Observational Study

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Cross-sectional study of the prevalence and risk factors of metabolic syndrome in a rural population of the Qianjiang area

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Abstract

The prevalence of the metabolic syndrome (MS) is increasing in China, but there are disparities between urban and rural populations, and across different regions.

To examine the prevalence and risk factors of MS in the rural area of Qianjiang (Southwest China).

From March 2016 to June 2018, 6 townships in the Qianjiang District of Chongqing Municipality were selected for a cross-sectional study of the residents in rural areas. Demographics and medical history were collected using a questionnaire. Anthropometry and blood pressure were obtained by physical examination. Blood lipids, fasting plasma glucose, and 2-h postprandial glucose were measured.

A total of 2949 (1067 males and 1882 females) were included. The mean age was 63.8 ± 10.7 years. The prevalence of MS in the study population was 16.8% (496/2949). The prevalence of MS was 7.4% in men, 22.2% in women, 15.7% in Han, 18.1% in Tujia, and 14.8% in Miao. According to age, the prevalence of MS was 10.6%, 17.0%, and 18.3% in the 30–50, 50–69, and ≥70 years groups. The multivariable analysis showed that female sex (OR = 33.36, 95%CI: 17.0–65.53), dyslipidemia (OR = 4.71, 95%CI: 1.73–12.82), kidney diseases (OR = 2.32, 95%CI: 1.37–3.94), waistline (OR = 1.39, 95%CI: 1.33–1.46), high-density lipoprotein cholesterol (OR = 0.12, 95%CI: 0.06–0.23), triglycerides (OR = 1.52, 95%CI: 1.31–1.76), alanine aminotransferase (OR = 0.98, 95% CI: 0.97–1.00), γ-glutamyltransferase (OR = 1.00, 95%CI: 1.00–1.01), and glycated hemoglobin (OR = 1.31, 95%CI: 1.08–1.59) were independently associated with MS.

The prevalence of MS was 16.8% in Qianjiang. Female sex, kidney diseases, alanine aminotransferase, and γ-glutamyltransferase were independent risk factors for MS.

Abbreviations: 2hPG = 2-hpostprandialglucose, ALT = alanine aminotransferase, BP = Blood pressure, CHOL = total cholesterol, FPG = fasting blood glucose, GGT = γ-glutamyltransferase, HbA1c = glycated hemoglobin, HDL-C = high-density lipoprotein cholesterol, IDF = International Diabetes Federation, LDL-C = Low-density lipoprotein cholesterol, MS = metabolic syndrome, TG = triglycerides.

Keywords: China, metabolic syndrome, prevalence, risk factors, rural population

1. Introduction

The metabolic syndrome (MS) is a cluster of commonly co-occurring metabolic risk factors associated with cardiovascular disease and type 2 diabetes mellitus, including elevated blood pressure (BP), atherogenic dyslipidemia, insulin resistance, and central obesity.[1–3] It is most common in overweight and obese patients, but can occur in normal-weight patients.[1,2] In the United States, the prevalence of MS in people ≥ 65 years of age and not taking drugs for hypertension or dyslipidemia is 21% to 28%.[4] In Europe, the prevalence of MS is 41% in men and 38% in women.[5] The risk factors include smoking, physical inactivity, and family history. The complications include atherosclerotic cardiovascular disease, diabetes, and chronic kidney disease.[2,3]

In the general population in China, the prevalence of MS was 9.8% in 2005,[6] 10.5% in 2009,[7] and 14.4% in 2013 to 2014.[8] The prevalence of MS among Chinese ≥ 60 years of age and living in Beijing has been reported to be as high as 58.1%,[9] and a large-scale study reported a prevalence of 33.9%, highlighting possible differences in MS definition.[10] This worrisome situation is the result of the rapid economic and lifestyle changes in China.[11,12] It is also of significance when considering that China has a population of 1.3 billion and the direct and indirect economic burdens associated with MS.[13–15]

Nevertheless, in 2013 to 2014, the prevalence of MS in rural China was higher than in urban China,[8] a situation that is reversed compared with 2005,[6] suggesting that recent public health measures taken in urban centers worked to some extent. In addition, there are important lifestyle differences across the different regions of China,[16] leading to vast disparities in the incidence and prevalence of a number of diseases across

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China.[17–19] Currently, there were few studies of rural areas and Southwest China, and there is currently no study of MS from the Qianjiang area. This area is in the hinterland of Wuling Mountain and the southeastern center of Chongqing. It is a minority area, with Tujia and Miao as the 2 main ethnic minorities.

Therefore, the present study examined the prevalence and risk factors of MS in the rural area of Qianjiang, hoping to better understand the overall MS situation of rural mountainous areas in southwestern China.

2. Methods

2.1. Study design and subjects

This was a cross-sectional study. From March 2016 to June 2018, six townships in the Qianjiang District of Chongqing Municipality were selected to conduct a cross-sectional study of the residents in rural areas. According to the population data of Chongqing in 2017, there were 17.41 million men and 16.48 million women. The sampling method of this study was multi-stage stratified cluster random sampling based on the population data of the government of Qianjiang (Table 1).

The inclusion criteria were:

(1) consent to participate in the study;
(2) resident population in rural areas of Qianjiang; and
(3) ≥30 years old. There were no exclusion criteria.

The study was approved by the Ethics Committee of Chongqing Qianjiang Central Hospital (2012/10/10). Informed consent was obtained from all subjects. This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association.

2.2. Diagnostic criteria

The definition of MS by the International Diabetes Federation (IDF) in 2005 was used,[20] that is, central obesity (waistline: male ≥90 cm, female ≥80 cm) and at least 2 of the following items:

(1) triglycerides (TG) ≥1.7 mmol/L;
(2) high-density lipoprotein cholesterol (HDL-C) <1.3 mmol/L (male) or <1.29 mmol/L (female);
(3) BP ≥130/85 mm Hg or with hypertension; and
(4) fasting blood glucose (FPG) ≥5.6 mmol/L or type 2 diabetes. The diagnosis of MS was determined before the investigation began.

Table 1

Characteristics of the population of Qianjiang in 2018.

	Number (10,000 people)	%
Total	55.66	100.0
Classification		
Urban	23.47	42.2
Rural	32.19	57.8
Sex		
Male	29.33	52.7
Female	26.33	47.3
Age (yr)		
0-17	12.25	22.0
18-34	14.26	25.6
35-59	19.96	35.9
≥60	9.19	16.5

The diagnostic criteria for hypertension were those of the World Health Organization/International Society of Hypertension Guidelines for the Treatment of Hypertension in 1999[21]: if an adult showed multiple measures of BP at the consulting room (not on the same day) with systolic BP ≥140 mm Hg, and/or diastolic BP ≥90 mm Hg, then it was diagnosed as hypertension.

The diagnostic criteria for diabetes were those of World Health Organization 1999[22]: FPG ≥7.0 mmol/L or 2-hpostprandial-glucose (2hPG) ≥11.1 mmol/L, or medical history of diabetes.

2.3. Data collection

Age, sex, nationality, marital status, living conditions, education level, occupation, medical history (diabetes, hypertension, hyperlipidemia, cardiovascular and cerebrovascular diseases, gastrointestinal diseases, liver diseases, gallbladder diseases, pancreatic diseases, respiratory diseases, and kidney diseases), fracture history, surgical history, family history of diabetes and hypertension, lifestyle (smoking, drinking, tea, diet, physical exercises, and sleep), female fertility, and menstruation were included in the study.

Occasional smoking was defined as not smoking every day. Constant smoking was defined as smoking every day or almost every day. For currently drinking, occasional drinking was defined as not drinking every week; constant drinking was defined as drinking every week or almost every week. For previous drinking, drinking occasionally was defined as drinking less than once in a week; constant drinking was defined as drinking every week. Occasional tea drinking was defined as drinking tea once to 3 times at most in a month and less than once in a week. Constant teat drinking was defined as drinking tea at least 1 day in a week.

Exercises referred to the exercises in leisure time rather than work time, and within the last 7 days. Strenuous exercises referred to physical activities with a feeling of labored respiration such as lifting heavy objects, playing basketball, swimming, running, etc., which lasted for at least 10 minute each time. Moderate exercises referred to physical activities with a feeling of slightly difficult respiration than normal such as slow running, playing table tennis, Tai Chi, but not including walking, and that lasted for at least 10 minute each time. Walking referred to any kind of walking in casual time, which lasted for at least 10 minute each time.

Cardiovascular and cerebrovascular diseases included myocardial infarction, stroke, coronary heart disease, and lower extremity arteriosclerosis. Gastrointestinal diseases included chronic gastroenteritis, gastroduodenal ulcer, and other gastrointestinal diseases. Liver diseases included fatty liver, viral hepatitis, cirrhosis, autoimmune liver disease, and other liver diseases. Gallbladder diseases included cholecystitis, gallstones, gallbladder polyps, and other biliary diseases. Pancreatic diseases included acute pancreatitis, chronic pancreatitis, and other pancreatic diseases. Kidney diseases included kidney stones, renal cysts, chronic nephritis, nephrotic syndrome, and other kidney diseases. Respiratory diseases included chronic bronchitis, emphysema, and other respiratory diseases.

Epidemiological questionnaires were used to collect all data. The questionnaires were filled by specially trained medical staff through face-to-face interviews.

2.4. Examinations

Height, weight, body mass index, BP, waistline, and hipline were measured during physical examinations. The horizontal line crossing the midpoint of the anterior superior iliac crest and the 12th rib lower edge was used to measure the waistline. The maximum circumferential diameter of the buttocks at the pubic symphysis level was measured as the hipline. The measurements were all accurate to 0.1 cm. The BP was measured using calibrated electronic sphygmomanometers (model HEM.7l17, OMRON Healthcare, Kyoto, Japan). After the subject rested for 5 minute in the sitting position, the BP of the right arm radial artery was measured, and the average of 3 measurements was taken as the BP value.

2.5. Biochemistry

Fasting measured biomarkers included: creatinine, HDL-C, low-density lipoprotein cholesterol (LDL-C), total cholesterol, TG, alanine aminotransferase (ALT), aspartate aminotransferase, γ-glutamyltransferase (GGT), FPG, and glycated hemoglobin (HbA1c). The subjects fasted and discontinued hypoglycemic drugs for 10 hour after 8:00 pm on the day before the investigation. In the morning, 10 mL of fasting venous blood were collected. Except for those with a history of diabetes, an oral 75-g glucose tolerance test was performed to determine 2hPG. All biochemical markers were measured using a Hitachi 7600 automatic biochemical analyzer (Hitachi, Ltd., Tokyo, Japan) at the central laboratory of Chongqing Qianjiang Hospital. The glucose oxidase method was used to detect blood glucose levels.

2.6. Statistical methods

Data were analyzed using SPSS 17 (SPSS Inc., Chicago, IL). Normal distribution tests were performed on all continuous variables using the Kolmogorov-Smirnov test. Continuous data with a normal distribution were presented as means ± standard deviations. Continuous data with a skewed distribution were presented as medians (interquartile range, IQR). Categorical data were presented as n (%). The chi-square test was used to analyze the prevalence of MS among different groups. The risk factors were analyzed by univariable and multivariable logistic regression analyses. The indicators with $P < .05$ in the univariable analyses were selected for inclusion. Two-sided P-values < .05 were considered statistically significant.

3. Results

3.1. Characteristics of the subjects

A total of 3214 permanent residents, ≥30 years of age and from the 6 towns, were selected as the study subjects. The actual number of subjects who completed all investigations and laboratory examinations was 2949 (1067 males and 1882 females), for a response rate of 91.8%. Table 2 presents the characteristics of the subjects. The mean age was 63.8 ± 10.7 years. Of note, the proportion of males was only 36.1%, probably because rural men often must migrate to work.

3.2. Prevalence of MS

Table 3 presents the prevalence of MS. The total prevalence of MS in the study population was 16.8% (496/2949). The prevalence of MS was 7.4% in men, 22.2% in women, 15.7% in Han, 18.1% in Tujia, and 14.8% in Miao. According to age, the prevalence of MS was 10.6%, 17.0%, and 18.3% in the 30 to 50, 50 to 69, and ≥ 70 years groups.

3.3. Univariable regression analyses of MS

The univariable analyses (Table 4) showed that female sex (OR = 3.56, 95%CI: 2.76–4.59, $P < .001$), diabetes (OR = 4.05, 95%CI: 2.51–6.54, $P < .001$), hypertension (OR = 3.39, 95%CI: 2.66–4.32, $P < .001$), dyslipidemia (OR = 9.49, 95%CI: 4.66–19.31, $P < .001$), cardio/cerebrovascular diseases (OR = 2.67, 95%CI: 1.77–4.02, $P < .001$), liver diseases (OR = 1.94, 95%CI: 1.29–2.91, $P = .001$), kidney diseases (OR = 1.82, 95%CI: 1.33–2.48, $P < .001$), smoking (OR = 0.27, 95%CI: 0.20–0.38, $P < .001$), previous smoking (occasionally, OR = 0.42, 95%CI: 0.19–0.92, $P = .03$; everyday, OR = 0.40, 95%CI: 0.29–0.56, $P < .001$), drinking alcohol (OR = 0.52, 95%CI: 0.41–0.67, $P < .001$), drinking tea (never, OR = 1.87, 95%CI: 1.44–2.42, $P < .001$; occasionally, OR = 1.72, 95%CI: 1.35–2.19, $P < .001$), body mass index (OR = 1.58, 95%CI: 1.52–1.65, $P < .001$), waistline (OR = 1.30, 95%CI: 1.27–1.32, $P < .001$), hipline (OR = 1.31, 95%CI: 1.28–1.34, $P < .001$), HDL-C (OR = 0.09, 95%CI: 0.06–0.13, $P < .001$), LDL-C (OR = 1.47, 95%CI: 1.31–1.65, $P < .001$), TG (OR = 2.11, 95%CI: 1.90–2.34, $P < .001$), ALT (OR = 1.01, 95% CI: 1.00–1.02, $P = .001$), GGT (OR = 1.00, 95%CI: 1.00–1.00, $P = .008$), FPG (OR = 1.24, 95%CI: 1.17–1.32, $P < .001$), 2hPG (OR = 1.13, 95%CI: 1.09–1.16, $P < .001$), and HbA1c (OR = 1.56, 95%CI: 1.39–1.76, $P < .001$) were associated with MS.

3.4. Multivariable analysis

The multivariable analysis (Table 5) showed that female sex (OR = 33.36, 95%CI: 17.0–65.53, $P < .001$), dyslipidemia (OR = 4.71, 95%CI: 1.73–12.82, $P = .002$), kidney diseases (OR = 2.32, 95%CI: 1.37–3.94, $P = .002$), waistline (OR = 1.39, 95% CI: 1.33–1.46, $P < .001$), HDL-C (OR = 0.12, 95%CI: 0.06–0.23, $P < .001$), TG (OR = 1.52, 95%CI: 1.31–1.76, $P < .001$), ALT (OR = 0.98, 95%CI: 0.97–1.00, $P = .01$), GGT (OR = 1.00, 95%CI: 1.00–1.01, $P = .03$), and HbA1c (OR = 1.31, 95%CI: 1.08–1.59, $P = .005$) were independently associated with MS.

4. Discussion

The prevalence of MS is increasing in China,[6–8] but there are disparities between urban and rural populations and across different regions.[8,16] Therefore, this study aimed to examine the prevalence and risk factors of MS in the rural area of Qianjiang (Southwest China). The results showed that the prevalence of MS was 16.8% in Qianjiang. Female sex, kidney diseases, ALT, and GGT were independent risk factors for MS.

Previous studies in China showed that the prevalence of MS is 14.4% when using the China Diabetes Society criteria,[8] 33.9% when using the NCEP ATP III (2004) definition,[3] or 18.2% when using the IDF criteria.[7] In the present study, MS was defined according to the IDF (2005),[20] and the total prevalence was 16.8%. Having multiple definitions of MS is a major issue in the epidemiological research of MS.[23] A study showed that the IDF definition led to a slightly higher prevalence of MS than the NCEP ATP III definition, at least in the United States.[24] Therefore, it can be seen that the prevalence of MS has been increasing in China, but remains lower than in Western countries.[4,5,24] Using the NCEP ATP III definition, a study revealed a prevalence of 24.2% in rural China.[25] Using the IDF criteria, another study in rural China showed a prevalence of 21.3% of MS, higher than in the present study.[26] A meta-analysis revealed a prevalence of 22.0% of MS in rural China.[27]

Table 2

Characteristics of the subjects.

Variable	Description	Value (N=2949)
Age	Mean±SD	63.8±10.7
	Median (IQR)	64 (55,71)
Sex	Male	1067 (36.1%)
	Female	1882 (63.8%)
Nationality	Han	1024 (36.1%)
	Tujia	1534 (63.8%)
	Miao	378 (1.1%)
Disease history	Diabetes (n=2928)	71 (2.4%)
	Hypertension (n=2920)	357 (12.1%)
	Dyslipidemia (n=2918)	34 (1.2%)
	Cardio- and cerebralvascular diseases	109 (3.7%)
	Gastrointestinal diseases (n=2946)	354 (12.0%)
	Liver diseases	124 (4.2%)
	Gallbladder diseases	182 (6.2%)
	Pancreatic diseases	9 (0.3%)
	Kidney diseases	229 (7.8%)
	Respiratory diseases	219 (7.4%)
Surgical history (n=2923)		545 (18.5%)
Bone fracture history (n=2816)		179 (6.1%)
Family history of diabetes (n=2891)		48 (1.6%)
Currently smoking	No	2163 (73.3%)
	Occasionally	71 (2.4%)
	Constantly	629 (21.3%)
Previous smoking	No	1989 (67.4%)
	Occasionally	71 (2.4%)
	Everyday	444 (15.0%)
Passive smoking (n=2812)		2354 (79.7%)
Family member smoking	Yes	2160 (73.2%)
	No	650 (22.0%)
Colleague smoking	Yes	935 (31.7%)
	No	1850 (62.7%)
Drinking wine	Currently no	2018 (68.4%)
	Occasionally	527 (17.9%)
	constantly	284 (9.6%)
Previous drinking	Never	1710 (58.0%)
	Occasionally	530 (18.0%)
	constantly	333 (11.3%)
White wine, 50 g/time	Mean±SD	2.4±1.9
	Median (IQR)	2 (1,3)
White wine, times/wk	Mean±SD	7.7±5.6
	Median (IQR)	7 (3,10)
White wine, n × 50 g/wk	Mean±SD	15.3±16.0
	Median (IQR)	10 (4,20)
Drinking tea	Never	691 (23.4%)
	Occasionally	985 (33.4%)
	Used to drink, but currently no	81 (2.7%)
	Constantly	1085 (36.8%)
Years of quitting tea	Mean±SD	3.3±3.4
	Median (IQR)	2.5 (1,5)
Green teacups/d	Mean±SD	3.9±2.1
	Median (IQR)	3 (3,5)
Green tea, d/wk	Mean±SD	6.9±1.1
	Median (IQR)	7 (7,7)
Amount of tea (cups)	Mean±SD	3.5±4.6
	Median (IQR)	2 (2,5)
Age of habitual drinking of tea	Mean±SD	21.1±11.7
	Median (IQR)	20 (10,30)
Meals per day	Mean±SD	2.8±0.4
	Median (IQR)	3 (3,3)
Strenuous exercise	Yes	280 (9.5%)
	No	2524 (85.6%)
Moderate exercise	Yes	378 (12.8%)
	No	2426 (82.3%)
Walking	Yes	1357 (46.0%)
	No	1451 (49.2%)
BMI (n=2949)	Mean±SD	22.1±3.5
	Median (IQR)	22.3 (20.4,24.8)
Waistline	Mean±SD	76.5±9.4
	Median (IQR)	75.9 (69.5,83)
Hipline (n=2951)	Mean±SD	90.0±6.5
	Median (IQR)	89.6 (85.5,94.1)
Creatinine (mmol/L)	Mean±SD	68.4±18.5
	Median (IQR)	64.6 (58.5,73.3)
HDL-C (mmol/L)	Mean±SD	1.4±0.3
	Median (IQR)	1.4 (1.2,1.6)
LDL-C (mmol/L)	Mean±SD	2.7±1.0
	Median (IQR)	2.6 (2.1,3.1)
CHOL (mmol/L)	Mean±SD	6.6±105.1
	Median (IQR)	4.6 (4.0,5.3)
TG (mmol/L)	Mean±SD	1.5±1.3
	Median (IQR)	1.1 (0.9,1.7)
ALT (U/L)	Mean±SD	20.1±18.1
	Median (IQR)	16 (12,23)
AST (U/L)	Mean±SD	28.6±21.2
	Median (IQR)	25 (21,31)
GGT (U/L)	Mean±SD	30.4±61.8
	Median (IQR)	17 (13,28)
FPG (mmol/L)	Mean±SD	5.7±1.4
	Median (IQR)	5.4 (5.0,5.8)
2hPG (mmol/L) (n=2888)	Mean±SD	7.3±3.2
	Median (IQR)	6.6 (5.6,8.0)
HbA1c (%) (n=2931)	Mean±SD	5.8±0.8
	Median (IQR)	5.7 (5.4,6.0)

(*continued*)

According to the Kolmogorov-Smirnov normality test, all continuous data had skewed distributions. 2hPG=2-h postprandial glucose, ALT=alanine aminotransferase, AST=aspartate aminotransferase, BMI=body mass index, CHOL=cholesterol, FPG=fasting plasma glucose, GGT=γ-glutamyl transferase, HbA1c=glycated hemoglobin, HDL-C=high-density lipoprotein cholesterol, IQR=interquartile range, LDL-C=low-density lipoprotein cholesterol, SD=standard deviation, TG=triglycerides.

Table 3

Prevalence of MS.

	Prevalence	*P*	Standardized prevalence
Total	496/2949 (16.8%)		14.6%
Gender			
Male	79/1067 (7.4%)	<.001	
Female	417/ 1882 (22.2%)		
Nationality			
Han	161/1024 (15.7%)	.154	15.6%
Tujia	277/1531 (18.1%)		16.2%
Miao	56/378 (14.8%)		14.1%
Age (yr)			
<30	–	.009	
30-49	30/284 (10.6%)		11.0%
50-69	298/1750 (17.0%)		15.6%
≥70	168/916 (18.3%)		18.1%

MS = metabolic syndrome.

Table 4

Univariable regression analyses of MS.

	OR	95%CI	P
Age	1.008	(0.999,1.017)	.087
Sex (female vs male)	3.559	(2.762,4.586)	<.001
Nationality			
Han	Reference		
Tujia	1.184	(0.957,1.465)	.120
Miao	0.932	(0.670,1.297)	.677
Disease history			
Diabetes	4.049	(2.507,6.54)	<.001
Hypertension	3.388	(2.656,4.32)	<.001
Dyslipidemia	9.488	(4.663,19.305)	<.001
Cardio- and cerebrovascular diseases	2.669	(1.773,4.017)	<.001
Liver diseases	1.935	(1.288,2.906)	.001
Gallbladder diseases	2.633	(1.901,3.646)	<.001
Pancreatic diseases	1.417	(0.294,6.84)	.664
Gastrointestinal diseases	1.106	(0.828,1.478)	.495
Kidney diseases	1.816	(1.327,2.484)	<.001
Respiratory diseases	1.079	(0.752,1.547)	.679
Smoking status			
Currently smoking			
No	Reference		
Occasionally and constantly	0.274	(0.199,0.378)	<.001
Previous smoking			
Currently no	Reference		
Occasionally	0.42	(0.191,0.923)	.031
Everyday	0.401	(0.287,0.561)	<.001
Passive smoking n=2812	1.263	(0.978,1.63)	.073
Drinking			
Currently drinking			
No	Reference		
Occasionally and constantly	0.522	(0.408,0.668)	<.001
Previous drinking			
Never	Reference		
Occasionally	0.712	(0.545,0.93)	.013
constantly	0.432	(0.294,0.633)	<.001
White wine 50 g/time	1.171	(1.001,1.371)	.049
White wine times/week	0.937	(0.862,1.018)	.125
White wine n × 50 g/week	1.000	(0.977,1.023)	.985
Drinking tea			
Never	1.868	(1.442,2.419)	<.001
Occasionally	1.722	(1.354,2.19)	<.001
Used to drink, but currently no	1.368		
Constantly	Reference		
Years of quitting tea	1.116	(0.927,1.344)	.247
Green tea cups/day	1.109	(1.001,1.229)	.048
Green tea days/week	1.15	(0.863,1.532)	.339
Amount of tea	0.987	(0.931,1.047)	.672
Age of habitual drinking of tea	0.996	(0.977,1.015)	.659
Meals per day	0.696	(0.55,0.88)	.002
Exercise			
Strenuous exercise			
Yes	1.279	(0.937,1.746)	.121
No	Reference		
Moderate exercise			
Yes	1.183	(0.896,1.562)	.237
No	Reference		
Walking			
Yes	1.014	(0.832,1.235)	.892
No	Reference		
BMI	1.581	(1.517,1.649)	<.001
Waistline	1.295	(1.267,1.324)	<.001
Hipline	1.310	(1.279,1.342)	<.001
Creatinine	1.004	(0.999,1.009)	.104

(continued)

Table 4

(continued).

	OR	95%CI	P
HDL-C	0.09	(0.063,0.129)	<.001
LDL-C	1.471	(1.312,1.651)	<.001
CHOL	1.000	(0.998,1.002)	.749
TG	2.107	(1.9,2.336)	<.001
ALT	1.009	(1.004,1.015)	.001
AST	0.997	(0.991,1.003)	.354
GGT	1.002	(1,1.003)	.008
FPG	1.241	(1.17,1.317)	<.001
2hPG	1.125	(1.094,1.157)	<.001
HbA1c	1.562	(1.388,1.757)	<.001

2hPG=2-h postprandial glucose, ALT=alanine aminotransferase, AST=aspartate aminotransferase, BMI=body mass index, CHOL=cholesterol, CI=confidence interval, FPG=fasting plasma glucose, GGT=γ-glutamyl transferase, HbA1c=glycated hemoglobin, HDL-C=high-density lipoprotein cholesterol, LDL-C=low-density lipoprotein cholesterol, MS = metabolic syndrome, OR=odds ratio, TG=triglycerides.

Table 5

Multivariable logistic regression analysis.

	OR	95%CI	P
Sex (female vs male)	33.363	(16.988,65.526)	<.001
Diabetes	1.274	(0.458,3.546)	.642
Hypertension	1.457	(0.933,2.276)	.098
Dyslipidemia	4.707	(1.728,12.822)	.002
Cardio/cerebrovascular diseases	1.047	(0.498,2.202)	.903
Liver diseases	1.143	(0.54,2.417)	.727
Gallbladder diseases	1.354	(0.782,2.346)	.28
Kidney diseases	2.323	(1.369,3.943)	.002
Currently drinking (drinking vs. never)	1.132	(0.732,1.752)	.576
Currently smoking (occasionally + constantly vs. never)	0.933	(0.461,1.889)	.847
Drinking tea			.994
Never	Reference		
Occasionally	1.009	(0.671,1.517)	.965
Used to drink, but currently no	0.895	(0.274,2.93)	.855
Constantly	0.965	(0.618,1.505)	.874
Meals per day	1.038	(0.691,1.559)	.857
BMI	0.987	(0.922,1.058)	.717
Waistline	1.392	(1.331,1.455)	<.001
Hipline	0.968	(0.922,1.017)	.196
HDL-C	0.118	(0.061,0.231)	<.001
LDL-C	1.101	(0.981,1.237)	.103
TG	1.517	(1.311,1.755)	<.001
ALT	0.984	(0.972,0.996)	.01
GGT	1.003	(1,1.006)	.034
FPG			
2hPG			
HbA1c	1.312	(1.084,1.588)	.005

2hPG=2-h postprandial glucose, ALT=alanine aminotransferase, BMI=body mass index, CI=confidence interval, FPG=fasting plasma glucose, GGT=γ-glutamyl transferase, HbA1c=glycated hemoglobin, HDL-C=high-density lipoprotein cholesterol, LDL-C=low-density lipoprotein cholesterol, OR=odds ratio, TG=triglycerides.

In the present study, factors like female sex, dyslipidemia, kidney diseases, waistline, and HDL-C, TG, ALT, GGT, and HbA1c levels were found to be independently associated with the diagnosis of MS. ALT and GGT levels are indicators of liver function and injury, and decreased liver function is associated with MS.[28] HbA1c levels are indicative of diabetes and insulin resistance, which are associated with MS.[20] Of course, some of those factors are already criteria for the diagnosis of MS, but they require to be combined together in a single patient to be able to diagnose MS.[20] Nevertheless, the present study indicates that the presence of any 1 of those factors increases the risk of MS. Previous studies examined the factors associated with MS in rural Chinese populations. Li et al[25] showed that low levels of physical activity and specific dietary elements (fungi and algae) were associated with MS in rural Chinese men, while low education and pork and nuts were associated with MS in rural Chinese women. Guo et al[26] showed that dietary factors were associated with MS in rural China. Zuo et al[29] showed that sex, age, income, family history of diabetes, family history of hypertension, education, and tea consumption were independently associated with MS. Three studies revealed that the increase in the prevalence of MS was more significant in rural Chinese women than in men,[27,29,30] which supports the association of MS with the female sex. In addition, high TG levels seem to play a role in this increasing prevalence.[30]

The present study has limitations. It used a single definition of MS, limiting the comparison of the prevalence with other regions of China and the world. In addition, the selection of the variables to be collected will influence the subsequent analyses. There was an under-representation of males compared with the region's population, probably because those men were part of the migrant population having to work outside their living area. No dietary factors were examined in the present study. Moreover, 18.5% (545/2923) had a surgical history, owing to sterilization due to the 1-child policy in 1980 s China. Finally, only 1 region of rural China was examined. Additional study is still necessary to determine the real status of MS in rural China.

5. Conclusion

The present study examined the prevalence and risk factors of MS in the rural area of Qianjiang, hoping to better understand the overall MS situation of rural mountainous areas in southwestern China. The results showed that the prevalence of MS is 16.8% in Qianjiang, which was lower than the reported Chinese prevalence, but similar to that of other studies of rural China. Female sex, kidney diseases, ALT, and GGT were independent risk factors for MS.

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Author contributions

All five parts of the article are contributed by Bing Ling.

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