RESEARCH PAPER

Pattern of Growth Faltering and Recovery in Under-5 Children in India Using WHO Growth Standards - A Study on First and Third National Family Health Survey

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Objective: To examine the pattern of growth faltering in preschool children, using World Health Organization (WHO) growth standards 2006 from the available datasets of first and third National Family Health Survey (NFHS 1 and 3).

Design: Data-analysis of two large-scale cross-sectional surveys done at a gap of 15 years.

Setting: General community.

Subjects: Preschool children included in NFHS 1 (*n* = 37,768) and NFHS 3 (*n* = 41,306).

Main outcome measures: Weight for age *Z*-scores (WAZ), height for age *Z* scores (HAZ) and weight for height *Z* scores (WHZ) based on WHO growth standards for the first four years of life.

Results: Mean WAZ score at '0' month during first and third surveys were -1.15 (*n*=268) and -0.76 (*n*=184), respectively. Of the total growth faltering in weight for age Z (WAZ) score by the end of third year, 55% and 44% of the growth faltering was already present at birth for the first and third survey, respectively. There was no change in weight for height Z (WHZ) score for the first three years during both the surveys.

Conclusions: A good part of the total growth faltering in India has already taken place at birth. Much of the growth faltering in early life can be attributed to faltering in HAZ scores or stunting. Understanding the causal role of stunting and its prevention as well as improving birth weight appears to be the key for better efficacy of public health programs in preventing under-5 malnutrition in India.

Key words: Growth faltering, India, Malnutrition, NFHS, Preschool children.

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Protein energy malnutrition is a public health problem in India. As per the NFHS 3 (National Family Health Survey 2006) report, 47% of children below 5 years of age are underweight, 46% of children are stunted and 17% of children are wasted [1]. This has been largely attributed to poor complementary feeding from the second half of first year of life [2,3]. Growth faltering in weight in developing countries has been shown to be starting around 4th month of life; however, stunting might start from the onset of birth, the causes of which are unknown [4]. This pattern of faltering has been shown from the reference growth standards of NCHS (National Center for Health Statistics), but these were derived from studies on bottle-fed infants and the growth of breast fed infants have been shown to be different from bottle fed infants [5].

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There is little data as to the timing of growth faltering in under-5 children in India and there exist no studies examining growth faltering at the National level in India. It was therefore of interest to examine the patterns of faltering and recovery using the new growth standards based on breast fed infants (WHO growth standards, 2006), using the available data from the first and third NFHS.

METHODS

NFHS had carried out anthropometric measurements in children below the age of 4 years in its first survey in 1991 (NFHS 1) in all the states in India, and later extended anthropometric measurements to children below five years of life and women aged 15 to 45 years during the second survey in 1999 [6,7]. In the third survey, anthropometric measurements of men aged 15 to 45 years were also included [1].

The study uses the raw data of NFHS available from Demographic Health Survey (www.measure.dhs). These two surveys were used as they represent the earliest (first) and latest (third) surveys and give us a better contrast in the extent of improvement during these two time points with a gap of 15 years. The sample design adopted in both surveys in each state was systematic, stratified sample of households with two stages in rural areas and three stages in urban areas.

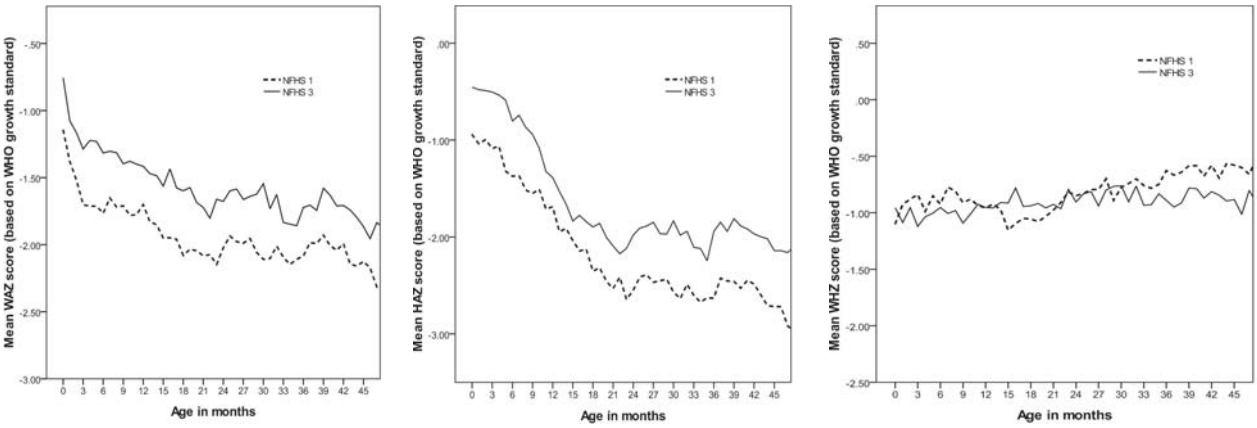
NFHS 1 conducted anthropometric measurements in 37,768 children below 4 years of age. Height was measured to the nearest 0.1cm and weight to the nearest 100 grams by the field staff. Age of the child was calculated in "days" based on the information on dates of birth and date of interview taken and was founded to the nearest "month". The guidelines given in the United Nations manual "How to weigh and measure children" were followed when training the field staff. Height was not measured in few states in the first survey (Andhra Pradesh, Himachal Pradesh, Madhya Pradesh, Tamil Nadu, West Bengal). However, the lack of height measurements for these states should not subsequently bias the national estimate of height for age and weight for height since these five states cluster closely around the national estimate of the percentage of children who are underweight (weight for age), as weight was measured in these states [6]. Weight for age (WAZ) Z scores, height for age (HAZ) Z scores, weight for height (WHZ) Z scores were calculated using NCHS growth standards. Z scores of all the above indices were recalculated using WHO 2006 growth standards for the survey. The software "ENA for SMART" used for the analysis is available at *www.nutrisurvey.net/ena*. In the third survey, anthropometric measurements in 41,306 children below 5 years as well as in adults aged 15-49 years (69245 men and 118796 women) were done. However, in the third survey, all the indices of nutritional status discussed above were calculated using both NCHS and WHO growth standards.

Statistical analysis: All analyses were performed with the Statistical Package for Social Sciences (SPSS) for windows, 17 (SPSS Inc, Chicago, USA). For this study, all the nutritional indices of children in the first and third survey, discussed above are plotted against age and are compared using WHO growth standards. This is restricted to first four years of life, as the first survey included measurements of children below the age of four years. Student *t* test was done to see significant differences in mean Z scores in children in the two surveys for the first three years in various ages, at three monthly intervals for the first year and a six monthly interval for the second and third year. Differences were considered significant at $P<0.05$.

RESULTS

The mean WAZ, HAZ and WHZ scores in relation to age in children below the age of 4 years during the first and third NFHS survey are shown in ***Fig*. 1**. Mean WAZ score at '0' month during first and third surveys were –1.15 (n = 268) and –0.76 (n = 184), respectively. Moreover, the difference in mean WAZ score (0.40 Z score) at 0 month in both surveys is nearly maintained until the end of third year of life (0.36 Z score) (***Fig.* 1*a***). Differences in mean WAZ scores for the first and third survey were significant at all time points for the first three years (***Table* I).**

Percent of growth faltering at 0 months (indicating the percent of total faltering at birth compared to the third year of life), 6 months (indicating the initiation of complementary feeding), 12 months (first year of life), 24 months (second year of life) compared to 36 months (third year of life) were calculated. Of the total faltering in weight for age at 36 months (–2.08 Z score) (***Fig*. 1**), 55% of growth faltering in weight had already taken place at birth (–1.15 Z score), this increased further to 82% by the end of 6 months (–1.71 Z score). No further increase in percent of growth faltering takes place



(*a*) (*b*) (*c*)

FIG.1 *Line graph showing (a) mean WAZ scores, (b) mean HAZ scores, and (c) mean WHZ scores against the age of <4 year Indian children during the first and third National Family Health Surveys (NFHS 1 and NFHS 3, respectively).*

from 6th month to 12th month (–1.70 Z score). By the end of 24 months, growth faltering is complete (–2.14 Z score). Similarly for the third survey, the percent of growth faltering at 0 months, 6 months, 12 months, and 24 months were 44%, 71%, 68% and 96%, respectively.

Mean HAZ scores at 0 month during first and third survey were -0.94 (*n*=158) and –0.45 Z (*n*=184) scores, respectively (***Fig.*1*b***). The difference increases slightly and by the end of third year mean HAZ score of the children were –2.63 Z score and -1.94 Z score for the first and third survey, respectively. Differences in mean HAZ zcores for the first and third survey were significant at all time points for the first years (***Table* I**).

Percent of growth faltering were calculated similarly with respect to HAZ score at the end of third year at both time points. During the first survey, percent of faltering in HAZ score at 0, 6, 12 and 24 months were 36%, 50%, 65%, and 96%, respectively. During the third survey, percent of faltering in HAZ score at 0, 6, 12 and 24 months were 23%, 41%, 71% and 102%, respectively **(*Fig*. 1*b*)**.

Mean WHZ scores during both the surveys (***Fig***. **1c**) were similar till the end of first year of life; however, during the first survey, there was a sudden decrease in WHZ scores during the beginning of second year of life followed by recovery by the end of second year. Thereafter, mean WHZ scores during the first survey were slightly higher than during the third survey. There was no statistical difference in mean WHZ scores for the first and third survey at most time points except at 3, 9 and 36 months, where the children of the first survey had slightly higher Z scores (***Table* I**).

DISCUSSION

Growth faltering in weight in developing countries has been known to start around the fourth month of life but these studies were based on NCHS growth standards [4]. In this study, growth faltering in weight appeared to start right from birth and there appeared a fall in WAZ scores for the first 3 months and thereafter, the rate of fall appeared to slow down. The pattern of growth faltering for weight for age in both survey points was remarkably similar. It is interesting to note that of the total faltering that had taken place by the end of first three years of life, 55% and 44% of growth faltering in the first and third surveys, respectively, was present at birth. Weight for age index depends on both stunting (HAZ) and wasting (WHZ) indices, which have a physiological role. Stunting is known to represent a state of chronic malnutrition and wasting represents a state of acute malnutrition [8]. Weight for age can then be a considered as a state, which merely reflects the characteristic of these two conditions, and might not as such have a physiological role independently.

With regard to wasting, the status of wasting at birth seem to be similar till the end of first three years of life, except for an abrupt decline in wasting at the

TABLE I MEAN WEIGHT FOR AGE Z (WAZ), HEIGHT FOR AGE Z (HAZ) AND WEIGHT FOR HEIGHT Z (WHZ) SCORES OF CHILDREN UNDER-3 YEARS IN THE FIRST (NFHS1) AND THIRD (NFHS3) NATIONAL FAMILY HEALTH SURVEYS

	NFHS1			NFHS3			*P* value
	n	MEAN	(SD)	*n*	MEAN	(SD)	
0 month							
WAZ	268	-1.15	(1.53)	184	-0.76	(1.35)	0.005
HAZ	158	-0.94	(2.06)	184	-0.45	(1.60)	0.014
WHZ	138	-1.10	(1.71)	184	-0.96	(1.89)	0.487
3 months							
WAZ	941	-1.70	(1.71)	627	01.29	(1.31)	<0.001
HAZ	741	-1.09	(2.06)	627	-0.50	(1.82)	<0.001
WHZ	748	-0.84	(1.97)	627	-1.12	(1.71)	<0.005
6 months							
WAZ	971	-1.77	(1.57)	710	-1.32	(1.31)	<0.001
HAZ	720	-1.37	(1.88)	710	-0.80	(1.73)	<0.001
WHZ	740	-0.92	(1.85)	710	-0.95	(1.60)	0.735
9 months							
WAZ	843	-1.71	(1.47)	703	-1.40	(1.34)	<0.001
HAZ	571	-1.55	(1.97)	703	-0.94	(1.72)	<0.001
WHZ	583	-0.91	(1.70)	703	-1.09	(1.49)	0.041
12 months							
WAZ	712	-1.70	(1.38)	663	-1.42	(1.27)	<0.001
HAZ	480	-1.69	(1.68)	663	-1.39	(1.61)	0.002
WHZ	490	-6.96	(1.55)	663	-0.95	(1.48)	0.948
18 months							
WAZ	882	-2.08	(1.50)	811	-1.60	(1.32)	<0.001
HAZ	663	-2.36	(1.80)	811	-1.90	(1.67)	<0.001
WHZ	690	-1.06	(1.54)	811	-0.94	(1.38)	0.118
24 months							
WAZ	696	-2.02	(1.44)	623	-1.68	(1.28)	<0.001
HAZ	496	-2.55	(1.80)	623	-1.98	(1.76)	<0.001
WHZ	507	-0.85	(1.51)	623	-0.90	(1.29)	0.513
30 months							
WAZ	759	-2.11	(1.43)	740	-1.55	(1.22)	<0.001
HAZ	551	-2.57	(1.65)	740	-1.83	(1.50)	<0.001
WHZ	569	-0.77	(1.50)	740	-0.76	(1.30)	0.864
36 months							
WAZ	675	-2.08	(1.31)	698	-1.72	(1.27)	<0.001
HAZ	475	-2.63	(1.76)	698	-1.94	(1.67)	<0.001
WHZ	486	-0.63	(1.37)	698	-0.89	(1.23)	0.001

beginning of first year of life in the first survey. The sudden rise and fall in WHZ scores for the first 6 months of life seen with NCHS growth standards in developing countries [4] is no longer seen with new WHO growth standards. It appears that the energy and protein needs are sufficient to maintain the wasting status of the child, but not sufficient enough to promote catch up growth.

The timing of stunting in developing countries, in a study based on worldwide demographic data (based on NCHS growth standards), showed that the onset of stunting starts at birth irrespective of region [4]. In this study, of the total faltering at three years of age, 36% and 23% in first and third survey respectively, occurred at birth. This increases further to 50% and 41% by the end of 6 months of life.

WHAT IS ALREADY KNOWN?

- Studies on growth faltering in weight and height in developing countries are based on NCHS growth standards which were based on bottle fed infants.

WHAT THIS STUDY ADDS?

- A good part of the total growth faltering in India has already taken place at birth and much of the growth faltering in early life can be attributed to faltering in HAZ scores or stunting.

Much of the growth faltering can be attributed to faltering in HAZ scores or stunting, since the status of wasting hardly changed by the end of third year compared to birth, and weight for age lacks a physiological role. The etiology of stunting has been poorly understood. Dietary quality rather than quantity has been regarded by some as an important etiological factor for stunting [9]. However, as seen from the above discussion, faltering in stunting in this study as well as in other developing countries [4] appears to start from birth and the similar efficacy of breast milk compared to other foods for the promotion of growth has been well documented [10-12]. It may possible that the recovery of stunting is intergenerational [13,14] and a complete recovery in stunting in one generation is unlikely to happen. The recovery in stunting has been seen in a span of two to three generations of children living in better environmental conditions, one such example being the secular trends in adult height in developed countries in 19th century, where the adult male height improved from around 164 cm to around 176 cm at a rate of 0.5 to 1.5 cm per decade [15,16]. It appears that understanding the intergenerational effects on linear growth and its causes is essential for building up a strategy to reduce the burden of stunting and hence under -5 nutrition in the country.

Percent of growth faltering can be calculated based on the assumption that the same child was followed up for the first three years of life. Limitation of our study is that it is a semi longitudinal study with two cross-sectional surveys at different time points and calculations based on a cross-sectional study may not be entirely appropriate for such analysis. However, it is often difficult to carry out longitudinal studies with an adequate sample size in a developing country due to resource and time constraints.

A good part of the total growth faltering in India has already taken place at birth. Much of the growth faltering in early life can be attributed to faltering in HAZ scores or stunting. Understanding the causal role of stunting and its prevention as well as improving birth weight appears to be the key for better efficacy of public health programs in preventing under-5 undernutrition in India.

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