

World Health Organization 2006 Child Growth Standards and 2007 Growth Reference Charts: A Discussion Paper by the Committee on Nutrition of the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition

**Dominique Turck, †Kim F. Michaelsen, ‡Raanan Shamir, §Christian Braegger, ¶Cristina Campoy, ¶Virginie Colomb, #Tamás Decsi, **Magnus Domellöf, ††Mary Fewtrell, ‡‡Sanja Kolacek, §§Walter Mihatsch, ||||Luis A. Moreno, and ¶¶Johannes van Goudoever, on Behalf of the ESPGHAN Committee on Nutrition*

ABSTRACT

Growth charts are essential for evaluating children's health including their nutrition; however, the evaluation of child growth trajectories and consequently the decision to intervene are highly dependent on the growth charts used. The aim of this discussion paper of the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition is to provide information on the background and rationale of the World Health Organization (WHO) 2006 child growth standards and WHO 2007 growth reference charts, describe their development, outline their main innovative aspects, discuss potential limitations, and make recommendations. WHO 2006 child growth standards (0–5 years) are based on prospectively collected data describing the growth of healthy infants who

were breast-fed according to WHO recommendations, showing a pattern of linear growth, which is remarkably consistent between different countries and ethnic groups. WHO 2007 growth reference charts (5–19 years) are based mainly on a re-analysis of National Centre for Health Statistics data from 1977, without information on feeding. European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition recommends that WHO child growth standards should be used to monitor growth in all children in the age range 0 to 2 years in Europe, whether breast- or formula-fed, and that they should be considered to be used in the age range 2 to 5 years. Implementation of the WHO child growth standards should be preceded by evaluation of the implication of their use on national healthcare policies. Health professionals should be guided on their use and interpretation and an adequate communication strategy should be available locally to ensure that parents receive clear and consistent advice. The decision on whether to implement the WHO growth references (5–19 years) should be made by national bodies because the growth pattern during the 5- to 19-year period differs between populations.

Key Words: breast-feeding, child health, growth, obesity, overweight, underweight, wasting

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From the *Jeanne de Flandre Children's Hospital, Lille University Faculty of Medicine, France, the †Department of Nutrition, Exercise, and Sports, University of Copenhagen, Denmark, the ‡Schneider Children's Medical Centre of Israel, Sackler Faculty of Medicine, Tel-Aviv University, Israel, the ¶University Children's Hospital, Zurich, Switzerland, the ||Department of Paediatrics, University of Granada School of Medicine, Spain, the ¶Hôpital des Enfants Malades, Université Paris V René Descartes, France, the #Department of Paediatrics, University of Pecs, Hungary, the **Department of Paediatrics, Umea University, Sweden, the ††Children's Nutrition Research Centre, University College London Institute of Child Health, UK, the ‡‡University Children's Hospital Zagreb, Croatia, the §§Department of Paediatrics, Munich Municipal Hospitals Harlaching, Germany, the ||||Escuela Universitaria de Ciencias de la Salud, Universidad de Zaragoza, Spain, and the ¶¶VU University Medical Centre and Academic Medical Centre, University of Amsterdam, The Netherlands.

Address correspondence and reprint requests to Dominique Turck, MD, Département de Pédiatrie, Unité de Gastro-entérologie, Hépatologie et Nutrition, Hôpital Jeanne de Flandre, Avenue Eugène Avinée, 59037 Lille, France (e-mail: dominique.turck@chru-lille.fr).

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Adequate nutrition during the early years of life is of paramount importance for survival, growth, development, and long-term health through adulthood. It is during infancy and early childhood that irreversible faltering in linear growth and cognitive deficits occur (1,2). Inadequate nutrition (either over or under) during this critical period contributes to significant morbidity and mortality (3).

Paediatricians and health professionals involved in child care rely largely on the assessment of children's growth pattern to determine whether or not infant and child nutrition is adequate. Growth charts are thus essential items in the paediatric toolkit for evaluating the degree to which physiological needs for growth and development are being met; however, the evaluation of child growth trajectories and consequently the decision to intervene are highly dependent on the growth charts used.

Worldwide, a large number of national growth references are available. Most of these are based on local cross-sectional data, frequently in populations with a low rate of breast-feeding. The use

of different growth references results in different definitions of underweight, overweight, and obesity. In 2006, the World Health Organization (WHO) released growth standards from birth to 5 years of age based on infants fed according to WHO recommendations (www.who.int/childgrowth) (4,5). The standards are the product of a detailed process initiated in the early 1990s involving various reviews of the uses of anthropometric references and alternative approaches to developing new tools to assess growth (6). The WHO child growth standards were developed to replace the National Centre for Health Statistics (NCHS)/WHO international growth reference (7,8), hereafter referred to as the NCHS reference, whose limitations have been described in detail elsewhere (9). Briefly, the NCHS reference was developed by combining 2 distinct datasets representing different age groups compiled in different decades. The reference from birth to 2 years of age was based upon a group of children in the Ohio Fels Research Institute Longitudinal Study from 1929 to 1975. This reference reflects the growth of children who were fed primarily with infant formula and were of restricted genetic, geographic, and socioeconomic background. The reference from 2 to 18 years was based on data of 3 cross-sectional US representative surveys conducted from 1960 to 1975. In 2007, WHO launched a new growth reference for 5 to 19 years (www.who.int/growthref), based on the same NCHS data from 1977 as the previous WHO reference. The objective of WHO was to construct growth curves for school-age children and adolescents that accord with the WHO child growth standards for preschool children.

The aim of this discussion paper of the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition Committee on Nutrition (ESPGHAN CoN) is to provide information on the background and rationale of the WHO 2006 child growth standards and the WHO 2007 growth reference charts, describe how the standards and the charts were developed, outline the main innovative aspects they provide, and discuss potential limitations. We also discuss the implications of using the WHO 2006 child growth standards and WHO 2007 growth reference charts for assessing the growth of children from birth to adulthood. Finally, we make recommendations on the use of the WHO growth standards and references. This paper is a narrative summary of literature reviewed by the authors.

RATIONALE FOR DEVELOPING CHILD GROWTH STANDARDS

The origin of the standards dates back to the early 1990s when WHO initiated a comprehensive review of the uses and interpretation of anthropometric references and conducted an in-depth analysis of growth data from breast-fed infants. This analysis based on 7 studies from Europe and North America, of which 4 were from Europe, showed a similar pattern in all 7 studies that infants breast-fed for at least 12 months have a growth pattern, which deviates to a significant extent from the NCHS reference, growing at a higher rate in early infancy (birth to 2–3 months) and at a slower rate later in infancy (3–12 months) compared with the NCHS/WHO growth reference (10). There is increasing evidence that this may be a better growth pattern in relation to later health (11). The review group concluded from these and other related findings that the NCHS reference did not adequately describe the growth trajectory of children and that its use to monitor the health and nutrition of individual children or to derive estimates of child malnutrition in populations was flawed.

The review group recommended therefore the development of standards, adopting a novel approach that would describe how a child should grow if it is free of disease and fed according to present WHO feeding recommendations (including breast-feeding and

adequate complementary feeding), which is the reason why it is called a standard and not a reference (6). On theoretical grounds, it is important to distinguish between a reference and a standard. A growth reference simply describes the growth of a sample of individuals and provides a common basis for comparing populations without making inferences about the meaning of observed differences. A standard describes the growth of a “healthy” population and suggests a prescriptive approach. Although standards and references both serve as a basis for comparison, each enables a different interpretation. Because a standard defines how children should grow, deviations from the pattern it describes are evidence of abnormal growth. A reference, however, does not provide a sound basis for such value judgments, although in practice, references often are mistakenly used as standards.

Following a Resolution from the World Health Assembly endorsing these recommendations (12), the WHO Multicentre Growth Reference Study (MGRS) was launched in 1997 to collect primary growth data that would allow the construction of new child growth charts consistent with WHO feeding recommendations and more relevant to children around the world (13).

DESIGN OF THE WHO MGRS

Implemented between 1997 and 2003, the MGRS is a study conducted in 6 countries from diverse geographical regions: Brazil, Ghana, India, Norway, Oman, and the United States (13). The study combined a longitudinal follow-up from birth to 24 months with a cross-sectional component of children who were ages 18 to 71 months.

In the longitudinal component, mothers and newborns were enrolled at birth and visited at home a total of 21 times at weeks 1, 2, 4, and 6; monthly from 2 to 12 months; and bimonthly in the second year. The study populations lived in socioeconomic conditions favourable to growth. The individual inclusion criteria were no known health or environmental constraints to growth, mothers willing to follow MGRS feeding recommendations (ie, exclusive or predominant breast-feeding for at least 4 months, introduction of complementary foods by 6 months of age, and continued breast-feeding to at least 12 months of age), no maternal smoking before and after delivery, single term birth, birth at altitude <1500 m, and absence of significant morbidity. Low birth weight (BW) (<2500 g) was not itself an exclusion criteria, although the overall prevalence was low (2.1% over all sites). Study participants were provided with breast-feeding support as required and were counselled on complementary feeding, with an emphasis on timing, energy density, feeding frequency, and micronutrient content.

Eligibility criteria for the cross-sectional component were the same as those for the longitudinal follow-up with the exception of infant feeding practices. The main infant feeding criterion was the use of breast-feeding, either partial or exclusive, of at least 3 months and there were no requirements for the timing of complementary feeding. Mothers did not receive assistance for optimizing their children’s nutrition. A full description of the MGRS and its implementation in the 6 study sites is found elsewhere (13).

CONSTRUCTION OF THE WHO CHILD GROWTH STANDARDS

Of 13,741 mother–infant pairs who were screened for the longitudinal component, 83% were ineligible and 5% refused to participate (14). The main reason for ineligibility was low socioeconomic status, especially in low-income countries. Of 1743 mother–child dyads enrolled in the MGRS longitudinal sample, 51% (n = 882) complied fully with the study’s infant-feeding and nonsmoking criteria and completed the follow-up period of 24 months. The level of parental education was high—between

14 and 15 years of education on average. The remainder either did not comply with the study criteria ($n = 654$), dropped out of the follow-up ($n = 201$), or experienced morbidity that affected their growth ($n = 6$) (Fig. 1) (14). The statistical strength (eg, extreme centiles stability) was maintained because the required sample size for the statistical desired power was 200 per sex and the final sample was of double size because of a much lower refusal rate than anticipated from sample size calculations. The ineligibility rate was expected because the study protocol was based on a population-based prescriptive sample involving developing country settings. The compliant sample ($n = 882$) was used to construct the WHO standards from birth to 2 years of age combined with 6669 children from the cross-sectional sample from ages 2 to 5 years (5). Data from all sites were pooled to construct the standards (14). The statistical methodology of the construction of the standards is described in detail elsewhere (14). For the longitudinal study, to avoid the influence of unhealthy weights for length, observations falling above 3 standard deviation (SD) and below -3 SD of the sample median were excluded before constructing the standards (5). Additionally, for the cross-sectional sample, the $+2$ SD cutoff was applied instead of 3 SD because the sample was exceedingly skewed to the right, indicating the need to identify and exclude high weights for height (5). The growth standards were published in 2006 and included data for weight-for-age, length/height-for-age, weight-for-length/height, body mass index (BMI)-for-age, and z -score values were generated for boys and girls ages 0 to 60 months. Detailed results of the MGRS study and the construction of the growth standards are available elsewhere (5,14). The full set of tables and charts is presented on the WHO Web site (http://www.who.int/childgrowth/standards/technical_report/en/index.html), together with tools such as software and training materials that facilitate their application. The standards provide data for length up to the age of 2 years and standing height thereafter. This causes a small step down in the centile lines at age 2 because height is consistently slightly less than length. Consequently, it also causes a small step up in the centile lines of BMI-for-age at age 2. Windows of achievement for 6 gross motor milestones to assess motor development collected in the MGRS (ie, sitting without support, standing with assistance, hands-and-knees crawling,

walking with assistance, standing alone, and walking alone) were also published and made available in a published article (15) and on the Web site (http://www.who.int/childgrowth/standards/motor_miles_tones/en/index.html).

Standards for other anthropometric variables (ie, head circumference-for-age, mid-upper arm circumference-for-age, and triceps and subscapular skinfolds-for-age) were released in 2007 (http://www.who.int/childgrowth/standards/second_set/technical_report_2/en/index.html), and growth velocity standards during periods of 1, 2, 3, 4, and 6 months for length/height, weight, head circumference for the first 2 years of life were made available on the Web site in 2008 (http://www.who.int/childgrowth/standards/velocity/technical_report/en/index.html).

STRENGTHS OF THE WHO CHILD GROWTH STANDARDS

The WHO child growth standards were derived from children who were raised in optimal environments that minimised constraints to growth such as inadequate diets and infection. More than 20 anthropometric measurements were available during the first 2 years of life in the longitudinal component of the standards. During the first 3 months, the growth standard had 7 measurements, whereas there was no measurement between birth and 3 months in the NHCS data, which is likely to have implications for the modelling of growth curves. With few measurements, it is not possible to model the steep increase in weight seen in breast-fed infants during the first 2 to 3 months of life. A key characteristic of these standards is that they explicitly identify breast-feeding as the biological norm and establish the breast-fed child as the model for growth and development. The children from the 6 participating countries grew similarly when their health and care needs were met. Therefore, the standards provide an opportunity to assess children independent of ethnicity, socioeconomic status, and type of feeding in most regions of the world. For example, the length of children younger than 24 months was impressively similar among the 6 sites. Children of this age have the same length, irrespective of ethnicity and where they live. The percentage of variance being the result of intersite differences was only about 3%, varying by age from 1% at 12 months to 7% at 60 months, whereas it was 70% for individuals within sites (16).

New standards for head circumference, triceps and subscapular skinfolds, arm circumferences, and BMI were developed for assessing body composition in early life. The study's longitudinal nature for the first 2 years of life also allowed the development of growth velocity standards.

The standards enable health care providers worldwide to assess the presence of undernutrition, overweight, or obesity, and evaluate growth patterns using a global tool. It is an advantage that scientists now have 1 common tool that can be used to define relevant cutoff values for diagnosis and intervention with the same tool.

LIMITATIONS OF THE WHO CHILD GROWTH STANDARDS

The growth standards beyond 2 years of age were constructed from cross-sectional measurements, that is, children were measured only once during the study period. This does not allow the calculation of growth velocity standards, as has been done for the first 2 years of life.

Compared with the first 2 years, infant feeding criteria were much less stringent, with a minimal duration of exclusive or partial breast-feeding of only 3 months and no criteria in relation to the timing and nature of complementary feeding; mothers were not

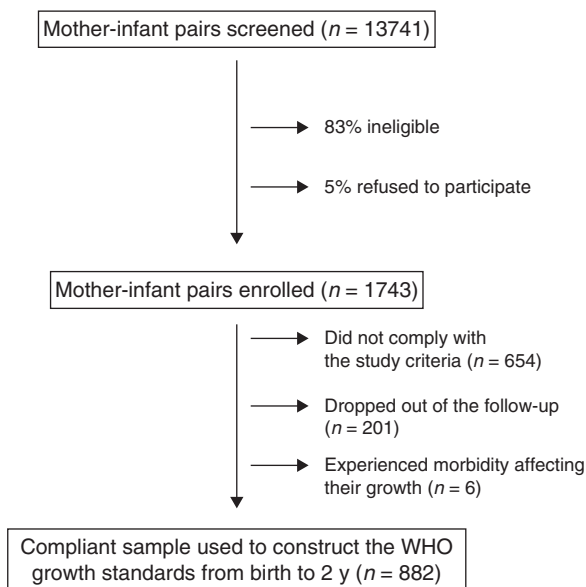


FIGURE 1. Flowchart summarizing the enrollment of infants in the longitudinal sample (0–2 years) of the World Health Organization (WHO) multicenter growth reference study (14).

given support to ensure that their children received optimal nutrition.

Some authors have suggested that the discrepancy of growth patterns in early infancy between WHO growth charts and several other references including the NCHS reference may be partly related to sample selection. In the study by van Buuren (17), it is suggested that the high exclusion rate (861/1743: 49.4%) was caused by the fact that those who had a high growth velocity were more likely to be retained. Binns and Lee (18,19) emphasized that the differences in growth patterns were greater for weights below the mean, for example, a situation in which parents and health professionals are more likely to be concerned about the infant's growth. As a consequence, they may be more likely to compromise breast-feeding in slow-growing infants who are falling off their growth curve trajectories by introducing supplementary foods or even to stop it by switching to infant formula. These differences in growth pattern during the first months of infancy were also underlined in a recent review by Ziegler and Nelson (20). These authors argued that the WHO growth standards may therefore turn out to be counterproductive in stimulating breast-feeding; however, in the analysis of growth in infants breast-fed for 12 months by Dewey et al (10), there was a clear pattern in 6 of the 7 studies included, that the growth velocity for the first 2 to 3 months was significantly higher compared to the NCHS reference. The same pattern was seen in the Euro-Growth study when analysing the infants who were exclusively breast-fed for the first 5 to 6 months (21). Furthermore, growth data from breast-fed infants in Bangladesh (22) showed better agreement with WHO growth standards than with NCHS data, also showing a high velocity during the first months of life. Thus, the growth pattern of infants breast-fed for 12 months with a higher growth velocity during the first 2 to 3 months of life is supported by other studies including infants breast-fed for 12 months. Information for health professionals and parents about which criteria based on weight gain should be used when suggesting to introduce formula is therefore of paramount importance when implementing the WHO growth standards. It would also be relevant to study how such advice and the use of the WHO growth standard are influencing rates of exclusive and partial breast-feeding. After the age of 12 months, the WHO growth standards have slightly lower values for weight and BMI compared with most other references. Therefore, experts have raised concerns (20) that the lower values will lead to misclassification of overweight and that unnecessary interventions will be instituted by practitioners (10); however, because in the field of pediatrics, infants are not put on diets to reduce weight, ESPGHAN CoN finds no harm in this scenario if health care providers are adequately trained to support feeding based on hunger signals and avoiding overfeeding.

There have been several studies showing that the WHO standards for head circumference are smaller than references from Belgium, Norway, the United Kingdom, and the United States (23–25). It has been suggested that part of this could be explained by the use of different measuring techniques, in which the method used in the WHO standards was to draw the tape tight anchored above the eyebrows (25), but also that there may be ethnic differences as shown in a study from the United Kingdom (25). Referral criteria for abnormal head growth, which are mainly based on abnormal growth velocity (crossing centiles up or down), should take these differences into account. It would be interesting to see whether there were differences in head circumference among the 6 sites included in the standard for head circumference. Likewise, it would be interesting to see whether there were differences in body weight among the 6 sites. It is only for length that a comparison of the 6 sites has been published.

The median BW in the WHO standards is 3.2 kg for girls and 3.3 kg for boys. Many European countries have during the last

decades seen an increase in BW, now typically 200 to 300 g higher than the WHO standards (26). Because a high BW is associated with an increased risk of later obesity and lifestyle diseases, this increase is not considered beneficial.

There are a lack of data on Asian ethnicity and there are no data from east Asia in the study population. Thus, the relevance of the WHO growth standards for these populations has been questioned. A previous WHO study of breast-fed children from 7 different countries (Australia, Chile, China, Guatemala, India, Nigeria, and Sweden) found growth patterns that were qualified as "strikingly similar" except for India and China (27). Data from a Hong Kong Chinese birth cohort of ~7500 children showed that although weight for age was close to the 50th percentile of WHO growth standards for both boys (mean *z* score: 0.00) and girls (0.04) at age 3 years, participants were shorter, with height *z* scores of -0.34 and -0.38 for boys and girls, respectively (28). The authors concluded that the WHO growth standards are probably not suitable for Hong Kong Chinese, and by extension for any other infants from east Asia with a similar socioeconomic developmental history and macroenvironment; however, the study from Hong Kong did not report on breast-feeding practices and the WHO study of breast-fed infants mentioned above did not apply the same strict socioeconomic exclusion criteria as in the data collection for the WHO standards.

IMPLEMENTATION OF THE WHO 2006 CHILD GROWTH STANDARDS AS NATIONAL STANDARDS

The International Paediatric Association, which includes 144 national paediatric societies from 139 countries and 10 regional paediatric societies representing all areas of the world, officially endorsed on April 20, 2006 the use of the WHO standards describing them as "an effective tool for detecting both undernutrition and obesity, thus addressing the double burden of malnutrition affecting populations on a global basis" (29). A survey was conducted by WHO 5 years after the release of the growth standards to document their worldwide implementation. WHO contacted national health authorities from 219 countries and territories of which 180 (82%) responded to the questionnaire. When launching the plans for the WHO growth standards, WHO's advice was that their growth standards should only be applied in countries in which satisfactory national standards were not available; however, by April 2011, 125 countries had adopted the WHO standards, another 25 were considering their adoption, and 30 had not adopted them, representing, respectively, 75%, 17%, and 7% of the world's under-5 population. All of these countries, with the exception of the United States and the United Kingdom, are using the standards from 0 to 5 years (30). Among the industrialized countries, the standards are now endorsed in 15 European countries as well as in North America. Several European countries (eg, France, Germany, Italy) have not adopted the standards and have decided to use local references. The UK Department of Health has recommended the use of the WHO child growth standards for children ages 2 weeks to 4 years in combination with UK BW charts (32–42 weeks' gestation). These data were used in preference to those of the WHO growth standards because the WHO dataset has no preterm birth data and UK term BWs were appreciably higher (31). Before the decision to use the WHO standards was made in the United Kingdom, a comprehensive report discussing pros and cons was prepared (32). Comprehensive educational materials were made available for health professionals, including PowerPoint slides, video clips, tutor notes, and exercises, and for parents, fact sheets and lay summaries (www.growthcharts.rcpch.ac.uk). This material also includes guidelines on which action to take when a child has reached a certain cutoff. Likewise, a

health professional's guide for using the new WHO growth charts has recently been published in Canada (33). In the United States, the Centers for Disease Control and Prevention, the National Institutes of Health, and the American Academy of Pediatrics have endorsed the use of the WHO growth standards from birth to 2 years of age (www.cdc.gov/growthcharts), with the recognition that educational measures are needed to assist with interpretation of the charts, but the standards are not yet implemented (34).

There are many national growth references available in Europe, but as far as we know, there are none based only on infants breast-fed according to the WHO recommendations. The Euro-Growth study, which included longitudinal data from 22 centres in 11 countries, had 1071 children completing the study up to 3 years (21). In an analysis of the subgroup of children being exclusively breast-fed for at least 4 to 5 months, they found that compared with the remaining children and with the NCHS reference, the breast-fed children had higher weight during the first 2 to 3 months and lower weight from 6 to 12 months, supporting the different growth pattern of breast-fed infants (21). An overview of some of the national European studies is presented in a recent report from the European Food Safety Authority (EFSA) (35). The aim of the EFSA report was to provide harmonised growth reference data from the European Union for derivation of dietary reference values. The report covers 22 studies, and 12 studies had >10,000 participants. Only 2 are longitudinal prospective studies, 2 are retrospective longitudinal, and 2 are mixed. None of the studies, however, included only breast-fed infants.

Overall, the WHO growth standards provide an opportunity to assess the growth of healthy breast-fed infants worldwide. Although one may argue that these standards experience the flaws detailed above and that in Europe, national data, reference based on EFSA or Euro-Growth can be used, ESPGHAN CoN argues that the adoption of this universal tool provides sufficient advantages to prefer the path taken by many countries worldwide with a fine example of local alterations demonstrated by the United Kingdom or the United States.

CONSTRUCTION OF THE WHO GROWTH REFERENCE CHARTS FOR SCHOOL-AGE CHILDREN 5 TO 19 YEARS

As countries proceeded with the implementation of WHO growth standards for children younger than 5 years, the gap across all centiles between these standards and existing growth references for older children has become a matter of concern. The 1977 NCHS reference as well as more recent references such as the Centers for Disease Control and Prevention 2000 reference and the International Obesity Task Force cutoff points are characterised by the extent of their positive skewness in body weight (36). The upward skewness of these 3 references may result in an underestimation of overweight and obesity and an overestimation of undernutrition. Moreover, the data for BMI-for-age in the NCHS reference were limited because they started only at 9 years of age and covered a restricted distribution range (5th–95th percentiles). Therefore, the need to harmonise growth assessment tools prompted WHO to evaluate the feasibility of developing a single international growth reference for school-age children and adolescents. It was agreed that appropriate growth references for these age groups should be developed for clinical and public health applications. It was also agreed that a multicenter study, similar to the one that led to the development of the WHO child growth standards from birth to 5 years of age, would not be feasible for older children because it would not be possible to control the dynamics of their environment. Therefore, as an alternative, it was decided that a growth reference would be constructed for this age group using existing historical

data. WHO launched in 2007 a new growth reference for 5 to 19 years (www.who.int/growthref), based on the same NCHS statistics data from 1977 as the previous WHO reference, but the new references have been constructed using different statistical methods to smooth the data with the 0- to 5-year-old standards (37).

CONSEQUENCES OF INTRODUCING THE NEW WHO CHARTS

WHO 2006 Child Growth Standards

The main consequence of using the WHO growth charts, compared with the previous WHO growth reference and with many other growth references, is a higher prevalence of underweight in the 0- to 6-month population and of overweight and obesity after the age of 6 months (38). Because the evaluation of child growth trajectories and the interventions designed to improve child health are highly dependent on the growth charts used, it is important to understand the effect of using the WHO versus the previously designed references on the assessment of growth and estimates of malnutrition. On May 22, 2009, WHO and UNICEF issued a joint statement endorsing case definitions of severe acute malnutrition for 6- to 60-month-old infants and children based on the 2006 WHO growth standards (39). Using weight-for-height, WHO and UNICEF recommend the use of a cutoff for weight-for-height of below -3 SD of the WHO standards to identify infants and children as having severe acute malnutrition, also called severe wasting. Weight-for-height between -2 SD and -3 SD is called moderate acute malnutrition or wasting.

De Onis et al used data from a pooled sample of 226 healthy breast-fed infants from 7 studies in North America and northern Europe as well as from the National Demographic and Health Survey from Bangladesh (1996–1997; $n=4787$) and from the Dominican Republic (2002; $n=10,381$) to compare the prevalence of over- and underweight using the new WHO standard or the old NCHS reference. More children were classified as underweight and fewer as overweight using the WHO child growth standards. The average weight of infants included in the WHO standards was above the NCHS median during the first half of infancy, crossed it at approximately 6 months, and tracked below thereafter (40). The prevalence of underweight (below -2 SD from the median for weight-for-age) using the WHO standards during the first 6 months was 2.5 times that derived from the NCHS reference. Thereafter, underweight rates were slightly lower when the WHO standard was used. Overall, the relative decrease in underweight prevalence from birth to 5 years of age was about 6%. The prevalence of stunting (below -2 SD from the median length/height-for-age) was higher for all age groups when using the WHO standards, especially in early infancy and from 24 to 35 months, with a relative increase of approximately 10%. During the first 6 months of life, the prevalence of wasting and severe wasting (respectively, below -2 SD and -3 SD from the median for weight-for-length/height) was respectively 2.5 and 3.5 times those estimated on the basis of the NCHS reference. Wasting rates were similar or only slightly higher from the second year through to age 5 years. For all age groups, the prevalence of overweight (above 2 SD from the median for weight-for-length/height) was higher when estimated by the WHO standard, with a relative increase of 34%.

An analysis of data of 9424 mother–infant pairs in Ghana, India, and Peru also showed that the prevalence of stunting, wasting, and underweight in infants younger than 6 months was higher with WHO standards than NCHS reference (41). In contrast, the prevalence of underweight in infants ages 6 to 12 months was lower with WHO standards. Moreover, malnutrition indicators determined

using WHO standards were better predictors of mortality than those determined using the NCHS reference. The use of the WHO child growth standards may therefore have important implications for child health programs.

WHO 2007 Growth Reference Charts

The growth pattern during the 5- to 19-year period differs more between populations than the 0- to 5-year pattern, mainly because of the marked difference in final height, age for pubertal development, and prevalence of overweight and obesity. In Europe, large differences in stature have been shown between conscripts in different countries. Compared with the median height of 19-year-old men in the WHO reference (176.5 cm), the height of conscripts in Norway, Sweden, Denmark, and the Netherlands have since 1985 been steady at about 180 to 181 cm, whereas countries like Portugal, Spain, and Italy had values in the 1990s that were at the <176.5-cm level with increasing secular trend (42,43). Because of these differences, some European countries may be reluctant to use the new WHO 5- to 19-year growth references. A dilemma in choosing the best references for the 5- to 18-year age in a given population is that present height of the population is often best reflected in a reference made from a recent survey, but in many populations, such a survey will also include a rising number of children with overweight and obesity and thereby will not be appropriate to identify early stages of overweight and obesity.

CONCLUSIONS

The WHO child growth standards (0–5 years) describe the pattern of growth for breast-fed infants with no socioeconomic constraints; they are suitable for all ethnic groups and set breast-feeding as the norm. These standards provide a tool to monitor growth in early infancy in ethnically diverse populations as well as a valuable tool for research and cross-national comparison. The standards are now endorsed by the majority of countries in the world and provide a unique possibility for developing common criteria for health care interventions at both individual and population levels, based on research defining growth patterns associated with short-term and long-term health problems (44). The use of the standards has the potential to encourage more prolonged breast-feeding and increase awareness about early obesity.

STATEMENTS AND RECOMMENDATIONS

WHO 2006 child growth standards (0–5 years) describe the growth of healthy infants who were exclusively or predominantly breast-fed for at least 3 months. They show a pattern of linear growth, which is remarkably consistent between different countries and ethnic groups.

ESPGHAN CoN recommends that:

1. WHO child growth standards should be used to monitor growth in the age range 0 to 2 years in Europe, whether breast- or formula-fed.
2. WHO child growth standards should be considered to be used to monitor growth in children in the age range 2 to 5 years in Europe, whether breast- or formula-fed.
3. WHO child growth standards should be used in European scientific articles in all children (0–5 years) to improve comparability of outcome data.
4. Implementation of the WHO child growth standards should be preceded by evaluation of the implication of their use on national health care policies.
5. Health professionals should be guided on their use and interpretation.
6. An adequate communication strategy should be available locally to ensure that parents receive clear and consistent advice.
7. The decision on whether to implement the WHO growth references (5–19 years) should be made by national bodies because the growth pattern during the 5- to 19-year period differs between populations.

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