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# Research / Recherche

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## An evaluation of infant growth: the use and interpretation of anthropometry in infants

WHO Working Group on Infant Growth<sup>1</sup>

*In reviewing the growth of infants who live under favourable conditions and are fed according to WHO feeding recommendations, the Working Group found significant differences between the growth patterns of these infants and the patterns reflected in the NCHS–WHO international reference. Given the short- and long-term consequences of growth failure, and the dangers of both the premature introduction of complementary foods and their undue delay — described as the “weanling’s dilemma”, the Working Group concluded that use of the current NCHS–WHO reference appears to accentuate the difficulty of avoiding these extremes rather than to help ensure optimal infant nutritional management.*

*The Working Group identified the following requirements: (a) a new reference which will enhance the nutritional management of infants; (b) the reference population should reflect current health recommendations because of the frequent use of such reference data as standards; (c) evaluation, in a broad range of settings, of the practical utility of using reference data based on infants for whom the WHO feeding recommendations are being followed; (d) close investigation of the effects of different complementary foods on the growth of infants who are being fed according to the WHO recommendations; (e) criteria for evaluating abnormal growth patterns; (f) research for identifying proxy measures for length; and (g) evaluation of reference data based on other anthropometric measurements, such as skinfold thickness and arm and head circumferences.*

### Introduction

In the preparatory process for a WHO Expert Committee meeting in November 1993 on “Physical status: the use and interpretation of anthropometry” (1), a Working Group was established by the WHO Nutrition Unit to evaluate infant growth with regard to (a) the appropriate use and interpretation of anthropometry in infants (for individuals and populations); (b) the identification and/or development of reference data for anthropometric indicators, with guidelines on their use; and (c) other crucial issues and gaps in knowledge needing further study.

The Working Group considered the following to be the major purposes of anthropometric assessments of individuals during infancy:

- detection of growth faltering, failure-to-thrive, and excessive growth;
- assessment of the adequacy of the intake of human milk or human milk substitutes;
- assessment of the appropriate age at which to introduce complementary foods;
- evaluation of the adequacy of the weaning diet;
- assessment of the impact of illness and response to treatment;
- screening for high-risk individuals needing special services; and
- assessment of the response to counselling on improvement of feeding and other health-related practices.

Applications in populations were given less emphasis than those identified for the individual.

It was therefore of great concern that the growth of breast-fed infants living under favourable conditions in various geographical areas has been reported to be less than expected on the basis of the current National Center for Health Statistics–World Health Organization (NCHS–WHO) growth reference (2, 3),

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especially during the latter half of the recommended exclusive breast-feeding period, i.e., after the age of 3 months. Slower growth is reported to persist during the ensuing period of mixed feeding with human milk and solid foods. The magnitude of the negative deviations in weight-for-age appears to be sufficient for health care workers to reach faulty decisions regarding the adequacy of growth in infants following current WHO feeding recommendations. This possibility is of special concern in developing countries where breast-feeding is a key to survival or, at the very least, to avoid severe infectious morbidity. Exclusive breast-feeding is recommended by WHO from birth to 4–6 months of age, after which the child should continue to be breast-fed, while receiving appropriate and adequate complementary foods for up to 2 years of age or beyond.<sup>a, b</sup>

### Focus of the analysis

The Working Group focused mainly on two issues not covered in previous WHO reports concerned with anthropometry during infancy: (a) the assessment of the growth patterns of infants following current WHO feeding recommendations, and (b) the relevance of such patterns to the development of growth references for infants. Increased recognition of the health, nutrition, and fertility benefits of breastfeeding, as well as the reliance on anthropometric indices as criteria for assessing dietary and growth adequacy in infancy, made this focus especially relevant.

### Terminology: references and standards

Consideration was given to the criteria for the development of growth references for infants. The Working Group recognized the importance of clarity in its terminology. A *reference* was defined as a tool providing a common basis for purposes of comparison; the term *standard* was viewed as embodying a concept of norm or target, i.e., a value judgement (3).

Traditionally, reference data are justified because they reflect a large, readily identifiable population where the nutrition, health and environmental conditions help the children to reach their genetic growth potential, e.g., a representative sample of all healthy infants in the USA born in a certain set of years. Little thought, however, has been given to whether a reference reflects the growth that should

occur, or to how variable “normal” growth is. Both the average growth and the variability in growth are critical because both affect clinical and public health decisions.

Representative sampling of a population reflects the population’s feeding patterns at the time of sampling. If feeding choices affect growth patterns, then the growth pattern of “the” reference population will change as its feeding patterns change. Another approach to this possibly unstable situation is to construct a reference on the basis of recommended rather than existing practices. Basing a reference on such criteria is more likely to yield a growth curve that is stable over time. Also, assessment of the need for a revised reference may be accomplished more systematically when recommendations are revised because of improved knowledge.

## Anthropometric measurements

### Selection and frequency

Criteria were considered for choosing anthropometric indices for specific purposes. While indices which best predict short-term and long-term functional outcomes are considered ideal, investigation of the relationships between infant anthropometric indices and functional outcomes is unfortunately not available. Even if such information existed, the relationship between anthropometric indices and outcomes is unlikely to be a fixed one in specific areas. The best approach identified to characterize an infant’s current status and to make inferences regarding previous and future states of well-being was to obtain several anthropometric measurements (e.g., length and weight). Repeated measurements were highly recommended during infancy because variability in initial size (e.g., birth weight) strongly affects the interpretation of indices of attained status, and because growth velocity is generally more sensitive than is a static measure. None the less, the Working Group was concerned with the practical constraints faced in many settings where repeated measurements are difficult to obtain.

The recommended frequency of measurement depends on the rate of change of specific indices of interest, measurement error, and the purpose of anthropometric assessment. The most common anthropometric measurements obtained during infancy are weight and length. The usual magnitude of the measurement error is approximately 240 grams for weight and 0.6 cm for length. When resources permit, both measurements should be obtained because they reflect different growth processes. The Working Group recognized that length measurements are often difficult to obtain accurately in many primary

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<sup>a</sup> Joint WHO/UNICEF Meeting on Infant and Young Child Feeding. Unpublished WHO document, FHE/ICF/79.3, 1979.

<sup>b</sup> World Health Assembly resolution WHA33.32. Thirty-third World Health Assembly, May 1980.

health care settings and recommended that proxies be developed for this useful measure. In circumstances where facilities prohibit assessment of all desired indices, prioritization of measurements specified by age categories (0–4 months, 4–6 months, and 6–12 months) is acceptable.

### **Evaluation of the current NCHS–WHO reference**

The current NCHS–WHO reference for infants is based on the Fels Longitudinal Study, conducted in Yellow Springs, Ohio, from 1929 to 1975. There are several limitations in these reference data. First, the sample was limited to Caucasian infants from predominantly middle-class families. Second, the measurements were taken every 3 months rather than every month, which is not ideal for characterizing the shape of the growth curve, particularly during the first 6 months of life. Lastly, most of the infants in the Fels study were bottle-fed; of those who were breast-fed, very few were breast-fed for more than 3 months.

To assess the utility of the current NCHS–WHO reference, the Working Group recognized that the reference is intended to serve as a general guide for screening and monitoring purposes, and not as an absolute diagnostic criterion to define malnutrition or pathology. In practice, however, current growth curves are being used as standards and specific decisions are made based on their distribution characteristics.

The application of the current NCHS–WHO reference as a standard has led some investigators to conclude that exclusively breast-fed infants begin to falter in growth by the third month (4). The Working Group therefore (a) evaluated the growth of infants who live under favourable environmental conditions and are fully or exclusively breast-fed for 4 to 6 months, and are breast-fed for the remainder of the first year; (b) determined whether their growth differed substantially from the current NCHS–WHO references for weight-for-age, length-for-age, and weight-for-length; and (c) evaluated whether the observed differences were of practical importance, i.e., of significance in clinical and public health settings, or in the evaluation of group data for public policy purposes. A complete description of these analyses (including growth curves) is available on request.<sup>c</sup>

A survey of investigators with data sets on the growth of breast-fed infants was conducted from

April to June 1992. The criteria for inclusion of a data set in the initial review were: (a) data available on growth during the first 12 months of life for a sample of at least 20 infants fully breast-fed for at least 4 months (i.e., given no solids and only minimal fluids other than human milk); (b) measurement intervals no greater than 2 months in the first 6 months and no greater than 3 months in the second 6 months of life; (c) information available on the duration of breast-feeding, use of supplemental milk, formulas, and solid foods, and the timing of their introduction; and (d) documentation of socioeconomic conditions is consistent with the likely achievement of the growth potential. Seven data sets fulfilled these criteria and were examined in detail: one each from Canada (5), Denmark (6), Finland (7), Sweden (8) and the United Kingdom (9), and two from the USA (10, 11). All these studies used standard anthropometric procedures to measure infant weight and length. In five of the seven studies, pre-term or low-birth-weight infants were excluded. Three of these studies also excluded large-for-gestational-age infants.

Of the 453 infants followed in the seven studies, 226 were breast-fed for at least 12 months and not given solids, formula or other milk until after the age of 4 months. These infants are referred to as the “12-month breast-fed pooled data set”. Of these 226 infants, 141 were not given other milk or formulas regularly in the first year of life. More than half the infants were not given solid foods until the age of 6 months or later.

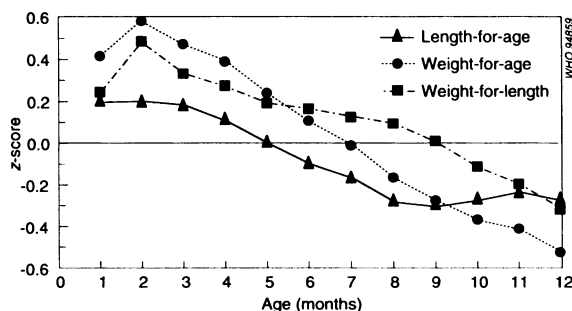
Maternal education levels were high in the three studies reporting this variable, with an overall mean of 15.4 years of education. Mean birth-weight in the seven studies ranged from 3414 to 3605 grams.

The *z*-score patterns of infants in the “12-month breast-fed pooled data set”, relative to the NCHS–WHO reference, are shown in Fig. 1. Mean weight-for-age declined continuously from 2 to 12 months to a low of almost –0.6 standard deviation at 12 months. The magnitude of the decline in length-for-age was not as great, with the mean *z*-score tending to stabilize or increase after 8 months; the mean value at 12 months was approximately –0.3 standard deviation. Mean weight-for-length at 12 months was also below the NCHS–WHO reference mean (approximately –0.3 standard deviation).

The declines in *z*-scores observed during the period of complementation (i.e., from 5 months onwards) are difficult to interpret. One possibility is that the declines are artifacts due to technical problems in the construction of the current NCHS–WHO reference (1); the magnitude of the decline, however, makes this an unlikely possibility. The declines also may be a consequence of specific weaning prac-

<sup>c</sup> From Nutrition Unit (WHO Working Group on Infant Growth), World Health Organization, 1211 Geneva 27, Switzerland.

Fig. 1. Mean z-scores of infants in the "breast-fed pooled data set", relative to the NCHS-WHO reference.



tices within the populations studied, or the result of other physiological effects attributable to continued breastfeeding, or even due to unidentified characteristics in the populations used to construct the NCHS-WHO reference and the "12-month breast-fed pooled data set".

There was a return towards the current NCHS-WHO reference means for weight-for-age, length-for-age, and weight-for-length between 12 and 24 months in most of the studies available to the Working Group with data on this age range. Although there were insufficient data at 24 months to determine whether the mean value for breast-fed infants coincided with the NCHS-WHO mean, the data available suggested that they may be close.

One of the objectives of the analyses of the growth of infants fed according to WHO recommendations was to examine the variance of the anthropometric indices. This is critical for the creation of reference data because the z-score or percentile lines, as well as statistically defined cut-off values (e.g.,  $\pm 2$  SD), depend on the "spread" of values in the original data set. If a reference population is "too" homogeneous, the distribution of values will be unacceptably narrow, resulting in cut-off values closer to the mean than would occur given an appropriately heterogeneous reference population.

For both boys and girls, the standard deviations from the "12-month breast-fed pooled data set" are smaller than those from the NCHS-WHO reference. Because of differences in the variances between the pooled data set and the NCHS-WHO reference, differences in cut-off values (such as  $-2$  SD) between the two depend on infant age. In the first 6–8 months, when the "12-month breast-fed pooled data set" median is higher than the NCHS-WHO median, the  $-2$  standard deviation values are higher for the pooled data set than those based on the NCHS-WHO reference. After approximately 8 months, the mean of the "12-month breast-fed pooled data set" is lower

than that of the current NCHS-WHO reference and the  $-2$  standard deviation values for the pooled data set are lower for weight than the corresponding values for the NCHS-WHO reference. This lower cut-off for length was similar for both the pooled data set and the NCHS-WHO reference. For the same reasons, the  $+2$  standard deviation values for the "12-month breast-fed pooled data set" were similar to those of the NCHS-WHO reference during early infancy, but considerably lower during later infancy.

The distribution of birth weight values is one major factor which may account for the lower variance of the "12-month breast-fed pooled data set", compared with the current NCHS-WHO reference. Most of the studies of breast-fed infants excluded pre-term or low-birth-weight infants, and several also excluded large-for-gestational-age infants. In addition, the samples included families of a generally high educational level living under favourable environmental circumstances. The mean birth-weight in the pooled data set was similar to that of a representative sample of white infants in the USA who met certain criteria indicative of low risk ( $\geq 37$  weeks gestational age; mother married and  $\geq 20$  years of age; and at least one parent completed high school) (12), but the standard deviation was about 70 grams lower ( $P < 0.05$ ).

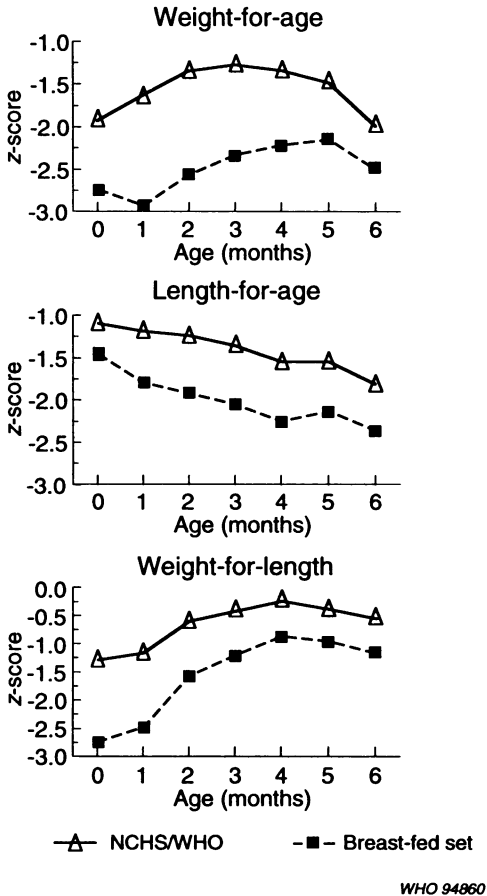
#### Comparison of growth between the "12-month breast-fed pooled data set" and selected test populations

To determine the potential impact of using a new growth chart based on breast-fed infants, data from several "test" populations were evaluated against both the "12-month breast-fed pooled data set" and the current NCHS-WHO reference. The test populations were breast-fed infants from poor populations in India<sup>d</sup> and Peru (13), breast-fed infants from a range of socioeconomic backgrounds (from five countries included in the WHO Human Reproduction Programme study (14)), and formula-fed infants from affluent populations (10; F. Haschke, personal communication, 1993).

The data from India came from a cross-sectional study of predominantly breast-fed infants under 6 months of age.<sup>d</sup> Fig. 2 shows the z-scores for these infants when calculated using either the current NCHS-WHO reference or the "12-month breast-fed pooled data set" as the basis for comparison. Regardless of the basis of comparison, the Indian infants have very low z-scores at birth. The z-scores are

<sup>d</sup> Anderson MA. The relationship between maternal nutrition and child growth in rural India. Doctoral dissertation, Tufts University, 1989.

Fig. 2. Weight-for-age, length-for-age and weight-for-length mean z-scores of rural Indian infants, compared with the current NCHS-WHO reference and the "breast-fed pooled data set".



more negative using the "12-month breast-fed pooled data set", as would be expected given that the pooled data set's medians during the first 6 months are higher than those of the current NCHS-WHO reference. The shape of the z-score pattern across ages is also quite different, resulting in different interpretations of when growth slackens. When compared against the current NCHS-WHO reference, the Indian infants' mean weight-for-age z-score increased between birth and 3 months, but then declined between 3 and 6 months. In contrast, when compared against the "12-month breast-fed pooled data set", the Indian infants show a slight decline in weight-for-age from birth to 1 month, but an increase in mean z-scores thereafter, which is sustained until 5 months. Therefore, declining status in weight-for-age is likely to be

identified beginning at 3 months using the current NCHS-WHO reference, but not until 5 months using the "12-month breast-fed pooled data set". If similar differences are observed in future comparisons of populations, such as those represented by the Indian infants with a more diverse sample of breast-fed infants whose growth is not constrained by poor environmental hygiene, additional support will be available for the current recommended timing of complementary feeding and for revised references.

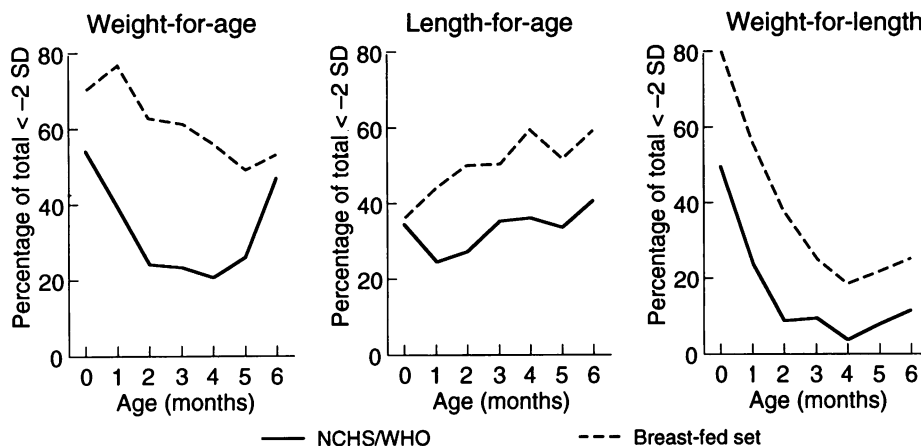
The mean length-for-age z-scores of the Indian infants were also lower when the "12-month breast-fed pooled data set" was used rather than the current NCHS-WHO reference. In contrast to the pattern in weight-for-age, which increased in the early months, the mean length-for-age z-scores of the Indian infants declined beginning at birth regardless of the basis of comparison used.

The mean weight-for-length z-scores of the Indian infants were low at birth, particularly with respect to the "12-month breast-fed pooled data set", but increased thereafter to approximately -0.5 using the current NCHS-WHO reference, and -1.0 using the "12-month breast-fed pooled data set". Declines were observed in both cases after 4 months of age.

Fig. 3 shows the same data expressed in terms of the percentage of infants below a -2 z-score of the current NCHS-WHO reference, or of the "12-month breast-fed pooled data set". Using the current NCHS-WHO reference, 20-55% of infants would be classified as underweight (i.e., below -2 SD) during the first 6 months, whereas in comparison with the "12-month breast-fed pooled data set", this is 50-75%. The percentage classified as stunted would be 25-40% using the current NCHS-WHO reference and 40-60% using the "12-month breast-fed pooled data set". Low weight-for-length was common at birth (45-80%), but much less prevalent at 2-6 months (10% or less using the current NCHS-WHO reference and 20-30% using the "12-month breast-fed pooled data set").

The results of a similar analysis conducted on subjects from a squatter community on the outskirts of Lima, Peru (13), yielded similar information. Comparison of the growth of Peruvian infants with the current NCHS-WHO reference and the "12-month breast-fed pooled data set" demonstrated declines in the mean weight-for-age z-score at approximately 3 and 5 months, respectively. However, the percentages of infants below the -2 SD cut-off was much lower than for the Indian sample. The percentage classified as underweight during the first 6 months was 0-2% using the current NCHS-WHO reference compared to 4-8% using the "12-month breast-fed pooled data set". In the second 6 months, the situation was reversed: by 12 months the percent-

Fig. 3. Percentages of rural Indian infants with weight-for-age, length-for-age or weight-for-length below the  $-2$  z-score cut-off, according to the current NCHS-WHO reference and to the "breast-fed pooled data set".



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age underweight was 16% using the current NCHS-WHO reference, but 10% using the "12-month breast-fed pooled data set". The percentages classified as stunted or low in weight-for-length were similar using either data set as the basis for comparison.

Data for a formula-fed test population are illustrated in Fig. 4 and 5. These data (10) and the EURONUT studies (Haschke F, personal communication, 1993) included all infants who were completely formula-fed or breast-fed for 3 months or less. Using the current NCHS-WHO reference, the mean weight-for-age of the formula-fed cohort was higher than the median for the first 8 months, but were relatively close to the median at 9–12 months. In contrast, the median weight-for-age z-scores generated using the "12-month breast-fed pooled data set" were close to the median in early infancy, but increased thereafter to an average at 12 months of about +0.6. Mean length-for-age and weight-for-length z-scores after 6 months also were higher using the "12-month breast-fed pooled data set". The percentage of formula-fed infants classified above a +2 z-score is shown in Fig. 5. About 7% of formula-fed infants would be classified as high in weight-for-length at 10–12 months using the "12-month breast-fed pooled data set", compared with 3% or less using the current NCHS-WHO reference.

Data from the WHO Human Reproduction Programme studies conducted in eight centres in Egypt, Hungary, Kenya, Thailand, and Chile were also used as a test population (14). The weights of 2478 infants were measured. Of these, 1273 infants were measured at each of the planned times: 1.5 months and at months 2 to 12. Nearly all infants (98%) were breast-

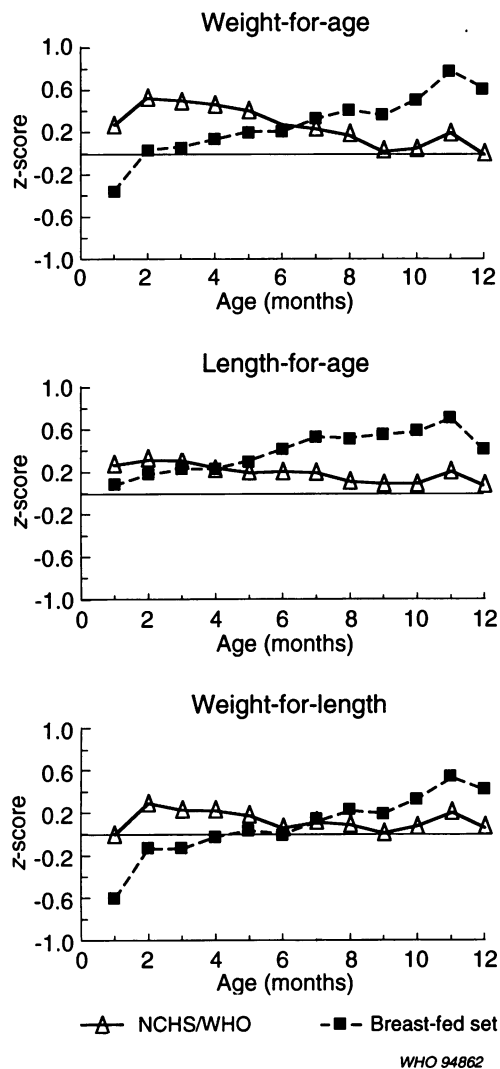
fed (two or more times per day) to at least 12 months. About one-third (30%) of the infants were fully breast-fed to at least 4 months, and then partially breast-fed to at least 12 months. The remaining two-thirds (68%) were fully breast-fed for less than 4 months, but partial breast-feeding continued for at least 12 months. Fig. 6 shows that, using the current NCHS-WHO reference, the mean weight-for-age z-scores began somewhat higher than 0, but crossed below the mean at 5 months and averaged approximately  $-0.6$  by 12 months. In comparison with the "12-month breast-fed pooled data set", the mean z-scores were very stable from 2 to 12 months, at about  $-0.3$ . The percentage of infants below a  $-2$  z-score at each month is shown in Fig. 7. In the first 6 months, the percentage classified as underweight was relatively low: 3–6% using the pooled data set, and less than 2% using the current NCHS-WHO reference. In the second 6 months, the percentage classified as underweight increased to about 11% at 12 months using the current NCHS-WHO reference, but increased to only 6% using the "12-month breast-fed pooled data set".

These findings suggest that the interpretation of the maintenance of adequate growth can vary substantially depending on whether the current NCHS-WHO reference or the "12-month breast-fed pooled data set" are used in longitudinal assessments of growth.

## Conclusions

The Working Group concluded that the present NCHS-WHO reference is not adequate and recom-

Fig. 4. Weight-for-age, length-for-age and weight-for-length mean z-scores of U.S. and European formula-fed infants, compared with the current NCHS-*WHO* reference and the "breast-fed pooled data set".



mends the development of a new weight and length reference for use in all infants. The growth of infants fed according to *WHO* recommendations and living under conditions favouring the attainment of their genetic growth potential deviated significantly from the current NCHS-*WHO* reference. Differences in growth patterns were most notable after 4–6 months. Although these differences in the first 4 to 6 months may be due partly to technical inadequacies in the construction of the current NCHS-*WHO* reference,

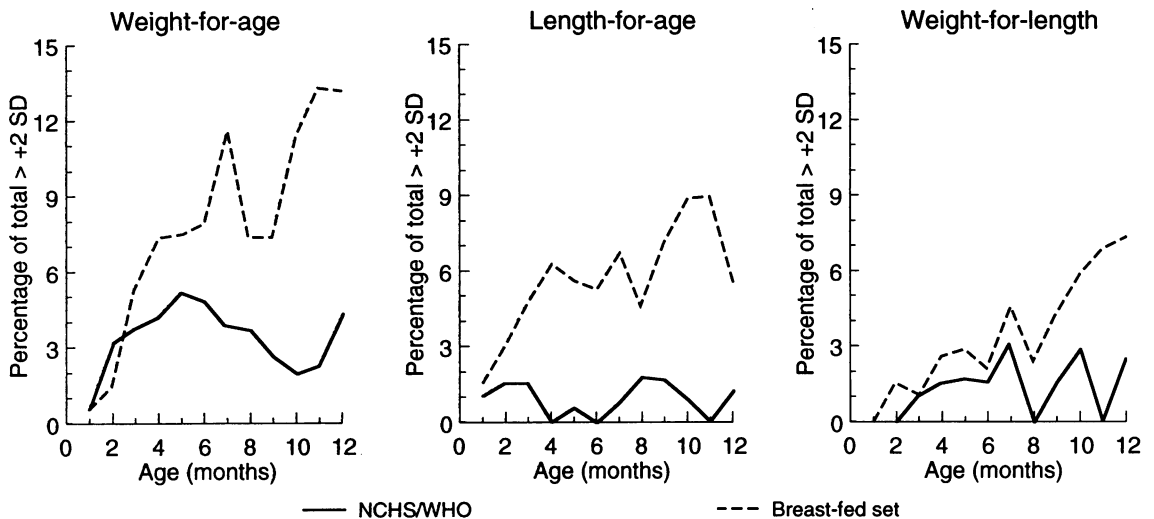
the magnitude of the differences in growth in later periods makes it unlikely that technical shortcomings are a sufficient explanation at later ages. While the deviations in length gain were less than those for weight gain, the lower gains in length after 4–6 months in breast-fed infants were sufficient to concern those who use the current NCHS-*WHO* reference as a standard for the assessment of the adequacy of feeding practices, and those who believe that maximum length reflects optimum health. These lower gains in length were observed despite the provision of safe weaning foods, fed presumably to satiety.

This analysis led the Working Group to conclude that the present *WHO* feeding recommendations, as practised in well-off populations, did not result in maximum growth during the first year. The growth of these infants could not be assessed satisfactorily at later ages. The Working Group was not, however, constituted to review the scientific merits of which is best—the *WHO* feeding recommendations or maximum growth. While an assumption of an equivalence of maximum with optimal growth underlies the rationale for the development of cut-offs based on the NCHS-*WHO* reference, this assumption has never been reviewed explicitly by an expert group. On the other hand, present *WHO* feeding recommendations are based on an expert review.<sup>6</sup> The Working Group recognized that future scientific information and worldwide improvements in sanitation may alter the present feeding recommendations, which are based on the best wisdom currently available to the global community. It therefore viewed as reasonable the selection of a population of infants fed according to *WHO* recommendations to evaluate the growth patterns of infants. The analyses of the test populations conducted by the Working Group suggest that the risks in many settings of continuing to use the current NCHS-*WHO* reference (e.g., misdiagnosis of the timing of growth faltering) are likely to be greater for breast-fed infants than are the potential risks to formula-fed infants (e.g., overdiagnosis of obesity) of adopting a reference based on *WHO* feeding recommendations.

The results of the "12-month breast-fed pooled data set" analyses revealed a relatively low variability in growth. This was of concern to the Working Group and is due partly to the dilemma that people who follow health recommendations are likely to be more homogeneous than the general population. Furthermore, the "12-month breast-fed pooled data set" consisted predominantly of North American and north European Caucasian infants. A revised refer-

<sup>6</sup> See footnote a on page 166.

Fig. 5. Percentages of U.S. and European formula-fed infants with weight-for-age, length-for-age or weight-for-length above the +2 z-score cutoff, according to the current NCHS-*WHO* reference and to the "breast-fed pooled data set".



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ence would preferably be racially and ethnically more diverse. These concerns are reviewed in greater detail in the report of the Working Group's analyses.<sup>f</sup> Further investigation of the observed variance was recommended.

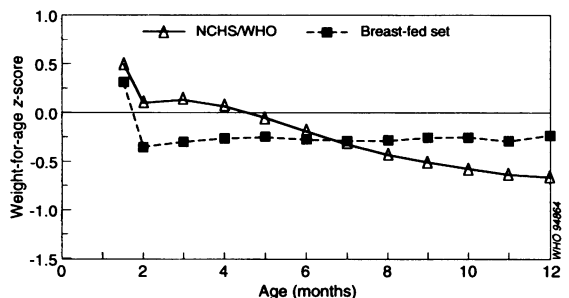
The analyses were sufficient to support the recommendation that the reference sample be chosen from a population of infants who are fed according to WHO feeding recommendations and live in "healthy" environments which do not limit growth, and are representative of characteristics influencing the normal variance in growth, e.g., birth weight and parental height. The sample size must be sufficient to achieve reasonable precision on estimates of the more extreme percentiles of weight and length distributions. The final specification of a reference population, however, requires further consideration of the issues reviewed by the Working Group.

Also, of special concern was the possible role of the nutrient composition of complementary foods in determining growth patterns. It was therefore recommended that research be done in advantaged populations to examine the effects of the nutrient quality of complementary foods on growth and other health

outcomes from 4 months onward. The Working Group was unable to find adequate information to evaluate this issue, which is essential to the development of cut-off values for specific populations. Furthermore, the Working Group was concerned that the lack of this information made it difficult to evaluate growth in the latter half of infancy and identify the etiology and measure the rates of stunting and/or wasting in infants within and between populations.

The Working Group concluded that a single growth reference would be preferable to separate charts for breast-fed and formula-fed infants. Devel-

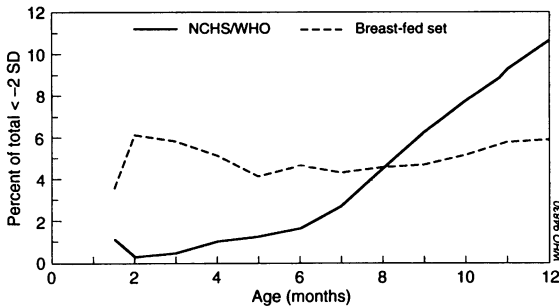
Fig. 6. Mean weight-for-age z-scores of infants enrolled in the WHO Human Reproduction Programme Study, compared with the current NCHS-*WHO* reference and the "breast-fed pooled data set".



<sup>f</sup> WHO Working Group on Infant Growth, Nutrition Unit. An evaluation of infant growth—A summary of analyses performed in preparation for the WHO Expert Committee on "Physical status: the use and interpretation of anthropometry". Unpublished document, WHO/NUT/94.8, 1994.



Fig. 7. Percentages of infants enrolled in the WHO Human Reproduction Programme Study with weight-for-age below the  $-2$  z-score cutoff, according to the current NCHS-WHO reference and to the "breast-fed pooled data set".



opment of two separate charts is not practical and would create confusion when evaluating the growth of infants on mixed feeding. It also recommended that the practical utility of references based on infants breast-fed for at least 12 months must be evaluated further. Growth curves based on the pooled analysis<sup>9</sup> should be used in research settings to assess the growth of exclusively or partially breast-fed infants and of infants fed formula alone. The proposed studies should include cohorts from both advantaged and disadvantaged populations. The objectives of the proposed research would be the identification of problems encountered by users (e.g., health care providers) in the interpretation of such curves and of the benefits or adverse consequences which may result from changes (relative to the current NCHS-WHO reference) in the proportions of infants classified as faltering, stunted, wasted, or obese or overweight, regardless of the mode of feeding.

### Summary of recommendations

The following recommendations (not listed in priority order) reflect the needs and gaps in knowledge identified during the Working Group's deliberations.

- (1) A new reference is needed, which enhances the nutritional management of infants.
- (2) The reference population should reflect current health and feeding recommendations because of the frequent use of such references as standards.
- (3) The practical utility of using reference data based on infants who are fed according to WHO

feeding recommendations should be evaluated in a broad range of settings.

- (4) The effects of different complementary foods on the growth of infants following WHO feeding recommendations merit close investigation.
- (5) Research is needed for identifying proxy measures for length.
- (6) Criteria for the evaluation of abnormal growth are needed.
- (7) An evaluation is needed of reference data based on other anthropometric measurements (e.g., skin-fold thickness and arm and head circumferences).

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### Résumé

#### Evaluation de la croissance infantile: utilisation et interprétation de l'anthropométrie

Dans le cadre du travail préparatoire à une réunion d'un comité OMS d'experts de l'utilisation et de l'interprétation de l'anthropométrie, l'Unité Nutrition de l'OMS a mis sur pied un groupe de travail sur la croissance du nourrisson, afin de réexaminer l'utilisation des indicateurs anthropométriques pour évaluer l'état nutritionnel des nourrissons, tant individuellement que collectivement. Une certaine préoccupation est apparue à la suite d'observations faisant état de nourrissons allaités au sein, qui dans des conditions favorables,

<sup>9</sup> See footnote f on page 172.

avaient une croissance moins bonne que prévu par la référence du NCHS-OMS. Le déficit du poids pour l'âge était suffisamment important pour que le personnel de santé en vienne à des conclusions inappropriées concernant la croissance de nourrissons alimentés conformément aux recommandations de l'OMS. Cette éventualité est particulièrement inquiétante dans les cas où les conditions de vie sont caractérisées par une mauvaise hygiène du milieu et un surpeuplement, et où l'allaitement au sein est la clé de la survie. À l'inverse, une insuffisance réelle de la croissance chez un nourrisson alimenté au sein peut avoir été interprétée par erreur comme le «déficit normal» habituellement attendu lorsqu'on compare le nourrisson alimenté au sein et la référence internationale actuelle.

Le réexamen par le groupe de travail des données concernant la croissance du nourrisson qui vit dans des conditions favorables et qui est alimenté conformément aux recommandations de l'OMS a mis en évidence des différences importantes entre la croissance de ces nourrissons et celle qui ressort des données de référence internationales du NCHS-OMS. En raison des conséquences à court et à long terme d'un déficit de croissance, et des risques tant de l'introduction prématurée d'aliments complémentaires que du retard de cette introduction, — double écueil connu sous le nom de «dilemme du sevrage» —, le groupe de travail est parvenu à la conclusion que l'utilisation de la référence actuelle du NCHS-OMS semble accentuer encore la difficulté qu'il y a d'éviter ces deux dangers, au lieu de permettre une prise en charge nutritionnelle optimale du nourrisson.

Il convient, selon le groupe de travail: 1) d'élaborer une nouvelle référence qui mettra l'accent sur la prise en charge nutritionnelle du nourrisson; 2) de choisir une population de référence qui sera le reflet des recommandations actuelles concernant la santé et l'alimentation, cette référence étant fréquemment utilisée comme norme; 3) d'évaluer dans ces contextes très différents, l'intérêt pratique des données de référence établies à partir de nourrissons pour lesquels les recommandations alimentaires de l'OMS sont suivies; 4) d'étudier en profondeur les effets de différents aliments de complément sur la croissance de nourrissons alimentés conformément aux recom-

mandations de l'OMS; 5) de définir des critères permettant d'apprécier les anomalies de croissance; 6) d'évaluer les données de référence fondées sur d'autres mesures anthropométriques telles que le pli cutané et les périmètres brachial et céphalique.

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