Evaluating Anthropometric References for Use with Developing Country Data

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Introduction:

Anthropometry is an inexpensive and universal tool for assessment of the size, growth, and health and welfare of individuals and populations. Anthropometric indices have been used to evaluate growth and health in children and infants, and in public health to assess rates of stunting, underweight and wasting, and more recently, overweight and obesity in populations. Anthropometric indicators have proven an effective tool for identifying populations at risk for nutritional deficits due to social or economic inequalities and for tracking public health interventions (WHO 1995).

Anthropometric indices are often expressed in terms of Z-scores, which can be used for comparisons, regardless of age or sex. Weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) Z-scores are calculated based on one of three available references. Two commonly used references, which are suggested for use by the WHO, are the 1978 National Center for Health and Statistics (NCHS) and the more recent 2000 Center for Disease Control and Prevention (CDC).

Anthropometric calculations using the 1978 NCHS/WHO growth reference are recommended by the WHO for international use though they suffer from several known weaknesses, including the '24-month' disjunction that results in a sharp increase in average Z-scores between 23 and 24 months (Moestue, et al. 2004). The 2000 CDC growth charts are considered to an improvement over the 1978 NCHS growth charts and are intended to replace the 1977 NCHS growth charts as a reference for the United States (Kuczmarski, et al. 2002). More recently, the WHO has provided a 2006 growth standard which also allows for the calculation of WAZ, HAZ, and WHZ in children up to 60 months of age. The WHO standards were derived from the Multicentre Growth Reference Study (MGRS) using an international sample of

healthy breastfed infants and young children raised in environments thought not to constrain growth.

Given the availability of multiple references, important questions are raised regarding which is most appropriate for use in non-westernized populations (Roberfroid, et al. 2006). Studies have shown the 2000 CDC reference to be superior to the 1978 NCHS reference because of the before-mentioned weaknesses in construction. One issue which has not been fully explored, however, is the increase in the prevalence of overweight that has occurred over the past generation in the reference population used to construct the 2000 CDC reference curves. Though increases in overweight are being observed worldwide, these changes are not uniform (Popkin 1994). A shift in body mass among the US reference population may result in relatively lower Z-scores from the 2000 CDC reference than other references. This paper uses cross-sectional data from three developing country populations to evaluate the effect of applying three different references for determination of WAZ, HAZ, and WHZ.

Methods:

Data for this study are drawn from previous studies among the Rendille, a now settled nomadic pastorialist group in northern Kenya, and the Bengali and Khasi of NE India. All anthropometrics were collected using standard techniques described by Gibson (1990) (for more information see Shell-Duncan and Obiero 2000; Leonetti, et al. 2005). For purposes of analysis, all data were truncated to include only those children who were 60 months of age or younger at the time their anthropometric measures were taken.

The anthropometric module of EPI INFO (version 3.3.2) was used to calculate sex-specific HAZ, WAZ, and WHZ based on the 1978 NCHS and the 2000 CDC reference data. Anthro 2005 software program (beta version, WHO) was used to calculate sex-specific HAZ, WAZ, and WHZ based on the the 2006 WHO reference data. Based on the methods of Moestue, et al. (2004), and to ensure measurement validity, children with Z-scores less than -6 or greater than +4 were excluded from the analysis for that particular Z-score. Mean HAZ, WAZ and WHZ were calculated for each reference and compared through ANOVA, using the Sidak test to adjust for multiple comparisons. The percent classified as stunted, underweight, or wasted were then calculated.

Children were considered stunted, underweight, or wasted if their corresponding Z-score was at least 2 standard deviations below the mean of the reference populations. Proportions of stunted, underweight and wasted for each reference were compared using chi squared tests.

Results and Implications:

For HAZ, the 2006 reference produced significantly lower Z-scores than the 1978 or 2000 references ($p<0.01$) (Table 1). The WHO standard is expected to produce HAZ that are greater at all ages given the manner in which it is constructed. We found that for WAZ and WHZ, the 2000 reference produced significantly lower Z-scores compared to the 1978 and 2006 references, illustrating the effect of increasing body mass in the 2000 US-based reference population (Table 1). Similarly, use of the 2000 reference shows a higher percentage of cases classified as underweight and wasted than either the 1978 or 2006 references (Table 2). Differences in the data distributions are shown in Figure 1. This shows substantial differences between the references resulting from measures of kurtosis and skewedness.

Conclusion:

Our findings suggest that the three references provide different estimations of standardized anthropometric measurements, that these differences vary according to which anthropometric measurement is being calculated, and that recent weight increases in the US reference population have impacted calculations of standardized anthropometric scores.

Table 1: Mean Z-scores for study population by reference.

	HAZ (N=2022)	WAZ (N=2022)	WHZ (N=1877)
1978	-2.06 (SD=1.71)	-1.65 (SD=1.29)	-0.59* (SD=1.28)
2000	-1.94 (SD=1.71)	-1.97* 9SD=1.610	-0.88* (SD=1.67)
2006	-2.25* (SD=1.80)	-1.56 (SD=1.34)	-0.44* (SD=1.46)

*differs from other references, $p<0.01$

Table 2: Percentage classified as stunted, underweight, and wasted by reference.

	Stunted	Underweight	Wasted
1978	36%	39 %	13%
2000	33%	43%	24%
2006	39%	16%	13%

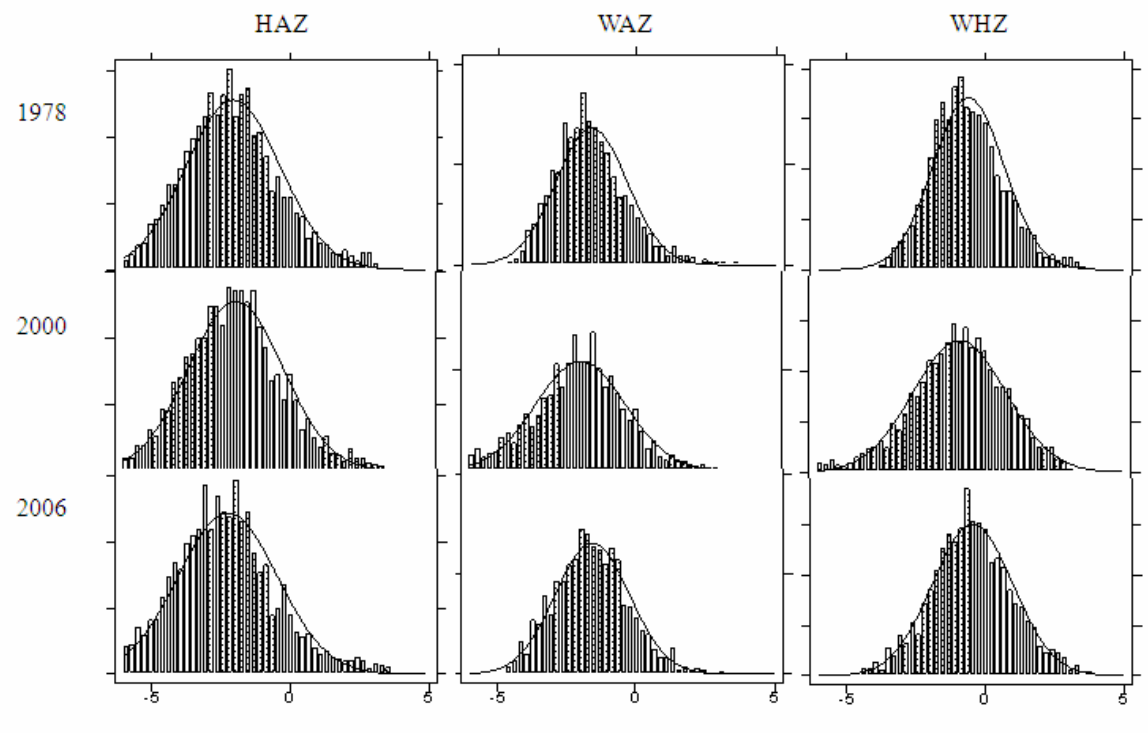

Figure 1: Distribution of Z-scores for study population by reference.

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