Short Communication

Weight-for-height charts for Japanese children based on the year 2000 Report of School Health Statistics Research

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Key words: weight-for-height charts, standard body weight, Japanese children, obesity index

Introduction

Obesity during adulthood has become a major health problem that can lead to other serious illnesses, such as hypertension, heart disease, stroke, and type 2 diabetes mellitus, thereby causing increased overall mortality (1). Many studies have suggested that these conditions originate in childhood and that preventive measures against adult obesity should be started as early as possible (2). Although evaluations of adiposity are essential for this purpose, the measurement of body fat is complicated (3). Therefore, body mass index (BMI, kg/m²), relative body weight (obesity index), and other adiposity-related indices are normally used as surrogate markers of body fat in the health care system, including in school-based examinations.

BMI and age-specific BMI percentiles are widely used in many countries, and have been proven to be closely related to adiposity in children (4). According to the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) growth references, obesity and overweight status are defined as a BMI that equals or exceeds the 95th percentile value for children and adolescents of the same age and sex (5).

In contrast, relative body weight is widely used in Japan. Relative body weight is the percentage of the median or standard body weight of children of the same height, and is called the obesity index. The obesity index is quite comprehensive and is easy to understand for the general public, including children and adolescents.

Accordingly, weight-for-height charts for preschool-aged children were developed (6) (Fig. 1, a: boys; b: girls) and are printed in maternity health record books. These books are distributed to all pregnant women and are used to maintain and promote health in pregnant women, mothers, fetuses, infants, and preschool-aged children.

Received: January 13, 2016
Accepted: January 25, 2016

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charts will not only be practical for evaluating the obesity status of individual children, but also for performing studies of public health.

**Methods**

We used the 2000 Report on School Health Survey (Ministry of Education, Culture, Sports, Science and Technology), which included 4.3% of all children and adolescents aged 5 to 17 yr in Japan (7). Using probability-proportional sampling, the data for the report were extracted from the results of school health examination in 2000, including anthropometric measurements from a total of 695,600 boys and girls.

In the report itself, correlations between height (cm) and weight (kg) were summarized in 26 tables according to age and gender. The tables were matrices in which heights and weights were organized as rows and columns and each matrix element (cell) showed the corresponding frequency.

Using these frequency matrices, we constructed a comprehensive frequency matrix that covered all ages for each sex. Frequencies in the age-specific matrices were summed according to height and weight, after which the median weights for each height were determined. Heights were excluded if the sum of frequencies was 0.1% or less.

Curves connecting these median weights were approximated by cubic functions with two connecting points, which were determined by investigating the curves that were to be fitted. The cubic functions were determined using the least squares method. Three formulas covered the following three height ranges, as evaluated separately for boys and girls: 101–140 cm, 140–180 cm, and 180 cm and above.

![Fig. 1. Weight-for-height charts with +30%, +20%, +15%, 0%, –15%, and –20% lines (obesity index) for preschool-aged Japanese boys (a) and girls (b). Obtained from reference (8).](image)
Weight-for-height charts

149 cm, and 149–184 cm for boys and 101–140 cm, 140–149 cm, and 149–171 cm for girls.

Results

Median weights for each height are shown in Table 1, as presented separately for boys and girls. The formulas that relate each median weight and height are summarized in Table 2. Statistical analyses of the residuals between the median weights and the calculated standard weights revealed the values of the mean, minimum, maximum, and the 25th, 50th, and 75th percentiles (0.13 kg, 0.0 kg, 0.92 kg, and 0.03 kg/0.08 kg/0.20 kg in boys, 0.11 kg, 0.001 kg, 0.60 kg, and 0.04 kg/0.08 kg/0.14 kg in girls). Using these formulas, weight for height lines and corresponding obesity indices (+50%, +30%, +20%, 0%, −10%, and −20%) were drawn, as presented in Fig. 2 (a: boys; b: girls).

Discussion

We have established weight-for-height charts with six obesity indices for Japanese children and adolescents.

Using these charts, an individual’s obesity index can be determined easily and without
calculation. In addition, the plotted data and lines on the charts can provide insight into several related factors, such as the timing of obesity onset and treatment goals. Therefore, by allowing individuals to see their own obesity indices, these charts may help to prevent obesity and reduce cardiovascular and metabolic risks, even in children and teens.

Table 2. Formulas for calculating standard body weights for boys and girls

| Boys: | | | |
|---|---|---|---|
| $< \text{Age 6}^a$ | $\text{Height: 70 cm} \leq H < 120 \text{ cm}$ | $2.0600 \times 10^{-3} \times H^2 - 1.1660 \times 10^{-4} \times H + 6.5273$ | |
| $\geq \text{Age 6}$ | $\text{Height: 101 cm} \leq H < 140 \text{ cm}$ | $3.03882 \times 10^{-5} \times H^3 - 5.71495 \times 10^{-3} \times H^2 + 5.08124 \times 10^{-4} \times H - 9.17791$ | |
| | $\text{Height: 140 cm} \leq H < 149 \text{ cm}$ | $-8.50130 \times 10^{-5} \times H^3 + 3.70692 \times 10^{-2} \times H^2 - 4.65580 \times H + 1.91847 \times 10^2$ | |
| | $\text{Height: 149 cm} \leq H < 184 \text{ cm}$ | $-3.10205 \times 10^{-4} \times H^3 + 1.51159 \times 10^{-1} \times H^2 - 2.36303 \times 10^3 \times H + 1.23104 \times 10^5$ | |

| Girls: | | | |
|---|---|---|---|
| $< \text{Age 6}^a$ | $\text{Height: 70 cm} \leq H < 120 \text{ cm}$ | $2.4900 \times 10^{-3} \times H^2 - 1.8580 \times 10^{-4} \times H + 9.0360$ | |
| $\geq \text{Age 6}$ | $\text{Height: 101 cm} \leq H < 140 \text{ cm}$ | $1.27719 \times 10^{-4} \times H^3 - 4.14712 \times 10^{-2} \times H^2 + 4.8575 \times H - 1.84492 \times 10^2$ | |
| | $\text{Height: 140 cm} \leq H < 149 \text{ cm}$ | $-1.78766 \times 10^{-5} \times H^3 + 8.03922 \times 10^{-1} \times H^2 - 1.19310 \times 10^2 \times H + 5.88503 \times 10^3$ | |
| | $\text{Height: 149 cm} \leq H < 171 \text{ cm}$ | $9.56401 \times 10^{-4} \times H^3 - 4.62755 \times 10^{-1} \times H^2 + 7.53058 \times 10^3 \times H - 4.06831 \times 10^3$ | |

H: height (cm). $^a$ Obtained from reference (8).

Fig. 2. Weight-for-height charts with $+50\%$, $+30\%$, $+20\%$, 0%, $-10\%$, and $-20\%$ lines (obesity index) for school-aged Japanese boys (a) and girls (b).
As mentioned above, these charts are based on relatively simple formulas. In Table 2, the previously published formulas for preschool-aged children have also been shown (8). Healthcare professionals can draw charts for all age-ranges of childhood by using these formulas with standard spreadsheet software, such as Microsoft Excel (Microsoft, Redmond, WA, USA).

When constructing these charts, we analyzed data on height-weight correlations from the 2000 Report on School Health Survey. Although the average heights and weights of children and teens change over the years, we chose to use the year 2000 data for several reasons. First of all, the year 2000 report includes all of the auxological data from Japanese children, including all age ranges in 10-year intervals from 1960 onwards. Considering secular trends (such as in maturation rates and obtained heights), the trend of increasing average height in childhood had almost completed by the year 2000, although that for adults had finished in the early 1990s. Furthermore, the tendency towards obesity in Japanese children began in the early 1980s at the latest. We used the data from the year 2000 report for these reasons (9).

Based on the year 2000 data, sex- and age-specific standard weights have also been published according to height (10). These are based on the analysis of height and weight correlations using 95% confidence ellipses, and are represented in linear equations. Five percent of children were excluded at the extremes, such that those with the shortest and tallest statures were not included. Furthermore, standard body weights will change just immediately after birthdays in the case of follow-up with short intervals. These disadvantages could be overcome by using weight-for-height charts.

However, the determination of standard body weights solely based on height and sex underestimates changes in body composition during puberty. Therefore, evaluations of obesity should not be only on the obesity index; they should also take puberty status into account.

In conclusion, our study provides weight-for-height charts for Japanese children, which could be used widely in health-promoting activities for children and teens.

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