Thinness and Overweight among Children belonging to the Bengalee Population Aged 3-10 Years

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ABSTRACT: The present cross-sectional study was conducted to assess the prevalence of thinness and obesity among 520 school children (boys: 287; girls: 233) aged between 3-10 years and residing in a rural area in the district of Darjeeling, West Bengal. Height and weight of the children were measured and the body mass index (BMI) was calculated. The new international BMI-based cut-off points proposed by Cole *et al*., (2007) for thinness and Cole *et al*., (2000) for overweight and obese were utilized to determine the respective prevalence. Boys have significantly higher height, weight and BMI than girls. Girls were more undernourished than boys. The clear rising of overweight and obesity along with the prevalence of undernutrition is alarming for the policy maker of the country.

INTRODUCTION

Undernutrition is a major public health concern in many of the developing countries (Khor, 2008). It has also been estimated that it is the largest contributor to the global burden of disease (Black *et al*., 2008). Approximately 200 million children are unable to attain their full development potential because of stunting and micronutrient deficiency (WHO, 2013). Malnourished children suffer from longer and more severe illnesses (Black *et al*.,'84; Sepulveda *et al*.,'98) and have a higher risk of mortality and morbidity (Schroeder and Brown, '94) as compared to well nourished ones. The evaluation of child growth also provides useful insights into the nutrition and health situation of entire population (Gorstein and Akre,'88). Healthy children are better able to learn, and healthy adults are better able to contribute socially and economically (WHO, 2013). It has been estimated this approximately 70.00% of the world's malnourished children live in Asia, giving that region the highest concentration of worldwide childhood malnutrition (Khor, 2008). In India, given its large population size and widespread poverty, a majority of individuals remain undernourished and underprivileged (Ramachandran, 2007; Antony and Laxmaiah, 2008). Moreover, India shows the highest occurrence of childhood undernutrition in the world (Bamji, 2003) and it has been estimated that more than half of Indian children are undernourished (Measham and Chatterjee,'99). The problem is more acute in the rural areas (Dolla *et al*., 2005). The legacy of malnutrition among children is a major public health problem and an impending obstacle to national development (Bishno *et al*., 2004).

Anthropometry is the universally applicable, inexpensive and non-invasive technique available to researchers for the assessment of the size and proportion of the human body (WHO,'95) and is a very useful tool in the assessment of growth and nutrition (Gorstein *et al*.,'94; Hamieda and Billot,

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2002). It is the single most universally applicable, easy to use, quick, non-invasive and inexpensive technique of choice to researchers to assess nutritional status of children (Bose *et al*., 2007; Mondal and Sen, 2010a; Sen *et al*., 2011). A variety of conventional anthropometric measures have been used to assess undernutrition on the basis of stunting (low height-for-age), wasting (low weight-for-height) and underweight (low weight-for-age) (WHO,'95; Nandy *et al*., 2005; Bose *et al*., 2007; Mondal and Sen, 2010a; WHO, 2007; Sen and Mondal, 2012). These conventional anthropometric measurements reflect certain distinct biological processes of human life and their usages are very important for determining appropriate nutritional interventions (WHO,'95, 2007). A number of studies have reported the prevalence of undernutrition among Indian children using these conventional anthropometric measures (Nandy *et al*., 2005; Som *et al*., 2006; Bose *et al*., 2007; Mondal and Sen, 2010a; Sen and Mondal, 2012).

Overweight and obesity are now considered to be two other very serious public health problems contributing to a number of preventable non-communicable diseases such as hypertension and diabetes mellitus. They substantially increase the risk of premature mortality and morbidity and are recognized as conditions where excess of body fat accumulates to such degrees that health of the individual remains negatively affected (Ulijaszek and Lofink, 2006). It has been observed that during the last few decades, obesity has been increasing at an alarming rate in both the developed and the developing countries (Popkin, 2001). In fact, some studies have reported that the prevalence of obesity had already reached epidemic proportions in the developed countries (Popkin and Doak,'98). Obesity is an environmental issue. Societies that are transitioning to westernized lifestyles are experiencing substantial increases in its prevalence. The primary environmental determinants of obesity are high calorie intake and low levels of activity. Socioeconomic status and place of residence are important contributors. These factors together comprise an 'obesogenic' or 'toxic' environment where the development of obesity is the expected course for humans leading lifestyles incompatible with their evolutionary development. A number of the developing countries typically portray high prevalence of undernutrition along with overweight and obesity. This is now being referred to as the "double burden of malnutrition". India is no exception and recent trends have shown that the prevalence of overweight and obesity along with that of undernutrition are major public health concerns in both the rural and sub-urban regions of the country (Popkin, 2002; Mungreiphy and Kapoor, 2010; Sen *et al*., 2011).

The body mass index (BMI) is a surrogate and proxy anthropometric measure that has been extensively used to assess nutritional status in terms of thinness (low BMI-for-age) or chronic energy deficiency (WHO, 2007; Cole *et al*., 2007). It has also been suggested that BMI-for-age is a better indicator than weight for age to assess the risk of infections associated with undernutrition (WHO, 2007; Ramachandran and Gopalan, 2009). Recently, BMI in relation to age (BMI-for-age) has been recommended to be the best surrogate anthropometric measure of thinness among children and adolescents aged between 2-18 years (Cole *et al*., 2007). International age-sex specific reference cut-offs have also been proposed (Cole *et al*., 2007; WHO, 2007). These cut-off points were derived based on multicentre data from four developed countries (the United States, Great Britain, Hong Kong, the Netherlands) and one developing country (Brazil). It has been further opined that undernutrition could be better assessed in terms of thinness (low BMI-for-age) (Cole *et al*., 2007). Prior to this proposal of Cole *et al*. (2007), there was no suitable cut-off points for thinness that would have encouraged direct comparisons of worldwide trends in thinness among children and adolescents and provide a classification of thinness for public health purposes. Very recently, there has been some studies that have utilized these cut-offs to report the magnitude of thinness among Indian children (Biswas *et al*., 2009; Chakraborty and Bose, 2009; Mandal *et al*., 2009; Bisai *et al*., 2010; Bisai and Manna, 2010; Mondal and Sen, 2010b; Das and Bose, 2011; Mandal and Bose, 2014; Tigga *et al*., 2015).

Therefore, information on prevalence of thinness among children belonging to the developing countries such as India where vast segments of the populations

remain undernourished and underprivileged, are needed to be generated for international and national comparisons. Moreover, the information can play an important role in formulating nutritional intervention programmes for the concerned individuals. With this issue in mind, the present study has been conducted to determine prevalence of thinness among school children aged between 3-10 years using the recently proposed international cut-offs of Cole *et al*. (2007). The present study also reports the prevalence of overweight and obesity in present population using BMI-for-age (Cole *et al*., 2000).

MATERIALS AND METHODS

The northern part of the state of West Bengal, India, is popularly known as North Bengal and comprises of six districts. The district of Darjeeling is one of them, which comprises of Eastern Himalayan hills and the foot hills, Terai. This northern-most district of West Bengal shares borders with Nepal in the west, state of Sikkim in the north, kingdom of Bhutan in the north-east. The area is inhabited by a number of indigenous, tribal and caste populations such as the Rajbanshi, Lepcha, Toto and Bengali Caste Hindu. Given the area's general backwardness, the communities of the region remain vulnerable to undernutrition (Banik *et al*., 2007; Mondal and Sen, 2010a; Sen and Mondal, 2012; Sen *et al*., 2011; Mondal and Sen, 2010b; Sen and Mondal 2013; Tigga *et al*., 2015).

The present community based cross-sectional study was carried out among 520 school children (boys: 287; girls: 233) aged between 3-10 years and residing in a rural area in the district of Darjeeling, West Bengal. The children covered in course of the study belonged to the heterogeneous Bengalee caste populations, nature of which has been described elsewhere (Mondal and Sen, 2010a). All the study participants were the students of 5 schools located in Naxalbari block of the district. The study area is located near the India-Nepal international border in the Terai region of the district. The study was conducted during the month of March, April and May 2014.

The children were selected using a multi-stage stratified random sampling method. Initially 564 children (boys: 312; girls: 252) were approached to take part in the study. Forty four of them of them (boys: 25; girls: 19) were subsequently excluded from the study as either their dates of birth were not available in the school records or they did not belong to the age-group selected. The final sample size consisted of 520 children (boys: 287; girls: 233). All the children were free from any physical deformities, nutritional deficiency symptoms, and were not suffering from any diseases at the time of data collection. Permissions for the study were taken from school authorities and local Panchayats (a village level governing authority) prior to data collection. An informed consent was obtained from either parent of the children. Necessary research approvals and clearances were obtained from the University of North Bengal. The study was conducted in accordance with the ethical guidelines for human experiments as laid down in the Helsinki Declaration of 2000 (Touitou *et al*., 2004).

ANTHROPOMETRIC MEASUREMENTS

Measurements of height and weight were recorded following standard procedures (Weiner and Lourie, '81). Height of the children was recorded using an anthropometer rod to the nearest 0.10 cm. Weight of the children wearing minimum clothing and with bare feet was taken using a portable weighing scale to the nearest 0.10 kg. Intra-observer and inter-observer technical errors of the measurements (TEM) were calculated using the standard procedure of Ulijaszek and Kerr ('99). The TEM was calculated using the following equation:

$TEM = \sqrt{(ÓD^2/2N)}$, D=difference between the measurements, N=number of individuals.

The co-efficient of reliability (R) was subsequently calculated from TEM using the following equation:

$R=\{1–(TEM)^2/SD^2\}$, SD= standard deviation of the measurements.

For calculating TEM, height and weight were recorded from 50 children other than those selected for the study by the author (BD) and another person well versed in the techniques of anthropometry. Very high values of R (>0.975) were obtained for TEM and these values were observed to be within acceptable limits (R=0.95) as proposed by Ulijaszek and Kerr ('99). Hence, the measurements recorded

by BD were considered to be reliable and reproducible.

ASSESSMENT OF NUTRITIONAL STATUS

The BMI was calculated following the internationally accepted standard equation (WHO,'95) which is as follows:

$$BMI=weight/height^2\ kg/m^2$$

The prevalence thinness (low BMI-for-age) has been assessed following the international BMI cut-off points as proposed by Cole *et al*. (2007). The BMI values were used to determine the definite grades of thinness (Grade-I: mild, Grade-II: moderate, Grade-III: severe). These grades are similar to the different chronic energy deficiency grades based on BMI among adults (WHO, 2007; Cole *et al*., 2007). Hence, a child observed to be below the thinness grades of I, II and III of the age and sex specific cut-offs has been classified as mild, moderate and severely thin respectively (Cole *et al*., 2007). Similarly overweight and obese were categorised using Cole et al., (2000). The classification are defined to pass through BMI values of 16.0, 17.0, and 18.5 kg/m^2 for thinness as in adult and 25.0 kg/m^2 for overweight and 30 kg/m^2 for obese, respectively, at age 18 years.

All statistical analyses were undertaken using the SPSS Statistical Package (version 17.0). One-way ANOVA (F-test) was performed to test for sex and age differences in means of weight, height and BMI. A p-value of <0.05 was considered to be statistically significant.

RESULTS

The overall mean and standard deviation of height, weight, BMI and age of the children are shown in Table 1. Boys have significantly ($p < 0.05$) higher height, weight and BMI than girls. There were significant mean difference between ages among boys in height ($F = 97.61$; $p < 0.05$), weight ($F = 46.24$; $p < 0.05$) and BMI ($F = 10.91$; $p < 0.05$). Similarly, among girls, significant difference were observe in height ($F = 106.24$; $p < 0.05$), weight ($F = 33.95$; $p < 0.05$) and BMI ($F = 2.57$; $p < 0.05$). Height and weight increases along the age- groups from lower to higher among both boys and girls except for the 4 years age-group boys. Age-group 3, 6 and 9 have higher BMI than the other age-group boys. Similarly age-group 3, 9 and 10 have higher BMI among girls.

TABLE 1

Mean (SD) of height, weight and BMI according to age and sex of the children

Age (years)	Boys				Girls			
	n	Height (cm)	Weight (kg)	BMI (kg/m^2)	n	Height (cm)	Weight (kg)	BMI (kg/m^2)
3	13	97.00 (8.39)*	14.77 (6.87)	15.10 (3.10)	14	94.46 (6.96)	13.64 (3.86)	15.03 (1.98)
4	43	101.20 (5.11)	14.57 (1.99)	14.19 (1.30)	31	100.51 (3.89)	14.68 (1.85)	14.50 (1.40)
5	30	108.43 (7.83)	17.01 (3.84)	14.31 (1.66)	38	107.04 (5.71)	16.34 (2.76)	14.21 (1.72)
6	46	113.03 (6.07)	19.59 (4.03)	15.24 (2.24)	36	110.20 (5.46)	17.65 (3.35)	14.48 (2.04)
7	47	119.74 (4.95)	21.54 (4.21)	14.93 (2.09)	42	119.09 (6.40)	21.10 (5.38)	14.72 (2.55)
8	36	123.15 (6.82)	22.75 (4.54)	14.88 (1.75)	33	123.18 (5.44)	22.53 (4.87)	14.76 (2.54)
9	31	129.15 (5.04)	27.40 (6.19)	16.33 (2.88)	19	126.75 (8.58)	25.00 (6.52)	15.32 (2.45)
10	41	128.47 (9.41)	30.45 (7.39)	18.63 (5.12)	20	132.18 (6.70)	28.93 (5.30)	16.49 (2.25)
Total	287	116.37 (12.24)	21.46 (7.15)	15.49 (3.05)	233	114.13 (12.29)	19.68 (6.12)	14.79 (2.20)

*Figures in parenthesis are percentages

TABLE 2

Prevalence of overall thinness, overweight and obesity among the children (both boys and girls combined)

Age (years)	n	Normal(%)	Gd I(%)	Gd II(%)	Gd III(%)	Overweight(%)	Obese(%)
3	27	11	6	5	2	1	2
		(40.74)*	(22.22)	(18.52)	(7.41)	(3.70)	(7.41)
4	74	36	17	11	9	1	0
		(48.65)	(22.97)	(14.86)	(12.16)	(1.35)	(0.00)
5	68	28	25	7	6	1	1
		(41.18)	(36.76)	(10.29)	(8.82)	(1.47)	(1.47)
6	82	41	17	11	4	5	4
		(50.00)	(20.73)	(13.41)	(4.88)	(6.10)	(4.88)
7	89	50	20	9	4	3	3
		(56.18)	(22.47)	(10.11)	(4.49)	(3.37)	(3.37)
8	69	33	18	9	4	4	1
		(47.83)	(26.09)	(13.04)	(5.80)	(5.80)	(1.45)
9	50	32	5	6	2	2	3
		(64.00)	(10.00)	(12.00)	(4.00)	(4.00)	(6.00)
10	61	37	6	3	3	6	6
		(60.66)	(9.84)	(4.92)	(4.92)	(9.84)	(9.84)
Total	520	268	114	61	34	23	20
		(51.54)	(21.92)	(11.73)	(6.54)	(4.42)	(3.85)

*Figures in parenthesis are percentages

Girls (44.21%) were more undernourished than boys (36.93%) in the present study are shown in Figure 1. Overall prevalence (sex combine) of thinness grade I, II and III were 21.92%, 11.73 % and 6.54% respectively and prevalence of overweight were 4.42% and obese were 3.85% among the studied population as shown in the Table 2. Prevalence of thinness, overweight and obese for boys and girls are separately depicted in the Table 3 and 4. For the boys percentage prevalence of thinness grade I, II and III were 19.51%, 9.76% and 7.67% respectively and among girls thinness grade I, II and III were 24.89%, 14.16% and 5.15% respectively. Grade III thinness (boys: 13.92%; girls: 9.68%) and Grade II thinness (boys: 13.95%; girls: 16.13%) were highest for 4 years age-group of the present study. Grade I thinness (40%)

TABLE 3

Prevalence of overall thinness, overweight and obesity among the boys

Age (years)	n	Normal (%)	Gd I (%)	Gd II (%)	Gd III (%)	Overweight (%)	Obese (%)
3	13	6	1	3	2	0	1
		(46.15)*	(7.69)	(23.08)	(15.38)	(0.00)	(7.69)
4	43	19	12	6	6	0	0
		(44.19)	(27.91)	(13.95)	(13.95)	(0.00)	(0.00)
5	30	12	12	2	4	0	0
		(40.00)	(40.00)	(6.67)	(13.33)	(0.00)	(0.00)
6	46	22	8	7	2	5	2
		(47.83)	(17.39)	(15.22)	(4.35)	(10.87)	(4.35)
7	47	29	9	5	2	1	1
		(61.70)	(19.15)	(10.64)	(4.26)	(2.13)	(2.13)
8	36	21	9	2	2	2	0
		(58.33)	(25.00)	(5.56)	(5.56)	(5.56)	(0.00)
9	31	21	4	1	1	1	3
		(67.74)	(12.90)	(3.23)	(3.23)	(3.23)	(9.68)
10	41	24	1	2	3	5	6
		(58.54)	(2.44)	(4.88)	(7.32)	(12.20)	(14.63)
Total	287	154	56	28	22	14	13
		(53.66)	(19.51)	(9.76)	(7.67)	(4.88)	(4.53)

*Figures in parenthesis are percentages

TABLE 4

Prevalence of overall thinness, overweight and obesity among the girls

Age (years)	n	Normal (%)	Gd I (%)	Gd II (%)	Gd III (%)	Overweight (%)	Obese (%)
3	14	5 (35.71)*	5 (35.71)	2 (14.29)	0 (0.00)	1 (7.14)	1 (7.14)
4	31	17 (54.84)	5 (16.13)	5 (16.13)	3 (9.68)	1 (3.23)	0 (0.00)
5	38	16 (42.11)	13 (34.21)	5 (13.16)	2 (5.26)	1 (2.63)	1 (2.63)
6	36	19 (52.78)	9 (25.00)	4 (11.11)	2 (5.56)	0 (0.00)	2 (5.56)
7	42	21 (50.00)	11 (26.19)	4 (9.52)	2 (4.76)	2 (4.76)	2 (4.76)
8	33	12 (36.36)	9 (27.27)	7 (21.21)	2 (6.06)	2 (6.06)	1 (3.03)
9	19	11 (57.89)	1 (5.26)	5 (26.32)	1 (5.26)	1 (5.26)	0 (0.00)
10	20	13 (65.00)	5 (25.00)	1 (5.00)	0 (0.00)	1 (5.00)	0 (0.00)
Total	233	114 (48.93)	58 (24.89)	33 (14.16)	12 (5.15)	9 (3.86)	7 (3.00)

*Figures in parenthesis are percentages

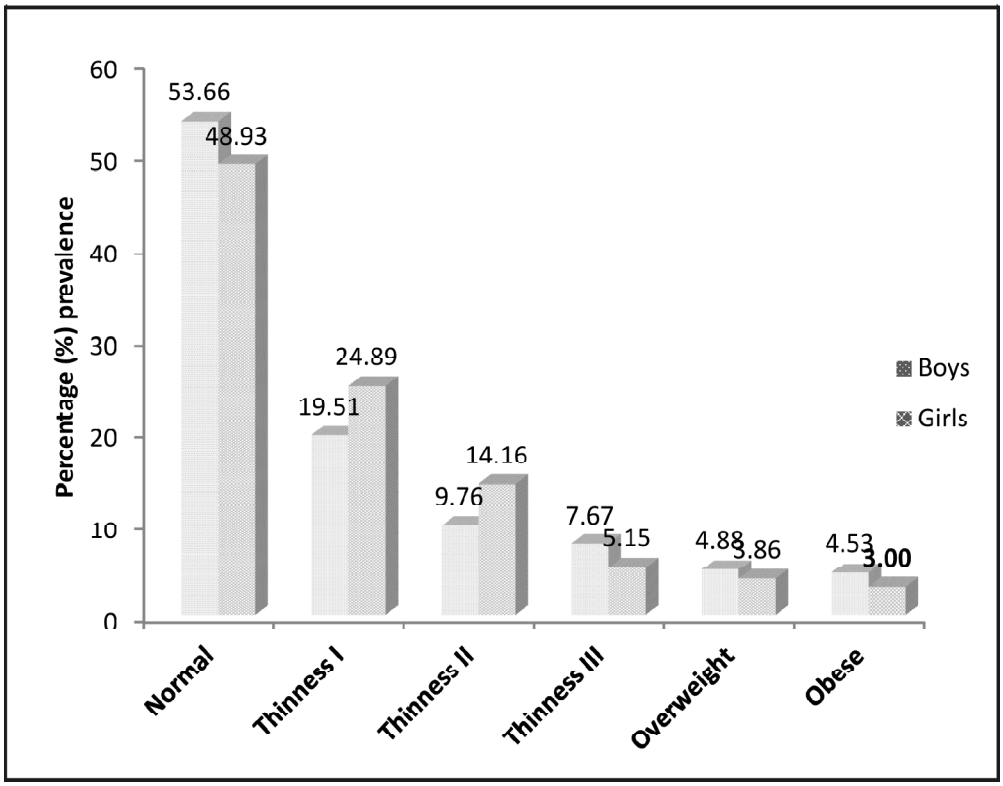

Figure 1: Percentage (%) prevalence of Thinness (Grade-III: severe, Grade-II: moderate, Grade-I: mild), Overweight and Obesity among the boys and girls of the present study.

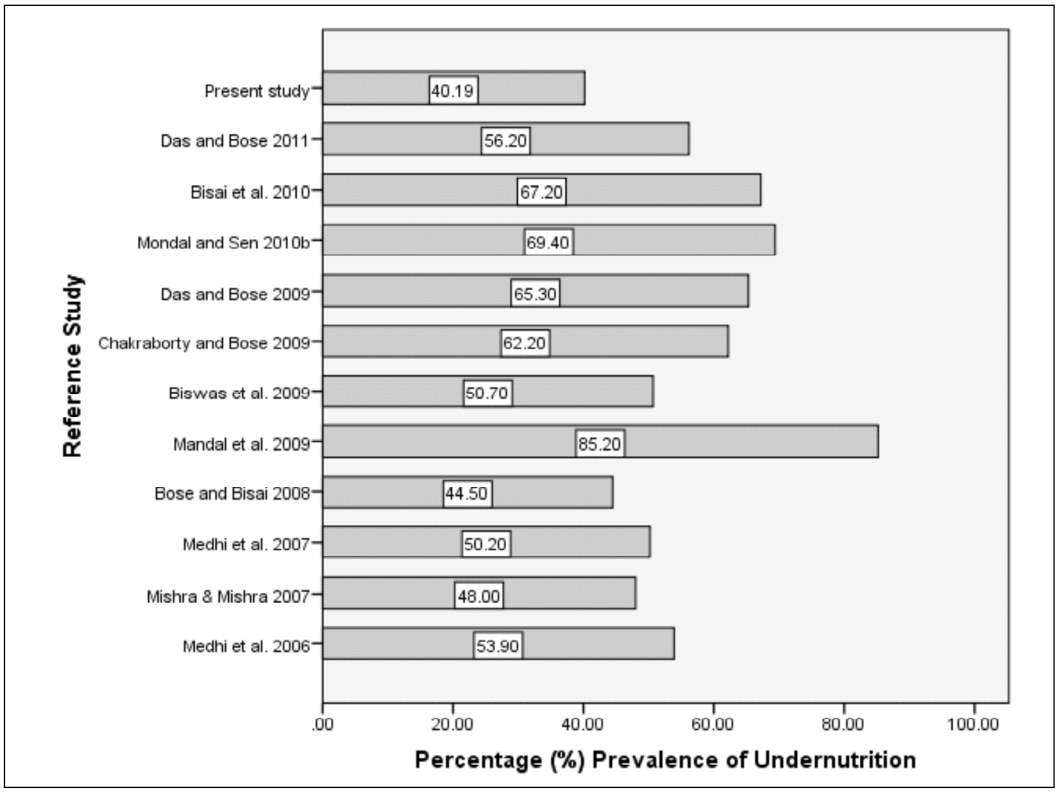

Figure 2: Comparison of thinness among children in India as reported by studies using the BMI-for-age cut-offs of Cole *et al*., 2007.

were highest among the boys of 5 years age-group and 3 years age-group girls shows highest prevalence of grade I thinness (35.71%).

On the other hand prevalence of overweight were 4.88% and obese were 4.53% among boys and among girls overweight were 3.86% and obese were 3.00%. Overweight were found highest among 10 years age-group (12.20%), followed by 6 years age-group (10.87%) boys. It is highest among 3 years age-group (7.14 %) followed by 8 years (6.06 %), 9 years (5.26%) and 10 years (5.00%) age-group. On the other hand obese boys are highest among 10 years age-group (14.63%) followed by 9 years age-group (9.68%) boys and among girls is 3 years age-group (7.14%) followed by 6 years (5.46%).

DISCUSSION

Assessments of nutritional status play a key role in documenting the overall health of an individual and/or population, and also act as an indicator of the well-being of a region. Despite economic developments, prevalence of undernutrition among children especially those aged under-5 years pose a major public health problem in many of the developing countries including India (Nandy *et al*., 2005; Ahmed *et al*., 2012; Bose *et al*., 2007; Mondal and Sen, 2012). Such prevalence is generally attributed to a large population size, illiteracy, poverty, poor infrastructure and inappropriate healthcare facilities (NFHS-3, 2005-2006; Antony and Laxmaiah, 2008; Bose *et al*., 2007; Sen and Mondal 2012; Measham and Chatterjee,'99; Som *et al*., 2006; Tigga *et al*., 2013). It also reflects inadequate nutrition during early childhood and is likely to be a consequence of well-known phenomenon of inadequate weaning food with lower energy-density as observed in India (NFHS-3, 2005 – 2006; Antony and Laxmaiah, 2008; Khor, 2008; Measham and Chatterjee,'99). The importance of assessing nutritional status of these nutritionally

vulnerable children should be recognized, not only for the improvement of the overall health condition of the future generations, but also for overall developments of the concerned region. The results of the present study undoubtedly shall be useful for policy makers in their endeavor to formulate various developmental and healthcare programmes and appropriate nutritional interventions and proper monitoring of the ongoing intervention programmes. Priority interventions are necessary in terms of appropriate complementary feeding, supplementation with proper balance food, micronutrient, breast feeding promotion and acute undernutrition and related morbidity management.

This study is among the few Indian studies which utilizes BMI-for-age after Cole *et al*., (2007; 2000) for different grade of thinness (I, II, III), overweight and obese. The study has also claim that BMI-for-age is comparatively better at assessing undernutrition than wasting (low weight for height), which also enable world-wide comparison of the trend. This cross-sectional study traces the prevalence of overweight and obese beside thinness among the young Bengali children of Naksalbari, Darjeeling District of West Bengal, India. Total sample size was 520 of which 268 (51.54%) were normal but overweight and obese were 23 (4.42%) and 20 (3.85%). The prevalence of overweight (0.8%) among Kura-Mundi children of Paschim Medinipur District of West Bengal is much lower than the present study (Basai *et al.,* 2010). However, study by Bose *et al*. (2007) reported overweight and obesity were 17.63% and 5.10%, respectively from their study of 431 Bengali school-girls of age 6-9 years from Kolkata. Similar prevalence of overweight (17.62%) and a higher obesity (6.41%) were found by Ghosh (2014) among the children of Kolkata.

The overall prevalence of thinness of the present study 40.19% is higher than the 34.39% of Bisai *et al*. (2008) and 36.39 % of Chaterjee and Saha (2008) reported from Paschim Midnapur and Kolkata respectively. However, other Bengali ethnic children of West Bengal have higher prevalence of undernutrition as reported 50.15% (Acharya *et al*., 2013), 62.21% (Chakraborty and Bose, 2009) and 85.18% (Mandal *et al*., 2009). The prevalence of stunting (46.6%) and thinness (42.4%) among adolescents of Darjeeling study by Mondal and Sen (2010) is also higher than the present study. The present study has lowest prevalence of undernutrition among the studies which uses Cole *et al*. (2007) BMI-for-age cut-offs to assess undernutrition in India as shown in the Figure 2 (Mishra and Mishra, 2007; Bose *et al*., 2008; Biswas *et al*., 2009, Bisai *et al*., 2010; Mondal and Sen, 2010b). It is apparent from the above figure there is high prevalence of undernutrition in the region.

It is clear from the preceding paragraphs obesity is raising and undernutrition still is a major problem. The prevailing double burden of nutrition equally impairs the physical and cognitive development of children, which ultimately leads to higher morbidity and mortality in the population. Findings suggest that there is raising challenge for policy maker of the country. Further there is need for more such studies.

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