The Characteristics of Living and Behavioral Factors in Chinese Patients with Metabolic Syndrome

Yuanxi Xu,[a] Yidong Wei,[a] Yajun Zhang,[b] Jianyun Gu,[a] Jun Ma,[a] Liqiang Zheng,[a] and Dayi Hu*,[a]

[a]*Heart, Lung and Blood Vessel Center, Tongji University, 1239 Siping Road, Shanghai, 200092, China and* [b]*Department of cardiology, Central Hospital of Changning District, Xianxia Road, Shanghai, 200032, China*

(Received August 26, 2006; Accepted October 24, 2006)

Metabolic syndrome (MS) is a combination of glucose and lipid abnormalities and associated with cardiac and cerebral events and the likelihood of inducible myocardial ischemia and stroke. As MS is partly a result of living and behavioral patterns, we assessed whether there exists some relationship between MS morbidity and the lifestyle of urban citizens. We evaluated 836 patients in the age range from 35 to 97 years. All participants were divided into five groups: MS group, essential hypertension group, type 2 diabetes group, essential hypertension combined with type 2 diabetes group and control group. The baseline data and other serum indices were collected. A specifically designed questionnaire was used to inquire about the current situation of each patient. Finally, we assess the influence of various factors on MS patients after grouping. Body mass index and waistline in the MS group were significantly greater than in other groups. Smoking, amount of alcohol consumption, and moderate physical activity were several crucial factors in the MS group compared with the control group. The intake of fatty and pickled food in the MS group was also higher compared with those in other groups. Average time of physical exercise decreased in the order control group, essential hypertension group, and MS group ($p < 0.05$ or $p < 0.01$). We conclude that among urban middle-aged and older patients in Shanghai, MS patients are overweight, have severe dyslipidemia, smoke and consume alcohol, eat more fatty food, and perform less physical exercise, which point out the importance of prevention, corresponding therapeutic lifestyle changes, and medication.

Key words —— metabolic syndrome, risk factors, therapeutic lifestyle changes

INTRODUCTION

Metabolic syndrome (MS) is defined as a condition characterized by a set of clinical criteria: insulin resistance, visceral obesity, atherogenic dyslipidemia, and hypertension.[1)] It is associated with increased risk for the development of atherosclerosis and cardiovascular disease (CVD), which are serious health threats.[1,2)] Therefore, on the basis of the diagnostic criteria of the World Health Organization (WHO) and National Cholesterol Education Program (NCEP), the International Diabetes Federation (IDF) proposed new criteria for diagnosing MS in 2005. The waistline is considered the central target and hypertension, dyslipidemia, and blood glucose abnormalities as judgment criteria.

Most prospective studies have emphasized the relationship between glucose and serum lipid levels and the occurrence of cardiac and cerebral vascular events. However, the prevalence of MS is also affected by different circumstances, regions, race, and even by living and behavioral patterns and diet, although the exact relations among these factors remain uncertain.[3–5)]

Current management recommendations promote therapeutic lifestyle changes (TLC) that mainly include diet, exercise, and for all of the core elements of the syndrome. These therapeutic measures are able to modify favorably the core components of MS and it is hoped that they will also improve the long-term cardiovascular prognosis in these patients.[2)]

This research aimed at investigating basic lifestyles or inappropriate habits that may speed the process of MS development and determine apparent risk factors so that countermeasures could be formu-

*To whom correspondence should be addressed: Heart, Lung and Blood Vessel center, Tongji University, 1239 Siping Road, Shanghai, 200092, China. Tel. & Fax: +86-21-65983185; E-mail: weiyidong@yahoo.com

lated to avoid it to some extent. We focused on root causes of the syndrome (atherogenic diet, sedentary lifestyle, and overweight/obesity) and highlight recent studies that have demonstrated the effectiveness of TLC in improving or preventing the components of MS through a practical approach with a focus that embraces not only patients but also physicians and healthcare professionals as well as the larger healthcare system.[6] This involved determining the prevalence of MS, as defined by the IDF, and its characteristic of lifestyles, diet, and other factors so that the predictive TLC value can be concluded in the Chinese MS and prospective setting.[7]

METHODS

Study Population —— The human portion of the study was approved by the Institutional Review Board of Tongji University School of Medicine. In this study, we evaluated 836 outpatients (410 men and 426 women; aged 72.5 ± 10.9 years). Informed consent was obtained from all for the use of the blood samples in the present study. However, because the original cut-off for abdominal obesity in the NCEP definition (waist circumference ≥102 cm for men and ≥89 cm for women) has previously been shown to be inappropriate for Asian populations[8,9] and the number of individuals in China who meet these criteria is extremely low, the cut-off limit was adjusted to the criteria of ≥90 cm for men and ≥80 cm for women, which were based on the risk of obesity-related disorders in the Asian population.[10] Participants selection criteria were: Han ethnicity older than 35 years, living in the community, and unrelated to any other participant. Exclusion criteria were: multiple organ dysfunction syndrome (MODS), pregnancy or lactating, mental disorder, serious diabetes mellitus or hypertension and their complications (ketoacidosis, hypertensive crisis, *etc*.), secondary hypertension, and type 1 diabetes.

Grouping and Diagnostic Criteria —— Participants were divided into five groups: MS group, essential hypertension (EH) group, type 2 diabetes (DM) group, essential hypertension combined with type 2 diabetes (EH+DM) group, and control group. Diagnostic criteria were based on the IDF in 2005, that is, on the basis of visceral obesity, we can diagnose MS with any two of four components: systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg, serum triglycerides (TG) ≥1.7 mmol/l, high density Lipoprotein-C ≤0.9 mmol/l (male) or ≤1.1 mmol/l (female), and blood glucose abnormality (fasting blood glucose ≥5.6 mmol/l or oral glucose tolerance test 2 hr ≥11.1 mmol/l). Diagnosis of EH and DM as based on WHO/International Society of hematology guidelines (1999) and American Dietetic Association criteria (1997), respectively. Patients with hypertension were treated with combinations of angiotensin-receptor blockers (ARBs), angiotensin-converting enzyme inhibitors (ACEIs), calcium channel blockers (CCBs), beta-receptor blockers, and diuretics. Patients with DM received insulin injection or oral antidiabetic drugs (OHA) or both.

Research Methods —— A baseline survey comprised of food records and a food frequency questionnaire that included basic conditions (occupation, educational level, martial and economic status), behavior and mental factors (smoking, drinking, dietary structure, type and amount of physical activity), family history coronary artery disease, stroke, and DM among all family members), personal history (hypertension, coronary heart disease, stroke, DM, and dyslipidemia), medical examination (body height, weight, and waist-hip ratio), and laboratory examination (glucose, lipid) were completed. Each risk factor was further divided into several variables at different levels (Table 1). Waist and hip circumferences were measured at the umbilicus and trochanter level, respectively. All laboratory tests were undertaken using the standard methods of each of the participating institutes.

Statistical Analysis —— All research data were analyzed using SAS (SAS Institute, Cary, NC, U.S.A.) and SPSS 11.5 (SPSS Inc., Chicago, IL, U.S.A.). Measurement data were expressed as mean ± S.D., numeration data group comparisons used the chi-square test. Group comparisons were made using the *t*-test. Multivariable regression analysis was also used to analyze risk levels for developing MS.

RESULTS

Baseline Characteristics and Prevalence of MS

The baseline characteristics of the study participants are shown in Table 2. In total, 41% met the criteria[10] (waist circumference ≥90 cm for men and ≥80 cm for women) for MS. A large number of participants had abnormal waistlines and more than 30% met the Asian criteria for MS and were finally diagnosed as having MS. This morbidity rate of MS

Table 1. Major Risk Factors

Factor	Quantification code
Occupation	1 worker 2 farmer 3 solder 4 cadre or employee 5 scientist, doctor, or teacher 6 small private business 7 service sector 8 housekeeping 9 retired 10 laid-off 11 husbandry 12 merchant
Educational level	1 illiteracy 2 primary school 3 junior high 4 high school or technical school 5 college 6 university or postgraduate
Martial status	1 unmarried 2 married 3 separated 4 divorced 5 loss of spouse
Economic status	1 high 2 middle 3 poor
History of smoking	1 usually 2 used to 3 accidentally 4 never
Passive smoking	0 no 1 yes 2 uncertain
History of drinking	1 usually 2 used to 3 accidentally 4 never
Amount drunk	1<100 ml/d 2100–300 ml/d 3300–500 ml/d 4>500 ml/d
Drinking category	1 spirits 2 beer 3 wine or yellow rice wine 4 others
Fat-rich food (day/week)	1<1 d 21—2 d 33—4 d 45—7 d 5 uncertain[a)]
Fried food (day/week)	1<1 d 21—2 d 33—4 d 45—7 d 5 uncertain
Pickled food (day/week)	1<1 d 21—2 d 33—4 d 45—7 d 5 uncertain
Sweet food (day/week)	1<1 d 21—2 d 33—4 d 45—7 d 5 uncertain
Fresh vegetables and fruit (/day)	1<100 g 2>100 g 3>200 g 4>300 g 5>500 g
Heavy physical activity (days/week)	1<1 d 22—3 d 34—5 d 46—7 d
Moderate physical activity (days/week)	1<1 d 22—3 d 34—5 d 46—7 d
Light physical activity (days/week)	1<1 d 22—3 d 34—5 d 46—7 d
Sedentary time (days/week)	1<1 d 22—3 d 34—5 d 46—7 d
Family history of hypertension	0 none 1 yes 2 uncertain
Family history of CAD	0 none 1 yes 2 uncertain
Family history of stroke	0 none 1 yes 2 uncertain
Family history of type 2 diabetes	0 none 1 yes 2 uncertain

a) Uncertain means a participant who cannot remember exactly how much food of each kind is consumed each week, and we calculated these data as "absence" or "no."

Table 2. Comparison of Baseline Characteristics (Mean ± S.D.)

Group	N	Age	Gender		BMI	Waistline	Waist-hip ratio	FBG
			Male (%)	Female (%)	(kg/m^2)	(cm)	(WHR)	(mmol/l)
Control group	211	73.76 ± 12.74	51.5	49.5	$23.41 \pm 3.26^{\text{※}}$	$88.52 \pm 6.91^{\text{※}}$	0.96 ± 0.78	4.35 ± 0.43
EH group	108	74.57 ± 9.42	50.1	49.9	$23.94 \pm 4.56^{\dagger\dagger,\text{※}}$	$91.16 \pm 6.91^{\dagger,\dagger\dagger,\text{※}}$	0.97 ± 0.79	4.66 ± 0.52
DM group	74	68.78 ± 12.67	44.1	55.9	$21.75 \pm 3.73^{\text{※}}$	$84.09 \pm 7.16^{**,\text{※}}$	0.99 ± 0.87	$6.08 \pm 1.75^{*,**}$
EH+DM group	147	75.19 ± 9.66	47.6	52.4	$22.04 \pm 3.21^{**,\text{※}}$	$85.93 \pm 6.33^{**,\text{※}}$	0.99 ± 0.90	$6.11 \pm 0.91^{*,**}$
MS group	296	$71.15 \pm 10.98^{\dagger\dagger}$	54.3	45.7	$26.28 \pm 4.09^{*,**,\dagger,\dagger\dagger}$	$97.69 \pm 10.22^{*,**,\dagger,\dagger\dagger}$	0.98 ± 0.77	$5.98 \pm 1.37^{*}$

Compared with control group, $^{*}p < 0.001$; compared with EH group, $^{**}p < 0.05$; compared with DM group, $^{\dagger}p < 0.001$; compared with EH+DM group, $^{\dagger\dagger}p < 0.05$; compared with MS group, $^{\text{※}}p < 0.001$.

was slightly higher than in other studies mainly because in-patients occupied a large part of enrollment and the clustering of obesity and other components of MS may have occurred. Through group comparisons, we found that there was no gender difference in any group. The average age of morbidity in the EH+DM (75.19 ± 9.66) was higher than in the MS (71.15 ± 10.98) group ($p < 0.05$). BMI (26.28 ± 4.09 kg/m^2) and waistline (97.69 ± 10.22 cm) were significantly higher compared with those in other groups ($p < 0.01$). The level of fasting blood glucose was markedly higher in the DM, EH+DM, and MS groups than in other groups but did not significantly differ among them.

Laboratory Examination Results

The total cholesterol (TC) level did not differ among the five groups. The level of Low density Lipoprotein-C in the MS group (0.99 ± 0.22 mmol/l) was significantly lower than in the EH group (1.13 ± 0.31 mmol/l) and irrelevant in the other groups. The Low density Lipoprotein-C level

Table 3. Comparison of Serum Lipid (Mean ± S.D.)

Group	N	TC (mmol/l)	HDL-C (mmol/l)	LDL-C (mmol/l)	TG ($\log^{-1}$)#
Control	211	4.95 ± 0.99	1.05 ± 0.20	2.50 ± 1.06	$0.17 \pm 0.19^{\dagger,\divideontimes}$
EH	108	4.63 ± 1.06	$1.13 \pm 0.31^{\dagger,\dagger\dagger,\divideontimes}$	$2.10 \pm 0.94^{\divideontimes}$	$0.17 \pm 0.20^{\dagger,\divideontimes}$
DM	74	4.68 ± 1.16	$0.95 \pm 0.14^{**}$	$1.94 \pm 0.95^{\divideontimes}$	$0.02 \pm 0.22^{*,**,\dagger\dagger,\divideontimes}$
EH+DM	147	4.65 ± 0.98	$0.99 \pm 0.26^{**}$	2.28 ± 0.87	$0.18 \pm 0.21^{\dagger,\divideontimes}$
MS	296	4.96 ± 1.18	$0.99 \pm 0.22^{**}$	$2.54 \pm 0.99^{**}$	$0.26 \pm 0.23^{*,**,\dagger,\dagger\dagger}$

Compared with control group, $^{*}p < 0.05$; compared with EH group, $^{**}p < 0.05$; compared with DM group, $^{\dagger}p < 0.05$; compared with EH+DM group, $^{\dagger\dagger}p < 0.05$; compared with MS group, $^{\divideontimes}p < 0.05$. #; $\log^{-1}$ was specifically used in the TG parameter due to skewed distribution of TG value and transformed into normal distribution. The lower the value, the higher the basic data (mmol/l).

Table 4. Comparison of Risk Factors (%)

		Control	EH group	DM group	EH+DM group	MS group
Smoking history	yes	33.3	18.4^{*}	27.3	78.6^{*}	$87.0^{*,**}$
	no	66.7	81.6	72.7	21.4	$13.0^{*,**}$
Passive smoking	yes	37.6	44.4	60.2	58.7	56.4
	no	62.4	55.6	39.8	41.3	43.6
Drinking history	yes	37.0	51.3^{*}	36.4	40.5	$65.4^{*,**,\dagger\dagger}$
	no	63.0	48.7	63.6	59.5	$34.6^{*,**,\dagger\dagger}$
Drinking category	liquor	40.0	29.5	25.0	35.3	22.2
	beer	40.0	28.6	25.0	29.4	48.1
	wine	20.0	41.9	50.0	35.3	25.9
Physical activity	yes	53.0	43.6	39.0	32.3	35.6^{*}
	no	47.0	56.4	61.0	67.7	64.4^{*}
Sedentary time	yes	58.5	60.7	59.3	65.7	68.1
	no	41.5	39.3	40.7	34.3	32.9
Family history EH	yes	21.2	48.1	23.7	30.7	34.0
	no	78.8	51.9	76.3	69.3	66.0
Family history DM	yes	5.5	8.5	16.3	15.5	21.3
	no	94.5	91.5	83.7	84.5	78.7

Compared with control group, $^{*}p < 0.05$; compared with EH group, $^{**}p < 0.05$; compared with EH+DM group, $^{\dagger\dagger}p < 0.05$.

in the MS group (2.54 ± 0.99 mmol/l) was higher only than that in the DM group, while the TG level (0.26 ± 0.23) was significantly higher compared with those in other groups ($p < 0.05$) (Table 3).

Risk Factors and Lifestyle Components of MS

Compared with the control group, there was a significant difference in the MS group in smoking (packs/year), alcohol consumption, moderate physical activity, and diet. No difference was found in economic status, passive smoking, and alcohol category predilection between these two groups. Smoking and drinking also differed between the MS and EH groups. In comparison to the EH+DM group and control group, drinking history and moderate physical activity were major factors in MS, respectively ($p < 0.05$ or $p < 0.01$) (Table 4).

Dietary Pattern in MS

Compared with the control group, the intake of fatty or fried food in the MS group was relatively higher and the daily consumption for fresh vegetables and fruits lower. The EH group differed in pickled food intake compared with the MS group. Compared with the DM group, the intake of fatty food was significantly higher in the MS group. In comparison with the EH+DM group, the MS group had a higher intake of fried or pickled and sweet food and relatively lower daily consumption of fresh vegetables and fruit. The amount of smoking (1220 ± 595 number/year) and drinking (2.25 ± 0.92) were both significantly different in the MS group compared with some other groups ($p < 0.05$ or $p < 0.01$) (Table 5).

Logistic Regression Analysis

Logistic regression analysis was used to assess

Table 5. Comparison of Dietary Patterns and Other Factors (Mean ± S.D.)

	Control	EH group	DM group	EH+DM group	MS group
Smoking (number/year)	774 ± 386	888 ± 702	1156 ± 848*	1283 ± 375*,**	1220 ± 595*,**
Income	2.49 ± 0.99	2.81 ± 1.47	2.60 ± 1.38	2.91 ± 0.81	2.72 ± 1.34
Amount of drunk	1.02 ± 0.51	1.16 ± 0.61	1.62 ± 0.21*	1.77 ± 0.47*,**	2.25 ± 0.92*,**,†
Light physical activities	1.57 ± 1.60	1.48 ± 1.09	1.66 ± 2.57	1.40 ± 3.23	1.79 ± 1.92
Moderate physical activity	1.43 ± 3.16	0.54 ± 1.72††	2.22 ± 2.81	2.44 ± 4.32**	0.99 ± 2.59††
Heavy physical activity	1.02 ± 0.50	0.98 ± 1.22	1.06 ± 1.38	1.07 ± 2.44	0.97 ± 1.27
Vegetables and fruit (/day)	3.11 ± 1.22	3.24 ± 1.03	3.36 ± 0.92	3.46 ± 1.19	2.68 ± 1.01*,††
Oil (/month)	8.44 ± 10.57	7.45 ± 2.73	7.36 ± 1.86	7.31 ± 2.96	8.63 ± 8.05
Sodium (/month)	27.78 ± 5.67	28.68 ± 7.73	27.09 ± 5.58	28.83 ± 8.28	27.10 ± 8.18
Fatty food (days/week)	1.78 ± 0.97	2.03 ± 1.03	1.55 ± 0.69	1.88 ± 0.97	2.22 ± 1.16*,†
Fried food (days/week)	1.52 ± 0.51	1.66 ± 0.81	1.82 ± 0.41	1.57 ± 0.67	1.85 ± 0.79*,††
Pickled food (days/week)	2.00 ± 1.04††	1.87 ± 0.90††	1.48 ± 0.63	1.91 ± 0.30*,**	2.29 ± 1.13**,††
Sweet food (days/week)	1.81 ± 1.08	1.87 ± 1.10	1.36 ± 0.67	1.60 ± 1.01	2.02 ± 1.18††

Compared with control group, $^{*}p < 0.05$; compared with EH group, $^{**}p < 0.05$; compared with DM group, $^{\dagger}p < 0.05$; compared with EH+DM group, $^{\dagger\dagger}p < 0.05$.

Table 6. Logistic Regression Analysis of Risk Factors between MS and Other Groups

Risk factor	Control		EH		DM		EH+DM	
	Sig.	95%CI	Sig.	95%CI	Sig.	95%CI	Sig.	95%CI
TC	0.005**	1.09–1.66	0.165	0.40–1.17	0.042*	2.01–2.91	0.063	0.26–1.04
TG	0.004**	1.70–14.96	0.065	0.97–3.42	0.035*	1.28–72.58	0.080	0.93–3.59
LDL-C	0.090	0.90–4.29	0.009**	1.23–4.14	0.052	0.98–79.18	0.080	0.93–3.46
BMI	0.655	0.75–1.19	0.184	0.96–1.25	0.966	0.70–1.46	0.556	0.87–1.29
Smoking	0.0001**	4.50–128.68	0.160	0.70–8.86	0.344	0.19–114.44	0.005**	1.85–29.80
Waistline	0.0001**	1.11–1.42	0.005**	1.04–1.21	0.049*	1.00–1.70	0.0001**	1.11–1.37
HDL-C	0.046*	0.59–0.91	0.001**	0.22–0.88	0.427	0.96–3.58	0.559	0.77–2.80
Light physical activity	0.342	0.884–1.428	0.437	0.387–1.508	0.655	0.754–1.194	0.090	0.900–4.288
Moderate physical activity	0.037*	0.39–1.51	0.0001*	0.25–0.67	0.311	0.06–2.51	0.458	0.61–2.97
Heavy physical activity	0.255	0.913–1.411	0.160	0.699–8.858	0.184	0.958–1.208	0.068	0.965–3.418

All other groups compared with MS group, $^{*}p < 0.05$, $^{**}p < 0.01$.

the odds ratio (ORs) of MS compared with the other groups using several variables. The results indicated that moderate physical activity and normal HDL-C were probably protective factors against the development of MS, while TC, TG, LDL-C, smoking, and waistline were all risk factors (Table 6).

DISCUSSION

In recent years, with the implementation of various large-scale epidemiologic surveys worldwide, the morbidity rate of MS, which incorporates several risk factors for cardiac and cerebral vascular diseases, has been shown to be increasing. The harmful results of MS are cardiac and cerebral implications that severely affect people's living standard or even cost lives.[11] Hence great importance must be attached to comprehensive and aggressive preventive care. Treatment directed at the individual components of MS will delay the progression to type 2 diabetes and reduce the incidence of cardiovascular disease.[12] Most previous studies focused mainly on general baseline surveys or genotype analysis with the criteria of WHO or the NCEP. The current investigation is based on the latest diagnostic criteria (IDF, 2005) to analyze possible relationships between different lifestyle and dietary patterns with the morbidity rate of MS and predict favorable TLC guidelines to preventing this syndrome to a certain extent.

The prevalence of overweight and obesity is es-

calating globally. Similarly, our current study indicated that the BMI and waistline in the MS group were significantly higher than in the control and other groups, which showed the susceptibility to MS in overweight people and confirmed that waistline is an independent risk factor in the process of MS development. In 2004, WHO showed that persons whose waistlines reached or exceeded the threshold value (in Asians, ≥94 cm in man and ≥80 cm in women), together with two or more two diagnostic elements of MS comprised more than 85% of the total number of MS cases. However, people whose waistlines were below the threshold value comprised only 12–14%.[13, 14] We draw the conclusion that increasing waistline is not only a screening index but an important predictive index as well. That is, we can both roughly select the MS cohort according to waistline and may further predict the possible combination of components with different waistline measurements. Second, the current investigation also indicated that in the MS group, in comparison with the EH+DM and control groups, the time spent in moderate physical activity (lifting light weights, riding a bicycle, Chinese boxing, *etc*.) decreased gradually, which implies the development of MS is attributable to a lack of exercise or low level of physical activity, at least in part.[15, 16] Furthermore, the importance of treating MS through moderate physical activity and weight reduction has been confirmed. In Denmark, more than 10% of the population is now severely overweight. After 15 weeks of intensive lifestyle intervention, there were significant improvements in aerobic fitness and metabolic risk parameters, and the observed weight loss was equivalent to that obtained by surgical treatment.[13] Previous research showed that moderate physical activity for 30–45 min/d, 3 to 5 days/week, is conducive to reducing 5–10% of body weight and lowering the risk of occurrence of other hazard components of MS (hypertension, dyslipidemia, and blood glucose level).[17]

Dyslipidemia is a prominent characteristic of MS patients. Interestingly, this study showed that the HDL-C level in the MS group was significantly lower than that in the EH group, but no significant difference in HDL-C was observed between the MS (0.99 ± 0.22) and control (1.05 ± 0.20) groups. In a sense, this implies the EH patients have higher HDL-C levels. This needs to be confirmed based on the mechanism. The HDL-C level is also an independent risk factor, bearing an inverse relationship with atherosclerotic cardiovascular disease (with risk rising sharply when levels are <1.04 mmol/l). Apart from its protective role in atherosclerosis, it is an antioxidant to LDL-C and decreases platelet aggregability. Plasma HDL-C levels >1.16 mmol/l may be considered optimal and between 1 and 1.16 mmol/l as desirable.[18] TG levels in the MS gourp were significantly higher than in the control group, which indicated that the combination of increasing waistline with dyslipidemia comprises a large proportion of MS patients. Kahn *et al.*[19] reported in the analysis of National Health and Nutrition Examination Surveys III research that fasting insulin, homeostasis model assessment-insulin resistance (HOMA-IR), and blood fasting glucose levels were higher in people with abnormal waistlines combined with high TG levels than those in the control group. Our research also showed that metabolic abnormalities were mainly caused by adipose excess aggregation due to the combination of abnormal waistline and high levels of LDL-C and TG. It also reflected insulin resistance to a large extent.

It is generally considered that a high-calorie, fat-rich, high-glucose, and low-cellulose diet contributes to MS. Our current research confirmed this. The weekly intake of fatty or fried food in the MS group was higher than in the control group, while vegetable and fruit intake was relatively lower. Saturated fatty acid in fat-rich food is the most harmful element relevant to insulin resistance.[19] Thus restriction of such food, above mentioned, especially of fat intake, may play an important role in reducing weight, improving dyslipidemia and glucose metabolism, and normalizing blood pressure.[20] Compared with other groups, the intake of fatty food in the MS group was higher, while there were no difference among the other groups, which indicated that such food may cause mixed metabolic disorders (*e.g*, obesity together with blood glucose abnormality, hyperlipidemia, *etc*.) rather than a single component alone. The alcohol consumption history in the MS group was also significantly different than that in the other groups. There was no difference among participants who consumed spirits, wine, or beer for the same amount of time. Moderate drinking may reduce platelet aggregation, improve endothelial cell function, and reduce levels of C-reactive protein. Excess drinking for a long time exacerbates insulin resistance and increases the morbidity of MS, or even causes obesity, dyslipidemia, and hypertension.[21, 22]

The current study not only identified baseline

characteristics and morbidity rate of MS in Chinese urban citizens, but also analyzed the accelerating or protective function of various living and behavioral factors in the development of MS and provided guidelines for TLC and secondary prevention. The treatment should be based on two major components: behavioral change to reduce caloric intake and an increase in physical activity. A realistic goal for weight reduction should be 7–10% over 6–12 months.[23, 24] Overweight people (for Asians, BMI $\geq$25 kg/m^2) should engage in moderate physical activity 3–5 days/week and reduce sedentary time as much as possible. Physical activity recommendations should include practical, regular, and moderate regimens of exercise, with a daily minimum of 30–60 min. An equal balance between aerobic exercise and strength training is advised. However, heavy physical activity is not encouraged for older people based on our results.

A reasonable diet is of great importance to overweight people. The general dietary recommendations should include low intake of saturated fats, animal fats, and cholesterol, and diets with a low glycemic index. Soy protein could be more beneficial than animal protein in weight reduction and correction of dyslipidemia.[25] It is also critical to consume more than 300 g fresh vegetables and fruit per day and avoid fried or pickled food. Moderate alcohol consumption, no matter what category, is also encouraged.

Last but not least, for patients with waistlines increasing gradually and dyslipidemia, medication is strongly recommended. An LDL-C level less than 2.6 mmol/l is now considered optimum for all individuals. In addition, HDL-C and TG cut-off points have been modified to reflect more accurately the risk associated with abnormalities in these lipoproteins and the near-term risk of experiencing a Coronary heart disease event and matching the intensity of treatment to this risk.[26] As a result, it is beneficial for people with a tendency to obesity accept TLC combined with moderate medication to prevent MS and its cardiac and cerebral vascular complications.

REFERENCES

1) Deedwania, P. C. and Volkova, N. (2005) Current treatment options for the metabolic syndrome. *Curr. Treat. Options Cardiovasc. Med.*, **7**, 61–74.
2) Hafidh, S., Senkottaivan, N. and Villarreal, D. (2005) Management of the metabolic syndrome. *Am. J. Med. Sci.*, **330**, 343–351.
3) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (2001) Executive summary of the third report of the National Cholesterol Education Program (NCEP). Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA*, **285**, 2486–2497.
4) National Cholesterol Education Program (NCEP) (2002) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third report of the National Cholesterol Education Program (NCEP). Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. *Circulation*, **106**, 3143–3421.
5) Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines (2004) *Circulation*, **110**, 227–239.
6) Stone, N. J. and Saxon, D. (2005) Approach to treatment of the patient with metabolic syndrome: lifestyle therapy. *Am. J. Cardiol.*, **96**, 15E–21E.
7) Sone, H., Mizuno, S. and Fujii, H. (2005) Is the diagnosis of metabolic syndrome useful for predicting cardiovascular disease in Asian diabetic patients? *Diabetes Care.*, **28**, 1463–1471.
8) Tan, C. E., Ma, S. and Wai, D. (2004) Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? *Diabetes Care.*, **27**, 1182–1186.
9) Jorgensen, M. E., Borch-Johnsen, K. (2004) The metabolic syndrome. Is one global definition possible? *Diabet. Med.*, **21**, 1064–1065.
10) Chien, K. L., Hsu, H. C. and Chao, C. L. (2006) Interaction of obesity, metabolic syndrome and Framingham risk on steatohepatitis among healthy Taiwanese: population-based nested case-control study. *Cardiovasc. Diabetol.*, **5**, 12.
11) Ford, E. S., Giles, W. H. and Diez, W. H. (2002) Prevalence of the metabolic syndrome among US adults: findings from the Third National Health and Nutrition Examination survey. *JAMA*, **287**, 356–359.
12) Rosenson, R. S. and Reasner, C. A. (2004) Therapeutic approaches in the prevention of cardiovascular disease in metabolic syndrome and in patients with type 2 diabetes. *Curr. Opin. Cardiol.*, **19**, 480–487.
13) Pedersen, J. O., Zimmermann, E. and Stallknecht,

B. M. (2006) Lifestyle intervention in the treatment of severe obesity. *Ugeskr. Laeger*, **168**, 167–172.
14) WHO consultation (2004) Appropriate body mass index for Asian population and its implications for policy and intervention strategies. *Lancet*, **363**, 157–163.
15) Laaksonen, D. E., Lakaa, K. M. and Salonen, J. T. (2002) Low levels of leisure-time physical activity and cardiorespiratory fitness predict development of the metabolic syndrome. *Diabetes Care.*, **25**, 1612–1618.
16) Liu, S. and Manson, J. E. (2001) Dietary carbohydrates, physical inactivity, obesity, and the "metabolic syndrome" as predictors of coronary heart disease. *Curr. Opin. Lipidol.*, **12**, 395–404.
17) Franz, M. J., Bantle, J. P. and Beebe, C. A. (2002) Evidence based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care.*, **25**, 148–198.
18) Kashyap, M. L., Tavintharan, S. and Kamanna, V. S. (2003) Optimal therapy of low levels of high density lipoprotein-cholesterol. *Am. J. Cardiovasc. Drugs.*, **3**, 53–65.
19) Kahn, H. S. and Valdez, R. (2003) Metabolic risks identified by the combination of enlarged waist and elevated triacylglycerol concentration. *Am. J. Clin. Nutr.*, **78**, 928–934.
20) Kris-Etherton, P. M. (1999) A new role for diet in reducing the incidence of cardiovascular disease: Evidence from recent studies. *Curr. Atheroscler. Rep.*, **1**, 185–187.
21) Zhang, Q. H., Das, K. and Siddiqui, S. (2000) Effects of acute, moderate ethanol consumption on human platelet aggregation in platelet-rich plasma and whole blood. *Alcohol. Clin. Exp. Res.*, **24**, 528–534.
22) Stewart, S. H., Mainous, A. G. and Gilbert, G. (2002) Relation between alcohol consumption and C-reactive protein levels in the adult US population. *Am. Board Fam. Pract.*, **15**, 437–442.
23) Meydani, M. (2005) A Mediterranean-style diet and metabolic syndrome. *Nutr. Rev.*, **63**, 312–314.
24) Gorowska-Pracka, D., Zozulinska, D. and Wierusz-Wysocka, B. (2005) Does the optimal diet for the prevention of cardiovascular disease exist? *Pol. Merkuriusz Lek.*, **19**, 115–117.
25) Laaksonen, D. E., Toppinen, L. K. and Juntunen, K. S. (2005) Dietary carbonhydrate modification enhances insulin secretion in persons with the metabolic syndrome. *Am. J. Clin. Nutr.*, **82**, 1218–1227.
26) McKenney, J. M. (2003) Update on the National Cholesterol Education Program Adult Treatment Panel III guidelines: getting to goal. *Pharmacotherapy*, **23**, 26S–33S.