ORIGINAL ARTICLE

PREVALENCE OF UNDERNUTRITION AMONG UNDERPRIVILEGED PRESCHOOL CHILDREN (2-6 YRS) OF MIDNAPORE TOWN, INDIA

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Abstract

Background: Malnutrition in preschool children is a major public health problem globally. It is more common in developing countries. It affects growth and development thus impairing both physical and mental ability. **Methods:** This community based, cross-sectional survey was carried out among 658 underprivileged children (315 boys) of 2-6 years from Midnapore, India. The nutritional status of the children, Composite Index of Anthropometric Failure (CIAF), and the index of their stunting, underweight and wasting were evaluated. The same parameters were calculated as Z-score using the suitable reference values. The One-way ANOVA analysis (F value), Student's 't' tests and Chi-square test were done to evaluate the association amongst individuals, group or set of data. **Results:** The overall prevalence of undernutrition was; underweight 43.77%, stunting 40.58% and wasting 23.40%. Severe underweight (Z score <-3), stunting and wasting was 12.61%, 16.72% and 5.32%, respectively. Prevalence of underweight, stunting and wasting was higher in boys (46.98%, 43.17%, and 25.40%) than girls (40.82%, 38.19% and 21.57% respectively). Altogether, the CIAF was 58.21%, and gender-wise boys, 61.3% and girls 55.39%. The indices of stunting, underweight and wasting of the studied population were 0.69, 0.75, and 0.40 respectively. **Conclusion:** The present study revealed a certain extent of prevalence of undernutrition among preschool children in the studied area. It is differentially manifested in boys and girls. Several actions have been initiated in this area by the Government at policy making and implementation level. Nutritional awareness and the up gradation of education in the population may improve the present scenario.

Keywords: Undernutrition, Preschool Children, Stunting, Wasting, CIAF
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Introduction

Global nutritional status is a major determinant of health and well-being among children which should be studied in relation to spatial as well as temporal dimension.[1] Malnutrition continues to be a major public health problem throughout the developing world, particularly in South Asia and sub-Saharan Africa.[2-5] It makes a child susceptible to infections especially sepsis, pneumonia and gastroenteritis.[6] It results slower the recovery from infection and increased child mortality.[7]

India has the highest incidence of childhood malnutrition in the world.[8] A significant number of preschool children are moderate to severely malnourished. The 30% of newborn children are significantly underweight. A large number of Indian women are also found to be anemic. Over the last few decades, one of the greatest problems in India is malnutrition among five year-old children. Based on the report of National Nutrition Monitoring Bureau and National Institute of Nutrition (1993) nearly 43.8% children suffer from moderate degrees of protein energy malnutrition.[9]

The Composite Index of Anthropometric Failure (CIAF) was proposed by Peter Svedberg (2000) as a new measure of undernutrition beside conventional indices i.e., stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height).[10] Based on Svedberg's model, Nandy et al. (2005) had utilized the CIAF on Indian data and recommended its use in preference to the three conventional measures of undernutrition i.e., stunting (ST), underweight (UW) and wasting (WS).[11] However, a recent report has highlighted some shortcomings of CIAF.[12] Although CIAF is a useful composite measure, it fails to highlight the individual contribution and importance of ST, UW and WS relative to the overall prevalence of undernutrition.[13] To know the rates of ST, UW and WS relative to the overall prevalence of undernutrition, three new indices are required and these are Stunting Index (SI), Underweight Index (UI) and Wasting Index (WI).[14] These new indices provide information on the relative significance and severity of these three measures with respect to the total prevalence of undernutrition. Our research provides, for the first time, evaluation on the level of undernutrition among preschool children (2 to 6 years) in Midnapore district in West Bengal using these new indices. The present outcome may be paralleled with the scenario of the analogous global populations from other developing countries. So, this outcome may increase the etiological predictability of nutritional impairment and the efficacy of global intervention procedure as well.

Methods

Study location and participants

The study is undertaken in the district town Midnapore and its surrounding areas of Paschim Medinipur District (22.25°N 87.65°E), West Bengal, India. Midnapore is 23 meters above the sea-level and 127 km away from Kolkata. In the 2011 census, Midnapore municipality had a population of 169,127, of which 85,362 are males. The 0–6 year's population is 14,365.[15]

The current research topic has been approved by the local institutional board of ethics within which the work is undertaken. Permission from the local municipality/ school authority is collected.

Study design

The study is designed as a community based cross-sectional type which is conducted from August 2011 to October 2011. We visited the study area several times during the stipulated period. In our investigation, 658 preschool children (2 to 6 years, 315 boys) are chosen by systematic random sampling. The socioeconomic status of the children's family is assessed by Kuppuswami's socioeconomic status.[16]

The questionnaire is based on demographic information, anthropometric data and personal hygiene. The child is identified by name, age and sex. The date of birth is obtained from the birth certificates in order to ensure the quality of data. The anthropometric measurements including the height and weight of the children are measured using standard techniques.[17] The height and weight measurements are recorded to the nearest 0.1 cm and 0.5 kg respectively.

The nutritional status of the children is evaluated using age and sex specific values of height and weight from the National Centre for Health Statistics (NCHS) reference data.[18] The indices of undernutrition such as stunting, underweight and wasting are calculated by Z-score using the reference values of height-for-age, weight-for-age and weight-for-height of NCHS standards, respectively. Z-scores are calculated following the standard formula:

Z-score = (X – Median of NCHS) / Standard deviation of NCHS, where X is an individual value. Three Z-scores are calculated: height-for-age Z-score (HAZ), weight-for-age Z-score (WAZ) and weight-for-height Z-score (WHZ). The following scheme is utilized to define undernutrition:

Stunting: HAZ <–2, underweight: WAZ <–2 and wasting: WHZ <–2.

Children with Z-score below –2 of any of the indices are considered to be undernourished and the children with Z-score below –3 are considered to be severely undernourished.

Based on their nutritional status children are grouped in six categories (A to F) to evaluate the CIAF value following the Peter Svedberg's (2000) model.[10] These groups included children with height and weight appropriate for their age (i.e., Z-scores > –2) and are designated under the category of no "anthropometric failure". And the rest children are designated as "anthropometric failure" of one or more forms. The CIAF evaluation are done excluding those children who are not in anthropometric failure group (A) and including those children who are wasted and/or stunted and/or underweight (groups B–F) (Table 3). It therefore provides a single measure with which overall prevalence of undernutrition may be estimated more precisely.[11] This measure extended the model of Svedberg (2000) by identifying an additional subgroup of only underweight designated as Y.

The three new indices of childhood undernutrition are:

Stunting Index (SI) = Stunting / CIAF

Underweight Index (UI) = Underweight / CIAF

Wasting Index (WI) = Wasting / CIAF

Statistical analysis

One-way ANOVA analysis (F value) was undertaken to test for age differences in mean height and weight. Student's 't' tests

were done in the present investigation. Chi-square tests were done to verify age association, difference between CIAF and 'no failure'. Data processing and statistical analyses were done using the SPSS for Windows statistical software package (Version 10.0, SPSS Inc., Chicago, IL, USA, 2001). Descriptive statistics were used for all the variables studied. The p value of

≤ 0.05 was considered statistically significant.

Results

Figure 1 shows an age wise changes in stunting, wasting and underweight index (SI, WI and UI respectively) in boys and girls child. These data indicate an increasing tendency in UI and WI in boys.
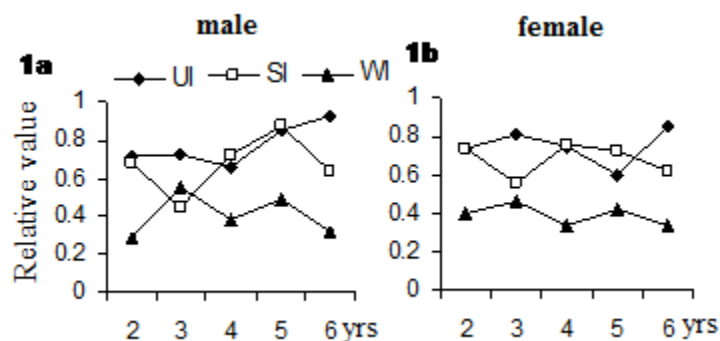

Figure 1. Age-wise changes in stunting, wasting and underweight index in the children

Figure 2 demonstrates the occurrence of CIAF, STN, UWT and WAS in different ages of children. These results illustrate a higher rate of CIAF in boys of all ages.
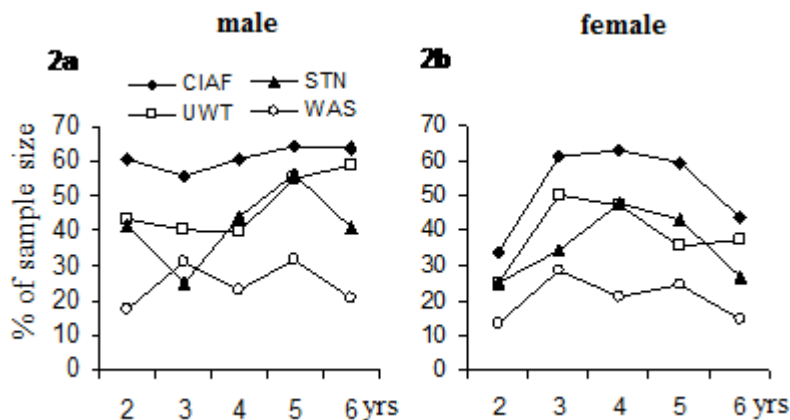

Figure 2. The occurrence of Composite index of anthropometric failure (CIAF), stunting (STN), underweight (UWT) and wasting (WAS) in different ages of children

Figure 3 demonstrate the similar type of occurrence of STN, WAS and UWT alone or in combination at different ages of either gender. Anthropometric failure in terms of

composite value is shown to be differentially manifested in girls and boys.

The age and sex related distribution of mean weight and height of the participants are

presented in Table 1. A total of 658 children (315 boys) are included in this study. There is no significant gender difference of weight and height in the studied group except in the age of 4 years when boys are significantly (P<0.05) heavier and taller than the girls. Significant (P<0.0001) age differences are noticed in their mean weight (boys- weight: F = 42.54; height: F = 99.98) and (girls- weight: F = 54.42; height: F = 112.87).

Table 2 presents the rates of stunting, wasting and underweight among the studied populations. Moderate (Z score between –2 to –3) or severe (Z score <3) underweight is found to be higher in boys than girls (33.65% vs. 28.86% & 13.33% vs. 11.90%, respectively). Prevalence of moderate stunting (Z score between –2 to –3) is higher in boys than girls (26.67% vs. 21.28%). The prevalence of severe wasting (Z score <3) is found to be predominant in boys (6.98% vs. 3.79). According to the reference criteria (Z score below –2) recommended by WHO, 43.77%, 40.58%, 23.40% children are found to be underweight, stunted and wasted respectively. Severe (Z score below –3) underweight, stunting and wasting are found in 12.61%, 16.72% and 5.32% of the children respectively.
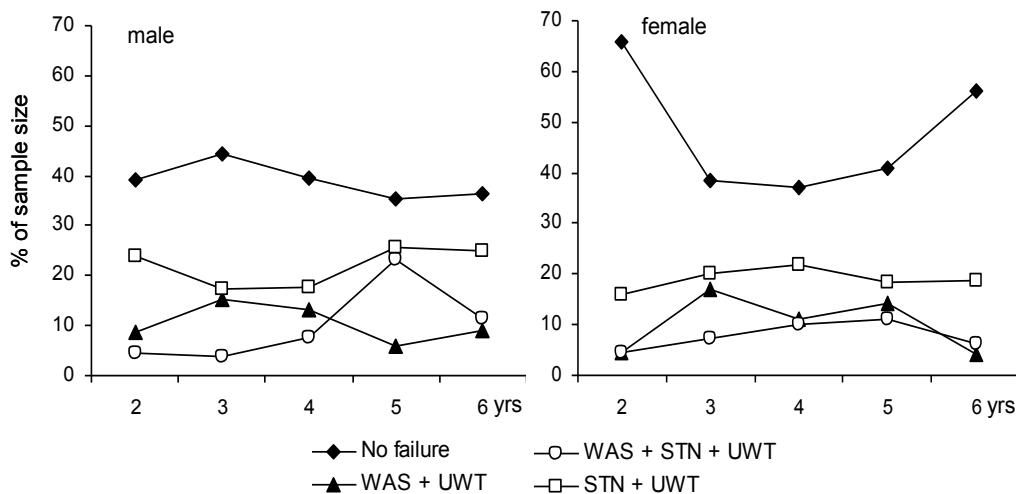

Figure 3. Occurrence of stunting (STN), underweight (UWT) and wasting (WAS) alone or their combination in the studied children

CIAF showed a higher prevalence of undernutrition with 58.21% of the studied children suffering from anthropometric failure (Table 3). Table 4 presents the gender-specific values of three anthropometric indices, SI, UI, and WI.

Discussion

The undernutrition is increasingly recognized as a prevalent and important health problem in many developing countries including India. This problem has serious and long term consequences for the child and as a whole the development of a nation.[19] The scenario of undernutrition in India is also similar to other developing nation with analogous socioeconomic and demographic profile i.e. South American, African, South East Asian countries and China.[14,20,21] So the present study has an immense importance in terms of the global perspective. In the relation to nutritional assessment, several anthropometric indices

and other advanced parameters like thinness, stunting, wasting, Z-score, CIAF values could serve well for evaluating community health status.[11] A recent report on underweight and stunting among children of certain location of Midnapore, India provides the information of malnutrition in this region.[22]

Table 1. Mean±SD of weight and height in the study population

Age group (years)	Boys			Girls		
	N	Weight (Kg)	Height (cm)	N	Weight (Kg)	Height (cm)
2	46	10.85±1.57	82.30±5.86	44	10.35±1.67	82.76±5.28
3	52	11.86±1.62	91.13±7.01	70	11.83±2.17	90.63±6.78
4	91	13.39±2.59*	96.29±7.84*	100	12.65±2.05	93.82±5.56
5	82	14.19±2.46	101.21±6.72	81	14.15±2.23	100.90±8.52
6	44	16.94±3.50	109.24±6.92	48	16.59±3.30	109.14±6.54
Overall	315	13.47±3.04	96.49±10.57	343	13.09±2.92	95.57±10.21
F value		42.540**	99.983**		54.421**	112.874**

**P<0.0001, *P<0.05 significant sex and age differences. F represents ANOVA.

Based on the WHO classification of severity of malnutrition,[23] the results of the present study (Table 3) clearly indicate that, the overall (age and gender combined) prevalence of underweight (43.77%), stunting (40.58%) and wasting (23.40%) are found to be very high. When these results are compared with the results from different states of India, it is found that the prevalence of underweight and wasting in our study is higher than the national prevalence. In this relation some report from different countries can be paralleled with our present findings.[25]

Table 2. Distribution of studied children aged 2-6 years according to z score

Z score	Underweight			Stunting			Wasting		
	Boys	Girls	Sex Combined	Boys	Girls	Sex combined	Boys	Girls	Sex combined
<-3	42 (13.33)	41 (11.9)	83 (12.61)	52 (16.51)	58 (16.91)	110 (16.72)	22 (6.98)	13 (3.79)	35 (5.32)
-2 to -3	106 (33.65)	99 (28.86)	205 (31.16)	84 (26.67)	73 (21.28)	157 (23.86)	58 (18.41)	61 (17.78)	119 (18.09)
Moderate to Severe (<-2)	**148 (46.98)**	**140 (40.82)**	**288 (43.77)**	**136 (43.17)**	**131 (38.19)**	**267 (40.58)**	**80 (25.40)**	**74 (21.57)**	**154 (23.40)**
-1 to -2	100 (31.75)	120 (34.99)	220 (33.43)	71 (22.54)	82 (23.91)	153 (23.25)	95 (30.16)	119 (34.69)	214 (32.52)
0 to -1	39 (12.38)	46 (13.41)	85 (12.92)	45 (14.29)	68 (19.83)	113 (17.17)	82 (26.03)	83 (24.20)	165 (25.08)
>0	28 (8.89)	37 (10.79)	65 (9.88)	63 (20.00)	62 (18.08)	125 (19.00)	58 (18.41)	67 (19.53)	125 (19.00)
Total	315 (100)	343 (100)	658 (100)	315 (100)	343 (100)	658 (100)	315 (100	343 (100)	658 (100)

Figures in parentheses are percentages.

In terms of gender, the prevalence of wasting among girls was 21.57% and among boys was 25.40%. The rates of underweight in boys are higher (46.98%) than girls (40.82%). Similarly, stunting in boys are higher (43.17%) than girls (38.19%). It can be summarized that both boys and girls are differentially affected with undernutrition. In search for the causative factors of different stressful conditions, the socioeconomic profile, distribution of health beneficiaries, household environment and health awareness are proposed to be significantly important. One report suggests that the qualitative and quantitative status of meals in family/ household may be useful for studying family mealtime environments and children's eating behaviors which is also a helpful predictor of health status.[25]

Our study shows a similar prevalence (58.21%) of overall undernutrition (as indicated by CIAF) in a recent study (59.8%) done by Nandy et al (2005) which is in line with the report of National Family Health Survey (NFHS-2, 1998-99).[11,26] Report reveals that children less than 5 years of age residing in the slum areas of Coimbatore, Tamil Nadu, India showed a higher prevalence of undernutrition (CIAF, 68.6%).[13] Similar prevalence of undernutrition is noticed in the pre-school children of Chapra, Nadia District, West Bengal, India.[27] In a global comparison, the present CIAF is higher than Nepal (56.5%), Tanzania (45.9%), Zimbabwe (35.8%), Bolivia (26.6%) and Peru (23.8%) (Nandy and Miranda, 2008). In relation to the precautionary measure against child undernutrition, a community-based supplementary feeding has been recommended for promoting the growth of children under five years.[28] In this regard, however, it can be noted that the government scheme of serving mid-day meal to school going children have been very popular. Not only it upgrades the child health but also attract the children to increase the school attendance. More attendance result more serving coverage and lowering the undernutrition. The improvement of the health facilities, incorporation of Integrated Child Development Scheme (ICDS) projects, antenatal care centre for the underprivileged group showed up gradation of the nutritional status of the preschool children. The program coverage needs to be increased to include more number of children. Beside materialistic support, more easygoing health education will increase the spontaneous participation of the children's family.

Table 3. Subgroups of anthropometric failure among the study population

Group		Boys		Girls		Sex combined	
		N	%	N	%	N	%
A	(No failure)	122	38.73	153	44.61	275	41.79
B	(Wasting only)	12	3.81	15	4.37	27	4.10
C	(Wasting and underweight)	33	10.48	30	8.75	63	9.57
D	(Wasting, stunting and underweight)	35	11.11	29	8.45	64	9.73
E	(Stunting and underweight)	68	21.59	67	19.53	135	20.52
F	(Stunting only)	33	10.48	35	10.20	68	10.33
Y	(Underweight only)	12	3.81	14	4.08	26	3.95
	CIAF (B-Y)	**193**	**61.3**	**190**	**55.39**	**383**	**58.21**

CIAF = Composite Index of Anthropometric Failure

In addition, it is suggested that precaution should be taken at the maternal level also. Among pregnant women in poor communities in Bangladesh, treatment with multiple micronutrients, including iron and folic acid combined with early food supplementation resulted in decreased childhood undernutrition and mortality.[29] The stunting and underweight index in our present study is very high (0.697 and 0.752 respectively) which indicate that the population is in chronic undernutrition necessitating increased long term nutritional intervention. Extreme levels of underweight and stunting among pre-adolescent children of low socioeconomic class have been reported from Madhyamgram and Barasat, which are the semi-urban places in West Bengal, India.[30] These places are not far away from the present study place. Protein energy malnutrition is found among the undernourished children when compared with the normal children. It may be the important cause of undernutrition noticed in our study. Beside this, socioeconomic status, hygienic condition, sanitation, life style and education play key role resulting malnutrition. Infection, adverse cultural practices of child care, breast feeding, weaning and some superstitious factors also influence certain community. The studied population was randomly selected from the marginalized or underprivileged community. Our earlier finding in similar type of population suggests that some time, the children do not complete their immunization course due to their parents' ignorance and lack of health awareness. In addition, the children experience a lower hygienic status, adverse household practice, infectious diseases and malnutrition.[31,32] Comprehensive child survival programme, supplementary feeding, health education and awareness may be the way out from undernutrition in this community.

Table 4. Values of SI, UI and WI among the studied children

Index	Boys CIAF = 193	Girls CIAF = 190	Overall (sex combined)
SI = Stunting / CIAF	136 / 193 = 0.705	131 / 190 = 0.689	267 / 383 = 0.697
UI = Underweight / CIAF	148 / 193 = 0.767	140 / 190 = 0.737	288 / 383 = 0.752
WI = Wasting / CIAF	80 / 193 = 0.415	74 / 190 = 0.389	154 / 383 = 0.402

Few interesting findings show that improving agricultural capabilities can have a positive impact on childhood nutritional outcomes. Interventions at grass-root level to improve education, health, sanitation and household infrastructure, care and feeding practices are also critically prerequisite. Innovative strategies that integrate agriculture and nutrition programs stand a better chance of combating the malnutrition problem.[33] India is an agriculture based country. But more innovation in field-productivity of drought-, flood- and other environmental ailment-resistant variety of grains should be introduced with the help of modern biotechnological research. Selective and cautious choice of land for industrial utilization and secured agricultural land bank and agricultural activities will help the sustenance of good social structure and proper community health. One report suggest that the overall nutritional status of children under 5 yr and relevant other social indicators was comparatively stable during and after the global economic crisis, attributable to the Chinese government's policy response.[34] Likewise, being agriculture based country; India also experienced a similar scenario of overall protection. But the nutritional status in

poorer rural areas fluctuated in response to the economic crisis. So, intervention must be taken to protect the most vulnerable population.[34]

In the present study we have covered only a limited population of the community. We think further detailed research work will reveal the clear picture. Socioeconomic up-gradation in the developing countries necessitates the continuous monitoring of nutritional factors and verify/ validate the developmental indicators in preschool children. In this regard, the policy of Chin and several countries may be mentioned.[35] Our present estimates will be helpful for the nation to formulate surveys which assess the prevalence of factors that contribute to undernutrition. Some recent actions have been taken in the present studied area at Government and local administration level to upgrade the nutritional/ health status of the local community and restore the equity in the distribution of benefits. Detail longitudinal investigations are required to conclude the possible association of different factors. The understanding of how several factors attributing to malnutrition, vary by geography, socio-demographic and economic profiles will make it easier to design global interventions that are more integrative and effective.

References

[1] International Institute of Population Sciences. National Family Health Survey (NFHS), Chhttisgarh (1998-1999). Mumbai, 2002.

[2] Schofield C, Ashworth A. Why have mortality rates for severe malnutrition remained so high? Bull World Health Organ 1996;74:223-229.

[3] World Health Organization. World Health report. Geneva: The Organization; 2002.

[4] World Health Organization, United Nations Children's Fund. Joint statement on the management of acute diarrhoea. Geneva: The Organization; 2004.

[5] Food and Agricultural Organization, United Nations. Undernourishment around the world. In: The state of food insecurity in the world 2004. Rome: The Organization; 2004.

[6] OP, Paul VK, Bagga A. Ghai Essential Pediatrics. 17 th ed. 2010; pp 62.

[7] Park K. Park's Textbook of Preventive and Social Medicine. 21st ed. Jabalpur; M/s Banarsidas Bhanot Publisher 2011.

[8] Bamji MS. Early nutrition and health-Indian perspective. Curr Sci. 2003;85: 1137-1142.

[9] National Nutrition Monitoring Bureau (NNMB and NIN). National Institute of Nutrition, Hyderabad. (c.f. Parvathi, 2001), 1993.

[10] Svedberg P. Poverty and Undernutrition; Theory, Measurement and Policy. Oxford India Paperbacks, New Delhi. 2000.

[11] Nandy S, Irving M, Gordon D, Subramanian SV, Davey Smith G. Poverty, child undernutrition and morbidity: new evidence from India. Bull World Health Organ. 2005;3:210-216.

[12] Bhattacharya AK. Composite index of anthropometric failure (CIAF) classification: is it more useful? Bull WHO 2006;86:335.

[13] Bose K and Mandal GC. Proposed New Anthropometric Indices of Childhood Undernutrition. Mal J Nutr. 2010;16:131-136.

[14] Nandy S, Miranda JJ. Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. Soc Sci Med. 2008;66:1963–1966.

[15] "Urban Agglomerations/Cities having population 1 lakh and above". Provisional Population Totals, Census of India 2011. http://www.censusindia.gov.in/2011 -prov-results/paper2/data_files/India2/Tabl e_3_PR_UA_Citiees_1Lakh_and_A bove.pdf. Retrieved 2011-10-21.

[16] Mishra D, Singh HP. Kuppuswami's socioeconomic status scale – A revision. Indian J Pediatr. 2003;70:273-274.

[17] Lee RD, Nieman DC. Nutritional assessment. 3rd ed. New York; McGraw Hill; 2003.

[18] World Health Organization. Measuring changes in nutritional status. Geneva: World Health Organization; 1983.

[19] Nyaruhucha CNM, Mamiro PS, Kerengi AJ, Shayo NB. Nutritional status of under five children in a pastoral community in Simanjiro district, Tanzania. Tanzan Health Res Bull. 2006;8:32-36.

[20] International Institute for Population Sciences (IIPS) and ORC Macro International. National Family Health Survey (NFHS-3), 2005-06, Mumbai: IIPS; 2007.

[21] Zhang J, Shi J, Himes JH, Du Y, Yang S, Shi S, Zhang J. Undernutrition status of children under 5 years in Chinese rural areas - data from the National Rural Children Growth Standard Survey, 2006. Asia Pac J Clin Nutr. 2011;20:584-592.

[22] Bisai S, Bose K, Dikshit S. Underweight and stunting among slum children of Midnapore, India. J Paediatr Child Health. 2009;45:161-162.

[23] World Health Organization. Physical Status: The use and Interpretation of Anthropometry. Technical report Series no. 854. WHO: Geneva 1995.

[24] Mark S, Lambert M, O'Loughlin J, Gray-Donald K. Household income, food insecurity and nutrition in Canadian youth. Can J Public Health. 2012;103:94-99.

[25] Anderson SE, Must A, Curtin C, Bandini LG. Meals in Our Household: reliability and initial validation of a questionnaire to assess child mealtime behaviors and family mealtime environments. J Acad Nutr Diet. 2012;112:276-284.

[26] National Family Health Survey (NFHS-2, 1998-99).

http://www.measuredhs.com/pubs/pdf/FRIND2/FRIND2.pdf

[27] Biswas S, Bose K, Mukhopadhyay A, Bhadra M. Prevalence of undernutrition among pre-school children of Chapra, Nadia District, West Bengal, India, measured by composite index of anthropometric failure (CIAF). Anthropol Anz. 2009;67:269-279.

[28] Sguassero Y, de Onis M, Bonotti AM, Carroli G. Community-based supplementary feeding for promoting the growth of children under five years of age in low and middle income countries. Cochrane Database Syst Rev. 2012;6:CD005039.

[29] Persson LÅ, Arifeen S, Ekström EC, Rasmussen KM, Frongillo EA, Yunus M. Effects of prenatal micronutrient and early food supplementation on maternal hemoglobin, birth weight, and infant mortality among children in Bangladesh: the MINIMat randomized trial. JAMA 2012;307:2050-2059.

[30] Bose K, Bisai S, Chakraborty J, Datta N, Banerjee P. Extreme levels of underweight and stunting among pre-adolescent children of low socioeconomic class from Madhyamgram and Barasat, West Bengal, India. Coll Antropol. 2008;32:73-77.

[31] Ray A, Sinha NK, Maiti S, Roy SK, Maiti K. Reciprocity between partial immunization and malnutrition significantly impairs health of preschool children. Indian Journal of Maternal and Child Health. 2013;15(1).

[32] Sinha NK, Maiti K, Samanta P, Das DC, Banerjee P. Nutritional status of 2–6 year old children of Kankabati grampanchayat, Paschim Medinipur district, West Bengal, India. Sri Lanka Journal of Child Health. 2012; 41(2):60-4.

[33] Gulati A, Ganesh-Kumar A, Shreedhar G, Nandakumar T. Agriculture and malnutrition in India. Food Nutr Bull. 2012;33:74-86.

[34] Chen C, He W, Wang Y, Deng L, Jia F. Nutritional status of children during and post-global economic crisis in China. Biomed Environ Sci. 2011;24:321-328.

[35] Liu J, Ai YX, Hanlon A, Shi Z, Dickerman B, Compher C. Micronutrients deficiency and associated sociodemographic factors in Chinese children. World J Pediatr. 2011;7:217-223.