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Overweight in children: definitions and interpretation

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Abstract

Studies in a variety of countries have shown increases in the prevalence of overweight among children in recent years. These increases have given rise to concern about children's health and well-being. The terminology used in these studies varies considerably. However, whatever the terminology used, such studies are generally based on weight [expressed as body mass index (BMI), a measure of weight for height, calculated as weight in kilograms divided by the square of height in meters] and not on body fatness *per se*. There are many different BMI references that can be used to define childhood overweight or obesity. Children are defined as overweight for population surveillance purposes using a variety of BMI cut points. BMI is a screening tool, not a diagnostic tool. Children with a BMI over these cut points do not necessarily have clinical complications or health risks related to overfatness. More in-depth assessment of individual children is required to ascertain health status. The definitions of overweight generally used are working definitions that are valuable for general public health surveillance, screening and similar purposes.

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Introduction

Studies in a variety of countries have shown increases in the prevalence of overweight among children in recent years [1–14]. The prevalence of overweight among school-age children and teens in the United States has more than tripled, from 5 to >16% in the last three decades [1–3]. Similar increases have been noted in Britain, Australia, Finland, China, Chile, Portugal, Brazil, Germany, France and Russia [4–13]. These increases have given rise to considerable concern about children's health and well-being [14].

The terminology used in these studies varies considerably. Some refer to 'overweight', some to 'obesity' and some to 'at risk for overweight'. Even when the same term is used (e.g. overweight), the meaning of that term is often not the same in different countries or across studies. However, whatever the terminology used, such studies are generally based on weight and not on body fatness *per se*.

In practice, measurement of body fat is difficult both in clinical applications and in population studies. In addition, there are no well-accepted standards for body fatness for children (or for adults). Thus, in general, weight, adjusted for height, is used rather than a more direct measure of body fat. A variety of methods have been used to adjust weight for height, but currently the most common, both for children and for adults, is the body mass index (BMI), defined as weight in kilograms divided by height in meters squared [15]. For children, BMI varies considerably with age, so generally the BMI of a child is compared with the BMI of a reference population of children of the same sex and age.

In adults, the cutoffs to define obesity or overweight are based on fixed BMI values related to

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health risk [16]. In children, there are no risk-based fixed values of BMI used to determine overweight, because it is unclear what risk-related criteria to use. The long time span before adverse outcomes appear and the small samples identifying cardiovascular risks in youth make finding risk-related cutoffs difficult. Consequently, a statistical definition of overweight based on the 85th and 95th percentiles of BMI-for-age in a specified reference population is often used in childhood [17, 18].

A variety of reference data sets for BMI in childhood exist. In many countries, BMI reference data are used or recommended as part of monitoring of children's growth [19–24]. Such reference data are usually based on representative data from a given country. For example, data for weight, height, BMI and head circumference from 37 000 children from surveys representative of England, Scotland and Wales were used to develop the 1990 British growth reference [19]. In the United States, the Centers for Disease Control and Prevention (CDC) 2000 growth charts for the United States were developed from five nationally representative survey data sets [the National Health Examination Surveys II and III in the 1960s, the National Health and Nutrition Examination Survey (NHANES) I and II in the 1970s and NHANES III, 1988–94]. They include sex-specific BMI-for-age growth curves for ages 2 through 19 years by single month of age [20]. All weight data from children ages $\geqslant$6 in 1988–94 were excluded because of the observed increase in weight in those children [1]. The 2000 CDC charts are revised versions of the 1977 National Center for Health Statistics growth charts [20].

The World Health Organization (WHO) is developing BMI-for-age growth charts for pre-school-age children from birth [25]. The WHO charts use a different approach. These charts will be based on healthy, breast-fed children from around the world and are intended to present a prescriptive rather than descriptive reference.

Reference sets of charts, such as the 1990 UK reference, the 2000 CDC growth charts and the forthcoming WHO charts, are intended for clinical use in monitoring children's growth. The use of selected percentiles of such charts to define overweight and obesity is a secondary purpose.

There are also several sets of BMI reference data that are intended specifically to define childhood overweight, rather than to be used for clinical monitoring of growth patterns. These include only a few cutoff values. One reference set of BMI values that has been widely used consists of sex-specific smoothed 85th and 95th percentiles for single year of age from 6–19 years based on data from the first NHANES I, 1971–74 in the United States [26]. In 1995, a WHO Expert Committee recommended the use of these reference values [27].

In 2000, Cole *et al.* [28] published a set of smoothed sex-specific BMI cutoff values based on six nationally representative data sets from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the United States. The US data used were the same as those from which the 2000 CDC growth charts were derived, except that no NHANES III data were used. The selection of data sets was based on specified criteria including a large nationally representative sample, minimum age ranges of 6–18 years and appropriate quality control. These values, often referred to as the International Obesity Task Force (IOTF) cutoff values, represent cutoff points chosen as the percentiles that matched the adult cutoffs of a BMI of 25 and 30 at age 18 years.

The Cole (IOTF) reference grew out of a workshop held by the IOTF and was developed to provide a suggested common basis for prevalence estimates internationally. The goal was to develop BMI criteria that could be used for international comparisons of prevalence without depending on using solely US reference data and without using a specified percentile, such as the 85th or 95th percentile, of a specific population. The IOTF cutoffs were not intended as clinical definitions and were not intended to replace national reference data, but rather to provide a common set of definitions that researchers and policy makers in different countries could use for descriptive and comparative purposes internationally. Several discussions on the use of national versus international reference data have been published [29–31].

Thus there is a plethora of different references that can be used to define childhood overweight or obesity for calculating prevalence estimates. There are also many articles that compare the use of different

definitions with the same population [9, 32–36]. For example, in one analysis, three different sets of BMI reference values were used to estimate the prevalence of overweight among children in the United States [32]. The three sets of BMI reference values resulted in similar but not identical estimates [32]. For young girls, estimates based on the Must reference values [26] were much higher than estimates based on the CDC [20] and Cole (IOTF) [28] references. The Cole (IOTF) reference gave rise to lower estimates for young children and higher estimates for older children than the Must and CDC references. As seen repeatedly, the various definitions do not give the same results.

Confusion may arise from the overlapping use of the descriptive terms overweight and obesity in children. Strictly speaking, obesity refers to excess body fatness and overweight to weight in excess of a weight standard. A BMI-for-age above a given value may be labeled obesity, but it is still a measure of excess weight, not necessarily of excess fat. In the IOTF reference, the terms overweight and obesity correspond roughly to the levels that would be labeled as at risk for overweight and overweight using the 2000 US CDC growth charts.

Expert committees in the United States have recommended using a BMI-for-age at or above the 95th percentile of a specified reference population to screen for obesity in adolescents and younger children [17, 18]. These values were not designed to provide clinical cut points, but rather to serve as screening values. The recommendations are that children and adolescents with BMI values at or above the 95th percentile of a suitable reference population undergo an in-depth assessment, stating that 'in-depth assessments are required to distinguish positively screened adolescents who are truly obese, to identify underlying diagnoses and to provide a basis for prescribing treatment'.

The same expert committees considered that children with BMI values between the 85th and 95th percentiles might also possibly be obese, although with a lower probability. Thus for these children, it was recommended that they be referred to a second-level screen, including consideration of family history, blood pressure, total cholesterol, large prior increment in BMI and concern about weight. These children would be referred for the in-depth evaluation only if they were positive for any of the items on the second-level screen. In the United States, overweight currently is generally defined as a BMI at or above the 95th percentile of the 2000 CDC growth charts, and at risk for overweight is generally defined as a BMI between the 85th and 95th percentile [1–3].

The category of at risk for overweight is sometimes interpreted as a designation for a child who is at risk for becoming overweight in the future. However, this is not the original intention of the term. The category as defined by the expert committees [17, 18] was intended to identify children who might be obese, in the sense of excess body fat, but who should undergo a second-level screen (as described above) to evaluate whether they should be referred for an in-depth assessment.

Health implications

Children are defined as overweight for population surveillance and screening purposes, using a variety of BMI cut points. However, these children do not necessarily have any clinical complications or health risks related to overfatness. The definitions of overweight generally used are working definitions that are valuable for general public health surveillance, screening and similar purposes and do not necessarily identify physiological states *per se*. According to the CDC [37], 'In-depth assessments are required to determine if children and adolescents with BMI-for-age $\geqslant$95th percentile are truly overfat and at increased risk for health complications related to overweight'.

Higher BMI among children is associated with higher levels of blood pressure, serum lipids and other factors [38] that in adults are associated with higher cardiovascular risk. The implications of a given level of BMI for children's future health, however, are unclear. This was noted in the expert committee report [18] published in 1994: 'Unfortunately, little published information exists regarding specific degrees of overweight in adolescence and current or subsequent

health-related outcomes. .... Further, because of the low prevalence of the sequelae of obesity among adolescents, specific cutoff values for BMI or other measures of overweight in adolescence associated with health risks have not been established'.

The same concern was echoed in 2005 in a commentary by the Childhood Obesity Task Force of the US Preventive Services Task Force [39], which put the issue succinctly: 'We do not know the best way to identify children who are at risk for future adverse health outcomes due to obesity or overweight. Although BMI is a convenient and widely agreed-on measure of obesity, it is not clear what BMI at any given age is associated with future good health'. The US Preventive Services Task Force report [40] summarized the considerable gaps in knowledge of the links between childhood weight and future health outcomes. In terms of health outcomes, the task force found insufficient evidence to currently recommend screening for BMI among children and adolescents. This finding does not mean that screening is not valuable, but rather that additional evidence is needed [40].

One concern is the emerging risk of Type 2 diabetes mellitus among children and adolescents [41]. It should be noted that among youth this is a very low prevalence condition, occurring primarily in children with a strong family history of diabetes who are from certain ethnic groups or who are markedly obese by adult standards or both [41–48]. The American Diabetes Association [42] recommends screening for diabetes in children who are overweight and have in addition two of the following factors: (i) family history of Type 2 diabetes; (ii) membership in specified race–ethnic groups (American Indians, African Americans, Hispanic Americans, Asians/South Pacific Islanders); (iii) signs of insulin resistance. The first cases of Type 2 diabetes among children reported in the United Kingdom were 8 girls, aged 9–16 years, of Pakistani, Indian or Arabic origin [45]. They were all overweight and had a family history of diabetes in at least two generations. Subsequent to this report, Type 2 diabetes was also observed among four white children in the United Kingdom [46], and Type 2 diabetes in obese white children has also been reported from elsewhere [47, 48]. Many of these cases occurred in children with very high BMIs, often in the range of 35–40, that would be considered Grade 2 or Grade 3 obesity in adults.

Regardless of the precise terminology and definitions used, the health impact of continuing increases in the prevalence of overweight among children and adolescents is clearly a cause for concern [14]. Most prevalence estimates are based on BMI, which is a screening tool, not a diagnostic tool [49]. The current definitions of overweight among children and adolescents rely on cutoff values of BMI that do not specifically identify individual children who are at risk for future weight-related health problems. These cutoff values of BMI used to define overweight are valuable for screening and for population surveillance.

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Conflict of interest statement

None declared.

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