International Journal of Pediatrics and Adolescent Medicine (2016) xx, 1–11

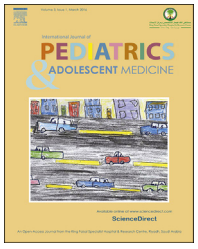
HOSTED BY

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/ijpam



Original Research Article

Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India

Q21 Amitava Pal [a,c], Amal Kumar Pari [b], Arunanshu Sinha [c], Prakash C. Dhara [a,*]

[a] Ergonomics and Sports Physiology Division, Dept. of Human Physiology with Community Health, Vidyasagar University, Midnapore, West Bengal, India
[b] Dept of Physiology, Suri Vidyasagar College, Birbhum, West Bengal, India
[c] Dept. of Physiology, Panskura Banamali College, Purba Midnapore, West Bengal, India

Received 20 April 2016; received in revised form 13 August 2016; accepted 16 August 2016

Q1 **KEYWORDS**
Adolescent;
Malnutrition;
Stunting;
Thinness;
Sociodemographic factors

Abstract *Background and objectives:* Malnutrition is a silent emergency. It is one of the most common causes of morbidity and mortality among children and adolescents throughout the world. The present study was undertaken to investigate the prevalence of malnutrition among 10- to 17-year-old adolescents and its association with socio-demographic factors.
Subjects and method: Anthropometric measures were measured using standard techniques in 560 adolescents from rural areas of West Bengal state, India. Different socio-demographic variables were studied by questionnaire method.
Results: In the present investigation, approximately 54% of adolescents had stunted growth, and 49% were thin. The adolescents who belonged to lower social classes were significantly more likely to have stunted growth (OR = 2.68) and be thin (OR = 2.44). Other variables such as father's occupation, mother's education, economic status and sanitation showed significant negative association with undernutrition. However, mother's working status showed significant positive association with undernutrition. Adolescents of working mothers were more likely to be stunted and thin than those with mothers who do not work outside of the home. The adolescents of women with higher education were less likely to be undernourished than adolescents of poor and uneducated women. Adolescents of nuclear families (family size <4) were more likely to be stunted and thin.
Conclusions: Poverty is found to be an important factor of undernutrition among the adolescents. Hence, there is a need to implement well-thought poverty reduction actions along

* Corresponding author. Ergonomics and Sports Physiology Division, Dept. of Human physiology with Community Health, Vidyasagar University, Midnapore, 721102, West Bengal, India. Tel.: +91 9433226695; fax: +91 03222 275329.
E-mail address: prakashdhara@rediffmail.com (P.C. Dhara).
Peer review under responsibility of King Faisal Specialist Hospital & Research Centre (General Organization), Saudi Arabia.

http://dx.doi.org/10.1016/j.ijpam.2016.08.009

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

with providing mass education regarding nutrition and health, with a special focus on economically and socially deprived sections of society.

1. Introduction

Malnutrition is a silent emergency, and it continues to be a major public health problem worldwide, especially in South-East Asia and sub-Saharan Africa. It is an indicator of poor nutrition, having a major consequence on human health as well as for the social and economic development of a population [1]. It is one of the most common causes of morbidity and mortality among children and adolescents throughout the world [2]. Every year, more that 10 million children worldwide die from preventable and treatable illnesses. At least half of these deaths are caused by malnutrition [3]. The health consequences of a prolonged state of malnutrition among children and adolescents include delayed their physical growth and impair motor and cognitive development, diminished cognitive performance, lower intellectual quotient (IQ), poor social skills, greater behavioral problems and vulnerability to contracting diseases [3,4]. Moreover, malnutrition also leads to important consequences in adult life in terms of physical growth, work capacity, reproductive performances and risk of chronic diseases [5]. The global scope of malnutrition is still unacceptably high, and the progress to reduce it is slow [6]. Malnutrition continues to be one of India's major human development challenge. Despite enormous economic progress achieved in the past two to three decades, malnutrition among children and adolescents in both urban and rural India still claims many lives due to the immense population size, illiteracy, inadequate access to health facilities, and socioeconomic disparities in India. As a result, nutritional assessments among the adolescent and children play a potential role in formulating developmental strategies and programs in India.

The studies of malnutrition at national and local levels have focused predominantly on children under 5 years of age. There is little information available from adolescents, the age group, with the highest growth velocity after infancy. The adolescent period is a very important phase in the life span of an individual. It is defined as the transition period from childhood to adulthood and is characterized by an exceptionally rapid growth. During this stage of the life cycle, adolescents experience rapid growth and developmental changes such as physical growth, improved gross and fine motor skills and biological maturity. The nutritional status of adolescents requires close monitoring because they represent the next generation of parents. This heightened physical growth depends upon dieting behavior and socio-economic status. Several epidemiological studies have shown an association between physical developments in adolescent period with socio-economic status [7–15]. Such a database is lacking at the moment in India. These types of database will enable the government and nongovernmental agencies to formulate policies for well-being of the adolescents.

There is little information available on the nutritional status of adolescents from West Bengal, although some important scientific papers are mentioned here [16–20]. West Bengal is a state in eastern India that stretches from the Himalayas in the North to the Bay of Bengal in the South and is the fourth-most populated state in the nation, with over 91 million inhabitants (7.55% of India's population) [21]. West Bengal's climate varies from tropical Savanna in the southern portions to humid subtropical in the north. The main seasons are summer, the rainy season, a short autumn, and winter. Monsoons bring rain to the whole state from June to September. The predominant occupation is agriculture.

The aim of the present study was to investigate the prevalence of malnutrition among adolescents in the rural areas of West Bengal and examine the possible association of different sociodemographic factors with malnutrition.

2. Materials and methods

2.1. Study participants

This cross-sectional descriptive study was conducted between May 2014 to April 2015 on 839 subjects, out of which 408 (48.63%) were boys and 431 were (51.37%) girls. Participants were selected from different villages of Howrah, Birbhum, and East and West Midnapore districts of West Bengal state, India. The eligibility criteria for recruitment of the participants for the present study were 10–17 years old; apparently, healthy and not suffering from any acute illness. Participants with background of acute (diarrhea, measles, mumps, chicken pox, etc.) or chronic (asthma, diabetes, cardio-vascular disease, epilepsy, tuberculosis, dermatitis, intestinal problems, etc.) diseases were excluded from the study. The authors disqualified 143 (17.04%) participants because they were not eligible based on these criteria. Among the 696 eligible participants, 79 were not interested to participate in the present study. Among the remaining 617 participants, 57 participants were excluded from the study due to missing or incomplete data. Thus, a total of 560 (80.46% of eligible) adolescents participated in the present survey.

2.2. Sample design

A stratified two-stage random cluster sampling was utilized for selecting participants. At first, fifteen clusters (village) were selected from each district. Then, a systematic random sampling method was used to identify 15

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

participants per cluster. To obtain the sampling interval, all the households in the cluster were listed and divided by the required number of participants. The first household was randomly selected by using the lottery method, and subsequent households were identified by adding the sampling interval to the random number. The selected households were approached during field visits and the protocol of the study was explained verbally in the local language (Bengali). Informed consent was obtained from the parents. Ethical approval and prior permission were obtained from the institutional Ethics Committee before the commencement of the study, and the study was conducted in accordance with the ethical standards of the committee and with the Helsinki Declaration.

2.3. Sociodemographic factors

A pre-structured schedule questionnaire containing different sociodemographic variables was used to determine sociodemographic status of the study participants. The type of house was determined by considering the type of its walls and roof and divided into three categories: kutcha, mud walls with a thatched roof; semi-pucca, brick walls with a thatched or tiled roof; and pucca, brick walls with a roof made of concrete.

2.4. Age

Assessment of age is most essential for conducting growth studies. The accurate age of the participants was recorded from their birth certificate.

2.5. Measurement of anthropometric dimensions

Height and weight of the participants were measured by following standard technique and appropriate landmarks. Height was measured to the nearest of 0.1 cm using an anthropometer (Hindustan Minerals) and weight to the nearest of 0.1 kg using a portable weighing machine (Libra). From measuring the height and weight of the participants, the body mass index (BMI) was computed. WHO classification was used for the assessment of malnutrition. Stunting was defined as the height-for-age z-score less than 2 standard deviations below the median of reference population [22,23]. Thinness was defined as BMI below the 5th percentile for age and overweight-obese was defined as BMI above the 85th percentile for age using the NHANES I reference population [22,23].

2.6. Statistical analysis

The sample size was determined by using the standard formula ($n = z^2pq/d^2$) [24]. The minimum estimated sample size was 556 [$(1.96^2 \times 0.3649 \times 0.6351)/0.04^2$]. The calculation was based on 36.49% prevalence (p) of undernutrition among the Bengalee adolescent [17] with desired precision (d) of 4%,where, q = p-1and z = 1.96. Before data collection, all measurements were taken twice for 40 participants (20 boys; 20 girls) to calculate the technical error of measurement (TEM), relative technical error of measurement (%TEM) and coefficient of reliability (R) [25]. In the present study, the relative TEM of measurements was low and below the acceptable relative TEM [26]. This implied that the observed error for measurements in the present study was small and reproducible without significant technical error. Data were presented by sex. Different anthropometric measures were described by their means and standard deviation. To test the significance differences in different parameters, a Student t-test was performed. Chi-square analysis was performed to determine the differences in the prevalence of thinness, overweight-obese and stunting across the sex, age groups and different sociodemographic factors. One-way ANOVA was employed to test age variation in height, weight and BMI. Odd ratio (OR) and 95% confidence interval (CI) were calculated to determine the risk of thinness and stunting with respect to different age groups and different sociodemographic factors. Statistical analyses were performed using the statistical software IBM SPSS version 20. Statistical significance was set at $P < .05$.

3. Results

The details of socio-demographic status of the participants are presented in Table 1. Approximately 79% of the adolescents belonged to the Hindu religion. More than 15% of the adolescents belonged to the socioeconomically vulnerable sections of lower social class i.e., scheduled tribe and scheduled caste. Approximately 42% of the fathers and 50% of the mothers were illiterate or just able to sign. Occupations of the fathers were diverse. Approximately 32% of the fathers were laborers, 59% were marginal farmers, and 7% ran small sized business or in administrative position. Most of the mothers did not work outside the home (66.79%). Housing conditions were of poor standard. Fifty-eight percent of the houses were semi-pucca, 30.36% were kutcha houses, and only 11.25% were pucca houses. Almost all of the houses had no water supply, and families used untreated water. A large proportion of the houses (24%) did not have a bathroom, and excrement was disposed of in the area surrounding the houses. The mean size of each household was 5.85 persons, and, in general, 65% of the families were large (≥5 members). The mean per capita income per month was about Rs. 1768/- (US $ 27.6). It was interesting to note that, for approximately 32% of the household, per capita income was less than Rs. 1000/-, and approximately 14% of the household had a monthly per capita income of more than Rs. 4000/month. This indicates a wide variation in the socio-economic status of the households.

The weight, height and body mass index (BMI) for different ages and sex are presented in Table 2. It was observed that the mean weight and height were significantly ($P < .001$) increased with the advancement of age. The mean BMI also significantly ($P < .001$) increased when boys and girls approached higher ages, except at the ages of 11 and 15 years among girls. The overall mean BMI of the boys (16.83(3.34) kg/m^2) was slightly higher than girls (16.35(2.71) kg/m^2).

The age-specific mean values of height, weight and BMI of the adolescents was plotted in relation to the WHO reference data (Fig. 1). The age-specific mean values of

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

Table 1 Socio-demographic characteristics of the participants.

	Boys and girls (n = 560)		Boys (n = 279)		Girls (n = 281)	
	f	%	f	%	f	%
Religious						
Hindu	443	79.11	214	76.70	229	81.49
Muslim	117	20.89	65	23.30	52	18.51
Caste						
Lower (SC and ST)	85	15.18	44	15.77	41	14.59
Other	475	84.82	235	84.23	240	85.41
Occupational status of father						
Laborer	178	31.79	91	32.62	87	30.96
Cultivator	331	59.11	163	58.42	168	59.79
Business/Service	38	6.79	19	6.81	19	6.76
Other	13	2.32	6	2.15	7	2.49
Educational status of father						
Illiterate or just able to sign	234	41.79	115	41.22	119	42.35
Up to primary	210	37.50	102	36.56	108	38.43
Secondary or above	116	20.71	62	22.22	54	19.22
Occupational status of mother						
Housewife	374	66.79	188	67.38	186	66.19
Laborer	69	12.32	34	12.19	35	12.46
Cultivator	103	18.39	48	17.20	55	19.57
Business/Service	14	2.50	9	3.23	5	1.78
Educational status of mother						
Illiterate or just able to sign	280	50.00	137	49.10	143	50.89
Up to primary	190	33.93	97	34.77	93	33.10
Secondary or above	90	16.07	45	16.13	45	16.01
Per capita monthly income						
Rs. ≤1000	297	53.04	146	52.33	151	53.74
Rs. 1001–4000	182	32.50	93	33.33	89	31.67
Rs. >4000	81	14.46	40	14.34	41	14.59
Family size						
≤4	194	34.64	93	33.33	101	35.94
5–7	324	57.86	161	57.71	163	58.01
≥8	42	7.50	25	8.96	17	6.05
Type of house						
Kutcha	170	30.36	79	28.32	91	32.38
Semi-pucca	327	58.39	165	59.14	162	57.65
Pucca	63	11.25	35	12.54	28	9.96
Sanitation						
Toilet (Present)	426	76.07	211	75.63	215	76.51
Toilet (Absent)	134	23.93	68	24.37	66	23.49

Table 2 Mean (SD) of physical characteristics of the participants.

	Age years	n	Height (Mean (SD))	Weight (Mean (SD))	BMI (Mean (SD))
Boy	**10**	30	128.32(5.41)	23.58(5.81)	14.12(2.28)
	11	31	132.87(8.38)	27.79(8.74)	15.38(3.01)
	12	32	138.56(9.13)	30.64(6.96)	15.95(3.27)
	13	34	145.08(9.01)	34.41(8.04)	16.27(3.37)
	14	31	149.91(9.23)	38.61(6.86)	17.34(3.71)
	15	31	155.47(6.28)	42.85(8.15)	17.76(3.47)
	16	47	157.53(7.29)	44.21(8.69)	17.75(2.86)
	17	43	158.61(6.35)	47.19(5.95)	18.81(2.49)
	All	279	147.04(13.23)	37.1(10.87)	16.83(3.34)
	F ratio		78.279 ($P < .001$)	44.636 ($P < .001$)	8.575 ($P < .001$)
Girl	**10**	35	130.75(5.71)	25.51(5.56)	14.78(2.24)
	11	40	135.74(7.0)	27.4(6.32)	14.68(2.1)
	12	33	139.41(6.7)	31.64(6.71)	16.17(2.52)
	13	35	143.18(6.22)	34.06(4.46)	16.67(2.44)
	14	28	147.23(6.4)	36.58(5.91)	16.93(2.94)
	15	30	148.51(7.39)	37.32(7.79)	16.81(2.83)
	16	41	150.66(5.39)	38.96(5.37)	17.19(2.39)
	17	39	152.22(5.72)	41.29(8.45)	17.71(2.77)
	All	281	143.43(9.58)	34.07(8.31)	16.35(2.71)
	F ratio		53.123 ($P < .001$)	27.697 ($P < .001$)	7.133 ($P < .001$)
Boy and Girl	**10**	65	129.63(5.66)	24.62(5.71)	14.47(2.26)
	11	71	134.49(7.71)	27.57(7.42)	14.99(2.54)
	12	65	138.99(7.94)	31.15(6.8)	16.06(2.89)
	13	69	144.11(7.72)	34.23(6.43)	16.48(2.92)
	14	59	148.63(8.06)	37.65(6.45)	17.15(3.34)
	15	61	152.11(7.68)	40.17(8.43)	17.3(3.22)
	16	88	154.33(7.3)	41.76(7.75)	17.49(2.65)
	17	82	155.57(6.82)	44.39(7.79)	18.28(2.67)
	All	560	145.23(11.68)	35.58(9.79)	16.59(3.05)
	F ratio		121.381 ($P < .001$)	69.18 ($P < .001$)	15.344 ($P < .001$)

height, weight and BMI for both sexes at all ages were below the median reference values of WHO.

The age and sex specific nutritional status of the adolescents are presented in Table 3. The overall prevalence of stunting and thinness among the adolescents were 53.57% and 48.75%, respectively, when both sexes were considered together. The prevalence of overall overweight-obesity was low (4.64%). Stratifying the prevalence of stunting by age revealed that the highest prevalence was observed among 17-year-old adolescents (63.64%). The prevalence of stunting based on age ranged from 32.31% (10 years) to 63.64% (17 years). With an increase in age, the adolescent showed a significantly higher prevalence of stunting (χ^2 28.77; $P < .001$). The risk of stunting among 17 years old adolescent was significant and approximately four times higher than the 10-year-old adolescents. The highest prevalence of thinness was observed among 10- and 12-year-old adolescents (56.92%). The age wise prevalence of thinness ranged from 39.02% (17 years) to 56.92% (10 and 12 years). The prevalence of thinness was significantly higher (χ^2 4.66; $P < .05$) in early adolescents than the late adolescents. The risk of thinness among 10-year-old adolescents was significant and approximately two times higher than 17-year-old adolescents. The prevalence of stunting among the girls (58.36%) was significantly (χ^2 5.21; $P < .05$) higher than boys (48.75%).

The adolescents of the present study were divided into three nutritional categories, thinness, normal and overweight-obese, according to the WHO recommended BMI cutoff value for adolescents, as mentioned above. The prevalence of stunting among the three nutritional groups was studied and is presented in Table 4. The results indicate that approximately 71% of the adolescents in the thinness category were stunted and that approximately 40%

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

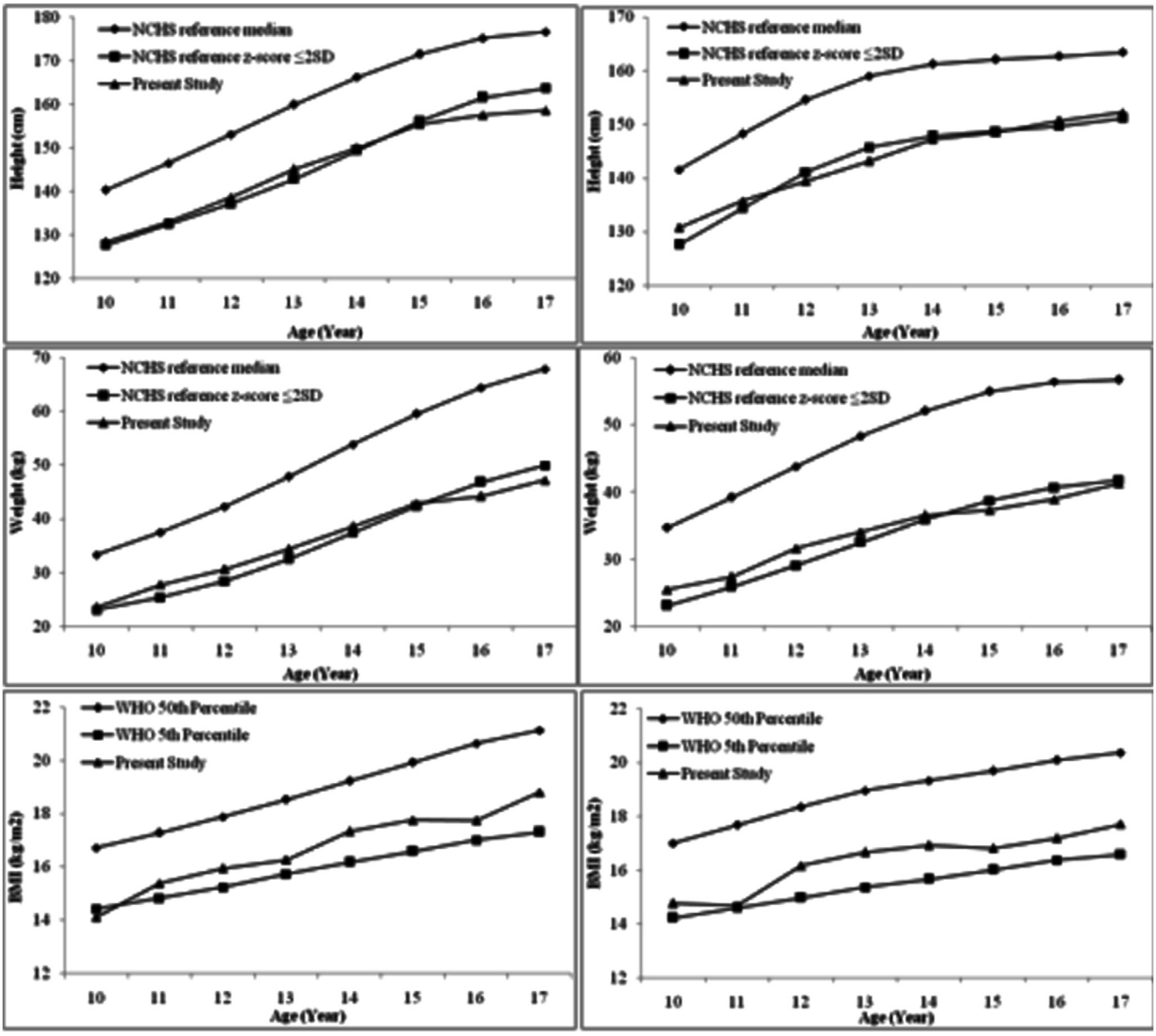


Figure 1

in the normal category were stunted. However, only 7.69% of the adolescents in the overweight-obese category were stunted.

As the bi-variate analysis shows only the gross differentials, the logistic regression analysis was used to examine the association of sociodemographic factors with adolescent's undernutrition (stunting and thinness). The results showed that the adolescents belonging to the lower social class (scheduled tribe and scheduled caste) were significantly more likely to be stunted (OR = 2.68, $P < .001$) and thin (OR = 2.44, $P < .001$) than the other social class (Table 5). Other variables such as father's occupation, mother's education, economic status and sanitation showed significant and negative association with undernutrition. However, mother's working status showed a significant positive association. Notably, adolescents of working mothers were more likely to be stunted and thin than those with mothers who do not work outside of the home. The adolescents of women with higher education who belong to better-off households were less likely to be undernourished than adolescents of poor and uneducated women. These results suggest that adolescents of nuclear families (family size <4) were more likely to be stunted (OR = 1.46) and thin (OR = 1.36). These results also showed that adolescents of

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

Table 3 Prevalence of stunting (Height for age z-score ≤2SD), thinness (<5th Percentile of BMI-for-age) and overweight-obese (>85th Percentile of BMI-for-age) among the adolescents.

Age group (years)		10	11	12	13	14	15	16	17	All
Boys	Stunting	10 (33.33%)	10 (32.26%)	13 (40.63%)	14 (41.18%)	17 (54.84%)	18 (58.06%)	27 (57.45%)	27 (62.79%)	136 (48.75%)
	OR (95% CI)	1	0.95 (0.33−2.77)	1.37 (0.48−3.86)	1.4 (0.5−3.88)	2.43 (0.86−6.85)	2.77 (0.98−7.85)	2.7 (1.04−7.01)	3.37 (1.27−8.98)	1.9 (0.86−4.2)
	Thinness	19 (63.33%)	17 (54.84%)	18 (56.25%)	16 (47.06%)	14 (45.16%)	13 (41.94%)	18 (38.3%)	15 (34.88%)	130 (46.59%)
	OR (95% CI)	3.22 (1.22−8.52)	2.27 (0.88−5.83)	2.4 (0.94−6.13)	1.66 (0.66−4.16)	1.54 (0.59−3.96)	1.35 (0.52−3.48)	1.16 (0.49−2.74)	1	1.63 (0.83−3.18)
	Overweight-Obese	1 (3.33%)	3 (9.68%)	2 (6.25%)	3 (8.82%)	3 (9.68%)	3 (9.68%)	3 (6.38%)	1 (2.33%)	19 (6.81%)
	OR (95% CI)	1	3.11 (0.−31.68)	1.93 (0.16−22.49)	2.81 (0.28−28.53)	3.11 (0.3−31.68)	3.11 (0.3−31.68)	1.98 (0.19−19.94)	0.69 (0.04−11.49)	2.12 (0.27−16.4)
Girls	Stunting	11 (31.43%)	17 (42.5%)	23 (62.86%)	22 (62.86%)	16 (57.14%)	19 (63.33%)	29 (70.73%)	27 (69.23%)	164 (58.36%)
	OR (95% CI)	1	1.6 (0.62−4.17)	5.02 (1.79−14.05)	3.69 (1.37−9.93)	2.91 (1.03−8.18)	3.77 (1.34−10.55)	5.27 (1.98−14.06)	4.91 (1.83−13.55)	3.06 (1.44−6.49)
	Thinness	18 (51.4%)	23 (57.5%)	19 (57.6%)	18 (51.4%)	15 (53.6%)	14 (46.67%)	19 (46.34%)	17 (43.59%)	143 (50.89%)
	OR (95% CI)	1.37 (0.55−3.43)	1.75 (0.72−4.27)	1.76 (0.69−4.48)	1.37 (0.55−3.43)	1.49 (0.56−3.96)	1.13 (0.43−2.95)	1.12 (0.46−2.69)	1	1.34 (0.68−2.63)
	Overweight-Obese	1 (2.9%)	0 (0.0%)	1 (3.0%)	0 (0.0%)	2 (7.1%)	1 (3.3%)	1 (2.4%)	1 (2.6%)	7 (2.5%)
	OR (95% CI)	1	0.28 (0.01−7.19)	1.06 (0.06−17.71)	0.32 (0.01−8.23)	2.61 (0.22−30.43)	1.17 (0.07−19.59)	0.85 (0.05−14.11)	0.89 (0.5−14.86)	0.87 (0.1−7.7)
Boys and Girls	Stunting (z-score ≤2SD)	21 (32.31%)	27 (38.03%)	36 (55.38%)	36 (52.17%)	33 (55.93%)	37 (52.46%)	56 (60.66%)	54 (63.64%)	300 (53.57%)
	Stunting	1	1.28 (0.63−2.61)	2.6 (1.27−5.31)	2.28 (1.13−4.61)	2.66 (1.28−5.52)	3.23 (1.55−6.71)	3.67 (1.86−7.22)	4.04 (2.03−8.07)	2.42 (1.4−4.17)
	OR (95% CI)	37 (56.92%)	40 (56.34%)	37 (56.92%)	34 (49.28%)	29 (49.15%)	27 (44.26%)	37 (42.05%)	32 (39.02%)	273 (48.75%)
	Thinness	2.06 (1.06−4.0)	2.01 (1.06−3.84)	2.06 (1.06−4.0)	1.52 (0.79−2.9)	1.51 (0.77−2.97)	1.24 (0.63−2.43)	1.13 (0.61−2.09)	1	1.49 (0.92−2.39)
	OR (95% CI)	2 (3.08%)	3 (4.23%)	3 (4.62%)	3 (4.35%)	5 (8.47%)	4 (6.56%)	4 (4.55%)	2 (2.44%)	26 (4.64%)
	Overweight-Obese	1	1.39 (0.22−8.59)	1.52 (0.25−9.44)	1.43 (0.23−8.86)	2.92 (0.54−15.64)	2.21 (0.39−12.53)	1.5 (0.27−8.45)	0.79 (0.11−5.45)	1.53 (0.35−6.61)

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

Table 4 Nutritional status classification of adolescents according to gender, BMI-for-age (percentiles) and height-for-age (Z-score).

	Height for age	BMI-for-age								
		<5th Percentile			>5th to <85th Percentile			>85th Percentile		
		Classification	n	%	Classification	n	%	Classification	n	%
Boys	≤- 2 SD	W + S	86	66.15	S	48	36.92	OWS	2	10.53
	> - 2 SD	W	44	33.8	N	82	63.1	OW	17	89.5
Girls	≤- 2 SD	W + S	108	75.52	S	56	42.75	OWS	0	0.0
	> - 2 SD	W	35	24.5	N	75	57.3	OW	7	100.0
All	≤- 2 SD	W + S	194	71.06	S	104	39.85	OWS	2	7.69
	> - 2 SD	W	79	28.9	N	157	60.2	OW	24	92.3

W + S — wasting + stunting; W — wasting; S — stunting; N — normal; OWS — overweight and stunting; OW — overweight.

large families (family size >8) were more likely to be stunted (OR = 1.3) and thin (OR = 1.69).

4. Discussion

India has a unique opportunity to improve the health and nutritional status of its citizens as a result of its tremendous economic development in the past two to three decades. There have been impressive improvements in some health indicators in the past two decades, including a drop in the fertility rate and reduction in infant mortality rate, but improvements in nutritional status have been less impressive [27,28]. More than half of the world's undernourished population lives in India [29]. Apart from overall poverty, the health status of the rural population reflects inequitable distribution of health resources, low purchasing capacity of foods and unequal food sharing pattern in the families making them socially and biologically vulnerable. Undernutrition is an indicator of poor nutrition and poor health of a population. However, very little information is available on the nutritional status of adolescents from rural areas of West Bengal. This lack of useful epidemiological data is the reason why we have attempted to investigate the nutritional status of adolescents from the rural areas of West Bengal state.

In the present study, overall (age and sex combined) prevalence of stunting and thinness were 53.57% and 48.75%, respectively. Based on the WHO classification of severity malnutrition [23], the overall prevalence of stunting and thinness among the studied population was very high. Comparing the results with global estimates show that, the prevalence of stunting and thinness among the adolescents in this area were higher than those reported for Nepal [30], Ethiopia [31], and Bangladesh [32] but lower than those of Kenya [33]. According to de Onis et al [18] 52% boys from Kolkata are stunted. A high prevalence of stunting (52.5%) has also been documented from West Bengal by Das et al [19] The exact figures of undernutrition among the adolescents vary from study to study [11,17,19,20,34], but there is no doubt that undernutrition is an extremely serious public health problem among the adolescents in India, especially among rural population. The basic reasons behind undernutrition are long-term cumulative inadequacies of health and nutrition and an insufficient intake of nutrients during the early stages of childhood. Pal et al [35] and Measham and Chatterjee [36] reported that one of the key causes of undernutrition among Indian communities was the lack of access to insufficient foods and resource amenities.

Dietary patterns, diarrhea episodes, prevalence of various parasitic infestation and other chronic illnesses were not studied in the present study. Moreover, it is likely that the rural populations have a nutritionally deficient diet and are also exposed to diseases due to the unsanitary conditions. They have to wash utensils and clothing in polluted pond water, which may make them more susceptible to parasitic infestations and other chronic infections, thus leading to a higher prevalence of undernutrition [35,37].

The prevalence of stunting was significantly higher among girls (58.4%) than boys (48.7%). The prevalence of thinness was also higher among girls than boys. According to the WHO Report on the Nutritional Status of Adolescents, the prevalence of stunting among girls is 45%, and that among boys is 20% [38]. The higher prevalence of undernutrition among girls is another well-known and accepted fact in almost every Indian community [39,40]. Several studies have already reported the discriminations made against the girl in India [20,41].

There are numerous and multifaceted causes of undernutrition. These causes are intertwining with each other and are hierarchically related. The most immediate determinants of undernutrition are poor diet and disease, which are caused by a set of underlying factors: household food security, education, income, nutritional situation of the parents, access to clean water and sanitation, access to primary health care, sex and age of child. In the present study, education of the mother was an important risk factor for stunting. Children of women with higher education were less likely to be undernourished. Education could be related to increased productivity, better methods of feeding and use of health-care facilities [7,42–44]. Women having higher education, owing to their exposure to the outside world, are more aware of personal hygiene and of promotive and curative health care than that of uneducated or less educated women. Education can also enable the women to make independent decisions and to have greater access to household resources that are vital for nutritional status [45]. Our results were also consistent with this study. With respect to the mother's working status, children of

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

Table 5 Logistic regression showing unadjusted and adjusted odds of adolescent under nutrition by different socio-demographic characteristics.

		Stunting				Thinness			
		%	χ^2	COR (95% CI)	AOR (95% CI)	%	χ^2	COR (95% CI)	AOR (95% CI)
Sex	**Male**	48.75	5.21*	1	1	46.59	1.03	1	1
	Female	58.36		1.47* (1.06–2.06)	1.71** (1.18–2.49)	50.89		1.19 (0.85–1.65)	1.23 (0.86–1.77)
Religious	**Hindu**	54.63	0.95	1.22 (0.81–1.84)	0.98 (0.61–1.57)	49.89	1.09	1.24 (0.83–1.87)	1.07 (0.68–1.7)
	Muslim	49.57		1	1	44.44		1	1
Caste	**Lower** (SC and ST)	72.94	15.12***	2.68*** (1.61–4.47)	2.57*** (1.45–4.56)	67.06	13.44***	2.44*** (1.49–3.97)	2.16** (1.26–3.71)
	Other	50.11		1	1	45.47		1	1
Occupational status of father	**Laborer**	61.8	15.08**	3.51*** (1.66–7.4)	5.29* (1.36–20.62)	59.55	16.12**	3.61*** (1.69–7.75)	5.18** (1.4–19.14)
	Cultivator	52.57		2.4* (1.17–4.92)	4.04* (1.1–14.87)	45.62		2.06* (0.99–4.29)	2.91 (0.84–10.08)
	Business/Service	31.58		1	1	28.95		1	1
	Other	30.77		0.96 (0.25–3.76)	2.47 (0.45–13.71)	38.46		1.53 (0.41–5.74)	3.65 (0.72–18.41)
Educational status of father	**Illiterate or just able to sign**	58.55	4.22	1.51 (0.97–2.37)	0.8 (0.42–1.53)	54.27	4.91	1.46 (0.93–2.28)	0.71 (0.38–1.34)
	Up to primary	50.95		1.11 (0.71–1.75)	0.87 (0.48–1.59)	44.76		0.99 (0.63–1.57)	0.67 (0.38–1.2)
	Secondary or above	48.28		1	1	44.83		1	1
Occupational status of mother	**Housewife**	46.79	20.88***	1	1	42.51	19.58***	1	1
	Laborer	68.12		2.43*** (1.41–4.19)	1.9 (0.95–3.8)	68.12		2.89*** (1.67–4.99)	1.79 (0.91–3.53)
	Cultivator	66.99		2.31*** (1.46–3.65)	2.66*** (1.51–4.67)	57.28		1.81** (1.17–2.82)	2.23** (1.31–3.79)
	Business/Service	64.29		2.05 (0.67–6.22)	14.7*** (3.06–70.73)	57.14		1.8 (0.61–5.29)	6.98** (1.62–30.08)
Educational status of mother	**Illiterate or just able to sign**	59.29	11.64**	2.29*** (1.41–3.72)	1.52 (0.77–3.01)	54.64	12.6***	2.41*** (1.46–3.96)	1.75 (0.89–3.45)
	Up to Primary	52.11		1.71* (1.03–2.85)	1.82 (0.94–3.52)	47.37		1.8* (1.07–3.04)	2.19* (1.12–4.28)
	Secondary or above	38.89		1	1	33.33		1	1
Economic status	**Rs. ≤1000**	60.61	13.21**	2.13* (1.29–3.5)	1.51 (0.6–3.78)	56.23	14.35***	2.07** (1.25–3.43)	1.65 (0.67–4.05)
	Rs. 1001–4000	47.25		1.24 (0.73–2.1)	1.15 (0.49–2.72)	41.21		1.13 (0.66–1.93)	1.09 (0.47–2.54)
	Rs. >4000	41.98		1	1	38.27		1	1
Family size	**≤4**	58.76	6.67*	1.48* (1.03–2.12)	1.46 (0.96–2.22)	53.09	6.78*	1.41 (0.99–2.02)	1.36 (0.91–2.05)
	5–7	49.07		1	1	44.44		1	1
	≥8	64.29		1.87 (0.96–3.64)	1.3 (0.62–2.74)	61.9		2.03 (1.05–3.93)	1.69 (0.83–3.49)
Type of house	**Kutcha**	57.65	1.66	1.32 (0.74–2.35)	0.43 (0.17–1.11)	51.76	1.16	1.34 (0.75–2.39)	0.48 (0.19–1.17)
	Semi-pucca	51.99		1.05 (0.61–1.79)	0.52 (0.22–1.19)	48.01		1.15 (0.67–1.98)	0.63 (0.28–1.39)
	Pucca	50.79		1	1	44.44		1	1
Sanitation	**Toilet Present**	49.77	9.41**	1	1	44.84	10.92***	1	1
	Toilet Absent	64.93		1.93*** (1.29–2.89)	1.72* (0.98–3.02)	61.19		1.94*** (1.3–2.88)	1.76* (1.01–3.04)

$^*P < .05$; $^{**}P < .01$; $^{***}P < .001$.

Q18

non-working mothers were less likely to be undernourished compared to working mothers. Mesfin et at [46]. also noted in their studied that the risk of stunting was greater for children born to working mothers than those born to housewives. Social class difference too had also found in child undernutrition. The risk of being undernourished was significantly higher among lower social class (Scheduled Tribe and Scheduled Caste) adolescent compared to the upper or middle social class. This may be because availability and accessibility of heath care services in rural areas are not in par with urban areas. As the socially backward groups have little exposure to the outside world, they probably stick to their traditional beliefs related to food preparation methods, child care, feeding practices, etc. [47], which have important implications for child nutrition. In addition to this, they live in inaccessible remote areas and hence, there is an issue of availability and accessibility. After controlling the effect of other variables, differentials in adolescent undernutrition by economic status, family size and type of house were not in evidence, indicating that differentials in undernutrition were confounded by other socioeconomic factors. Adolescents reared in joint families were found less likely to be stunted than those in nuclear families. Sapkota and Gurung [8], reported that the children who were reared in nuclear families were more likely to be stunted than those raised in joint families. Studies conducted on prevalence and determination of malnutrition among children in Nigeria showed that malnutrition was significantly associated with gender and age of child, education of mother, calorie intake of the households, access to clean water and presence of toilet in the households [48]. Similar research conducted in Nepal showed that, poor socioeconomic status was found as the risk factors for both stunting and being underweight [8]. Malnutrition varies from country to country depending on ecological, social, economic, and other factors. In India, at present, the most serious nutritional problems are mainly due to poverty. Tesfaye [9] reported that the main predictors of children nutritional status were maternal education, occupation of mother, age of mothers, preceding birth interval, age of child, sex of child, source of water drinking and place of residence.

India, with a population of more than 1 billion, has many challenges in improving the health of its citizens. Steady declines have been noted in the fertility rate, maternal mortality, infant and child mortalities and the prevalence of severe manifestations of nutritional deficiencies, but the pace has been slow. From the foregoing analysis, it is evident that undernutrition among adolescent shows a gloomy picture in West Bengal. In the present investigation, approximately 54% of adolescent were stunted, and 49% were thin. The present study showed that socially, economically and educationally weaker sections of this state were more likely to be undernourished. In addition to the existing universal education program, there is a need to provide mass education regarding health and child nutrition in the rural regions, particularly among the socioeconomic groups that are educationally lagging. In this endeavor, cooperation is necessary among the government, non-governmental organizations, medical personnel and the local people. The results of the present study will be useful for policy makers and programmers to formulate various developmental and health care programs. Nutritional intervention is also necessary to improve the nutritional status among the adolescents.

5. Study limitation

The current study has certain limitations. In the present study, different factors affecting adolescent nutritional status were studied; however, some potential confounders, such as the physical activity of the study participants, age of the mother at first birth, mother's BMI, preceding birth interval, diarrhea episode, prevalence of various parasitic infestation, type of food consume and method of feeding, were not studied. There are limitations associated with using cross-sectional data, as in every cross sectional study, conclusions related to cause and effect cannot be drawn. A longitudinal dataset would be better suited to examine the influence of sociodemographic factors on nutritional status of adolescent. However, as far as we are aware, this is the only provincial study to define the relationship between sociodemographic factors and nutritional status of adolescent. This study was conducted among 10- to 17-year-old children. Additional study is needed for children under 10 years of age.

Author's contribution

1. Amitava Pal has an active contribution in conception and design of paper and collection and analysis of data and interpretation of the data and drafting of the paper.
2. Amal Kumar Pari has contribution in collection and analysis of data of the paper.
3. Arunanshu Sinha has contribution in conception and design of paper.
4. Prakash C. Dhara has an active contribution in conception and design of paper and interpretation of the data and drafting of the paper.

Ethical approval

Ethical approval and prior permission were obtained from the institutional Ethics Committee before commencement of the study.

Conflict of interest

The authors declare that there are no conflicts of interest.

Acknowledgments

All the authors wish to express their gratitude to the participants who volunteered for this study.

References

[1] Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet 2003;361:2226–34.
[2] The State of the World's Children 2005- Childhood under threat.

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

[3] Mengistu K, Alemu K, Destaw B. Prevalence of malnutrition and associated factors among children aged 6-59 Months at Hidabu Abote district, North Shewa, Oromia regional state. J Nutr Disord Ther 2013. T1: 001.
[4] Park K. Park's textbook of preventive and social medicine. 18th ed. Jabalpur: Banarasidas Bhanot Publishers; 2005. p. 405.
[5] Singh JP, Gupta SB, Shrotriya VP, Singh PN. Study of nutritional status among under five children attending out patient department at a primary care rural hospital, Bareilly (UP). Sch J App Med Sci 2013;1:769–73.
[6] ACC/SCN. Fourth report on the world nutrition situation. Geneva: ACC/SCN in collaboration with IFPRI; 2000.
[7] Shah SM, Selwyn BJ, Luby S, Merchant A, Bano R. Prevalence and correlates of stunting among children in rural Pakistan. Pediatr Int 2003;45:49–53.
[8] Sapkota VP, Gurung CK. Prevalence and predictors of underweight, stunting and wasting in under-five children. Nepal Health Res Counc 2009;7:120–6.
[9] Tesfaye M. Bayesian approach to identify predictors of children Nutritional status in Ethiopia. 2009.
[10] Ahmed OE, Elkhalifa MY, Elnasikh MH. Nutritional status of the children under age of five in a decertified area of Sudan - Alrawakeeb valley. Int J Curr Res 2011;2:103–8.
[11] Melaku YA, Zello GA, Gill TK, Adams RJ, Shi Z. Prevalence and factors associated with stunting and thinness among adolescent students in Northern Ethiopia: a comparison to World Health Organization standards. Arch Public Health 2015;73:44. http://dx.doi.org/10.1186/s13690-015-0093-9.
[12] Kodali PB, Kopparty S, Vallabhuni R, Rao Kalapala G. Mid-day meal programme and adolescent undernutrition- an epidemiological study in Hyderabad, India. J Pharm Pract Community Med 2016;2(1):16–20.
[13] Mohammed AY, Tefera RB. Nutritional status and associated risk factors among adolescent girls in Agarfa high school, Bale Zone, Oromia region, South East Ethiopia. Int J Nutr Food Sci 2015;4(4):445–52.
[14] Degarege D, Degarege A, Animut A. Undernutrition and associated risk factors among school age children in Addis Ababa, Ethiopia. BMC Public Health 2015;15:375. http://dx.doi.org/10.1186/s12889-015-1714-5.
[15] Herrador Z, Sordo L, Gadisa E, Moreno J, Nieto J, Benito A, et al. Cross-Sectional study of malnutrition and associated factors among school aged children in rural and urban settings of Fogera and Libo Kemkem Districts, Ethiopia. PLoS One 2014;9(9):e105880. http://dx.doi.org/10.1371/journal.pone.0105880.
[16] Maiti S, Chattterjee K, Ali KM, Ghosh D, Paul S. Assessment of nutritional status of rural early adolescent school Girls in Dantan-ii block, Paschim Medinipur district, West Bengal. Natl J Community Med 2011;2(1):14–8.
[17] Mukhopadhyay A, Bhadra M, Bose K. Anthropometric assessment of nutritional status of adolescents of Kolkata, West Bengal. J Hum Ecol 2005;18:213–6.
[18] de-Onis M, Dasgupta P, Saha S, Sengupta D, Blossner M. The national center for health statistics reference and the growth of Indian adolescent boys. Am J Clin Nutr 2001;74:248–53.
[19] Das P, Ray SK, Joardar GK, Dasgupta S. Nutritional profiles of adolescents in a rural community of Hooghly district in West Bengal. Indian J Public Health 2007;51:120–1.
[20] Mondal N, Sen J. Prevalence of stunting and thinness among rural adolescents of Darjeeling district, West Bengal, India. Italian J Public Health 2010;7:54–61.
[21] Census of India: Census of India, Govt of India, Chapter 4, 00–36-2011 Cen-Data Highlights (E) (1000), 2011.
[22] WHO. Measuring change in nutritional status. Geneva: World Health Organization; 1983.
[23] WHO Expert Committee on Physical Status. Physical status: the use and interpretation of anthropometry, report of a WHO expert committee. Geneva: World Health Organization; 1995 (WHO Technical Report Series, No. 854).
[24] Naing L, Winn T, Rusli BN. Practical issues in calculating the sample size for prevalence studies. Arch Orofac Sci 2006;1:9–14.
[25] Jamaiyah H, Geeta A, Safiza MN, Khor GL, Wong NF, Kee CC, et al. Reliability, technical error of measurements and validity of length and weight measurements for children under two years old in Malaysia. Med J Malays 2010;65:131–7.
[26] Perini TA, de-Oliveira GL, Ornellas JS, De-Oliveira FP. Technical error of measurement in anthropometry. Rev Bras Med Esporte 2005;11:86–90.
[27] World Bank. World development report 2000/2001: attacking poverty. New York: Oxford University Press; 2000.
[28] National family health survey (NFHS-3), 2005–06: India: vol. I. Mumbai: IIPS. 2007.
[29] Krishnaswami K. Country profile: India. nutritional disorders—old and changing. Lancet 2000;351:1268–9.
[30] Woodruff BA, Duffield A, Blanck H, Larson MK, Pahari S, Bhatia R. Prevalence of low body mass index and specific micronutrient deficiencies in adolescents 10-19 y of age in bhutanese refugee camps, Nepal. Atlanta: Centers for Disease Control and Prevention; 1999.
[31] Zerfu M, Mekasha A. Anthropometric assessment of school age children in Addis Ababa. Ethiop Med J 2006;44:347–52.
[32] Ahmed SM, Adams A, Chowdhury AM, Bhuiya A. Chronic energy deficiency in women from rural Bangladesh: some socioeconomic determinants. J Biosoc Sci 1998;30:349–58.
[33] International Rescue Committee. Nutritional status of school aged children in kakuma refugee camp. Nairobi: International Rescue Committee; 1997.
[34] Gupta A, Sharma D, Thakur D, Thakur A, Mazta SR. Prevalence and predictors of the dual burden of malnutrition among adolescents in North India. Saudi J Obes 2014;2(2):63–7.
[35] Pal A, De S, Sengupta P, Maity P, Dhara PC. An investigation on prevalence of anemia in relation to BMI and nutrient intake among adult rural population of West Bengal, India. Epidemiol Biostat Public Health 2014;11(2):e89151–891510.
[36] Measham AR, Chatterjee M. Wasting Away: the crisis of malnutrition in India. Washington D C: The World Bank; 1999.
[37] Seshadri S. Nutritional anaemia in South Asia. In: Gillespie S, editor. Malnutrition in South Asia: a regional profile. ROSA Publication: UNICEF; 1997. p. 75–124. No.5.
[38] WHO. Nutritional status of adolescents girls and women of reproductive age. Report of Regional Consultation. Geneva: World Health Organization; 1998. SEA/NUT/14.
[39] Medhi GK, Hazarika NC, Mahanta J. Nutritional status of adolescents among tea garden workers. Ind J Pediatr 2007;74:343–7.
[40] Malhotra A, Passi SJ. Diet quality and nutritional status of rural adolescent girl beneficiaries of ICDS in north India. Asia Pac J Clin Nutr 2007;16:8–16.
[41] Borooah VK. Gender bias among children in India in their diet and immunisation against disease. Soc Sci Med 2004;58:1719–31.
[42] Gebregyorgis T, Tadesse T, Atenafu A. Prevalence of thinness and stunting and associated factors among adolescent school girls in Adwa Town, North Ethiopia. Int J Food Sci 2016. http://dx.doi.org/10.1155/2016/8323982.
[43] Chrysanthakopoulos NA. Prevalence of gingivitis and associated factors in 13–16-year-old adolescents in Greece. Eur J Gen Dent 2016;5:58–64.
[44] Roba KT, Abdo M, Wakayo T. Nutritional status and its associated factors among school adolescent girls in Adama City, Central Ethiopia. J Nutr Food Sci 2016;6:493. http://dx.doi.org/10.4172/2155-9600.1000493.

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009

[45] Das S, Sahoo H. An investigation into factors affecting child undernutrition in Madhya Pradesh. Anthropologist 2011;13: 227–33.
[46] Mesfin F, Berhane Y, Worku A. Prevalence and associated factors of stunting among primary school children in Eastern Ethiopia. Nutr Diet Suppl 2015;7:61–8.
[47] Bepari M, Pal A, Maity P, Maiti Choudhury S. Nutritional and health status of adult women of the Lodha tribal population of Paschim Midnapore, West Bengal, India: compared with non-tribal women. East Afr J Public Health 2015;12(1):988–96.
[48] USAID. Nutritional status and its determinants in southern Sudan. 2007.

Please cite this article in press as: Pal A, et al., Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India, International Journal of Pediatrics and Adolescent Medicine (2016), http://dx.doi.org/10.1016/j.ijpam.2016.08.009