

BMI and Adiposity in Children

A global perspective

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Key messages

- > The WHO BMI-for-age definition of obesity underestimates the prevalence of excessive fatness in Asian and African children.
- > A universal reference may not be appropriate for assessment of obesity-related disease risk in children and adolescents.
- > There is a need for reference data on body composition of children and adolescents from diverse ethnic backgrounds living in low- and middle-income countries to complement the data from high-income countries.



A schoolchild eating lunch in Mauritius



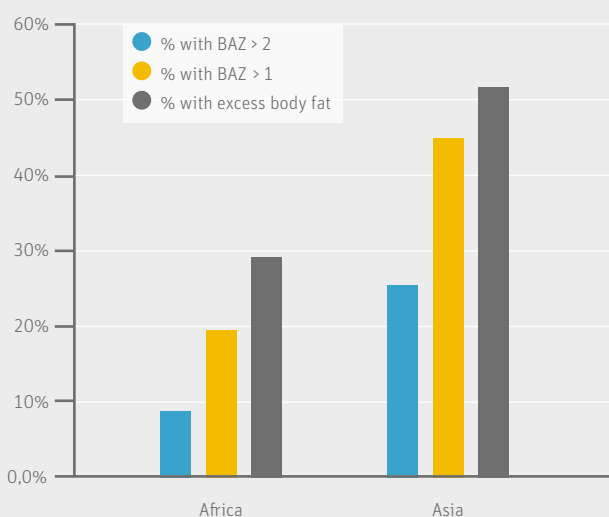
Children line up for snacks in Mauritius

In health surveillance, body mass index (BMI)-for-age (BA) is a well-established indicator for pediatric obesity. The WHO recommends that obesity in school-age children and adolescents is defined as a BA z-score (BAZ) of >2 (equivalent to BMI 30 kg/m² at 19 years), and overweight as BAZ >1 (equivalent to BMI 25 kg/m² at 19 years).^{1,2} However, obesity-related adverse health effects are related to an excess of body fat, not an excess of body weight, and there is consistent evidence that high BAZ correctly identifies individuals with highest body fatness and highest risk of co-morbidities, but fails to identify children who are excessively fat but who do not have high BAZ.³⁻⁶ It has high specificity (low false positive rate), but low to moderate sensitivity (moderate to high false negative rate).⁷ The high specificity is an advantage for clinical use, but low to moderate sensitivity is problematic for public health applications, such as obesity surveillance, since relatively large numbers of children with high body fat content will “test negative.”⁸ It is estimated that 25%–50% of children and adolescents defined as having a healthy BMI-for-age will also have excess body fat.^{5,6} Most of the evidence comes from systematic reviews based largely on European and Western populations.⁹ In many other populations, the bias associated with the use of BMI is worse, leading to more pronounced underestimates of obesity prevalence, and complicating global comparisons.¹⁰ Asians have

TABLE 1: Characteristics of the African and Asian children

Characteristics	Africa ¹⁵	Asia ¹²
<i>n</i>	1,516	1,039
Age span	8–11 years	8–10 years
BAZ median (IQR)	-0.35 (-1.09–0.71)	0.64 (-0.38–2.02)
Body fat % median (IQR)	22.65 (17.43–29.60)	28.39 (21.00–36.11)

IQR: Interquartile range

FIGURE 1: Two examples from Africa¹⁵ and Asia,¹² comparing currently recommended cut-off values for obesity and overweight by BMI-for-age z-score (BAZ) and excessive body fat percent assessed by deuterium dilution (excessive body fat defined as >25% in boys and >30% in girls)

Lunchtime at a primary/elementary school in Mauritius

more body fat at a given BMI than Europeans, but there is also wide variation between Asian populations.^{11–14} The same has been observed in a study of children from eight African countries.¹⁵ Therefore, the widespread application of a single BMI cut-off point may not be appropriate to screen for health risks in all children.

“The widespread application of a single BMI cut-off point may not be appropriate to screen for health risks in all children”

Most of the reference data for children’s body composition comes from high-income countries.¹⁶ Body-composition reference data for British and Indian children and adolescents are available.^{17–20} There is a clear need for more data from low- and middle-income countries assessing BAZ against measures of body fatness with low bias and acceptable individual accuracy.^{11,17,21} The ideal ‘criterion’ method for assessing body composition uses a multi-compartment model to measure total body water (TBW) by deuterium dilution, body density by air displacement plethysmography and bone mineral content by dual energy X-ray absorptiometry (DXA), but it is not practical for large epidemiological studies.^{22,23} However, body fat mass estimated from TBW using a two-compartment model is feasible for large epidemiological studies, and has been used to assess body composition in large studies in Asia,¹² Latin America,²⁴ and Africa.¹⁵ The International Atomic Energy Agency has published practical guidance and eLearning materials to standardize the protocols for assessing body composition by deuterium dilution,^{25–27} and is compiling a database containing information on the body composition, assessed by deuterium dilution, and risk factors for obesity-related noncommunicable diseases. The database currently contains data from approximately 4,000 children and adolescents, aged 6–18 years, from Asia, Africa and Latin America.

Two large studies from Asia¹² and Africa¹⁵ highlight that current BAZ cut-offs for obesity and overweight most likely underestimate the proportion of children with excessive body fat, which is associated with adverse health outcomes. The study populations are described in **Table 1**. In both studies, the age range was similar (8–11 years in the African study and 8–10 years in the Asian study), but the nutritional status of the children, as indicated by BAZ, was markedly different. The median (interquartile range) BAZ in the African children was -0.35 (-1.09 to 0.71), while that of the Asian children was 0.64 (-0.38 to 2.02). In both studies, body fat mass was assessed by deuterium dilution, and



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excess adiposity was defined as >25% body fat in boys and >30% body fat in girls.²⁸

Figure 1 illustrates the percentage of children that were classified as overweight (BAZ > 1), obese (BAZ > 2) and having excess body fat, and indicates that the currently recommended cut-offs may underestimate the prevalence of excessive fatness in African and Asian children, and a universal reference for obesity-related disease risk may not be applicable for all children. Further research is required on the association between adiposity and disease risk in children and adolescents from diverse ethnic backgrounds living in low- and middle-income countries to complement the data from high-income countries.

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