Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee[1-3]

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ABSTRACT The World Health Organization (WHO) convened an Expert Committee to reevaluate the use of anthropometry at different ages for assessing health, nutrition, and social wellbeing. The Committee's task included identifying reference data for anthropometric indexes when appropriate, and providing guidelines on how the data should be used. For fetal growth, the Committee recommended an existing sex-specific multiracial reference. In view of the significant technical drawbacks of the current National Center for Health Statistics (NCHS)/WHO reference and its inadequacy for assessing the growth of breast-fed infants, the Committee recommended the development of a new reference concerning weight and length/height for infants and children, which will be a complex and costly undertaking. Proper interpretation of midupper arm circumference for preschoolers requires age-specific reference data. To evaluate adolescent height-for-age, the Committee recommended the current NCHS/WHO reference. Use of the NCHS body mass index (BMI) data, with their upper percentile elevations and skewness, is undesirable for setting health goals; however, these data were provisionally recommended for defining obesity based on a combination of elevated BMI and high subcutaneous fat. The NCHS values were provisionally recommended as reference data for subscapular and triceps skinfold thicknesses. Guidelines were also provided for adjusting adolescent anthropometric comparisons for maturational status. Currently, there is no need for adult reference data for BMI; interpretation should be based on pragmatic BMI cutoffs. Finally, the Committee noted that few normative anthropometric data exist for the elderly, especially for those > 80 y of age. Proper definitions of health status, function, and biologic age remain to be developed for this group. *Am J Clin Nutr* 1996;64:650–8.

KEY WORDS Reference standards, anthropometry, nutritional assessment, nutritional status, growth, obesity, nutritional disorders, world health, stunting, wasting.

INTRODUCTION

Over the years, the World Health Organization (WHO) has sought to provide guidance on the appropriate use and interpretation of anthropometric indexes (1–5). Initially, attention focused largely on infants and young children because of their vulnerability, and on the value of anthropometry in characterizing growth and well-being. However, recent advances show the relevance of anthropometry throughout the life cycle, not only for individual assessments but also for reflecting the health status and social and economic circumstances of populations. Consequently, an Expert Committee was convened by the WHO Nutrition Unit to reevaluate the use and interpretation of anthropometric measurements in subjects of all ages. The charge to the Committee included identifying reference data for anthropometric indicators when appropriate, and providing guidelines on how these reference data should be used.

Anthropometry is the single most portable, universally applicable, inexpensive, and noninvasive method available to assess the proportions, size, and composition of the human body. It reflects both health and nutrition and predicts performance, health, and survival. For these reasons it is used for selecting individuals and populations for health and nutrition interventions, as well as for monitoring their health and nutrition.

In practical terms, anthropometric values are compared across individuals or populations in relation to an acceptable set of reference values. Previous presentations of the WHO reference values (3, 5) have claimed that they are to be used without making value judgements about the observed differences between the reference and the measured value. This may be true when the reference values are used as a common basis for purely descriptive comparisons of populations, but for most uses in screening and monitoring of adequate growth in individuals and populations, the reference values are used as a standard, which embraces the notion of a norm or desirable target, a level that ought to be met, and thus involves a value judgement about deviations from them.

There are certain general issues that need to be considered when the reference values are used as a standard. An important

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one is the context in which the meaning of the deviation from the standard is interpreted. The implications for most decisions at the individual and population level of a same deviation from the norm are different for a 6-mo old than for a 6-y old. At 6 mo of age a substantial deviation from the weight- or height-for-age norm, in the context of a deprived population, almost always means ongoing malnutrition. At 6 y of age the same deviation may be a reflection of previous but not of current malnutrition, depending on the deviations observed at younger ages.

Another relevant issue is the magnitude of the effect of nonpathologic factors that influence the normal growth of the populations from which the reference values are drawn, compared with the pathologic effects that anthropometry seeks to identify. In public health settings, where use of one or a few sets of reference values is more practical than the use of many, reference data should not reflect inconsequential influences. The importance of the influence is determined by the margin of error it causes in interpreting judgements about deviations from the norm. For instance, the effect of sex is usually of such importance that reference data differentiate between them. Although in some situations in which malnutrition is prevalent and severe, such as in emergencies, the use of only one set of combined-sex reference values is recommended (6). In other settings, however, usually clinical situations, as many influences as possible need to be taken into account to make the right judgements when monitoring the effects of hormonal treatment, for instance. For this purpose, different standards may be used according to the different specific determinants (eg, parental height).

The Expert Committee focused above all on reference data to be used in public health settings. These data also fill many clinical needs, but not the more specialized ones. This article summarizes the recommended existing anthropometric reference data from infancy to old age, discusses its adequacy for universal applicability, and proposes the development of more useful references when necessary. Recommended reference values in tabulated and graphic format are available in the Committee's report (7).

THE FETUS AND NEWBORN INFANT

The period of intrauterine development constitutes one of the most vulnerable in the life cycle, with a lasting profound influence on subsequent growth. It is universally acknowledged that size at birth is an important indicator of fetal and neonatal health. Size at birth is the product of duration of gestation and rate of fetal growth. Any of the recently published early-gestation references curves (or a meta-analysis based on several of them) could be used for developing a single fetal growth standard up to 24-26 wk (8–10), because the effects on fetal growth of different sex, race, and exposure to common growth-promoting and growth-inhibiting environmental influences do not appear to diverge until the late second or early third trimesters. In later gestation, however, the existing curves differ to some degree. Starting at about the third trimester, female fetuses are, on average, smaller than male fetuses. Several within-country studies have shown that, before 34–36 wk of gestation, black infants are larger than white infants; thereafter, the pattern reverses (11–14). Although it has not been possible to distinguish nature from nurture in explaining the differences in mean birth weight-for-gestational-age between different racial groups, it is difficult to imagine any environmental influence that would lead to faster growth early in the third trimester and slower growth later on. Unless evidence is produced to the contrary, differences in the rate of growth at different periods of gestation seem likely to be genetically determined. These differences are, however, small.

Differences in methods of assessing gestational age, socioeconomic status, and altitude, and inclusion compared with exclusion of multiple births, of stillbirths, or of infants with congenital anomalies is probably far more responsible than race for the differences between the existing reference curves (15). In summary, fetal sex is a major influence on birth weight, but current knowledge does not confirm large genetic differences in birth weight among various populations and therefore does not support the use of separate, race-specific reference curves in situations where race is associated with other risk factors, such as poor nutrition or low socioeconomic status. Thus, the use of a single, sex-specific international reference is recommended.

The relevant characteristics of 11 fetal growth references published since the early 1950s were reviewed in detail by the Expert Committee. In addition, two references currently under development were also considered. Despite the many differences in calendar time, population characteristics, exclusions, and methods of estimating gestational age, the similarities among the various references are more striking than their differences. Although none of the reference curves published or under development meet all desirable criteria, several appear to come close. The best are probably those from California (16), Sweden (17), and Canada (18). The Canadian reference is the most recent one, but there are irregularities in extreme percentiles at low gestational ages because no smoothing technique was used. The Swedish reference is slightly dated, but the statistically smoothed curves and presentation of means plus and minus multiples of the SDs make it useful for the diagnosis of small-for-gestational age (SGA) and large-for-gestational age (LGA). Because this is based on a selected "healthy" population (of mothers and newborns) it could be of value when a growth chart from a population that has achieved a high level of its growth potential is needed for purposes of international comparison. The Committee considered that the multiracial reference of Williams et al (16) represents the best option presently available. The reference is well known, it is based on a large sample size at the lower end of the gestational age distribution, and it is comparable with many other candidate curves. A distinctive feature is that it provides data on the relation between birth weight for gestational age and neonatal mortality. Thus, the criteria for diagnosis of SGA and LGA can be based on perinatal risk rather than on arbitrary statistical cutoffs. Reference curves for singleton boys and girls, as well as for multiple births, are provided in the Expert Committee's report (7).

To decide whether future reference curves need to be more specific than the sex-specific curves recommended for present use, additional research is needed using large populations and ultrasound confirmation of gestational age to assess whether infants of different races born at a given weight for gestational age are at substantially different risks for important health outcomes. Similar research is needed for infants born to mothers of different parity and stature to determine whether infants who are born small because their mothers are primiparous or of short stature are at the same risk for adverse sequelae as those of equivalent size who are small because their mothers have preeclampsia or smoke cigarettes.

INFANTS AND CHILDREN

Growth assessment is the single measurement that best defines the health and nutritional status of children because disturbances in health and nutrition, regardless of their etiology, invariably affect child growth. The most commonly used anthropometric indexes for assessing child growth are weight-for-height, height-for-age, weight-for-age, and midupper arm circumference (MUAC).

The issue of which reference population to use in assessing the adequacy of growth during childhood has received considerable attention in the last decades. The WHO adopted the reference curves of the NCHS for international use (3) based on the then growing evidence that the growth patterns of well-fed, healthy preschool children from diverse ethnic backgrounds are surprisingly similar (19). Differences of genetic origin are evident for some comparisons; however, these variations are relatively minor compared with the large worldwide variation in growth related to health and nutrition (20). A detailed account of the historical background of the currently used NCHS/WHO growth charts, together with a discussion of some of the contemporary scientific issues, can be found elsewhere (21).

The international growth reference has served many useful purposes by providing a single set of growth references that permit comparison of growth data from different populations. However, in part because two distinct data sets were used to construct the reference curves, the international growth reference has important technical limitations that complicate the interpretation of growth data from nutrition surveys and surveillance. In essence, for children younger than 2 y of age the data used are from the Fels Research Institute in Yellow Springs, OH, and come from studies of a white, middle-class population. For older children the data come from nationally representative surveys of children in the United States and include all ethnic groups and social classes (22). Furthermore, the younger children were measured supine (length) whereas the older children were measured standing (height). For any child, the length measurement is always greater than the height measurement. Thus, there is a marked discrepancy in estimated height status immediately before and after 24 mo of age, where the two curves merge. This represents the combined effect of an underestimation of height status with interpretation of the Fels sample length-based curves and an overestimation of height status with the height-based curves from the US sample at 24 mo of age. The magnitude of this disjunction is approximately one-half an SD. The effect of the 24-mo disjunction on the prevalence of low height-for-age is illustrated in **Figure 1**. The magnitude of these deviations warrants caution when using the international reference to interpret the growth status of children covering a range of ages that includes this disjunction.

In addition, the distributions of weight-for-age and weight-for-height are markedly skewed toward the higher end, reflecting a substantial level of childhood obesity. The upward skew-

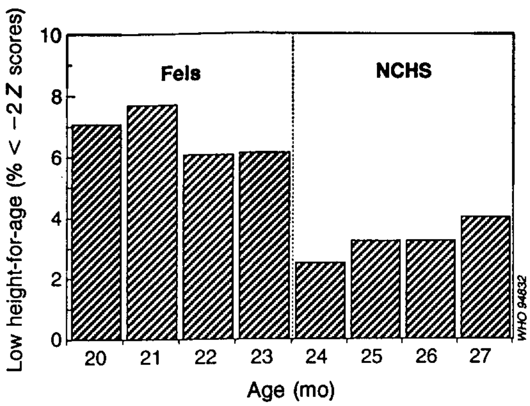

FIGURE 1. Change in prevalence of low height-for-age for low-income US children, illustrating the effect of the 24-mo disjunction as a result of using the Fels length-based curves for children younger than 2 y of age and the NCHS height-based curves for older children (7).

ness reflects an unhealthy characteristic of the reference sample and may result in the misclassification of overweight children as "normal." However, because there is insufficient knowledge of the normality of weight distribution in children of different ages, the issue of skewness should be the subject of further research.

Concern has also been expressed that the NCHS/WHO curves are inappropriate for healthy, breast-fed infants. As part of the preparatory work for the Expert Committee, a Working Group on Infant Growth was established to assess the growth patterns of infants following current WHO feeding recommendations (23), and the relevance of such patterns to the development of growth reference data. In reviewing the growth of breast-fed infants who live under favorable environmental conditions in different parts of the world, the Working Group found significant differences between the growth patterns of these infants and the patterns reflected in the NCHS/WHO reference. Infants fed according to WHO recommendations and living under conditions that favor the achievement of genetic growth potential grew less rapidly than, and deviated significantly from, the international reference (**Figure 2**). Concerning the clinical and public health significance of these differences, the Working Group placed particular emphasis on the risks associated with both the premature introduction of complementary foods and their undue delay, and concluded that the current growth reference has limited value as a tool for the optimal

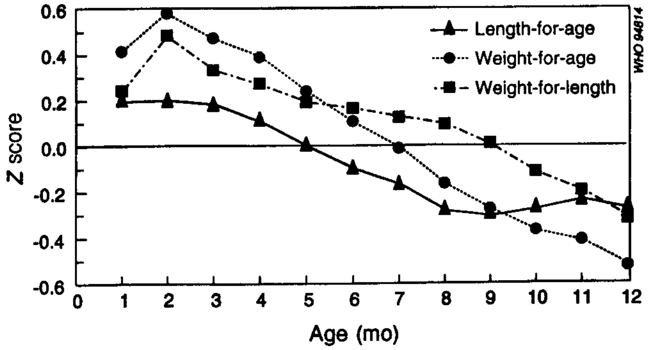

FIGURE 2. Mean *Z* scores of infants in the breast-fed set, relative to the National Center for Health Statistics/WHO reference (7).

nutritional management of infants. A complete description of the group's analyses can be found elsewhere (24, 25).

After its evaluation of present knowledge about infant-growth assessment, the Expert Committee reaffirmed the previous WHO position of using a single international reference. However, because of the significant technical drawbacks of the current NCHS/WHO growth reference, especially for population-based applications, an update or replacement in the near future was recommended. Updating a reference, or developing an entirely new one, is an extremely complex, costly, and time-consuming undertaking. The difficulties inherent in generating statistically sound and appropriate growth curves are many. To be of lasting value, therefore, it is clear that the next reference must be exceptionally well-prepared. The Expert Committee identified some of the desirable characteristics for data sets to be used in the development of a new reference population (**Table 1**). Applying the Committee's recommendation of the formulation of a truly international reference based on carefully conducted surveys covering broad populations from several countries might be more acceptable than data from a single country. This procedure will avert the political difficulties that have arisen from using a single country's child-growth pattern as a worldwide "standard" for optimal growth.

The Expert Committee also reviewed the use and interpretation of MUAC. Until now, a low MUAC has been based on a fixed cutoff point—generally 12.5 or 13.0 cm—based on the general notion that MUAC is age- and sex-independent between 1 and 4 y of age. However, this assumption of age independence does not reflect the true pattern of midupper arm growth, and the use of a fixed cutoff results in wasting being overdiagnosed among younger children and underdiagnosed among older ones. Mean MUAC values across ages show a definite age-dependent increase of ≈2 cm between the ages of 6 and 59 mo in both affluent and nonaffluent populations (7). Thus, younger children are more likely to have low MUACs. Younger children also have higher mortality rates for reasons completely unrelated to those that affect MUAC. This explains why the MUAC predicts childhood mortality better than height- and weight-age adjusted indicators in community-based studies. Analysis carried out in preparation for the Expert Committee showed that this superior performance of the MUAC declined significantly after adjustment for age. In fact, the ability of the MUAC to predict mortality was comparable with that of age, height, or weight based on fixed cutoffs (unadjusted for age) (7). It was therefore concluded that proper interpretation of the MUAC with regard to nutritional status or to its etiologic relation to functional outcomes requires the use of age-specific reference data to permit interpretation of findings. On the basis of this recommendation, MUAC-for-age reference data were developed for international use based on children aged 6–60 mo from the samples collected for the first and second National Health and Nutrition Examination Surveys (NHANES I and II) in the United States. Reference tables and curves for boys, girls, and both sexes combined are presented elsewhere (26). Nonetheless, the interpretation of low MUAC based on a fixed cutoff is still of value for certain applications, especially when it is desirable to give priority to younger children who are more vulnerable to morbidity and mortality.

TABLE 1
Desirable characteristics for anthropometric data to be used in the development of a new international growth reference

Several countries from different geographical regions should be included, among them less-developed ones
Data should be based on healthy populations with unconstrained growth (not necessarily representative of the whole population); the definition of healthy populations is important in deciding whether or not the choice should take infant feeding modes into account
Sample sizes and procedures should be adequate
Raw data should be available
The age range from birth to adolescence should be covered by most data sources
Quality control and measurements should be standardized and standardization procedures should be documented
For adolescents, measures of sexual maturity should be available
Secular trends in growth should be small or absent because they suggest the presence of growth inhibiting factors in a population

ADOLESCENTS

Adolescence is a significant period of human growth and maturation; unique changes occur and many adult patterns are established during this period. In addition, the proximity of adolescence to biological maturity and adulthood may provide final opportunities for preventing adult health problems. Human growth and maturation are continuous processes, and transitions from childhood into adulthood are not abrupt. In contrast with the previous age groups, which are defined by chronologic age, adolescence begins with pubescence, the earliest signs of development of secondary sexual characteristics, and continues until morphologic and physiologic changes approximate adult status, usually near the end of the second decade of life.

Whereas adolescence is clearly an important period in human development, it has often failed to receive the attention given to earlier periods in childhood with regard to health-related uses and interpretations of anthropometry. Historically, the rapid changes in somatic growth in adolescence, the problems of dealing with variation in maturation, and the difficulties involved in separating normal variations from those associated with health risks, have all discouraged researchers from developing a body of knowledge about adolescent anthropometry that would link it directly to health determinants and outcomes. The Expert Committee's intention was therefore to bring together available information on adolescent anthropometry to form a basis for future work and discussion.

The anthropometric indexes recommended for adolescents are height-for-age, BMI-for-age, and triceps and subscapular skinfold thicknesses-for-age. Until now, the WHO has made no specific recommendations for adolescent anthropometric reference data, but advocated the NCHS reference data for younger children, which include SDs and percentiles of height through the adolescent years. The Expert Committee therefore considered whether the international NCHS/WHO reference data were the most appropriate for adolescents or whether other reference data should be recommended. Although other reliable reference data are available, the Committee deemed it essential that all the different variables included in the reference data be measured on the same population. It was also considered desirable that there be continuity in reference levels from age to age. On this basis, the NCHS/WHO reference data were recommended for height-for-age. In some cases, local reference data may be required or other local factors must be considered; these are discussed in the context of specific uses in the Committee's report (7). The NCHS/WHO values, however, are available only up to 18 y of age in each sex (4). The Expert Committee did not recommend any reference data for height in adulthood because of the wide international variation, the lack of understanding of genetic and environmental determinants, and the inability to intervene. If reference data for height are required for ages 18–24 y, the values at 18 y provided in the NCHS/WHO reference may be used if there are no other appropriate local reference data available.

Considerable discussion focused on the appropriateness for international comparison of BMI [wt (kg)/ht^2 (m^2)] data from adolescents in the United States. The very high upper percentile levels at any given age and the marked skewing of the age-specific distributions toward higher values when compared with many other well-nourished populations were of particular concern. At the median BMI-for-age and lower percentiles, there is much less variation among well-nourished populations (27). For example, selected age-specific BMI percentiles for US children (28, 29) are compared with those for French children (30) in **Figure 3**. Major differences are evident in the skew of the upper percentiles for US boys and in their absolute values. The 85th percentiles of BMI for US boys exceeded the 90th percentiles for the French boys, and approximate the 97th percentiles. These differences mean that between two and five times more US boys than French boys have a BMI greater than the US 85th percentile. Comparisons of BMI distributions for US and French girls during adolescence yielded similar results, although the age patterns of population differences changed somewhat.

Little is known regarding specific BMI values in adolescence and their relations with concurrent or future risk or response to interventions. Nevertheless, the Committee concluded that the elevated and skewed levels of the upper percentiles of the BMI distributions for US children, and for children with similar patterns in other developed countries, did not provide a desirable pattern that should be used as a healthy goal for adolescents internationally. For uniform reporting purposes, however, and in the absence of other data specifying optimum cutoff values for BMI in adolescence, it was recommended that the BMI-for-age data for US children published by Must et al (28, 29) be used on a provisional basis until better reference data for adolescent growth are available. No incremental or longitudinal reference data were recommended for international use.

The Committee considered the combination of elevated BMI and high subcutaneous fat—determined by measuring subscapular and triceps skinfold thicknesses—as a provisional recommendation for defining obesity and recommended NCHS values as reference data for subcutaneous fat (31, 32). Reference data tables for BMI and skinfold thickness are available in the Committee's report (7). This meets the requirement for all anthropometric variables to be derived from the same reference population, and the same source population and reference data are recommended during adolescence as in childhood, so that there is continuity from one age group to another. Nonetheless, because of inadequate evidence of its universal applicability, full answers to research questions identified by the Committee would be required before these recommendations can be considered more than provisional.

Finally, the Committee recommended that maturational status be taken into account for interpreting anthropometric data based on chronologic age and gave recommendations on how to incorporate maturational status in the evaluation scheme. In essence, when population estimates of maturational status are available, age-specific means or medians for anthropometry may be adjusted for rates of maturation that differ from the reference data (**Table 2**). When mean or median values of anthropometric variables are calculated for an adolescent population, mean chronologic age for that sample should also be calculated; population median ages of maturation can then be compared with those in Table 2. The population estimates of median maturational age are subtracted from the corresponding NCHS estimates, and, on the basis of that difference, the years or fractions of 1 y are added to (or subtracted from) the mean chronologic age of the population sample. Age-specific data for the sample can then be compared with reference data for that age. The resultant comparisons correct for differences in maturation rate. If different maturity indicators give slightly variant differences in maturation rates, the differences should be averaged and the average used as the adjustment for maturation.

ADULTS

The nutrition and health of adults is particularly important because it is this age group that is primarily responsible for the economic support of the rest of the society. In nonindustrialized societies, where agricultural work is the dominant economic activity, physical capacity and endurance are critical to the ability of adults to sustain the socioeconomic and cultural integrity of their community. Variability in adult weight is recognized as being linked with variation in adult height, which in turn reflects several environmental factors active throughout much of childhood. The term "underweight" in adult assessment was therefore applied to individuals of low body weight relative to height; generally expressed in terms of BMI.

After its review of current evidence, the Committee concluded that there is no obvious need for reference data for BMI in adults, and it would be best to rely on pragmatically derived cutoff values of BMI. This recommendation is based on evidence that the prevalence of thinness and overweight varies widely from country to country, and there are no indications that different populations with the same distributions of BMI have similar relative and attributable risks of morbidity and mortality associated with different degrees of overweight and thinness. BMI values vary widely depending on the populations assessed (**Figure 4**). Also, as the proportion of the population with low BMI decreases, there is an almost symmetrical increase in the proportion with BMIs $\geq$ 25. This indicates a tendency for a population-wide shift as socioeconomic conditions improve, with overweight replacing thinness.

If sufficient data are collected in the future, however, reference data or even standards could be developed. To understand the distribution of BMI values in a healthy population and collect appropriate data for generating a reference set of weights, it is important that data are derived from populations with no nutrition problems (underfeeding and overfeeding), in

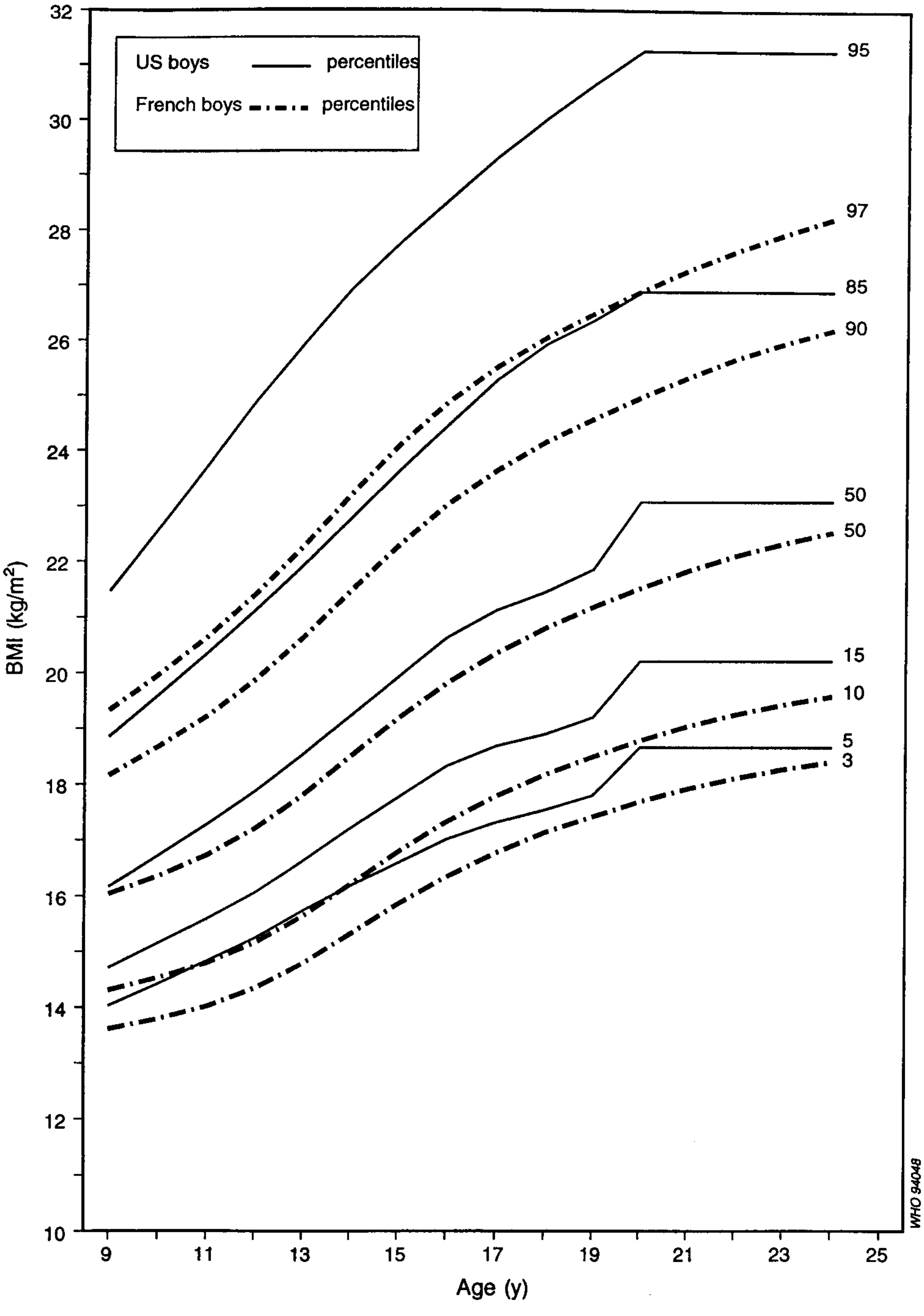

FIGURE 3. Selected percentiles of BMI-for-age for US and French boys (7).

whom children's growth is unimpaired by recurrent infections, and the young individuals in the population are largely free of disease and do not smoke.

Data for the potential development of reference data should at least include weight, height, age, sex, and race. Socioeconomic status and smoking habits may be necessary to adjust for these influences. Information would also need to be included that would permit the exclusion of persons with abnormal weight relative to healthy well-nourished nonpregnant individuals, eg, the presence of disease, dieting, and weight history.

ADULTS ≥ 60 Y OF AGE

The elderly represent the fastest-growing segment of populations throughout the world, with the distinctive feature of being a very heterogeneous group; a healthy 80-y-old person is not comparable with a healthy 60-y-old person, nor are two healthy 80-y-old persons necessarily comparable with each other in biological age. Indeed, the concept of functional or biological age should gain more consideration in the elderly. Within any single population, individual variation is increased

TABLE 2
Estimated median ages for maturational events in the National Center for Health Statistics/WHO reference population[1]

Maturational stage	Median age
	y
Boys	
Genitalia stage 3	12.4
Peak height velocity	13.5
Adult voice	14.5
Girls	
Breast stage 2	10.6
Peak height velocity	11.7
Menarche	12.8

[1] From reference 7.

because of variable rates of aging from person to person and from physiological system to physiological system within the same individual. There are also special groups of elderly, such as those bedridden or institutionalized.

Currently available anthropometric data rarely include very old persons. NHANES II, the most comprehensive data set for anthropometry, does not include people older than 74 y. Canadian normative data include people up to the age of 70 y, data from Japan include people > 80 y, and data from the United Kingdom include people ≤ 64 y. Few normative data exist for the elderly in developing countries, and there is no evidence that what is normal for, say, a 75-y-old man in the United States is also normal for a 75-y-old man in a developing country.

Different elderly populations show large geographic and ethnic variations in height, weight, and BMI, much of which reflects differences in lifestyle and environment over the life course, genetic differences, and, to an uncertain extent, differences in health status (7). Given this worldwide variation, the Committee considered with caution the validity of various data sets for use as reference data, applying the criteria that data should be presented in 10-y age groups and by sex; with means, SDs, and percentiles available for each anthropometric index and age group; and that data for people older than 80 y of age should be included because it is thought that data from people in their 60s should not be extrapolated to those in their 80s. Moreover, the population-based sample should be free from major disabilities and living in a healthy environment, although it would be likely to contain some unhealthy individuals because most elderly people probably have one or more diseases. Given the high prevalence of multiple disease conditions in the elderly and the fact that very few, if any, individuals are completely free of disease, the definition of health used to select the sample has a major influence on the reference data. There may also be significant cohort differences in the elderly: the elderly of today grew up under quite different conditions from those who will be elderly 40 y hence. Finally, the influence of differential survivorship on anthropometry may vary across populations or over time.

After its review of available reference data and recognizing the limitations and numerous gaps in knowledge when using and interpreting anthropometry data in the elderly, the Committee did not recommend the use of universal reference data, but rather the collection of data describing local levels and patterns. For those countries that have no local data or that lack the resources to develop them, the Committee recommended the use of NHANES III data for comparisons between different population groups. The NHANES III survey collected data over the period 1988–1991 (phase 1) on a sample of 600 elderly individuals (equal numbers of whites, blacks, and Hispanics) with no upper age limit and with oversampling of the oldest age group (33). It should be emphasized that these data are pertinent if used exclusively as reference data for comparison purposes, ie, to compare means and SDs across populations. They should not be used as standards. This distinction is particularly important, and the Committee expressed particular concern regarding the applicability as a standard of any available data to other populations.

The Committee encouraged countries to collect anthropometric data on adults aged ≥ 60 y through anthropometric surveys conducted at regular intervals coupled with the monitoring of the health and functional status of this segment of the population. Special attention should be paid to selection criteria in choosing population-based samples, taking into consideration the heterogeneity of the elderly and the high prevalence of chronic conditions that may affect nutritional status. Several years hence, a consultation should be organized by the WHO to review the current recommendations in light of available new data. Furthermore, the Committee identified areas of research for improving the use and interpretation of anthropometry in the elderly.

CONCLUSION

The recommendations of the Expert Committee fill an existing need to identify reference data when appropriate, for each of the specific age groups, to be used in assessing individuals and populations at greatest risk for nutritional and health problems. In a key achievement, the report sets out an extensive series of tabular reference data that have not been distributed previously by the WHO. For adolescents and the elderly, because of lack of evidence of its universal applicability and inadequacy of available reference data, full answers to several crucial questions raised by the Committee are required before these recommendations can be considered more than provisional. For other age groups, the Committee recommends that the WHO foster the development of more appropriate international anthropometric reference data. Special emphasis should be placed on infants and children because present reference data do not correspond with the growth patterns of infants who are fed in accordance with WHO recommendations. The need for a new international growth reference is becoming a matter of urgency, especially in underprivileged populations in whom the optimal nutritional management of infants and young children is key to survival, or at least to preventing severe infections. An international effort is currently underway to develop such reference data.

Most important, the Committee recognized that in addition to recommending acceptable reference values for international use, efforts should concentrate on the appropriate use of the reference data. The way in which a reference is interpreted and the clinical and public health decisions that will be based on it are often more important than the choice of reference. The reference should be used as a general guide for screening and

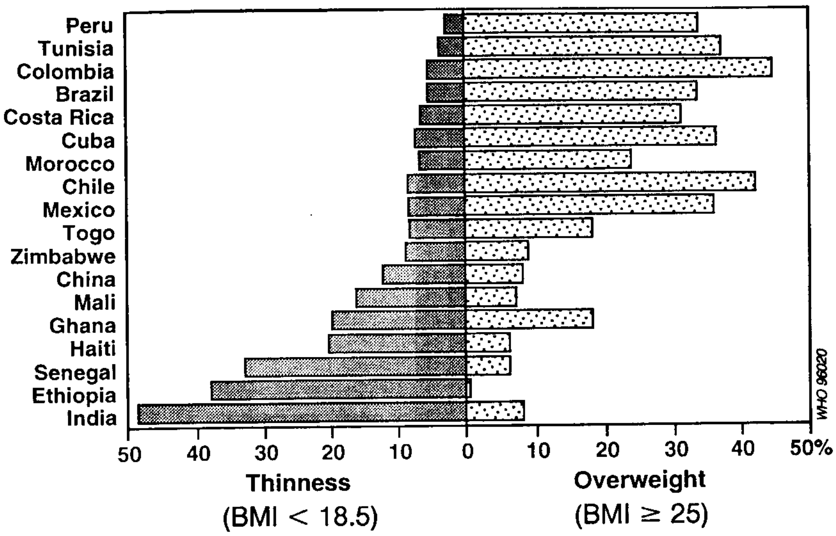

FIGURE 4. BMI distribution of various adult populations of both sexes worldwide (7).

monitoring and not as a fixed standard that can be applied in a rigid fashion to individuals with different ethnic, socioeconomic, nutritional, and health backgrounds. For clinical or individual-based application, reference values should be used as a screening tool to detect individuals at greater risk of health or nutritional disorders, and they should not be viewed as a self-sufficient diagnostic tool. For population-based applications, the reference values should be used for comparison and monitoring purposes. In a given population, a high prevalence of anthropometric deficit will be indicative of significant health and nutritional problems; however, it is not only those individuals below the cutoff point who are at risk; the entire population is at risk and the cutoff point should be used only to facilitate the application of the indicator.

The Expert Committee's report, developed in consultation with > 100 experts worldwide, provides scientists, clinicians, and public health professionals with an authoritative review, reference data, and recommendations for using and interpreting anthropometry throughout the life cycle. The present recommendations should also stimulate discussion and research and serve as the basis for future efforts.

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