Implications of adopting the WHO 2006 Child Growth Standards: case study from urban South Africa, the Birth to Twenty cohort

Introduction

In 2006 the World Health Organisation (WHO) published growth charts to replace and address the limitations of the 1977 National Centre for Health Statistics (NCHS) and 2000 Centre for Disease Control (CDC) growth references (Hamil et al. 1979; Hediger et al. 2000; Kuczmarski et al. 2002; de Onis and Onyango 2003; Butte et al. 2007; de Onis et al.2007). The WHO Multicentre Growth Reference Study (MGRS), a population-based multicountry project, was designed to develop new growth references for infants and children up to the age of 5 years. MGRS collected data from 8,500 children across six countries (Brazil, Ghana, India, Norway, Oman and USA) living in socioeconomic conditions favourable to growth (i.e. no known health or environmental constraints to growth and where morbidity was low, exclusive or predominant breast-feeding for at least 4 months, introduction of complementary foods by 6 months of age and continued breastfeeding to at least 12 months of age, no maternal smoking before and after delivery, term birth of a singleton, and the absence of significant morbidity) (de Onis et al. 2004; de Onis et al. 2007). The authors of the WHO 2006 believe these *references* are indeed *standards* and provide information on "how children should grow", rather than on "how children are growing" (Butte et al. 2007). To understand the implications of adopting WHO 2006 in South Africa for growth monitoring and public health, we examine how well urban South African children match to, or diverge from, WHO 2006 in comparison with NCHS and CDC references using growth data from the 1990 Birth to Twenty cohort (Bt20).

Subjects and methods

The enrolment methods, attrition, and profile of the Bt20 cohort have been well documented in several publications (Yach et al 1991; Norris et al 2007; Richter et al 2007). In summary, Bt20 enrolled 3273 mother-child pairs (60% of all births that occurred over a 7 week period between April and June in 1990) that fulfilled the criteria of a singleton birth and continued residence within the metropolitan area of Johannesburg/Soweto (South Africa) for at least 6 months after the birth of the child. The primary aim of the study was to track growth, health, and wellbeing across the life course. The cohort is predominantly Black children (79%), and after 18 years the study is still in contact with 70% of the cohort.

Birth weight was retrieved from maternity records and growth (length/height and weight) of the participants was assessed on four occasions between birth and age 5 years (6-months, 12-months, 24-months and 60-months) using standard techniques (Cameron 1998). For the first set of analyses, data from 2788 (50.6% female) full term and normal birthweight infants were used. For each child, age and sex-adjusted Z-scores for weight, height (length < 2 years old) and weight-for-height were calculated using NCHS, CDC and WHO 2006 growth references. However, not all participants were measured at every time point. Therefore, the analytical sample is a mixed cross-sectional/longitudinal sample. Relative risks and confidence intervals were generated to compare stunting (<2 Z-score height-for-age), wasting (<2 Z-score weight-for-height), and overweight (>2 Z-score weight-for-age) classifications between NCHS and WHO 2006. NCHS was selected as the reference category as it is commonly applied in South African clinics. Ethical approval was

obtained from the University of the Witwatersrand Committee for Research on Human Subjects.

Results

Figure 1 graphically depicts the changes in mean Z-scores for weight-for-age, height-for-age and weight-for-height over the first 5 years of life of the children enrolled in the Bt20 study. The WHO 2006 pattern of weight-for-age Z-score change was different to those of NCHS and CDC, particularly over the first 24-months. The pattern of height-for-age Z-score change was similar across all three growth references, except that the mean Z-score values using WHO 2006 were noticeably lower at 24 and 60 months of age as compared to NCHS and CDC. The WHO 2006 pattern of weight-for-height Z-scores was significantly different to those of the NCHS and CDC with mean values above the median of the reference population, whereas the CDC and NCHS values were below the median at 24 months. Furthermore, WHO 2006 values were considerably higher at the 12 and 24 month assessment.

[INSERT FIGURE 1 HERE]

The prevalence of stunting at all ages using the WHO 2006 growth references was noticeably higher than those generated using the NCHS and CDC (ranged from 7.8% at 12 months to 26.5% at 24 months of age), and therefore, infants were more likely to be classified as stunted (relative risk of being classified as stunted ranged from 1.20 to 1.64 when compared to NCHS; Table I). The prevalence of underweight when applying WHO 2006 varied across the age range with a higher chance of being classified as underweight at 60 months (relative risk of being classified as underweight of 1.94 when compared to NCHS; Table I), no difference at 6 and 12 months, and a lower chance of being classified as underweight at 24 months

(relative risk 0.51), and the prevalence of wasting significantly differed at 6 and 60 months (relative risk of being classified as wasted of 5.17 and 2.57 respectively when compared to NCHS, Table I). The prevalence of overweight was higher at all ages, except at 60 months, than the rates generated using the NCHS growth references (relative risk of being classified as overweight ranged from 1.33 to 1.42 when compared to NCHS; Table I).

[INSERT TABLE 1 HERE]

Discussion

Given the critical aim of WHO 2006 to define growth in an unconstrained environment, an environment in which growth is not adversely affected, meant that when all the selection criteria were applied only 17% of all those participants screened were included (i.e. 83% of infants, over 13000, were excluded) into the longitudinal analytical study sample of the WHO 2006 reference (birth to two years). Furthermore, only 31% of all the children surveyed older than 2 years were included into the cross-sectional analytical study sample component. Therefore, we should not expect growth data to fit the different references as if they were one and the same tool. Indeed, as reflected by our study results, the WHO 2006 does behave differently from the NCHS and CDC, but not from what one would expect given that Bt20 is a cohort in a developing country not selected on the basis of unconstrained growth.

Based on the Bt20 case study (urban Johannesburg/Soweto, HIV negative at birth), the adoption of WHO 2006 for contemporary South African children from birth to 5 years would have a significant impact on the interpretation of their nutritional status. It increases the possibility of classifying children as stunted, overweight,

and/or wasted, and would likely do this to a greater extent in rural South African settings and for HIV positive children. The higher stunting rates have also been documented in a secondary analysis of data from Bangladesh, Dominican Republic and a pooled sample of infants from North America and Northern Europe to compare growth from birth to 12 months using NCHS, CDC and WHO 2006 (de Onis et al. 2006; de Onis et al. 2007). On the individual level, adopting WHO 2006 may well provide a more sensitive benchmark to monitor and optimise infant/child growth, but clinicians may argue that they observe rates of growth and tracking to investigate growth faltering, changing from NCHS to WHO 2006 may make little change to individual infant/child care. This may not necessarily be the case when applying a *standard* (the WHO 2006 growth charts are defined as such by the authors of the charts) as opposed to a growth *reference*, for greater intervention may be necessary to optimise growth (for example monitoring infant feeding, nutrition education and supplementation, and screening for any underlying morbidity or endocrine complications). Indeed, it is in this that significant challenges arise. Firstly, public health care clinics in South Africa often only measure and monitor weight and do not consistently measure height and important anthropometric indicators such as mid-upper arm circumference (MUAC), especially as WHO plans to release MUAC-for-age curves. Consequently, an enormous education campaign is needed to inform clinicians, clinic nursing staff, public health practitioners, and parents what the difference is between a growth reference and standard, and how one implements and interprets the results from standards. Secondly, how best to optimise growth and what are the best interventions to apply to different scenarios that can be clearly communicated to and consistently applied by health service providers is a challenge. Thirdly, no current research exists in South Africa to evaluate the impact of how

changing over to WHO 2006 will affect caseloads and public health care costs. On a practical level, commonly used growth cards (e.g. Road to Health cards in South Africa) will need to be redrawn and adequately distributed and the old growth cards discontinued. This process may not be particularly disruptive, difficult or costly, but there are economic and resource costs that the Department of Health will bear to successfully educate, train and implement the WHO 2006 “standard” on the individual level.

At the community and national level, adopting WHO 2006 will have an impact as the prevalence of stunting and/or overweight will change significantly. Any public health policy, such as those linked to the Millennium Development Goals and national target programme to combat undernutrition, that relies on longitudinal data to measure health indices (for example: stunting) will potentially conclude erroneous changes in prevalence unless previous data are converted to WHO standards. Careful attention is needed to either continue with NCHS or apply WHO 2006 to historical data. Similarly, on an international level, making comparisons across countries will be impeded unless standardization of growth references/standards is implemented. In transitional populations, where stunting and obesity can both be present and both pose particular public health challenges, avoidance of stunting is important as it will bring health, educational and economic benefits. However, the risk of targeting public health concerns to reduce stunting may inadvertently result in an increased risk of obesity and its concomitant health risks.

Even though this study is of a single urban population, it does provide data to highlight key challenges and research gaps that need to be addressed around the adoption of WHO 2006 in South Africa. The question still exists as to whether these charts should be adopted as standards and what are the implications for how the

charts are used and applied in South Africa? Adequate discourse on the impact of this adoption on the primary health care system and public health monitoring in South Africa is needed and sufficient planning by the Department of Health around not only the implementation, but also comparability with historical malnutrition data and long-term monitoring and evaluation is essential.

Acknowledgements

The Birth to Twenty Research Programme is funded by the Wellcome Trust (UK), Human Sciences Research Council (South Africa), University of the Witwatersrand, Johannesburg, Medical Research Council (South Africa), South African Netherlands Programme on Alternative Development, and the National Research Foundation (South Africa). Norris is supported by a Wellcome Trust (UK) research fellowship, and Griffiths is supported by an MRC, UK grant (grant id 70363).

References

Butte NF, Garza C, de Onis M. 2007. Evaluation of the feasibility of international growth standards for school-aged children and adolescents. J Nutr 137:153-57.

Cameron N, De Wet T, Ellison GT, Bogin B. 1998. Growth in height and weight of South African urban infants from birth to five years: The Birth to Ten study. Am J Hum Bio 10: 495-504.

de Onis M, Onyango AW. 2003. The Centres for Disease Control and Prevention 2000 growth charts and the growth of breast-fed infants. Acta Paediatr. 92:413-9.

de Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J. 2004. The WHO multicentre growth reference study: planning, study design, and methodology. Food Nutr Bulletin 25:S15-S26.

de Onis M, Onyango AW, Borghi E, Garza C, Yang H, WHO Multicentre Growth Reference Study Group. 2006. Comparison of the World Health Organization (WHO) child growth standards and the National Centre of Health Statistics/WHO international growth reference: implication for child health programmes. Public Health Nutr 9:942-7.

de Onis M, Garza C, Onyango AW, Borghi E. 2007. Comparison of the WHO child growth standards and the CDC 2000 growth charts. J Nutr 137:144-148.

Hamil PVV, Drizd TA, Johnson CL, Reed RB, Roche AE, Moore WM. 1979. Physical growth: national centre for health statistics percentiles. Am J Clin Nutr 32:607-29.

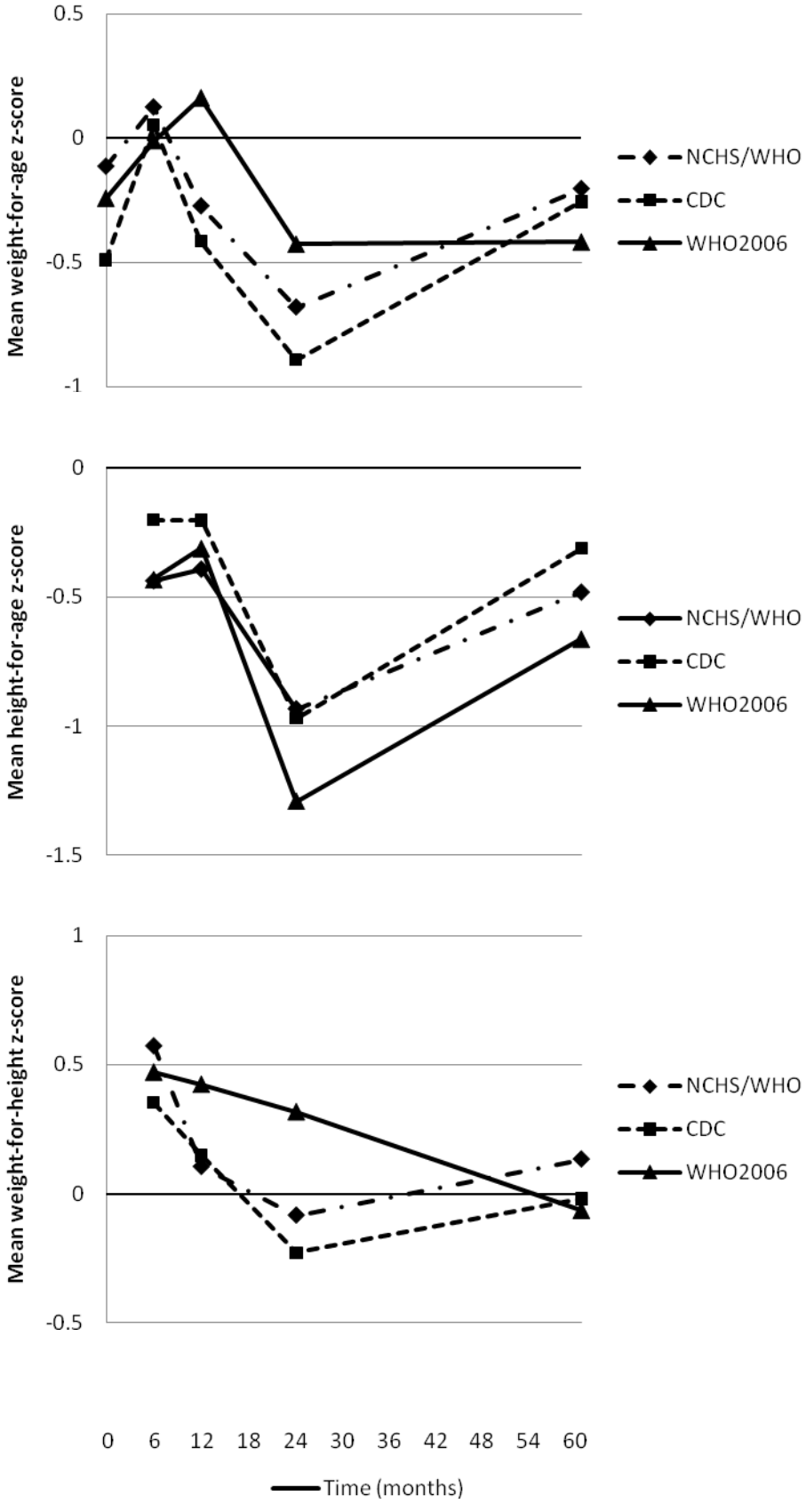
Hediger ML, overpeck MD, Ruan WJ, Troendle JF. 2000. Early infant feeding and growth status of US-born infants and children aged 4-17 mo: analyses from the first National Health and Nutrition Examination Survey, 1988-1994. Am J Clin Nutr 72:159-67.

Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF, Johnson CL. 2002. CDC growth charts for the United States: methods and development. Vital Health Stat 246:1-190.

Norris SA, Richter LM, Fleetwood SA. (2007). Panel studies in developing countries: case analysis of sample attrition over the past 15 years within the Birth to Twenty cohort in Johannesburg, South Africa. J Int Develop 19:1143-150.

Richter LM, Norris SA, Pettifor JM, Yach D, Cameron N. (2007). Mandela's children: The 1990 Birth to Twenty study in South Africa. Int J Epi 36: 1-8.

Yach D, Cameron N, Padayachee N, Wagstaff L, Richter LM, Fonn S. (1991). Birth to Ten: Child health in South Africa in the 1990's. Rationale and methods of a birth cohort study. Paed Perinat Epi 5: 211-233.


0.5
0
-0.5
-1
Mean weight-for-age z-score
NCHS/WHO
CDC
WHO2006
0
-0.5
-1
-1.5
Mean height-for-age z-score
NCHS/WHO
CDC
WHO2006
1
0.5
0
-0.5
Mean weight-for-height z-score
NCHS/WHO
CDC
WHO2006
0 6 12 18 24 30 36 42 48 54 60
Time (months)

Legend Figure 1

Mean Z-scores for (a) weight-for-age, (b) height-for-age, and (c) weight-for-height from birth to 60 months of age according to the NCHS 1977 (diamond and dashed lines) and CDC 2000 (square and dashed lines) growth references, and the WHO 2006 growth standards (triangle and solid lines).

Table 1. Prevalence of malnutrition according to anthropometric norm systems, Z-scores, Birth to Twenty, Johannesburg/Soweto, South Africa (1990-1996; full-term; normal birth weight children).

	Growth Reference			Relative risk of being classified according to WHO 2006 as compared to NCHS 1977 (95% CI)
	NCHS 1977	CDC 2000	WHO 2006	
Stunting				
6-months (n=623)	10.8%	8.3%	15.0%	**1.39 (1.03-1.86)**
12-months (n=1221)	6.5%	4.2%	7.8%	1.20 (0.90-1.60)
24-months (n=997)	17.3%	15.5%	26.5%	**1.42 (1.19-1.69)**
60-months (n=1162)	5.6%	3.2%	9.1%	**1.64 (1.22-2.20)**
Underweight				
6-months	2.1%	3.2%	3.7%	1.77 (0.90-3.46)
12-months	7.5%	4.2%	7.8%	1.03 (0.78-1.36)
24-months <-2 Z-score	17.9%	24.5%	8.7%	**0.51 (0.40-0.64)**
60-months <-2 Z-score	2.9%	3.9%	5.7%	**1.94 (1.29-2.91)**
Wasting				
6-months	2.0%	7.6%	10.0%	**5.17 (2.81-9.49)**

12-months	3.7%	5.8%	3.0%	0.82 (0.54-1.26)
24-months	6.6%	14.1%	6.5%	0.99 (0.71-1.37)
60-months	0.6%	2.9%	1.7%	**2.57 (1.08-6.13)**
Overweight				
6-months	17.2%	15.2%	24.4%	**1.42 (1.14-1.77)**
12-months	7.5%	7.1%	10.0%	**1.33 (1.02-1.72)**
24-months	6.1%	6.6%	12.0%	**1.46 (1.46-2.64)**
60-months	3.5%	0.9%	1.3%	**0.37 (0.20-0.66)**