

Implications of the use of the new WHO growth charts on the interpretation of malnutrition and obesity in infants and young children in Oman

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تأثيرات استخدام مخططات النمو الجديدة لمنظمة الصحة العالمية على تفسير سوء التغذية والبدانة بين الرضع وصغار الأطفال في عُمان
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المخالصة: قد درس الباحثان الاختلافات في تقديرات معدلات الانتشار لمؤشرات الحصائل في كل من المرجع المعياري لقياس نمو الأطفال ومرجع المركز الوطني للإحصائيات الصحية/ منظمة الصحة العالمية مستخدمين مجموعة معطيات مستمدة من مسح سوء التغذية للبروتين والطاقة. واستناداً إلى مرجع منظمة الصحة العالمية/ المركز الوطني للإحصاءات الصحية كانت التقديرات الإجمالية لمعدل انتشار نقص الوزن 17.8% وللدهال 7.4% وللتقزم 10.9% ولفرط الوزن 1.3%. بينما بلغت هذه التقديرات الإجمالية، وفقاً للمرجع القياسي لنمو الأطفال لمنظمة الصحة العالمية لعام 2006، لنقص الوزن 11.3% وللدهال 7.6%، وللتقزم 13.0% ولفرط الوزن 1.9%. وقد أظهر التقزم وفرط الوزن تقديرات أعلى بشكل يعتد به إحصائياً، فيما كان تقدير نقص الوزن أقل بشكل يعتد به إحصائياً أيضاً. ولم تكن هذه الفروق متسقة عبر مجموعات الأعمار.

ABSTRACT We examined the difference in the prevalence estimates of the outcome indicators for the new World Health Organization (WHO) child growth standard reference (WHO 2006) and the National Center for Health Statistics (NCHS)/WHO reference using the National Protein–Energy Malnutrition Survey dataset. Based on the NCHS/WHO reference, overall prevalence estimates of underweight, wasting, stunting and overweight were 17.8%, 7.4%, 10.9% and 1.3% compared to 11.3%, 7.6%, 13.0% and 1.9% respectively calculated according to the WHO 2006 reference: stunting and overweight showed statistically significantly higher estimates, whereas underweight was statistically significantly lower. The differences were not consistent across age groups.

Impact de l'utilisation des nouvelles courbes de croissance de l'OMS sur l'interprétation de la malnutrition et de l'obésité chez le nourrisson et le jeune enfant à Oman

RÉSUMÉ Nous avons examiné la différence entre les estimations de prévalence associées aux indicateurs de résultats pour les nouvelles normes OMS de croissance de l'enfant (WHO Anthro) et la référence du *National Center for Health Statistics* (NCHS)/de l'OMS, en utilisant l'ensemble de données de l'enquête nationale sur la malnutrition protéino-énergétique. D'après la référence NCHS/OMS, les estimations de la prévalence globale de l'insuffisance pondérale, de l'émaciation, du retard de croissance et du surpoids étaient de 17,8 %, 7,4 %, 10,9 % et 1,3 %, contre respectivement 11,3 %, 7,6 %, 13,0 % et 1,9 % d'après la référence WHO Anthro : s'agissant du retard de croissance et du surpoids, les estimations étaient significativement plus élevées d'un point de vue statistique, mais moins en ce qui concerne l'insuffisance pondérale. Les différences n'étaient pas homogènes dans tous les groupes d'âge.

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Introduction

Growth charts are used universally in paediatric care for growth monitoring of infants and young children [1], as well as for research and the promotion of child health in the community. The development of an internationally accepted tool for growth monitoring was initiated in 1995 by the World Health Organization (WHO) working group following an evaluation of infant growth. The group recommendation was to develop a new reference that takes into account socioeconomic factors and child feeding as well as maternal nutrition and health status [2–5]. A multi-centre study was initiated by WHO and involved Brazil, Ghana, India, Norway, Oman and the United States of America, and the new WHO reference was published in April 2006 [6]. The transition from the National Center for Health Statistics (NCHS)/WHO charts [7] to the WHO 2006 child growth charts should be accompanied by appropriate training that will equip policy-makers and public health workers with the skills necessary for adequate interpretation of the new curves. In addition, it is necessary to understand the implications on child growth parameters and resultant public health actions.

Background and rationale

In Oman, protein–energy malnutrition (PEM) indicated by weight-for-age, fell from 62.9% among children below the age of 5 years in 1980 to 24.4% in 1992 and remained at that level over the next few years (it was 23.6% in 1995) [8–10]. The National PEM Survey carried out in 1999 showed a prevalence of 17.9%, with no significant difference between males and females [11]. On average, underweight decreased by about 2.4% per year from 1980 to 1999, mostly during the first 12 years. De Onis et al. compared the results of the 1995 Oman

Family health Survey and Mussaigher's 1992 study, and observed that the annual rate of decrease in stunting was about 1% [12], a trend that continued until 1999.

Since then, several interventions have been implemented to control PEM in Oman, including early screening and management of cases, a social marketing campaign and the introduction of the complementary feeding policy as well as the adoption of the WHO global strategy for infant and young child feeding [13].

The prevalence of overweight was 0.6% over all age groups in the national PEM survey 1999 [11]. Overweight was not perceived as a public health problem in these age groups at the time in view of the low prevalence estimates. However, recent evidence suggests a worldwide increase in obesity among children, and prevention strategies need to be considered [14].

The launching of the new WHO reference poses a question regarding the magnitude of the impact of the current interventions in Oman, and probably in many parts of the world where child malnutrition exists. With the emergence of the obesity epidemic, it also raises the question of the validity of current estimates of obesity among infants and young children.

Our objective was to compare the overall prevalence estimates of underweight, stunting and wasting, as well as overweight and obesity, using the NCHS/WHO and WHO 2006 references. This would allow a greater understanding of the expected change in prevalence estimates in PEM, i.e. how much of the change was real and how much was due to the reference used. We also investigated the age-specific differences and standard deviations and examined the implications of those differences on the interpretation and programme management of infant and young child nutrition.

Methods

Raw data from the national PEM study in Oman [11] were compared for the NCHS/WHO and the new WHO 2006 growth references using WHO *Anthro* software to determine the difference in the prevalence estimates generated for malnutrition and obesity. Data collection was carried out in 1999 on a representative sample of 16 000 infants and young children in Oman. The sample was selected from the total population of children aged 0–5 years in the child health registers of primary health care institutions in Oman. The sample was drawn 2 weeks before data collection to ensure adequate sampling of infants aged under 1 month. Sample selection, data collection and analysis have been described previously [11].

The z-scores of weight-for-age, height-for-age, and weight-for-height were created in *Anthro 2005* based on the NCHS/WHO and the WHO 2006 reference populations independently; the files were then exported to *SPSS*, version 14.0, and merged to carry out data analysis.

Data analysis was performed using the complex samples crosstabs; descriptives and logistic regression procedures in *SPSS* to generate the prevalence estimates, means and confidence intervals and to calculate whether the prevalence estimates were significantly different for the NCHS/WHO and WHO 2006 estimates.

Results

The overall mean weight-for-age z-score was -0.98 [95% confidence interval (CI): -1.03 , -0.92] calculated according to the NCHS/WHO reference compared to -0.82 (95% CI -0.87 , -0.77) with WHO 2006 (Table 1). The prevalence estimates for underweight (weight-for-age < -2 z-scores)

are illustrated in Table 2; the overall prevalence was 17.8% using NCHS/WHO compared to 11.3% based on WHO 2006; this difference was statistically significant ($P < 0.01$). Underweight according to WHO 2006 was statistically significantly greater for age group 0–5 months; and lower for all other groups. There was no statistically significant difference between males and females.

The mean height-for-age z-scores for WHO 2006 was -0.78 (95% CI: -0.84 , -0.72) and for NCHS/WHO it was -0.64 (95% CI: -0.69 , -0.58) (Table 3).

The prevalence of stunting (height-for-age < -2 z-scores) calculated using both references is shown in Table 2. The overall stunting based on the WHO 2006 reference was 13.0% compared 10.9% according to the NCHS/WHO reference. The peak of the estimates based on the WHO 2006 reference was for age group 24–35 months, 16.4% (95% CI: 13.2, 20.1), whereas it was highest for age group 12–23 months using the NCHS/WHO reference, 18.6% (95% CI: 16.9, 20.4). The WHO 2006 reference generated higher stunting prevalence estimates overall and in all age groups except 12–23 months. These difference were statistically significant ($P < 0.05$).

The mean weight-for-height z-scores for WHO 2006 was -0.55 (95% CI: -0.59 , -0.51) and for NCHS/WHO it was -0.69 (95% CI: -0.74 , -0.66) (Table 4).

The difference in the prevalence estimates for wasting (weight-for-height < -2 z-scores) overall was not statistically significant: 7.6% according to the WHO 2006 reference compared to 7.4% according to the NCHS/WHO reference ($P = 0.92$) (Table 2). The prevalence was statistically significantly higher according to the WHO 2006 reference for age groups 0–5 months (3.6%–10.2%) and 48–60 months (5.4%–7.3%) ($P < 0.01$). The prevalence for

Table 1 Mean z-scores of weight for age according to the WHO/NCHS and WHO 2006 references for a sample of Omani children aged of 0–60 months

Age (months)	No.	Mean z-score	SE	95% CI (min, max)
<i>0–5</i>				
NCHS/WHO	1 371	0.35	0.05	0.25, 0.46
WHO 2006	1 371	–0.14	0.06	–0.26, –0.02
<i>6–11</i>				
NCHS/WHO	1 455	–0.54	0.03	–0.59, –0.43
WHO 2006	1 455	–0.37	0.03	–0.43, –0.31
<i>12–29</i>				
NCHS/WHO	2 497	–1.09	0.04	–1.18, –1.00
WHO 2006	2 497	–0.67	0.04	–0.76, –0.59
<i>24–35</i>				
NCHS/WHO	2 716	–1.19	0.04	–1.28, –1.10
WHO 2006	2 716	–0.95	0.04	–1.04, –0.86
<i>36–47</i>				
NCHS/WHO	2 644	–1.21	0.05	–1.31, –1.12
WHO 2006	2 644	–1.06	0.05	–1.15, –0.97
<i>48–60</i>				
NCHS/WHO	2 706	–1.16	0.02	–1.21, –1.10
WHO 2006	2 706	–1.06	0.03	–1.11, –1.00
<i>Total</i>				
NCHS/WHO	13 389	–0.98	0.03	–1.03, –0.92
WHO 2006	13 389	–0.82	0.02	–0.87, –0.77

SE = standard error; CI = confidence interval.

age group 12–23 months was significantly lower using the WHO 2006 reference, 12.6%, compared to 7.7% for the NCHS/WHO reference ($P < 0.01$).

We compared the prevalence estimates for overweight/obesity based on the weight-for-height z-scores ($> +2$ standard deviations) (Table 2) and found that, although prevalence was low for both references, the difference was statistically significant for the overall sample, 1.9% for the WHO 2006 reference compared to 1.3% for the NCHS/WHO ($P < 0.01$). From age 12 months on, the WHO 2006 reference consistently generated higher prevalence estimates. The differences were statistically significant ($P < 0.01$).

Discussion

Growth charts are used almost universally in paediatric care: 68% of the countries of the world used the NCHS/WHO standard as a reference in 2004 [15]. The trend is supported by the realization of the nutrition and medical community that child growth, along with such indicators as per capita gross domestic product and the human development index, is the gold reference for measuring human development [16].

Poor growth in children is associated with child morbidity and mortality as well as chronic diseases in adulthood. A synergistic relationship seems to exist between infection and faltered growth; moreover

Table 2 Comparison of prevalence estimates calculated according to WHO 2006 and NCHS/WHO references for wasting, stunting, underweight and overweight across age-groups for a sample of Omani children aged 0–60 months

Age (months)	No.	WHO 2006		NCHS/WHO		P-value
		< -2 SD (%)	95% CI	< -2 SD (%)	95% CI	
Underweight (weight for age)						
0–5	1 394	5.8	4.7–7.2	1.9	1.6–2.4	< 0.01
6–11	1 467	5.3	4.3–6.7	6.4	5.2–7.7	0.99
12–23	2 789	9.7	7.7–12.2	27.7	25.3–30.2	< 0.01
24–35	2 723	13.5	10.8–16.8	20.3	16.7–24.4	< 0.01
36–47	2 657	14.9	12.4–17.7	19.2	16.2–22.6	0.65
48–60	2 702	12.3	10.6–14.4	16.4	14.0–19.1	< 0.01
Total	13 861	11.3	10.2–12.6	17.8	16.2–19.4	< 0.01
Wasting (weight for height)						
0–5	1 410	10.2	7.9–13.0	3.6	2.0–6.3	< 0.01
6–11	1 508	4.5	2.9–6.9	3.3	2.1–5.3	0.89
12–23	2 800	7.7	6.0–9.7	12.6	10.6–15.0	< 0.01
24–35	2 759	6.7	5.5–8.2	6.8	5.7–8.1	0.99
36–47	2 691	9.3	7.5–11.4	8.1	6.7–9.9	0.89
48–60	2 822	7.3	6.3–8.4	5.4	4.5–6.4	< 0.01
Total	14 119	7.6	7.0–8.3	7.4	6.6–8.2	0.92
Stunting (height for age)						
0–5	1 394	4.5	3.4–5.9	2.2	1.7–2.9	< 0.01
6–11	1 474	7.3	5.6–9.6	5.6	3.8–8.2	0.99
12–23	2 789	13.6	12.2–15.0	18.6	16.9–20.4	< 0.01
24–35	2 738	16.4	13.2–20.1	9.0	6.9–11.6	< 0.01
36–47	2 663	15.6	13.4–18.1	10.3	8.0–13.2	< 0.01
48–60	2 718	12.8	10.6–15.4	11.4	9.4–13.9	< 0.01
Total	13 905	13.0	11.8–14.3	10.9	9.9–11.8	< 0.01
Overweight^a (weight for height)						
0–5	1 412	2.5	1.3–4.7	2.6	1.4–4.9	1.00
6–11	1 508	4.0	3.2–4.9	4.1	3.3–5.2	1.00
12–23	2 808	1.3	1.0–1.8	0.8	0.6–1.2	< 0.01
24–35	2 762	1.1	0.8–1.5	0.4	0.3–0.5	< 0.01
36–47	2 699	2.3	0.9–5.5	1.3	0.7–2.5	< 0.01
48–60	2 825	1.6	0.9–3.0	0.9	0.4–1.7	< 0.01
Total	14 144	1.9	1.3–2.8	1.3	1.0–1.8	< 0.01

^a> +2 SD.

SD = standard deviation; CI = confidence interval.

a reduction of low weight-for-age by 5% could reduce childhood mortality by 30% [17–19].

Malnutrition, indicated by poor growth during infancy, is associated with increased risk of ischaemic heart disease; this rela-

tionship is corroborated with findings from developing countries [20,21]. It is therefore important to monitor the nutrition situation of children on both sides of the growth curve. Our results indicate that overall reported prevalence estimates of underweight

Table 3 Mean z-scores of height-for-age calculated according to the WHO/NCHS and WHO Anthro references for a sample of Omani children at the age of 0–60 months across age groups

Age (months)	No.	Mean z-score	SE	95% CI (min, max)
<i>0–5</i>				
NCHS/WHO	1 371	0.29	0.07	0.16, 0.43
WHO 2006	1 371	0.29	0.07	0.12, 0.46
<i>6–11</i>				
NCHS/WHO	1 455	–0.32	0.03	–0.38, –0.25
WHO 2006	1 455	–0.24	0.04	–0.31, –0.16
<i>12–23</i>				
NCHS/WHO	2 496	–0.75	0.04	–0.82, –0.25
WHO 2006	2 496	–0.75	0.04	–0.31, –0.16
<i>24–35</i>				
NCHS/WHO	2 716	–0.59	0.06	–0.71, –0.48
WHO 2006	2 716	–0.99	0.06	–1.11, –0.09
<i>36–47</i>				
NCHS/WHO	2 644	–0.80	0.03	–0.87, –0.74
WHO 2006	2 644	–1.04	0.03	–1.10, –0.97
<i>48–60</i>				
NCHS/WHO	2 706	–0.93	0.05	–1.02, –0.83
WHO 2006	2 706	–1.03	0.05	–1.13, –0.94
<i>Total</i>				
NCHS/WHO	13 388	–0.64	0.03	–0.69, –0.58
WHO Anthro	13 388	–0.78	0.03	–0.84, –0.72

SE = standard error; CI = confidence interval.

will drop significantly for children under 5 years; but higher estimates should be reported for children under 6 months old. A global decline in malnutrition is anticipated but an increase in obesity rates has also been observed in both developed and developing countries. Many countries are witnessing the coexistence of both problems although obesity rates are seldom reported as part of child nutrition outcomes [22,23].

As indicated from our results, the NCHS/WHO reference consistently underestimated stunting among most age groups and in the overall population of children aged 0–60 months, which implies that higher rates of stunting will be reported as countries adopt the new standard.

The reported prevalence estimates of wasting should not differ significantly as a result of adopting the new growth charts, however, children in the age group 0–5 months will show higher estimates. For populations with higher rates of overweight than Oman, the reported estimates are expected to increase using the new reference.

Countries that choose to change the standards used from the NCHS/WHO to the WHO 2006 will require significant investment and will have to make important decisions on which indicators to choose. A balance between the expected outcome and the required equipment, manpower and training is needed for optimum results of the use of the new charts [24]. It is therefore

Table 4 Mean z-scores of weight-for-height calculated according to the WHO/NCHS and WHO 2006 references for a sample of Omani children aged 0–60 months

Age (months)	No.	Mean z-score	SE	95% CI (min, max)
<i>0–5</i>				
NCHS/WHO	1 391	0.03	0.05	–0.52, –0.31
WHO 2006	1 396	–0.41	0.04	–0.05, 0.11
<i>6–11</i>				
NCHS/WHO	1 490	–0.33	0.05	–0.43, –0.23
WHO 2006	1 490	–0.23	0.05	–0.35, –0.13
<i>12–23</i>				
NCHS/WHO	2 519	–0.83	0.04	–0.91, –0.76
WHO 2006	2 519	–0.42	0.02	–0.51, –0.34
<i>24–35</i>				
NCHS/WHO	2 741	–0.87	0.02	–0.92, –0.82
WHO 2006	2 741	–0.61	0.02	–0.66, –0.56
<i>36–47</i>				
NCHS/WHO	2 678	–0.84	0.04	–0.93, –0.75
WHO 2006	2 678	–0.69	0.05	–0.79, –0.59
<i>48–60</i>				
NCHS/WHO	2 810	–0.74	0.04	–0.82, –0.67
WHO 2006	2 808	–0.66	0.04	–0.75, –0.57
<i>Total</i>				
NCHS/WHO	13 629	–0.69	0.02	–0.74, –0.66
WHO 2006	13 632	–0.55	0.02	–0.59, –0.51

SE = standard error; CI = confidence interval.

important to understand the implications on child nutrition indicators.

Our findings show that 0–6 months, 12–23 months and 48–60 months are the age groups where the indicators will show the most significant changes in the reported estimates.

The reference cohort of the study was exclusively breastfed for 4 months, whereas the general rate of exclusive breastfeeding in Oman was 26% in 1999, which is an indication that, since exclusively breastfed children have a higher rate of growth at 0–6 months [25], if the rate of breastfeeding was increased in these children, growth would also improve. In spite of the well-

documented benefits of breastfeeding; exclusive breastfeeding remains low in many parts of the world [26]. The adoption of the new charts will require countries to put more vigorous efforts into promotion and counselling of exclusive breastfeeding.

The other age groups of concern are the 12–24 months and 48–60 months, where percentages increased significantly using the WHO 2006 charts as a reference. The literature available discusses the age group 0–5 years, and therefore we could not find any comparable data pertaining to those specific age groups. More research is needed to understand the socioeconomic factors related to feeding and nutrition at this age.

Our study is the first to address the comparison of overweight and obesity among children between the NCHS/WHO and WHO 2005 references. Although the overall rates are small in this population; the percentages were significantly different at older age groups. Beyond the fourth year the prevalence of both underweight and overweight were greater when using the WHO 2006 reference. Both underweight and obese children are at higher risk of ischaemic heart disease, obesity and diabetes later in life. Countries of the world signed a resolution to adopt the Global Strategy on Diet, Physical Activity and Health, which emphasizes the importance of develop-

ing national food-based dietary guidelines [26]. These guidelines target the population from 2 years onwards; however very little emphasis is placed on children aged 3–5 years compared to adults. Better guidelines should be developed for diet and physical activity at this age.

Our findings were consistent with an earlier comparison [27]: in summary, countries that adopt the new growth reference will show an increase in prevalence estimates for underweight, stunting and overweight. In order to improve the nutritional status of pre-school children age specific interventions should be considered.

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