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REVIEW ARTICLE

Childhood obesity: current definitions and recommendations for their use

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Abstract

Childhood obesity is considered a major issue because of its high prevalence and because of its severe consequences on adult health. Prevalence studies are carried out in numerous countries. Analysis of time trends and geographic comparisons are particularly useful, as they may help to identify factors promoting obesity. These studies require adequate definitions of nutritional status and standardized protocols, but in practice, the references, cut-offs and the terminology used vary considerably, and consequently ambiguous information may be found in the literature. Recommendations for the definition of childhood obesity were previously published in 1995 by the European Childhood Obesity Group (ECOG), but new references appeared later. A clarification of the different definitions was needed. Currently used classifications of nutritional status in children are summarized, and recommendations for the references, cut-offs and terms to be used in different contexts are provided. These new ECOG recommendations should help harmonize the various protocols and improve comparisons between studies.

Key words: *Overweight, obesity, thinness, child, prevalence, epidemiology, growth and development, reference values*

Introduction

Reference growth curves are widely used to monitor growth in individual children and to assess the nutritional status of populations. They were originally set up to detect growth deficits. Later, the problem of obesity emerged, and the weight-for-height initially used to assess undernutrition was used to define overweight in children (1). In the early 1980s, the body mass index (BMI), calculated as weight (kg) divided by the square of height (m) and expressed as a function of age and gender, was validated in children, and the first BMI charts were published (2). Nowadays, the BMI is widely used in children, and numerous references and cut-offs are available. Thus, the plethora of references that can be used makes it difficult to choose between them and to have a clear idea of childhood obesity prevalence worldwide. Recommendations for the definition of childhood obesity were proposed by the European Childhood Obesity Group (ECOG) in 1995 (3). At that time, few references were available, then the use of French references published in 1982 (2) and subsequently revised in 1991 (4) were recommended. In 2008, at the ECOG general assembly, it was decided that the problem regarding childhood obesity definitions should be reconsidered and that recommendations for their use should be provided (5).

The main objective of the present paper is to summarize the current definitions for a better understanding of the different cut-offs and terminologies and to propose new ECOG recommendations in order to facilitate their use in different contexts and improve comparability between studies. This information should help all professionals, particularly researchers, involved in the problem of childhood obesity.

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Current definitions

Defining obesity consists of choosing a suitable measure of body fat, and a suitable cut-off. Because it is associated with body composition and risk factors and because it is based on widely available measurements, the BMI is now accepted as a valid indirect measure of adiposity in children. However, as children grow in size, anthropometric cut-offs for fatness need to be adjusted for age. For this reason, grades of nutritional status are usually assessed according to a reference population.

References

Following publication of French BMI references (2,4), Must et al.'s references generated from data gathered in the National Health and Nutrition Examination Survey I (NHANES I) in the USA were published in 1991, and their use was recommended by the World Health Organization (WHO) in 1995 (1). Subsequently, other references from various countries were published. In 2000 in the USA, the Centers for Disease Control and Prevention (CDC) published sex-specific BMI-for-age growth charts (6). Generally, references are based on nationally representative data, without selection criteria for feeding practices. The new WHO standards, released in 2006 for assessing the growth of children from birth to five years of age, were constructed differently (7). They were created from samples made up of healthy breast-fed children from various countries around the world, and were intended to present a 'standard' of physiological growth rather than a descriptive 'reference'. In order to extend these growth curves to school age children and adolescence, in 2007 the WHO developed references for 5- to 19-year-olds based on data from US surveys (8).

All these charts were intended for both clinical use and epidemiological studies. Monitoring children's BMI based on BMI reference charts enables individuals' assessment of weight status and determination of age at adiposity rebound (the second rise in the BMI curve during childhood) that predicts future obesity risk (9).

In 2000, the International Obesity TaskForce (IOTF) developed BMI centiles constructed on the basis of 6 nationally representative data sets to define childhood overweight and obesity (10).

As for the CDC (6) and WHO references (8), the same data from US surveys were incorporated in the IOTF references, leading to some similarities between reference curves. The IOTF definition was intended for international descriptive and comparative purposes only, and was not meant to replace national reference data for clinical use.

Cut-offs

Cut-offs to define grades of nutritional status vary according to the reference used. Percentiles from various references are presented in Figure 1. Major differences appear before the age of 5 years which may be explained by the different approaches to construct the curves. From the age of 5 years, three main cut-offs of BMI distribution status emerge (Level − 1, Level + 1 and Level + 2) constituting four ranges, globally termed as thin, normal, overweight (not obese) and obese. Precise terminology for each reference is presented in Table I.

As a rule, references are constituted on arbitrarily selected specific centiles or standard deviation scores (SDS) based on BMI distributions. The 85th and 95th sex and age-specific percentiles (6), or a SDS of +1 and +2 (7,8), are currently used to define overweight categories. A novel approach was used by the IOTF (10). Cut-offs for childhood overweight and obesity are smooth sex-specific BMI centiles, constructed to match the values of 25 and 30 kg/m^2, respectively at 18 years. These values, corresponding to a significantly increased risk of mortality in adults, are consistent with the WHO adult definition (1). Recently, methods similar to those used by the IOTF to define overweight and obesity were used by Cole et al. to define grades of thinness (11). The centiles that match the values of 18.5, 17 and 16 kg/m^2 at 18 years are consistent with adult classification (1). They define grades 1, 2 and 3 of thinness, respectively. Because it matches existing criteria for wasting in children, the authors propose that the centile passing through a BMI of 17 at age 18 years should be a basis for an international definition of thinness in children and adolescents.

Terminology

The terminology used to define the different levels of BMI varies considerably. The terms 'at risk of overweight', 'overweight' and 'obesity' can be found in the literature, but the same term may not define the same level of adiposity. Terminologies corresponding to Levels − 1, +1 and +2 in Figure 1 are presented in Table I. The IOTF terminology for the childhood obesity definition (10) corresponds to WHO terminology in adults (1). In contrast to the WHO classification for adults and the IOTF classification for children, for the CDC, 'overweight' does not include 'obesity' (12). 'Overweight' corresponds to BMI values falling between the 85th and 95th percentiles and 'obesity' to values greater than the 95th centile. Values ≥ 85th centile thus correspond to 'overweight + obesity'. WHO 2006 (7) and 2007 (8) use SDS lines to determine grades of nutritional status, and the terminology is not the same for children below and above 5 years

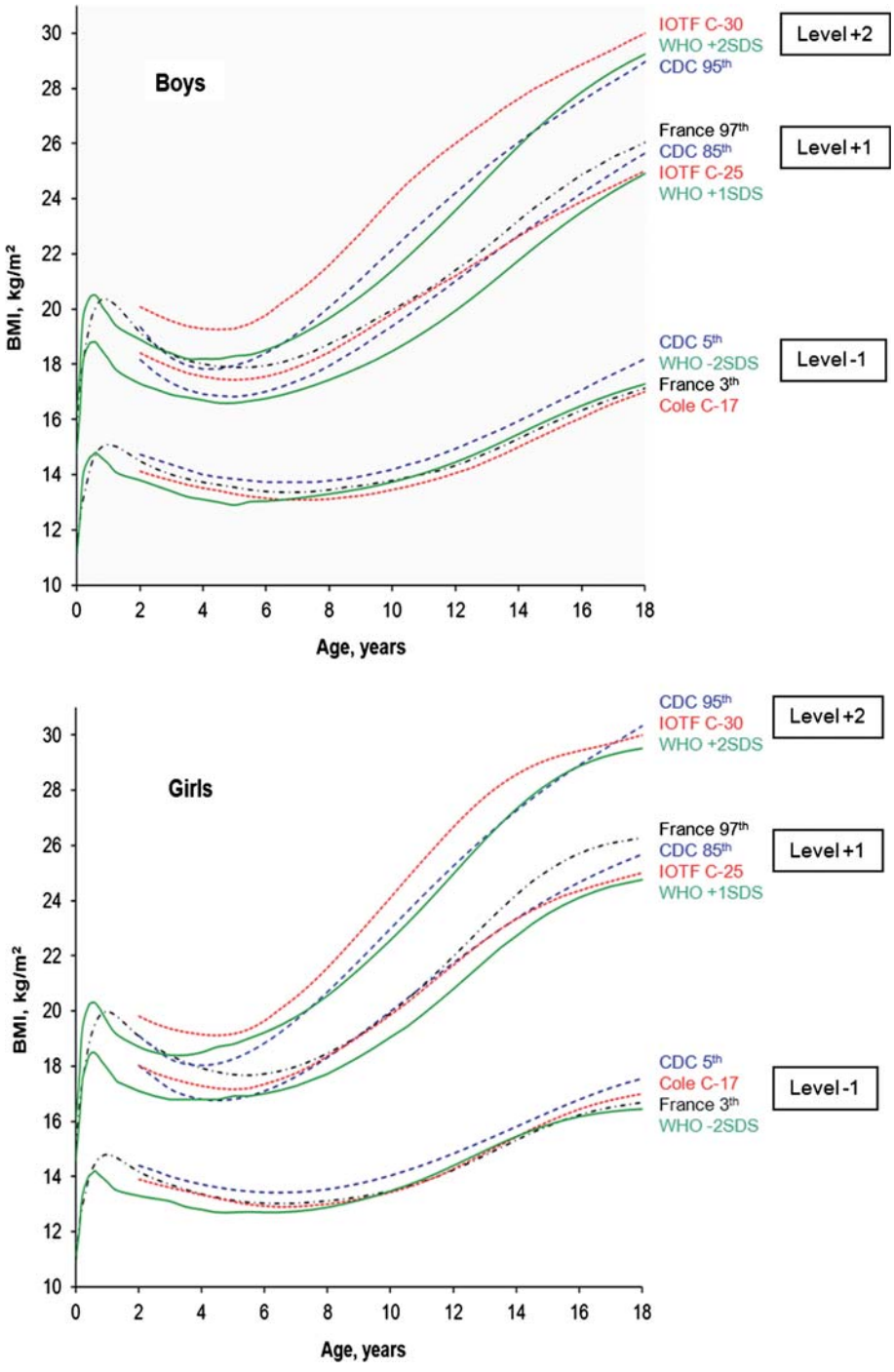

Figure 1. BMI curves from various references and standards: IOTF (10) and Cole et al. (11) centiles ----; WHO 2006 (0–5 y) (7) and WHO 2007 (5–19 y) (8) SDS ——; CDC (6) centiles - - - - and French (4) centiles - . - . - . SDS, Standard Deviation Score; IOTF C-25 and IOTF C-30 correspond to centiles that match BMI 25 and 30 at the age of 18 y; Cole C-17 corresponds to the centile that matches BMI 17 at the age of 18 y. This Figure is reproduced in colour in the online version of *International Journal of Pediatric Obesity.*

(Table I). For example, a cut-off of + 2 SDS defines 'overweight' in under 5 years while it defines 'obesity' over 5 years. The reference populations and terminology should then be precisely described when using these definitions. According to the French references, 'overweight' corresponds to values above the 97th centile and there is no cut-off for 'obesity' (13).

Differences in terminologies are also explained by the fact that some terminologies have changed over time. In accordance with the recent recommendation of an expert committee, the term 'at risk of overweight' previously used by the CDC has been replaced by 'overweight', and 'overweight' by 'obesity' (12).

Table I. BMI classification for thinness, overweight and obesity according to different definitions, and website links to BMI reference tables and charts.

	Low BMI	High BMI			
Classification	< Level − 1*	Level + 1 to + 2*	> Level + 2*	> Level + 1*	Websites
WHO Adults (1)	BMI < 18.5 "Grades 1 + 2 + 3 thinness"	25 ≤ BMI < 30 "Grade 1 OW" or "OW excluding obesity"	BMI ≥ 30 "Grade 2 OW" or "Obesity"	BMI ≥ 25 "Grades 1 + 2 OW" or "OW"	α, β
Cole et al. (11) and IOTF (10)	BMI < C-18.5** "Grades 1 + 2[a] + 3 thinness"	C-25** ≤ BMI < C-30** "OW excluding obesity"	BMI ≥ C-30** "Obesity"	BMI ≥ C-25** "OW" (including obesity)	χ, δ
WHO < 5 years (7)	BMI < −2SDS "Thinness"[b]	+1SDS < BMI ≤ +2SDS "At risk of OW excluding OW"	BMI > +2SDS "OW"[c]	BMI > +1SDS "At risk of OW" (including OW)	ε
WHO 5–19 years (8)	BMI < −2SDS "Thinness"[b]	+1SDS < BMI ≤ +2SDS "OW excluding obesity"	BMI > +2SDS "Obesity"[d]	BMI > +1SDS "OW" (including obesity)	ϕ
US CDC (6)	BMI < 5th centile "Underweight"	85th ≤ BMI < 95th centile "OW"	BMI ≥ 95th centile "Obesity"	BMI ≥ 85th centile "OW + obesity"	γ
French (4)	BMI < 3rd centile "Thinness"	-[e]	-	BMI ≥ 97th centile "OW"	

*Levels −1, +1 and +2 as in Figure 1;
**C-18.5; C-25 and C-30 correspond to centiles that match BMI 18.5, 25 and 30 at the age of 18 y;
OW: Overweight;
SDS: Standard Deviation Score;
α: http://whqlibdoc.who.int/trs/WHO_TRS_854_%28chp7%29.pdf (page 329) (accessed June 16, 2011);
β: http://apps.who.int/bmi/index.jsp?introPage = intro_3.html (accessed June 16, 2011);
χ: http://www.bmj.com/content/335/7612/194.full.pdf (accessed June 16, 2011);
δ: http://www.bmj.com/content/320/7244/1240.full.pdf (accessed June 16, 2011);
ε: http://www.who.int/childgrowth/standards/bmi_for_age/en/index.html (accessed June 16, 2011);
ϕ: http://www.who.int/growthref/who2007_bmi_for_age/en/index.html (accessed June 16, 2011);
γ: http://www.cdc.gov/growthcharts/percentile_data_files.htm (accessed June 16, 2011);
[a]The authors (11) propose that the centile that matches a BMI of 17 at 18 y (defining grades 2 + 3 thinness) should be a basis for an international definition of thinness;
[b]Thinness includes 'severe thinness' (< −3SDS);
[c]Overweight includes 'obesity' (> 3SDS);
[d]Obesity includes 'severe obesity' (> 3SDS);
[e]No cut-offs for obesity.

In the context of undernutrition, the terms 'underweight', 'wasting' and 'thinness' are used. Differences are explained by the criteria ('underweight' for weight-for-age, 'wasting' for weight-for-length/height and 'thinness' for BMI-for-age) and by the reference used (Table I).

Recommendations

BMI references

Epidemiological studies. Adoption of a common methodology is a matter of concern, particularly in the perspective of evaluating and comparing the prevalence of overweight and obesity across epidemiological studies. In a European prevalence study protocol proposed by ECOG in 1999 (14) and developed in 2010 (15), the need for a common reference was emphasized. Nowadays, several international references are available. The IOTF references established for 2–18-year-olds have several advantages. They are internationally based and, because they are built to pass through adult cut-offs which are linked with mortality rates, they are less arbitrary than other cut-offs. They are also less geographically and temporally dependent than some other references. Since the last decade, IOTF cut-offs have been used in many prevalence studies, in Europe (13,16–18), and other continents (19–22). The use of the IOTF definition will thus enable the study of time trends.

WHO standards and references (7,8) have several advantages. They display data from birth and references for various anthropometric measurements. In addition, the WHO software (23) converts anthropometric measurements into SDS allowing to express measurements as continuous variables and to define high levels of excess weight.

Ideally, a common definition of childhood obesity should be adopted, but in the absence of a widely shared consensus, prevalence should be reported using several references. Thus, in prevalence studies, IOTF (10) and WHO (7,8) definitions should be used. Besides, additional references such as the CDC (6) or national references can also be used.

Low BMI in infancy and childhood can be associated with adult obesity and metabolic diseases (24), and most overweight adults were not overweight and even lighter during childhood (25). In addition, in the context of developing countries, obesity may coexist with undernutrition in the same country. The prevalence of weight deficit should then also be considered. Cole et al. (11) and WHO standards and references (7,8) should be used to assess thinness. Additional definitions, such as the CDC (6) or national references can also be used.

The use of various references has already been implemented in several previous studies as for example in France, Poland, Czech Republic, USA, Brazil, Canada or China (13,17–22). An example of reported prevalence using several definitions, in a sample of 7–9-year-old French children (26) is presented in Table II. Large differences can be observed. Particularly, in most studies, marked higher prevalence was obtained using the WHO as compared to IOTF definition. The methodologies used to construct the different references must then be taken into account when interpreting these results. However, the aim of the recommendation to use several definitions is not for comparison of prevalence according to the reference used, but to provide more opportunities of comparisons between studies. In analyses comparing different subgroups, it is difficult to use several definitions, but it is encouraged to present the main results according to several references.

Clinical studies

In clinical studies, national or international references can be used to assess growth, but harmonization of methods should improve comparability between results. The choice of a reference can rest on practical aspects. Cole et al. cut-offs (10,11) provide only limited centile ranges, they do not allow to calculate SDS, they start at 2 years of age and display only BMI references. The WHO standards (7) which start at birth and depict physiological growth under optimal environmental conditions are particularly appropriate to assess growth in early life and the WHO references (8) are useful in studies where assessment of the child's and adolescent growth is needed. The WHO cut-offs should be particularly useful to assess growth from birth to 5 years of age in breast fed infants and when national references are not available.

Terminology

Because of the inconsistency of existing terminologies for defining levels of overweight, ambiguous information is frequently encountered in the literature. It is generally agreed that according to IOTF criteria, the estimated prevalence of overweight in European children is about 20% (16). This prevalence includes all children with a BMI greater than the centile curve that matches the value of 25 at 18 years. However, as it may be confused with CDC terminology, the range between the IOTF centiles 25 and 30 is also often termed 'overweight', thereby providing ambiguous information. In every publication, the definition used must be clearly stated and the exact terms corresponding to each definition, as summarized in Table I, must be used.

Additional body measurements

BMI definitions are very helpful for making comparisons between different population groups or monitoring a population over time. However, the BMI has several limitations. An elevated BMI is an indicator of 'overweight' rather than of 'overfatness'. A high BMI may be due to extra muscle mass or to

Table II. Prevalence of BMI categories using several international and national (French as an example) definitions in a sample of 2525 children aged 7–9 years (26).

	Thinness (%) < BMI cut-offs				Overweight* (including obesity) (%) > BMI cut-offs				Obesity (%) > BMI cut-offs		
Ref.	Cole (11)	WHO (8)	CDC (6)	French (4)	IOTF (10)	WHO (8)	CDC (6)	French (4)	IOTF (10)	WHO (8)	CDC (6)
Cut-offs	C-17	− 2 SDS	5th	3rd	C-25	+ 1 SDS	85th	97th	C-30	+ 2 SDS	95th
Boys	1.2	2.1	4.9	2.9	17.4	27.6	20.7	16.5	4.0	10.8	8.4
Girls	2.0	1.9	5.3	2.3	19.5	25.2	19.4	19.1	3.7	6.5	6.2
All	1.6	2.0	5.1	2.6	18.4	26.4	20.1	17.8	3.8	8.7	7.3

C-17; C-25 and C-30 correspond to centiles that match BMI 17, 25 and 30 at the age of 18 y; SDS, Standard Deviation Score; *For the CDC, this category is named 'Overweight + Obesity'.

stunted linear growth. A study aimed at validating BMI against dual X-ray absorptiometry (DXA) supported the use of BMI as a fatness measure in groups of children and adolescents, although this study showed that interpretation should be cautious when comparing BMI across groups that differ in age or when predicting a specific individual's body fat (27). BMI may also be affected by ethnic differences in body composition. For these reasons, results must be interpreted cautiously. Measurements such as arm (1) and waist circumferences (28), skinfolds (1,7) or bioelectrical impedance analysis (29) could help interpret BMI variations such as time trends or differences according to physical activity level. BMI variations can reflect changes in lean rather than fat mass or internal rather than peripheral fat, implicating different health risks. Like for weight and height, these measurements should be carefully recorded following standardized procedures (30).

Conclusion

Various definitions are used in studies investigating childhood obesity, but to date, none of them is considered to be ideal and their use is mostly based on current practice or on practical aspects.

The present paper describes the different definitions in order to improve their understanding and clarify their use, and proposes recommendations for their utilization in different contexts. A consensus for the choice of a single definition is desirable and further research on the association between childhood BMI level and adult pathologies is required to identify the definition that is most suitable in both epidemiological and clinical contexts. Additional consensus for internationally accepted terminology, age ranges, demographic groupings or cut offs for various anthropometric measurements are needed. This would allow a better harmonisation of the methods used and improve comparisons between studies.

Summary of recommendations for the classification of weight status in children

1. Use IOTF and WHO definitions to assess the prevalence of childhood overweight and obesity and use Cole et al. (2007) and WHO definitions for the prevalence of thinness;
2. Additional definitions (CDC and national references) could also be used in order to provide more opportunities of comparisons of prevalence between studies;
3. Use WHO standards and references in clinical studies involving growth assessment to improve comparability between results;
4. Always state explicitly the definition used and use the exact terms corresponding to each definition, clearly stating whether or not the term overweight includes obesity and specify which definition is used to assess weight deficit;
5. Whenever possible, perform additional body measurements, including arm and waist circumferences, skinfolds and bioelectrical impedance analysis;
6. Perform anthropometric measurements according to standardized procedures.

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References

1. World Health Organization. Physical status: the use and interpretation of anthropometry: report of a WHO Expert Committee. WHO Technical Report Series, No. 854, WHO: Geneva; 1995.
2. Rolland-Cachera MF, Sempé M, Guilloud-Bataille M, Patois E, Péquignot-Guggenbuhl F, Fautrad V. Adiposity indices in children. Am J Clin Nutr. 1982;36:178–84.
3. Poskitt EM. Defining childhood obesity: the relative body mass index (BMI). European Childhood Obesity Group. Acta Paediatr. 1995;84:961–3.
4. Rolland-Cachera MF, Cole TJ, Sempé M, Tichet J, Rossignol C, Charraud A. Body Mass Index variations: centiles from birth to 87 years. Eur J Clin Nutr. 1991;45:13–21.
5. European Childhood Obesity Group. Available at: http://www.ecog-obesity.eu/index.php?a = science. Accessed June 16, 2011.
6. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R et al. CDC growth charts: United States. Adv Data. 2000;314:1–27.

7. WHO Multicentre Growth Reference Study Group. WHO Child Growth. Standards based on length/height, weight and age. Acta Paediatr (Suppl). 2006;450:76–85.
8. 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 WHO. 2007;85:660–7.
9. 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.
10. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ. 2000;320:1240–3.
11. Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ. 2007;335:194.
12. Ogden CL, Flegal KM. Changes in terminology for childhood overweight and obesity. Natl Health Stat Report. 2010;25:1–5.
13. Rolland-Cachera MF, Castetbon K, Arnault N, Bellisle F, Romano MC, Lehingue Y et al. Body mass index in 7–9-y-old French children: frequency of obesity, overweight and thinness. Int J Obes. 2002;26:1610–6.
14. Lehingue Y. The European Childhood Obesity Group (ECOG) project: the European collaborative study on the prevalence of obesity in children. Am J Clin Nutr. 1999;70:166S–8S.
15. Salanave B, Péneau S, Rolland-Cachera MF, Hercberg S, Castetbon K. Survey protocol based on protocol proposed by the European Childhood Obesity Group (ECOG). Available at: http://www.ecog-obesity.eu/files/ECOG%20Prevalence%20Protocol%20%28English%20version%29.pdf. Accessed June 16, 2011.
16. Lobstein T, Frelut ML. Prevalence of overweight among children in Europe. Obes Rev. 2003;4:195–200.
17. Matusik P, Malecka-Tendera E, Klimek K. Polish Childhood Obesity Study Group. Nutritional state of Polish prepubertal children assessed by population-specific and international standards. Acta Paediatr. 2007;96:276–80.
18. Monasta L, Lobstein T, Cole TJ, Vignerová J, Cattaneo A. Defining overweight and obesity in pre-school children: IOTF reference or WHO standard? Obes Rev. 2011;12:295–300.
19. Flegal KM, Ogden CL, Wei R, Kuczmarski RL, Johnson CL. Prevalence of overweight in US children: comparison of US growth charts from the Centers for Disease Control and Prevention with other reference values for body mass index. Am J Clin Nutr. 2001;73:1086–93.
20. de Assis MA, Rolland-Cachera MF, Grosseman S, de Vasconcelos FA, Luna ME, Calvo MC et al. Obesity, overweight and thinness in schoolchildren of the city of Florianópolis, Southern Brazil. Eur J Clin Nutr. 2005;59:1015–21.
21. Shields M, Tremblay MS. Canadian childhood obesity estimates based on WHO, IOTF and CDC cut-points. Int J Pediatr Obes. 2010;5:265–73.
22. Shan XY, Xi B, Cheng H, Hou DQ, Wang Y, Mi J. Prevalence and behavioral risk factors of overweight and obesity among children aged 2–18 in Beijing, China. Int J Pediatr Obes. 2010;5:383–9.
23. WHO Anthro (version 3.2.2, January 2011) and macros: Software for assessing growth and development of the world's children. Geneva: WHO, 2011. Available at: http://www.who.int/childgrowth/software/en/. Accessed June 16, 2011.
24. Barker DJ, Osmond C, Forsén TJ, Kajantie E, Eriksson JG. Trajectories of growth among children who have coronary events as adults. N Engl J Med. 2005;353:1802–9.
25. Péneau S, Thibault H, Rolland-Cachera MF. Massively obese adolescents are normal weight at the age of adiposity rebound. Obesity. 2009;17(7):1309–10.
26. Salanave B, Peneau S, Rolland-Cachera MF, Hercberg S, Castetbon K. Stabilization of overweight prevalence in French children between 2000 and 2007. Int J Pediatr Obes. 2009;4:66–72.
27. Pietrobelli A, Faith AS, Allison DB, Gallagher D, Chiumello G, Heymsfield SB. Body mass index as a measure of adiposity among children and adolescents: a validation study. J Pediatr. 1998;132:204–10.
28. Goran MI. Visceral fat in prepubertal children: influence of obesity, anthropometry, ethnicity, gender, diet, and growth. Am J Hum Biol. 1999;11:201–7.
29. Pecoraro P, Guida B, Caroli M, Trio R, Falconi C, Principato S et al. Body mass index and skinfold thickness versus bioimpedance analysis: fat mass prediction in children. Acta Diabetol. 2003;40(Suppl. 1):S278–81.
30. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization. Reference Manual. Champaign, IL: Human Kinetics Books; 1988.