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Normalisation of body composition parameters for nutritional assessment

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Normalisation of body composition parameters to an index of body size facilitates comparison of a subject's measurements with those of a population. There is an obvious focus on indexes of obesity, but first it is informative to consider Fat Free Mass (FFM) in the context of common anthropometric measures of body size namely, height and weight. The contention is that FFM is a more physiological measure of body size than body mass. Many studies have shown that FFM relates to height^p. Although there is debate over the appropriate exponent especially in early life, it appears to lie between 2 and 3. If 2, then FFM Index (FFMI; kg/m2) and Fat Mass Index (FMI; kg/m2) can be summed to give BMI. If 3 were used as exponent, then FFMI (kg/m3) plus FMI (kg/m3) gives the Ponderal Index (PI; weight/height3). In 2013, Burton argued that that a cubic exponent is appropriate for normalisation as it is a dimensionless quotient. In 2012, Wang and co-workers repeated earlier observations showing a strong linear relationship between FFM and height3. The importance of the latter study comes from the fact that a 4 compartment body composition model was used, which is recognised as the most accurate means of describing FFM.

Once the basis of a FFMI has been defined it can be used to compare measurements with those of a population, either directly, as a ratio to a norm or as a Z-score. FFMI charts could be developed for use in child growth. Other related indexes can be determined for use in specific circumstances such as: body cell mass index (growth and wasting); skeletal muscle mass index (SMMI) or appendicular SMMI (growth and sarcopenia); bone mineral mass index (osteoporosis); extracellular fluid index (hydration). Finally, it is logical that the same system is used to define an adiposity index, so Fat Mass Index (FMI; kg/height3) can be used as it is consistent with FFMI (kg/height3) and PI. It should also be noted that the index FM/FFM, describes an individual's adiposity in relation to their measured body size, independent of height. Field measures such as skinfold thickness (SFT) and mid-upper arm circumference (MUAC; probably corrected for triceps SFT) can be expressed in proportion to indexes by considering their dimensions. MUAC/height best relates to FFMI (kg/height3), whereas SFT/height relates to FMI (kg/height3).

Body composition charts based upon PI will be demonstrated, similar to those based on BMI as described by Hattori in 1997. These could be developed as a graphical tool to illustrate cross-sectional and longitudinal measurements in the context of a population. In conclusion, a common framework of body composition indexes can be developed once the means to normalise FFM has been optimised. If the consensus is to apply a height exponent other than 3, this approach is equally relevant.

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