Original Article

Effect of lifestyle on the prevalence of the metabolic syndrome among farmers, migrants with Yi ethnicity and the Han population in Sichuan province of China

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Yi people are the most primitive society in China. Little information on the metabolic syndrome (MS) is available in Yi people. We explored whether differing lifestyle affected the prevalence of MS among farmers and migrants of Yi ethnicity and Han population in one of the Southwestern parts of China. The prevalence of MS among the three populations was described under the same International Diabetes Federation (IDF) criteria. The study populations comprised of 1,535 Yi farmers, 1,306 Yi migrants and 2,130 Han people. The effects of physical activity, obesity and other risk factor on MS were evaluated. Results showed that the age- and sex-adjusted prevalence of MS was 9.9 times higher in Yi migrants (23.8%) and 6.3 times higher in Han people (15.2%) than in Yi farmers (2.4%). In addition, the prevalence of MS increased significantly with age in both sexes, except for a slight increase in Yi farmers. The prevalence of overweight and obesity was much lower in Yi farmers (9.3% in men and 16.5% in women) than that in Yi migrants (46.2% in men and 34.8% in women) and Han people (40.6% in men and 31.9% in women). Levels of physical activity were much greater in Yi farmers than in Yi migrants and Han people. These results indicated that lifestyle had strongly influenced the development of MS in Han and Yi Chinese and our study provided one more piece of evidence imputing that high prevalence of MS might be related to a change in lifestyle associated with urbanization.

Key Words: the metabolic syndrome, prevalence, obesity, lifestyle, ethnicity

INTRODUCTION

The metabolic syndrome (MS) stands for a cluster of risk factors that predispose individuals to cardiovascular disease (CVD) and type 2 diabetes.[1-5] These factors include abdominal obesity, high triglycerides, low HDL cholesterol levels, high blood pressure and high fasting plasma glucose. Epidemiological studies have showed that the prevalence of the MS is on the rise and ethnic predisposition is suggested in Asians.[6,7] The prevalence of MS is 23% in American[8] and 15% in European populations[9]. As for Asians, the prevalence varies from 7% in Korea[10] to 13.7% in China [11] and 32% in India,[12] which might partially be due to the use of different definitions for MS and the ethnicity of the population.[13]

Over the past two decades, China has experienced rapid socioeconomic growth, resulting in lifestyle changes that have promoted the development of the MS and other chronic diseases within the population.[11,14] From 1992 to 2002, the prevalence of overweight and obesity and obesity-related chronic diseases have increased considerably in China.[14] Cardiovascular disease is therefore becoming more prevalent and has been a leading cause of death.

The MS and overweight are becoming increasingly common in China.[11,14] Most studies have shown that dramatic changes in lifestyle appear to play a primary role in the presence of the MS. Some lifestyle behaviors, including sedentary activities, smoking, alcohol intake and unhealthy dietary habits, particularly high carbohydrate and fat intake, are associated with the MS in adults.[15-17]

We conducted a population-based study of the MS and associated factors among the farmers and migrants of Yi ethnicity and in Han people from August 2007 to August 2008. Previous studies had demonstrated a low prevalence of hypertension among Yi farmers in the Southwestern part of China.[18-21] However, all of these studies focused on estimating the population distribution of major risk factors for CVDs and have not estimated the clustering of such risk factors in the form of the MS.

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Yi people belong to the larger ethnic minority population in China, principally living in the remote mountainous areas in some Southwestern parts of China. Yi farmers are isolated from the outside world and have preserved less acculturated lifestyle. Most of their villages are situated on high mountains or in deep valleys, with only extremely steep and narrow paths leading to each village so it takes several hours to walk from one village to another. Their main occupation is subsistence agriculture. Because they farm and grow most of their own food stuff with primitive tools, they engage in extremely heavy agricultural labor. Their principal components of the diet are potatoes, corn, buckwheat, oats and rice while consumption of meat is limited to occasions such as wedding, funeral or semi-annual celebrations. The ethnic background of the Yi migrants is the same as that of the Yi farmers. In contrast to Yi farmers, Yi migrants and Han residents live in the same communities and consume similar diets composing of rice, meat and fresh vegetables and have experienced a transition from a traditional to a more typical urbanized lifestyle with higher fat intake and lighter physical activity.

The main aims of this study are to compare the prevalence of the MS and associated factors among the same ethnic groups in different environments as well as populations of different ethnic background living under the same environment.

MATERIALS AND METHODS

Subjects

The study comprised of 1,535 Yi farmers living in Butuo, Zhaojue, Jinyang, Puge, and Xide counties; 1,306 Yi migrants and 2,130 Han people living in the county seats of these counties and in Xichang city. Yi farmers were selected by random cluster sampling from the high mountain townships, from August to November 2007, and again at the same time in 2008. The selected townships were composed of 14 villages; and a village consisted of less than thirty households. The study population including Yi migrants and Han residents was stratified by their living areas, and then 15 communities were randomly selected. All adults (over 20 years of age) in all selected communities or villages were surveyed. Subjects were considered Yi migrants if their parents were both of Yi ethnicity, and reported that they moved to towns from remote mountain villages and stayed in the current towns for over five years. The study was approved by the local ethics committee and informed consent was obtained from the study subjects.

Measurements

In the morning after overnight fasting, each subjects received an interview, physical and blood pressure measurements and venous blood sampling. The selected individuals were interviewed and questionnaires were filled out by local trained interviewers who were fluent in the Yi or Han dialogues. The questionnaires were used to collect information on demographic, socioeconomic and lifestyle factors, including age, sex, race, education, occupation, smoking, alcohol intake, family income and family history. The interview included questions related to the diagnosis and treatment of hypertension and diabetes. All subjects gave their written informed consent to participate in the survey.

Blood pressure was measured to the nearest 2 mmHg on the right arm using a standard mercury sphygmomanometer. The second measurement was taken after a 10-min resting period in a sitting position, and the mean of three consecutive readings was used for analyses.

Obesity was assessed by body mass index (BMI: weight in kilograms divided by the square of height in meters) with weight measured on a battery-operated electronic scale and height by a portable stadiometer to the nearest 0.1cm and 0.1kg respectively, with the subjects wearing light clothing and no shoes.

Fasting venous blood samples were selected from each subjects at the time of interview and processed at the examination center, then shipped to the central clinical laboratory in Beijing where all the samples were kept at -40℃ before being analyzed. The fasting plasma glucose levels were measured by glucose oxidase method. The HDL-cholesterol and triglyceride levels were determined by enzymatic methods. All biochemical analyses were done using a Hitachi 7600 automatic analyzer (Boehringer Mannheim, Mannheim, Germany).

The variables and response categories used in this study were: smoking was defined as never smoker, or ever smoker if the subject was a current smoker or a former smoker. Excessive alcohol intake was defined as the ingestion of more than 30.0g of alcohol a day according to the cut off points proposed by Dawson and revised by Dufour.[22] Assessment of usual physical activities was based on occupational activity and defined as three categories: light, moderate, and heavy. Family history was defined as whether or not any of subject's biological parents or siblings had diabetes, hypertension, or Cardiovascular diseases

Definition of the metabolic syndrome

According to the IDF (2005) definition of the MS,[23] individuals satisfying the essential component central obesity plus two or more of the following components, were diagnosed as having the MS:

(1) High blood pressure (systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥ 85 mmHg);
(2) Hypertriglyceridemia: triglycerides level ≥ 1.7 mmol/L (150 mg/dL);
(3) Low HDL cholesterol: HDL <1.0 mmol/L (40mg/dL) in men and <1.3 mmol/L (50mg/dL) in women;
(4) Fasting glucose level ≥ 5.6 mmol/L (100mg/dL)

Subjects who received antihypertensive or antidiabetic medication met the criteria for high blood pressure or high fasting glucose. Waist circumstance was not measured during the interview; BMI ≥24 was used as an indicator of overweight and obesity, since this cut-off point was found to have the best sensitivity and specificity for identifying risk factors including hypertension, diabetes, and CVDs in the Chinese population.[24]

Statistical analysis

All data were entered twice with EpiData software and checked. Continuous variables were showed as means ±SD. Prevalence was expressed in terms of percentage and 95% confidence interval (CI). The difference in the

mean between the three groups was tested by ANOVA. The difference in the frequency between the three groups was tested by a chi-square test. Directly standardized age- and age/sex-adjusted prevalence of the MS were calculated among the populations, using the combined Yi people and Han people samples as the reference population. Multiple logistic regression analysis was performed to estimate the risk of the MS associated with demographic and lifestyle factors. The odds ratios (OR) were presented together with their 95% CI. All data analyses were performed using SAS 9.1 (SAS Institute, Cary, NC, USA) with $p < 0.05$ considered to be statistically significant.

RESULTS

General characteristics associated with the MS among the three study groups are shown in Table 1. On average, Han people were elder than Yi migrants and Yi farmers, with female Yi migrants as the youngest group. Mean body mass index was lower in Yi farmers than in Yi migrants and Han people (all $p < 0.0001$). The overall prevalence of overweight and obesity (BMI $\geq 24 kg/m^2$) in men and women were only 9.3% and 16.5% in Yi farmers, compared to 46.2% and 34.8% in Yi migrants, and 40.6% and 31.9% in Han people (all $p < 0.0001$). High blood pressure was much less common in Yi farmers (6.8%) than in Yi migrants (25.6%) or in Han people (27.8%) ($p < 0.0001$).

Among Yi farmers, 6.0% of men and 2.9% of women were diagnosed as being diabetic; with prevalence lower than that in Yi migrants, of whom 9.5% of men and 4.0% of women had the disease ($p < 0.01$). However, the difference between male Yi farmers and male Han people was not statistically significant. The prevalence of high fasting glucose (≥5.6 mmol/L) was significantly lower in Yi farmers than in Yi migrants ($p < 0.01$). Compared to Han people, the prevalence of high fasting glucose was slightly lower in Yi farmers, but the difference was not significant. Triglyceride level was considerably higher both in Yi migrants and Han people than in Yi farmers (all $p < 0.0001$). The prevalence of hyper-triglyceridaemia was significantly higher in Yi migrants compared to Han people and Yi farmers (all $p < 0.001$). However, the prevalence of low HDL levels were more commonly seen

Table 1. Characteristics of the study population in southern China, by group and sex, 2007-2008

	Male			Female			*p*
	Yi Farmers	Yi Migrants	Han People	Yi Farmers	Yi Migrants	Han People	
Number	675	760	1080	860	546	1050	
Age, yrs	39.2 ± 12.3	40.3 ± 11.7	43.6 ± 13.0	40.1 ± 11.5	37.4 ± 11.7	45.0 ± 13.3	**, ***
Body Mass Index, kg/m^2	21.1 ± 2.1	23.9 ± 3.5	23.3 ± 3.3	21.7 ± 2.6	23.1 ± 4.1	22.7 ± 3.3	*, ** ***
Fasting glucose, mmol/L	5.4 ± 1.2	5.6 ± 2.8	5.3 ± 1.5	5.2 ± 0.8	5.2 ± 1.4	5.2 ± 1.5	*, ***
Systolic BP, mmHg	101.5 ± 16.2	118.3 ± 16.8	117.6 ± 16.9	96.4 ± 16.3	109.3 ± 16.8	113.8 ± 19.2	*, **
Diastolic BP, mmHg	68.6 ± 12.1	78.9 ± 11.8	78.5 ± 11.1	64.7 ± 10.7	72.4 ± 11.2	74.1 ± 10.8	*, **
Triglyceride, mmol/L	1.2 ± 1.2	2.3 ± 2.3	2.0 ± 2.0	1.1 ± 0.7	1.3 ± 0.9	1.4 ± 1.2	*, ** ***
HDL-cholesterol mmol/L	1.1 ± 0.3	1.0 ± 0.3	1.1 ± 0.3	1.2 ± 0.3	1.2 ± 0.3	1.3 ± 0.3	*, ** ***
High blood pressure† (%)	10.2 (7.9, 12.5)	33.0 (29.7, 36.3)	31.5 (28.7, 34.3)	4.2 (2.9, 5.5)	15.2 (12.2, 18.2)	24.1 (21.5, 26.7)	*, **
Overweight and obesity (BMI ≥24)(%)	9.3 (7.1, 11.5)	46.2 (42.6, 49.8)	40.6 (37.7, 43.5)	16.5 (14.0, 19.0)	34.8 (30.8, 38.8)	31.9 (29.1, 34.7)	*, ** ***
Fasting Glucose ≥5.6 mmol/L (%)	23.8 (20.6, 27.0)	27.9 (24.7, 31.1)	22.0 (19.5, 24.5)	14.8 (12.4, 17.2)	17.1 (13.8, 20.4)	18.2 (15.8, 20.6)	*, ***
Fasting Glucose ≥7.0 mmol/L (%)	6.0 (4.2, 7.8)	9.5 (7.4, 11.6)	5.7 (4.3, 7.1)	2.9 (1.8, 4.0)	4.0 (2.4, 5.6)	5.2 (3.9, 6.5)	*, **
Triglyceride ≥1.7 mmol/L (%)	15.7 (13.0, 18.4)	46.7 (43.2, 50.3)	40.4 (37.4, 43.4)	10.6 (8.6, 12.6)	21.2 (17.8, 24.6)	23.7 (21.1, 26.3)	*, ** ***
Low HDL-cholesterol‡ (%)	49.3 (45.5, 53.1)	49.1 (45.5, 52.7)	42.4 (39.5, 45.3)	66.0 (62.8, 69.2)	67.2 (63.2, 71.2)	56.8 (53.8, 59.8)	**, ***
Current Smokers (%)	80.2 (77.2, 83.2)	70.2 (66.9, 73.5)	61.0 (58.1, 63.9)	10.0 (8.0, 12.0)	7.2 (5.0, 9.4)	1.2 (0.6, 1.8)	**, ***
Excessive alcohol use (%)	25.8 (22.5, 29.1)	32.6 (29.3, 35.9)	19.1 (16.7, 21.5)	1.7 (0.8, 2.6)	2.0 (0.8, 3.2)	1.1 (0.5, 1.7)	*, ** ***
Heavy physical activity (%)	95.2 (93.6, 96.8)	6.0 (4.3, 7.7)	8.8 (7.1, 10.5)	86.1 (83.8, 88.4)	9.3 (6.9, 11.7)	4.9 (3.6, 6.2)	*, **

*denotes $p < 0.05$ for the difference between Yi Farmers and Yi Migrants.
** denotes $p < 0.05$ for the difference between Yi Farmers and Han people.
*** denotes $p < 0.05$ for the difference between Yi Migrants and Han people.
† Systolic blood pressure(SBP) ≥130 mmHg or diastolic blood pressure(DBP) ≥85mmHg or taking antihypertensive medication.
‡ Low HDL cholesterol: <1.04 mmol/L (40mg/dL) in men and <1.30 mmol/L (50mg/dL) in women.
Data are mean (±SD) or percentage (95%Cl).

in Yi people than in Han people (p <0.0001).

Also in Table 1, Frequency of heavy physical activity was much greater in Yi farmers, as the results of their occupational difference. Smoking and excessive alcohol intake appeared to be more common in male than in female among all three groups.

The age and sex-specific prevalence of the MS in Yi and Han people were presented in Figure 1. The prevalence of the MS increased significantly with increasing age in both sexes, but the trends differed by groups. Risk of the MS tended to remarkably increase with age in Yi migrants and Han people (all p <0.001), reaching peak levels in the 5th decades, whereas the Yi farmers showed low prevalence rates of the MS with minimal or no adult age-related rise. At all ages, male Yi migrants had higher prevalence of the MS than male Yi farmers and even than male Han people. The prevalence was similar among Yi migrant women and Han women and higher than in Yi farmers before 30 years of age. However, after age 30, the prevalence was substantially higher in Yi migrant women than in Han women. Sex differences in the prevalence of the MS are shown in Yi migrants and Han people but not significant in Yi farmers. The prevalence was remarkably more prevalent in men compared to women among Yi migrants and Han people (p <0.001).

Figure 2 showed the age- standardized MS prevalence in men and women for the three groups. The age- standardized prevalence was present in 2.7% of male Yi farmers and 2.0% of female Yi farmers, in 29.5% of Yi migrant men and 18.0% of Yi migrant women, and in 18.4% of Han men and 11.8% of Han women. The age- and sex-adjusted prevalence was 9.9 times higher in Yi migrants and 6.3 times higher in Han people than in Yi farmers (p <0.0001).

Multivariate logistic regression analysis revealed the MS was independently associated with male gender, age, excessive alcohol intake, family history of hypertension and diabetes, low physical activity, and high family in-

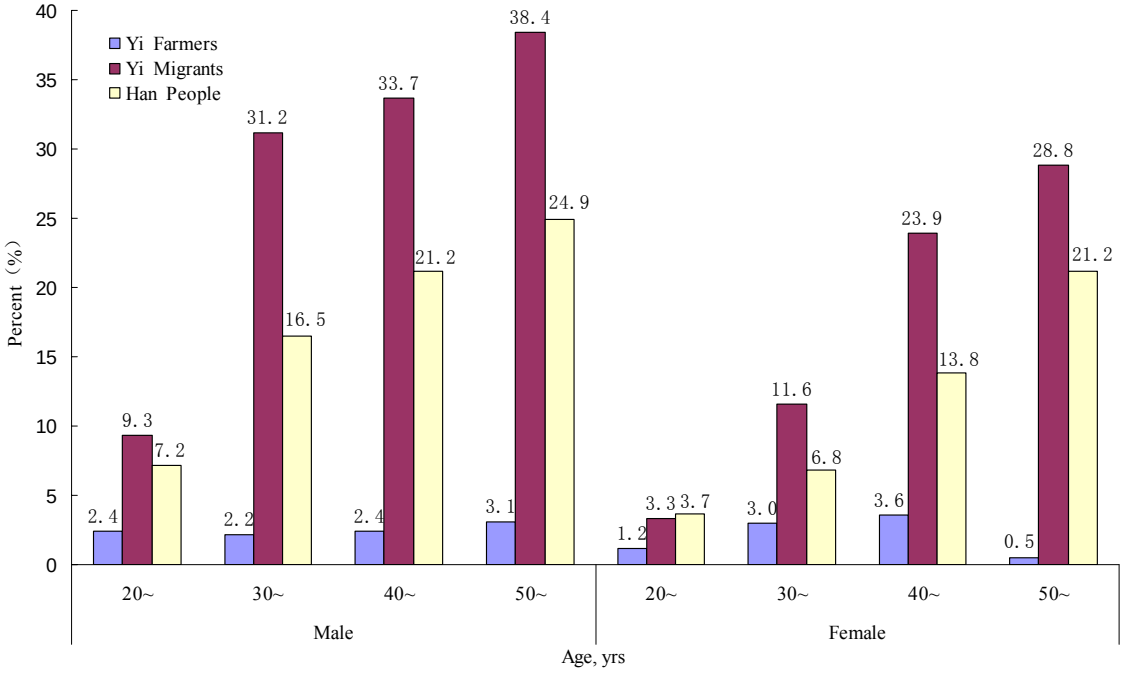

Figure 1. Age-Specific prevalence of metabolic syndrome in Yi farmers, Yi migrants and Han people by sex in southern China, 2007-2008

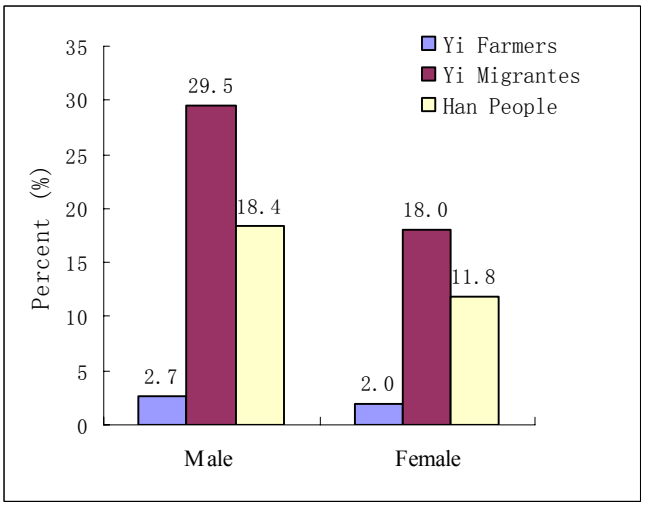

Figure 2. Age-standardized prevalence of metabolic syndrome in Yi farmers, Yi migrants and Han people by sex in southern China, 2007-2008

Table 2. Multiple logistic regression of risk factors for the metabolic syndrome in a study population from southern China, 2007-2008

Risk factors	OR (95% CI)	*p*
Group (vs. Yi farmers)		
Yi migrants	7.68 (4.49-13.15)	< 0.001
Han people	4.15 (2.43-7.10)	< 0.001
Sex (vs. female)		
Male	1.71 (1.40-2.10)	< 0.001
Age (years) (vs. 20~)		
30~	3.22 (2.11-4.91)	< 0.001
40~	4.75 (3.12-7.25)	< 0.001
50~	6.08 (3.98-9.28)	< 0.001
Excessive alcohol intake (vs. no)		
Yes	1.36 (1.06-1.75)	0.016
Physical activity (vs. low)		
Moderate	0.58 (0.43-0.80)	<0.001
Heavy	0.66 (0.40-0.95)	<0.021
Family history (vs. no)		
Yes	1.46 (1.15-1.87)	0.002
Family income (RMB/year) (vs. <500)		
500~5000	1.94 (1.00-3.73)	0.040
>5000	1.81 (1.02-3.58)	0.045

All the variables in the model are $p<0.05$.

come in the study population (Table 2). Yi migrants and Han people had higher risk of the MS than Yi farmers. Compared with females, the risk of having the MS was significantly higher in males, and the relative risk of developing the MS was 1.7 after adjusting for risk factors. In the model, a significant linear association was observed for age group. Additionally, heavy alcohol intake was accompanied by an increased risk of having the MS. Moderate and heavy physical activities lowered the risk of the MS. Family history of diabetes or hypertension was found to be a significant risk factor in the study population. The risk of the MS in participants with higher family income level was significantly higher than those with lower family income level. However, no significant associations were found between the MS and education level or current smoking.

DISCUSSION

Little has been written regarding the prevalence of the MS in Yi people, some previous studies of the Yi people were mainly on the major risk factors for CVD rather than clustering of these factors.[18-20,25] In this study, when comparing the prevalence rates of the MS among the three groups, we noticed that the proportions of subjects with the MS, overweight and obesity, high blood pressure and elevated triglycerides levels in the Yi farmers were all considerably lower than that in Yi migrants and Han people. Low HDL levels appeared to be more common in Yi people than in Han people. It remained unknown, however, whether this result was due to the genetic predisposition of Yi people or influenced by other environmental factors.

A notable difference between the present study and previous reports was the remarkable increase in overweight (BMI ≥25) and hypertension (SBP ≥140 mmHg or DBP ≥90 mmHg).[25] The prevalence of overweight in Yi migrants was far higher than the corresponding figures of the 1988 studies (38.7 vs. 7.7% in men, 24.5 vs.11.8% in women, respectively). However, the change in Han people was similar to Yi migrants. In contrast, these figures among Yi farmers had a modest change compared to that of twenty years ago (4.9 vs. 1.8% in men, 9.4 vs. 5.4% in women). Hypertension also had a remarkable increasing trend in Yi migrants (19.5 vs. 9.6% in men and 9.7 vs. 3.4% in women, respectively) and in Han people (18.6 vs. 9.5% in men and 17.2 vs. 6.1% in women, respectively), whereas the prevalence of hypertension in Yi farmers had no significant change (4.6 vs. 2.7% in men and 2.0 vs. 2.4% in women, respectively). Data from our study demonstrated the crucial role of rapidly urbanized lifestyles on the prevalence of hypertension and overweight or obesity among Yi migrates and Han people in southern China during the last two decades.

Presently, the standard of living among the Yi farmers still lagged behind the current economic and social developments of other population groups due to environmental conditions and other reasons. Limited family income reflected that they had few opportunities for the consumption of high-fat and high-energy foods such as meats and processed foods. Many studies revealed that low socioeconomic status is associated with a higher mortality rate from CVDs.[26,27] However, we found that risk of the MS among the study population was significantly lower in participants with lower family income. These data suggested that low social position might have decreased the risk of the MS. Physical activity reduced individual cardiovascular risk by improving blood pressure, plasma triglycerides, blood glucose and low HDL cholesterol levels.[28,29,30] Our study also showed that the risk of the MS lowed in participants with heavy work physical activity levels, which was consistent with the results of the low prevalence of the MS in Yi farmers. Excessive alcohol intake was found to be a significant independent risk factor for the MS in accordance with previous studies. [31,32] Some evidence suggested that genetic factors and family history had a significant effect on the development of the MS, and a positive family history for CVDs had been reported to affect blood pressure and the plasma glucose level[33] In the present study, we also found that a family history of hypertension or diabetes was related to increased risk of the MS.

Currently, the underlying cause of the MS continues to be unclear, but both insulin resistance and central obesity are considered as significant factors. Genetics, ageing, and lifestyle may also have causal effects, but the role of these may vary depending on groups with different ethnic backgrounds. However, more evidences suggest that the risk of developing abnormal components of the MS is markedly higher among obese people compared to people with normal weight. In contrast, weight loss through dietary modification and regular physical activity are known to be effective in correcting metabolic abnormalities in obese people.[30,34-36]

In the present study, although the ethnic background of Yi migrants was similar to that of Yi farmers, the prevalence of the MS and the trend of prevalence with increasing age were more similar to what was seen in Han people, and even much higher than in Han people. The relation with age remained after the data was treated with multivariate adjustment. The MS affected 23.8% of the subjects under research including 29.5% of the men and 18.0% of the women in Yi migrants, which approximated the data from developed nations. It was most likely that the ten-fold difference in prevalence could be attributed only to the differences in lifestyles and environments. This result suggested that a transition in lifestyle, including dietary compositions and physical activities levels, were important on the development of the MS and it's components among Yi migrants.

One of the limitations of our study was that waist circumstance had not been recorded during the interview as we only used BMI as a substitute for waist circumstance, despite the fact that the use of BMI rather than waist circumference was a widely accepted modification, and several previous studies described risk factors for the MS using the same modification.[37-40] In addition, a BMI of 24kg/m^2 was found to have the best sensitivity and specificity for identifying risk factors including hypertension, diabetes and dyslipidaemia in the Chinese population.[24]Therefore, in our study, using BMI as an obesity index is an appropriate alternative for the diagnosis of the MS.

Our study was cross-sectionally designed rather than longitudinal, which made it hard to draw conclusions about the causal relationship between migration time and the risk of developing the MS. However, we proposed that the low prevalence of the MS in Yi farmers was largely due to absence of obesity, resulted from less fat gain and heavy physical activities.

In summary, findings from this study indicated that environmental factors, rather than genetic factors, might have predominantly contributed to the progression of the MS by comparing populations with similar genetic background but with different environmental circumstances, and populations with same environmental circumstances but with different genetic backgrounds. As expected, our findings revealed the contributing risk factors for the MS would include: sex, age, excessive alcohol intake, physical activity, family history and family income. Since the MS is a major risk factor for type 2 diabetes and CVDs, lifestyles change may also be responsible for the increase in risk of CVDs in the long run. Hopefully the results from our study may somehow contribute to the development of a MS prevention strategy that could lead to the reduction of related risks associated to CVDs.

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AUTHOR DISCLOSURES

No conflicts of interest.

REFERENCES

1. Trevisan M, Liu J, Bahsas FB, Menotti A. Syndrome X and mortality: a population-based study. Risk Factor and Life Expectancy Research Group. Am J Epidemiol. 1998;148: 958-66.
2. Y He, B Jiang, J Wang. Prevalence of the metabolic syndrome and its relation to cardiovascular disease in an elderly Chinese population. Am Coll Cardiol. 2006;47:1588-94.
3. Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J et al. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA. 2002;288:2709-16.
4. Onat A, Ceyhan K, Basar O, Erer B, Toprak S, Sansoy V. Metabolic syndrome: major impact on coronary risk in a population with low cholesterol levels--a prospective and cross-sectional evaluation. Atherosclerosis. 2002;165:285-92.
5. Isomaa B, Almgren P, Tuomi T, Forsen B, Lahti K, Nissen M et al. Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care. 2001;24:683-9.
6. Abate N, Carulli L, Jr Cabo-Chan A, Chandalia M, Snell PG, Grundy SM. Genetic polymorphism PC-1 K121Q and ethnic susceptibility to insulin resistance. J Clin Endocrinol Metab. 2003;88:5927-34.
7. Cassell PG, Saker PJ, Huxtable SJ, Kousta E, Jackson AE, Hattersley AT et al. Evidence that single nucleotide polymorphism in the uncoupling protein 3 (UCP3) gene influences fat distribution in women of European and Asian origin. Diabetologia. 2000;43:1558-64.
8. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA. 2002;287:356-9.
9. Hu G, Qiao Q, Tuomilehto J, DECODE Study Group. Prevalence of the metabolic syndrome and its relation to all-cause and cardiovascular mortality in nondiabetic European men and women. Arch Intern Med. 2004;164:1066-76.
10. Lee WY, Park JS, Noh SY, Rhee EJ, Kim SW, Zimmet PZ. Prevalence of the metabolic syndrome among 40,698 Korean metropolitan subjects. Diabetes Res Clin Pract 2004; 65:143-9.
11. Gu D, Reynolds K, Wu X, Chen J, Duan X, Reynolds RF et al. Prevalence of the metabolic syndrome and overweight among adults in China. Inter ASIA Collaborative Group. Lancet. 2005;365:1398-1405
12. Gupta R, Deedwania PC, Gupta A, Rastogi S, Panwar RB, Kothari K. Prevalence of metabolic syndrome in an Indian urban population. Int J Cardiol. 2004;97:257-61.
13. Yang W, Reynolds K, Gu D, Chen J, He J. A comparison of two proposed definitions for metabolic syndrome in the Chinese adult population. Am J Med Sci. 2007;334:184-9.
14. Wang Y, Mi J, Shan XY, Wang QJ, Ge KY. Is China facing an obesity epidemic and the consequences? The trends in

obesity and chronic disease in China. Int J Obes (Lond). 2007;31:177-88.
15. Wirfalt E, Hedblad B, Gullberg B, Mattisson I, Andren C, Rosander U et al. Food patterns and components of the metabolic syndrome in men and women: a cross-sectional study within the Malmo Diet and Cancer cohort. Am J Epidemiol. 2001;154:1150-9.
16. Liu S, Manson JE. Dietary carbohydrates, physical inactivity, obesity, and the 'metabolic syndrome' as predictors of coronary heart disease. Curr Opin Lipidol. 2001;12:395-404.
17. Lutsey PL, Steffen LM, Stevens J. Dietary intake and the development of the metabolic syndrome: the Atherosclerosis Risk in Communities study. Circulation. 2008;117:754-61.
18. He J, Tell GS, Tang YC, Mo PS, He GQ. Relation of electrolytes to blood pressure in men. The Yi people study. Hypertension. 1991;17:378-85.
19. He J, Klag MJ, Whelton PK, Chen JY, Mo JP, Qian MC et al. Migration, blood pressure pattern, and hypertension: the Yi Migrant Study. Am J Epidemiol. 1991;134:1085-1101.
20. He J, Tell GS, Tang YC, Mo PS, He GQ. Effect of migration on blood pressure: the Yi People Study. Epidemiology. 1991;2:88-97.
21. Wu DC, Tang YC. Preliminary report on blood pressure of Yi farmers in Liangshan Autonomous Prefecture, Sichuan province, China. Chin J Cardiol. 1981;9:2. (in Chinese)
22. Dufour MC. What is moderate drinking? Defining “drinks” and drinking levels. Alcohol Res Health. 1999; 23:5-14.
23. IDF consensus worldwide definition of the metabolic syndrome. [cited 2005/6/7]; Available from: http://www.idf.org/webdata/docs/IDF_Metasydrome_definition.pdf
24. Zhou BF. Cooperative Meta-Analysis Group of the Working Group on Obesity in China. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults – study on optimal cut-off points of body mass index and waist circumference in Chinese adults. Biomed Environ Sci. 2002;15:83-96.
25. He J, Klag MJ, Whelton PK, Chen JY, Qian MC, He GQ. Body mass and blood pressure in a lean population in southwestern China. Am J Epidemiol. 1994;139:380-9.
26. Choiniere R, Lafontaine P, Edwards AC. Distribution of cardiovascular disease risk factors by socioeconomic status among Canadian adults. Can Med Assoc J. 2000;62:13-24.
27. Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. Circulation. 1993;88: 1973-98.
28. Ekelund U, Franks PW, Sharp S, Brage S, Wareham NJ. Increase in physical activity energy expenditure is associated with reduced metabolic risk independent of change in fatness and fitness. Diabetes Care. 2007;30:2101-16.
29. Kraus WE, Houmard JA, Duscha BD, Knetzger KJ. Effects of the amount and intensity of exercise on plasma lipoproteins. N Engl J Med. 2002;347:1483-92.
30. Ingelsson E, Arnlov J, Sundstrom J, Riserus U, Michaelsson K, Byberg L. Relative importance and conjoint effects of obesity and physical inactivity for the development of insulin resistance. Eur J Cardiovasc Prev Rehabil. 2009;16:28-33.
31. Trevisan M, Dorn J, Falkner K, Russell M, Ram M, Muti P et al. Drinking pattern and risk of non-fatal myocardial infarction: a population-based case-control study. Addiction. 2004;99:313-22.
32. Suh I, Shaten BJ, Cutler JA, Kuller LH. Alcohol use and mortality from coronary heart disease: the role of high-densitylipoprotein cholesterol. The multiple risk factor intervention trial research group. Ann. Intern. Med. 1992;116: 881-7.
33. Hunt KJ, Heiss G, Sholinsky PD, Province MA. Familial history of metabolic disorders and the multiple metabolic syndrome: the NHLBI family heart study. Genet. Epidemiol. 2000;19:395-409.
34. Li G, Chen X, Jang Y, Wang J, Xing X, Yang W et al. Obesity, coronary heart disease risk factors and diabetes in Chinese: an approach to the criteria of obesity in the Chinese population. Obes Rev. 2002;3:167-72.
35. Esposito K, Ciotola M, Maiorino MI, Giugliano D. Lifestyle approach for type 2 diabetes and metabolic syndrome. Curr Atheroscler Rep. 2008;10:523-8.
36. Anderson PJ, Critchley JA, Chan JC, Cockram CS, Lee ZS, Thomas GN et al. Factor analysis of the metabolic syndrome: obesity vs insulin resistance as the central abnormality. Int J Obes Relat Metab Disord. 2001;25:1782-8.
37. Nakanishi N, Suzuki K, Tatara K. Serum gamma-glutamyltransferase and risk of metabolic syndrome and type 2 diabetes in middle-aged Japanese men. Diabetes Care. 2004;27: 1427-32.
38. Medina-Lezama J, Zea-Diaz H, Morey-Vargas OL, Bolanos-Salazar JF, Munoz-Atahualpa E, Postigo-MacDowall M et al. Prevalence of the metabolic syndrome in Peruvian Andean hispanics: the PREVENCION study. Diabetes Res Clin Pract. 2007;78:270-81.
39. Sattar N, Gaw A, Scherbakova O, Ford I, O'Reilly DS, Haffner SM et al. Metabolic syndrome with and without C-reactive protein as a predictor of coronary heart disease and diabetes in the West of Scotland Coronary Prevention Study. Circulation. 2003;108:414-9.
40. Alegria E, Cordero A, Laclaustra M, Grima A, Leon M, Casasnovas JA et al. Prevalence of metabolic syndrome in the Spanish working population: MESYAS registry. Rev Esp Cardiol. 2005;58:797-806.

Original Article

Effect of lifestyle on the prevalence of the metabolic syndrome among farmers, migrants with Yi ethnicity and the Han population in Sichuan province of China

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中国四川省彝族农民、彝族移民和汉族居民的生活方式对代谢综合征的影响

彝族是中国保持最原始生活方式的少数民族之一，目前仍少见关于彝族代谢综合征患病率的研究报道。本文探讨中国西南地区彝族农民、彝族移民和汉族居民的不同生活方式等环境因素对代谢综合征患病的影响。共调查彝族农民 1,535 人，彝族移民 1,306 人與汉族居民 2,130 人。代谢综合征诊断标准采用 2005 年国际糖尿病联合会(IDF)的定义。評估体力劳动、肥胖、及其他代谢综合征的危險因子。研究结果显示彝族农民代谢综合征年龄-性别标化患病率為 2.4%，而彝族移民标化患病率(23.8%)為其 9.9 倍，汉族居民标化患病率(15.2%)則為其 6.3 倍。彝族移民和汉族居民代谢综合征患病率均随年龄的增加而显著增高，而彝族农民代谢综合征患病率随年龄增加仅有轻微的上昇。彝族农民超重和肥胖盛行率(男性：9.3%；女性：16.5%)明显低于彝族移民(男性：46.2%；女性：34.8%)和汉族居民(男性：40.6%；女性：31.9%)。彝族农民从事重体力劳动者所占比例显著高于彝族移民和汉族居民。研究结果表明，生活方式等环境因素是造成彝族农民、彝族移民和汉族居民代谢综合征患病率差异的主要因素。本研究为农村生活方式城镇化对代谢综合征的发生、发展的影响提供了一定的科学依据。

關鍵字：代谢综合征、盛行率、肥胖、生活方式、種族