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EDITORIAL

When is the estimation of weight and height *good enough*? A life cycle view

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Anthropometry – the measurement of body size and proportion – is an *objective* component of a comprehensive nutrition assessment.[1] As such, it is intended to give a true (accurate and precise) reflection of the reality which one wants to observe. This applies to dietetic and clinical practice as well as the scientific study of growth and nutritional status throughout the life cycle. Measurements of weight and the height/length of the human body are the foundation of anthropometric assessment.[2] True values for these parameters are obtained through measurement, using calibrated equipment and appropriate technique.

Sometimes, the direct measurement of actual weight and height is not possible, and estimations are used instead. Estimation may be driven by limitations related to the subject (i.e. the person being measured), the assessor (i.e. the person taking the measurement) or the context (e.g. availability of equipment, time and funding). In addition, the aim of the assessment (e.g. nutrition screening) may be used to justify estimation as opposed to measurement. Methods and equations for estimating weight and height have been investigated in different settings and at different stages of the life cycle, in international as well as South African literature.[3–7]

In taking a life cycle view of anthropometric assessment, one has to consider the foetal period first. Foetal weight must unavoidably be estimated, since the subject (the unborn foetus) is physically inaccessible. Although total body length cannot be measured, biometric parameters such as femur and humerus lengths, biparietal diameter and head and abdominal circumferences can be quantified using ultrasonography. These values are then used in prediction equations (e.g. Hadlock [Shaheena *et al*.][8] and INTERGROWTH-21st [Sternemann *et al*.[9]]) to estimate foetal weight.

At birth, direct measurement of weight and length becomes possible. Birth and neonatal weight should be measured using the best available electronic scales and following a meticulous, standardised technique, because weight change in the neonate is a sensitive indicator of overall health. Measuring length at birth remains challenging. In practice, the 'measurement' is often only a rather unreliable estimation.[10] Various factors contribute to this difficulty, including neonate postural constraints[11] and assessors' non-adherence to equipment and technique protocols.[12] Measuring segment lengths of the newborn instead of the whole body has been proposed as an alternative for length estimation,[13] but this is not widely implemented.

For healthy, able-bodied infants, children and adults there is little justification for estimating rather than measuring weight and height. Nonetheless, estimation of weight and height may be necessary in certain cases; most commonly, when subject-related ill-health conditions such as spasticity, deformity or immobility preclude accurate and precise measurement.

Whenever estimations are used, the limitations of the method and the potential for error should be understood and acknowledged. Studies such as the investigation by Williamson and colleagues in this issue of the SAJCN[7] evaluate estimations against a 'true value' criterion – in this case, stretched stature – and make a judgement on whether the deviation of the estimation from the true value is acceptable. The authors give a worked example to show, for an individual subject in a research setting, the impact of estimating height by measuring recumbent length, on measured height (stretched stature) and a body mass index (BMI) calculation. The clinical relevance of the error now needs to be judged, for example in terms of how such an error may impact on the nutritional care of the example case. Conversely, when using knee height to estimate stretched stature, the difference between estimated and measured height was found to be statistically not significant, yet in this case the context (availability of knee height metres) and the skills to take the measurement (assessor factor) need to be considered when judging clinical relevance. The findings show that statistical and clinical significance may differ and then they need to be carefully weighed.

A further, heretofore neglected consideration involves translating the results of research studies directly to clinical practice. In the research setting, all measurements are taken by trained assessors, under well-controlled conditions, using calibrated equipment. While this is good research practice, it cannot be assumed that it represents everyday measurement practice, which may involve less motivated assessors, less-than-ideal contexts and sub-optimal equipment.[14] Whether estimations based on accurately performed measurements give a better indication of anthropometric status than poorly performed direct measurements remains to be tested. Assessor- and technique-related factors are central to these questions.

The acceptability of estimation over direct measurement depends on several factors, including which parameters are being estimated, the age of the subject(s) in question, and whether the purpose is to assess an individual or a group of people.

As already explained, in the assessment of an individual the estimation of some parameters may be more problematic than others. For instance, the estimation of weight is more problematic than that of length/height, particularly in those instances where weight is divided by powers of height/length (e.g. the BMI or the Ponderal Index, where weight is divided by height/length to the power of 2 and 3 respectively). These indices minimise the effect of height/length. It follows that height/length estimation in such cases has a smaller effect on the subsequent conclusions. However, the same is not true for estimation of weight. Visual estimations of weight/BMI (based on silhouettes, figure rating scales, photographs etc.) should be treated with utmost caution, especially in the nutrition assessment and management of individuals, as the objectivity can be questioned. Such methods have usually been validated using broad categorisations of BMI,[15] and borderline cases tend be to be questionable. Likewise, self-reported weight and height are associated with considerable error. Such errors appear to be systematic, with a tendency to overestimation of height and underestimation of weight, an effect that is more pronounced in overweight and obese individuals.[16] Indeed, self-report is one of the major weaknesses of the Metropolitan Weight–Height Tables, which have been used for decades and were included in many nutrition and medicine textbooks.

Additionally, the age of the subject is important. The younger the person is, the more attention should be paid to quality assurance of the estimation – an error of a given size becomes proportionally more pronounced when the true weight or length/height of the subject is smaller.

Where the estimations are part of a very large dataset (e.g. in national surveys) and the estimation errors are random (as opposed to systematic, i.e. biased in a particular direction), the net effect of using estimations may become negligible as the mean values may eventually reflect the true population value. Nonetheless, it remains important to determine the accuracy of fieldworkers' measurement technique in any large-scale survey; such standardisation provides evidence of intra-rater and inter-rater reliability of anthropometric measurements and confirms the absence of systematic bias in the measurements. The relevance of this has already been demonstrated worldwide in national studies such as the Demographic and Health Surveys[17] and preliminary observations in South Africa confirmed this in the training and standardisation of anthropometry fieldworkers for the 2022 National Dietary Intake Survey (NDIS-2022). The importance of ongoing quality control in anthropometric assessment is often underappreciated. Obtaining quality anthropometric data in large-scale surveys requires the will and means to purchase calibrated, fit-for-purpose equipment and the empowerment of fieldworkers (assessors) to measure accurately and take responsibility for equipment verification and maintenance. To this end, a set of South African protocols and training materials for anthropometric assessment in large-scale surveys was recently developed,[18] for first-time, large-scale use in the current NDIS-2022.

In conclusion, for anthropometry to be an objective component of nutrition assessment it should rely on measurement, not estimation, yet measurement per se is no guarantee of accuracy and precision. Calibrated equipment and standardised techniques are always essential. When estimations are unavoidable the interpretation and application of the information require careful consideration, including an understanding of the error structure of the estimation approach used. Very often publications conclude with recommendations that locally relevant prediction equations should be developed. Yes, this would reduce error, but an estimation always remains an estimation, especially on the individual level for clinical care. Finally, clinical (individual) compared with research (group-level) settings, whether weight or height/length is estimated, and participant (subject) factors need to be kept in mind, and the results obtained should be interpreted and communicated accordingly.

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