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Relative Risk of Metabolic Syndrome in Middle Aged Adults with Different Weight Living in Urban Beijing, China

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ABSTRACT

The purpose of this study is to compare the relative risk of metabolic syndrome (MS) in middle aged adults with different body weights. 155 subjects living in urban Beijing were recruited from 24 neighborhood committees of urban Beijing. They were divided into normal weight, overweight and obese groups according to their BMIs. The general information of the subjects was collected using an interview-administered questionnaire. Standard procedure was followed to measure subject's weight, height and waist. Biochemical parameters (total cholesterol (TC), low- and high-density lipoprotein cholesterol (LDL-C ; HDL-C), triglyceride (TG), and fasting glucose) and blood pressure were also determined. The results indicated that the systolic and diastolic blood pressure, HDL-C of obese group was lower than that of the normal weight group. Fasting glucose of obese males was significantly higher than that of normal weight males. No significant difference of fasting glucose was found among female groups. No significant difference of TG was found among male groups, while TG of overweight and obese females was both significantly higher than normal weight females. There was no significant difference of TC and LDL-C among normal weight, overweight and obese groups in both males and females. The MS rate of obese males was significantly higher than the normal weight and overweight males, as was the female. The relative risk of MS in obese group was about 11 times higher (OR = 11.249, 95%CI = 3.812 − 33.191) than the normal weight group after adjusting for age, gender, smoking, drinking, family economic level and education status. It is concluded that obesity contributed to lower HDL-C, hypertriglyceride, hypertension and MS after controlling the effects of age, gender, socioeconomic status, alcohol drinking and smoking. Obese individuals have a higher risk of having MS than their normal weight counterparts. (*J Community Nutrition* 6(3) : 131~136, 2004)

KEY WORDS : metabolic syndrome · obesity.

Introduction

There has been a rapid increase of obesity, hypertension and diabetes prevalence of Chinese people in recent years, as indicated by the 2002 Chinese Nutrition and Health Survey. The prevalence of adult obesity has increased 97% and the numbers of Chinese people suffering from hypertension have almost doubled in 10 years. It was also estimated that there were 160 million people in China who had abnormal blood lipids levels.

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The metabolic syndrome (MS) is the combination of multiple metabolic and physiological risk factors for both type 2 diabetes mellitus and atherosclerotic cardiovascular disease. In general, MS consists of hypertension, glucose intolerance, obesity, and dyslipidaemia. The concept that these abnormalities might all be facets of one syndrome has sparked much controversy over which single factor amongst the many interrelated variables is present in all the conditions of MS and provides the link that unifies them. A number of groups have examined the clustering of variables in MS in Caucasian populations by using exploratory factor analysis. However, the results have not been consistent. Some studies indicated that obesity could play an important role in the etiology of MS (Iqbal 2004 ; Rachel 2000 ; Han 2002), whereas there was less information on the relation between obesity and MS in China.

The purpose of this study is to investigate the cross-sectional associations of different body weights with MS among middle aged adults living in Beijing, China.

Subjects and Methods

1. Subjects

Five hundred adults aged 35 – 52 years from 24 neighborhood committees in 4 urban districts of Beijing were involved in the screen. An interview-administrated questionnaire was used for screening, and 155 of 500 candidates qualified for the study. They were divided into normal weight, overweight and obese groups according to their BMIs (WHO/NUT/NCD 1998).

Normal weight : BMI 18.5 – 24.9kg/m^2

Overweight : BMI 25.0 – 29.9kg/m^2

Obesity : BMI ≥ 30.0kg/m^2

2. Methods

1) General information

The general information of the subjects was collected using an interview-administered questionnaire. The family property and income of family members was recorded to evaluate the family economic levels (high, moderate and low) of the subjects. Information on smoking and alcohol intake was collected as well.

2) Anthropometric measurement

The height, fasting body weight and waist circumference (WC) were measured following a standardized procedure by a trained technician. The BMI was calculated as weight (kg) divided by height (m^2).

3) Blood pressure

Blood pressure was measured by a physician using standard mercury sphygmomanometer (Country Technology Inc., Gays Mills, WI). Three sequential blood pressure measurements were obtained after the subjects rested for 10 minutes in the seated position. Systolic blood pressure was measured as the point of appearance (phase I) of Korotkoff sounds ; diastolic blood pressure was measured as the point of disappearance (phase V). Readings were recorded to the nearest 2 mmHg. The mean of the readings was used in the analysis.

4) Biochemical parameters

A single blood sample of 30ml was collected after a 12 – 14h overnight fasting. 20ml blood was drawn into two 10ml lavender-top tubes (containing EDTA as an anticoagulant) for preparation of plasma and 10ml blood was drawn into one 10ml red-top tube for preparation of serum. After the blood draw, the lavender-top tubes were gently shaken and then promptly cooled on ice, while the red-top tubes were first placed at room temperature for at least 30min for blood clotting and then cooled on ice. Within 3h of the collection, the plasma/serum was separated by centrifugation at 2500 rpm for 20min at 4℃.

Plasma TC, TG, and HDL-C concentrations were determined enzymatically with a bichromatic analyzer (Abbott Diagnostics Spectrum CCX, Abbott Laboratory, North Chicago, IL) using enzymatic reagents (Cholesterol reagent : Abbott, North Chicago, IL ; triglyceride reagent : Technicon Division of Miles, Tarrytown, NY). LDL-C was estimated by the Friedewald formula, which is reliable when TG concentration was <400mg/dl.

The standard cutoffs to determine high cardiovascular risk were used as follows : WC ≥ 102cm in men and (88cm in women and BMI ≥ 30 ; TG level of ≥ 150mg/dl ; TC level of ≥ 200mg/dl ; HDL-C level of < 40mg/dl in men and < 50mg/dl in women ; blood pressure of ≥ 130/85 mmHg ; serum glucose level of ≥ 11 mg/dl ; high LDL-C level was defined as > 120mg/dl. Subjects having 3 or more of the above indicators were defined as MS (ATP III 1994) in this study.

3. Statistical analysis

All questionnaires were checked, coded and then were entered into different database. Logical checking was performed before analysis.

Values were expressed as median and quartile range, differences between the three groups were compared using ANOVA analysis ; differences of rate between three groups were compared using (2-test. Statistic significance was accepted at $P < 0.05$. Logistic regression models were developed to compare the relative risk of MS of three groups after adjustment for possible confounding and interactive effects. Dependent aviate was whether the subjects had MS (0 = yes, 1 = no).

The studies were conducted with ethical approval obtained from the Human Investigations Review Committees at the Chinese Academy of Preventive Medicine.

Results

1. Subjects

A total of 155 subjects (78 males, 77 females) completed

Table 1. The characteristics of the subjects in three groups

		Normal weight	Overweight	Obesity
Gender				
Male	N	26	26	26
Female	N	26	26	25
Total	N	52	52	51
Age (yrs)				
Male	Mean ± ±Std[1)]	43.8 ± 3.8	42.9 ± 4.0	41.8 ± 3.8
Female	Mean ± Std	43.5 ± 3.4	43.1 ± 3.5	42.2 ± 4.2
Education				
Junior middle school and less	%[2)]	32.7	34.6	43.1
Senior middle school	%	48.1	42.3	39.2
University and college	%	19.2	23.1	17.6
Family economic status				
Low	%	19.2	13.5	27.5
Middle	%	40.4	36.5	35.3
High	%	40.4	50.0	37.3
Height (cm)				
Male	Mean ± Std	170.8 ± 4.7	170.9 ± 6.1	172.2 ± 7.7
Female	Mean ± Std	159.7 ± 6.7	158.3 ± 3.8	159.7 ± 6.1
Body weight (kg)				
Male	Mean ± Std	66.7 ± 6.8^a	79.2 ± 7.7^b	95.7 ± 9.7^c
Female	Mean ± Std	56.9 ± 16.9^a	69.6 ± 3.9^b	83.4 ± 11.4^c
BMI (kg/m^2)				
Male	Mean ± Std	22.8 ± 1.8^a	27.1 ± 1.2^b	32.2 ± 2.0^c
Female	Mean ± Std	22.2 ± 2.0^a	27.8 ± 1.4^b	32.6 ± 3.3^c
Smoking (cigarettes *yrs/d)				
0	%	53.8	65.4	52.9
0 ~ 500	%	38.5	25.0	25.5
> 500	%	7.7	9.6	21.6
Drinking (alcohol) (g/day)				
0	%	23.1	30.8	29.4
0 ~ 25	%	65.4	51.9	56.9
> 25	%	11.5	17.3	13.7

1) ANOVA test, mean with same letter in each group was not significantly different, and with different letter was significantly different.
2) χ^2-test, rate with same letter in each group was not significantly different, and with different letter was significantly different.

the study. Their age, gender, height, weight, BMI, education, family economic level, smoking and drinking are shown in Table 1. There were no significant differences of age, gender, height, education, family economic level, smoking and drinking between the three groups. Significant differences were found in the weight and BMI between the normal, overweight and obesity groups.

2. Blood pressure, fasting glucose and lipid profiles

The diastolic and systolic blood pressures of obese males were 134.3mmHg and 89.4mmHg, respectively, which were significantly higher than that of both normal weight and overweight males ($P < 0.05$). No significant difference was found between normal weight and overweight males. The diastolic blood pressures of overweight and obese females were 123.6mmHg and 125.8mmHg, respectively, which were both significantly higher than normal weight females ($P < 0.05$). The systolic blood pressures of obese females were significantly higher than that of normal weight females (Table 2).

The average fasting glucose of obese males was 93.5mg/dl, significantly higher than that of the normal weight males ($P < 0.05$). There was no significant difference of the fasting glucose between normal weight and overweight males, and

Table 2. The Comparison of blood pressure, fasting glucose and lipid profiles

		Normal weight		Overweight		Obese	
		Med[1)]	Q3-Q1	Med	Q3-Q1	Med	Q3-Q1
Male	DBP(mmHg)[2)]	123.5[a]	15.1	125.5[a]	9.2	134.3[b]	20.0
	SBP(mmHg)	83.2[a]	8.6	83.5[a]	6.5	89.4[b]	11.9
	Fasting glucose(mg/dl)	90.0[a]	14.2	92.0[ab]	13.4	93.5[b]	20.3
	TG(mg/dl)	141.0	83.0	162.5	108.2	169.5	91.0
	TC(mg/dl)	164.5	32.0	179.5	25.0	166.5	29.0
	HDL-C(mg/dl)	42.5[a]	16.0	39.0[b]	12.0	33.5[b]	7.0
	LDL-C(mg/dl)	93.5	25.0	109.0	29.0	94.5	26.0
Female	DBP(mmHg)	112.1[a]	8.3	123.6[b]	12.7	125.8[b]	17.6
	SBP(mmHg)	76.3[a]	6.8	80.2[ab]	10.1	84.8[b]	8.3
	Fasting glucose(mg/dl)	91.0	10.0	97.0	17.1	100.0	21.1
	TG(mg/dl)	74.0[a]	54.0	120.0[b]	52.0	118.0[b]	54.0
	TC(mg/dl)	150.0	30.0	164.5	34.0	164.0	28.0
	HDL-C(mg/dl)	47.0[a]	10.0	44.0[b]	15.0	38.0[b]	11.0
	LDL-C(mg/dl)	85.5	38.0	93.0	32.0	91.0	35.0
Total							
	DBP(mmHg)	117.8[a]	13.4	124.5[b]	11.0	130.2[b]	19.2
	SBP(mmHg)	79.8[a]	8.4	81.9[a]	8.6	87.2[b]	10.4
	Fasting glucose(mg/dl)	91.0[a]	13.5	94.0[b]	16.0	95.0[b]	20.0
	TG(mg/dl)	92.0[a]	73.5	128.5[b]	101.5	132.0[b]	91.0
	TC(mg/dl)	156.5	33.0	172.0	35.0	165.0	32.0
	HDL-C(mg/dl)	45.5[a]	12.5	39.0[b]	13.5	37.0[b]	8.0
	LDL-C(mg/dl)	90.5	33.0	103.0	30.0	93.0	33.0

1) Wilcoxon test, median with same letter in each group was not significantly different, and with different letter was significantly different.
2) DBP, SBP, TG, TC, HDL-C and LDL-C were the abbreviation for diastolic blood pressure, systolic blood pressure, triglyceride, total cholesterol, high density lipoprotein cholesterol and low density lipoprotein cholesterol, respectively.

between overweight and obese males. The average fasting glucose of normal weight, overweight and obese females was 91.0mg/dl, 97.0mg/dl and 100.0mg/dl, respectively. No significant difference was found in females between each of the two groups.

The average triglyceride of overweight and obese female were 120.0mg/dl and 118.0mg/dl, respectively, which were both significantly higher than that of normal weight female ($P<0.05$). No significant difference of the average triglyceride levels was found between each two of the normal weight, overweight and obese males. There was no significant difference of total cholesterol levels between each of the two groups of the normal weight, overweight and obese groups in both males and females.

The HDL-C of overweight and obese males were 39.0mg/dl and 33.5mg/dl, 44.0mg/dl and 38.0mg/dl of female overweight and obese ones, which were all significantly higher than that of the normal weight males and females, respectively ($P<0.05$). There was no significant difference of LDL-C levels in both males and females between each of the two groups.

3. Metabolic syndrome rate(%)

The MS rates in normal weight, overweight and obese males were 11.5%, 26.9% and 73.1%, respectively. The MS rate of obese males was significantly higher than that of normal weight and overweight males using chi-square testing with no adjustment for other variables. The MS rate of overweight and obese females were 11.5% and 60.0%, respectively, the difference between these two groups was significant ($P<0.05$) (Table 3).

4. Relative risk of MS of obese group after adjusted relative factors

The relative risk of MS in overweight and obese groups was about 4 times (OR = 4.135, 95%CI = 0.901 − 18.974) and 11 times (OR = 11.249, 95%CI = 3.812 − 33.191) than

Table 3. Metabolic syndrome rate (%) in three groups

	Normal weight		Overweight		Obese	
	N	%[1)]	N	%	N	%
Male	3	11.5[a]	7	26.9[a]	19	73.1[b]
Female	0	0.0	3	11.5[a]	15	60.0[b]
Total	3	5.8[a]	10	19.2[a]	34	66.7[b]

1) χ^2-test, metabolic syndrome rate with same letter in each group was not significantly different, and with different letter was significantly different.

Table 4. Relative risk of metabolic syndrome of obese group after adjusted relative factors

	Parameter estimate	Standard error	Wald chi-square	*P*	Standard estimate	OR	95%CI
Slope	0.2597	2.8070	0.0086	0.9263			
Gender	−2.4353	1.1693	4.3376	0.0373	−0.6734	0.088	0.009~ 0.866
Age	0.0617	0.4596	0.0180	0.8933	0.0257	0.940	0.382~ 2.315
Family economic level	−0.1612	0.3999	0.1625	0.6869	−0.0693	0.851	0.389~ 1.864
Educational	−0.0861	0.4035	0.0455	0.8310	−0.0424	0.918	0.416~ 2.023
Smoking Index	−0.1910	0.4314	0.1961	0.6579	−0.0828	0.826	0.355~ 1.924
Drinking	0.7704	0.5484	1.9720	0.1602	0.2658	2.161	0.737~ 6.332
Normal weight							
Overweight	1.4195	0.7773	3.3348	0.0678	0.3820	4.135	0.901~18.974
Obesity	5.2307	1.2413	17.7564	<0.0001	0.9691	11.249	3.812~33.191

the normal weight group, respectively after adjusting for age, gender, smoking, drinking, family economic level and education status (Table 4).

Discussion

The MS consists of a cluster of heart disease risk factors, including low HDL-cholesterol, high triglycerides, impaired carbohydrate metabolism, central obesity, and high blood pressure. Each component of the MS is independently associated with an increased risk of cardiovascular disease.

The results of this study indicated that body weight was associated with several metabolic components including blood pressure, fasting glucose, triglyceride, serum total cholesterol, HDL-C and LDL-C. The MS rate of the obese group tended to be significantly higher than that of the normal weight and overweight groups. The relative risk of MS in the obese group was about 11 times more than the normal weight group after the adjustment for age, gender, smoking, drinking, family economic level and education status. These findings are consistent with data from other studies (Zeng 2003 ; Iqbal 2004 ; Rachel 2000). Cross-sectional study and prospective study showed that BMI was an important indicator of the MS (Zeng 2003 ; Han 2002), and weight loss contributed to the improvement in each component of the MS, which further supported the relation between obesity and MS. Case et al. found that a moderate decrease in weight (6.5%) induced by a very low calorie diet resulted in substantial reductions of systolic (11.1mmHg) and diastolic (5.8mmHg) blood pressure, glucose (17mg/ml), triglycerides (94mg/dl) and total cholesterol (37mg/dl) at 4 weeks after diet control.

This study showed that there was higher MS rate in men than in women in normal weight, overweight and obesity adults. Additionally, stepwise manual logistic regression analysis shows that independent of obesity, gender was significantly associated with MS, indicating a gender-related difference. This result was also found in previous studies. The reasons for this difference are not well-known.

The gender difference in visceral adipose tissue accumulation was an important factor in explaining the gender differences in cardiovascular risk profile (Lemieux 1994). Lemieux et al. (1994) studied 80 men and 69 pre-menopausal women, aged 23 − 50 years. Despite the fact that women had higher levels of total body fat, they displayed lower areas of abdominal visceral adipose tissue and a lower ratio of abdominal visceral to midthigh adipose tissue areas than men. After adjustment for body fat mass, women generally displayed a more favorable risk profile than men, which in-

cluded higher plasma HDL-C and lower plasma insulin, apolipoprotein B, and triglyceride levels. Falkner also indicated that there were significant gender differences in plasma insulin levels and in insulin sensitivity in African-Americans (Falkner 1994). The gender difference of abdominal visceral adipose could contribute to a gender-specific pattern of MS. Smith and Zachwieja (Smith 1999) reported that all forms of weight loss affect visceral fat more than subcutaneous fat, and there was a gender difference, with men appearing to lose more visceral fat than women for any given weight loss. In addition, the gender difference of sex hormones and lifestyle could have a substantial influence on MS (Falkner 1994).

A number of studies have employed factor analysis to examine the MS in larger Caucasian or African-American study populations (Anderson 2001). While all these studies agree that the clustering of metabolic variables in MS is a result of multiple factors and not a single etiology ; the factors defined are not uniform. An extension of factor analysis, structural equation modeling tests hypotheses about independent causal pathways between the variables, and the results were conflicting. The present studies did not include a test of insulin sensitivity or resistance, so it is impossible to determine which variable was the central factor of MS.

Summary and Conclusion

In order to compare the relative risk of MS of middle aged adults with different weight living in urban Beijing, a total of 155 subjects were included in the study. The MS rates of normal weight, overweight and obese males were 11.5%, 26.9% and 73.1%, respectively. The MS rate of the obese group tended to be significantly higher than that in the normal weight and overweight by gender with no adjustment for other variables. The MS rates of overweight and obese females were 11.5% and 60.0%, respectively, the difference between these two groups was significant. After adjusting for age, gender, smoking, drinking, family economic level and education status, the relative risk of MS in overweight and obese adults were about 4 and 11 times higher than the normal weight adults, respectively.

These findings support the hypothesis that excess adiposity plays a key role in the pathophysiology of all facets of the MS. Further strategies to identify these individuals should be undertaken as they will benefit most from a medically supervised weight loss program for obese individuals with MS may be offset by the reduced need for pharmacological therapy for hypertension, dyslipidaemia and hyperglycaemia.

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