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Prevalence of thinness among rural children of West Bengal, India

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ABSTRACT

Background: *Prevalence of child undernutrition is a major public health problem in India. Thinness (low BMI-for-age) is an important anthropometric measure of undernutrition.* ***Aims and Objectives:*** *The objectives of the present study were to determine age-sex specific prevalence of thinness and its association with socio-economic and demographic variables among rural children of West Bengal, India.* ***Material and Methods:*** *The present cross-sectional study was carried out among 1250 (618 boys; 632 girls) rural children aged 5 to12 years of Darjeeling, West Bengal. Height and weight were collected using standard anthropometric procedures and Body mass index (BMI) was calculated using standard formula. The prevalence of thinness was assessed by using recently proposed age-sex specific international reference. The data were analyzed using chi-square (χ^2) analysis, ANOVA and binary logistic regression in SPSS (version 17.0).* ***Results:*** *Overall prevalence of thinness among the children was 57.36% (boys: 65.53%; girls: 47.94%; $p<0.05$). Age-specific prevalence of thinness was observed to be higher in 12 years age-group 82.86% (in boys) and 57.58% (in girls). Binary logistic regression analysis showed that e.g., family size, number of individuals, number of sibs, birth order, fathers occupation, mothers occupation, monthly income and toilet facility were significantly associated with prevalence of thinness among the children ($p<0.05$).* ***Conclusion:*** *The prevalence of greater degree of thinness among these children indicates nutritional deprivation. Proper intervention programmes and dissemination of nutrition knowledge are needed. Socio-economic improvement is also necessary to ameliorate the nutrition situation of the children.*

Keywords: Anthropometry, BMI, Public Health, Thinness, Undernutrition

INTRODUCTION

Nutritional issues have been greatly elevated on the global development agenda and have been committed into reducing the prevalence of undernutrition especially among the vulnerable segments of the population (e.g., children and women). Undernutrition undoubtedly is a serious public health challenge in many of the developing countries including India (Khor, 2008; Bhutta *et al*., 2013; Black et al., 2013; Varadharajan *et al.,* 2013; Ramachandran, 2014; UNICEF/WHO, 2016; Debnath *et al.,* 2017; Debnath *et al.,* 2018; Kramsapi *et al.,* 2018; Menon *et al.,* 2018; Mondal and Sharma, 2018). Child undernutrition is estimated to be the largest contributor to the global burden of disease, killing millions of children in the developing countries and causing heavy health expenditures (Black *et al.,* 2003; Bhutta *et al*., 2013; Lenoir- Wijnkoop *et al.,* 2013; Kromeyer-Hauschild *et al.,* 2016; Madrid and Traisci-Marandola, 2016; Debnath *et al.,* 2018; Mondal and Sharma, 2018). Prevalence of undernutrition was accounts for several vulnerable infections and diseases among children which increases the risk of premature mortality among children (Nandy *et al.,* 2005; Nandy and Miranda, 2008; Bhutta *et al*., 2013; Kismul *et al*., 2015; Mohsena *et al*., 2017; Nagar *et al.,* 2018). The prevalence of undernutrition was estimated to be 45.0% of all deaths among children <5 years estimated to be 3.1 million children worldwide (Black *et al.,* 2013) and 800000 neonatal deaths annually (Bhutta *et al*., 2013). Several researchers have pointed out that the widespread poverty and poor socio-economic condition were observed to be the two main underlying causes of undernutrition (Khor, 2008; Antony and Laxmaiah, 2008; Varadharajan *et al.,* 2013; Ramachandran, 2014; Pappachan and Choonara, 2017). It has been estimated that more than half of the children in the country remain undernourished and the country has shown the highest prevalence of global child undernutrition (Khor, 2008; Antony and Laxmaiah, 2008; Varadharajan *et al.,* 2013; Ramachandran, 2014; Khan and Mohanty, 2018). Moreover, studies have reported gender discrimination against the female child i.e., girls were nutritionally more vulnerable than boys (Mondal and Sen, 2010; Sen and Mondal, 2013; Tigga *et al.,* 2015a,b; Rengma *et al.,* 2016; Angadi and Jawaregowda, 2017; Debnath *et al.,* 2018). Child undernutrition is also influenced by several socio-economic and demographic variables such as age, gender, birth order, family size, number of siblings, mother's age at childbirth, residence, family income and sanitation (Mondal and Sen, 2010; Sen and Mondal, 2013; Mahgoub *et al.,* 2006; Mondal *et al.,* 2015; Tigga *et al.,* 2015a; Rengma *et al.,* 2016; Debnath *et al.,* 2018; Khan and Mohanty, 2018; Menon *et al.,* 2018). Research studies have revealed wide socio-economic

differences in the prevalence of co-morbidities and mortality among children (Nandy *et al.*, 2005; Kismul *et al.*, 2015; Mohsena *et al.*, 2017; Pappachan and Choonara, 2017).

Most commonly used conventional anthropometric measures are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height) (WHO 1995; Sen and Mondal, 2013; Nandy *et al.*, 2005; WHO, 2007). The Body Mass Index (BMI) is widely used a surrogate and proxy anthropometric measure to assess nutritional status [chronic energy deficiency (CED) and/or overweight-obesity] of an individual or population (WHO, 1995, 2007; Hall *et al.*, 2007). The use of BMI in relation to age was recommended as the best surrogate anthropometric measure of thinness and overweight during adolescents (WHO 1995, 2007; Cole *et al.*, 2000, 2007). The use of BMI in relation to age (e.g., BMI-for-age) was recommended as the best surrogate anthropometric measure of thinness and overweight during childhood and adolescence (WHO, 1995; Cole *et al.*, 2000, 2007). Recent studies have reported the magnitude of thinness using recently proposed references among Indian children (Mondal, 2014; Sharma and Mondal, 2014; Mondal *et al.*, 2015; Das *et al.*, 2017; Khatun *et al.*, 2017). Therefore, studies on the prevalence of child undernutrition assessment remain important for both international and national comparisons due to the nutritional vulnerability in the vast segment of the population in India. The effects of different socio-economic, demographic and lifestyle factors on thinness also need to be reported for the overall development of the population. It is generally attributed to the poor socio-economic status, environment, sanitation and livelihood which lead to increase the relative risk of morbidity, mortality and undernutrition among infant and children. Special attentions are required on inequalities in health status during the early years of life as they are likely to perpetuate inequality in the future adult population. The objectives of the present study are to assess the prevalence of thinness and to identify the associations of certain socio-economic and demographic variables with thinness among rural children aged between 5-12 years of Darjeeling district, West Bengal, India.

MATERIAL AND METHODS

The present cross-sectional study was carried out among 1250 children (618 boys; 632 girls) aged 5-12 years residing in rural areas of Phansidewa Block of the Darjeeling, West Bengal, India. This community block (Latitude 26º 34´59´´ N, Longitude 88º 22´00´´ E) is situated near the Indo-Bangladesh border region and ~35– 40 km from the sub-divisional town of Siliguri and covers an area of 308.65 km^2. According to the National Census (2011), the community block has a total population of 1,71,508 individuals (males: 87,945; females: 83,563) with the literacy rate of 41.59% (males: 51.85%; females: 30.80%).

The residents of Phansidewa block have access to all the basic amenities, such as hospitals, schools, markets, post office and government offices (Mondal and Sen, 2010; Sen and Mondal, 2013). The children were enrolled in 12 primary schools located under three Gram Panchayets (a village level local governing authority). Selected schools had minimum student strength of at least 120 students per school. The schools were selected using simple random sampling method and those situated in remote locations were included based on convenience and easy road accessibility from the block of Phansidewa. An informed consent was taken from the parents of the children before data collection. Participation was purely voluntary. The study was conducted in accordance with the ethical guidelines for human experiments, as laid down the Helsinki Declaration of 2000 (Touitou *et al*., 2004). The children were free from any physical deformities, previous histories of medical/surgical episodes and not suffering from any disease at the time of data collection. The data were collected during the period from September 2014 to September 2015.

Collection of Socio-economic and Demographic data

The data on age, gender, parents' occupation, parents' education, monthly family income, family size, family types, house-conditions, electricity facility, sanitary conditions and drinking water facilities were collected using pre-structured interview schedule. The data were collected by interviewing the parents of the children. The interviews were undertaken by both school and households visits. Ample care was taken while briefing the questions to the respondents for valid responses at the time of data collection. A modified version Kuppuswamy's socio-economic scale was used to evaluate the socio-economic status (SES) of the children. This scale is based on a score calculated from education, occupation and monthly income (Kumar *et al.*, 2007). The SES determination showed that all the children belonged to lower-middle SES.

Anthropometric Measurements Collected

Anthropometric measurements of height and weight were recorded using standard anthropometric procedures (Hall *et al.,* 2007). Height of the children was recorded to the nearest 0.1 cm with the help of an anthropometer rod with the head held in the Frankfort horizontal plane. Weight of the children was taken wearing minimum clothing and with bare feet using a portable weighing scales to the nearest 100 gm. The children were measured with ample precision for avoiding any possible systematic errors of anthropometric data collection (e.g., instrumental or landmarks) (Harris and Smith, 2009). Intra-observer and inter-observer technical errors of the measurements (TEM) were calculated to determine the accuracy of the anthropometric measurement using the standard procedure (Ulijaszek and Kerr, 1999). For

calculating TEM, height and weight were recorded from a different data set of 40 children other than those selected for the investigation by SD. The coefficient of reliability (R) of the measurements was calculated for testing the reliability of the measurements. Very high values of R (>0.97) were obtained for height and weight and these values were observed to be within the recommended cut-off (i.e., 0.95) (Ulijaszek and Kerr, 1999). Hence, the measurements recorded by SD were considered to be reliable and reproducible.

Assessment of Nutritional status or Thinness

The BMI was calculated to assess nutritional status or thinness of the rural children using the following standard equation (WHO 1995):

BMI= Weight/ Height, kg/m^2

The assessment of nutritional status in the present study was determined based on the anthropometric indices of thinness (low BMI-for-age). The prevalence of thinness was assessed by comparing the age-sex specific newly proposed international reference and cut-offs of Cole *et al*. (2007). The age-sex specific BMI values were used to classify the children into BMI grade of thinness includes mild (Grade-I), moderate (Grade-II) and severe (Grade-III). The proposed thinness classifications are similar to the adult CED classification as proposed by WHO (1995). Several researchers have assessed the prevalence of thinness using this recently proposed BMI reference among Indian children (Mondal and Sen, 2010; Mondal, 2014; Mondal *et al.*, 2015).

Statistical analysis

The data were statistically analyzed using the Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL; version 17.0). The descriptive statistical analysis of the data obtained was depicted in terms of mean and standard deviation (±SD). One way ANOVA has been performed to test the age-specific mean differences in anthropometric variables of the groups. Chi-square (χ^2) analysis was used to assess age and gender specific differences in prevalence of undernutrition. The Yates correction term was taken into consideration in the case of χ^2- analysis where the cells possessed less than five individuals. This correction term adds to the accuracy of χ^2 determinations when the numbers of classes are small. Binary logistic regression (BLR) analysis was fitted to estimate the crude odds ratios (ORs) and 95% confidence intervals (CIs) associated with thinness, separately. The BLR analysis allows the creation of categorical depended variables and the odds ratio were obtained by comparing with the reference category. To create dichotomous dependent variables of thinness vs. normal were coded as‘1’and normal was coded as ‘0’ in BLR models. The predictor variables

of gender, age, family size, number of sibs, birth order, father's occupation, mother's occupation, income head, monthly income (rupees), house condition and toilet facilities were entered as dummy variables and results were obtained by comparing with reference categories, separately. The p-value of <0.05 and <0.01were considered to be statistically significant.

RESULTS

Age-sex specific subject distribution and descriptive statistics (mean ±SD) of anthropometric variables of height, weight and BMI were shown in Table 1. Mean age-specific height ranged from 107.34 cm (in 5 years) to 131.91cm (in 12 years) among boys and from 108.65 cm (in 5 years) to 135.65 cm (in 11 years) among girls. Mean age-specific weight of the children ranged from 16.26 kg (in 5 years) to 25.03 kg (in 12 years) among boys and 16.21 kg (in 5 years) to 29.28 kg (in 11 years) among girls. Age-specific mean BMI ranged from 14.08 kg/m^2 (in 5years) to 14.36 kg/m^2 (in 11 years) among boys and among girls mean BMI ranged from 3.75 kg/m^2 (in 5 years) to 15.82 kg/m^2 (in 11 years). The age-specific mean differences in height (F-value of boys=198.67; p<0.000; F-value of girls=154.19; p<0.000), weight (F-value for boys=98.87; p<0.000; F-value for girls=98.34; p<0.000) and BMI (F-value for boys= 3.08; p<0.000; F-value for girls= 13.43; p<0.000) were observed to be significant in boys and girls. Comparison of age and sex-specific height, weight and BMI of reference population of NHANES, CDC and WHO with present study is depicted in Figure 1-3. The age-specific mean comparison of height, weight and BMI of the boys and girls were found in <25^{th} percentile in most of the age groups, but the mean height and BMI of the children (in 12 years) were observed to be <5^{th} percentile indicates poor physical growth and nutritional status (Figures 1 and 3).

Prevalence of thinness (low BMI-for-age) among children

The overall prevalence of thinness among the children was 57.36%. Prevalence of overall thinness was observed to be significantly higher among boys than girls (boys: 65.53% and girls: 47.94%) (p<0.01). The age-sex specific thinness was observed to be higher among boys than girls. Age-specific overall prevalence of thinness was observed to be higher in higher age groups of boys (82.86%) (in 12 years) and girls (57.58%) (in 12 years). The prevalence of mild thinness was observed to be higher among boys (32.30%) and girls (14.29%) in 5 years. However, the age-specific prevalence of moderate thinness was observed to be higher among boys (42.86%) and girls (36.36%) in 12 years. In case of severe thinness, the prevalence of thinness was observed to be higher among 12 years (20.00%) and 5 years (20.41%) among boys and girls, respectively. The age-sex specific difference in the

prevalence of thinness was observed to be statistically not significant in most age-groups ($p>0.05$). However, the sex specific difference on the prevalence of thinness was observed only in case of overall thinness ($\chi^2= 10.919$; $p<0.01$) and mild thinness ($\chi^2= 24.076$; $p<0.01$) among boys and girls; and age-specific differences in 11 years ($\chi^2= 4.033$; $p<0.05$) showed statistically significant sex difference in thinness prevalence ($p<0.05$).

Socio-economic, demographic and lifestyle variables associations with prevalence of thinness among children

The results of the BLR analysis between prevalence of thinness and different socio-economic, demographic and lifestyle variables are depicted in Table 3. The results of the BLR analysis showed that boys were in significantly greater risk of thinness with higher odds ratio (Odds: 2.07, 95% CI 1.64-2.59) than girls ($p<0.01$). Socio-economic and demographic variables like family size, number of sibs, fathers occupation, household income and toilet facility have showed significant association with the prevalence of thinness. The children belonging to larger families were in greater risk (Odds: 1.25, 95% CI 1.00-1.58) ($p<0.05$), having ≥4 sibs (Odds: 1.73, 95% CI 1.31-2.27) ($p<0.01$), having cultivator fathers (odds ratio: 1.77 times) ($p<0.01$) belonging to low income group (Odds: 1.88, 95% CI 1.38-2.58) ($p<0.01$) and children living in the no toilet facility (Odds: 2.06, 95% CI 2.28-3.31) ($p<0.01$) were at greater risk of thinness.

DISCUSSION

The prevalence of unacceptably high magnitude of undernutrition in India is a major public health challenge. Poverty and differences in socio-economic condition are considered to be the major underlying causes of such widespread undernutrition in India (Mondal and Sen, 2010; Gopalan, 2013; Varadharajan *et al.,* 2013; Rengma *et al.,* 2016; Pappachan and Choonara, 2017; Khan and Mohanty, 2018; Seshadri and Ramakrishna, 2018). It is generally accepted that high prevalence of undernutrition in the developing countries are attributed to poor socio-economic conditions, ethnic/population, socio-economic, demographic disparities, nutrient deficiencies and environmental issues in populations (Mondal and Sen, 2010; Mahgoub *et al*., 2006; Bhutta *et al*., 2013; Tigga *et al*., 2015a; Rengma *et al*., 2016; Menon *et al*., 2018). Poor nutrition during childhood contributes to the poor cognitive development, lower level of academic performances and slowdown of overall growth and wellbeing of the children (Black *et al*. 2013). Present study has reported a very high prevalence of thinness 57.36% (boys 65.53% and girls 49.37%; $p<0.01$) among the rural children (Table 2). Sex/gender related trends in undernutrition among Indian children showed that prevalence of

thinness was higher among boys than girls (Medhi *et al.,* 2007; Chowdhury *et al.,* 2008; Sen and Mondal, 2010; Mondal, 2014; Mondal and Terangpi, 2014; Angadi and Jawaregowda, 2017; Debnath *et al.,* 2018). Comparison of other studies which assessed the prevalence of thinness with the present study showed in Table 4. Present study showed higher prevalence of thinness (57.36%) than children and adolescents (9–17 years) of West Bengal (21.76%) (Ghosh and Bandyopadhyay, 2009), school-aged children and adolescents (5-18 years) of southern Nigeria (13.00%) (Ene-Obong *et al.,* 2012), French children (7-9 years) (6.00%) (Rolland-Cachera *et al.,* 2002), School children of Brazil (3.2%) (de Assis *et al.,* 2005), rural Bengalee pre-school children of West Bengal (50.69%) (Biswas *et al*., 2009), tribal adolescents of Karbi Anglong, Assam (13.40%) (Mondal and Terangpi, 2014) and children and adolescents of China (12.42%) (Zhang *et al.,* 2016). Studies among ICDS children (2–6 years) of West Bengal (85.18%) (Mandal *et al.,* 2009), Indian school children (5-10 years) (63.86%) (Chakraborty and Bose, 2009), children of West Bengal (76.13%) (Mondal and Sen, 2010) and early adolescent rural school girls (10-14 years) of Paschim Medinipur, West Bengal (58.30%) (Maiti *et al.,* 2011) have showed higher prevalence of thinness than it has been observed in the present study (Table 4).

In India, due to genetic variations, socio-economic disparities, poverty, education improper feeding practices children are unable to attain optimal growth potentials. Such variation in the prevalence of thinness can be attributed to the large ethnic variation, socio-economic disparity and diverse socio-cultural and healthcare practices across the populations. The comparison with the NHANES (Frisancho, 1990), CDC (2000) and WHO (2007) showed that the majority of the children reflected inadequate nutritional status and poor physical growth attainments than their normal counterparts (Figures 1− 3). Majority of the boys and girls were found $<25^{th}$ percentile in most of the age groups. In case of 12 years the height and BMI were observed to be $<5^{th}$ percentile indicates inadequate physical growth attainment of the children (Figure 3). Therefore, they are showed inadequate growth attainment than the reference counterparts. Several physical growth attainment studies have reported that rural children have relatively lower attainment of physical growth and nutritional status than the reference counter parts as observed in the present study in India (Medhi *et al.,* 2007; Mondal, 2014; Tigga *et al.,* 2015; Eze *et al.,* 2017; Joshi *et al.,* 2017; Debnath *et al.,* 2018). Prevalence of undernutrition during childhood and adolescence has not only delayed the physical growth attainment but affected overall linear mechanism of growth and development processes (WHO, 1995; Parasuraman *et al.,* 2009; de Onis *et al.,* 2001; Eze *et al.,* 2017; Joshi *et al.,* 2017; Mondal and Sharma, 2018). Researchers have already

attributed to many resource poor settings, dietary or nutrients intake/availability that are consistently inadequate and infectious diseases are found to be widely prevalent, impeding the process of poor catch-up growth attainment and therefore, potentially increase the prevalence of undernutrition children and adolescents (Nandy *et al.,* 2005; Keino *et al.,* 2014; Rengma *et al.,* 2016). The children and adolescents were suffering from thinness is more likely to develop into thin adults with a lower BMI (e.g., CED) that would have an impact on the reproductive outcomes (e.g., Low birth weight) and reduced physical work productivity as well as may lead to greater morbidity and mortality in population (WHO, 1995; Strickland, 2002; Deshmukh *et al.,* 2006; de Onis, 2017; Eze *et al.,* 2017). Moreover, introduction of physical training could substantially improve the work capacity, but inactivity leads to rapid and substantial reductions in the ability to sustain heavy physical work in adults.

The results of the present study has observed statistically significant association between the prevalence of thinness and the socio-economic and demographic variables e.g., gender, family size, number of sibs, father's occupation, monthly income and toilet facilities ($p<0.05$) (Table 3). Studies have observed significant association between the prevalence of undernutrition and the socio-economic and demographic status as observed in the present study (Greene and Merrick, 2005; Cleland *et al.,* 2006; Mahgoub *et al.,* 2006; Janevic *et al.,* 2010; Asfaw *et al.,* 2015; Chirande *et al.,* 2015; Tigga *et al.,* 2015a,b; Rengma *et al.,* 2016; Khan and Mohanty, 2018; Nagar *et al.,* 2018). A number of research studies have observed that large family size and larger number of sibs have significant association with undernutrition among children these associations were also observed in the present study. A large household size suggests increased competition for scarce resources (Greene and Merrick, 2005; Cleland *et al.,* 2006; Engebretsen *et al.,* 2008; Darteh *et al.,* 2014; Asfaw *et al.,* 2015; Pravana *et al.,* 2017). Several researchers have reported that increase in number of sibs increases the risk of undernutrition among children (Sinnaeve *et al.,* 2006; Sen and Mondal, 2010; Asfaw *et al.,* 2015; Nagar *et al.,* 2018). Several studies have reported that fathers occupation have strong association with the nutritional status of children (Owoaje *et al.,* 2014; Tigga *et al.,* 2015b; Rengma *et al.,* 2016). The poor socio-economic status is a determinant of higher risk of undernutrition (e.g., thinness) and poverty highly affects the linear growth attainment than body weight of the children (Black *et al.,* 2008; Janevic *et al.,* 2010; Agostoni and Fattore, 2013; Pappachan and Choonara, 2017; Pravana *et al.,* 2017; Khan and Mohanty, 2018). It is evident that the health and nutritional benefits from economic growth tend to be concentrated only among the economically advantaged population groups (Mushtaq *et al.,* 2011). The BLR analysis showed that children belonging to the poor

household income group (i.e., ≤ Rupees 4000) had 1.88 (95% CI 1.38-2.58) times significantly greater risks of thinness ($p<0.01$) (Table 3). Several studies have reported that prevalence of undernutrition is significantly associated with the household income (Mahgoub *et al.,* 2006; Janevic *et al.,* 2010; Chirande *et al.,* 2015; Tigga *et al.,* 2015a,b; Rengma *et al.,* 2016; Debnath *et al.,* 2017). Food insecurity, poor access to healthcare services, cultural taboos or hindrances, socio-economic conditions and increased morbidity and mortality are the major problems of developing countries (Zere and McIntyre, 2003; Nandy *et al.,* 2005; Nandy and Miranda, 2008; Bhutta *et al*., 2013; Smith and Haddad, 2015). Present study have observed significant association of toilet use and hygiene ($p<0.05$) and several other research studies have found similar trends and considerable effect of hygiene on child growth (Checkley *et al.,* 2004; Fink *et al.,* 2011; García *et al.,* 2017).

CONCLUSION

Prevalence of undernutrition is acknowledged to play a major role in premature mortality and morbidity of millions of children in developing countries. Present study showed a very high prevalence of thinness among the rural children. Several socio-economic, demographic and lifestyle variables such age gender, age, family size, number of sibs, birth order, fathers occupation, mother's occupation, income head, monthly income, house condition and toilet facilities were observed to be significantly affecting the prevalence of thinness. Special attentions are required to address the inequalities in health status during the early years of life as they are likely to perpetuate in the future adult population. The findings of the present study are important in providing more insight for future investigations in the field investigations and propose a major opportunity to improve through proper intervention programmes. Limitation of the present study is that the study may not represent the exact nutritional situation of the whole country because the study has been done in a limited area and limited sample. The results of the present study are helpful to formulate any appropriate intervention programmes and strategies and data for national and international comparison of nutritional status.

RECOMMENDATION

The prevalence of thinness is transversely apparent among rural children in the present investigation. Therefore, following recommendations may be proposed for overall improvements of the nutritional status of the rural children are as follows:

1. Appropriate intervention and policies may be implemented for improvement of overall nutritional status of the rural children of West Bengal, India. Furthermore, the efficacy of ongoing nutritional intervention programmes (e.g., midday meal

programme) must be evaluated for effective implementation and improvement of nutritional status.

2. Dissemination of knowledge, awareness and health education of nutritional requirements and related health consequences or disorders of poor nutritional status of the rural children at community level should be initiated by the government and health personnel.
3. Regular health check-up camps are necessary for early diagnosis of any nutritional deficiency or poor attainment of physical growth and cure of the health issues related to undernutrition and diseases in order to meet the optimal physical growth potentials the children.
4. The Government policies for improving the overall socio-economic and demographic situation of the poor children are necessary in order to reduce the menaces of undernutrition in population. Moreover, there is need for nutritive sensitive approaches include the women empowerment, education and employment to improve the greater burden of child undernutrition.

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Table 1: Age and sex-specific descriptive statistics (mean ±SD) of anthropometric variables among the children

Age Group	Height (cm)		Weight (kg)		BMI (kg/m^2)	
	Boys	Girls	Boys	Girls	Boys	Girls
5 years	107.34 ±4.67	108.65 ±7.46	16.26 ±2.44	16.21 ±2.31	14.08 ±1.43	13.75 ±1.51
6 years	110.98 ±5.28	111.74 ±6.77	16.76 ±2.26	17.67 ±2.62	13.57 ±1.08	14.14 ±1.63
7 years	115.94 ±5.95	117.01 ±5.69	19.11 ±2.55	19.19 ±2.49	14.21 ±1.57	13.97 ±1.12
8 years	121.27 ±5.50	121.64 ±6.84	20.53 ±2.94	20.92 ±2.79	13.90 ±1.20	14.12 ±1.33
9 years	126.30 ±4.07	126.88 ±5.85	22.28 ±2.58	23.65 ±3.67	13.94 ±1.22	14.65 ±1.78
10 years	129.70 ±5.85	130.43 ±6.31	23.89 ±3.43	26.06 ±5.20	14.15 ±1.36	15.22 ±2.15
11 years	131.45 ±5.75	135.64 ±6.47	24.88 ±2.96	29.28 ±5.60	14.36 ±0.99	15.82 ±2.09
12 years	131.91 ±5.81	135.58 ±10.97	25.03 ±3.22	28.08 ±5.72	14.35 ±1.19	15.10 ±1.55
Total	120.52 ±9.63	124.19 ±11.09	20.53 ±3.99	22.97 ±5.86	14.02 ±1.30	14.67 ±1.85
F-value	198.67	154.19	98.87	98.34	3.08	13.43
P-value	0.00	0.00	0.00	0.00	0.00	0.00

Table 2: Age-sex specific prevalence of different grades of thinness among the children

Age Group	Thinness (low BMI-for-age) (Cole *et al*., 2007)							
	Overall (BMI<18.50 kg/m^2)		Mild (Grade-I) (BMI=16.00-17.00 kg/m^2)		Moderate (Grade-II) (BMI=17.00-18.50 kg/m^2)		Severe(Grade-III) (BMI<16.00 kg/m^2)	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
5 years	37 (62.71)	26 (53.06)	19 (32.20)	7 (14.29)	15 (25.42)	9 (18.36)	3 (5.08)	10 (20.41)
6 years	66 (73.33)	32 (44.44)	23 (25.56)	9 (12.50)	31 (34.44)	17 (23.61)	12 (13.33)	6 (8.33)
7 years	52 (45.61)	42 (50.60)	18 (15.79)	7 (8.43)	23 (20.18)	30 (36.14)	11 (9.65)	5 (6.02)
8 years	74 (67.27)	36 (43.37)	20 (18.18)	10 (12.05)	47 (42.73)	22 (26.50)	7 (6.36)	4 (4.82)
9 years	71 (70.30)	54 (48.65)	22 (21.78)	8 (7.21)	40 (39.60)	40 (36.04)	9 (8.91)	6 (5.41)
10 years	38 (66.67)	59 (51.30)	9 (15.79)	9 (8.70)	24 (42.11)	43 (37.4)	5 (8.77)	7 (6.1)
11 years	38* (73.08)	35* (40.70)	11 (21.15)	5 (5.81)	23 (44.23)	27 (31.40)	4 (7.69)	3 (3.49)
12 years	29 (82.86)	19 (57.58)	7 (20.00)	4 (12.12)	15 (42.86)	12 (36.36)	7 (20.00)	3 (9.09)
Total	405** (65.53)	303** (47.94)	129** (20.87)	59** (9.34)	218 (35.27)	200 (31.65)	58 (9.39)	44 (6.96)

Values in parenthesis indicates percentage; *p<0.05; **p<0.01

Table 3: Binary logistic regression analysis and socio-economic and demographic variables associations with prevalence of thinness among the children

Variables		Number of Individuals (N=1250)	Thinness				
			Prevalence (N=708)	Chi square	Crude odds ratio (95% C.I.)	Wald	S.E.
Gender	Boys	618	405 (57.20)**	10.92**	2.07** (1.64-2.59)	28.92	0.12
	Girls	632	303 (42.79)**		1	-	-
Age	5-8 years	660	377 (53.25)	0.04	1.04 (0.83-1.30)	0.13	0.11
	9-12 years	590	331 (46.75)		1	-	-
Family Size (No. of individuals)	≤ 4	463	246 (34.75)	1.03	1	-	-
	5 and above	787	462 (65.25)		1.25* (1.00-1.58)	3.68	0.12
No. of Sibs	≤3	954	511 (72.18)*	4.12*	1	-	-
	≥ 4	296	197 (27.82)*		1.73** (1.31-2.27)	15.33	0.14
Birth Order	≤2	917	518 (73.16)	0.01	1	-	-
	≥ 3	333	190 (26.84)		1.02	0.03	0.13
Fathers occupation	Cultivator	1009	599 (84.60)*	4.65*	1.77** (1.33-2.35)	15.61	0.14
	Non-cultivator	241	109 (15.40)*		1	-	-
Mothers Occupation	Housewife	1150	649 (91.67)	0.07	1	-	-
	Working	100	59 (8.33)		1.11 (0.73-1.68)	0.25	0.21
Income Head	≤ 1	1132	637 (89.97)	0.18	0.85 (0.58-1.25)	0.67	0.20
	≥ 2	118	71 (10.03)		1	-	-
Monthly Income (Rupees)	≤ 4000	1063	627 (87.15)**	4.74**	1.88**(1.38-2.58)	15.58	0.16
	>4000	187	81 (11.44)**		1	-	-
House Condition	Bricked	490	273 (38.56)	0.08	1	-	-
	Non-bricked	760	435 (61.44)		1.06 (0.85-1.34)	0.28	0.12
Toilet	Yes	1161	644 (90.96)	2.31	1	-	-
	No	89	64 (9.04)		2.06** (1.28-3.31)	8.78	0.24

Values are parenthesis indicates percentage; *p<0.05; **p<0.01

Table 4: Comparison of the prevalence of thinness of present study and other studies

Population	**Sample size**	**Overall Prevalence of thinness (**%)	**Reference**
French children (7-9 years)	1582	6.00	Rolland-Cachera*et al*., 2002
School children (7–10 years)of Brazil	2936	3.20	de Assis *et al*., 2005
Rural Bengalee Pre-school Children (3-5 years)of West Bengal, India	2016	50.69	Biswas*et al*., 2009
ICDS children (2–6 years) of West Bengal, India	1012	85.18	Mandal *et al*., 2009
School children (5-10 years)	596	63.86	Chakraborty and Bose, 2009
Urban children and adolescents (9–17 years) of West Bengal, India	1153	21.76	Ghosh and Bandyopadhyay, 2009
Early Adolescent rural School Girls (10-14 years) of West Bengal, India	3693	58.30	Maiti *et al*., 2011
Urban school-aged children and adolescents (5-18 years) of southern Nigeria	1,599	13.00	Ene-Obong *et al*., 2012
Childen (5-12 years) of West Bengal, India	2111	76.13	Mondal and Sen, 2010
Adolescents (10-18 years) of Northeast India	1,165	49.10	Mondal, 2014
tribal adolescents of KarbiAnglong district of Assam, Northeast India	864	13.40	Mondal and Terangpi, 2014
Children and adolescents (7-18 years) of China	42348	12.42	Zhang *et al*., 2016
Muslim School Children (10-17 years) of West Bengal, India	1068	54.78	Khatun *et al*., 2017
Children (2-12 years) of West Bengal, India	2310	62.42	Das *et al*., 2017
Rural children (5-12 years) of West Bengal, India	1250	57.36	Present study

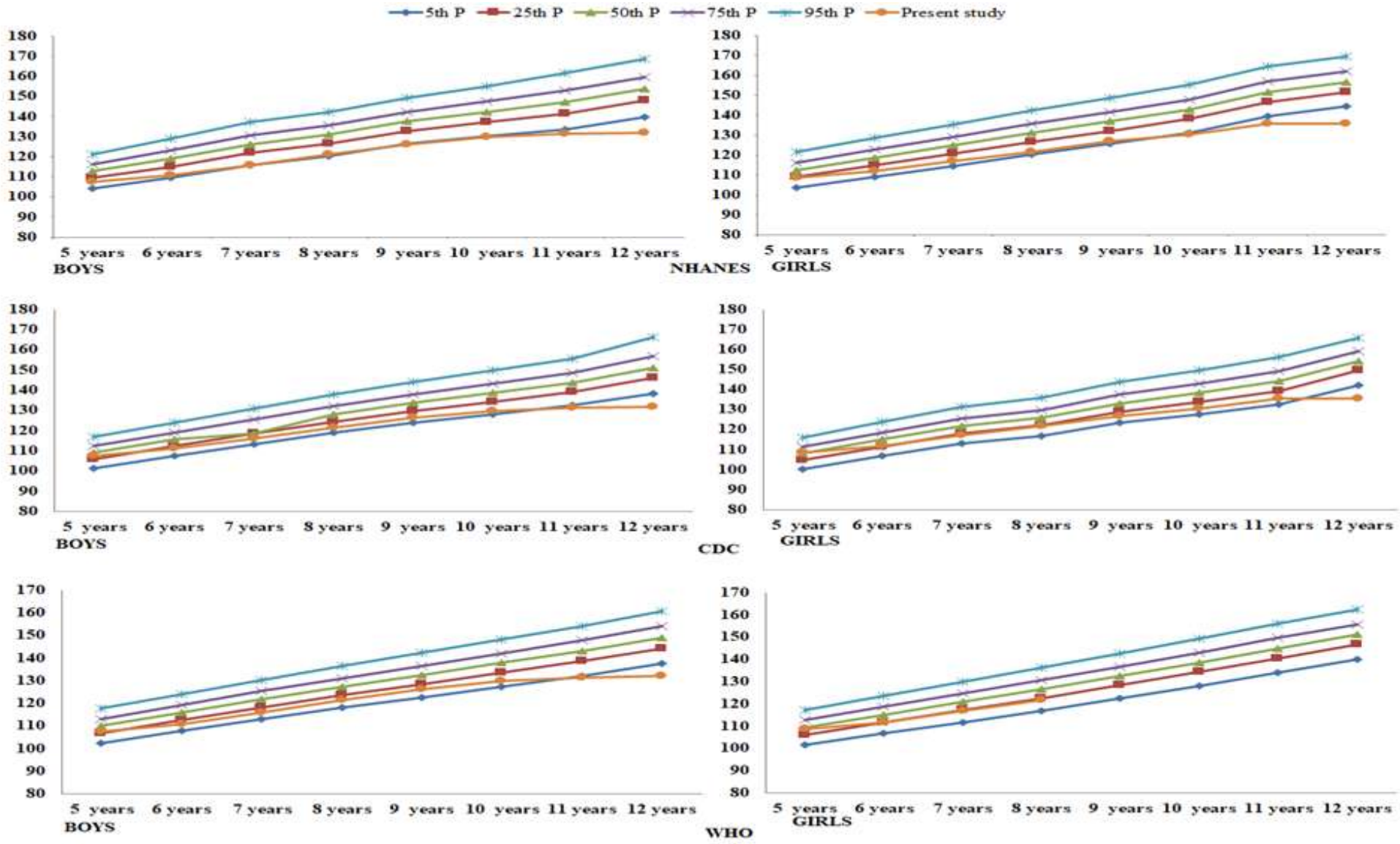

Figure 1: Comparison of age-sex specific mean height (cm) of NHANES (Frisancho 1990), CDC (2000) and WHO (2007) with boys and girls

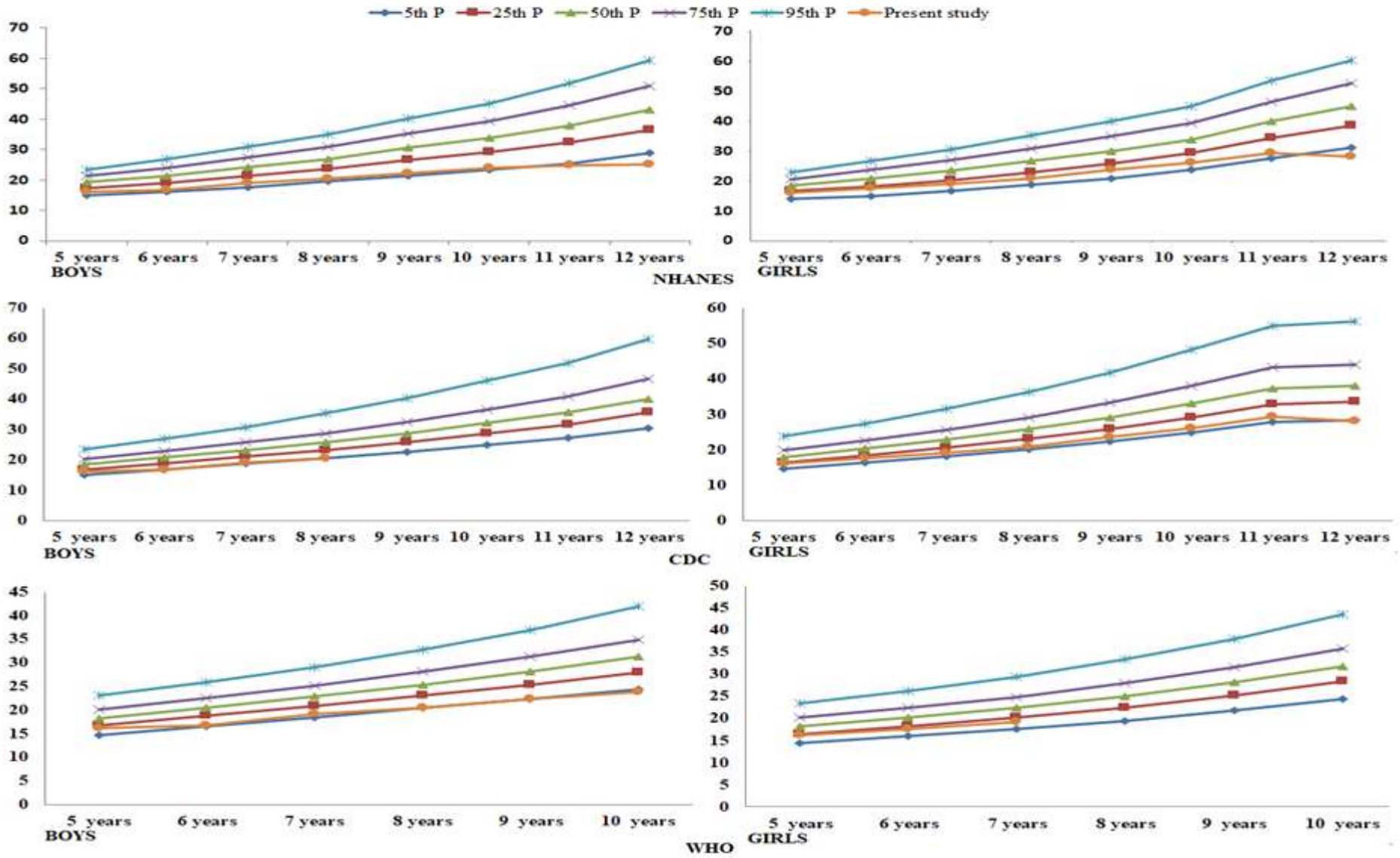

Figure 2: Comparison of age- sex specific mean weight (kg) of NHANES (Frisancho 1990), CDC (2000) and WHO (2007) with boys and girls

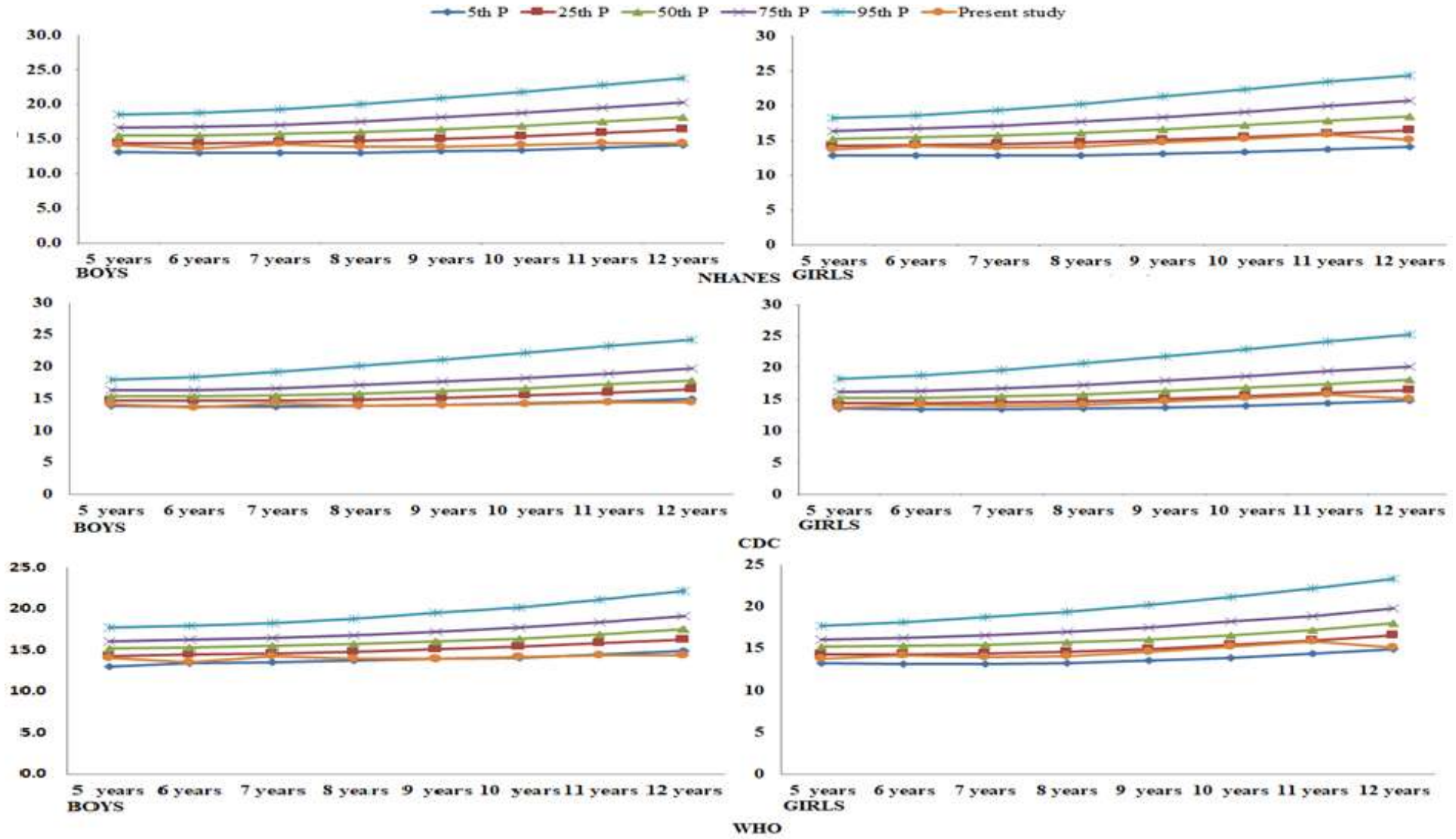

Figure 3: Comparison of age-sex specific mean BMI (kg/m^2) values of NHANES (Frisancho 1990), CDC (2000) and WHO (2007) with boys and girls