_____

Original scientific paper

Assessment of Growth and nutritional status of primary school going children - A scenario of North 24 Parganas in West Bengal, India

Sreeparna Banerjee[1], Subir Biswas[2], Manoranjan Pal[3] and Premananda Bharati[4]

Authors and affiliations

[1]**Sreeparna Banerjee,** Research Scholar, Department of Anthropology, West Bengal State University, Corresponding Author: banerjeesree15@gmail.com;
[2]**Subir Biswas,** Professor, Department of Anthropology, West Bengal State University <gargisubir@gmail.com>;
[3]**Manoranjan Pal,** Former Professor and Head, Economic Research Unit, Indian Statistical Institute manoranjan.pal@gmail.com;
[4]**Premananda Bharati**, Retired Professor and Head, Biological Anthropology Unit, Indian Statistical Institute, <pbharati@gmail.com>

Corresponding author: Sreeparna Banerjee, Research Scholar, Department of Anthropology, West Bengal State University. Email: banerjeesree15@gmail.com

Assessment of Growth and nutritional status of primary school going children - A scenario of North 24 Parganas in West Bengal, India

Sreeparna Banerjee[1], Subir Biswas[2], Manoranjan Pal[3] and Premananda Bharati[4]

[1]**Sreeparna Banerjee,** Research Scholar, Department of Anthropology, West Bengal State University, Corresponding Author: banerjeesree15@gmail.com;
[2]**Subir Biswas,** Professor, Department of Anthropology, West Bengal State University <gargisubir@gmail.com>;
[3]**Manoranjan Pal,** Former Professor and Head, Economic Research Unit, Indian Statistical Institute manoranjan.pal@gmail.com;
[4]**Premananda Bharati**, Retired Professor and Head, Biological Anthropology Unit, Indian Statistical Institute, <pbharati@gmail.com>

Corresponding author: Sreeparna Banerjee, Research Scholar, Department of Anthropology, West Bengal State University. Email: banerjeesree15@gmail.com

ABSTRACT

The study is carried out on 1219 primary school going Bengali children (609 are girls and 610 are boys) of North 24 Parganas district of West Bengal to investigate the physical growth as well as nutritional status. The study reveals that mean height, weight and body mass index (BMI) of boys are higher than girls up to 9 years of age respectively. After that, girls became taller and heavier than boys. Comparison of the current study findings with NCHS reference data reveals that boys and girls of present study have lower mean values of height, weight and BMI. The overall prevalence of overweight is 27.9 percent (30% for boys; 25.8% for girls), underweight is 24 percent (21.3% for boys; 26.6% for girls), thinness is 22.6 percent (21.6% for boys; 23.5% for girls), and about 14.8 percent children are stunted (13.8% for boys; 15.9% for girls). The highest prevalence (25.6%) of underweight is found among 9-year-old children and the lowest (21.9%) is found in the age group of 10 year. Stunting is the highest in the age group of 10 years (24.1%) and the lowest prevalence of stunting is 4.8 percent in the age group of 6 years of children. The highest prevalence of thinness (26.7%) is found in the age 6 years and the lowest prevalence (17.8%) is found in the age 10 years. Regarding overweight, the highest prevalence of overweight is found among 10-year-old children (33%) and the lowest (20.3%) is found in the age 6-year-old children. Region or population specific cut-off points should be developed. It may better reflect the actual scenario of any ethnic groups under the study.

Key words: *Undernutrition, stunting, underweight, modified composite index, anthropometric failure*

INTRODUCTION

Anthropometry is used as an important tool to assess the growth and nutritional status of individuals or population groups or community. Now-a-days, child growth and nutritional status is a global concern in both developed and developing countries. NFHS-5 (2019-2021), depicts that 26 percent of children under five years of age are stunted, 19 percent are wasted, 32 percent are underweight, and 3 percent are overweight.

Childhood is a crucial stage of human life because it is associated with human growth and development. Growth proceeds expeditiously in early life, downtrend in middle childhood and speed up at puberty before linear growth ceases (Bartolo, 2014). Improper nutrition leads to the increase in the risk of illness and is directly or indirectly responsible for child mortality (WHO, 2009). The burden of malnutrition remains inextricable, specifically in low- and middle-income countries, where about 200 million children in 2020 are affected by stunting or wasting and almost double as many suffer from the deficiencies in vitamins and other essential micronutrients. These micronutrient deficiencies are often termed as 'hidden hunger' or 'hidden malnutrition' as they inconspicuously affect the health and development of a population (Grebmer et al. 2014). At the same time the number of children with overweight and obesity is growing at an alarming rate, increasingly affecting children from poorer households. The co-existing of these three forms of malnutrition (undernutrition in the form of stunting and wasting; micronutrient deficiencies and overweight or obesity) within the same population is defined as the triple burden of malnutrition (UNICEF, Nutrition, For every Child: UNICEF nutrition strategy 2020-2030, 2020). This causes unrepairable physical damage to their bodies and brains, exert influence on children's ability to learn in school (UNICEF, Nutrition First: From surviving to thriving, 2019).

Children are vulnerable to malnutrition because of food insecurity amongst children (Govender et al. 2004), recurrent infections, uneven distribution of food in the family, improper care etc. (De & Chattopadhyay, 2019). Poverty and ignorance are the responsible factors for malnourishment and malnourishment is the major cause of diseases and mortality among children in developing countries like India. In 2002 the UN's Standing Committee on Nutrition began to upgrade research and inventions regarding malnutrition of school-age children, because of this age group children have the potential to experience 'catch up' growth, for example, school-age children who are undernourished early in life can grow to have normal weight- for -age if they are provided a proper or balanced diet. Without proper nutrition during childhood leads to delayed moto skill (Action Against Hunger, 2006), lower cognitive development as well as school performance (Acham et al. 2012; Alderman et al. 2017). Undernourishment has a prolonged effect on growth and development and sometimes may result in growth failure and permanent impairment of the body of the child (Osmani & Sen 2003). Malnutrition in children has a long-term effect on health of children in the coming years (Khan & Raza 2013).

There exist lots of studies in the field of child health and nutrition status of children in different parts of West Bengal (Khanra et al. 2019; Bisai & Mallick 2011; Bose et al. 2007;

Chakraborty & Datta 2018; Das et al. 2017)**, but a scanty information is available regarding nutrition status of primary school age children of North 24 Parganas District, West Bengal.

In this backdrop, the present study is an attempt to investigate the prevalence of undernutrition, stunting, thinness and overweight among urban primary school children in North 24 Parganas District of West Bengal.

MATERIALS AND METHODS

Study area and respondents: The present study is conducted in North 24 Parganas district, West Bengal, India. A total of 1219 children are covered out of which 609 are girls and 610 are boys.

Research design: Present study is based on the primary data. It is a cross-sectional field based retrospective study. All data is collected by the researcher herself during 9-Feburary 2023 to 10 October 2023. Age is ascertained in completed year of each subject verified through school diary or identity cards. In this study, the age of individual has been reckoned as whole number without considering months such as 6 years 0 months to 6 years 11 months has been considered as 6 years.

Sampling procedure: From the list of primary schools in North 24 parganas district with substantial numbers of girls and boys, some schools are selected randomly and then the willing students at these schools are interviewed. Prior consent from the school authorities is taken before collection of data. Appropriate anthropometric measurements are taken according to the method suggested by Weiner & Lourie (1981).

Statistical analysis: Independent t test is used to assess the differences in the height, weight and BMI between the age and sex. All the statistical analyses are performed using SPSS 19 package. p value less than 0.05 is considered statistically significant.

Assessment of nutritional status: WHO (2006) growth standard for children is used as the reference data for examining the nutritional status of children. Three commonly used undernutrition indicators are low- weight-for-age (Underweight), Low height-for-age (stuntedness), low BMI-for-age (thinness) are used to evaluate the nutritional status of the subjects. At the same time overweight and obesity is also considered in the study. The severity of undernutrition is assessed by utilizing the percentile. Subject with less than 5th percentile is classified as suffering from underweight, stuntedness and thinness. Modified composite index of anthropometric failure (mCIAF) models developed by (Destaw et al. 2021) is used for the present study.

Table 1. The modified CIAF model adapted for children age group 6-10 as follows

Categories	Description	Stunting	Underweight	Thinness	Overweight
A	Without anthropometric failure	No	No	No	No
B	Thinness only	NO	No	Yes	No
C	Thinness and underweight	No	Yes	Yes	No
D	Stunting, Thinness and Underweight	Yes	Yes	Yes	No
E	Stunting and underweight	Yes	Yes	No	No
F	Stunting only	Yes	No	No	No
G	Overweight	No	No	No	Yes
H	Stunting and excess weight (overweight and obese)	Yes	No	No	Yes
Y	Underweight only	No	Yes	No	No

RESULTS

Table 2 shows the descriptive statistics for height, body weight and Body Mass Index (BMI) across age groups for boys and girls separately. Boys are taller than girls up to 9 years of age. After reaching 10 years, girls exceed boys becoming significantly taller than boys. Significant sex differences in mean height by age groups are observed. Similarly, boys are heavier than girls up to 9 years and it is significant at 5 percent level except at age 7 and 10. At age 10 girls became heavier than boys but it is not statistically significant.

From this table, it is clear that mean height, body weight and BMI increased with age for boys and girls. In the case of height, the mean values are increasing as the age increases in both boys and girls. For example, among boys, the mean values of height are 114.8 cm at age 6 years, 119.4 cm at age 7 years, 123.4 cm at age 8 years, 127.8 cm at age 9 years and 130.3 cm at age 10 years. The mean values of weight increase with the increasing age of the children. The lowest value of weight is observed at the age of 6 years which is 20.1 Kg, and the highest value is 29.1 Kg, observed for boys at age 10. Gradual increase of weight is traced between different ages of boys. Similar trends are observed among girls. Similarly, the lowest BMI is 15.2 kg/m^2 for boys and 14.6 kg/m^2 for girls both at age 6 years. The highest BMI is 17.2 kg/m^2 and 17.5 kg/m^2 in boys and girls at 10 years of age. There is no significant sex difference in mean BMI values except at age 6.

The statistical comparative analysis of the present height, weight and BMI with National Center for Health Statistics data is shown in Table 3 and Figure 1,2 and 3. The study points out that the present study has a much lower mean value of height than NCHS reference data for both boys and girls. The pattern indicates a small difference in early age, with increment of age this difference becomes further widen. Among boys at age 6, the difference of height of present study with NCHS reference data is about 5.7 cm and this difference increases as age increases (7.0 cm at age 7, 9.5 cm at age 8, 11.0 cm at age 9, and 12.4cm at age 10). Similar trends are observed for girls. The table also shows that in all age groups, the difference of mean height of the present study with reference data is highly statistically significant.

Table 4 presents the prevalence of underweight, stuntedness, thinness and overweight by age and sex. The findings do not reveal significant differences between boys and girls so far as prevalence of underweight, stunting, thinness and overweight are concerned. The prevalence of underweight among girls is 26.6 percent which is higher than that of boys (21.3%) but this difference is not statistically significant. The table also shows that the highest prevalence (31.8%) of underweight is found among 6 years of girls and the lowest (21.6%) is found in the age group of 10. In contrast to boys, the highest prevalence (22.8%) of underweight is found in 8 years of age and the lowest (17.2%) is found in the age group of 6. Stunting is the highest (23.8%) in the age group of 10 years of girls and the lowest (4.5%) is found in the age group of 6. Whereas among boys, the highest prevalence of stunting (23.8%) is found among age of 10 years and the lowest (5.1%) is found in the age group of 6. Similarly, the highest percentage of thinness (28.4%) is found in the age group of 6 years of girls and the lowest (18.4%) is found in the age group of 10

years. In contrast to boys, the highest prevalence of thinness (27.1%) is found in the age group of 8years and the lowest (17.3%) is found in the age group of 10 years. Interestingly, the highest prevalence of overweight (31.4%) is found among girls in the age of 10 years and the lowest (22.0%) is found in the age of 7 years. However, among boys, the highest prevalence (34.6%) of overweight is found in the age of 10 years and the lowest (22%) is found in the age of 7 years.

The study also pointed out that the prevalence of overweight is higher among boys (30%) than girls (25.8%), though the differences are not significant. The prevalence of underweight is higher among girls (26.6%) than boys (21.3%). However, no statistically significant differences are observed regarding underweight, stunting and thinness among boys and girls.

Comparison of mCIAF between girls and boys depicts insignificant differences (chi-square = 0.239; df =1) as shown in Table 5. The study reveals that 41.5 percent boys and 42.9 percent girls have no anthropometric failure, thus 58.5 percent boys and 57.1 percent girls are under CIAF category. Furthermore, 3.4 percent of boys and girls are only stunted. Similarly, 3.6 percent boys and 1.8 percent girls are only thin whereas 1.3 percent boys and 2.3 percent girls are underweighted only. 25.6 percent of boys and 19 percent of girls are only overweight (the highest proportion in the subgroup).

About 14 percent of boys and 17.6 percent of girls are under thinness as well as underweight category, 3.6 percent boys and 4.1 percent girls fall under stunting, thinness and underweight category. About 2 percent of children (boys and girls) are stunting as well as underweight, moreover 4.4 percent boys and 6.2 percent girls are stunting as well as having excess weight. Furthermore, no consistent gender differences are observed regarding composite anthropometric failure.

DISCUSSION

The present study tries to measure overall anthropometric failure that shows the prevalence of malnutrition among school age children in West Bengal. The sex and age specific mean height, weight and BMI are used to identify the growth pattern of the children of North 24 Parganas. The mean height, mean body weight, mean BMI of all age group children for both boys and girls are significantly lower than that of NCHS reference data except girls at 9 years of age that show no significant difference regarding weight when compared to NCHS reference data. Similar study conducted by Deb & Dhara (2013) shows lower mean values of height, weight and BMI in respect of age and sex than the present study.

The assessment of malnutrition in the present study is based on height-for-age (stunting), weight-for-age (underweight), low BMI-for-age (thinness), high BMI-for-age (overweight). Although the conventional indices determine the prevalence of malnutrition, mCIAF shows a much higher proportion of malnourished school children. mCIAF also identifies single and multiple anthropometric failures at a time.

Malnutrition continues to be a serious problem in most of the developing countries like India. Studies on nutritional status of school-age children in different parts of India shows prevalence of varying proportion of malnutrition. The incidences of anthropometric failure in the current study are found to be distinctly lower than the study of Nandy et al. (2005), which depicts that 59.8 percent of children are falling under CIAF, Seetharaman et al. (2007) revealed that 68.6 percent of Tamil children are under anthropometric failure, Boregowda et al. (2015) identified 62.1 percent of children of Chhattisgarh are suffering from undernutrition based on CIAF. A study conducted by Ghosh & Shah, (2004) shows 71.7 percent of children are under anthropometric failure. However, a study conducted in Bankura, West Bengal (Shit et al. 2012), depicts that percentage of CIAF among toddlers is 78.1%, which is higher than previously mentioned study as well as the current study. A recent study in West Bengal reports that 61.3 percent of preschool children suffer from CIAF (Biswas et al. 2018). An impressive study done by Sen et al. (2011) reports the prevalence of CIAF as 57.6 percent among Bengalee Muslim children aged 5-11 years in the Darjeeling district, West Bengal, which slightly lower than the present study.

In the current study, the prevalence of mCIAF is higher than other conventional undernutrition indices (underweight 24%, stunting- 14.8%, thinness 22.6%, overweight 27.9%). About 57.8 percent of children shows single and multiple anthropometric failure.

The incidences of undernutrition obtained in the current study is found to be lower than children of Rajasthan (53% stunting, 60% underweight and 28% wasted) as pointed by Singh et al. (2006) and among the school going children of Purba Medinipur, West Bengal (31% stunted, 21.1%wasted, 41.9% underweight) as documented by Khanra et al. (2019). The incidences of underweight is significantly higher among girls than boys in the current study. Similarly, the incidence of stunting in the current study is found to be lower than the values reported from West Bengal (13.9%) and in Assam, the percentage of stunting (14.2%) as reported by Som et al. (2006) which is more or less same compared to the present study.

An impressive study conducted by Cole et al. (2007) highlights that undernutrition is better assessed by thinness (low-BMI-for-age) than wasting (low-weight-for-height). So, in the present study we considered low BMI-for-age instead of low weight-for height. The incidence of thinness (12.6%) in the present study by age and sex combined is lower than children of Nandigram study (62.9% thinness among boys and 61.6% thinness among girls) done by Mahapatra & Bose, (2020). Bisai & Manna, (2010), documented that about 47% of children are suffering from thinness (11.9% Grade III, 12.4 % Grade II and 22.8 % Grade I) which is higher than current study (12.6%).

The prevalence of overweight/obesity among primary school children is found to be 35.9 percent (Overweight 21.6% and obesity 14.3%) in Thanhhoa city, conducted by Ba & Dinh, (2022). Another study in Tanzania, revealed that about 15.9% percent and 5.7 percent of children are suffering from overweight (Pangani et al. 2016). Surprisingly, the prevalence of overweight is higher among children of current study (27.9%). About 14.9 percent and 3.8 percent of boys of

Midnapore, West Bengal are suffering from overweight and obesity which is higher than the current study (Bisai et al. 2012).

Existing literature based on burden of malnutrition among school going children reveals that there is scanty of data from Indian, particularly among Bengali population of West Bengal. Moreover, to the best of our knowledge, there is no study available on mCIAF among primary school going children in North 24 Parganas of West Bengal, India.

Conclusion

The current study documents that the prevalence of malnutrition among primary school going children is still a major concern. In addition, there is also an emerging trend of overweight, which indicates dual burden of malnutrition. Furthermore, as the study is conducted in urban area of North 24 Parganas, no gender differences are observed regarding nutritional status of children. It is recommended that due to huge physical variation in the country (India) any single reference is not comparable to cover all the population. Therefore, region or population specific cut-off points should be developed covering all the age group of the population and it may better reflect the actual scenario of any ethnic groups under. The current study will help government and NGOs to formulate effective nutritional intervention and public health policies.

Acknowledgements

Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

1. Acham, H., Kikafunda, J., Malde, M., Tjeron, O., Wilna, H., & Egal, A. A. (2012). Breakfast, midday meals and academic achievement in rural primary schools in Uganda: implications for education and school health policy. *Food & Nutrition Research, 56*(1), 1-12.

2. Action Against Hunger. (2006). *ACF International Annual Activity Report 2006.* New York, United States: Action Against Hunger.

3. Alderman, H., Behrman, J. R., Glewwe, P., Fernald, L., Walker, S. (2017). Evidence of Impact of Interventions on Growth and et Development during Early and Middle Childhood. In D. Bundy, N. Silva, S. Horton , & S. N. Bundy DAP (Ed.), *Child and Adolescent Health and Development. 3rd edition.* Washington (DC): The International Bank for Reconstruction and Development / The World Bank. doi:https://www.ncbi.nlm.nih.gov/books/NBK525234/ doi: 10.1596/978-1-4648-0423-6_ch7

4. Ba Le, G., & Dinh, D. X. (2022). Prevalence and associated factors of overweight and obesity among primary school children: a cross-sectional study in Thanhhoa City, Vietnam. *BMJ Open, 12*(e058504), 1-10.

5. Bartolo, M. (2014). Nutrition in childhood. *J Malta College Doctors, 3*, 12-20.

6. Bisai, S., & Mallick, C. (2011). Prevalence of undernutrition among Kore-Mudi childlren aged 2013 years in Paschim Medinipur District, West Bengal, India. *World Journal of Pediatrics, 7*(1), 31-36. doi:10.1007/s12519-010-0239-3

7. Bisai, S., & Manna, I. (2010). Prevalence of Thinness among Urban Poor Pre-School Children in West Bengal, India. *Sudanese Journal of Public Health, 5*(4), 193-198.

8. Bisai, S., Khongsdier, R., Bose, K., & Mahalanabis, D. (2012). Double burden of malnutrition among urban Bengalee adolescent boys in Midnapore, West Bengal, India. *Nature Preceding*, 1-16.

9. Biswas, S., Giri, S., & Bose, K. (2018). Assessment of nutritional staus by composite index of anthropometric failure (CIAF): a study among preschool children of Sagar Block, South 24 Parganas DIstrict, West Bengal, India. *Anthropol Rev, 81*, 225-51.

10. Boregowda, G., Soni, G., Jain, K., & Agrawal, S. (2015). Assessment of Under Nutrition Using Composite Index of Anthropometric Failure (CIAF) amongst Toddlers esiding in Urban Slums of Raipur City, Chhattisgarh, India. *Journal of Clinical and Diagnostic Research, 9*(7), LC04-LC06.

11. Bose, K., Bisai, S., & Mukherjee, S. (2007). Anthropometric charatceristics and nutritional status of rural school children. *The Internet Journal of Biological Anthropology, 2*(1), 1-6.

12. Chakraborty, S., & Datta , S. (2018). Malnutrition Scebario of West Bengal. *International Journal if Interdisciplinary Research and Innovations, 6*(3), 123-132.

13. Cole, T. J., Flegal, K. M., Nicholls, D., & Jackson, A. A. (2007). Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ, 335*(194), 1-8. doi:https://doi.org/10.1136/bmj.39238.399444.55

14. Das, S., Ghritlahre, M., Tiwari, B., & Bose, K. (2017). Assessment of Nutritional status among 2 to 12 years children of two districts in West Bengal, India. *Journal of Life Science, 9*(2), 118-125. doi:10.1080/09751270.2017.1336019

15. Das, S., Ghritlahre, M., Tiwari, B., & Bose, K. (2017). Assessment of nutritional status among 2 to 12 years children of two districts in WestBengal. *Journal if life sciebce, 9*(2), 118-125.

16. De, P., & Chattopadhyay, N. (2019). Effects of malnutrition on child development: Evidence from a backward district of India. *Clinical Epidemiology and Global Health, 7*(3), 439-445.

17. Deb, P., & Dhara, P. (2013). Anthropometric Measurements and Undernutrition: A Case on School Children of SOuth Tripura, India. *Journal of Life Science, 5*(1), 47-51.

18. Destaw, Z., Wencheko, E., Zemenfesidus,S., Challa, Y., Triuneh, M., Fite, M. T., Shaleka,D., Ashenafi, M. (2021). Use of modified composite index of anthropometric failure and MUAC-for-age to assess prevalence of malnutrition among school-age children and adolescents involved in the school feeding program in Addis Ababa, Ethiopia. *BMC nutrition, 7*(81), 1-11.

19. Ghosh, S., & Shah, D. (2004). Nutritional problems in Urban slum children. *Indian Pediatr, 41*, 682-96.

20. Govender, I., Rangiah, S., Kaswa, R., & Nzaumvila, D. (2004). Malnutrition in children under teh age of 5 years in a primary health care setting. *South African Family Practice, 63*(1), 1-6.

21. Grebmer, K. V., Birol, E., Wiesman, D., Prasai, N., Yin, S., Yohannes, Y., Menon, P., Thompson, J., Sonntag, A. (2014). *2014 Global Hunger Index: The challenge of hidden hunger.* (A. Sonntag, L. Neubauer, O. Towey, K. V. Grebmer, & S. Yin, Eds.) Bonn, Germany, Washington, D.C, Dublin, Ireland: Welthungerhilfe, International Food Policy Research Institute, and Concern Worldwide. doi:10.2499/9780896299580

22. Khan, R. E., & Raza, M. A. (2013). Child malnutrition in developing economies: a case study of Bangladesh. *Quality and Quantity, 48*, 1389-1408.

23. Khanra, P., Biswas, S., & Bose, K. (2019). Nutritional assessment by composite Index of anthropometric failure among school going children of Purba Medinipur, West Bengal, India. *Human Biology Review, 8*(1), 66-76.

24. Mahapatra, B., & Bose, K. (2020). Prevalence of Thinness among tribal preschool children of West Bengal: An assessment measured by BMI cut off points. *Antrocom Journal of Anthropology, 2*(2020), 213-222.

25. Nandy, S., Irving, M., Gordon, D., Subramanuan, S., & Smith, D. G. (2005). Poverty, child undernutrition and morbidity: New evidence from India. *Bull World Health Organ, 83*, 210-6.

26. National Family Health Survey (NFHS-5). (2019-2021). *Compendium of fact sheets, India adn 14 states/UT (phase-II).* NFHS.

27. Osmani, S., & Sen, A. (2003). The hidden penalties of gender inqualitty: fetal origins of ill-health. *Economics and Human Biology, 1*, 105-121.

28. Pangani, I. N., Kiplamai, F., Kamau, J., & Onywera, V. O. (2016). Prevalence of Overweight and Obesity among Primary School Children Aged 8–13 Years in Dar es Salaam City, Tanzania. *Advances in Preventive Medicine, 2016*, 1-5.

29. Seetharaman, N., Chacko, T. V., Shankar, R. S., & Mathew, A. (2007). Measuring malnutrition-The role of Z-scores and the Composite Index of ANthropometric Failure (CIAF). *Indian Journal of Community Medicine, 32*(1), 35-39.

30. Sen, J., Dey, S., & Mondal, N. (2011`). Conventional nutritional indices and composite index of anthropometric failure: which seems more appropriate for assessing undernutrition amon children? A cross-sectional study among school children of the Bengalee Muslim polulation of North Bengal, INid. *Indian J Publ Health, 9*, 172-185.

31. Shit, S., Tharapdar, P., Mukhopadhyay, D., Sinhababu, A., & Biswas, A. (2012). Assessment of nutritional status by Composite index of anthropometric failure: a study among children in Bankura, West Bengal. *Indian J Public Health, 56*, 305-07.

32. Singh, M., Fotedar, R., Lakshminarayana, J., & Anand, P. (2006). Studies on the nutritional status of children aged 0-5 years in a drought-affected desert area of WesternRajasthan, India. *Public Health Nutrition, 9*, 961-67.

33. Som, S., Pal, M., Bhattacharya, B., Bharati, S., & Bharati, P. (2006). Socioeconomic differences in nutritional status of children in the states of WestBengal and Assam, India. *J Biosoc Sci, 38*, 625-42.

34. UNICEF. (2019). *Nutrition First: From surviving to thriving.* Retrieved June 20, 2024, from UNICEF for every child: https://www.unicef.org/india/what-we do/nutrition#:~:text=Good%20nutrition%20%2D%20Bedrock%20of%20child,on%20a%20child's%20entire%20lifetime.

35. UNICEF. (2020). *Nutrition, For every Child: UNICEF nutrition strategy 2020-2030.* New York: UNICEF.

36. Weiner, J., & Lourie, J. (1981). *Practical human biology.* Newyotk, London.

37. World Health Organization (WHO). (2009). *Infant and young child feeding: Model chapter for textbooks for medical students and allied health professionals.* Geneva: WHO.

Table 2. Age and sex wise mean and standard deviations of height (cm), weight (Kg) and BMI (kg/m^2) of the children

Age (years)	N		Height		t-test	Weight		t-test	BMI		t-test
			Mean ± SD			Mean ± SD			Mean ± SD		
	Boys	Girls	Boys	Girls		Boys	Girls		Boys	Girls	
6	99	88	114.8±3.9	113.5±4.0	2.23*	20.1±3.66	18.9±3.7	2.26*	15.2±2.6	14.6±2.6	1.52*
7	118	109	119.4±4.6	117.7±4.7	2.85**	21.6±4.0	20.6±4.6	1.74	15.1±2.5	14.9±3.0	0.78
8	114	110	123.4±4.1	121.8±4.8	2.65**	24.6±5.5	23.0±5.1	2.22*	16.1±3.2	15.5±3.3	1.36
9	94	117	127.8±4.4	125.9±4.1	3.31**	27.5±6.7	25.8±6.1	1.98*	16.8±3.8	16.3±3.8	0.99
10	185	185	130.3±4.2	132.2±9.3	-2.49*	29.1±6.1	30.3±7.1	-1.68	17.2±3.6	17.5±4.4	-0.80

Source: Survey data collected by one of the authors

Table 3. Height (cm), weight (Kg) and Body-Mass-Index (kg/m^2) ~~for age~~ of boys and girls from the present study and NCHS data

Age	Height						Weight						BMI					
	Girls			Boys			Girls			Boys			Girls			Boys		
	Present	NCHS	t-test	Present	NCHS	t-test	Present	NCHS	t-test	Present	NCHS	t-test	Present	NCHS	t-test	Present	NCHS	t-test
6	113.5	119.2	7.16**	114.8	119.3	6.54**	18.9	23.6	5.79**	20.1	24.3	5.95**	14.6	16.5	4.68**	15.2	16.9	4.19**
7	117.6	124.6	8.84**	119.4	125.4	9.10**	20.6	26.8	6.51**	21.6	26.7	7.96**	14.8	17.1	5.74**	15.2	16.9	5.44**
8	121.8	131.3	7.99**	123.4	131.6	8.73**	23.0	31.9	6.26**	24.6	31.3	6.54**	15.5	18.3	4.95**	16.1	17.9	4.20**
9	125.9	137.0	16.26**	127.8	137.9	12.13**	25.8	35.5	0.81	27.5	36.6	5.21**	16.2	18.7	3.98**	16.8	18.9	3.46**
10	132.1	144.5	14.46**	130.3	142.3	23.51**	30.3	41.1	11.96**	29.1	40.0	10.33**	17.4	19.5	4.93**	17.1	19.6	5.67**

Source: Survey data collected by one of the authors and NCHS data (2007-2010)

Figure 1. Height-for-age of boys and girls from the present study and NCHS reference data

Legend:
- NCHS Girls
- NCHS Boys
- Present study boys
- Present study girls

Y-axis: Height in cms
X-axis: Age in years

Figure 2. Weight-for-age of boys and girls from the present study and NCHS reference data

Legend:
- NCHS Boys
- NCHS Girls
- Present study Boys
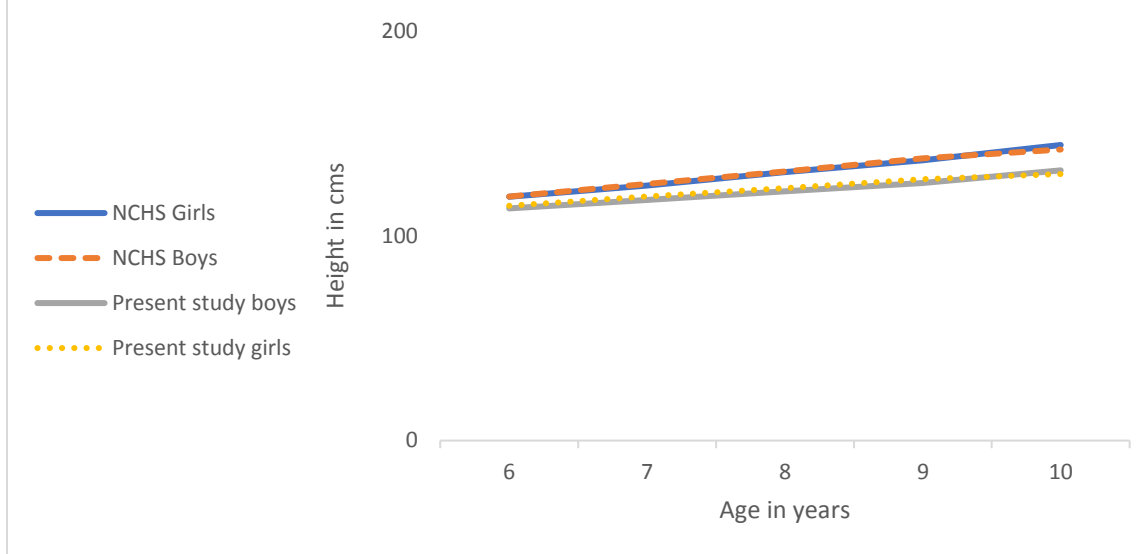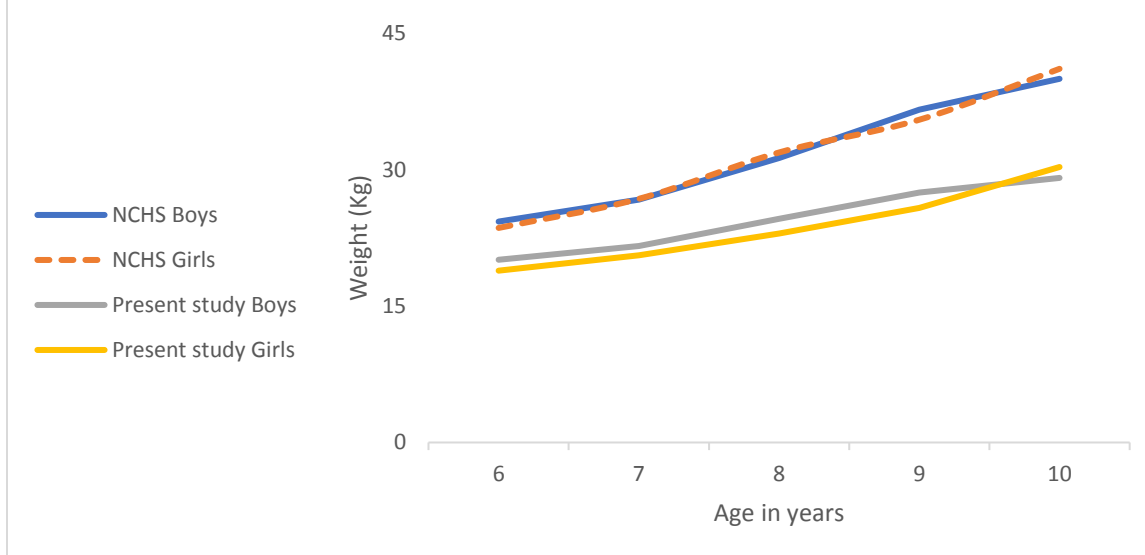- Present study Girls

Y-axis: Weight (Kg)
X-axis: Age in years

Figure 3. BMI-for-age of boys and girls from the present study and NCHS reference data
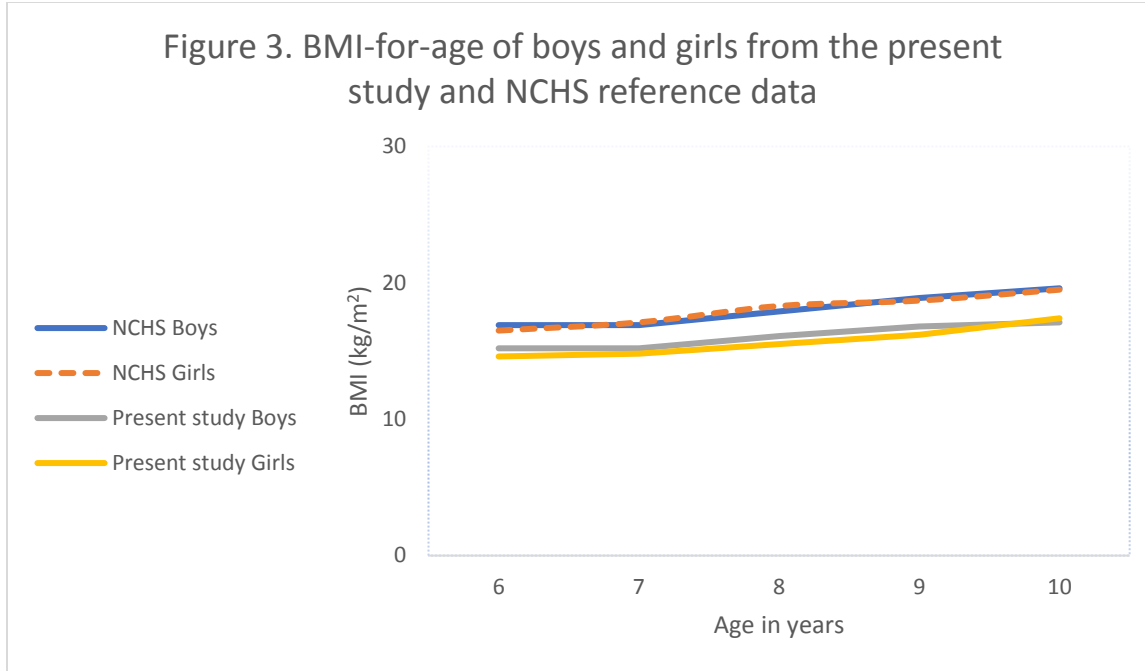
Table 4. Prevalence of malnutrition by age and sex among school-age children

Age (Years)	Underweight			Stunting			Thinness			Overweight		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
6	17 (17.2)	28 (31.8)	45 (24.1)	05 (5.1)	04 (4.5)	09 (4.8)	25 (25.3)	25 (28.4)	50 (26.7)	25 (25.3)	13 (14.8)	38 (20.3)
7	25 (21.2)	32 (29.4)	57 (25.1)	11 (9.3)	11 (10.1)	22 (9.7)	32 (27.1)	32 (29.4)	64 (28.2)	26 (22.0)	26 (23.9)	52 (22.9)
8	26 (22.8)	29 (26.4)	55 (24.6)	11 (9.6)	17 (15.5)	28 (12.5)	24 (21.1)	23 (20.9)	47 (21.0)	33 (28.9)	26 (23.6)	59 (26.3)
9	21 (22.3)	22 (28.2)	54 (25.6)	12 (12.8)	21 (17.9)	33 (15.6)	19 (20.2)	29 (24.8)	48 (22.7)	35 (37.2)	34 (29.1)	69 (32.7)
10	41 (22.2)	40 (21.6)	81 (21.9)	45 (24.3)	44 (23.8)	89 (24.1)	32 (17.3)	34 (18.4)	66 (17.8)	64 (34.6)	58 (31.4)	122 (33.0)
Overall	130 (21.3)	162 (26.6)	292 (24.0)	84 (13.8)	97 (15.9)	181 (14.8)	132 (21.6)	143 (23.5)	275 (22.6)	183 (30.0)	157 (25.8)	340 (27.9)
Total	610	609	1219	610	609	1219	610	609	1219	610	609	1219
Chi square	0.637			0.831			0.373			1.521		

Source: Survey data

Table 5. Distribution of primary school going boys and girls as per different state of undernutrition and modified composite Index of anthropometric failure (mCIAF)

Categories	Description	Boys	(%)	Girls	(%)	Sex combined	(%)
1	Without anthropometric failure	253	41.5	261	42.9	514	42.2
2	Stunting only	21	3.4	21	3.4	42	3.4
3	Thinness only	22	3.6	11	1.8	33	2.7
4	Underweight only *	08	1.3	14	2.3	22	1.8
5	Overweight only	156	25.6	116	19.0	272	22.3
6	Thinness and underweight*	87	14.3	107	17.6	194	15.9
7	Stunting, Thinness and Underweight	22	3.6	25	4.1	47	3.9
8	Stunting and underweight	13	2.1	13	2.1	26	2.1
9	Stunting and excess weight (overweight and obese)	27	4.4	38	6.2	65	5.3
	mCIAF	**357**	**58.5**	**348**	**57.1**	**705**	**57.8**
Chi square test		**0.063**					

Source: Survey data collected by one of the authors.