urban and 26.3% in rural areas). The prevalence of dyslipidemia was significantly higher in males than in females (41.9% *vs*. 32.5%; $P < 0.001$) [10]. Serum lipid levels and the prevalence of dyslipidemia are determined by multiple environmental factors such as poor diet [11, 12], unhealthy lifestyle [12, 13], physical inactivity [14, 15]; genetic factors [16] and their interactions [17, 18]. In addition, there may be an area [10, 19, 20] and ethnic/racial [11, 21, 22] difference in the prevalence and management [23-25] of dyslipidemia. Safford et al. [23, 24] have showed that hyperlipidemia was more aggressively treated and controlled among white men compared with white women, black men, and especially black women among those at highest risk for coronary heart disease. Effective management of dyslipidemia, by pharmacological treatment or lifestyle changes, is known to reduce the rate of cardiovascular disease morbidity and mortality [26-28].

There are 56 ethnic groups in China, Han is the largest group and Maonan is one of the 55 minorities with a population of 107,166 (Rank 37) according to the sixth national census statistics of China in 2010. Approximately 80% of the total Maonan people reside in the Huanjiang Maonan Autonomous County in the Northwestern of Guangxi Zhuang Autonomous Region, which is located in Southwestern China, especially in the three townships of Shangnan, Zhongnan and Xianan. Thus, the county of Huanjiang is called as “the hometown of Maonan people”. The remaining Maonan people are scattered in the counties of Yishan, Nandan, Du’an, etc. The Maonan people have their own national language, which belongs to the branch of Zhuang and Dong Languages, Han and Zang Language System, and they don’t have their own written language. In history, they were known as “Maotan, Angtan, and Maonan” successively, but they call themselves Anan, meaning “the people who live in this area or local people”. This implies that the Maonan people are the aborigines of this area. They are actually the aboriginal ethnic group of Lingxi area, and Lingxi used to be the name of today’s Guangxi Zhuang Autonomous Region in ancient times. Recent phylogenetic and principal component analyses revealed that the Maonan people belong to the southeastern Asian group and are most closely related to the Buyi people [29]. Several previous studies have showed that the genetic relationship between Maonan nationality and other minorities in Guangxi [30, 31] was much closer than that between Maonan and Han nationalities [32, 33]. In spite of a very small population, the Maonan ethnic group is well known in China for its long history and unique culture. The special customs and culture, including their clothing, intra-ethnic marriages, dietary habits, lifestyle factors are different from those of local Han ethnic group [34]. It is well-known that precise estimation of the frequency and patterns of dyslipidemia is essential for proper planning of health actions for prevention of negative clinical consequences. To the best of our knowledge, however, the serum lipid profiles, the prevalence of dyslipidemia and the risk factors in this isolated population have not been reported previously. Therefore, the present study was undertaken to compare the differences in serum lipid levels and their risk factors in the Chinese Maonan and Han populations from the same region.

Material and methods

Participants

The study adopted a multistage, stratified and randomized sampling scheme [35-37]. (i) 36

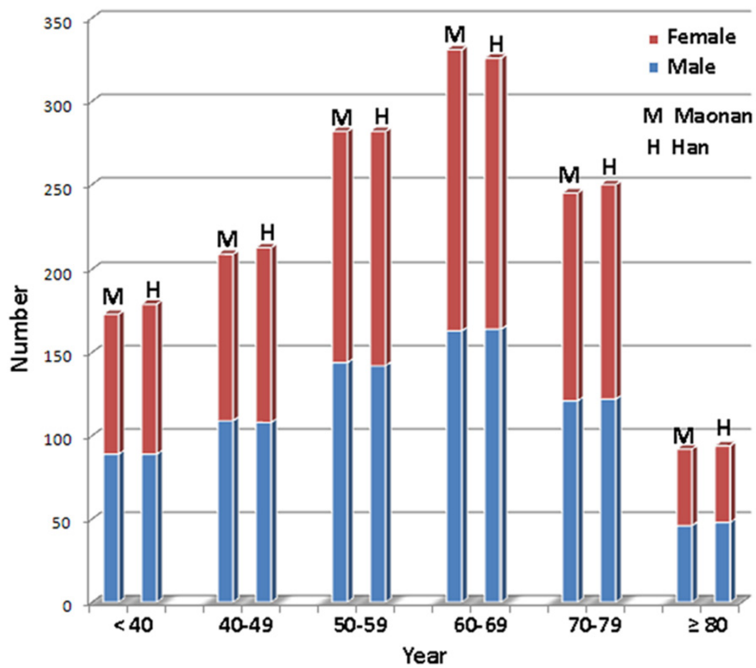

Figure 1. Comparison of the sex and age structure between the Maonan and Han populations. The female/male ratio in < 40, 40-49, 50-59, 60-69, 70-79 and ≥ 80 y age subgroups was 89/84, 109/100, 144/138, 163/168, 121/124, and 46/46 in Maonan ethnic group, and 89/90, 108/105, 142/140, 164/162, 122/128, and 48/46 in Han nationality, respectively.

villages (resident communities; inhabitants) were selected randomly from the three Maonan settled townships (12 villages for each township). (ii) Sex and age subgroups in each village were stratified for the survey. (iii) 50 households within each village or community were randomly selected. (iv) One adult, aged ≥ 18 years was selected randomly from each household using a Kish selection table [38]. A total of 1800 Maonan subjects were asked to participate in the study and 1548 subjects actually participated. The response rate was 86%. A total of 216 persons (13.95%) with a history and/or evidence of other diseases were excluded from the samples. The sampling of the Han population was also done by the same method. A total of 1800 Han subjects were asked to participate in the study and 1602 subjects actually participated. The response rate was 89%. A total of 258 persons (16.10%) were excluded. Inclusion criteria were: (i) three generations of ancestors are Han or Maonan; (ii) unrelated permanent residents (men or women) aged ≥ 18 years; (iii) with no severe chronic disease or systemic disease; (iv) willing and able to give informed consent; and (v) with complete data on key research variables. Mentally and physically too ill subjects and retarded patients, temporary residents (< 6 months), and armed forces personnel, prisoners, hospitalized patients, monks, and nuns, were not invited to participate. Subjects with medical diseases such as cardiovascular (heart attack, myocardial infarction, stroke, or congestive heart failure), hepatic, renal, thyroid diseases, and diabetes mellitus or fasting blood glucose ≥ 7.0 mmol/L determined by glucose meter, or pregnant women have been excluded. This study included 1332 unrelated subjects of Maonan nationality and 1344 participants of Han nationality. All subjects were rural agricultural workers from the same area. The subjects of Maonan included 660 males (49.55%) and 672 females (50.45%), age ranged from 18 to 96 (mean 57.41±15.23) years. Ages < 40, 40-49, 50-59, 60-69, 70-79 and ≥ 80 years were 173 (12.99%), 209 (15.69%), 282 (21.17%), 331 (24.85%), 245 (18.39%) and 92 (6.91%) people; respectively. The participants of Han included 671 men (49.93%) and 673 women (50.07%), age ranged from18 to 98 (mean 57.26±15.15) years. Ages < 40, 40-49, 50-59, 60-69, 70-79 and ≥ 80 years were 179 (13.32%), 213 (15.85%), 282 (20.98%), 326 (24.26%), 250 (18.60%) and 94 (6.99%) persons; respectively. The sex and age structure between the two populations was shown in **Figure 1**. The Ethics Committee of the First Affiliated Hospital, Guangxi Medical University approved the study protocol prior to data collection, and all participants provided informed consent by signature or by fingerprint (if the participant was illiterate) after they had been informed of the objectives, benefits, medical items and confidentiality agreement of personal information. All procedures were performed in accordance with ethical standards.

Epidemiological survey

The survey was carried out using internationally standardized methods. Before the survey, all of the research assistants were trained to assure the quality and validity of the measurements. The training projects included the purpose of this study, completion of the questionnaire, the standard method of measurements, the importance of standardization and the study procedures. A strict test was administered after this training, and only those who scored perfectly on the test were accepted as investigators. During data collection, our supervisors assessed the completeness and consistency of the questionnaire after each interview. Data on demographic characteristics, educational level, lifestyle risk factors, and medical history were collected by trained health professionals with standardized questionnaires. Dietary intake was assessed by the single 24-h dietary recall method. All subjects were requested to maintain their usual diet before testing [39]. The intakes of macronutrients from the ingredients were calculated by using the 2002 Chinese Food Composition Table [40]. Physical activity was ascertained with the use of a modified version of the Harvard Alumni Physical Activity Questionnaire [41]. Educational level was divided into primary school or below, middle school and high school or above. The alcohol information included questions about the number of grams of rice wine, wine, beer, or liquor consumed during the preceding 12 months. Current smoking was defined as more than one cigarette per day. Participants who reported having smoked ≥ 100 cigarettes during their lifetime were classified as current smokers if they currently smoked and former smokers if they did not [42]. Harmful use of alcohol was defined as daily consumption of pure alcohol ≥ 15 g for women and ≥ 25 g for men [43]. Sitting blood pressure was measured three times at 5-min intervals after at least 5 min of rest using a standardized mercury sphygmomanometer, and the average of the three measurements was used for the blood pressure analyses. Systolic blood pressure was determined by the first Korotkoff sound, and diastolic blood pressure by the fifth Korotkoff sound. Body weight was measured using a portable balance scale to the nearest 0.5 kg with the participants in light weight clothing. Height was measured using a portable steel measuring device to the nearest 0.1 cm with the participants without shoes. Body mass index (BMI, kg/m^2) was calculated as weight in kilograms divided by the square of the height in meters. Waist circumference was measured at the midpoint between the lower rib and upper margin of the iliac crest using a non-elastic tape (to the nearest 0.1 cm), with the participants standing at the end of normal expiration.

Biochemical analysis

Venous blood samples of all subjects were obtained from an antecubital vein. For blood collection, the individuals were instructed to fast for 12 hours before and to abstain from alcohol for 3 days before the test as well as to avoid physical activity or effort on the day of the test. Serum was subsequently isolated from the whole blood. Serum TC, TG, HDL-C, and LDL-C levels were assayed by enzymatic methods using commercially available kits (RANDOX Laboratories Ltd., Ardmore, Diamond Road, Crumlin Co. Antrim, United Kingdom, BT29 4QY; or Daiichi Pure Chemicals Co., Ltd., Tokyo, Japan), respectively. Serum ApoA1 and ApoB levels were measured by an immunoturbidimetric assay (RANDOX Laboratories Ltd.). All determinations were analyzed using an autoanalyzer (Type 7170A; Hitachi Ltd., Tokyo, Japan) [35-37].

Diagnostic criteria

The normal values of serum TC, TG, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1 to ApoB in our hospital were 3.10-5.17, 0.56-1.70, 1.16-1.42, 2.70-3.10 mmol/L, 1.20-1.60, 0.80-1.05 g/L, and 1.00-2.50, respectively. The individuals with TC > 5.17 mmol/L and/or TG > 1.70 mmol/L were defined as hyperlipidemic [35-37]. Hypertension was defined as an average systolic pressure of 140 mmHg or greater and/or an average diastolic pressure of 90 mmHg or greater, and/or self-reported pharmacological treatment for hypertension within the 2 weeks prior to the interview [44, 45]. Normal weight, overweight and obesity were defined as a BMI < 24, 24 to 28, and > 28 kg/m^2, respectively [37, 44-46].

Statistical analysis

The mean and standard deviation of continuous variables were expressed as mean ± SD, and percentage was calculated for categorical variables. All analyses were performed with SPSS 11.5 (SPSS Inc., Chicago, Illinois). Differences in mean values were assessed

Table 1. General characteristics, serum lipid levels and the prevalence of dyslipidemia between the Maonan and Han populations

Characteristics	Maonan (*n* = 1332)	Han (*n* = 1344)	t (x^2)	*p*
Age (years)	57.41±15.23	57.26±15.15	0.255	0.798
Male/Female	660/672	671/673	0.038	0.846
Education level (years)	5.59±3.95	4.17±4.15	9.065	0.000
Physical activity (h/week)	44.38±8.89	43.98±6.67	1.317	0.188
Height (cm)	154.74±8.27	146.48±6.53	28.688	0.000
Weight (kg)	54.11±11.28	48.01±6.84	16.932	0.000
Body mass index (kg/m^2)	22.44±3.51	21.29±2.54	9.716	0.000
> 24 kg/m^2 [*n* (%)]	368 (27.67)	311 (23.14)	7.115	0.008
Waist circumference (cm)	79.39±11.53	74.09±9.95	12.734	0.000
Alcohol consumption [*n* (%)]	322 (24.17)	590 (43.90)	115.855	0.000
Cigarette smoking [*n* (%)]	352 (26.43)	416 (30.95)	6.697	0.010
Energy (kJ/day)	8994.33±503.11	8838.66±487.36	8.129	0.010
Carbohydrate (g/day)	421.08±28.64	389.65±26.45	29.495	0.000
Protein (g/day)	50.22±7.73	47.79±7.12	8.459	0.000
Total fat (g/day)	29.44±5.77	25.34±4.81	19.973	0.000
Dietary cholesterol (mg/day)	198.36±88.15	171.52±92.17	7.697	0.000
Prevalence of hypertension [*n* (%)]	647 (48.57)	414 (30.80)	88.283	0.000
Total cholesterol (TC, mmol/l)	5.01±1.06	4.90±0.98	2.788	0.005
TC > 5.17 mmol/l [*n* (%)]	534 (40.09)	456 (33.93)	10.896	0.001
Triglyceride (TG, mmol/l)	1.63±1.71	1.34±1.27	4.983	0.000
TG > 1.70 mmol/l [*n* (%)]	388 (29.13)	222 (16.52)	60.457	0.000
HDL-C (mmol/l)	1.60±0.39	1.98±0.50	-21.908	0.000
HDL-C < 1.16 mmol/l [*n* (%)]	138 (10.36)	33 (2.46)	69.886	0.000
LDL-C (mmol/l)	2.86±0.82	2.70±0.72	5.365	0.000
LDL-C > 3.10 mmol/l [*n* (%)]	478 (35.89)	311 (23.14)	52.274	0.000
Apolipoprotein A1 (ApoA1, g/l)	1.39±0.31	1.46±0.25	-6.433	0.000
ApoA1 < 1.20 g/l [*n* (%)]	248 (18.62)	152 (11.31)	28.112	0.000
Apolipoprotein B (ApoB, g/l)	0.88±0.20	0.94±0.22	-7.380	0.000
ApoB > 1.05 g/l [*n* (%)]	233 (17.49)	387 (28.79)	48.006	0.000
ApoA1/ApoB	1.66±0.57	1.65±0.57	0.454	0.650
ApoA1/ApoB < 1.00 [*n* (%)]	54 (4.05)	48 (3.57)	0.425	0.514
Prevalence of hyperlipidemia [*n* (%)]	692 (51.95)	552 (41.07)	31.837	0.000

HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC > 5.17 mmol/l, hypercholesterolaemia; TG > 1.70 mmol/l, hypertriacylglycerolaemia.

using analysis of covariance (ANCOVA) and the Student's unpaired *t* test. Sex, age, BMI, hypertension, alcohol consumption, cigarette smoking were included in the statistical models as covariates. The difference of percentage was tested by the Chi-square test. In order to evaluate the risk factors for hyperlipidemia, unconditional logistic regression analyses were performed separately for the combined population of Maonan and Han, Maonan, and Han; respectively. For the multiple logistic regression analysis, the data were recorded as follows: ethnic group: Maonan = 0, Han = 1; sex: female = 0, male = 1; age (year): < 40 = 0, 40-49 = 1, 50-59 = 2, 60-69 = 3, 70-79 = 4, ≥ 80 = 5; BMI (kg/m^2): ≤ 24 = 0, > 24 = 1; = 1; blood pressure: normotensives = 0, hypertensives = 1; educational level: 0 year = 0, 1-6 years = 1, 7-9 years = 2, 10-12 years = 3, and ≥ 12 years = 4; alcohol consumption (g/day): nondrinkers = 0, < 25 (females < 15) = 1, ≥ 25 (females ≥ 15) = 2; cigarette smoking (cigarettes/day): nonsmokers = 0, < 10 = 1, ≥ 10 = 2; and so on. Total intake of each nutrient was summed over all foods consumed. The Matlab5.0 software was used for processing these procedures by the method of multiplication of matrix [47]. All statistical tests were two-tailed and A P value < 0.05 was considered statistically significant.

Results

General characteristics

The general characteristics between the two populations are shown in **Table 1**. The levels of education, height, weight, BMI, waist circumference, the intakes of energy, carbohydrate, protein, cholesterol, and total fat; and the prevalence of hypertension were higher in Maonan than in Han (P < 0.01-0.001), whereas the percentage of subjects who consumed alcohol or smoked cigarettes were lower in Maonan than in Han (P < 0.01-0.001). There were no significant differences in the levels of physical activity, age and sex structure between the two populations (P > 0.05 for all).

Serum lipid levels and the prevalence of dyslipidemia

As listed in **Table 1**, the levels of TC, TG and LDL-C were higher but the levels of HDL-C, ApoA1 and ApoB were lower in Maonan than in Han (P < 0.01-0.001). There was no significant difference in the ratio of ApoA1 to ApoB between the two populations (P > 0.05). The prevalence of hypercholesterolemia (40.09% *vs*. 33.93%, P < 0.01), hypertriacylglycerolemia (29.13% *vs*. 16.52%, P < 0.001) and hyperlipidemia (51.95% *vs*. 41.07%, P < 0.001) was higher in Maonan than in Han. The anormal rates of HDL-C (10.36% *vs*. 2.46%, P < 0.001), LDL-C (35.89% *vs*. 23.14%, P < 0.001), and ApoA1 (18.62% *vs*. 11.31%, P < 0.001) were also higher in Maonan than in Han. However, the anormal rate of ApoB was lower in Maonan than in Han (17.49% *vs*. 28.79%, P < 0.001). There was no significant difference in the anormal rate of the ApoA1/ApoB ratio between the two populations (4.05% *vs*. 3.57%, P > 0.05).

Sex, BMI, hypertension, alcohol, smoking, and age on serum lipid levels

The effects of sex, BMI, hypertension, alcohol consumption, cigarette smoking, and age on serum lipid levels between Maonan and Han are described in **Table 2**. For the Maonan population, the levels of HDL-C and ApoA1 were higher in males than in females (P < 0.01 for each); the levels of TC, TG, LDL-C and ApoB were higher but the levels of HDL-C, ApoA1 and the ratio of ApoA1 to ApoB were lower in subjects with a BMI > 24 kg/m^2 than in those with a BMI ≤ 24 kg/m^2 (P < 0.001 for all); the levels of TC, TG, LDL-C and ApoB were higher but the levels of HDL-C and the ratio of ApoA1 to ApoB were lower in hypertensives than in normotensives (P < 0.05-0.001); the levels of HDL-C and the ratio of ApoA1 to ApoB were higher but the levels of LDL-C and ApoB were lower in drinkers than in nondrinkers or in smokers than in nonsmokers (P < 0.05-0.001); and the levels of TC, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1 to ApoB were also different among the 6 age subgroups (P < 0.05-0.001).

For the Han population, the levels of TC, LDL-C, ApoA1 and ApoB were higher in females than in males (P < 0.01-0.001); the levels of TC, TG, LDL-C and ApoB were higher but the levels of HDL-C, ApoA1 and the ratio of ApoA1 to ApoB were lower in subjects with a BMI > 24 kg/m^2 than in those with a BMI ≤ 24 kg/m^2 (P < 0.05-0.001); the levels of TC, TG and ApoA1 were higher in hypertensives than in normotensives (P < 0.01-0.001); the levels of HDL-C, ApoA1 and the ratio of ApoA1 to ApoB were higher but the levels of TC and LDL-C were lower in drinkers than in nondrinkers (P < 0.01-0.001); the ratio of ApoA1 to ApoB was higher but the levels of TC, LDL-C and ApoB were lower in smokers than in nonsmokers (P < 0.001 for all); and the levels of TC, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1 to ApoB were also different among the 6 age subgroups (P < 0.01-0.001).

Sex, BMI, hyperlipidemia, alcohol, smoking, and age on the prevalence of dyslipidemia

The effects of sex, BMI, hypertension, alcohol consumption, cigarette smoking, and age on the prevalence of dyslipidemia between the two populations are summarized in **Table 3**. For the Maonan population, the anormal rates of HDL-C, ApoA1 and the ratio of ApoA1 to ApoB were higher in females than in males (P < 0.01-0.001); the anormal rates of TC, TG, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1 to ApoB were higher in subjects with a BMI > 24 kg/m^2 than in those with a BMI ≤ 24 kg/m^2 (P < 0.01-0.001); the anormal rates of TC, TG, LDL-

Table 2. Effects of sex, BMI, hypertension, alcohol consumption, cigarette smoking, and age on serum lipid levels between the Maonan and Han populations

Characteristics	*n*	TC (mmol/L)	TG (mmol/L)	HDL-C (mmol/L)	LDL-C (mmol/L)	ApoA1 (g/L)	ApoB (g/L)	ApoA1/ ApoB
Maonan								
Male	660	4.99±1.16	1.62±1.88	1.63±0.38	2.84±0.79	1.41±0.36	0.88±0.20	1.69±0.63
Female	672	5.02±0.96	1.64±1.53	1.57±0.40[b]	2.88±0.85	1.36±0.25[b]	0.88±0.19	1.64±0.51
BMI ≤ 24 (kg/m²)	964	4.91±1.10	1.38±0.83	1.66±0.39	2.80±0.80	1.41±0.34	0.85±0.19	1.74±0.61
BMI > 24 (kg/m²)	368	5.24±0.94[c]	2.28±2.87[c]	1.45±0.36[c]	3.03±0.85[c]	1.32±0.23[c]	0.96±0.19[c]	1.45±0.41[c]
Normotensive	685	4.89±0.90	1.53±2.09	1.63±0.39	2.79±0.76	1.40±0.36	0.85±0.18	1.72±0.60
Hypertensive	647	5.13±1.20[c]	1.74±1.19[a]	1.57±0.39[b]	2.94±0.87[c]	1.38±0.25	0.91±0.21[c]	1.60±0.54[c]
Nondrinker	1010	5.02±0.99	1.62±1.36	1.59±0.39	2.91±0.83	1.39±0.33	0.90±0.20	1.64±0.60
Drinker	322	4.94±1.27	1.65±2.53	1.64±0.39[a]	2.73±0.77[c]	1.39±0.24	0.84±0.18[c]	1.74±0.49[b]
Nonsmoker	980	5.04±0.99	1.65±1.37	1.58±0.39	2.91±0.84	1.38±0.24	0.90±0.20	1.62±0.51
Smoker	352	4.91±1.24	1.57±2.43	1.65±0.39[b]	2.72±0.76[c]	1.42±0.45	0.84±0.18[c]	1.78±0.72[c]
Age < 40	173	5.28±1.50	1.83±3.20	1.57±0.29	2.96±0.81	1.33±0.20	0.91±0.19	1.53±0.38
40-49	209	4.91±0.95	1.53±1.23	1.67±0.39	2.76±0.84	1.41±0.23	0.84±0.17	1.77±0.53
50-59	282	4.76±0.89	1.51±1.41	1.59±0.43	2.67±0.75	1.37±0.27	0.82±0.19	1.77±0.57
60-69	331	5.04±0.93	1.57±1.07	1.61±0.40	2.96±0.78	1.43±0.47	0.91±0.20	1.66±0.73
70-79	245	5.00±1.09	1.78±1.80	1.55±0.40	2.90±0.89	1.37±0.24	0.93±0.21	1.56±0.51
≥ 80	92	5.31±1.03	1.66±0.89	1.65±0.36	3.05±0.81	1.41±0.21	0.91±0.19	1.60±0.39
F for 6 age groups	-	7.376	1.359	2.735	6.396	3.038	13.262	7.220
P for 6 age groups	-	0.000	0.237	0.018	0.000	0.009	0.000	0.000
Han								
Male	671	4.80±1.03[y]	1.38±1.54[x]	1.96±0.54[z]	2.63±0.74[z]	1.44±0.25	0.92±0.22[z]	1.66±0.62
Female	673	4.99±0.91[c]	1.30±0.92[z]	2.00±0.46[z]	2.77±0.70[c,y]	1.48±0.24[b,z]	0.96±0.21[c,z]	1.63±0.51
BMI ≤ 24 (kg/m²)	1033	4.80±0.93[x]	1.19±0.85[z]	2.02±0.50[z]	2.64±0.71[z]	1.47±0.25[z]	0.92±0.22[z]	1.69±0.60
BMI > 24 (kg/m²)	311	5.23±1.05[c]	1.85±2.07[c,x]	1.85±0.50[c,z]	2.90±0.74[c,x]	1.44±0.23[a,z]	1.01±0.21[c,y]	1.49±0.42[c]
Normotensive	930	4.83±0.92	1.24±0.97[z]	1.97±0.48[z]	2.68±0.70[y]	1.45±0.23[y]	0.94±0.20[z]	1.62±0.43[z]
Hypertensive	414	5.06±1.08[c]	1.56±1.75[c]	1.99±0.56[z]	2.74±0.77[z]	1.49±0.28[b,z]	0.96±0.25[z]	1.70±0.79[x]
Nondrinker	754	4.96±0.99	1.29±1.05[z]	1.93±0.45[z]	2.82±0.76[x]	1.44±0.24[z]	0.95±0.23[z]	1.61±0.47
Drinker	590	4.82±0.95[b]	1.40±1.50	2.05±0.56[c,z]	2.55±0.64[c,z]	1.48±0.25[b,z]	0.93±0.21[z]	1.70±0.57[b]
Nonsmoker	928	4.98±0.94	1.31±1.04[z]	1.98±0.47[z]	2.79±0.69[z]	1.46±0.23[z]	0.97±0.21[z]	1.58±0.44
Smoker	416	4.72±1.03[c,x]	1.41±1.68	1.98±0.57[z]	2.51±0.76[c,z]	1.45±0.27	0.88±0.22[c,y]	1.78±0.76[c]
Age < 40	179	4.71±0.96[z]	1.33±1.25	1.88±0.47[z]	2.63±0.73[z]	1.42±0.25[z]	0.89±0.20	1.65±0.41[y]
40-49	213	4.99±1.17	1.53±2.26	1.99±0.46[z]	2.72±0.83	1.47±0.23[y]	0.95±0.23[z]	1.64±0.45[y]
50-59	282	4.99±0.92[y]	1.26±0.92[x]	2.02±0.55[z]	2.78±0.81	1.48±0.24[z]	0.96±0.22[z]	1.64±0.57[y]
60-69	326	4.88±0.77[x]	1.36±1.13[x]	2.00±0.47[z]	2.65±0.60[z]	1.49±0.25[x]	0.90±0.20	1.78±0.75[x]
70-79	250	4.81±1.10	1.24±0.69[z]	2.03±0.51[z]	2.64±0.70[z]	1.46±0.24[z]	0.95±0.21	1.61±0.47
≥ 80	94	5.06±0.90	1.34±0.52[y]	1.77±0.55	2.93±0.52	1.32±0.21[y]	1.07±0.24[z]	1.29±0.33[z]
F for 6 age groups	-	3.187	1.506	5.725	3.664	8.832	11.864	11.761
P for 6 age groups	-	0.007	0.185	0.000	0.003	0.000	0.000	0.000

TC, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; ApoA1, apolipoprotein A1; ApoB, apolipoprotein B; ApoA1/ApoB, the ratio of apolipoprotein A1 to apolipoprotein B; BMI, body mass index; [a]$P < 0.05$, [b]$P < 0.01$ and [c]$P < 0.001$ in comparison with male, BMI ≤ 24 (kg/m²), normotensive, nondrinker, or nonsmoker of the same ethnic group; [x]$P < 0.05$, [y]$P < 0.01$ and [z]$P < 0.001$ in comparison with the same subgroup of the Maonan population.

C, ApoB, and the ratio of ApoA1 to ApoB were higher in hypertensives than in normotensives ($P < 0.001$ for all); the anormal rates of TC, TG, HDL-C, ApoB, and the ratio of ApoA1 to ApoB were lower in drinkers than in nondrinkers ($P <$ 0.05-0.01); the anormal rates of TC, TG, HDL-C, LDL-C, ApoB, and the ratio of ApoA1 to ApoB were lower in smokers than in nonsmokers ($P <$ 0.05-0.001); and the anormal rates of TC, TG, LDL-C, ApoB, and the ratio of ApoA1 to ApoB were also different among the 6 age subgroups ($P <$ 0.05-0.001).

Table 3. Effects of sex, BMI, hypertension, alcohol consumption, cigarette smoking, and age on the prevalence of dyslipidemia between the Maonan and Han populations [*n* (%)]

Characteristics	*n*	TC > 5.17 mmol/L	TG > 1.70 mmol/L	HDL-C < 1.16 mmol/L	LDL-C > 3.10 mmol/L	Apo A1 < 1.20 g/L	Apo B > 1.05 g/L	ApoA1/ApoB < 1.00
Maonan								
Male	660	253 (38.33)	194 (29.39)	50 (7.58)	245 (37.12)	100 (15.15)	120 (18.18)	16 (2.42)
Female	672	281 (41.82)	194 (28.87)	88 (13.10)^{c}	233 (34.67)	148 (22.02)^{b}	113 (16.82)	38 (5.65)^{b}
BMI ≤ 24 (kg/m^2)	964	341 (35.37)	214 (22.20)	74 (7.68)	310 (32.16)	161 (16.70)	129 (13.38)	18 (1.87)
BMI > 24 (kg/m^2)	368	193 (52.45)^{c}	174 (47.28)^{c}	64 (17.39)^{c}	168 (45.65)^{c}	87 (23.64)^{b}	104 (28.26)^{c}	36 (9.78)^{c}
Normotensive	685	238 (34.74)	160 (23.36)	68 (9.93)	215 (31.39)	119 (17.37)	88 (12.85)	14 (2.04)
Hypertensive	647	296 (45.75)^{c}	228 (35.24)^{c}	70 (10.82)	263 (40.65)^{c}	129 (19.94)	145 (22.41)^{c}	40 (6.18)^{c}
Nondrinker	1010	421 (41.68)	310 (30.69)	115 (11.39)	375 (37.13)	197 (19.51)	189 (18.71)	50 (4.95)
Drinker	322	113 (35.09)^{a}	78 (24.22)^{a}	23 (7.14)^{a}	103 (31.99)	51 (15.84)	44 (13.66)^{a}	4 (1.24)^{b}
Nonsmoker	980	417 (42.55)	310 (31.63)	113 (11.53)	371 (37.86)	190 (19.39)	187 (19.08)	50 (5.10)
Smoker	352	117 (33.24)^{b}	78 (22.16)^{c}	25 (7.10)^{a}	107 (30.40)^{a}	58 (16.48)	46 (13.07)^{a}	4 (1.14)^{b}
Age < 40	173	81 (46.82)	42 (24.28)	11 (6.36)	72 (41.62)	33 (19.08)	36 (20.81)	7 (4.05)
40-49	209	81 (38.76)	55 (26.32)	17 (8.13)	64 (30.62)	34 (16.27)	22 (10.53)	3 (1.44)
50-59	282	79 (28.01)	74 (26.24)	30 (10.64)	80 (28.37)	50 (17.73)	23 (8.16)	7 (2.48)
60-69	331	145 (43.81)	97 (29.31)	38 (11.48)	123 (37.16)	69 (20.85)	69 (20.85)	22 (6.65)
70-79	245	106 (43.27)	85 (34.69)	35 (14.29)	102 (41.63)	51 (20.82)	63 (25.71)	14 (5.71)
≥ 80	92	42 (45.65)	35 (38.04)	7 (7.61)	37 (40.22)	11 (11.96)	20 (21.74)	1 (1.09)
x^2 for 6 age groups	-	24.657	11.135	9.385	16.414	5.492	40.582	15.013
P for 6 age groups	-	0.000	0.049	0.095	0.006	0.359	0.000	0.010
Han								
Male	671	214 (31.89)^{x}	121 (18.03)^{z}	26 (3.87)^{y}	157 (23.40)^{z}	89 (13.26)	162 (24.14)^{y}	28 (4.17)
Female	673	242 (35.96)^{x}	101 (15.01)^{z}	7 (1.04)^{c,z}	154 (22.88)^{z}	63 (9.36)^{a,z}	225 (33.43)^{c,z}	20 (2.97)^{x}
BMI ≤ 24 (kg/m^2)	1033	307 (29.72)^{y}	130 (12.58)^{z}	16 (1.55)^{z}	202 (19.56)^{z}	102 (9.87)^{z}	267 (25.85)^{z}	26 (2.52)
BMI > 24 (kg/m^2)	311	149 (47.91)^{c}	92(29.58)^{c,z}	17 (5.47)^{c,z}	109 (35.05)^{c,y}	50 (16.08)^{b,x}	120 (38.59)^{c,z}	22 (7.07)^{c}
Normotensive	930	285 (30.65)	136 (14.62)^{z}	19 (2.04)^{z}	196 (21.08)^{z}	111 (11.94)^{y}	230 (24.73)^{z}	27 (2.90)
Hypertensive	414	171 (41.30)^{c}	86 (20.77)^{b,z}	14 (3.38)^{z}	115 (27.78)^{b,z}	41 (9.90)^{z}	157 (37.92)^{c,z}	21 (5.07)^{a}
Nondrinker	754	264 (35.01)^{y}	127 (16.84)^{z}	23 (3.05)^{z}	206 (27.32)^{z}	94 (12.47)^{z}	225 (29.84)^{z}	35 (4.64)
Drinker	590	192 (32.54)	95 (16.10)^{y}	10 (1.69)^{z}	105 (17.80)^{c,z}	58 (9.83)^{y}	162 (27.46)^{z}	13 (2.20)^{a}
Nonsmoker	928	354 (38.15)^{x}	143 (15.41)^{y}	18 (1.94)^{z}	245 (26.40)^{z}	93 (10.02)^{z}	311 (33.51)^{z}	34 (3.66)
Smoker	416	102 (24.52)^{c,y}	79 (18.99)	15 (3.61)^{x}	66 (15.87)^{c,z}	59 (14.18)^{a}	76 (18.27)^{c,x}	14 (3.37)^{x}
Age < 40	179	45 (25.14)^{z}	26 (14.53)^{x}	9 (5.03)	38 (21.23)^{z}	28 (15.64)	28 (15.64)	3 (1.68)
40-49	213	77 (36.15)	43 (20.19)	3 (1.41)^{y}	60 (28.17)	16 (7.51)^{y}	60 (28.17)^{z}	6 (2.82)
50-59	282	109 (38.65)^{y}	48 (17.02)^{y}	9 (3.19)^{z}	85 (30.14)	22 (7.80)^{z}	107 (37.94)^{z}	12 (4.26)
60-69	326	110 (33.74)^{y}	59 (18.10)^{z}	4 (1.23)^{z}	65 (19.94)^{z}	30 (9.20)^{z}	75 (23.01)	3 (0.92)^{z}
70-79	250	77 (30.80)^{y}	32 (12.80)^{z}	0 (0)^{z}	36 (14.40)^{z}	31 (12.40)^{x}	74 (29.60)	5 (2.00)^{x}
≥ 80	94	38 (40.43)	14 (14.89)^{z}	8 (8.51)	27 (28.72)	25 (26.60)^{x}	43 (45.74)^{z}	19 (20.21)^{z}
x^2 for 6 age groups	-	12.311	5.924	29.296	25.434	33.511	45.232	86.637
P for 6 age groups	-	0.031	0.314	0.000	0.000	0.000	0.000	0.000

TC, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; ApoA1, apolipoprotein A1; ApoB, apolipoprotein B; ApoA1/ApoB, the ratio of apolipoprotein A1 to apolipoprotein B; BMI, body mass index; $^{a}P < 0.05$, $^{b}P < 0.01$ and $^{c}P < 0.001$ in comparison with male, BMI ≤ 24 (kg/m^2), normotensive, nondrinker, or nonsmoker of the same ethnic group; $^{x}P < 0.05$, $^{y}P < 0.01$ and $^{z}P < 0.001$ in comparison with the same subgroup of the Maonan population.

For the Han population, the anormal rates of HDL-C and ApoA1 were lower but the anormal rate of ApoB was higher in females than in males (P < 0.05-0.001); the anormal rates of TC, TG, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1 to ApoB were higher in subjects with a BMI > 24 kg/m^2 than in those with a BMI ≤ 24 kg/m^2 (P < 0.01-0.001); the anormal rates of TC, TG, LDL-C, ApoB, and the ratio of ApoA1 to ApoB were higher in hypertensives than in normotensives (P < 0.05-0.001); the anormal rates of LDL-C, and the ratio of ApoA1 to ApoB were lower in drinkers than in nondrinkers (P < 0.05); the anormal rate of ApoA1 was higher but the anormal rates of TC, LDL-C and ApoB were lower in smokers than in nonsmokers (P < 0.05-0.001); and the anormal rates of TC, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1

Table 4. Risk factors for hyperlipidemia between the Maonan and Han populations

Population	Risk factor	Regression coefficient	Standard error	Wald	*P* value	Odds ratio	95% Confidence intervel
Maonan+Han	Ethnic group	-0.503	0.122	17.000	0.000	0.605	0.476-0.768
	Body mass index	0.961	0.112	73.720	0.000	2.613	2.099-3.254
	Hypertension	0.417	0.101	17.195	0.000	1.518	1.246-1.848
	Total energy	0.555	0.178	10.264	0.002	1.478	1.385-2.423
	Total fat	0.501	0.173	17.930	0.000	1.547	1.213-1.864
Maonan	Body mass index	0.906	0.131	48.202	0.000	2.475	1.916-3.197
	Hypertension	0.470	0.114	17.085	0.000	1.600	1.280-1.999
	Total energy	0.611	0.163	12.147	0.001	1.935	1.179-2.535
	Total fat	0.532	0.168	9.321	0.003	1.892	1.215-2.746
Han	Body mass index	1.035	0.221	21.945	0.000	2.814	1.825-4.338
	Total energy	0.502	0.224	7.749	0.005	1.778	1.446-2.369
	Total fat	0.488	0.214	9.293	0.003	1.660	1.223-2.354

to ApoB were also different among the 6 age subgroups ($P < 0.05$-0.001).

Risk factors for hyperlipidemia

Multivariate logistic regression analysis showed that the prevalence of hyperlipidemia was positively correlated with BMI, hypertension and the intakes of total energy and total fat in Maonan ($P < 0.01$ for all), whereas it was positively associated with BMI, and the intakes of total energy and total fat in Han ($P < 0.01$, **Table 4**).

Discussion

To the best of our knowledge, the present study is the first survey to explore the serum lipid profiles, the prevalence of dyslipidemia and its risk factors in the Chinese Maonan population. The present cross-sectional, descriptive, and analytical study showed that the levels of TC, TG and LDL-C were higher but the levels of HDL-C, ApoA1 and ApoB were lower in Maonan than in Han. There was no significant difference in the ratio of ApoA1 to ApoB between the two populations. The prevalence of hypercholesterolemia, hypertriacylglycerolemia, hyperlipidemia; and the anormal rates of HDL-C, LDL-C, and ApoA1 were also higher in Maonan than in Han. But the anormal rate of ApoB was lower in Maonan than in Han. There was no significant difference in the anormal rate of the ApoA1/ApoB ratio between the two populations. Additionally, it is worth noting that the prevalence of dyslipidemia increased significantly and showed a younger-age trend (< 40-year subgroup) in the Maonan population. This may be explained by changes in behavioral risk factors on this part of the participants, including unhealthy and excessive diet, cigarette smoking, excessive alcohol consumption, physical inactivity, weight gain and so on. A previous study also reported that TG levels have increased over the past 20 years in both men and women in the United States, with increases being most noticeable in younger age groups (i.e. individuals aged 20-49 years) [48]. These differences in serum lipid profiles and the prevalence of dyslipidemia between the two ethnic groups might result from the combined effects of different BMI, hypertension, diet, lifestyle, and genetic background. In the present study, we showed that the educational level was significantly low in the both Maonan and Han populations. A lack of public awareness and understanding of dyslipidemia and its complications may contribute to the epidemic of uncontrolled dyslipidemia in the two populations. These results also underscore the urgent need for developing a good cholesterol education program to coordinate the efforts in detection, prevention, and treatment of dyslipidemia in the rural areas of China.

The relationship between obesity and dyslipidemia is well recognized. Excess body fat is closely related to blood lipids [49]. The present study showed that the BMI level was significantly higher in Maonan than in Han. The levels of TC, TG, LDL-C and ApoB were higher but the levels of HDL-C, ApoA1 and the ratio of ApoA1 to ApoB were lower in subjects with a BMI > 24 kg/m^2 than in those with a BMI ≤ 24 kg/m^2 in both ethnic groups. The anormal rates of TC, TG, HDL-C, LDL-C, ApoA1, ApoB, and the ratio of ApoA1 to ApoB in both ethnic groups were also higher in subjects with a BMI > 24 kg/m^2 than in those with a BMI ≤ 24 kg/m^2. Dyslipidemia in overweight/obese individuals has been defined by the presence of at least one alteration in the lipid profile: increased serum levels of LDL-C and TG and/or decreased levels of HDL-C [1]. The causes of dyslipidemia in obesity may be multifactorial and include hepatic over production of very low density lipoproteins (VLDL), decreased circulating TG lipolysis and impaired the acylation-stimulating protein (ASP)/C3adesArg pathway, and peripheral free fatty acid (FFA) trapping, increased FFA fluxes from adipocytes to the liver and other tissues and the formation of small dense LDL [50].

The association of dyslipidemia and hypertension is still not completely understood. In the present study, we showed that the levels of TC, TG, LDL-C and ApoB in Maonan and TC, TG and ApoA1 in Han were higher but the levels of HDL-C and the ratio of ApoA1 to ApoB in Maonan were lower in hypertensives than in normotensives. The anormal rates of TC, TG, LDL-C, ApoB, and the ratio of ApoA1 to ApoB in both ethnic groups were higher in hypertensives than in normotensives. These results suggest that dyslipidemia may share a similar pathophysiology with hypertension [51]. The presence of dyslipidemia and the resulting endothelial damage and dysfunction may play a crucial role in the development of hypertension [52]. Ivanovic *et al*. [53] showed that at least one-third of the population of Western Europe had hypertension and hypercholesterolemia. Several biohumoral mechanisms could explain the relationship between hypertension and hypercholesterolemia and the association between these risk factors and accelerated atherosclerosis. The most investigated mechanisms are the renin-angiotensin-aldosterone system, oxidative stress, endothelial dysfunction, and increased production of endothelin-1.

It is widely recognized that that unhealthy diet is strongly associated with dyslipidemia [11, 12]. In the current study, we found that the intakes of total energy, total fat and dietary cholesterol were higher in Maonan than in Han. Multivariate logistic regression analysis also showed that the prevalence of hyperlipidemia was positively correlated with the intakes of total energy and total fat in both ethnic groups. Thus, the discrepancies in serum lipid profiles between the two ethnic groups may mainly be attributed to the differences in dietary patterns. The dietary patterns and lifestyle may be more disadvantageous for serum lipid profiles in Maonan than in Han. The Maonan people chiefly engage in agriculture, but also weave bambooware, raise beef cattle, make wooden articles and cast iron. They are experts in raising beef cattle, which are marketed in Shanghai, Guangzhou and Hong Kong. The Maonan people like to pickle sour meat, snails and vegetables. They get meat mainly from poultries and livestocks, such as pigs, oxen, chickens, ducks and so on. A typical food, Minglun Sliced Pig is a well known dish of the Maonan ethnic group. It is made from their local pig, Guangxi Huanjiang Xiang Pig [54], which is a unique miniature pig strain from Huanjiang Maonan Autonomous County of Guangxi, China. Most of the Maonan people like to eat food which is cooked half ripe, as they believe that some kinds of vegetables and meat, especially chickens, will lose their delicious flavor if they are boiled to be too much ripe. In addition, they also like to eat beef, pork and/or animal offals in a hot pot which contain abundant saturated fatty acid. Long-term high saturated fat diet is an important risk factor for obesity, dyslipidemia, atherosclerosis, and hypertension [11, 12]. The major dietary saturated long-chain fatty acids such as myristic acid (14:0) and palmitic acid (16:0) have been associated with deleterious effects on blood lipid metabolism, especially due to their influence on plasma TG, TC and LDL-C levels [55].

Unhealthy lifestyle factors such as excessive alcohol consumption and cigarette smoking have been associated with dyslipidemia [12, 13]. In the present study, we showed that the levels of HDL-C and the ratio of ApoA1 to ApoB were higher but the levels of LDL-C and ApoB were lower in drinkers than in nondrinkers or in smokers than in nonsmokers in the Maonan populations. The levels of HDL-C, ApoA1 and the ratio of ApoA1 to ApoB were higher but the levels of TC and LDL-C were lower in drinkers than in nondrinkers; and the ratio of ApoA1 to ApoB was higher but the levels of TC, LDL-C and ApoB were lower in smokers than in nonsmokers in the Han population. These findings suggest that the vast majority of drinkers in this study are a moderate intake of alcohol, which is beneficial for serum lipid profiles. In this study, 90% of the wine drunk by the participants was rum or local wine (Maonan), or rice wine sold in the markets (Han) in which the alcohol content is low. Most of the local adult men of the Maonan and Han people like to drink. They even have the custom that it will be considered to be impolite to treat their guests without wines. Some families make wines themselves using grain sorghums and corns. A previous study found that liquor consumption was weakly positively associated with HDL-C in men. Beer consumption in men and wine consumption in women were also positively associated with HDL-C, but were not significant in the fully adjusted model [56]. Another study showed that increased wine consumption was more related to HDL-C levels, whereas beer and spirits were related to increased TG levels [57]. In the present study, we also found that the vast majority of smokers also consumed alcohol. There were 188 (53.41%) drinkers among 352 smokers and 134 (13.67%) drinkers among 980 nonsmokers in the Maonan population; and 277 (66.58%) drinkers among 416 smokers and 313 (33.73%) drinkers among 928 nonsmokers in the Han population. Thus, the changes of serum lipid profiles in the drinkers and smokers were very consistent in the both ethnic groups. These results suggest that cigarette smoking may not be the main risk factor for dyslipidaemia in the two ethnic groups.

In addition to the environmental factors, genetic variants might also be involved in the development of dyslipidaemia [16]. Data from family and twin studies suggest that genetic variation accounts for 40%-60% of the individual variation in serum lipid levels [58-60]. Intra-ethnic marriages were popular in Maonan. For example, more than 80% of the Maonan people share the same surname: Tan. Other frequent surnames in this ethnic group are Lu, Meng, Wei and Yan. Thus, the hereditary characteristics and phenotypes of some lipid metabolism-related genes in Maonan may be different from those in Han. Several previous studies have showed that the genetic polymorphisms of some genes in the Maonan population were different from those in Han Chinese [32, 33]. But this remains to be conclusively determined.

Study limitations

Several limitations should be noted in this study. Firstly, the sample size was relatively small as compared with many other epidemiological studies. Therefore, further studies with larger sample sizes are needed to confirm our results. Secondly, this was a cross-sectional study; therefore, the causal associations between the risk factors and dyslipidemia cannot be inferred. Thirdly, the investigated population was relatively old, with a mean age of 57.41±15.23 years in Maonan, and 57.26±15.15 years in Han. Furthermore, < 20, 20-29 and 30-39 age subgroups were not separated for the analyses. Finally, it is well-known that serum lipid levels are regulated by multiple environmental and genetic factors, and their interactions [11-18]. Although we have detected the effect of several risk factors on serum lipid levels in this study, there are still many unmeasured environmental and genetic factors and their interactions. Therefore, further epidemiological studies are needed to understand more comprehensive information in order to develop the means of prevention and treatment.

Conclusions

The present study reveals that the levels of TC, TG and LDL-C were higher but the levels of HDL-C, ApoA1 and ApoB were lower in Maonan than in Han. The prevalence of hypercholesterolemia, hypertriacylglycerolemia, hyperlipidemia; and the anormal rates of HDL-C, LDL-C, and ApoA1 were also higher in Maonan than in Han. The prevalence of hyperlipidemia was positively correlated with BMI, hypertension and the intakes of total energy and total fat in Maonan, whereas it was positively associated with BMI, and the intakes of total energy and total fat in Han. The difference in the serum lipid profiles and the prevalence of hyperlipidemia between the Maonan and Han populations might result from the combined effects of different BMI, hypertension, diet, lifestyle, and genetic background.

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Disclosure of conflict of interest

None.

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