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Socio-economic and Demographic Determinants of Double Burden of Malnutrition among Rajbanshi School-going Children aged 9-14 Years from North Bengal, India

Antara Bose[1], Isita Sinha[1], Pushpa LataTigga[2], Nitish Mondal[3] and Jaydip Sen[1]

[1]Department of Anthropology, University of North Bengal, P.O. NBU, Raja Rammohunpur, District: Darjeeling, West Bengal, India; [2]Department of Anthropology, Mrinalini Datta Mahavidyaputh, Birati, Kolkata - 700 051, West Bengal, India; [3]Department of Anthropology, Sikkim University, Gangtok - 737102, Sikkim,, India; corresponding author's e-mail: <jaydipsen@rediffmail.com>

KEYWORDS

Anthropology, BMI, Overweight, Public Health, Thinness

ABSTRACT

The Double Burden of Malnutrition (DBM) is a recent phenomenon in the nutritional situation among populations belonging to the low-middle-income countries. Socio-economic, demographic factors with adoption of western lifestyle, unhealthy diets and physical inactivities are the main cause of DBM. The study aims to evaluate the socio-economic and demographic determinants among school-going children belonging to the Rajbanshi population of North Bengal, India. Prevalence of dual burden of undernutrition and overweight were among tha Rajbanshi adolescents children 9-14 years. The DBM has associations with sex/gender, age, birth order and house type. Higher associations were seen among higher age groups and those living in pakka houses.

Introduction

The "Double Burden of Malnutrition" (DBM) refers to the prevalence of both under- and overnutrition within an individual or household or population (Doak *et al.* 2005; Keino *et al.* 2014; Tzioumis and Adair 2014; Wong *et al.* 2015; Gubert *et al.* 2017; Yang *et al.* 2019). The DMB is an important health issue in many of the developing countries such as India. With rapid socio-economic, demographic and nutritional transitions, these countries are portrating an increases in incidence of overweight-obesity with relative risks of associated non-communicable diseases within the population. The DBM co-exists with an increasing incidence in a number of non-communicable diseases in many of these countries (Kavle *et al.* 2016; Nethan *et al.* 2017; Ayogu *et al.* 2018; Modjadj and Madiba 2019) including India (Khor 2008; Mondal *et al.* 2015; Kulkarni *et al.* 2017; Bharali *et al.* 2017; Tigga *et al.* 2018; Debnath *et al.* 2019). Studies have observed that such prevalence were usually confined to the urban socio-economic groups, the principal reasons being adoption of western lifestyles and physical inactivities (Subramanian *et al.* 2007; Tzioumis and Adair 2014; Ranjani *et al.* 2016; Jaiswal *et al.* 2017; Mondal *et al.* 2017; Yang *et al.* 2019). Studies have also reported certain socio-economic and demographic variables that are associated with an increase in DBM among Indian populations (Subramanian *et al.* 2007; Regma *et al.* 2015; Mondal *et al.* 2017; Bharali and Mondal 2019; Dev *et al.* 2020; Bose and Sen 2020). Several researchers have reported a high prevalence of thinness or stunting along with overweight within the same population/household (Popkin *et al.*

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1996; Doak *et al*. 2005; Keino *et al*. 2014; Tzioumis and Adair 2014; Mondal *et al*. 2015; Pereira *et al*. 2017; Ahmad *et al*. 2018; Varghese and Stein 2019; Debnath *et al*. 2019) are mentionable. The cut-offs of overweight and obesity among adults as recommended by the International Obesity Task Force (IOTF) or WHO reference (Cole *et al*. 2000) are BMI >25.0 kg/m^2 and 30.0 kg/m^2. In Africa, it has been documented that the prevalence of stunting hovered unchanged at 40 percent over the past few decades. Projections of stunting for 2020 painted the same picture for Africa. However, stunting rates decreased in Asia and Latin America. Moreover, the incidence of obesity has increased at a high rate among children (Black *et al*. 2013; Biswas *et al*. 2017; Sagbo *et al*. 2018; Dali *et al*. 2018; de Onis *et al*. 2019). de Onis *et al*. (2010) reported that 43 million children <5 years during the year 2010 were overweight- obese, with another 93 million children being at risk of being overweight, thus the global prevalence of overweight/obesity increased from 4.2 percent in 1990 to 6.7 percent in 2010. Studies have indicated a slight decrease in undernutrition along with a simultaneous acceleration of overweight-obesity, thus showing existence of a DBM (Subremanian *et al*. 2007; Khor 2008; Kapil and Sachdev 2012; Mondal *et al*. 2015; Ranjani *et al*. 2016; Song *et al*. 2018; Dali *et al*. 2018; Modjadj and Madiba 2019). Although, prevalence of overweight/obesity had slightly increased during the past decade, it is relatively high among some urban and high socio-economic groups. This could be attributed to the adoption of western food habits and lifestyles (Khadilkar and Khadilkar 2004; Sidhu *et al*. 2006; Subremanian *et al*. 2007; Laxmaiah *et al*. 2007; Sharma *et al*. 2007; Mondal *et al*. 2015; Regma *et al*. 2015; Pawar *et al*. 2016; Sagbo *et al*. 2018; Popkin and Reardon 2018; Min *et al*. 2018) However, the published literature from the country continued to demonstrate that undernutrition still remained a significant public health issue due to substantial socio-economic and demographic disparities, nutritional insufficiencies and environmental conditions (Bose *et al*. 2007; Chowdhury *et al*. 2008; Subramanian *et al*. 2007; Sen and Mondal 2012; Rengma *et al*. 2015; Debnath *et al*. 2018, 2019; Levin *et al*. 2019). Higher socio-economic status, demographic factors, lifestyle modification and higher education are strongly associated with prevalence of a greater risk of overweight-obese among Indian populations (Subremanian *et al*. 2007; Wang *et al*. 2009; Sen and Mondal. 2013; Keino *et al*. 2014; Mondal *et al*. 2015; Rengma *et al*. 2015; Pandita *et al*. 2016; Mishra 2017; Ahmad *et al*. 2018; Debnath *et al*. 2019). The period of adolescence (9-18 years) is a period of transition between childhood and adulthood which is characterized by an exceptional rapid growth and development. There are great individual variations that present difficulty in defining normality among children. Based on current estimates, adolescents contribute to 1.2 billion individuals of the global population and make up one of the largest cohorts (243 million) of the Indian population (Roy *et al*. 2016). The rapid growth and maturation, demand extra nutrients and energy-rich foods which make them potentially nutritionally vulnerable group. Studies have revealed that diets that are not adequate in nature, along with unfavourable environmental and socio-economic conditions adversely affect their physical growth and nutritional status (Roy *et al*. 2016; Tigga *et al*. 2018; Debnath *et al*. 2018). The nutritional status of adolescent girls warrants special focus as they are the 'future mothers' and they contribute significantly to the overall nutritional status and health of the concerned population (Chowdhury *et al*. 2008; Mondal and Sen 2010a; Rengma *et al*. 2015; Jeyakumar and Ghugre 2017; Kunwar *et al*. 2018; Tigga *et al*. 2018; Varghese and Stein 2019; Debnath *et al*. 2019). It is a major area of concern as these girls have the potential to be associated with many concurrent and future adverse health outcomes, such as poor reproductive outcome or intra-uterine growth retardation, thereby contributing to the vicious cycle of malnutrition (WHO 1995; Roy *et al*. 2016). It has also been observed that adolescents in India often attained lower growth than their reference counterparts (Sen *et al*. 2015; Bharali *et al*. 2017; Varghese and Stein 2019; Debnath *et al*. 2019). It is only recently that efforts have been made to include adolescents as beneficiaries in some of the countrywide healthcare and nutritional intervention programmes of the country (Mondal and Sen 2010a; Kapil and Sachdev 2012; Samal and Dehury 2017; Debnath *et al*. 2019).

It becomes imperative to investigate the effects and implications of both overweight-obesity occurring simultaneously with undernutrition in the individual level and/or in the same household and community. The objectives of the present investigation are to assess the coexistence of overweight-obesity, and associations of different socio-economic and demographic variables that have the potential to affect DBM among adolescents belonging to the same ethnic population and residing within the same geographical area.

Materials and Methods

North Bengal popularly refers to the northern part of the state of West Bengal, India and is made up of 8 districts (Darjeeling, Kalimpong, Jalpaiguri, Cooch Behar, Alipurduar, North Dinajpur, South Dinajpur and Malda). The region is the homeland of large number of populations who speak different languages and dialects, having diverse ethnic origins and varied cultural traditions. The populations of the area include the Lepcha, Nepali, Bhutia Toto, Rajbanshi, Mech, Drukpa, Sherpa, Bengalee Speaking Hindu Caste and Bengali Muslim population. Studies have consistently reported that these populations are affected by undernutrition (Mondal and Sen 2010b; Sen and Mondal 2012; Debnath *et al*. 2017; Tigga *et al*. 2018).

The present cross-sectional study was carried among 350 school-going adolescent indigenous Rajbanshi children (boys: 175; girls: 175) aged between 9-14 years and residing in a rural area in the district of Darjeeling, West Bengal. The children were the students of one Rajbanshi dominated school located in Mulaijote located in Block Matigara of the district. The Rajbanshis are mainly located in some districts of North Bengal and the state of Assam. Ethnically they are related to the Koch population of Assam and it is believed that they belong to a mixed ethnicity of Austroasian/Dravidian and Mongolian. Kumar *et al*. (2004) utilizing the genetic markers reported that the Rajbanshi were a semi-Hinduized caste group located in-between the clusters of the Caucasoid caste and Mongoloid tribal populations.

The children were selected using a multi-stage stratified random sampling method. Initially 388 children (boys: 190; girls: 198) were approached to take part in the study investigation. Thirty eight of them (boys: 15; girls: 23) were subsequently excluded from the investigation as either they did not belong to the age group selected or they did not being to the Rajbanshi population. The final sample size consisted of 350 children (boys: 175; girls: 175). All the children were observed to be free from any physical deformities, nutritional deficiency symptoms and did not suffer from any disease at the time of data collection. Permission for the study was taken from the school authorities and Department of Anthropology, North Bengal University prior to data collection. Age and ethnicity of the children were determined from the school records. The work 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 Recorded

Anthropometry is a useful, non-invasive and easy-to-use technique to determine the nutritional status and body composition of an individual or population (WHO 1995; Rysha *et al*. 2017). The measurements of height and weight were recorded following standard procedures. The 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 weighting scale to the nearest 0.10 kg.

The technical error measurement (TEM) was calculated using the standard method (Ulijaszek and Kerr 1999) so as to determine the accuracy of the anthropometric measurements. To calculate TEM, a total of 50 children, other than those covered in the present investigation were measured by two of the authors (PT and AB). The TEM was calculated using the following formula:

$TEM=\sqrt{(\Sigma D2/2N)}$ [D=difference between the measurements, N=number of individuals measured].

The co-efficient of reliability (R) was subsequently calculated using TEM by the following equation: $R= \{1- (TEM)2/SD2\}$, SD= standard deviation of the measurements.

The intra-observer and inter-observer TEM were recorded to be within the cut-off value (R=0.95) as specified (Ulijaszek and Kerr 1999). Hence, the anthropometric measurements recorded by PT and AB were considered to be reliable and reproducible. All the anthropometric measurements in the course of the present study were subsequently recorded by one of the authors (AB).

Assessment of Nutritional Status

Nutritional status has been assessed in terms of Body Mass Index (BMI). The BMI was calculated following the internationally accepted standard equation (WHO 1995) which is as follows: $BMI= Weight/Height^2$ (kg/m^2).

The BMI is considered to be the most widely utilized and reliable indicator of both undernutrition and overnutrition (overweight-obesity) in both epidemiological and clinical investigations. The World Health Organization proposed age-sex specific reference values of BMIAZ among the children for the age group of 9-14 years (WHO 2007) were used to calculate the age-sex specific thinness and overweight. The age-sex specific z-score values were calculated by utilizing the L, M, S values of the respective growth references given for the children. Those children exhibiting z-scores values of $<-2SD$ and $\geq+1SD$ were categorized under 'thinness' and 'overweight-obesity', respectively (WHO 2007).

Socio-economic and Socio-demographic Data Recorded

A structured schedule was used to collect the data on socio-economic and socio-demographic and lifestyle variables recorded following household visits. The data were collected from parents of the children by adopting face-to-face interview and household survey methods. The variables recorded were birth order, mother's occupation, father's occupation, toilet facility, water facility, house type and household income. Ample precision and care was taken into consideration while briefing the questions and recording the data.

Statistical Analysis

The data was statically analyzed using the Statistical Package of Social Sciences (SPSS, Version 17.0). One way analysis of variance (ANOVA) was used to assess age-sex specific mean differences in the anthropometric variables. A binary logical regression (BLR) analysis using maximum livelihood estimation model was fitted to estimate the odds of being affected by thinness and overweight. The BLR model allowed the creation of categorical depended variable dichotomously and the odds were obtained by comparing with the reference categories. The prediction variables of sex, age, birth order, mother's occupation, father's occupation, toilet facilities, water facilities, house type and household income were used to assess the odds ratio. A child observed to be undernourished (e.g., thinness) in any of the categories of mild, moderate and severe thinness and overweight were coded separately as '0' and those being normal as '1'. Similarly, the predictor variables were entered in the BLR

model as a set of dummy variable separately for each regression model. The results obtained were subsequently compared with the reference categories. An odds ratio of 1 indicated that the odds of being undernourished (e.g., thinness) or overweight were not different from the reference category. If the estimated odds ratio was greater than 1, then the likelihood of being affected by undernutrition was higher relative to the reference category. If the odds were observed to be lower than the reference, then the probability of being undernourished was lower relative to the reference category. The p-values of <0.05 and <0.01 was considered to be statistically significant.

Results

Descriptive Statistics

The mean and standard deviation of height, weight and BMI with respect to age of both boys and girls are depicted in Table 1. Overall mean BMI among boys and girls were 21.67 ± 3.94 kg/m² and 18.38 ± 3.94 kg/m². Using ANOVA, it was observed that there were significant difference between ages among boys in height ($F = 17.84$; $p<0.05$), weight ($F = 4.76$; $p<0.05$) and BMI ($F = 1.92$; $p<0.05$). Similar differences existed among girls in height ($F = 23.42$; $p<0.05$); weight ($F = 17.96$; $p<0.05$); BMI ($F = 12.15$; $p<0.05$). Overall mean height was 138.01 ± 7.95 cm, weight was 31.88 ± 6.57 kg and BMI was 22.55 ± 3.81 kg/m² of the children. Height of both sexes increased from lower to higher ages, but weight and BMI did not. The weight and BMI of both boys and girls also increased from lower to higher ages except among boys aged 12 years and 14 years, among girls aged 14 years. The BMI of 14 years old boys and girls were lower than in the other ages. It is evident from Table 2, that majority of boys and girls were overweight (49.14% and 56.57% respectively). On the other hand, prevalence of thinness among boys was 13.71 percent and that among girls were 10.85 percent. Overweight was highest among boys aged 12 years (86.11%) followed by those aged 13 years (75%). Thinness was documented to be highest among boys aged 10 years (23.68%) followed by those aged 14 years (26.32%). Thinness was observed to be highest among girls aged 14 years (26.32%) followed by those aged 10 years (23.68%). Overweight was observed to be highest among boys than girls. The percentage prevalence of thinness and overweight among the children is depicted in Table 2.

Effects of Socio-economic and Socio-demographic Factors on Prevalence of Thinness and Overweight

Results of the multinomial logistic regression portraying the effects of different socio-economic and socio-demographic on overweight sand thinness are depicted in Table 3. Girls were observed to exhibit significantly 1.172 times thinness and 1.268 times overweight than boys ($p<0.01$). The odds were found to be significantly lower among thinness children (1.257 times) of age group 11-12 years ($p<0.05$). The odds were also significantly lower among both thinness and overweight children (1.101 times; 1.215 times) aged 13-14 years ($p<0.05$). The results showed that children belonging to <3 birth order exhibited (1.302 times; $p<0.05$) lower risk of overweight whereas 1.351 times higher risk of thinness was observed among children of <3 birth order. Significant risks were observed among children residing in pakka houses in cases of both undernutrition (1.208; $p<0.05$), and overnutrition (0.524 times).

Discussion

The present investigation has reported the overall prevalence of thinness (boys: 13.71%; girls: 10.85%) was lower that the prevalence of overweight (boys: 49.14%; girls 56.57%) (Table 2). This

could be indicative of the fact that overweight-obesity was more pronounced than undernutrition (i.e., thinness) among these adolescents. Several researchers have reported that populations living in poverty, poor socio-economic status and rural environments were affected with greater incidence of undernutrition while those residing in urban environments and a higher socio-economic status were associated with overweight/obesity (Keino *et al*. 2014; Tzioumis and Adair 2014; Mondal *et al*. 2015; Biswas *et al*. 2017; Sagbo *et al*. 2018; Tigga *et al*. 2018; de Onis *et al*. 2019). The prevalence of undernutrition is usually attributed to long-term relative physical growth retardation, physiological and developmental delays, impaired immune function and reduced cognitive functions (Bose *et al*. 2007; Sen and Mondal 2012; Keino *et al*. 2014; Song *et al*. 2018). The present investigation has observed that boys were more undernourished than girl, even though several research investigations have observed instances of nutritional discrimination against the girl child in India (Bose *et al*. 2007; Mondal *et al*. 2015; Biswas *et al*. 2017; Tigga *et al*. 2018; Bharali and Mondal 2019). Several research investigations have observed that there was a significant increase in age-specific undernutrition among girls in the country (Bose *et al*. 2007; Mondal and Sen 2010b; Mondal *et al*. 2015; Gubert *et al*. 2017; Bharali and Mondal 2019). The prevalence of thinness (low BMI-for-age) in the present investigation was lower than that reported among Malaysian children (26.10% underweight) (Marjan *et al*. 1998), children from Karnataka (31.20% underweight) (Joseph *et al*. 2002), Pakistani children (29.50% underweight) (Mian *et al*. 2002), Tibetan children (24.70% underweight) (Dang *et al*. 2004), tribal children from Madhya Pradesh (61.60% underweight) (Rao *et al*. 2005), Rajasthan (60.0% underweight) (Singh *et al*. 2006) and Santal children of Purulia district of West Bengal (33.70% underweight) (Choudhary *et al*. 2008). Amha and Girum (2018) reported 12.6% prevalence of thinness among adolescents girls from Ethiopia, which was comparatively higer than the present study.

Poverty, poor socio-economic status, and environmental conditions, and ethnic and demographic disparities are the major determinant factors of undernutrition among children in India (Mondal and Sen 2010b; Mondal *et al*. 2015; Ahmad *et al*. 2018). A number of research investigations have focused on the associations of different socio-economic and demographic variables among children (Mondal *et al*. 2015; Sen and Mondal 2012; Tigga *et al*. 2018). The results of the BLR analysis in the present investigation revealed that adolescent girls (Odds 1.172 times) exhibited higher risk of undernourishment. A study observed a similar significant result where the 11-12 years (Odds 1.257 times) and 13-14 years (Odds 1.101 times) age groups exhibited greater odds (Sen and Mondal 2012) and also those children living in pakka house odds showed higher (1.208 times) than those living in kaccha houses. Results of the BLR analyses showed insignificant lower odds in case of mothers' occupation, fathers' occupation, toilet facilities, water facilities and income categories. However, several research investigation have reported significant association of these variables with undernutrition among children (Mondal *et al*. 2015; Debnath *et al*. 2018).

The present investigation revealed that overall prevalence of overweight was 52.84 percent (boys: 49.14%; girls: 56.57% respectively) (Table 3). Several studies have reported that the prevalence of population-specific overweight-obesity has increased among Indian children. It was documented to be 19.9 percent from Pune (Khadilkar and Khadilkar 2004), 22 percent among those residing in urban areas of Delhi (Sharma *et al*., 2007), 14.31 percent from Punjab (Sidhu *et al*. 2006), 7.22 percent from Andhra Pradesh (Laxmaiah *et al*. 2007), 21 percent from a pooled sample from North-India (Bhargava *et al*. 2016) and 25.30 percent from Mumbai (Pawar *et al*. 2016). A comparison showed that the magnitude of overweight-obesity in the present investigation was relatively higher than those reported among Indian children. A study among adolescent school children in Ludhiana revealed that the prevalence of overweight was 12.7 percent (Aggarwal *et al*. 2008) which was lower than that reported in the present investigation (17.75%). Such acceleration in the prevalence of overweight-obesity prevalence could be attributed to an obesogenic environment, rapid urbanization, changes in

socio-economic, demographic situations, dietary patterns and sedentary lifestyle factors (Khadilkar and Khadilka 2004; Sharma *et al*. 2007; Sen *et al*. 2013; Bhargava *et al*. 2016; Yang *et al*. 2019) The present investigation showed that girls were observed to be 1.268 times ($p<0.01$) at greater odds than boys to being overweight in Table 3.The risk was significantly greater in higher age groups of 11-12 years (1.223 times), and 13-14 years (1.215 times) for being overweight, respectively ($p<0.01$) (Table 3). Several studies have reported that age exhibited significant effects on the prevalence of overweight-obesity (Sharma *et al*. 2007; Keino *et al*. 2014; Mondal *et al*. 2015; Bharali *et al*. 2017; Ahmad *et al*. 2018; Tigga *et al*. 2018; Bharali and Mondal 2019; Bose and Sen 2020). The present investigation also revealed that children belonging to higher birth order (e.g., ≥2nd Order) had significantly 1.352 folds ($p<0.05$) higher risk of overnutrition than those born with lower birth orders. It may be summarized here that childhood overweight-obesity along with undernutrition could be a major public health challenge for the healthcare providers and certainly contributes to several non-communicable diseases and related consequences of mortality and morbidity in the foreseeable future generation (Mondal *et al*. 2015).

Conclusion

The present investigation indicates the co-existence of a dual burden of undernutrition (e.g., thinness) and overweight among Rajbanshi adolescents children aged 9-14 years. There is strong evidence to suggest that the proportion of children/adolescent categorized as thinness and overweight increased in same environment/population over last two decades, either rural or urban area. Furthermore, it must be mentioned here that due to the cross-sectional design of the present investigation, lack of information on food and dietary consumption, diet diversification, physical activity measurement, resource allocation, cultural practices and disease prevalence, it is difficult to draw a major conclusion and/or identify the actual cause(s) of DBM. Several socio-economic and demographic variables significantly influenced the prevalence of undernutrition and overweight. The DBM is seen to be associated with sex/gender, age, birth order and house type. The prevalence of the dual burden was higher particularly among those belonging to the higher age group and those living in pakka houses. The increase of DBM can lead to risks of morbidity and mortality including risks of developing non-communicable diseases in later life.

Recommendations

Prevalence of overweight-obesity among children residing both in rural-urban settings may also be indicative of poor prioritization and commitment to different nutritional and public health issues. Hence, an appropriate nutritional intervention programme remains necessary among the target population to ameliorate the DBM. The dissemination of nutrition-related knowledge and awareness among parents and community levels could be helpful to reduce the future possibility of childhood overweight-obesity prevalence and related consequences of mortalities and morbidities among populations. More research is needed to find out the associations between thinness and overweight with socio-economic and demographic variables in population to address the phenomenon. A comprehensive intervention approach has been proposed to prevent DBM and should be integrated into the development of healthcare systems to control the effect of DBM among the vulnerable segments in populations.

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Tables

Table 1: Age and gender specific mean (±SD) of height, weight and BMI

Age (in years)	Boys (N)	Girls (N)	Height (cm)		Weight (kg)		BMI (kg/m^2)	
			Boys	Girls	Boys	Girls	Boys	Girls
9	16	12	132.41 ±04.47	131.84 ±08.43	27.55 ±04.70	25.14 ±04.37	21.48 ±02.78	21.91 ±02.77
10	38	15	133.54 ±04.87	132.40 ±04.13	28.93 ±05.67	24.18 ±04.11	21.60 ±03.80	21.96 ±02.55
11	50	32	135.00 ±03.82	136.00 ±06.50	21.47 ±06.43	18.28 ±06.05	23.05 ±04.15	22.00 ±03.51
12	36	49	136.97 ±05.64	138.88 ±06.07	18.30 ±06.67	18.01 ±05.67	18.29 ±04.08	18.80 ±03.40
13	19	48	141.98 ±05.27	142.02 ±04.88	18.48 ±07.19	18.75 ±04.46	23.25 ±03.75	25.84 ±02.76
14	16	19	158.07 ±01.03	147.65 ±06.66	18.25 ±02.50	17.60 ±02.76	19.92 ±01.24	18.47 ±01.52
Total	175	175	134.91 ±06.69	141.11 ±07.66	21.65 ±06.56	17.55 ±06.16	21.67 ±03.94	18.38 ±03.49
F value			17.84**	23.42**	4.67*	17.96**	01.92	11.33**

Table 2: Prevalence of overweight and underweight among the children

Age (in years)	Girls				Boys			
	N (175)	Thinness (<- 2 SD)	Normal	Overweight-obesity (≥ 1 SD)	N (175)	Thinness (<- 2 SD)	Normal	Over-weight-obesity (≥1 SD)
9	12	2 (16.67)	3 (3.33)	7 (58.33)	16	2 (12.50)	7 (43.75)	7 (43.75)
10	15	2 (13.33)	7 (46.67)	6 (40.00)	38	9 (23.68)	16 (42.10)	13 (34.21)
11	32	6 (3.13)	16 (50.00)	10 (31.25)	50	5 (10.00)	29 (58.00)	16 (32.00)
12	49	5 (10.20)	13 (26.53)	31 (63.27)	36	3 (8.33)	2 (5.55)	31 (86.11)
13	48	4 (8.33)	8 (16.67)	36 (75.00)	19	2 (10.53)	3 (15.79)	14 (73.68)
14	19	5 (26.32)	5 (26.32)	9 (52.63)	16	3 (18.75)	8 (50.00)	5 (31.25)
Total	175	19 (10.85)	52 (29.71)	99 (56.57)	175	24 (13.71)	64 (36.57)	86 (49.14)

*p<0.05; **p<0.01

Table 3: Results of multinomial logistic regression analysis showing association of underweight and overweight with socio-economic, socio-demographic and lifestyle related factors

Category	Sub-category	N (350)	Thinness (<-2SD)(N=33)			Overweight-obesity (>+1SD) (N=185)		
			Odds	Significant	95% CI	Odds	Significant	95% CI
Sex	Boys	175	-	-	-	-	-	-
	Girls	175	1.172	0.002**	(0.058-0.511)	1.268	0.00**	(0.131-0.549)
Age	9-10 years	81	-	-	-	-	-	-
	11-12 years	167	1.257	0.007**	(0.113-0.618)	1.223	0.003**	(0.071-0.760)
	13-14 years	102	1.101	0.004**	(0.014-0.404)	1.215	0.010**	(0.589-3.277)
Birth Order	1-2	248	-	-	-	-	-	-
	Above 2	102	1.302	0.435	(0.599-3.287)	1.351	0.001**	(0.187-0.661)
Mothers Occupation	Housewife	187	-	-	-	-	-	-
	Manual worker	163	1.164	0.882	(0.471-2.401)	0.654	0.617	(0.459-1.588)
Fathers Occupation	Manual worker	267	-	-	-	-	-	-
	Other/Service	83	0.393	0.352	(0.198-1.780)	1.323	0.479	(0.610-2.869)
Toilet Facility	Yes	326	1.198	0.815	(0.265-5.412)	1.064	0.304	(0.304-3.718)
	No	24	-	-	-	-	-	-
Water Supply	Piped	338	0.165	0.210	(0.075-1.77)	0.592	0.620	(0.075-4.696)
	Well/Others	12	-	-	-	-	-	-
House Type	Kaccha	57	-	-	-	-	-	-
	Pakka	293	1.208	0.008**	(0.129-0.737)	0.744	0.524	(0.300-1.847)
Income (Rupees)	Below 2000	64	0.169	0.184	(0.085-1.606)	1.286	0.564	(0.300-1.847)
	Above 2000	286	-	-	-	-	-	-

p<0.05;p<0.01*