

Comparison of under-nutrition among children aged 1-5 years using WHO and NCHS growth charts

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Abstract: *Introduction:* Anthropometric indices are widely used to assess the health and nutritional status of children. National Centre for Health Statistics /World Health Organisation growth reference (NCHS reference) and World Health Organisation (WHO) Growth standards are the two different growth charts used to monitor the growth of under-five children. Since the evaluation of child growth trajectories and the interventions designed to improve child health are highly dependent on the growth charts used, it is important to understand the impact of using the WHO versus the NCHS charts on the assessment of growth and estimates of malnutrition. *Objective:* The objective was to assess the nutritional status of under-five children based on anthropometry and to compare the under-nutrition rates based on newly developed WHO standards and the older NCHS reference. *Materials and Methods:* A cross sectional study was undertaken in a Primary Health Centre area comprising of 933 children aged between 1-5yrs and their mothers. Anthropometric measurements i.e. height and weight of each subject were taken according to standard procedures. Children were considered as underweight, stunted and wasted if their weight-for age, height-for-age and weight-for-height z-scores were below -2.0 SD of the NCHS and WHO growth charts. Statistical analysis were performed using EPI INFO version 7.1.4 statistical package. *Results:* Out of 933 under-five children 453 were boys and 480 were girls. The prevalence of wasting, stunting and underweight (< -2 SD) by WHO standards was 23.7%, 38.2% and 37% respectively and by NCHS reference was 23.5%, 33% and 46.6% respectively. The prevalence of severe wasting, stunting and underweight (< -3 SD) was 7.4%, 14.3% and 8.8% respectively by WHO standards and 4.1%, 11.8% and 9.8% respectively by NCHS standards. *Conclusion:* Prevalence of underweight was higher with NCHS reference and that of stunting was higher with WHO standards. However there was no much difference seen with wasting. Severe wasting and stunting was more by WHO classification. The rates of severe wasting, severe stunting were higher in boys and severe underweight was higher in girls WHO classification would be preferred to assess malnutrition among Indian under-five children.

Keywords: Comparison, under-nutrition, WHO, NCHS

Introduction

Malnutrition derives from the etymological origins *malus* (bad) and *nutire* (to nourish). It conveys and denotes the sense of improper nutritional status, outside the norm of healthy boundaries, either to the under-nutrition side or the over-nutrition side [1]. India is home to more than one-third of the world's under-nourished children. In 2010, 1 in 5 children were estimated to be underweight in developing countries [2].

The World Health Organisation (WHO) Health statistics of 2012 for India show the proportion of stunting as 47.9% and that of underweight as 43.5% [3]. According to the NFHS -3 survey

conducted in 2005-06, 48% of children were stunted, 20% were wasted and 43% were underweight [4].

Children between one to five years of age are the most vulnerable section of the population. They constitute 16.5% of the total population whereas mortality in this age group constitutes 40% of the total deaths in the country [5]. Growth in the first five years of life is considered an expression of health, nutritional status, and well-being. Anthropometric indices are widely used to assess the health and nutritional status of children. Together with the developmental milestones; growth forms the basis of most assessments of both

individual children and populations. NCHS/WHO growth reference (NCHS reference) is being used for assessment of nutritional status since late 1960's. The NCHS reference, however, may not adequately reflect the growth of breastfed infants and children. In particular, it may not be appropriate for making judgments about growth faltering in the population of developing countries, where most infants and young children are breastfed for a long period. In the new WHO standards, the children fostered by mother's milk, were presented as the normal growth pattern [6].

Since the evaluation of child growth trajectories and the interventions designed to improve child health are highly dependent on the growth charts used, it is important to understand the impact of using the WHO versus the NCHS charts on the assessment of growth and estimates of malnutrition [7]. Hence the present study focuses on the differences in the rates of underweight, stunting, wasting and evaluates the growth performance of healthy breast-fed infants according to the WHO standards and the NCHS reference.

Material and Methods

The present cross sectional study was undertaken in Handignur Primary Health Centre, a field practice area of Jawaharlal Nehru Medical College, Belgaum, Karnataka during January to December 2011. The study population comprised of children aged between 1-5yrs and their mothers. The optimal sample size of 933 study subjects was calculated on the basis of 30% prevalence of underweight children (Karnataka NFHS-3) [4] using the formula,

$$N = 4 pq / d^2, \text{ where } p = \text{prevalence, } q = 100 - p, d = \text{allowable error } 10\% \text{ of } p$$

A total of 2098 children were registered between 1-5 years age group. Simple random sampling was done using a random number table to select 933 children from the total children registered. After taking written informed consent, a pre-designed and pre-tested questionnaire was used to collect information from the child's mother. The questionnaire included demographic information, breastfeeding practices, socio-cultural and economic factors and anthropometric data. Socio economic status was assessed using Modified B.G.Prasad classification [8] using the latest All

India Consumer Price Index (AICPI) [9]. Every child was subjected to anthropometric measurements at the anganwadi. Height and weight of each subject were taken according to standard procedures [10]. Weight was taken using a Salter's weighing scale to the nearest 0.1 kg and height using a stadiometer to the nearest 0.1 cm. Children were considered as underweight, stunted and wasted if their weight-for-age, height-for-age and weight-for-height z-scores were below -2.0 SD of the NCHS reference and WHO standards. Moderate and Severe under-nutrition was defined as z-scores between -2.0 and -3.0 SD and below -3.0 SD respectively.

Statistical analysis: Data were analysed using EPI INFO version 7.1.4 statistical percentage. The anthropometric data of children were analysed using the WHO Anthro version 2 software and expressed as z-scores for each of the anthropometric indices of malnutrition against both the new WHO child growth standards and the older NCHS reference. Kappa statistics was used to measure the agreement between the WHO and NCHS standards. Statistical significance was considered as p value less than 0.05.

Results

The present study included 933 (453 males and 480 females) under-five children. Maximum children belonged to the age group between 48-60 months (28.8%) followed by 24-35 months (25.4%), 36-48 months (23.3%) and 12 - 23 months (22.5%) (Table-1). According to Modified B.G. Prasad classification, majority of children belonged to Class IV and Class V socio-economic status. 45.7% of mothers had secondary education and 55.8% of mothers were housewives.

Age in months	N	Percent %
12 - 23	210	22.5
24 - 35	237	25.4
36 - 47	217	23.3
48 - 60	269	28.8
Total	933	100

Table-2: Mean Protein & Calorie Intake of Children in the age group of 1 – 5 Years

Age (months)	Proteins			Calories		
	Mean (gm)	RDA	% deficit	Mean	RDA	% deficit
12 - 23	9.64	14.1	31.7	843.9	1060	20.4
24 - 35	9.41	15.1	37.7	840.3	1060	20.8
36 - 47	9.71	16.8	42.3	842.0	1350	37.7
48 - 60	9.67	17.8	45.7	850.5	1350	37

Mean intake of calorie and proteins in different age groups [11] is given in Table 2. The mean intake of both calories and proteins was grossly deficient in all the age groups.

of severe wasting, stunting and underweight (< - 3 SD) was 7.4%, 14.3% and 8.8% respectively by WHO standards and 4.1%, 11.8% and 9.8% respectively by NCHS standards.

Prevalence of malnutrition by WHO and NCHS growth charts is given in Table 3. The prevalence

Table-3: Age-wise prevalence of malnutrition according to WHO and NCHS growth charts

Age in months	WHO (< - 2 SD)			NCHS (< - 2SD)		
	Wasting %	Stunting %	Underweight %	Wasting %	Stunting %	Underweight %
12 – 23	24.3	30	27.1	27.6	32.4	44.8
24 – 35	27	39.7	42.6	27.8	28.7	52.3
36 – 47	24.4	41.5	41.5	21.7	33.6	47
48 – 60	19.7	40.5	36.1	17.8	36.8	42.8
Total	23.7	38.2	37	23.5	33	46.6

Table-4: Sex-wise comparison of malnutrition based on WHO and NCHS reference

Reference	Sex	Wasting	Stunting	Underweight
NCHS	Males	24.6	33.7	48.6
	Females	22.4	32.4	44.8
WHO	Males	26.4	39.7	38.1
	Females	21.2	36.7	35.9

The proportion of underweight reported by NCHS was much higher (46.6%) compared to the WHO standards (37%). Prevalence of stunting was higher with WHO standards (38.2%) compared to NCHS (33%). However there was no significant difference in the proportion of wasting by WHO (23.7%) and NCHS (23.5%).

of 36-47 months, followed by 48 – 60 months (40.5%) and 24 – 35 months (39.7%)(Table 3). Wasting, stunting and underweight was higher among boys as compared to girls (Table 4 and Figures 1-6). WHO reported a higher prevalence of severe wasting (7.4%) and severe stunting (14.3%) compared to NCHS (4.1% and 11.8% respectively).The rates of severe wasting (boys vs. girls : 8.9 % vs. 6.0 %), severe stunting (boys vs. girls : 15.7% vs. 12.9%) were higher in boys and severe underweight (boys vs. girls : 7.8 % vs. 9.8%) was higher in girls.

According to the WHO standards, majority of the children who were wasted (27%) and underweight (42.6%) were in the age group of 24 – 35 months and the number decreased with the increase in age. Similarly the proportion of stunting was maximum (41.5%) in the age group

Kappa statistics showed good agreement for wasting and stunting between WHO and NCHS growth charts (kappa value = 0.658 for wasting

and 0.650 for stunting with $p < 0.01$) but no agreement was seen for underweight ($p > 0.05$).

Figure-1: Sex comparison of weight for height based on WHO reference

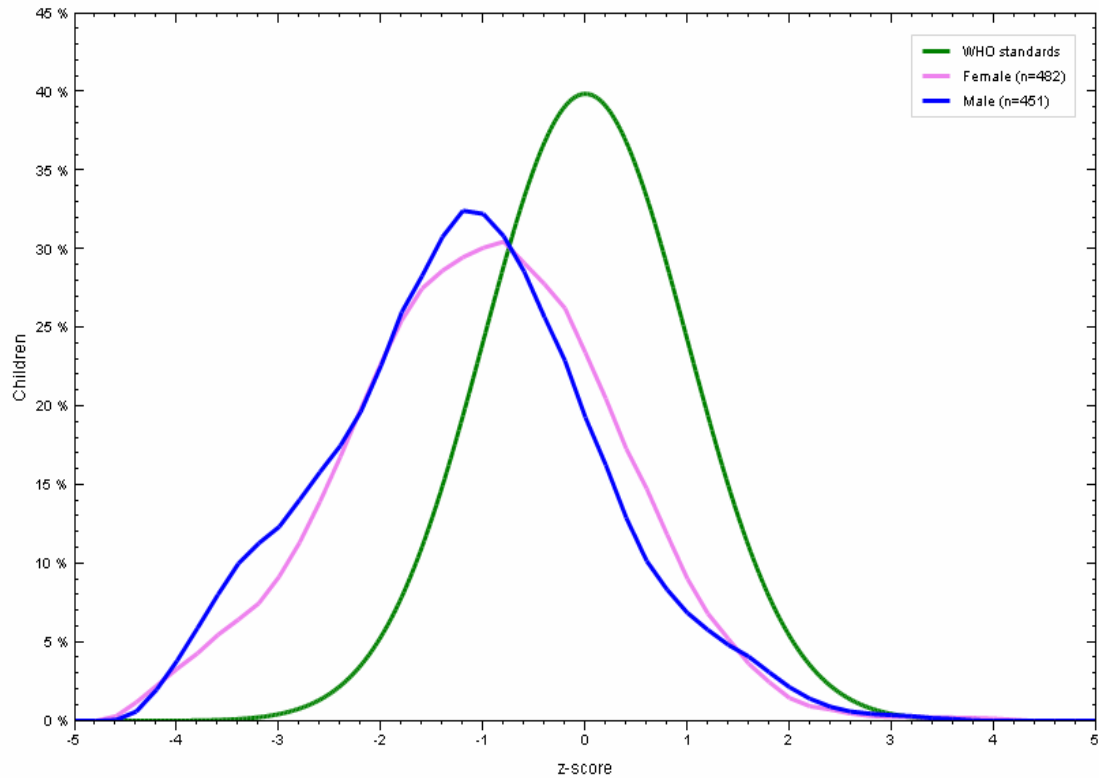


Figure-2: Sex comparison of weight for height based on NCHS reference

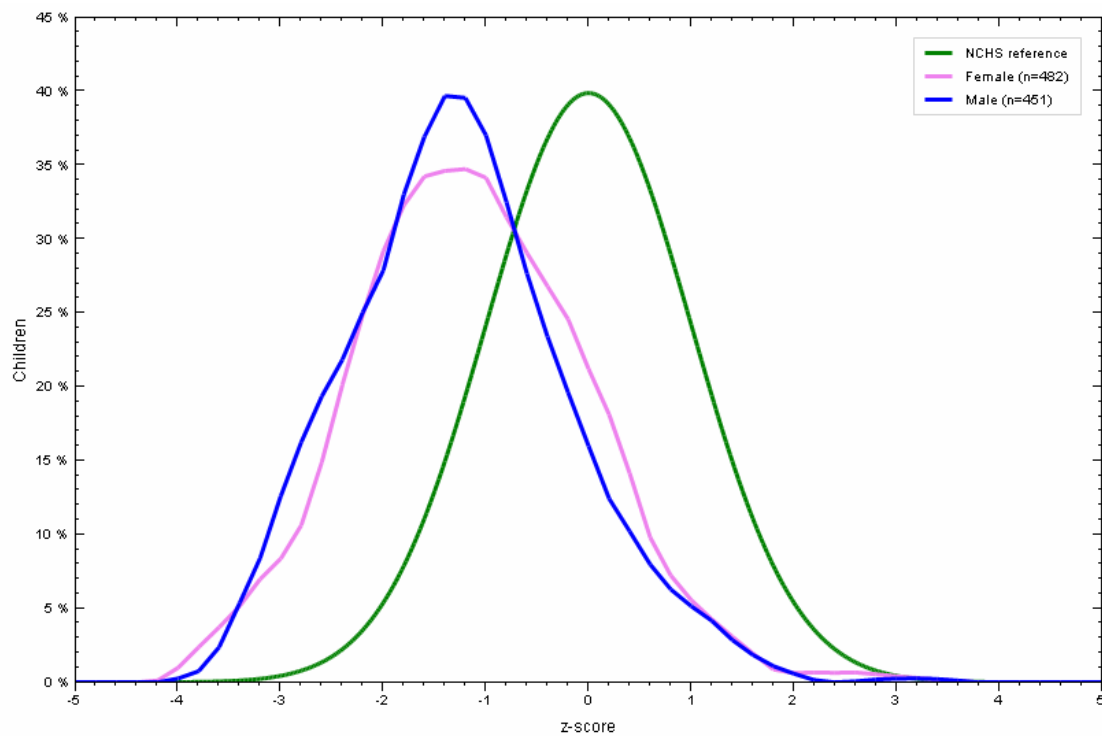


Figure-3: Sex comparison of weight for age based on WHO reference

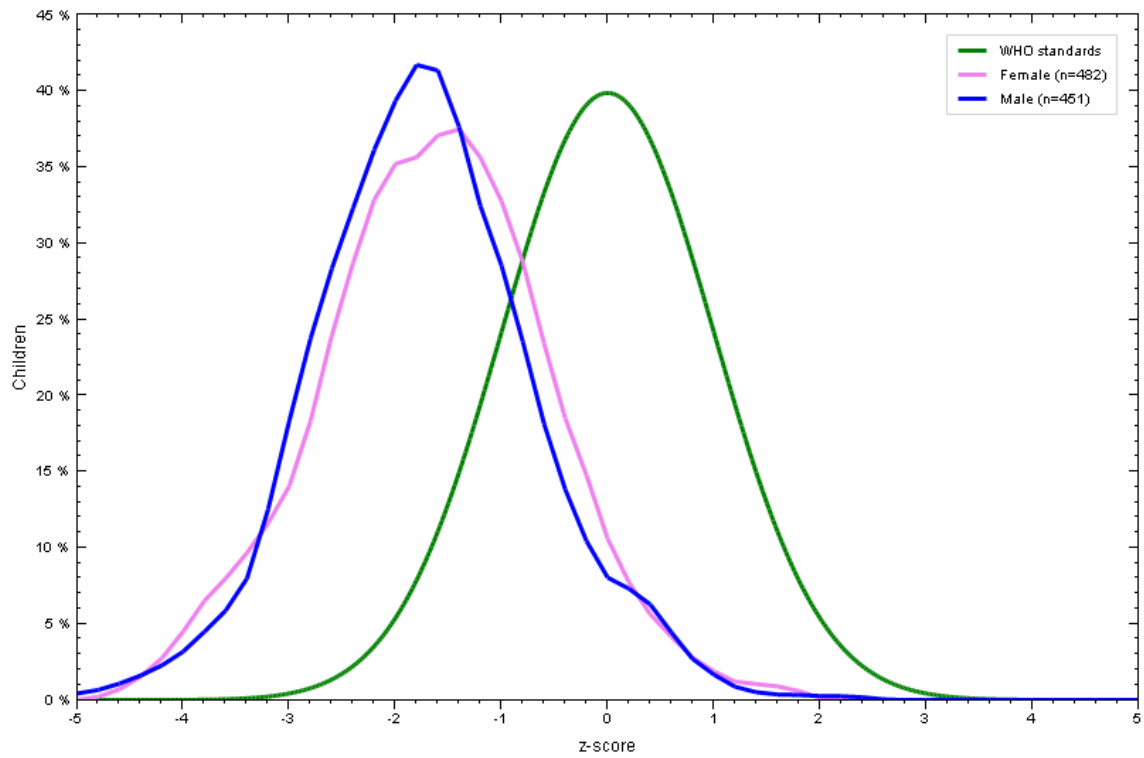


Figure-4: Sex comparison of weight for age based on NCHS reference

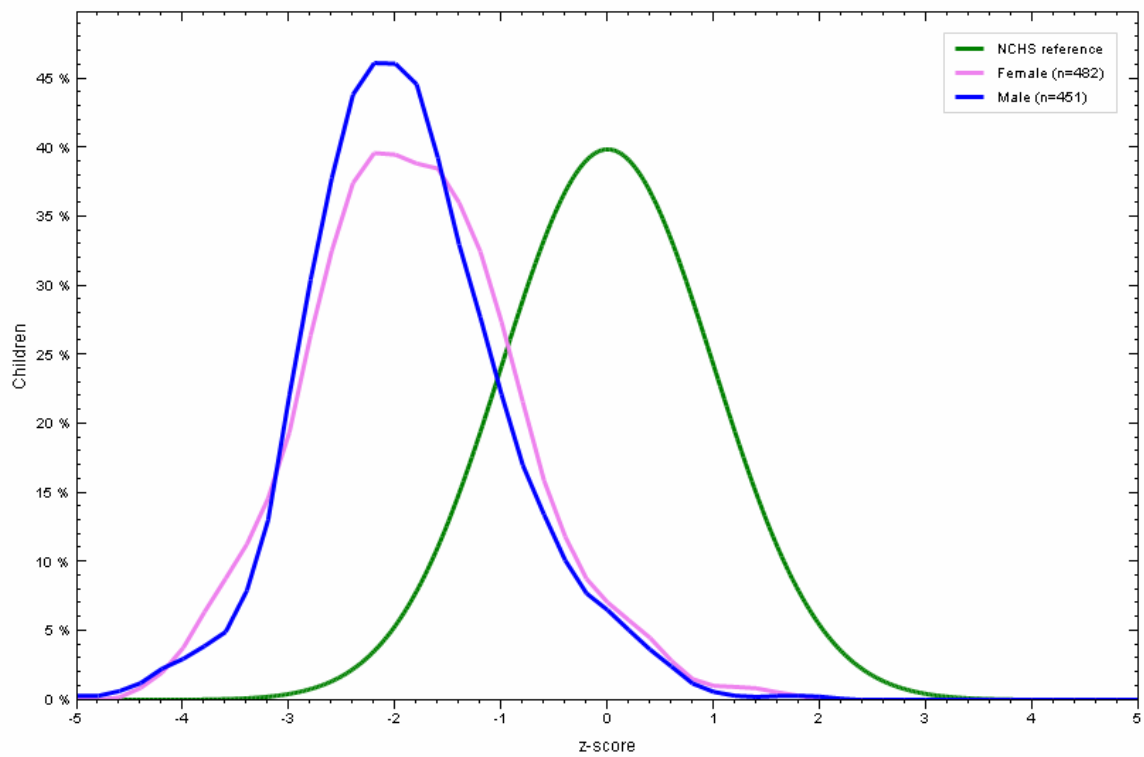


Figure-5: Sex comparison of height for age based on WHO reference

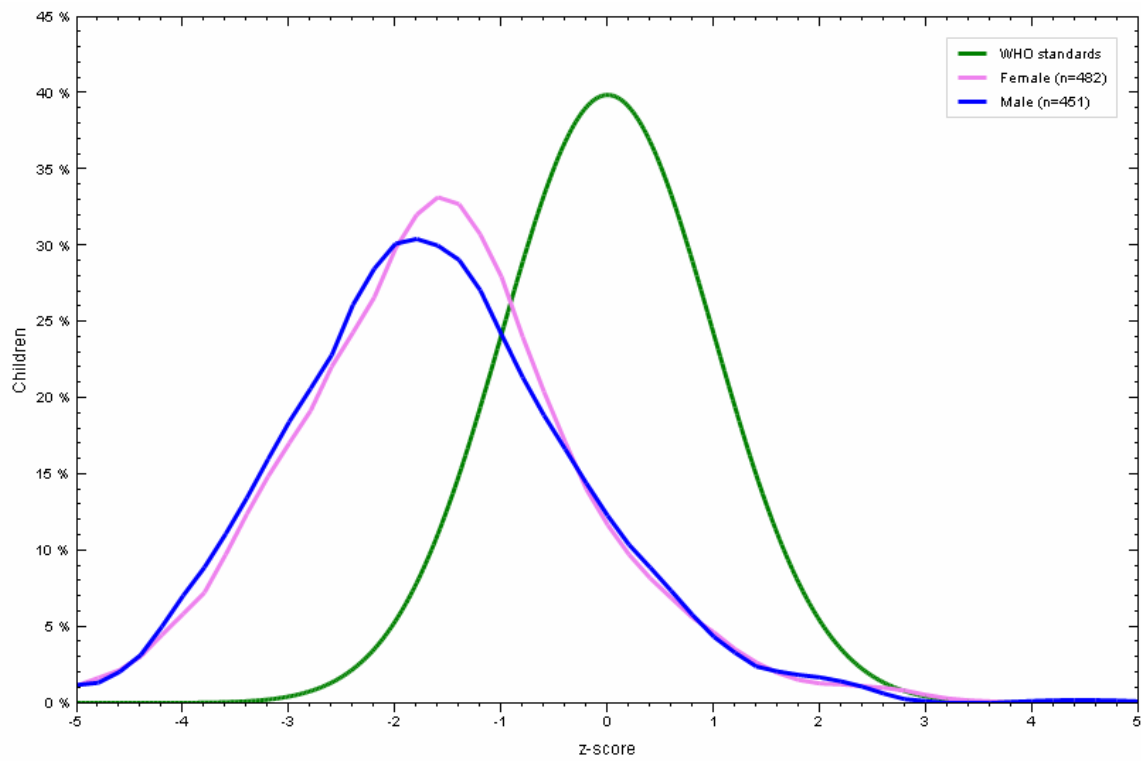
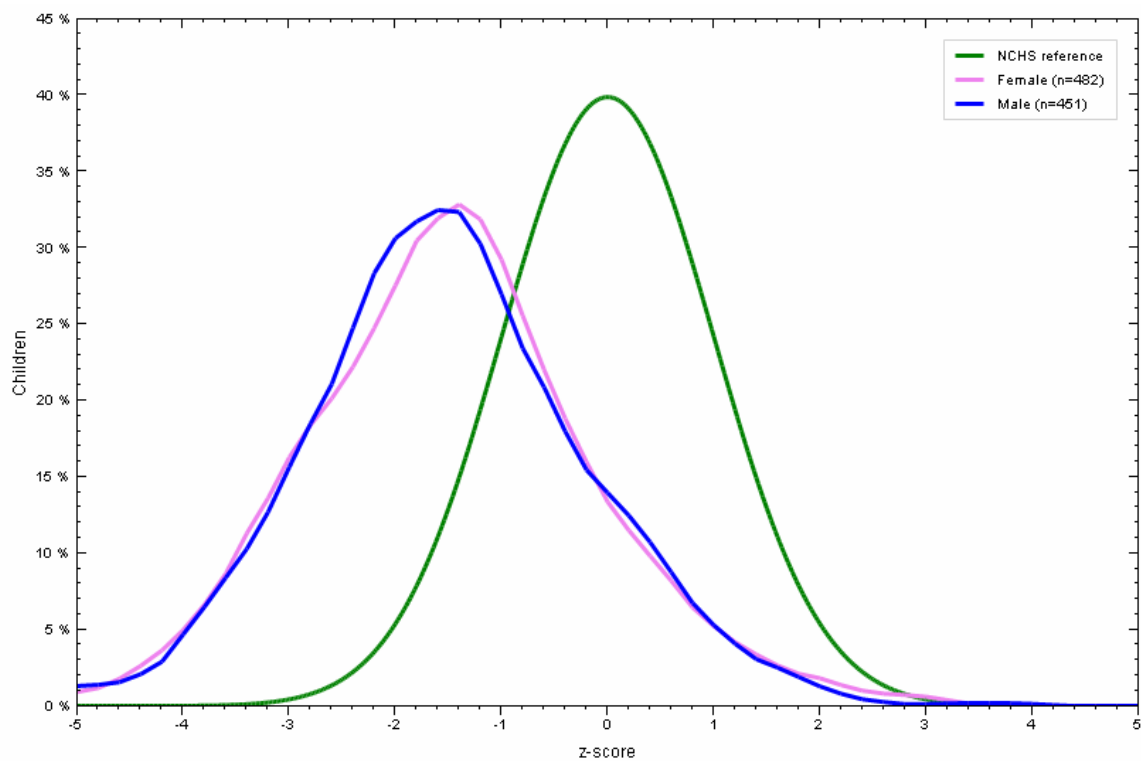


Figure-6: Sex comparison of height for age based on NCHS reference



Breast-feeding was given to 99.4% of children. 324 children (34.7%) were given pre-lacteal feeds among which maximum were given sugar water (29.5%), followed by honey (2.9%) and gutti (1.9%). Thirty nine percent of mothers preferred only cereals as weaning foods whereas 27.4% preferred both cereals and pulses.

Discussion

NCHS reference has certain limitations. First, sample was limited to Caucasian infants predominantly from middle class families. Second, measurements were taken every 3 months rather than every month, which is not ideal for characterizing the shape of growth curve, particularly during the first 6 months of life. Third, most of the infants were bottle fed, of those who were breast fed, very few were breast fed for more than 3 months. However the newly introduced WHO standards are unique in that it is purposely designed to produce a standard rather than reference. The WHO standards are based on healthy children who were breast fed and anthropometric measurements were taken a total of 21 times on week 1,2,4 & 6, monthly from 2 to 12 months, bimonthly in the second year and children between 18 – 71 months were measured once in 3 months. It also included samples from diverse set of countries (both developed and developing countries). All these features make the new WHO standards more technically robust for assessing the nutritional status of the children, individually and also in surveys [12].

As expected, in our study there are important differences between the WHO standards and the NCHS reference that vary by age group, growth indicator, specific percentile or Z-score curve, and the nutritional status of index populations.

Underweight estimated by WHO standards in our study was 37% when compared to NCHS reference (46.6%). A multi-centric study carried out in Bangladesh, Dominican Republic, Northern America and Europe [7] showed higher prevalence of Underweight reported by NCHS (56.5%) compared to WHO (52.9%). Similar results were reported from studies in Phillipines [13] (WHO vs NCHS: 20.7 vs. 26.8%), Sub-Saharan Africa [14] (WHO vs NCHS: 33% vs 38%) and Wardha [12] (WHO vs NCHS: 47.4 vs. 53%).

However in our study, WHO Standards reported a higher prevalence of Stunting and wasting (38.2% and 23.7% respectively) compared to NCHS reference (33% and 23.5% respectively). The same was seen with other comparison studies [7, 12-13]. Hence these studies including our study conclude that NCHS reference over-estimates cases of underweight but the same is not true for stunting and wasting.

Based on WHO standards, the overall prevalence of underweight, stunting and wasting was 37 %, 38.2 % and 23.7%, respectively in our study. The prevalence of underweight (37 %) was similar to that in a Madhya Pradesh study (37.4%) [15] but less than the national prevalence as assessed during 2005-2006 NFHS-3 survey [4] (43%). Bisai et al [16] reported that the prevalence of underweight, stunting and wasting was 33.9%, 26.1% and 19.4% respectively which was much less compared to our study. Similarly in our study, 8.8 %, 14.3 % and 7.4 % of children were found to be severely underweight, stunted and wasted respectively where as West Bengal study [16] reported 9.1%, 12.7% and 3.6% respectively.

Chowdhury et al [17] reported the rates of severe underweight, stunting and wasting as 7.9%, 5.0%, and 9.5%, respectively. The prevalence of underweight, stunting and wasting was higher in boys than in girls. The higher prevalence of under-nutrition in boys is consistent with other studies reported [16, 18]. It is well documented that boys are more likely to suffer from under-nutrition than girls due to increased nutritional needs in boys than in girls [15]. However, it must be mentioned that there are limitations in the present study including lack of precise data on dietary intake.

Conclusion

Prevalence of underweight was higher with NCHS reference and that of stunting was higher with WHO standards. However there was no much difference seen with wasting. Severe wasting and stunting was more by WHO classification. WHO classification would be preferred to assess malnutrition

among Indian under-five children. Also, the nutritional status of under-five children in the present study is poor. Positive inputs are needed to improve growth and to overcome body weight deficits. Preventive measures are needed to improve food security and strengthen the supplementary feeding programs.

Acknowledgements

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Recommendation

NCHS reference gives a very high proportion of underweight and hence an over-estimation. WHO standards would be more appropriate for Indian children.

References

1. Szajewska H, Warsaw. Malnutrition in Developing countries-A changing face. *Annals Nestle* 2009; 67(2):73-80.
2. Sengupta P, Philip N, Benjamin AI. Epidemiological correlates of under-nutrition in Under-five years children in an urban slum of Ludhiana. *Health and population* 2010; 33(1):1-9.
3. WHO Health Statistics 2012.
4. National Family Health Survey (NFHS-3) India 2005-06. Nutrition in India. Ministry of Health and Family Welfare, Government of India. *NFHS 2006*.
5. Elizabeth KE. Nutrition and Child development. *Paras Medical Publisher, Hyderabad* 2005; 133-187.
6. Namakin K, Sharifzadeh GR, Zardast M, Khoshmohabbat Z, Saboori M. Comparison of the WHO Child Growth Standards with the NCHS for the estimation of malnutrition in Birjand-Iran. *International Journal of Preventive Medicine* 2014; 5(5):653-57.
7. De Onis M, Onyango A, Borgi E, Garza C, Yang H. Comparison of the World Organisation (WHO) Child Growth Standards and the National Centre for Health Statistics/WHO International growth reference: implications for child health programmes. *Public Health Nutrition* 2006; 9(7):942-47.
8. Prasad BG. Social classification of Indian families. *J Indian Med Assoc* 1961; 37:250-1.
9. Labour Bureau, Government of India, [cited 2012 Dec 12]. Available from <http://labourbureau.nic.in/indnum.htm>
10. Indian Council of Medical Research (ICMR). Growth and development of Indian infants and children. *Technical Report Series No. 18. New Delhi: ICMR, 1972*.
11. Indian Council of Medical Research (ICMR). Nutrient Requirements and Recommended Dietary Allowances for Indians. *National Institute of Nutrition, Hyderabad* 2009.
12. Deshmukh PR, Dongre AR, Gupta SS, Garg BS. Newly developed WHO Growth Standards: Implications for demographic surveys and Child Health Programs. *Indian Journal of Pediatrics* 2007; 74:987-90.
13. Molano WL, Gulles AA, De Leon JY. Prevalence of malnutrition using the WHO Multicentric Growth Reference study and International Reference Standards: *Issues and implications* 2007
14. Macro International Inc.2008. Nutrition of Young Children & Women, Ethiopia 2005. Calverton, Maryland, USA: *Macro International Inc. 2005*
15. Sharma B, Mitra M, Chakrabarty S, Bharati P. Nutritional status of pre-school children of Raj-Gond-A tribal population in Madhya Pradesh, India. *Malays J Nutr* 2006; 12:147-155.
16. Bisai S, Bose K, Ghosh A. Nutritional status of Lodha children in a village of Paschim Medinipur district, West Bengal. *Indian J Public Health* 2008; 52:203-06.
17. Chowdhury SD, Chakraborty T, Ghosh T. Prevalence of under-nutrition in Santal children of Puruliya district, West Bengal. *Indian Pediatr* 2008; 45:43-46.
18. Marcoux A. Sex differentials in under-nutrition: a look at survey evidence. *Popul Dev Rev* 2002; 28:275-284.

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