

Emergence of Cardiovascular Risk Factors From Mild Obesity in Japanese Elementary School Children

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Clustering of individual cardiovascular risk factors, such as central obesity, insulin resistance, hypertension, and dyslipidemia, together known as metabolic syndrome, is largely confined to obese populations in both children and adults (1,2). The underlying pathophysiology of metabolic syndrome is thought to be related to insulin resistance (3).

In Asian countries, especially Japan, obesity-associated disorders arise in mildly to moderately obese adults (4,5). The association between mild obesity in children and individual risk factors in Asian countries is not well defined. The purpose of the present study is to determine the prevalence of, and sex differences in, abdominal obesity and insulin resistance, key features of metabolic syndrome, and assess whether risk of these factors is associated with mild obesity in Japanese elementary school children.

RESEARCH DESIGN AND METHODS

Subjects were elementary school children aged 6–12 years who were screened as having a percent relative body weight (%RBW) $\geq 35\%$ (6). A total of 863 children (561 boys, 302 girls) participated in a screening program for comorbidity of obesity conducted in 2002 and 2003 by the Kagoshima City Board of Education and Kagoshima City Medical Association, Japan. Of these, 754 obese

children (490 boys, 264 girls) were included in the present study. One hundred nine subjects were excluded: 9 subjects (6 boys, 3 girls) were excluded because they had normal %RBW, and 100 subjects (65 boys, 35 girls) were excluded because of incomplete information. For 146 subjects (93 boys, 53 girls) who participated in the program in both years, only the 2002 data were used.

We obtained permission to use and analyze these data from the committees for ethics of Kagoshima City Medical Association and the National Hospital Organization Kyushu Cardiovascular Center under the condition that confidentiality regarding all personal data would be maintained. The components of the screening program have been described elsewhere (7).

Of the parameters examined in the programs, waist circumference, an index of obesity, and homeostasis model assessment of insulin resistance (HOMA-IR) were used in this study. Height, weight, and waist circumference were measured by each subject's home doctor. Height and waist circumference were measured to the nearest 0.1 cm and weight to the nearest 0.1 kg (7). Blood samples were collected at each clinic the morning after an overnight fast. Insulin concentrations were measured by means of a chemiluminescence immunological assay (Chemi-

lumi Insulin; Kyowa Medics, Tokyo, Japan). HOMA-IR was used as a measure of insulin resistance (8).

As a measure of obesity, we computed the %RBW: (individual body weight)/(age-, sex-, and height-specific body weight from a reference population) $\times 100$ (6). Obesity was classified as follows: mild, %RBW ≥ 20 to $<30\%$; moderate, %RBW ≥ 30 to $<50\%$; and severe, %RBW $\geq 50\%$ (12). Subjects were divided into four groups: those with %RBW ≥ 20 to $<30\%$, ≥ 30 to $<40\%$, ≥ 40 to $<50\%$, and $\geq 50\%$. The data for levels of waist circumference, fasting insulin, and HOMA-IR of nonobese children (%RBW $\geq -20\%$ and $<20\%$) were obtained from previous studies (9–11).

Statistical testing for the difference in mean values between two groups was performed using the Mann-Whitney test. A level of $P < 0.05$ was considered statistically significant.

RESULTS — The mean waist circumference value of boys (78.6 ± 8.3 cm) was significantly higher than that of girls (74.5 ± 8.3 cm) ($P < 0.0001$). On the other hand, the mean HOMA-IR level of girls (3.07 [95% CI 2.79 – 3.34]) was significantly higher than that of boys (2.65 [2.48–2.82]) ($P < 0.0001$).

Regarding waist circumference, significant differences were present among neighboring subgroups in both boys and girls; however, the greatest significance was between normal and mildly obese boys (Fig. 1). The difference in levels of HOMA-IR between normal and mildly obese children was more prominent in boys (Fig. 2). On the other hand, HOMA-IR levels gradually increased until the 40–50% RBW grouping in girls (Fig. 2).

CONCLUSIONS — Previous studies have shown that significant differences were found in the levels of systolic and diastolic blood pressure, HDL cholesterol, triglyceride, insulin, and HOMA-IR between overweight at-risk (BMI 23.0 – 24.9 kg/m²) and normal adults (BMI 18.5 – 22.9) in Japan (4). On the other hand, no significant differences in these

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Received for publication 26 December 2005 and accepted in revised form 23 February 2006.

Abbreviations: HOMA-IR, homeostasis model assessment of insulin resistance; %RBW, percent relative body weight.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

DOI: 10.2337/dc06-2538

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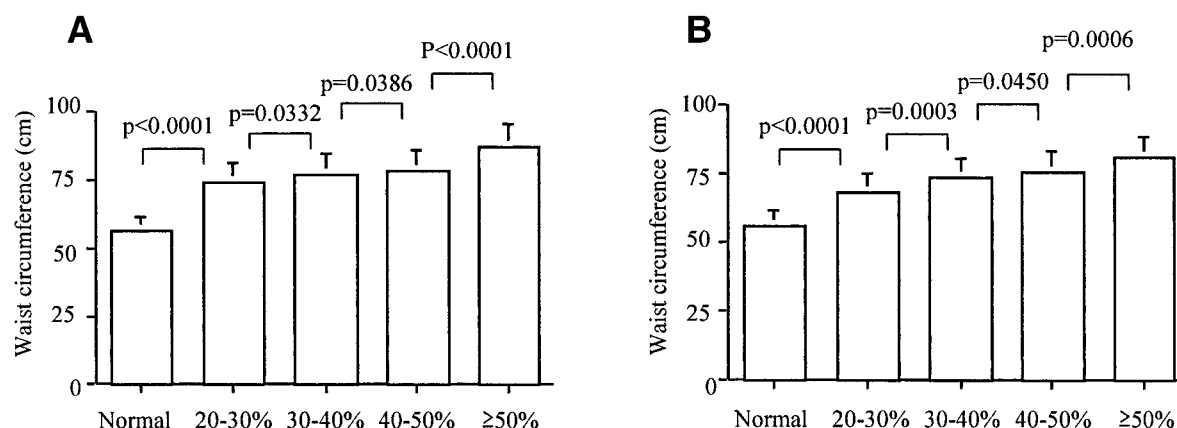


Figure 1—Changes in waist circumference among normal and obese boys (A) and girls (B) with %RBW of 20–30, 30–40, 40–50, and ≥50%. The greatest significance was present between normal and mildly obese boys (20–30% RBW group). In boys, the *z* values between normal control subjects and the 20–30% RBW group and between the 40–50 and ≥50% RBW groups were -12.143 and -6.488 , respectively. Waist circumference gradually increased with increasing obesity in girls.

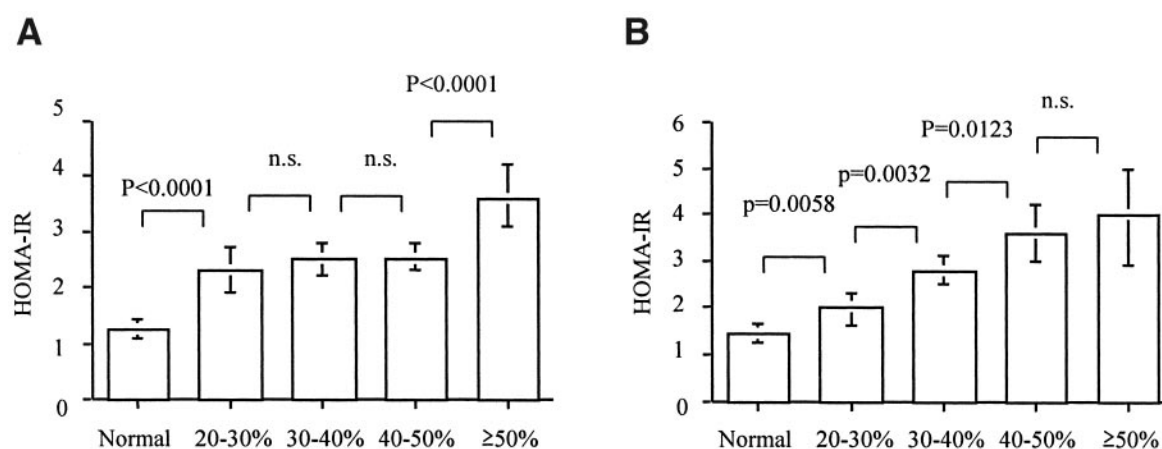


Figure 2—Changes in HOMA-IR levels among normal and obese boys (A) and girls (B) with %RBW of 20–30, 30–40, 40–50, and ≥50%. HOMA-IR data are expressed as the mean and 95% CI because values were skewed. The greatest significance was present between normal and mildly obese boys (20–30% RBW group); the *z* values between normal control subjects and the 20–30% RBW group and between the 40–50 and ≥50% RBW groups were -4.949 and -4.381 , respectively. The HOMA-IR level gradually increased until the 40–50% RBW grouping in girls.

risk factors, except diastolic blood pressure, have been shown between overweight at-risk and normal adults in Mongol (4). In Japan, BMI slightly increased in men and slightly decreased in women during the period 1976–1995, according to national surveys; however, the prevalence of diabetes and dyslipidemia has been rapidly increasing (5). These previous findings and the present data indicate a tendency toward early development of cardiovascular risk factors from mild obesity, not only in adults, but also in children aged 6–12 years in Japan. An important feature in boys is that an abrupt worsening of insulin resistance can emerge from both mild and severe obesity. This suggests that primary prevention is extremely important among preteen Japanese boys.

The approach used in this study has some limitations. First, data from former studies (9–11) were used as controls. Although these studies (9–11) were conducted using data of Japanese children, and although the control data for fasting glucose and insulin were obtained from an elementary school in the same city (10,11), future studies should include a subject control group. Possible limitations also include the use of HOMA-IR and waist circumference for surrogate assessment of insulin resistance and abdominal obesity, respectively. In addition, the present study included a larger percentage of boys than girls. However, recent increases in the prevalence of obesity during elementary school years have been shown in boys but not girls in Japan (12), indicating that a focus on boys is justified.

The reason for this rapid increase in boys needs investigation in the future.

Acknowledgments—This work was supported by grants from the Foundation of Health and Labor Sciences Research (Comprehensive Research on Cardiovascular Diseases [17160501]) and Foundation of Tanita Healthy Weight Promotion (2004).

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