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Obesity and Cardiovascular Risk Factors among Men and Women Aged 40 Years and Older in a Rural Area of Japan

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Abstract Obesity is one of the most common health problems, and is recognized worldwide as an "escalating epidemic." For the establishment of an obesity-prevention strategy in Japan, it is important to assess the association between obesity and cardiovascular risk factors. Therefore, we conducted anthropometric measures of obesity and investigated the association of obesity with cardiovascular risk factors such as hypertension, diabetes, and dyslipidemia among community-dwelling men (N=85) and women (N=173) aged 40 years and older. Height, weight, and waist circumference (WC) were measured, and body mass index (BMI) was calculated. Subjects with a BMI≥25 kg/m^2 were considered obese (BMI obesity), while men with a WC≥85 cm and women with a WC≥90 cm were classified as obese (WC obesity). In the present study, we defined 'obesity' as a BMI≥25 kg/m^2 or a WC≥85 cm for men, and a BMI≥25 kg/m^2 or a WC≥90 cm for women. The results of an age- and sex-adjusted logistic regression analysis indicated that BMI obesity was associated with dyslipidemia (p=0.04), WC obesity was associated with dyslipidemia (p=0.07), and 'obesity' was associated with diabetes (p=0.06) and dyslipidemia (p=0.01). These results emphasize the importance of preventing obesity in Japan. Therefore, healthcare professionals should measure BMI and WC in order to enhance their assessment of cardiovascular risk. *J Physiol Anthropol 25(6): 371–375, 2006* http://www.jstage.jst.go.jp/browse/jpa2
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Keywords: obesity, body mass index, waist circumference, hypertension, diabetes, dyslipidemia, Japanese

Introduction

Obesity is one of the most common health problems, and is recognized worldwide as an "escalating epidemic" (James et al., 2001; World Health Organization, 2005). Obesity indices, such as body mass index (BMI) and waist circumference (WC), are considered useful, non-invasive anthropometric measurements that provide information on cardiovascular risks, such as hypertension, diabetes, and dyslipidemia (Ho et al., 2001; Pouliot et al., 1994; Reeder et al., 1992). BMI has been the most frequently used measure of obesity because of the robust nature of weight and height measurements (Dalton et al., 2003). In addition, several studies have reported a strong positive association between abdominal adiposity (measured by WC) and cardiovascular risk factors (Han et al., 1995; Pouliot et al., 1994; Zhu et al., 2002).

Recently, in Japan, the prevalence of obesity has increased in men for all ages and in elderly women (Ministry of Health, Labor and Welfare, Japan, 2004), while mortality from cardiovascular disease has been increasing (Statistics and Information Department Minister's Secretariat, Ministry of Health, Labour and Welfare, Japan, 2005). For the establishment of an obesity-prevention strategy, it is important to assess the association between obesity and cardiovascular risk factors.

Therefore, we conducted anthropometric measures of obesity (BMI and WC), and investigated the association between obesity and cardiovascular risk factors, such as hypertension, diabetes, and dyslipidemia in Japanese men and women aged 40 years and older.

Subjects and Methods

Subjects in the present study were community-dwelling men and women aged 40 years and older in the town of Oshima, in Nagasaki Prefecture, Japan. The subjects were identified through the municipal electoral list and invited by mail to participate as part of a periodic health examination. A total of 258 subjects (85 men and 173 women) participated in the study. The town of Oshima has a population of approximately 5800. Despite having a shipyard in the town, Oshima is primarily a farming/fishery district. The study was conducted in 2004.

A self-administered questionnaire was conducted on participants in order to collect information on age, gender, job, smoking, alcohol consumption, exercise, history of hypertension, dyslipidemia, or diabetes, and use of antihypertensive, antihyperlipidemic, or antidiabetic medication.

Participants' height and weight were measured in a standing position without shoes while wearing light clothes. BMI was calculated as weight/height^2 (kg/m^2). Participants' WC in centimeters was measured in a standing position, above the iliac crests and below the lowest rib margin at minimal respiration. All measurements were taken by trained nurses. Subjects with a BMI≥25 kg/m^2 were considered obese (BMI obesity) (Examination Committee of Criteria for Obesity Disease in Japan; Japan Society for the Study of Obesity 2002). Men with a WC≥85 cm and women with a WC≥90 cm were classified as obese (WC obesity) (Examination Committee of Criteria for Obesity Disease in Japan; Japan Society for the Study of Obesity 2002). In the present study, we defined 'obesity' as a BMI≥25 kg/m^2 or a WC≥85 cm in men, and a BMI≥25 kg/m^2 or a WC≥90 cm in women.

Blood pressure was measured using an appropriately sized cuff and a standard mercury sphygmomanometer. The systolic blood pressure (SBP) was determined by the onset of the "tapping" Korotkoff sounds. The fifth Korotkoff sound, or the disappearance of the Korotkoff sound, was used to define the diastolic blood pressure (DBP). Random blood samples were obtained from participants. Hemoglobin A1c (HgA1c) was measured by the latex agglutination method. Total cholesterol (TCHO), low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C) were measured by enzymatic methods. Hypertension was defined as an SBP≥135 mmHg and/or DBP≥85 mmHg (The Committee of Criteria for Metabolic Syndrome (Japan), 2005) and/or taking antihypertensive medications. Type 2 diabetes was defined as HgA1c≥6.5% (Kuzuya et al., 2002) and/or taking antidiabetic medications. Dyslipidemia was defined as TCHO≥220 mg/dL and/or LDL-C≥140 mg/dL and/or HDL-C<40 mg/dL (Japan Atherosclerosis Society, 2002) and/or taking antihyperlipidemic medications.

All subjects provided written informed consent prior to participating in the examination. The protocol of the present research was approved by the Ethics Committee of Fukuoka University.

Statistical analysis

Student's *t*-tests were used to compare the selected characteristics between subjects without risk factor and with risk factors for continuous variables. The chi-square test was used to analyze the relationship of obesity (BMI obesity, WC obesity, or 'obesity') with cardiovascular risk factors, such as hypertension, dyslipidemia, or diabetes, and the difference in prevalence of obesity between sexes. Logistic regression analysis adjusting for age and sex was used to evaluate the effects of obesity on the cardiovascular risk factors. The odds ratio and its 95% confidence interval were calculated. A probability value of $p<0.05$ was considered to indicate significance. All statistical analyses were performed using SAS, version 8.2 (SAS Institute Inc., Cary, NC, USA) software.

Results

Seventy percent of men and 81% of women did not have a job. Thirty percent of men and 5% of women was current smokers. Fifty-six percent of men and 10% of women drank alcohol at least once a week. Forty-one percent of men and 36% of women continued exercise above 30 minutes per day for one year.

Selected characteristics of the male participants are shown in Table 1. Selected characteristics for female participants are shown in Table 2. The mean ages (SD, range) of the men and

Table 1 Selected characteristics (mean (SD)) of men (n=85)

	Overall population	No risk factor	At least one risk factor	Hypertension	Diabetes	Dyslipidemia
N (%)	85	3	82	74	6	30
Age (years)	71.3 (8.6)	68.7 (6.7)	71.4 (8.7)	71.8 (8.4)	75.2 (3.6)	70.9 (8.6)
Weight (kg)	60.3 (9.0)	60.4 (11.5)	60.3 (9.0)	60.1 (9.2)	60.9 (13.5)	59.2 (9.2)
Height (cm)	161.0 (6.0)	166.7 (6.1)	160.8 (5.9)	160.6 (5.9)	159.3 (5.1)	159.3 (6.0)
Body mass index (kg/m^2)	23.2 (2.9)	21.6 (2.6)	23.3 (2.9)	23.3 (3.0)	23.9 (4.8)	23.3 (2.9)
Waist circumference (cm)	84.3 (7.6)	78.7 (10.7)	84.5 (7.5)	84.2 (7.7)	85.5 (9.1)	85.0 (8.4)
Systolic blood pressure (mmHg)	141.2 (12.1)	126.0 (2.0)	141.8 (12.0)^a	143.8 (10.9)^b	139.3 (6.3)^a	138.1 (13.3)
Diastolic blood pressure (mmHg)	80.1 (9.1)	76.7 (5.8)	80.2 (9.2)	81.2 (9.1)	80.7 (5.2)	79.1 (9.9)
Hemoglobin A1C (%)	5.3 (0.5)	5.4 (0.5)	5.3 (0.5)	5.3 (0.5)	6.4 (0.7)	5.3 (0.5)
Total cholesterol (mg/dL)	189.5 (29.5)	190.7 (6.0)	189.5 (30.0)	186.1 (28.2)	173.7 (39.4)	205.1 (37.0)
LDL-cholesterol (mg/dL)	112.1 (27.5)	111.3 (20.8)	112.1 (27.8)	108.8 (26.6)	107.2 (30.1)	128.3 (27.9)
HDL-cholesterol (mg/dL)	53.1 (15.1)	59.3 (12.7)	52.9 (15.2)	53.1 (15.5)	41.0 (8.8)^a	49.9 (16.2)

^{a}: $p<0.05$, ^{b}: $p<0.01$ compared with no risk factor

Table 2 Selected characteristics (mean (SD)) of women (n=173)

	Overall population	No risk factor	At least one risk factor	Hypertension	Diabetes	Dyslipidemia
N (%)	173	17	156	135	11	88
Age (years)	67.2 (10.2)	63.9 (14.6)	67.6 (9.6)	68.5 (9.4)	72.1 (6.5)	66.8 (9.4)
Weight (kg)	51.7 (8.8)	49.7 (6.0)	51.9 (9.0)	52.0 (9.3)	53.1 (14.2)	53.0 (9.8)
Height (cm)	149.5 (7.2)	151.8 (8.0)	149.2 (7.1)	149.2 (7.0)	146.1 (7.9)	149.5 (7.2)
Body mass index (kg/m^2)	23.1 (3.4)	21.6 (2.1)	23.3 (3.5)^a	23.3 (3.6)^a	24.6 (4.6)^a	23.7 (3.8)^a
Waist circumference (cm)	77.2 (8.2)	75.4 (7.5)	77.4 (8.3)	77.6 (8.5)	79.0 (10.1)	78.2 (8.3)
Systolic blood pressure (mmHg)	136.9 (13.0)	120.9 (6.0)	138.7 (12.4)^b	141.5 (10.7)^b	145.1 (13.2)^b	138.1 (13.6)^b
Diastolic blood pressure (mmHg)	77.7 (8.7)	70.0 (6.1)	78.6 (8.5)^b	79.6 (8.2)^b	81.3 (10.5)^b	79.3 (9.2)^b
Hemoglobin A1C (%)	5.3 (0.5)	5.3 (0.4)	5.3 (0.5)	5.3 (0.6)	6.4 (0.8)^b	5.3 (0.6)
Total cholesterol (mg/dL)	212.0 (33.9)	183.9 (18.0)	215.1 (33.9)^b	210.1 (31.3)^b	225.3 (53.4)^b	234.9 (29.4)^b
LDL-cholesterol (mg/dL)	127.4 (29.0)	102.1 (16.0)	130.2 (28.8)^b	126.8 (27.6)^b	139.2 (38.8)^b	146.7 (25.6)^b
HDL-cholesterol (mg/dL)	59.0 (15.4)	60.0 (11.1)	58.9 (15.9)	58.8 (16.3)	58.8 (14.8)	58.9 (17.0)

^{a}: $p<0.05$, ^{b}: $p<0.01$ compared with no risk factor

Table 3 Prevalence of cardiovascular risk factors according to BMI, WC and 'obesity'

		Hypertension N (%)	Diabetes N (%)	Dyslipidemia N (%)
Men (n=85)				
Body mass index (kg/m^2)	≥25 (n=20)	18 (90.0)	2 (10.0)	8 (40.0)
Waist circumference (cm)	≥85 (n=45)	38 (84.4)	4 (8.9)	18 (40.0)
Obesity*	Yes (n=47)	40 (85.1)	4 (8.5)	18 (38.3)
Women (n=173)				
Body mass index (kg/m^2)	≥25 (n=34)	29 (85.3)	3 (8.8)	23 (67.7)^a
Waist circumference (cm)	≥90 (n=14)	13 (92.9)	2 (14.3)	10 (71.4)
Obesity*	Yes (n=37)	32 (86.5)	5 (13.5)^a	26 (70.3)^a

* defined as BMI≥25 kg/m^2 or WC≥85 cm in men, and BMI≥25 kg/m^2 or WC≥90 cm in women.
^{a}: $p<0.05$

Table 4 Age and sex adjusted odds ratios (95% confidence intervals) of body mass index, waist circumference and 'obesity' for cardiovascular risk factors

	Comparison	Hypertension	Diabetes	Dyslipidemia
Body mass index (kg/m^2)	≥25 vs. <25	1.8 (0.7–4.4)	1.8 (0.6–5.4)	1.9 (1.0–3.5)^b
Waist circumference (cm)	≥85 vs. <85 for men ≥90 vs. <90 for women	1.1 (0.4–2.8)	2.1 (0.6–7.0)	1.9 (0.9–4.0)^a
Obesity*	yes vs. no	1.4 (0.6–2.9)	2.8 (1.0–8.2)^a	2.1 (1.2–3.7)^b

* defined as BMI≥25 kg/m^2 or WC≥85 cm in men, and BMI≥25 kg/m^2 or WC≥90 cm in women.
^{a}: $p<0.1$, ^{b}: $p<0.05$

women were 71.3 (8.6, 42–88) years and 67.2 (10.2, 42–87) years, respectively. Mean (SD) BMI and WC were 23.2 (2.9) kg/m^2 and 84.3 (7.6) cm for men, respectively, and 23.1 (3.4) kg/m^2 and 77.2 (8.2) cm for women, respectively.

Table 3 shows the prevalence of the cardiovascular disease risk factors (hypertension, diabetes, and dyslipidemia) according to BMI, WC, and 'obesity'. 'Obesity' was more prevalent in men (55.3%) than in women (21.4%, $p<0.0001$). In men, BMI obesity (≥25 kg/m^2) was observed in 24%, WC obesity (≥85 cm) in 53%, and 'obesity' in 55% of subjects. In women, BMI obesity (≥25 kg/m^2) was observed in 20%, WC obesity (≥90 cm) in 8%, and 'obesity' in 21% of subjects. No significant differences in cardiovascular risk factors were observed between obese and non-obese men. Women with BMI obesity had a significantly higher prevalence of dyslipidemia when compared with women that did not have BMI obesity. Women with 'obesity' had a significantly higher prevalence of diabetes and dyslipidemia when compared with non-'obesity' women.

Table 4 shows the age- and sex-adjusted odds ratios (95% confidence intervals) for cardiovascular risk factors according to BMI obesity, WC obesity, or 'obesity'. BMI obesity was associated with dyslipidemia (p=0.04), WC obesity was associated with dyslipidemia (p=0.07), and 'obesity' was associated with diabetes (p=0.06) and dyslipidemia (p=0.01).

Discussion

The present results showed that 'obesity' was associated with diabetes and dyslipidemia in a multiple logistic regression model. Although no association with hypertension was observed in the present study, previous studies have demonstrated that obesity is associated with a higher prevalence of hypertension (Hartz et al., 1984; Van Itallie, 1985), diabetes (Barrett-Connor, 1989; Bonham and Brock, 1985; Knowler et al., 1981; Van Itallie, 1985), and dyslipidemia (Manabe et al., 1999; Seidell et al., 2001). Therefore, obesity represents a serious health concern that must be addressed in order to improve the health of the Japanese population.

According to the National Nutrition Survey in Japan (Ministry of Health, Labor and Welfare, Japan, 2004), the prevalence of general obesity ($BMI \geq 25\ kg/m^2$) in men and women aged 40 years and older was 30% and 28%, respectively. However, the prevalence among subjects in the present study was lower than that among the previous population.

A recent study in Japan showed that prevalence of BMI obesity and WC obesity in men was 24.0% and 54.8% respectively, and that in women 13.3% and 5.8 (Hsieh and Muto, 2006). These values were similar to our results. The prevalence of WC obesity was higher than that of BMI obesity in men. On the other hand, the prevalence of WC obesity was lower than that of BMI obesity in women. The criteria for WC obesity seem rather low for men and high for women. The difference might influence the relationship of obesity to cardiovascular risk factors in each gender. Future study is needed to clarify the significance of BMI and WC by gender.

Recent studies have introduced WC as a superior indicator of abdominal obesity and predictor of cardiovascular disease than either BMI or waist-hip ratio (Dobbelsteyn et al., 2001; Foucan et al., 2002; Huang et al., 2005; Pouliot et al., 1994). Abdominal visceral adipose tissue deposition is associated with an increase in portal free fatty acid concentrations, which leads to hyperinsulinemia (Foucan et al., 2002; Larsson et al., 1984). This hyperinsulinemia may be linked to the clustering of cardiovascular disease risk factors (Schmidt et al., 1996).

Both total fat and abdominal fat can now be precisely measured using double energy X-ray densitometry, and CT and MRI imaging, respectively. Thus, these measurements could more precisely predict the impact of total fat and abdominal fat on health. However, their inherent high costs and radiation risks prevent their use in large-scale epidemiological studies or self-assessments.

Obese people are at a high risk for multiple heath problems and should be the focus of special attempts to provide guidance and support (Reeder et al., 1992). Health promotion activities at the community level must focus on the development of physical and social environments that support healthy food choices and activity patterns. The attainment of a healthy weight and the reduction of abdominal obesity should be emphasized (Reeder et al., 1992).

This present study has several limitations. Since we used cross-sectional data to predict obesity-related cardiovascular risk factors, causality cannot be determined. Future longitudinal studies are therefore required in order to examine the relationship between obesity and obesity-related risk. Data from fasting blood samples were not available in the present study, and we could not use data on blood glucose and triglyceride. Therefore, HgA1c was used as substitute in the definition of type 2 diabetes. Cardiovascular risk factors are heterogeneous and, in addition to anthropometric measurements, other factors such as heredity and menopausal status must be considered. Furthermore, the present study had a small sample size, especially for men.

The present results emphasize the importance of obesity prevention in Japan. A preventive approach to risk factors for cardiovascular disease could result in the identification of at-risk individuals using simple anthropometric parameters as screening tools. Once identified, such individuals could be provided with appropriate advice or information regarding potential treatments. Therefore, healthcare professionals should incorporate measurements of BMI and WC into their routine examinations of individuals in order to enhance their assessment of health risk (Reeder et al., 1992).

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