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SPECIAL ARTICLE

New Growth Charts for Taiwanese Children and Adolescents Based on World Health Organization Standards and Health-related Physical Fitness

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1. Growth Charts

Children are not small adults. Growth (changes in size of the body as a whole or of its separate parts) and development (changes of function) consist of unique processes from birth to adulthood. Growth charts for height, weight and body mass index (BMI) are indispensable tools for both pediatricians and healthcare providers. They constitute not only the basic tools required for clinical evaluation, but are also useful for the purposes of public health and preventive medicine. On May 8, 2009 the Bureau of Health Promotion, Department of Health (DOH), officially launched new growth charts for infants and pre-school children in Taiwan.[1] These new growth charts, unlike previous population-based ones, were adapted from the World Health Organization (WHO) Child Growth Standards for 0–5 years of age.[2] This report briefly describes the new methods (criterion-based approach) used to construct these standards and compares the new growth charts with the old ones. We also propose growth charts for children and adolescents over 5 years of age in Taiwan.

2. Old Growth Curves

Previous measurements of height and weight were generally conducted by sampling the entire population. Following the rapid economic development in Taiwan and the associated increases in the standard of living and social well-being of its people, survey results have shown that child growth trends have also gradually increased each year. The reference growth charts previously

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used in Taiwan were based on the combined data from two population-based surveys: the DOH (survey by stratified sampling of children from 0–6 years of age) and the Ministry of Education (nationwide survey of students).[3] When these data were compared with those from the 2000 National Center for Health Statistics (NCHS), USA, it was found that the weight of boys aged 7–15 years in Taiwan was higher by an average of 1.6 kg, while the height was lower by 2.3 cm.[3] These differences have raised several questions: (1) Is the method of sampling from the entire population acceptable, especially when the prevalence of childhood obesity has rapidly increased in recently years, (2) does the so-called "reference" agree with the real standard?

3. Growth Standard With Criteria

Although the results derived from population-based surveys seem unreasonable, the choice of suitable criteria and samples presents a problem. In view of the fact that a large proportion of infants are usually fed with infant formula, the current growth references derived from infants fed with formula should not reflect the health recommendations. In 1998, the WHO convened an expert committee to discuss the appropriate growth patterns of healthy children; this resulted in the initiation of a project to develop growth standards for children worldwide. The characteristic features of this project were, (1) an approach that included maternal support for breast feeding and an unconstrained environment for optimal growth; (2) an international sampling frame; and (3) the use of modern statistical methods.[4,5] It seems likely that a growth standard based on criteria for young children can be developed, but the application of these approaches to adolescents presents a greater challenge. To solve the problems associated with the presence of overweight and obese cases in the population and survey samples, Chen et al[6] attempted to use health-related physical fitness as the screening criterion. Using four measures of physical fitness (800/1600-m run, standing long jump, curl-up, and sit-and-reach), the study collected height, weight and BMI data from students whose results for each of the four fitness tests were all above the 25th percentile, and used these to construct the 2003 Taiwan growth curves.[6,7] After reaching a consensus from the expert committee organized by the DOH, the growth curves have now become the growth standards for school-aged children and adolescents in Taiwan and have been published on the website for public use.[8] Criterion-based approaches, also known as prescriptive approaches,[9] such as breastfeeding or health-related physical fitness, are identical to adult criteria that are based on mortality and morbidity rates. These approaches not only differ significantly from the previous population-based approach (also known as the descriptive approach),[9] but also focus on how children should grow, rather than on how they grew in a particular time and place.

4. Growth Standards and References

In April 2006, the WHO released new standards for assessing the growth of children from birth to 5 years of age.[10] These new standards were the product of a previous project that included a longitudinal follow-up of 882 infants from birth to 24 months and a cross-sectional component of 6669 children aged 18–71 months in six countries from diverse geographical regions, including Brazil, Ghana, India, Norway, Oman and the United States. The eligibility criteria were: single-term birth and no known significant morbidity, exclusive or predominant breastfeeding for at least 4 months, introduction of complementary foods by 6 months of age, no maternal smoking before or after delivery, and no known health or environmental constraints to growth. However, as countries proceed with the implementation of the 2006 WHO growth standards for children under 5 years of age, the need to develop appropriate growth standards for school-aged children and adolescents has become more urgent. WHO experts agreed that a project similar to that responsible for the development of the 2006 WHO standards was not feasible because it was not possible to control the dynamics of the environment for these age groups. Experts therefore suggested using historical growth data that were stable in term of secular increments of height and weight, and not subjected to the influences of overweight and obesity. Due to a lack of existing data sets from various countries, WHO experts agreed to reconstruct the 1977 NCHS/WHO growth reference for 5–19 years of age, using the original sample (a less obese sample of the expected height) and applying a new statistical method, to develop a 2007 WHO growth reference for school-aged children and adolescents.[11] Table 1[3,6,7,10,11] summarizes the characteristics of the two standards and the two references from the WHO and Taiwan.

5. Comparison Between Standards and References

The differences between these data were compared using growth curves. Figure 1 shows the comparison between the WHO growth curves for boys (2006 WHO standard and 2007 WHO reference) and the existing curves used in Taiwan, which include the population-based data (for boys aged under 6 years)