



ELSEVIER

SPECIAL ARTICLE

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

Walter Chen^{1*}, Mei-Hwei Chang²

¹Department of Pediatrics, China Medical University Beigang Hospital, Yulin and China Medical University College of Medicine, Taichung, Taiwan

²Department of Pediatrics, National Taiwan University Hospital and National Taiwan University College of Medicine, Taipei, Taiwan

Received: Jul 19, 2009
Revised: Aug 12, 2009
Accepted: Aug 17, 2009

KEY WORDS:

body mass index;
growth charts;
health-related physical
fitness;
Taiwanese children;
World Health Organization
standards

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

*Corresponding author. Department of Pediatrics, China Medical University Beigang Hospital, Yulin and China Medical University College of Medicine, 91 Hsueh-Shih Road, Taichung 40402, Taiwan.
E-mail: chenwalt@yahoo.com

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 recent 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 al⁶ 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 breast-feeding 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

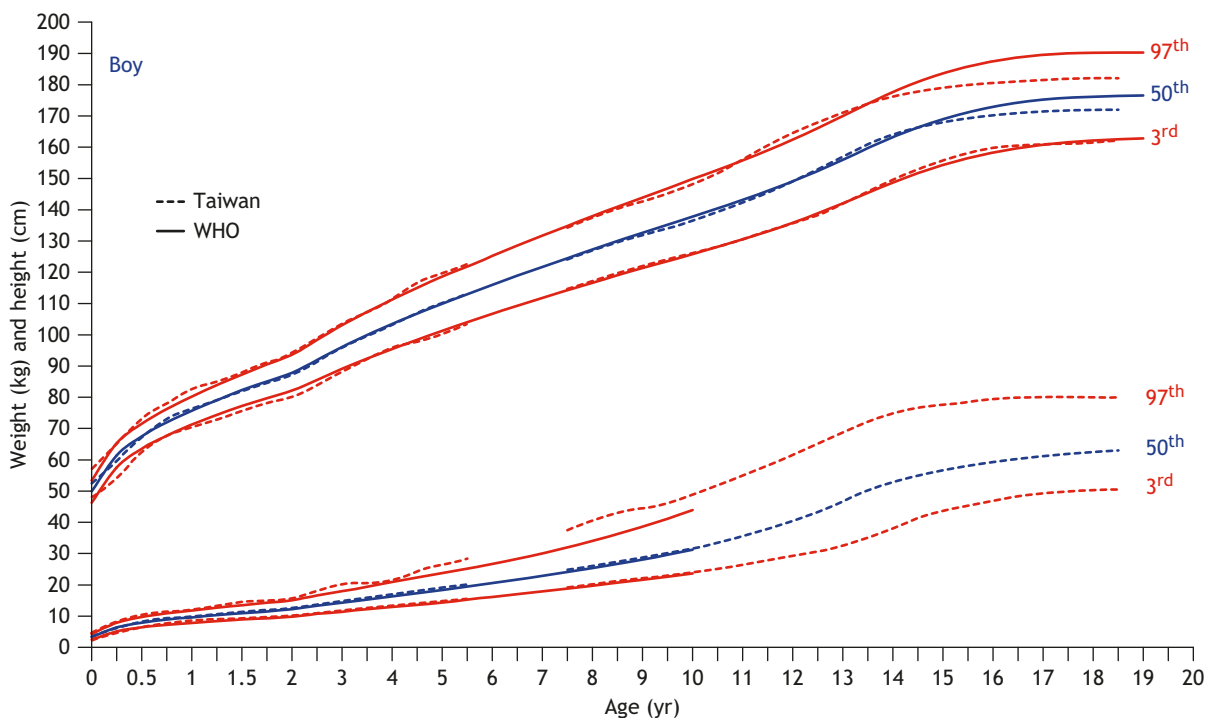
In April 2006, the WHO released new standards for assessing the growth of children from birth to 5 years of age.¹⁰ These new standards were the product of a previous project that included a longitudinal follow-up of 882 infants from birth to 24 months and a cross-sectional component of 6669 children 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)

Table 1 Characteristics of two growth standards and references from the World Health Organization (WHO) and Taiwan^{3,6,7,10,11}

	Standard	Reference
Infants & pre-school children	2006 WHO (Criterion-based: optimal feeding practice) ¹⁰	1997 Taiwan (Population-based: data sets include slim and fat) ³
Children & adolescents	2002 Taiwan, Chen et al, (Criterion-based: health-related physical fitness) ^{6,7}	2007 WHO (Population-based: 1977 non-obese population, USA) ¹¹

**Figure 1** Comparison between World Health Organization (WHO) and Taiwan weight-for-age and height-for-age growth curves for boys by percentile.

and health-related physical fitness-based data (for children aged over 7 years, 2003 Taiwan growth standard). Taking the 50th percentile as an example, the WHO height is higher by an average of 0.1 cm for boys aged 0–5 years, 0.5 cm for those aged 7–13 years, and 2.5 cm for those aged 13–18 years. In contrast, the WHO weight is lower by an average of 0.3 kg for boys aged 0–5 years and 0.7 kg for those aged 7–10 years. Importantly, the WHO weights were truncated at 10 years of age because WHO experts believed that routine measurements of weight alone were inadequate for monitoring growth beyond childhood.¹¹ Figure 2 shows the equivalent comparison for girls. As for boys, the WHO height was higher by an average of 0.1 cm for girls aged 0–5 years, 1.0 cm for those aged 7–11 years, and 2.9 cm for those aged 11–18 years. WHO weights were lower by an average of 0.2 kg for girls

aged 0–5 years and 0.1 kg for those aged 7–10 years. Moreover, regardless of sex, the differences for the 97th percentile showed higher significance than those for the 50th percentile.

Figures 3 and 4 show that the differences in BMI between the two data sets are more significant than those for weight and height. The WHO 95th percentile curve almost overlaps the Taiwan 85th percentile curve for boys from 7 to 10 years old. After puberty, however, the upper Taiwan BMI curves are much lower than the WHO references for both sexes.

6. Adopting the New WHO Standards and References

In early 2007, the DOH in Taiwan convened an expert meeting for pediatricians and nutritionists.

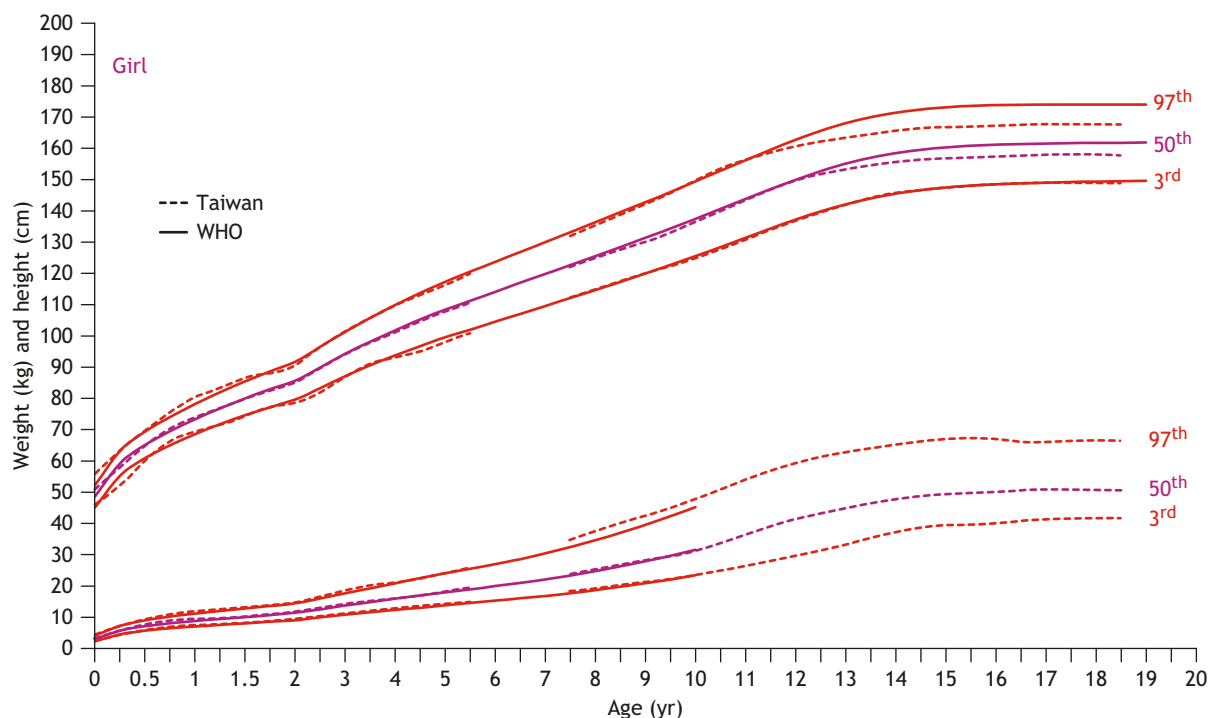


Figure 2 Comparison between World Health Organization (WHO) and Taiwan weight-for-age and height-for-age growth curves for girls by percentile.

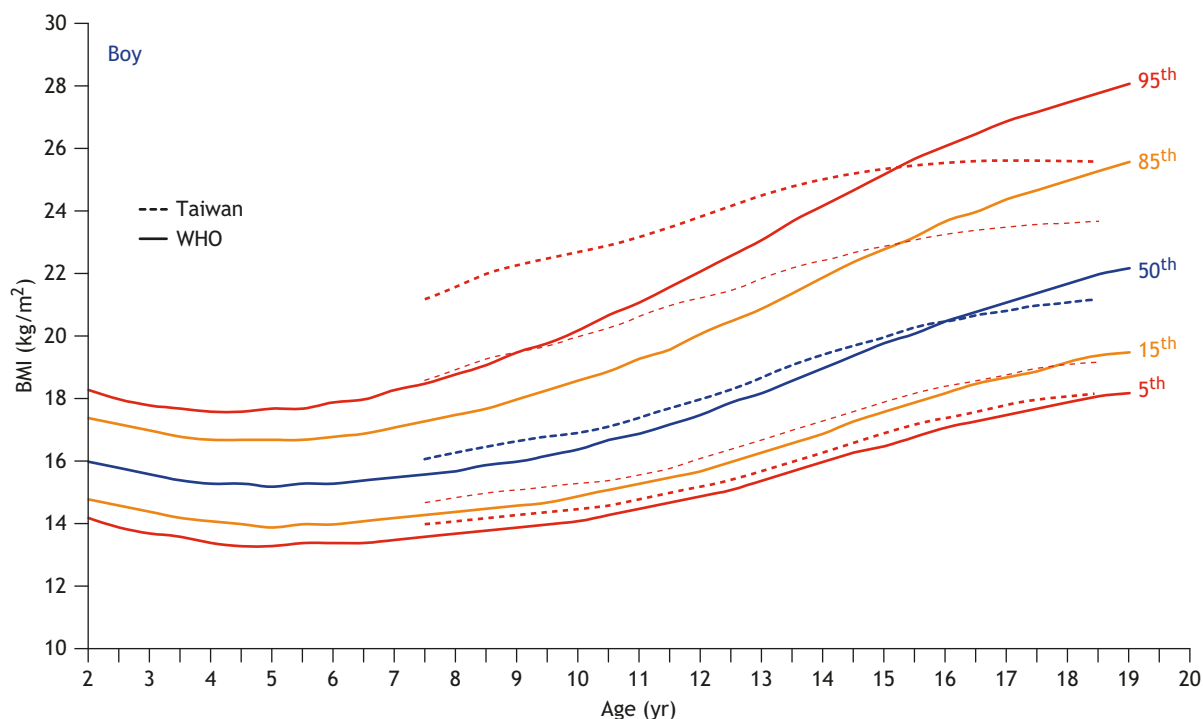


Figure 3 Comparison between World Health Organization (WHO) and Taiwan body mass index (BMI)-for-age growth curves for boys by percentile.

The WHO growth standards for children aged 0–5 years emphasize the “golden standard” of breastfeeding, against which other growth patterns with formula feeding can be compared. The meeting

reached a consensus agreement to adopt the 2006 WHO standards for infants and children in Taiwan from 0–5 years of age. The new growth charts for boys and girls were formally announced in May 2009.¹

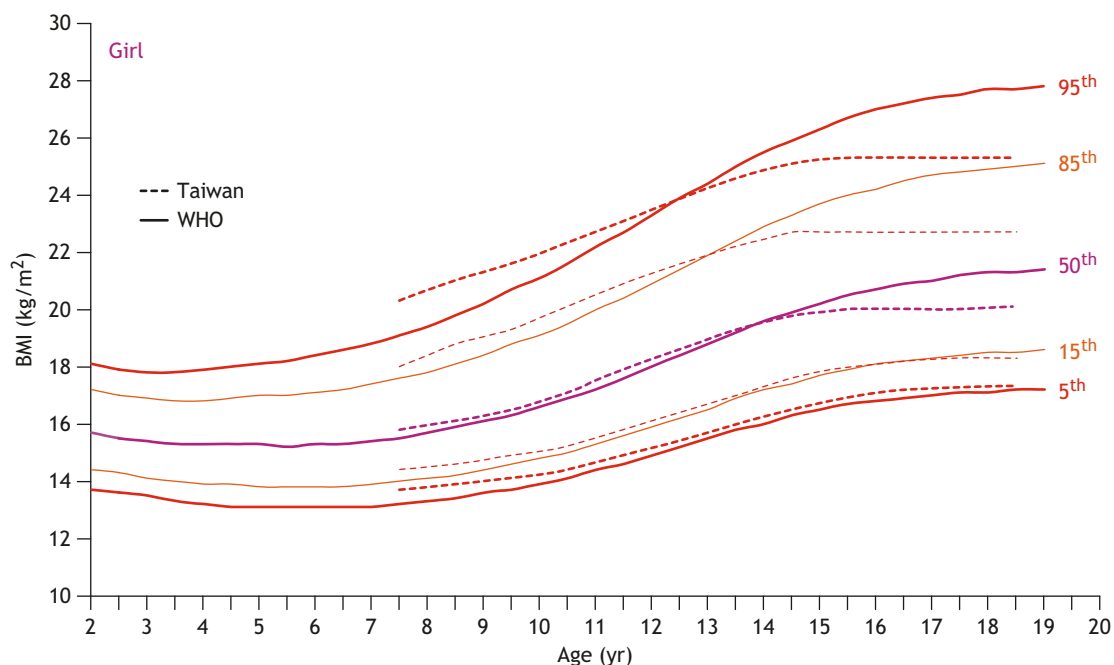


Figure 4 Comparison between World Health Organization (WHO) and Taiwan body mass index (BMI)-for-age growth curves for girls by percentile.

With respect to standards for children above 5 years of age, however, the gap across all percentiles between the WHO references and existing local standards has become a matter of great concern. The differences between the 2007 WHO reference and the 2003 Taiwan standard are significant, especially in the upper percentiles and during adolescence (Figures 1–4). Whether or not the direct implementation of the WHO growth references for children above 5 years of age is appropriate or not is still under debate.

7. Linking the WHO and Taiwan Growth Standards

The 2006 WHO standards are available for children up to 5 years of age, while the 2003 Taiwan standards are available from 7 to 18 years of age. This means that standards are lacking for children aged 5–7 years, while a suitable way of bridging the gap presents a problem. This is because height and weight increase with continued growth, it is relatively easy to bridge the gap for these parameters. However, two issues regarding BMI need to be addressed:

1. The BMI curve shows irregular changes according to age. BMI value increases rapidly after birth and reaches a peak at about 6 months. It then falls and reaches a low between 5 and 6 years of age, before gradually increasing again during adolescence. This phenomenon is known as “adiposity rebound”,^{15,16} and is considered a key indicator for predicting future obesity at an early stage.

Thus, the different percentile curves of BMI mean that BMI rebound will commence at different ages,¹⁷ and the gap in values between 5 and 7 years of age cannot be directly bridged.

2. Domestic studies on anthropometric measurements almost all come from two government offices. Those from newborns to children 6 years of age are composed by the DOH, while those for students come from the Ministry of Education. Few data sets cover the gap from 5 to 7 years of age. Although the study by Chen et al¹⁸ includes measurement results from children and adolescents aged 4–18 years, the BMI curve does not show a rebound phenomenon, and is thus unreliable.

To overcome these difficulties, we suggest using the trend in WHO BMI rebound as a reference. Table 2 lists the ages at which the lowest BMI value was measured at different percentiles, and the ages when the BMI starts to rebound for both boys and girls. According to the principle of proportionality, the related percentile curves were then linked. It is hoped that these approaches can, at least temporarily, resolve the lack of assessment tools for clinical and public applications for this intermediate age group.

8. New Growth Charts in Taiwan

The growth curves produced using the above approaches are shown in Figures 5–8. The linking data for children aged 5–7 years are represented by

Table 2 Ages of minimum and rebound body mass indices (BMI) according to World Health Organization growth references

	Percentile	Age (yr:mo) of minimum BMI	Age (yr:mo) of BMI rebound
Boy	95 th	3:9–4:10	4:11
	85 th	3:10–5:7	5:8
	50 th	4:7–5:0	5:1
	15 th	4:10–5:0	5:1
	5 th	4:5–5:0	5:1
Girl	95 th	2:11–3:10	3:11
	85 th	3:1–4:3	4:4
	50 th	5:1–5:7	5:8
	15 th	4:8–6:8	6:9
	5 th	4:4–7:1	7:2

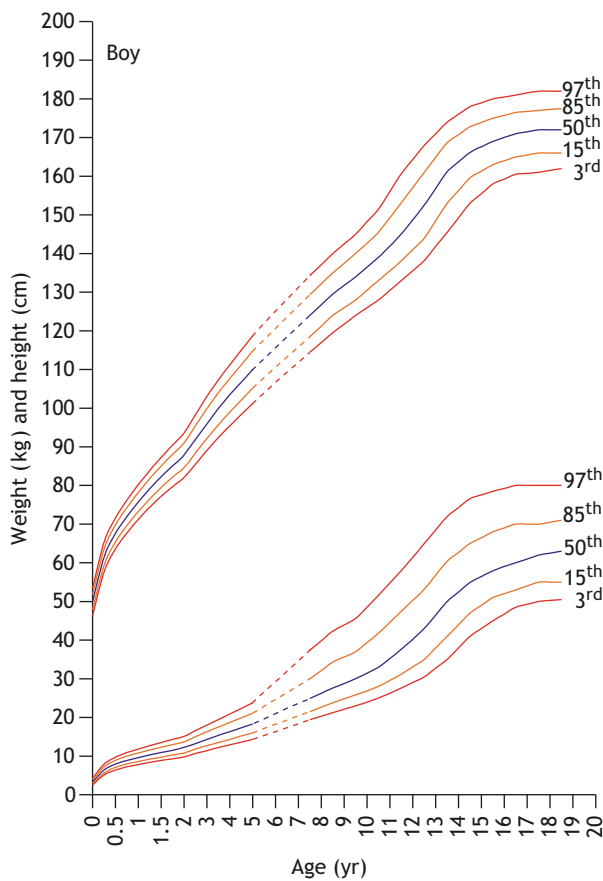


Figure 5 Boys' weight-for-age and height-for-age growth curves by percentile, based on 2006 World Health Organization standards and 2003 Taiwan standard, based on health-related physical fitness (solid lines). The dotted lines represent the linking data for boys aged 5–7 years.

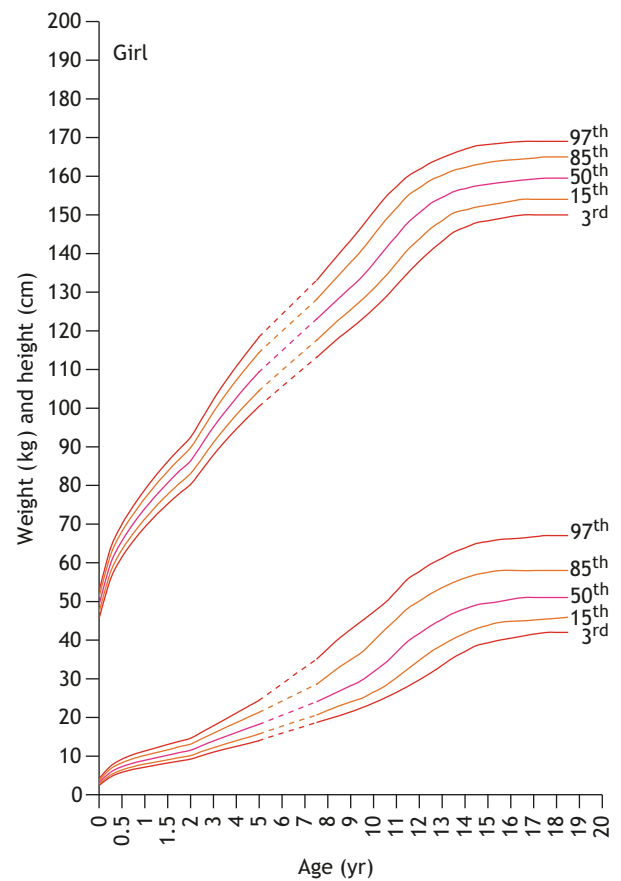


Figure 6 Girls' weight-for-age and height-for-age growth curves by percentile, based on 2006 World Health Organization standards and 2003 Taiwan standard, based on health-related physical fitness (solid lines). The dotted lines represent the linking data for girls aged 5–7 years.

dotted lines for comparison. It is worth noting that there is a discrepancy of about 0.7cm between body length (lying position) and body height (standing position). The data for children less than 2 years of age are indicated by body length, while those for children more than 2 years of age are indicated

by body height. Finally, for clinical application, the 3rd and 97th percentile curves are shown for height-for-age and weight-for-age, while the 5th and 95th percentile curves are shown for BMI-for-age. Tables 3–5 show the actual values used in the figures.

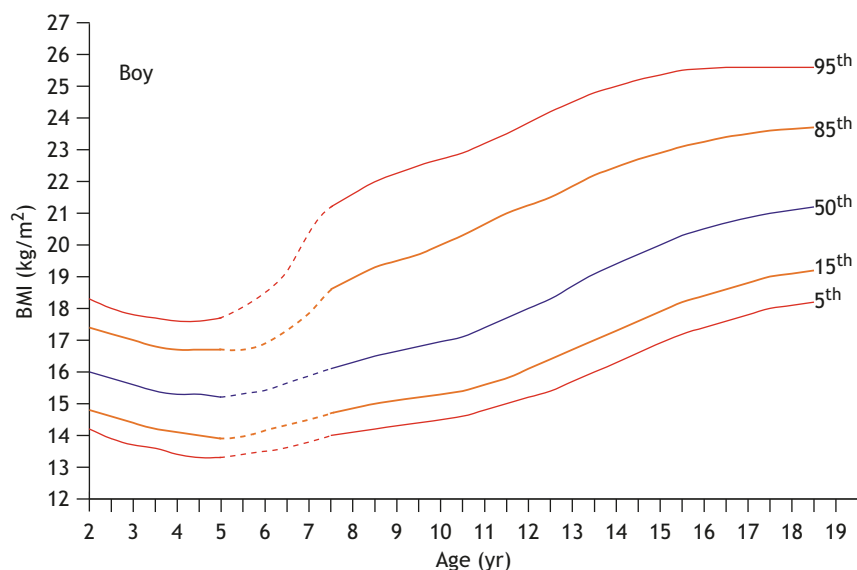


Figure 7 Boys' body mass index (BMI)-for-age curves by percentile, based on 2006 World Health Organization standards and 2003 Taiwan standard based on health-related physical fitness (solid lines). The dotted lines represent the linking data for boys aged 5–7 years.

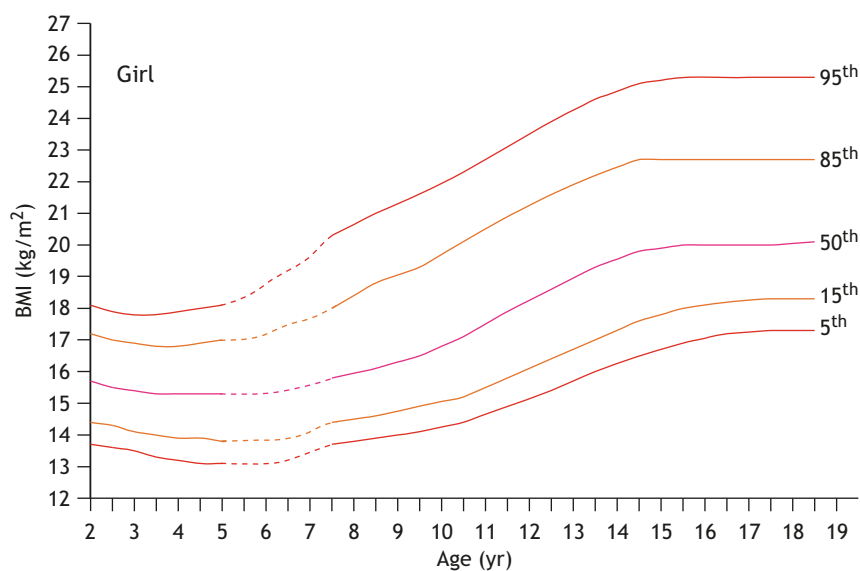


Figure 8 Girls' body mass index (BMI)-for-age curves by percentile, based on 2006 World Health Organization standards and 2003 Taiwan standard based on health-related physical fitness (solid lines). The dotted lines represent the linking data for girls aged 5–7 years.

9. Conclusions

The proposal to link WHO growth standards and existing data based on health-related physical fitness will not only link different international standards, but also take into account ethnic differences and secular trends. Although the growth norms beyond 5 years of age remain to be defined by the DOH in Taiwan, we believe that the proposal set out in the current report represents the most feasible and

rational approach. Criterion-based approaches that move away from the creation of a reference value (i.e., a tool that can be used effectively for comparative purposes, but does not allow value judgments) to a standard value (i.e., a tool that can be used more effectively to assess interventions and health policies) is well-founded to provide sound guidelines for public health.¹⁹ In the long-term, regular surveys of growth parameters and health-related physical fitness should be conducted and the

Table 3 Weight-for-age and height-for-age values for boys based on WHO standards (0–5yr), the linking data (5.5–7yr) and health-related physical fitness (7.5–18.5yr)

Age (yr)	Boys' weight (kg) in percentiles							Boys' length/height (cm) in percentiles						
	3 rd	15 th	25 th	50 th	75 th	85 th	97 th	3 rd	15 th	25 th	50 th	75 th	85 th	97 th
0	2.5	2.9	3.0	3.3	3.7	3.9	4.3	46.3	47.9	48.6	49.9	51.2	51.8	53.4
0.5	6.4	7.1	7.4	7.9	8.5	8.9	9.7	63.6	65.4	66.2	67.6	69.1	69.8	71.6
1	7.8	8.6	9.0	9.6	10.4	10.8	11.8	71.3	73.3	74.1	75.7	77.4	78.2	80.2
1.5	8.9	9.7	10.1	10.9	11.8	12.3	13.5	77.2	79.5	80.4	82.3	84.1	85.1	87.3
2	9.8	10.8	11.3	12.2	13.1	13.7	15.1	82.1	84.6	85.8	87.8	89.9	91.0	93.6
2.5	10.7	11.8	12.3	13.3	14.4	15.0	16.6	85.5	88.4	89.6	91.9	94.2	95.5	98.3
3	11.4	12.7	13.2	14.3	15.6	16.3	18.0	89.1	92.2	93.6	96.1	98.6	99.9	103.1
3.5	12.2	13.5	14.1	15.3	16.7	17.5	19.4	92.4	95.7	97.2	99.9	102.5	104.0	107.3
4	12.9	14.3	15.0	16.3	17.8	18.7	20.9	95.4	99.0	100.5	103.5	106.2	107.7	111.2
4.5	13.6	15.2	15.9	17.3	19.0	19.9	22.3	98.4	102.1	103.7	106.7	109.6	111.2	115.0
5	14.3	16.0	16.7	18.3	20.1	21.1	23.8	101.2	105.2	106.8	110.0	113.1	114.8	118.7
5.5	15.3	17.1	17.9	19.6	21.6	22.9	26.5	103.9	107.9	109.5	112.8	116.0	117.7	121.8
6	16.3	18.2	19.0	20.9	23.2	24.7	29.2	106.5	110.5	112.3	115.6	118.9	120.6	124.9
6.5	17.4	19.3	20.2	22.3	24.7	26.4	32.0	109.2	113.2	115.0	118.4	121.7	123.6	128.1
7	18.4	20.4	21.3	23.6	26.3	28.2	34.7	111.8	115.8	117.8	121.2	124.6	126.5	131.2
7.5	19.4	21.5	22.5	24.9	27.8	30.0	37.4	114.5	118.5	120.5	124.0	127.5	129.4	134.3
8	20.3	22.7	23.8	26.3	29.6	32.2	40.2	117.0	121.3	123.3	126.8	130.3	132.2	137.2
8.5	21.2	23.8	25.0	27.6	31.4	34.3	42.3	119.5	124.0	126.0	129.5	133.0	135.0	140.0
9	22.1	24.8	26.0	28.8	32.7	35.7	44.3	121.8	126.0	128.0	131.8	135.5	137.5	142.5
9.5	23.0	25.8	27.0	30.0	34.0	37.0	45.6	124.0	128.0	130.0	134.0	138.0	140.0	145.0
10	24.0	26.9	28.4	31.5	36.0	39.4	48.6	126.0	130.5	132.5	136.5	140.5	142.8	148.3
10.5	25.0	28.0	29.8	33.0	38.0	41.8	51.6	128.0	133.0	135.0	139.0	143.0	145.5	151.5
11	26.3	29.6	31.4	35.3	40.8	44.7	54.8	130.5	135.6	137.8	142.0	146.7	149.4	156.1
11.5	27.6	31.2	33.0	37.6	43.5	47.5	58.0	133.0	138.1	140.5	145.0	150.4	153.2	160.7
12	29.3	33.1	35.2	40.3	46.5	50.4	61.5	135.6	141.1	143.8	148.8	154.2	157.1	164.4
12.5	30.5	35.0	37.3	43.0	49.5	53.2	65.0	138.2	144.0	147.0	152.5	158.0	161.0	168.0
13	32.8	38.0	40.7	46.5	53.0	56.8	68.5	141.9	148.5	151.5	156.9	162.0	164.9	171.0
13.5	35.0	41.0	44.0	50.0	56.4	60.4	72.0	145.5	153.0	156.0	161.2	166.0	168.7	174.0
14	38.0	44.0	46.8	52.5	58.7	62.7	74.3	149.3	156.3	159.0	163.7	168.3	170.8	176.0
14.5	41.0	47.0	49.5	54.9	61.0	65.0	76.6	153.0	159.6	162.0	166.2	170.5	172.8	178.0
15	43.0	49.0	51.3	56.5	62.5	66.5	77.6	155.5	161.3	163.5	167.6	171.8	173.9	179.0
15.5	45.0	51.0	53.0	58.0	64.0	68.0	78.5	158.0	163.0	165.0	169.0	173.0	175.0	180.0
16	46.8	52.0	54.1	59.0	65.0	69.0	79.3	159.3	164.0	166.2	170.0	173.8	175.8	180.5
16.5	48.5	53.0	55.1	60.0	66.0	70.0	80.0	160.5	165.0	167.3	171.0	174.5	176.5	181.0
17	49.3	54.0	56.1	61.0	66.6	70.0	80.0	160.9	165.5	167.7	171.5	174.8	176.8	181.5
17.5	50.0	55.0	57.0	62.0	67.2	70.0	80.0	161.0	166.0	168.0	172.0	175.0	177.0	182.0
18	50.3	55.0	57.5	62.5	67.6	70.5	80.0	161.5	166.0	168.0	172.0	175.0	177.3	182.0
18.5	50.5	55.0	58.0	63.0	68.0	71.0	80.0	162.0	166.0	168.0	172.0	175.0	177.5	182.0

Table 4 Weight-for-age and height-for-age values for girls based on World Health Organization standards (0–5 yr), the linking data (5.5–7 yr) and health-related physical fitness (7.5–18.5 yr)

Age (yr)	Girls' weight (kg) in percentiles							Girls' length/height (cm) in percentiles						
	3 rd	15 th	25 th	50 th	75 th	85 th	97 th	3 rd	15 th	25 th	50 th	75 th	85 th	97 th
0	2.4	2.8	2.9	3.2	3.6	3.7	4.2	45.6	47.2	47.9	49.1	50.4	51.1	52.7
0.5	5.8	6.4	6.7	7.3	7.9	8.3	9.2	61.5	63.4	64.2	65.7	67.3	68.1	70.0
1	7.1	7.9	8.2	8.9	9.7	10.2	11.3	69.2	71.3	72.3	74.0	75.8	76.7	78.9
1.5	8.2	9.0	9.4	10.2	11.1	11.6	13.0	75.2	77.7	78.7	80.7	82.7	83.7	86.2
2	9.2	10.1	10.6	11.5	12.5	13.1	14.6	80.3	83.1	84.2	86.4	88.6	89.8	92.5
2.5	10.1	11.2	11.7	12.7	13.8	14.5	16.2	84.0	87.0	88.3	90.7	93.1	94.3	97.3
3	11.0	12.1	12.7	13.9	15.1	15.9	17.8	87.9	91.1	92.5	95.1	97.6	99.0	102.2
3.5	11.8	13.1	13.7	15.0	16.4	17.3	19.5	91.4	94.8	96.3	99.0	101.8	103.3	106.7
4	12.5	14.0	14.7	16.1	17.7	18.6	21.1	94.6	98.3	99.8	102.7	105.6	107.2	110.8
4.5	13.2	14.8	15.6	17.2	18.9	20.0	22.8	97.6	101.5	103.1	106.2	109.2	110.9	114.7
5	14.0	15.7	16.5	18.2	20.2	21.3	24.4	100.5	104.5	106.2	109.4	112.6	114.4	118.4
5.5	14.9	16.7	17.5	19.4	21.5	22.7	26.5	103.0	107.1	108.8	112.1	115.3	117.1	121.3
6	15.9	17.7	18.5	20.5	22.8	24.2	28.6	105.5	109.7	111.3	114.8	118.0	119.9	124.2
6.5	16.8	18.6	19.6	21.7	24.0	25.6	30.8	108.1	112.3	113.9	117.6	120.8	122.6	127.2
7	17.8	19.6	20.6	22.8	25.3	27.1	32.9	110.6	114.9	116.4	120.3	123.5	125.4	130.1
7.5	18.7	20.6	21.6	24.0	26.6	28.5	35.0	113.1	117.5	119.0	123.0	126.2	128.1	133.0
8	19.6	21.8	22.8	25.4	28.4	30.8	37.8	115.7	120.3	122.0	125.8	129.2	131.3	136.5
8.5	20.4	23.0	24.0	26.8	30.1	33.0	40.5	118.3	123.0	125.0	128.5	132.2	134.5	140.0
9	21.5	24.0	25.3	28.2	32.1	35.0	42.8	120.7	125.5	127.5	131.3	135.4	137.8	143.5
9.5	22.5	25.0	26.5	29.6	34.0	36.9	45.0	123.0	128.0	130.0	134.0	138.5	141.0	147.0
10	23.8	26.6	28.3	31.8	36.7	39.8	47.3	125.8	131.0	133.0	137.5	142.3	144.8	150.8
10.5	25.0	28.1	30.0	34.0	39.4	42.7	49.6	128.5	134.0	136.0	141.0	146.0	148.5	154.5
11	26.5	30.3	32.5	36.9	42.2	45.5	52.7	131.8	137.5	139.8	144.5	149.4	151.8	157.3
11.5	28.0	32.5	35.0	39.7	45.0	48.2	55.8	135.0	141.0	143.5	148.0	152.7	155.0	160.0
12	29.8	34.8	37.1	41.7	47.0	50.1	57.8	137.9	143.8	146.3	150.5	154.9	157.0	161.8
12.5	31.5	37.0	39.1	43.7	49.0	52.0	59.7	140.8	146.5	149.0	153.0	157.0	159.0	163.5
13	33.5	38.7	40.9	45.4	50.5	53.5	61.2	143.2	148.5	150.7	154.5	158.4	160.3	164.8
13.5	35.5	40.4	42.6	47.0	52.0	55.0	62.7	145.5	150.5	152.4	156.0	159.7	161.5	166.0
14	37.1	41.7	43.8	48.1	53.0	56.0	63.9	146.8	151.3	153.2	156.8	160.4	162.3	167.0
14.5	38.6	43.0	45.0	49.1	54.0	57.0	65.0	148.0	152.0	154.0	157.5	161.0	163.0	167.9
15	39.3	43.8	45.7	49.6	54.5	57.5	65.5	148.5	152.5	154.5	157.9	161.5	163.5	168.2
15.5	40.0	44.6	46.3	50.0	55.0	58.0	66.0	149.0	153.0	155.0	158.3	162.0	164.0	168.5
16	40.5	44.8	46.7	50.5	55.0	58.0	66.2	149.5	153.5	155.3	158.7	162.3	164.2	168.8
16.5	41.0	45.0	47.0	51.0	55.0	58.0	66.4	150.0	154.0	155.5	159.0	162.5	164.4	169.0
17	41.5	45.2	47.2	51.0	55.0	58.0	66.7	150.0	154.0	155.8	159.3	162.8	164.7	169.0
17.5	42.0	45.4	47.3	51.0	55.0	58.0	67.0	150.0	154.0	156.0	159.5	163.0	165.0	169.0
18	42.0	45.7	47.3	51.0	55.0	58.0	67.0	150.0	154.0	156.0	159.5	163.0	165.0	169.0
18.5	42.0	45.9	47.3	51.0	55.0	58.0	67.0	150.0	154.0	156.0	159.5	163.0	165.0	169.0

Table 5 Body mass index (BMI)-for-age based on World Health Organization standards (2–5 yr), the linking data (5.5–7 yr) and health-related physical fitness (7.5–18.5 yr)

Age (yr)	BMI (kg/m ²) in percentiles									
	Boys					Girls				
	5 th	15 th	50 th	85 th	95 th	5 th	15 th	50 th	85 th	95 th
2	14.2	14.8	16.0	17.4	18.3	13.7	14.4	15.7	17.2	18.1
2.5	13.9	14.6	15.8	17.2	18.0	13.6	14.3	15.5	17.0	17.9
3	13.7	14.4	15.6	17.0	17.8	13.5	14.1	15.4	16.9	17.8
3.5	13.6	14.2	15.4	16.8	17.7	13.3	14.0	15.3	16.8	17.8
4	13.4	14.1	15.3	16.7	17.6	13.2	13.9	15.3	16.8	17.9
4.5	13.3	14.0	15.3	16.7	17.6	13.1	13.9	15.3	16.9	18.0
5	13.3	13.9	15.2	16.7	17.7	13.1	13.8	15.3	17.0	18.1
5.5	13.4	14.0	15.3	16.7	18.0	13.1	13.8	15.3	17.0	18.3
6	13.5	14.2	15.4	16.9	18.5	13.1	13.8	15.3	17.2	18.8
6.5	13.6	14.3	15.7	17.3	19.2	13.2	13.9	15.4	17.5	19.2
7	13.8	14.5	15.9	17.9	20.3	13.4	14.1	15.6	17.7	19.6
7.5	14.0	14.7	16.1	18.6	21.2	13.7	14.4	15.8	18.0	20.3
8	14.1	14.9	16.3	19.0	21.6	13.8	14.5	16.0	18.4	20.7
8.5	14.2	15.0	16.5	19.3	22.0	13.9	14.6	16.1	18.8	21.0
9	14.3	15.1	16.7	19.5	22.3	14.0	14.8	16.3	19.1	21.3
9.5	14.4	15.2	16.8	19.7	22.5	14.1	14.9	16.5	19.3	21.6
10	14.5	15.3	17.0	20.0	22.7	14.3	15.1	16.8	19.7	22.0
10.5	14.6	15.4	17.1	20.3	22.9	14.4	15.2	17.1	20.1	22.3
11	14.8	15.6	17.4	20.7	23.2	14.7	15.5	17.5	20.5	22.7
11.5	15.0	15.8	17.7	21.0	23.5	14.9	15.8	17.9	20.9	23.1
12	15.2	16.1	18.0	21.3	23.9	15.2	16.1	18.3	21.3	23.5
12.5	15.4	16.4	18.3	21.5	24.2	15.4	16.4	18.6	21.6	23.9
13	15.7	16.7	18.7	21.9	24.5	15.7	16.7	19.0	21.9	24.3
13.5	16.0	17.0	19.1	22.2	24.8	16.0	17.0	19.3	22.2	24.6
14	16.3	17.3	19.4	22.5	25.0	16.3	17.3	19.6	22.5	24.9
14.5	16.6	17.6	19.7	22.7	25.2	16.5	17.6	19.8	22.7	25.1
15	16.9	17.9	20.0	22.9	25.4	16.7	17.8	19.9	22.7	25.2
15.5	17.2	18.2	20.3	23.1	25.5	16.9	18.0	20.0	22.7	25.3
16	17.4	18.4	20.5	23.3	25.6	17.1	18.1	20.0	22.7	25.3
16.5	17.6	18.6	20.7	23.4	25.6	17.2	18.2	20.0	22.7	25.3
17	17.8	18.8	20.9	23.5	25.6	17.3	18.3	20.0	22.7	25.3
17.5	18.0	19.0	21.0	23.6	25.6	17.3	18.3	20.0	22.7	25.3
18	18.1	19.1	21.1	23.7	25.6	17.3	18.3	20.1	22.7	25.3
18.5	18.2	19.2	21.2	23.7	25.6	17.3	18.3	20.1	22.7	25.3

data analyzed to identify trends in growth changes and provide the basis for future amendments.

Footnote

The printable color growth charts for clinical use can be downloaded from the website of the Taiwan Pediatric Association at <http://www.pediatr.org.tw>.

References

1. Bureau of Health Promotion, Department of Health. The New Growth Charts for Children. Available at: <http://www.bhp.doh.gov.tw/BHPnet/Portal/ActivityShow.aspx?No=200905080001>. [Date accessed: January 12, 2008]
2. World Health Organization. The WHO Child Growth Standards. Available at: <http://www.who.int/childgrowth/standards/en/>. [Date accessed: January 12, 2008]
3. Chen W, Chiang J, Huang PC. Revised growth charts, Taiwan, 1997. *Mid Taiwan J Med* 1999;4:256–63. [In Chinese]
4. WHO Working Group on the Growth Reference Protocol. *A growth curve for the 21st century: the WHO Multicentre Growth Reference Study*. Geneva: WHO, 1998.
5. Garza C, de Onis M. A new international growth reference for young children. *Am J Clin Nutr* 1999;70:169S–72S.
6. Chen W, Lin CC, Peng CT, et al. Approaching healthy body mass index norms for children and adolescents from health-related physical fitness. *Obes Rev* 2002;3:225–32.
7. Chen W, Tsai CY, Chen AC, Wu SF, Lin TW, Lin HC. Growth charts of Taiwanese youth: norms based on health-related physical fitness. *Mid Taiwan J Med* 2003;8(Suppl 2):S85–93. [In Chinese]
8. Department of Health, Executive Yuan. Definition and guiding principles of obesity in children and adolescents. Available at: http://food.doh.gov.tw/Health_5.asp?idCategory=47. [Date accessed: January 12, 2008]
9. Butte NF, Garza C, de Onis M. Evaluation of the feasibility of international growth standards for school-aged children and adolescents. *J Nutr* 2007;137:153–7.
10. WHO Multicentre Growth Reference Study Group. WHO child growth standards based on length/height, weight and age. *Acta Paediatrica Suppl* 2006;450:76–85.
11. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ* 2007;85:660–7.
12. Ko GTC, Chan JCN, Cockram CS, et al. Prediction of hypertension, diabetes, dyslipidemia or albuminuria using simple anthropometric indexes in Hong Kong Chinese. *Int J Obes* 1999;23:1136–42.
13. Deurenberg-Yap M, Chew SK, Deurenberg P. Elevated body fat percentage and cardiovascular risks at low body mass index levels among Singaporean Chinese, Malays and Indians. *Obes Rev* 2002;3:20915.
14. Department of Health, Executive Yuan. Definition and guiding principles of obesity in adult. Available at: http://www.doh.gov.tw/CHT2006/DM/SEARCH_RESULT.aspx. [Date accessed: January 12, 2008]
15. Rolland-Cachera MF, Deheeger M, Bellisle F, Sempé M, Guilloud-Bataille M, Patois E. Adiposity rebound in children: a simple indicator for predicting obesity. *Am J Clin Nutr* 1984;39:129–35.
16. Whitaker RC, Pepe MS, Wright JA, Seidel KD, Dietz WH. Early adiposity rebound and the risk of adult obesity. *Pediatrics* 1998;101:E5.
17. Pan H, Jiang Y, Jing X, Fu S, Jiang Y, Lin Z, Sheng Z, Cole TJ. Child body mass index in four cities of East China compared to Western references. *Ann Hum Biol* 2009;36:98–109.
18. Chen JY, Chang HY, Pan WH. A modified locally weighted method for developing reference standards for height, weight, and body mass index of boys and girls aged 4 to 18 in Taiwan. *Hum Biol* 2003;75:749–70.
19. Garza C, de Onis M. Introduction. A new 21st century international growth standard for infants and young children. *J Nutr* 2007;137:142–3.