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Editorial

Estimated-Adult BMI Versus BMI for Monitoring Childhood Obesity

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A child or an adult is considered obese (wasted), when the incumbent has excess (lesser) mass-for-height. BMI (body-mass index) is, universally, employed to estimate status of obesity (wasting). The name was given by Ancel Keys (1904-2004) and co-workers, replacing the earlier name 'Quetelet index' (1832) after the Belgian astronomer, mathematician and statistician, Adolphe Quetelet (1796-1874). To compute BMI of an individual, one should divide the incumbent's mass (in kg — kilograms) by square of height (in m — meters). This index has its weak as well as its strong points. It is not able to account for factors like size of body frame as well as muscularity. Further, it is based on incorrect assumptions about body fat and lean mass distribution. As the person attains mature age, a decrease in height occurs, which results in BMI reduction, although the mass is not altered. Further, BMI is not able to establish a universal threshold for conditions of overweight and underweight as well as inter- and intra-region variations in body compositions of different communities, the later one appears by the presence of different ethnic groups within the same region. For children, the BMI range, which is routinely employed for estimating statuses for adults, is not applicable. BMI tables are needed to interpret childhood obesity-and-malnutrition.

Although method of calculation of BMI score is same for children and adolescents as the one for adults, the criteria used for assessment of weight are different. This is because of the fact that BMI in youngsters vary significantly with age. BMI score in children and adolescents is compared against reference charts for children matched by age and gender, in order to transform them into percentile scores (Kolimechkov & Petrov, 2020). Each individual is classified as severely thin, underweight, normal, overweight or obese based on this percentile score. Kamal et al. (2011) analyzed data of 70 family members (17 fathers, 17 mothers, 16 boys, 20 girls). Based on this analysis, the author's group concluded that boys tend to be at a higher risk of being obese as compared to girls, when both parents are obese. Lee et al. (2022) performed a systematic review and a meta-analysis of global relationship between parent and child obesity. They concluded that childhood-obesity risk is, mainly, influenced by weight status of parents and indicated that parents could play a proactive role in preventing childhood obesity.

Estimated-adult BMI was defined in 2012 to predict obesity status of children, when they reach adulthood. The name, estimated-adult BMI, was mentioned at the turn of this century by Freedman et al. (2001). However, a complete definition was given by Kamal & Jamil (2012), which is based on the current trajectory of height and mass (weight). It is computed

by replacing height and mass of a child with the respective estimated-adult values and expressed in units of kg/m2.

The method of computing estimated-adult BMI and determination of snapshot from the measured height and mass of a child may be summarized into the following steps — d), e) and f) explained in Kamal et al. (2011):

a) Obtain accurate, precise and reproducible measurements of standing heights and masses (weights) of children to least counts of 0.005 *cm* and 0.005 *kg*, respectively. Boys and girls should be barefoot, bareheaded and completely undressed (with the exception of short underpants, everything needs to be taken off, which may include cap, chain, hair accessories, leggings, ornaments, scarf, shoes, socks, stockings, watch, *etc.*) to ensure proper posture, non-flexing of elbows and knees as well as complete inhaling to get maximum chest expansion and abdomen in. A standard 1-*m* (100-*cm*) scale and a standard 2-*kg* mass were used to calibrate height- and mass-measurement instruments daily at the beginning of each session accompanied with recording of zero errors.
b) For measurement of standing height (stature), the stripped youngster is asked to stand touching the mounted engineering tape (vertical alignment ascertained through plumb line) and instructed to align hands with body, palms touching thighs and heels together. Stature is obtained with the child in attention position. A pencil is placed at eye level to make sure that chin of the child is parallel to floor.
c) For recording of mass (weight), the undressed youngster is instructed to step on the beam scale (central position) in stand-at-ease position, palms on thighs and feet separated. A pencil is, then, held at eye level to make sure that the child is looking straight.
d) Convert age of child expressed as *year-month-day* into decimal age (*years* as a whole number as well as *months* and *days* in the form of decimal entries).
e) Evaluate percentile-of-height and percentile-of-mass (employing CDC Growth Charts and Tables, extended to include percentile range 0.01^{P} to 99.99^{P} — CDC stands for Centers for Disease Control and Prevention https**:**//cdc.gov) using the mathematical-statistical technique of box interpolation. Percentile, corresponding to height (mass), of youngster is computed by first calculating heights (masses) at the given age, which are lesser and greater than the measured height (mass) employing linear interpolation (constant-percentile route; computations performed for 3 or 4 percentiles, to ensure that the required interval is not overlooked). Once the upper and the lower bounds are determined at the given age, the required percentile is obtained by another linear interpolation (constant-age route).
f) Compute estimated-adult height and estimated-adult mass using the technique of linear interpolation employing age-20 values of height and mass read off from gender-specific growth charts.
g) Divide estimated-adult mass of a child (in *kg*) by square of estimated-adult height (in *m*) to calculate estimated-adult *BMI.*
h) Use Table-1 to classify the youngster as excessively wasted, severely wasted, wasted, normal, obese, moderately obese, severely obese or excessively obese.

Table-1

WHO classification of estimated-adult BMI, applicable to pediatric population

Descriptive Label	**$BMI_{est\text{-}adult}$ Values (kg/m^2)**
Excessively Wasted	$BMI_{est\text{-}adult} < 15$
Severely Wasted	$15 \leq BMI_{est\text{-}adult} < 16$
Wasted	$16 \leq BMI_{est\text{-}adult} < 18.5$
Normal	$18.5 \leq BMII_{est\text{-}adult} < 25$
Obese	$25 \leq BMII_{est\text{-}adult} < 30$
Moderately Obese	$30 \leq BMII_{est\text{-}adult} < 35$
Severely Obese	$35 \leq BMII_{est\text{-}adult} < 40$
Excessively Obese	$BMII_{est\text{-}adult} \geq 40$

Note: The terminologies underweight and overweight are replaced by 'wasted' and 'obese' with appropriate adjectives

A snapshot of obesity on the basis of estimated-adult BMI is not enough to chart out the true state of affairs. Beyond estimated-adult BMI, the author has proposed other indicators of childhood obesity during the last decade, viz. height-percentile-based-optimal mass (2011), status, pertaining-to-mass (2011), BMI ratio (2014), algebraic status, pertaining-to-mass (2015), qualitative status, pertaining-to-mass (2015), BMI-based-optimal mass (2017), modified status, pertaining-to-mass (2018), descriptive status, pertaining-to-mass (2018), fractional status, pertaining-to-mass (2018), reference-BMI-based-optimal mass (2020), estimated-adult-specific BMI (2020), refined status, pertaining-to-mass (2021), depictive status, pertaining-to-mass (2021) and complex status, pertaining-to-mass (2021) combined with relative BMI, proposed by Poskitt (1995). All of these indicators leave the obesity researcher confused and perplexed as to which one should be used and how it should be interpreted. The author has proposed unified approaches in terms of Growth-and-Obesity Roadmaps 4.5 and 5.0 (last one used for still-growing parents) as part of solutions to childhood obesity-and-malnutrition (Kamal, 2022).

These roadmaps give enhanced-nutritional status, classified into 23 categories, viz. special categories (normality, obesity, wasting, tallness, stunting), regular categories (over-nutrition, under-nutrition, energy-channelization I-II), extended categories (obesity dominated over-nutrition, tallness dominated over-nutrition, tallness dominated energy-channelization I, wasting dominated energy-channelization I, wasting dominated under-nutrition, stunting dominated under-nutrition, stunting dominated energy-channelization II, obesity dominated energy-channelization II) and limiting cases (acute malnutrition, true over-nutrition, true under-nutrition, true energy-channelization I-II, energy-channelization III, sometimes termed as puberty-induced energy-channelization). In addition, height-gain-target-achievement and mass-management-target-achievement indices, for the current checkup, are evaluated from the recommended values based on the previous checkup. For peri-pubertal children (those are just going to enter puberty), puberty rating should be performed at each checkup.

It is suggested that such roadmaps should be generated for every child from the age of around 3 years (when it is possible to obtain a reliable standing height) to the end of growth (19 years for girls; 21 years for boys). Induction into the Armed Forces of any country

should not be based on one measurement of height and mass (weight) but a complete growth trajectory generated from the time of pre-school entry.

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