

Short Communication

Is the 2000 CDC growth reference appropriate for developing countries?

Dominique Roberfroid^{1,*}, Marie-Paule Lerude², Armando Pérez-Cueto¹ and Patrick Kolsteren¹

¹Department of Public Health, Nutrition Unit, Institute of Tropical Medicine, 155 Nationalestraat, B-2000 Antwerp, Belgium; ²Médecins du Monde, Brussels, Belgium

Submitted 21 April 2005; Accepted 23 August 2005

Abstract

In 2000, the Centers for Disease Control and Prevention (CDC) produced a revised growth reference. This has already been used in different settings outside the USA. Using data obtained during a nutritional survey in Madagascar, we compare results produced by using both the 2000 CDC and the 1978 National Center for Health Statistics (NCHS)/World Health Organization (WHO) growth references. We show that changing the reference has an important impact on nutritional diagnosis. In particular, the prevalence of wasting is greatly increased. This could generate substantial operational and clinical difficulties. We recommend continued use of the 1978 NCHS/WHO reference until release of the new WHO multi-country growth charts.

Keywords
Growth reference
2000 CDC
1978 NCHS/WHO
Wasting
Nutritional survey

Anthropometry is a widely used tool for research and operational decision-making. One of the corner-stones in translating the measurements into information is the availability of a reference dataset. Until recently, the 1978 National Center for Health Statistics (NCHS)/World Health Organization (WHO) growth reference (REF1) was commonly used. However, in 2000, the Centers for Disease Control and Prevention (CDC) proposed a revised version of the reference growth charts (REF2) based on more comprehensive national survey data and improved statistical smoothing procedures¹. Overall, the 2000 growth curves are quite similar to the 1978 ones and their use has been recommended by the CDC². The new growth reference, which can be found on the Internet (<http://www.cdc.gov/growthcharts/>) and in the widespread Epi-Info software program, has already been used in numerous settings outside the USA^{3,4}. However, use of the new growth reference for assessing the nutritional status of children in developing countries has an impact on the estimates of wasting and stunting. This is documented in the present communication.

Participants, methods and results

In August 2004, a nutrition survey was conducted in Maroantsetra health district in Madagascar by a non-governmental organisation (Médecins du Monde) to evaluate the needs of the population after the Gafilo cyclone. The sample included 969 children (49.9% males) aged 6–59 months (mean age 29.9 months; 95% confidence

interval: 29.0–30.8) in 30 clusters. The sampling and measurement procedures were based on international recommendations (<http://www.fantaproject.org/publications/anthropom.shtml>). Anthropometric indices (weight-for-height Z-score (WHZ), height-for-age Z-score (HAZ)) were computed using Epi-Info version 3.3.2 (February 2005 release; CDC, Atlanta, GA, USA) and the 1978 and 2000 growth references, alternatively, for comparison. The output was exported to Stata 8.0 (StataCorp, College Station, TX, USA). The paired *t*-test and the Wilcoxon matched-pairs signed-ranks test were used to compare anthropometric indices as continuous and categorical variables, respectively. Multivariable analysis of variance (ANOVA) was used to investigate if sex, age, wasting and stunting had an influence on the difference between 1978- and 2000-based WHZ and HAZ indices.

Children with WHZ <−4.00 or >6.00, and children with HAZ <−6.00 or >6.00, were considered outliers. Two outliers were removed from the original dataset. A further 10 values were missing for WHZ based on REF2 because of a software problem; i.e. when using the 2000 CDC growth reference, Epi-Info 3.3.2 does not define WHZ for children measuring less than 77.00 cm in non-recumbent position even if aged more than 24 months. Therefore, all computations based on WHZ include 955 records.

Use of the CDC reference yields a much more important proportion of wasted children than by the NCHS/WHO reference (12.2% vs. 3.2% respectively, Table 1). Some 9.5% (88/926) of normal children and 37.9% (11/29) of moderately malnourished children as assessed by REF1

*Corresponding author: Email droberfroid@itg.be

Table 1 Comparison of malnutrition indicators using the 1978 National Center for Health Statistics (NCHS)/World Health Organization (WHO) growth reference (REF1) and the 2000 Centers for Disease Control and Prevention growth reference (REF2)

Index	REF1				REF2				P-value
	n	Mean	%	95% CI	n	Mean	%	95% CI	
HAZ*	967	-1.62		(-1.69, -1.55)	967	-1.50		(-1.57, -1.42)	<0.00001†
Severe			9.5	(7.7, 11.5)			8.2	(6.5, 10.1)	
Moderate			26.3	(23.5, 29.2)			21.8	(19.2, 24.6)	
Normal			64.2	(61.1, 67.2)			70.0	(67.0, 72.9)	<0.000001‡
WHZ*	967	-0.59		(-0.64, -0.53)	955	-0.72		(-0.79, -0.65)	<0.00001†
Severe			0.1	(0.0, 0.6)			1.1	(0.6, 2.0)	
Moderate			3.1	(2.1, 4.4)			11.1	(9.2, 13.3)	
Normal			96.8	(95.5, 97.8)			87.7	(85.5, 89.8)	<0.00001‡

CI – confidence interval; HAZ – height-for-age Z-score; WHZ – weight-for-height Z-score.

* Severe = minimum to -3.01 standard deviations (SD); moderate = -3.00SD to -2.01SD; normal = -2.00SD to maximum.

† Paired t-test.

‡ Wilcoxon matched-pairs signed-ranks test.

are classified as moderately and severely malnourished by using REF2, respectively. ANOVA showed that four factors are independently associated with the difference in weight-for-height between the two references (expressed in Z-score): sex, age, weight-for-height and height-for-age. On average, the difference in WHZ between the two references is more important for females (-0.179 ± 0.27 vs. -0.099 ± 0.27 , $P < 0.0001$). The difference in WHZ between references is consistent from age 6 months to age 59 months in girls, although smaller during the second year of life (geometric mean: -0.119 ± 0.21 , $P < 0.0001$). For boys, age is not a significant factor. The more a child is wasted, the more the new reference tends to worsen the diagnosis ($P < 0.0001$, Fig. 1). The same relationship is valid for height-for-age ($P = 0.0006$), although not significant during the third and fourth year of life.

In contrast, for stunting, use of REF2 produces smaller proportions than with REF1 (Table 1). Thus 18.5% (17/92) and 24.0% (61/254) of children classified as severely and moderately stunted with REF1 are diagnosed as moderately stunted and not stunted according to REF2. ANOVA revealed three factors to be independently

associated with the HAZ difference between references: sex, age and height-for-age. The difference in HAZ is more important for females ($P < 0.00001$). The mean HAZ is on average lower with the 1978 NCHS/WHO reference, except during the third year of life ($P < 0.00001$, Fig. 2), and this is more accentuated for boys than for girls (P for interaction < 0.0001). Height-for-age also has an influence on the HAZ difference ($P < 0.00001$), but with no clear pattern because of an interaction with age and sex ($P < 0.00001$ for both interactions).

Comments

It has been demonstrated recently that the estimated prevalence of wasting in breast-fed infants is higher using the 2000 CDC growth reference⁵. Our findings demonstrate that this is also the case for children aged 6–59 months. Moreover, we show herein that the estimation of stunting prevalence also differs between the two references, the rate of stunting being lower with REF2. This is consistent with the results of another study⁶. Two factors could explain these differences: an improved methodology in establishing the new reference curves and changes in the anthropometry of the reference population, particularly an increase of the mean WHZ. Although some of these differences between the 1978 and the 2000 growth references are acknowledged by CDC, still the organisation encourages users to make the transition from the 1978 NCHS/WHO growth charts to the 2000 CDC growth charts². In our view, this is likely to generate substantial difficulties for clinicians and field operators committed to improving child health in developing countries. First, it would greatly increase the number of children to treat. In our study, using the 2000 CDC reference, the community diagnosis was alarming with 12.2% of wasted children in need of urgent nutrition rehabilitation. However, observations in the field did not give us the impression that so many children were clinically malnourished, and this is in agreement with the diagnosis based on the 1978 NCHS/WHO reference. Thus, utilisation of the 2000 CDC growth charts worldwide is likely to generate an over-

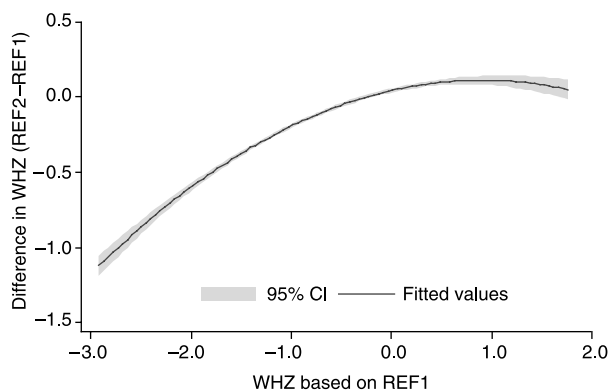


Fig. 1 Difference in weight-for-height Z-score (WHZ) between the two references (REF1 – 1978 National Center for Health Statistics (NCHS)/World Health Organization (WHO) growth reference; REF2 – 2000 Centers for Disease Control and Prevention growth reference) according to WHZ based on REF1: fitted values and 95% confidence interval (CI)

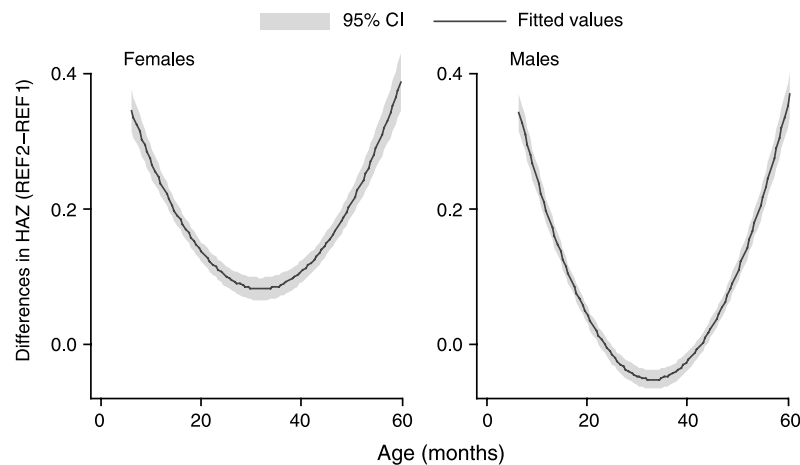


Fig. 2 Difference in height-for-age Z-score (HAZ) between the two references (REF1 – 1978 National Center for Health Statistics (NCHS)/World Health Organization (WHO) growth reference; REF2 – 2000 Centers for Disease Control and Prevention growth reference) according to age, by sex: fitted values and 95% confidence interval (CI)

consumption of health services by not truly undernourished children, and hence dilute the efforts for those in most need. Second, morbidity and mortality due to malnutrition have been established in reference to the NCHS/WHO growth charts, but little is known about the clinical significance of malnutrition as defined by the new reference⁷. Important questions remain. Are heavier US children necessarily healthier than children whose measurements were used in the 1978 reference? What are the health risks for children classified as malnourished by the new reference? These questions could be addressed by using the new values of cut-off points defining malnutrition in secondary analysis of existing datasets. Third, little is known about the appropriateness of the current recommendations for malnutrition management⁸ when applied to children diagnosed as malnourished by the new CDC reference. The same question arises for nutritional advice to be shared with caregivers.

Our analysis shows that changing the reference has important implications. In particular, it could increase greatly the burden of acute malnutrition management for families and health services. Finding a growth reference that could be universally appropriate seems difficult and we have no tools to evaluate which reference captures reality best. However, WHO is currently working on producing a new multi-country growth reference⁹. These new charts, including populations where breast-feeding is prevalent, could be a more appropriate reference for clinical practice and population-based activities in the developing world. Until these new charts come out, we advise continued use of the 1978 NCHS/WHO growth reference.

Acknowledgements

Conflict of interest: None declared.

Contributors: D.R., P.K. and M.-P.L. were responsible for study design. M.-P.L. organised the fieldwork and data

collection. D.R. undertook the analysis and drafted the paper. P.K. and A.P. critically reviewed the manuscript.

Acknowledgement: We thank Médecins du Monde, Belgium, for allowing secondary analysis of their survey results.

References

- Ogden CL, Kuczmarski RJ, Flegal KM, Mei Z, Guo S, Wei R, *et al.* Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version. *Pediatrics* 2002; **109**(1): 45–60.
- Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, *et al.* 2000 CDC Growth Charts for the United States: methods and development. *Vital and Health Statistics* 2002; **11**(246): 1–190.
- Goldstein A, Haelyon U, Krolik E, Sack J. Comparison of body weight and height of Israeli schoolchildren with the Tanner and Centers for Disease Control and Prevention growth charts. *Pediatrics* 2001; **108**(6): E108.
- Hasan MA, Batiha A, Jadou H, Khawaldeh AK, Ajlouni K. Growth status of Jordanian schoolchildren in military-funded schools. *European Journal of Clinical Nutrition* 2001; **55**(5): 380–6.
- De Onis M, Onyango AW. The Centers for Disease Control and Prevention 2000 growth charts and the growth of breastfed infants. *Acta Paediatrica* 2003; **92**(4): 413–9.
- Eckhardt CL, Adair LS. Differences in stunting prevalences calculated from two similar growth references may be large and inconsistent in undernourished children. *Annals of Human Biology* 2002; **29**(5): 566–78.
- Rice AL, Sacco L, Hyder A, Black RE. Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. *Bulletin of the World Health Organization* 2000; **78**(10): 1207–21.
- World Health Organization (WHO). *Management of Severe Malnutrition: A Manual for Physicians and Other Senior Health Workers*. Geneva: WHO, 1999; 72.
- De Onis M, Garza C, Habicht JP. Time for a new growth reference. *Pediatrics* 1997; **100**(5): E8.