Low Prevalence of Metabolic Syndrome and Its Components in Rural Japan

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Tsunan, Niigata is a non-westernized rural Japanese town, known for heavy snowfalls and as a rice-producing area, whose inhabitants have a long life expectancy. We investigated the prevalence of obesity, metabolic syndrome (MetS) and its components in Tsunan. A total of 1,155 men and women, 40-69 years of age were recruited from participants in the 2005 public-health program in Tsunan. Obesity was defined as body-mass index (BMI) ≥ 25 kg/m². MetS was defined as BMI ≥ 25 kg/m² as well as at least two of the following three items: (1) high glycosylated hemoglobin (HbA1c ≥ 5.5%); (2) high blood pressure (HBP: systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg), and (3) low high-density lipoprotein cholesterol (HDL-C < 40 mg/dL). If an individual was diagnosed with diabetes, hypertension, or dyslipidemia, each item was recorded as a positive finding. The prevalence of MetS and its components among Tsunan inhabitants were compared to the results of the 2005 Japanese nationwide survey. The prevalence of MetS was 4.6% in males and 4.2% in females. The prevalence of obesity, high HbA1c, HBP, and low HDL-C were 22.1/22.2%, 13.4/16.4%, 46.6/40.0%, and 9.2/3.9% in males/females, respectively. All values were significantly lower than the national results, except for the rate of female obesity. The lower prevalence of MetS and its components in Tsunan may be due to the consumption of traditional Japanese food, which is still commonly eaten there, and the higher levels of regular physical activity of farmers.

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Materials and Methods

Subjects aged between 40 and 69 years were recruited from participants in a public health program in Tsunan carried out in 2005 that was open to any policyholder of the National Health Insurance System. Their body height, weight, blood pressure, high-density lipoprotein cholesterol (HDL-C), and glycosylated hemoglobin (HbA1c) were measured, and medical histories checked using a questionnaire.

Obesity was defined as a body-mass index (BMI) ≥ 25 kg/m². MetS was defined as a BMI ≥ 25 kg/m² as an essential condition, as well as at least two of the following three items: (1) high HbA1c (HbA1c ≥ 5.5%); (2) high blood pressure (HBP: systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg), and (3) low HDL-C (HDL-C < 40 mg/dL). If an individual was diagnosed with diabetes, hypertension, or dyslipidemia, each item was recorded as a positive finding regardless of the test data. The diagnostic criteria used to define obesity and MetS were the same as that used in the Japanese nationwide survey except for using BMI instead of waist circumference, as waist circumference was not measured in this cohort.

Blood samples were drawn randomly, in either a fasting or non-fasting state both in the nationwide survey and our study. HbA1c was measured using the high-performance liquid chromatography method with an analyzer, HLC-723 G8 (Toso, Japan). HDL-C was measured using the direct method with the 7600, 7700 Clinical Analyzer (Hitachi, Japan).

The prevalence of obesity, MetS, and individual MetS components were investigated and compared to the results of the 2005 Japanese nationwide survey (http://www-bm.mhlw.go.jp/houdou/2007/05/dl/h0516-3c.pdf). In addition, the prevalence of individual MetS components was examined among all subjects, obese subjects, and subjects with MetS in gender-divided groups. We also investigated the percentages of subjects according to their number of MetS components.

The chi-square test or Fisher’s exact test were used to test statistical significance. Statistical analyses were conducted using SAS software (SAS Institute, Cary, NC). P-values less than 0.05 were considered to be statistically significant (two-sided test). This study was approved by the Institutional Review Board of Jikei University School of Medicine.

Results

Subjects included 412 males and 743 females aged between 40 and 69 years who participated in a public health program in Tsunan in 2005 (Table 1). Forty six point one percent of males and 29.5% of females were farmers. The participation rate was 17.4% in males and 33.8% in females. The rate was higher in the higher age group, as shown in Table 1.

Obesity

The prevalence of obesity was 22.1% (95% CI: 18.1-26.1%) in males and 22.2% (19.2-25.2%) in females (Fig. 1, Obesity). The prevalence in males was significantly lower than that in the nationwide survey. However, there was no significant difference in females.

Metabolic syndrome

The prevalence of MetS was 4.6% (95% CI: 2.6-6.6%) in males and 4.2% (2.7-5.6%) in females, which was significantly lower than that in the nationwide survey except for females aged 40-49 years (Fig. 1, MetS). The rates were approximately 20% of the nationwide survey in males and 40% in females.

High HbA1c

The prevalence of high HbA1c was 13.4% (95% CI: 10.1-16.6%) in males and 16.4% (13.8-19.1%) in females (Fig. 1, High HbA1c). The prevalence in Tsunan was significantly lower...
than that in the nationwide survey except for males aged 40-49 years. The prevalence of high HbA1c among obese subjects was 22.0% (13.5-30.5%) in males and 29.1% (22.2-36.0%) in females (Fig. 2, High HbA1c in obese subjects), and 89.5% (75.7-100%) in males and 96.8% (90.6-100%) in females among subjects with MetS (Fig. 2, High HbA1c in MetS subjects).

**High blood pressure**

The prevalence of HBP was 46.6% (95% CI: 41.8-51.4%) in males and 40.0% (36.5-43.5%) in females (Fig. 1, HBP). These rates were significantly lower than those in the nationwide survey. The prevalence of HBP among obese subjects was 53.9% (43.6-64.1%) in males and 52.1% (44.5-59.7%) in females (Fig. 2, HBP in obese subjects), and 79.0% (60.6-97.3%) in males and 93.6% (84.9-100%) in females among subjects with MetS (Fig. 2, HBP in MetS subjects).

**Low HDL-C**

The prevalence of low HDL-C was 9.2% (95% CI: 6.4-12.0%) in males and 3.9% (2.5-5.3%) in females (Fig. 1, Low HDL-C). These rates were significantly lower than those in the nationwide survey except for females aged 40-49 years. The prevalence of low HDL-C among obese subjects was 17.6% (9.8-25.4%) in males and 5.5% (2.0-8.9%) in females (Fig. 2, Low HDL-C in obese subjects), and 31.6% (10.7-52.5%) in males and 22.6% (7.9-37.3%) in females among subjects with MetS (Fig. 2, Low HDL-C in MetS subjects).

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### Table 1. Demographic Characteristics of study subjects by gender and age.

<table>
<thead>
<tr>
<th></th>
<th>40-49 years</th>
<th>50-59 years</th>
<th>60-69 years</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>n</td>
<td>93</td>
<td>122</td>
<td>197</td>
<td>412</td>
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<tr>
<td>age (years)</td>
<td>44.7 ± 2.9</td>
<td>54.3 ± 2.6</td>
<td>65.6 ± 2.8</td>
<td>57.6 ± 8.9</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>23.0 ± 2.9</td>
<td>22.6 ± 2.8</td>
<td>22.5 ± 3.1</td>
<td>22.6 ± 3.0</td>
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<tr>
<td>HbA1c (%)</td>
<td>4.9 ± 0.6</td>
<td>5.1 ± 0.5</td>
<td>5.2 ± 0.9</td>
<td>5.1 ± 0.7</td>
</tr>
<tr>
<td>systolic blood pressure (mmHg)</td>
<td>127.3 ± 18.5</td>
<td>127.6 ± 16.4</td>
<td>133.7 ± 19.9</td>
<td>130.5 ± 18.8</td>
</tr>
<tr>
<td>diastolic blood pressure (mmHg)</td>
<td>78.2 ± 12.6</td>
<td>79.6 ± 11.1</td>
<td>80.4 ± 11.5</td>
<td>79.7 ± 11.7</td>
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<tr>
<td>HDL-C (mg/dL)</td>
<td>56.6 ± 16.0</td>
<td>60.0 ± 17.1</td>
<td>58.3 ± 16.6</td>
<td>58.4 ± 16.6</td>
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<td>participation rate (%)</td>
<td>12.6</td>
<td>13.5</td>
<td>27.4</td>
<td>17.4</td>
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<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>n</td>
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<td>232</td>
<td>346</td>
<td>743</td>
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<tr>
<td>age (years)</td>
<td>44.5 ± 2.8</td>
<td>54.7 ± 2.7</td>
<td>65.1 ± 2.7</td>
<td>57.3 ± 8.6</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.3 ± 3.8</td>
<td>22.6 ± 3.2</td>
<td>23.3 ± 3.1</td>
<td>22.9 ± 3.3</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>4.9 ± 0.7</td>
<td>5.1 ± 0.5</td>
<td>5.3 ± 0.7</td>
<td>5.1 ± 0.7</td>
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<tr>
<td>systolic blood pressure (mmHg)</td>
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<td>125.1 ± 17.6</td>
<td>129.4 ± 16.8</td>
<td>125.3 ± 17.3</td>
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<tr>
<td>diastolic blood pressure (mmHg)</td>
<td>71.4 ± 10.4</td>
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<td>76.0 ± 10.3</td>
<td>75.3 ± 10.8</td>
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<tr>
<td>HDL-C (mg/dL)</td>
<td>65.5 ± 13.3</td>
<td>63.8 ± 15.5</td>
<td>60.8 ± 13.6</td>
<td>62.8 ± 14.3</td>
</tr>
<tr>
<td>participation rate (%)</td>
<td>23.9</td>
<td>29.9</td>
<td>47.1</td>
<td>33.8</td>
</tr>
</tbody>
</table>

Data are mean ± s.d.
Fig. 1. The prevalence of obesity, MetS, and individual MetS components in Tsunan and in the nationwide survey. Obesity: Defined as BMI ≥ 25 kg/m². MetS: Defined as central obesity (Tsunan: BMI ≥ 25 kg/m², Nationwide survey: waist circumference ≥ 85 cm in males and ≥ 90 cm in females) as well as at least two of the following three items: (1) high HbA1c (HbA1c ≥ 5.5%); (2) high blood pressure (HBP: systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg), and (3) low HDL-C (HDL-C < 40 mg/dL). In both cohorts, if an individual was diagnosed with diabetes, hypertension, or dyslipidemia, each item was recorded as a positive finding regardless of the test data. * p < 0.05, ** p < 0.005.
Number of MetS components

The percentages of subjects who satisfied any of the criteria of MetS components (High HbA1c, HBP, and Low HDL-C) were as follows: 0 components: 42.0% in males, 50.6% in females; 1 component: 47.1% in males, 39.7% in females; 2 components: 10.7% in males, 8.5% in females; and 3 components: 0.2% in males, 1.2% in females. In addition, the percentages of obese subjects according to the number of MetS components were as follows: 0 components: 27.5% in males, 34.6% in females; 1 component: 51.7% in males, 46.7% in females; 2 components: 20.9% in males, 16.4% in females; and 3 components: 0% in males, 2.4% in females. Accordingly, approximately 20% of obese subjects satisfied the criteria of MetS.

DISCUSSION

The prevalence of obesity, MetS, and indi-
individual MetS components were investigated in Tsunan, Japan, whose inhabitants have a long life expectancy, and compared to results from a nationwide survey. In summary, prevalence rates for all investigated factors except for obesity in females were significantly lower in Tsunan compared with national results. Tsunan is a non-westernized rural area, with only 2 convenience stores and no fast food restaurants. Therefore, there are few opportunities for residents to eat fast food, which has been associated with weight gain or insulin resistance (Pereira et al. 2005). Traditional Japanese foods including rice and vegetables and regular physical work among the predominant occupational group of farmers might be responsible for the beneficial results documented in this study, which showed that the prevalence of MetS was significantly lower than that in the nationwide survey.

The higher prevalence of obesity or diabetes in an urban area compared with a rural area has frequently been reported in developing countries (Al-Nuaim 1997; Singh et al. 1998; Sobngwi et al. 2002; Hussain et al. 2005). One explanation for this may be differences in lifestyle or levels of physical activity, and also a higher prevalence of obesity in urban areas is noted as a reason for the higher prevalence of diabetes.

In regard to individual MetS components, the highest prevalence was for HBP, followed by high HbA1c and low HDL-C. Another Japanese report ranking the prevalence of individual MetS components listed HBP as most prevalent, followed by dyslipidemia, and then high fasting glucose (Nishimura et al. 2007). Therefore, our study results agreed with the most prevalent component being HBP.

The most common cause of death in Tsunan in 2005 was cancer, followed by heart disease, and then cerebrovascular disease (http://www.pref.niigata.jp/fukushihoken/fukushigyousei/nenpo/17/17oukeihyo.html). Studies have indicated that the risk of cardiovascular disease (CVD) or mortality increases as the number of MetS components increases (Wannamethee et al. 2005; Asia Pacific Cohort Studies Collaboration. 2006; Eberly et al. 2006; Tanomsup et al. 2007). It is therefore also necessary to investigate the relationship between MetS components and CVD or mortality in Tsunan.

The percentages of current smokers and ex-smokers were 42.5% and 16.0% in males, and 5.0% and 0.9% in females in this study cohort. The rate of current smoking was slightly higher than that in the nationwide survey in males, and lower in females. Although smoking is considered to be one of the risk factors for visceral fat accumulation and deterioration of glucose and lipid metabolism (Komiyama et al. 2006), the current study failed to demonstrate this association. The prevalence of MetS, obesity, high HbA1c, HBP, and low HDL-C among current smokers, ex-smokers and non-smokers were similar for each gender, except for a significantly higher prevalence of HBP in female non-smokers and a significantly higher prevalence of high HbA1c in male ex-smokers. Because of the high percentages of smokers in Tsunan males, it is therefore also necessary to investigate the relationship between smoking status and CVD mortality.

There are several limitations in our study. Firstly, the number of female subjects was approximately double that of male subjects, and more elderly people participated in the study than younger people. Secondly, as we did not have waist circumference data for the Tsunan cohort, we used BMI instead of waist circumference, which had been used in the nationwide survey. It was demonstrated that there was a strong correlation between BMI and waist circumference and both of them similarly correlate with high blood pressure, low HDL-C, and high HbA1c among Japanese (Nakamura et al. 2007). We had shown that the correlation between BMI and waist circumference was very strong among people aged 12-13 years old (Morimoto et al. 2007). Therefore, it is possible to use BMI as a marker in this situation. This is supported by the use of BMI $\geq$ 25 kg/m$^2$ to investigate MetS in other Japanese studies (Shiwaku et al. 2005; Ishizaka et al. 2005). Thirdly, random blood samples were taken and not always in a fasting state, and TG levels were not used as a criterion of MetS. However, this was similar to the national survey, which also
took non-fasting samples, and did not use TG levels as one of the criterion for MetS.

In conclusion, the prevalence of obesity, MetS, and individual MetS components in Tsunan were significantly lower than the results of the nationwide survey except for obesity in females. This may partly be due to the high percentage of farmers in the sample, who have higher levels of regular physical activity. In addition, Tsunan is not as westernized as Japanese cities, with most participants consuming a traditional Japanese diet.

Acknowledgments

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References


