Weight and height: the foundation of anthropometry and body composition

Nutrition screening and assessment initiate the nutrition care process of individuals and groups and are also core in nutrition monitoring and evaluation.[1] Anthropometry is an objective nutritional assessment method, and, in the case of infants and children, growth monitoring is also a sensitive indicator of health status. Most quantitative nutrition research studies involving nutritional status include a description of the subjects' weight and height. Among the advantages associated with weight and height are the universal use, ease of taking the measurements as well as availability and low cost of the necessary equipment. On the other hand, two publications in this issue[2,3] argue that in different South African settings height measurement poses challenges, thereby justifying an analysis of the accuracy of available height estimation equations from segment lengths. In both cases the authors raise doubts about the performance of the equations tested.

Estimations of weight and height are not limited to the prediction thereof from anthropometric segment lengths, but may also include self[4,5] or surrogate (e.g. parental[6]) assessments, as well as judgement of body size from figural drawings, silhouettes or photographs.[7] The measurement of mid upper arm circumference in lieu of body mass index (BMI)[8] can also be added to this list.

When using or interpreting estimations of weight or height, the considerations below may be helpful.

If the estimations are intended as a *screening* procedure, then the nature and degree of resultant errors should be known. These errors may be random and/or systematic. The latter typically leads to bias in the form of consistent over- or under-estimation. Where the estimation is used in a classification, its performance may be expressed in terms of parameters of diagnostic accuracy[1,9] such as sensitivity and specificity. False positives have resource implications and false negative rates result in missed opportunities.

If the estimations are one part of a comprehensive nutritional assessment,[1] then the effect of potential misclassification may be modulated by the other elements of the assessment and an integrative (albeit potentially subjective) judgement by the nutrition professional. Estimations as once-off descriptions of current anthropometric status, as opposed to the use of these estimates for monitoring progress / impact of (nutritional) care, need to be interpreted carefully. Detection of changes within an individual or group, or differences between groups or between health and disease, are often what is needed.[10] In the clinical setting, weight history (as opposed to current weight) is strongly emerging as diagnostic criterion for malnutrition.[11] This approach is also evident in the commonly used Subjective Global Assessment (SGA).[12] However, in South Africa many individuals appear to be unaware of their usual weight, and hence percentage unplanned weight change in a given period cannot reliably be determined, particularly by inexperienced professionals.

Where estimated weight and height are to be used for the calculation of the BMI, ideal body weight, phenotyping[13] or the assessment of risk/morbidity and mortality (e.g. for non-communicable diseases), it should be remembered that that BMI as such is not the determinant of health and disease. The index aims to express body mass in a way that is minimally dependent on height. It follows that efforts aimed at improving estimation of weight (and not height) may be of greater value. The technical debate whether we should be talking about mass or weight has limited practical consequences. The use of the BMI is usually justified by its linear relationship with body fatness, even though it has been pointed out[10] that when fat mass determined by dual-energy X-ray absorptiometry scan (DEXA) is regressed on BMI, the standard deviation of residuals is considerable: about 3.2kg. This implies that body composition is the preferred approach when an association with morbidity is studied, particularly for individuals. Nevertheless, total body weight underpins most body composition techniques.[10] The interrelatedness of weight, height, BMI and components of body composition may even call for cautious application of statistical methods.[14]

It has been argued that healthy body weight is not about a specific value or range, but about its role in a specific physical and functional, age and sex-specific metabolic context.[15] South Africa, a country in transition with an extremely high prevalence of female overweight and obesity against the backdrop of stunting,[16] deserves context-specific anthropometric research, using appropriate technology. Issues such as sarcopenia, cachexia, sarcopenic obesity and metabolic healthy obesity cannot be ignored.[17]

Using estimated weight and height for calculating a diet prescription, may exacerbate the error inherent to the underlying formulae. The limitations of resting energy estimation equations in general and in specific populations are well-documented.[18] This body of evidence includes a South African study which showed that among overweight women none of the generally available equations performed satisfactorily.[19] Similarly, the use of estimated weight for determining macronutrient (e.g. protein) requirements can be debated.

If anthropometry and body composition are to remain the objective pillars for assessing current and change in nutritional status, impact and risk of morbidity and mortality, then relevant measurements of good quality must form the foundation thereof. Estimation is only acceptable if, from the outset, the practitioner or researcher is fully aware of the implications of the errors that are to be expected, and of delayed nutrition care. The latter includes special circumstances such as emergency situations,[20,21] non-mobile patients[22] or people

with developmental challenges such as Down Syndrome[23] or cerebral palsy.[24] Overall, the emphasis should be on quality assurance of weight and height measurements. Physiological variability may need to be considered here, including short-term (within-day) body weight fluctuations related to food/fluid intake, urine/fecal output, but also within-week or -month variations, [25,26] as well as technical matters related to technique and equipment. This is particularly critical in the anthropometric assessment of infants and children. Standardisation of techniques and implementation of good maintenance plans for equipment are not negotiable as precision in these basic measurements has to be ensured.

The relative importance of quick and crude estimations of weight and height versus multi-compartment techniques of body composition will remain a point of debate. The aim and use of the measurements should dictate the most appropriate choice. Whether we work with individuals or groups, in clinical practice or research, in a metabolic ward or community setting, does play a role. Since most sophisticated body composition techniques express the body compartments relative to weight and/or height, precise measurement of these will remain on the agenda. Cost, convenience, availability and skills as reasons for substituting weight and height estimations for the actual measurement thereof should only be considered when patient care is otherwise compromised. Then informed estimation is better than nothing.

In the end, the purpose should be to fight the "skeleton"[27] in the hospital or public nutrition closet. We concur with Souza et al.[28] that this will not depend on new technologies, but on the wider adoption of precisely implemented nutrition assessment, followed by tailored nutrition intervention!

Friedeburg AM Wenhold, PhD; RD(SA). Senior lecturer, Department Human Nutrition, Faculty of Health Sciences, University of Pretoria, South Africa.

References

1. Field LB, Hand RK. Differentiating malnutrition screening and assessment: a nutrition care process perspective. J Acad Nutr Diet. 2015;115(5):824-828.
2. Lahner CR, Kassier SM, Veldman FJ. Arm-associated measurements as estimates of true height in black and white young adults of both genders: an exploratory study, Pietermaritzburg, KwaZulu-Natal, South Africa. S Afr J Clin Nutr. 2016.
3. Van den Berg L, Nel M, Brand D et al. Agreement between measured height, and height predicted from ulna length in adult patients in Bloemfontein, South Africa. S Afr J Clin Nutr. 2016.
4. Yoong SL, Carey ML, D'Este C, Sanson-Fisher RW. Agreement between self-reported and measured weight and height collected in general practice patients: a prospective study. BMC Med Res Meth. 2013;13:38. [DOI: http://www.biomedcentral.com/1471-2288/13/38]
5. Tang W, Aggarwal A, Moudon AV, Drewnowski A. Self-reported and measured weights and heights among adults in Seattle and King County. BMC Obesity. 2016;3:11. doi: 10.1186/s40608-1016-0088-2
6. Lundahl A, Kidwell KM, Nelson TD. Parental misperceptions of children's underweight status: a meta-analysis. Ann Behav Med. 2014;48:184-193. doi: 10.1007/s12160-013-9587-2
7. Dratva J, Bertelsen R, Janson C, et al. Validation of self-reported figural drawing scales against anthropometric measurements in adults. Publ Health Nutr. 2016;19(11):1944-1951.
8. Brito NB, Lianos JPS, Ferrer M, et al. Relationship between mid-upper arm circumference and body mass index in inpatients. PLOS ONE. 2016. doi: 10.1371/journal.pone.0160480
9. Gleason PM, Harris J, Sheean PM, et al. Publishing nutrition research: validity, reliability, and diagnostic test assessment in nutrition-related research. J Am Diet Assoc. 2010;110(3):409-419.
10. Murgatroyd P, Bluck L, Watson L. Methods for assessing nutritional status and body composition. In: Lovegrove JA, Hodson L, Sharma S, Lanham-New SA (Ed): Nutrition research methodologies. Oxford: Wiley Blackwell, 2015.
11. Cederholm T, Bosaeus I, Barazzoni R, et al. Diagnostic criteria for malnutrition – an ESPEN consensus statement. Clin Nutr. 2015;34:335-340.
12. Fink JdS, de Mello PD, de Mello ED. Subjective global assessment of nutritional status – a systematic review of the literature. Clin Nutr. 2015;34:785-792.
13. Peterson CM, Thomas DM, Blackburn GL, Heymsfield SB. Universal equation for estimating ideal body weight and body weight at any BMI. Am J Clin Nutr. 2016. doi: 10.3945/ajcn.115.121178
14. Yu K, Liu X, Alhamzawi, et al. Statistical methods for body mass index: a selective review. Statis Meth Med Res. 2016:1-14. doi: 10.1177/0962280216643117.
15. Muller MJ. Ideal body weight or BMI: so, what's it to be? Am J Clin Nutr. 2016. doi: 10.3945/ajcn.116.134221
16. Shisana O, Labadariois D, Rehle T, et al. South African national health and Nutrition Examination Survey (SANHANES-1). Cape Town: HSRC Press, 2013.
17. Prado CM, Cushen SJ, Orsso CE, Ryan AM. Sarcopenia and cachexia in the era of obesity; clinical and nutritional impact. Proc Nutr Soc. 2016;75:188-198.
18. Madden AM, Mulrooney HM, Shah S. Estimation of energy expenditure using prediction equations in overweight and obese adults: a systematic review. J Hum Nutr Diet. 2016;29:458-476.
19. Olivier N, Wenhold FAM, Becker P. Resting energy expenditure of black overweight women in South Africa is lower than of white women. Ann Nutr Metab. 2016;69:24-30.
20. Young KD, Korozer NC. Weight estimation methods in children: a systematic review. Ann Emergency Med. 2016. doi: 10.1016/j.annemergmed.2016.012.043
21. Britnell S, Taylor S, Koziol-Mclain J. Emergency weight estimation lookup tables for New Zealand children aged 5-10 years. Emergency Med Australasia. 2016. doi: 10.1111/1742-6723.12637
22. L'her E, Martin-Babau J, Lellouche F. Accuracy of height estimation and tidal volume setting using anthropometric formulas in an ICU Caucasian population. Intensive Care. 2016;6:55 doi: 10.1186/s13613-016-1054-4
23. Talib NJ, Rahm G, Abdel-Rahman SM. Estimating weight in children with Down Syndrome. Glob Ped Health. 2015:1-5. doi: 10.1177/2333794X14568450
24. Haapala H, Peterson H, Daunter A, Hurvitz EA. Actual height and estimated height using segmental limb lengths for individuals with cerebral palsy. Am J Phys Med Rehabil. 2015;94(7):539-46. doi: 10.1097/PHM.0000000000000205
25. Vivanti A, Yu L, Dakin L, et al. Short-term body fluctuations in older well-hydrated hospitalised patients. J Hum Nutr Diet. 2013; 26:429-435 doi: 10.111/jhn.12034
26. Orsama A-L, Mattila E, Ermes M, et al. Weight rhythms: weight increases during weekends and decreases during weekday. Obes Facts. 2014;7:36-47.
27. Butterworth CR. The skeleton in the hospital closet. Nutr Today. 1974;9:4-9.
28. Souza T, Sturion CJ, Faintuch J. Is the skeleton still in the hospital closet? A review of hospital malnutrition emphasizing health economic aspects. Clin Nutr. 2015;34:1088-1092.