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Original Article

Nutritional Status of the Adolescent Girls in Relation with Parasitic Infestation

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ABSTRACT: The present study was conducted among 1570 adolescent girls (aged 10-19 years) in rural, urban and slum areas in and around Dhaka city, Bangladesh to investigate the association of parasitic infestation and nutritional status of the adolescent girls. Two protozoan parasites (*Entamoeba histolytica and Giardia lamblia*) and four helminthes parasites (*Ascaris lumbricoides, Trichuris trichura, Strongyloides stercoralis* and hookworm) were identified during the present investigation. About one third (33.50%) of the adolescent girls were found to be infected with parasites. The prevalence was higher in rural (49.62%) area compared to the slum (33.43%) and urban (18.22%) areas. Among the parasites, *A. lumbricoides* was found to be more prevalent (14.20%) followed by *T. trichura* (4.20%), *E. histolytica* (3.63%) and hookworm (2.03%). The mean height of the infected and non infected girls was 142.38 cm and 144.21 cm respectively and the mean weight was 34.58 kg and 40.40 kg respectively. The Body Mass Index (BMI) of the infected group was lower (18.23 kg/m2) than the non infected group (19.13kg/m^2). The difference of BMI between the infected and non infected groups was not statistically significant ($p>0.05$). According to the Z-score classification, nutritional status (stunted, under weight and wasted) of the non infected adolescent girls were much better than the infected girls ($p<0.000$).

KEYWORDS: nutritional status, BMI, parasitic infestation, adolescent girls, Bangladesh.

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INTRODUCTION

The transitional period from childhood to adulthood is commonly called adolescence. As defined by the World Health Organization,[1] "Adolescence is the period of life between 10 and 19 years of age". Adolescence marks an important phase in development of an individual in the sense that it comprises nearly half of the bodily growing period. Specific biological changes occur during adolescence. For example, growth rate increases during early adolescence, body composition changes and sexual maturity is achieved. In girls, this is the time when physiological preparation for motherhood takes place.[2]

Adolescents constitute about 20% of the total population in the countries of South East Asia including Bangladesh, with the exception of Sri Lanka and Thailand, where they comprised about 17% of the population.[3]

About 12% of the Bangladeshi populations are adolescent girls[4] and 22.6% of them suffer from severe malnutrition.[5] Most of the studies aimed at understanding the malnutrition in Bangladesh have been carried out in infants, preschool children and pregnant women. Bangladesh is a society of poor economic infrastructure with male biased social pattern, which makes adolescent females a vulnerable group for nutrient deprivation, a large number of adolescent girls suffer from various degrees of nutritional disorders that result from inadequate intake of nutrients.[6-8]

Riley (1987)[9] worked in Bangladeshi rural adolescent and observed that the adolescent growth spurt was considerably delayed, extended and less intense in Bangladeshi females compared to sample of British girls. Taj (1993)[10] carried out a study in adolescent school girls, aged between 12-15 years in four girls' high schools at predominantly upper middle class areas of Dhaka city. He observed that 24% of the girls were thin (<90% weight for height) and 50% were short (<95% height for age). Begum (1993)[11] worked with 152 adolescent school girls of a school in Dhaka city and observed that by body mass index 25% of the adolescent school girls were undernourished. Chowdhury (1994)[12] investigated the nutritional status of 81 girls aged between 13 and 16 years residing in Sir Salimullah Orphanage dormitory in Dhaka. Situation with them was remarkably different because of benevolent donations and reported that only 12% of the orphanage girls were thin (90% weight for height), and nearly 30% were overweight (>110% weight for height), not surprisingly 62% subjects were short (95% height for age).

Malnutrition in children and adolescent is also thought to be related to intestinal helminth infections through several mechanisms. As summarized by Lunn and Northrop-Clewes (1993),[13] animal and human studies have shown that intestinal helminthiasis may reduce appetite and cause maldigestion, malabsorption, gastrointestinal losses and inflammatory responses. These mechanisms explain in large part why children with helminth infections will develop growth failure or malnutrition. The intensity of parasitic infections has been shown to be related to the degree of malnutrition. Two studies that were done in clinics by Gilman *et al.* (1983)[14] in Malaysia and Cooper *et al.* (1990)[15] in Jamaica showed marked growth deficits in children with heavy *Trichuris* infection and dysentery syndrome compared to control children with light or no *Trichuris* infection.

Malnutrition is a major problem among the Bangladeshi young people. Intestinal parasitic infections are high and extremely common among the malnourished young population. Malnutrition forms a vicious cycle among them and such cycle if allowed to continue, the young population of the affected community is likely to suffer from permanent damages, such as stunted growth, low reproductive performance and motherhood, lack of memory and thinking capacity.

Adolescents are important segments of the whole population. Their health and nutritional status will largely determine the quality and calibre of the next generation. But the nutritional issues regarding the proper growth and development of the adolescent which might be influenced by parasitic infestation, presence of anemia, dietery behaviour and prevailing socioeconomic condition were not explored in the country in the scale of statistical and scientific dimension.

MATERIALS AND METHODS

The present investigation was a cross sectional study conducted with a sample size of 1570 adolescent girls (aged 10-19 years) during the period of June 2006 to May 2009. The study areas were located in and around Dhaka city, representing rural (Kamrangirchar and Zinjira), urban (Savar and Lalbag) and slum (Mirpur and Mohammadpur) areas. Stool and blood samples were collected from adolescent girls of the selected study areas. To determine the concentration of parasitic cyst/trophozoites/eggs/larva of the fresh and preserved faeces the most recommended formol ether concentration method (Cheesbrough, 1987)[16] was applied in the present study. Prepared slides of the stool samples were examined microscopically in the Parasitology Laboratory of the Department of Zoology, University of Dhaka., International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Mohakhali, Dhaka, Institute of Public Health (IPH), Mohakhali, Dhaka and Barakah General Hospital Ltd., Rajarbag, Dhaka.

The stool samples those showed the presence of cysts/ trophozoites of two protozoan (*Entamoeba histolytica, Giardia lamblia*) and eggs/larva of four helminth (*Ascaris lumbricoides, Trichuris trichura,* hookworm, *Strongyloides stercoralis*) parasites and classified as infected group. Those did not show any presence of protozoan and helminth parasites were termed as non-infected group.

Blood samples were collected from the adolescent girls to measure haemoglobin level instantly in the field using Shahli's haemoglobinometer according to WHO (1994) procedure.[17]

Anthropometric data-height and weight were also taken from the adolescent girls. Body Mass Index (BMI) was calculated using height and weight.

Data were composed and analysed by using Microsoft Office and SPSS software package. Chi-square test (χ^2) was done to find out the positive association between dependent and independent variables. Odds Ratio (OR) was done to find out the positive association of exposure (malnourished adolescent girls) with the disease causing factors. Relative Risk (RR) was done to find out the risk of exposure than non exposure (not malnourished adolescent girls) to develop disorder or diseases. Correlation coefficient (r) was done to find out the degree of relationship among the variables. Nutritional status of the adolescent girls was determined by using Z-score classification and BMI.

Table 1. Prevalence of infestation of intestinal parasites among the adolescent girls in different study areas.

Study Areas		No. of stool samples of the adolescent girls examined	No. of parasite positive cases	Prevalence (%)
Rural Areas	Kamrangirchar	270	134	49.62
	Zinjira	230	105	45.65
Urban Areas	Lalbag	310	65	20.96
	Savar	225	41	18.22
Slum Areas	Mohammadpur	320	107	33.43
	Mirpur	215	74	34.41
Total		**1570**	**526**	**33.50**

RESULTS

Parasitic infestation among the adolescent girls

The research work was conducted with 1570 adolescent girls in rural (Kamrangirchar and Zinzira), urban (Lalbag and Savar) and slum (Mohammadpur and Mirpur) areas in and around Dhaka city. Among them, about one third (33.50%) of the adolescent girls were found to be infected with parasites. The highest percentage of parasitic infection (49.62%) was found in rural Kamrangirchar and the lowest (18.22%) in urban Savar. Comparatively higher rates of infection was identified in slum girls of Mohammadpur (33.43%) and Mirpur (34.41%) respectively (Table 1).[18] Among the parasites, *A. lumbricoides* was found to be more prevalent (14.20%) followed by *T. trichura* (4.20%), *E. histolytica* (3.63%) and hookworm (2.03%) (Table 2).

Age of the adolescent girls observed as an important factor in parasitic infection. The highest prevalence (48.74%) of intestinal parasite was found at the age group of 12-13 years and the lowest (14.09%) at 18-19 years among all five age groups. The prevalence was negatively correlated with age groups ($r = -0.83$, $p<0.08$) which implied that as the age increased, rates of infestation tends to decreased (Figure 1).[18]

Table 2. Prevalence of different protozoan and helminth parasites among the adolescent girls in different study areas.

Study Areas		No. of stool samples	Infected by Protozoans			Infected by Helminths				
			Infected by EH	Infected by GL	Total	Infected by AL	Infected by TT	Infected by HW	Infected by SS	Total
			N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Rural Areas	Kamrangirchar	270	12 (4.44)	6 (2.22)	18 (6.66)	59 (21.85)	18 (6.66)	8 (2.96)	2 (0.74)	87 (32.22)
	Zinjira	230	16 (6.95)	4 (1.73)	20 (8.96)	40 (17.39)	8 (3.47)	11 (4.78)	3 (1.30)	62 (26.95)
Urban Areas	Lalbag	310	6 (1.93)	14 (4.51)	20 (6.45)	22 (7.09)	10 (3.22)	4 (1.29)	0 (0.00)	36 (11.61)
	Savar	225	4 (1.77)	8 (3.55)	12 (5.33)	18 (8.00)	5 (2.22)	2 (0.88)	0 (0.00)	25 (11.11)
Slum Areas	Mohammadpur	320	9 (2.81)	5 (1.56)	14 (4.37)	54 (16.87)	16 (5.00)	4 (1.25)	2 (0.62)	76 (23.75)
	Mirpur	215	10 (4.65)	5 (2.32)	15 (6.97)	30 (13.95)	9 (4.18)	3 (1.39)	0 (0.00)	42 (19.53)
Total		1570	57 (3.63)	42 (2.67)	99 (6.30)	223 (14.20)	66 (4.20)	32 (2.03)	7 (0.44)	328 (20.89)

AL = *Ascaris lumbricoides*, TT = *Trichuris trichura*, HW = hookworm, SS = *Strongyloides stercoralis*, EH = *Entamoeba histolytica*, GL = *Giardia lamblia*, % = Prevalence, N = Number.

Table 3. The anthropometric measurements (Height, Weightt and Body Mass Index) of adolescent girls.

Variables	Positive infection		Negative infection		Z-test for equality of mean	Sig. (p-value)
	N	Mean ± SD	N	Mean ± SD		
Height	526	142.38 ± 7.38	1044	144.21 ± 7.92	- 0.376	0.717
Weight	526	34.58 ± 6.32	1044	40.40 ± 10.30	- 1.076	0.319
Body Mass Index (BMI)	526	18.23 ± 2.18	1044	19.13 ± 3.18	- 0.521	0.619

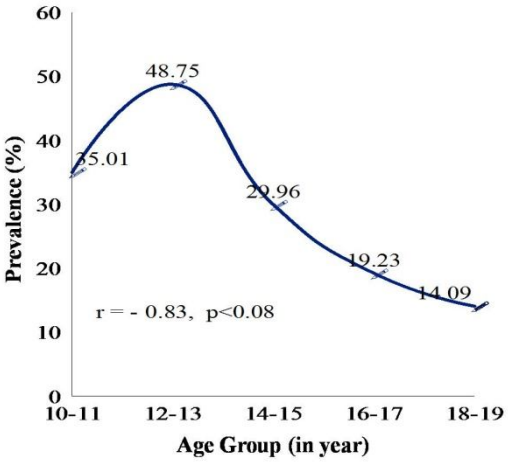

Figure 1. Prevalence of intestinal parasites and helminth parasites among the adolescent girls in different study areas.

Anthropometric measurements in relation to parasitic infestation

Although, mean height, weight and BMI of the non infected groups were higher than those of infected girls, the difference was not statistically significant. The mean height of the infected and non infected girls was 142.38 cm and 144.21 cm respectively and the mean weight was 34.58 kg and 40.40 kg respectively. The BMI of the infected group was 18.23 kg/m^2 and 19.13 kg/m^2 for the non infected group (Table 3).

Considering all age categories of the adolescent girls, the mean height, weight and BMI in the infected groups ranged from 130-148.25 cm, 25-41.2 kg and 15-20.66 kg/m^2 respectively against those of 131-150 cm, 26-52 kg, 15-23.11 kg/m^2 in the non infective groups. The mean height, weight and BMI were found to increase with the increase of age of the girls. Mean BMI of the 18-19 years adolescent girls of the infected group was 22.66 kg/m^2 which were less than the BMI (23.11 kg/m^2) of the non infected group of the same age category (Table 4).

The parasitic infection significantly affects BMI of the adolescent girls. Age and BMI of the adolescent girls were positively correlated. This implies that age increased as BMI stands to increased (Figure 2). Strength of relationship ($r = 0.99$, $p<0.001$) between age and BMI of the adolescent girls who had negative infection was higher than that of the positive infected girls ($r = 0.96$, $p<0.007$).

It was found that 75.28%, 70.34%, and 65.78% of the parasite infected adolescent girls were stunted, under weight and wasted respectively. On the other hand, 45.40%, 42.53% and 40.61% of the non infected girls were stunted, under weight and wasted respectively (Table-3). It was found that Height for age Z-score (HAZ), Weight for age Z-score (WAZ) and Weight for height Z-score (WHZ) were significantly associated ($p< 0.000$) with parasite positive infection. Odds Ratio (OR) also showed that exposer (malnourished girls) positively associated with parasite infection. Relative Risk (RR) showed that risk of exposer (malnourished girls) was higher than that of non exposure (not malnourished girls) to form infection (Table 5).

DISCUSSION

Very few studies have been reported regarding the association of parasite infection with nutritional status of the adolescent girls in comparison with other groups like women and children in the world and it is the case in Bangladesh too. The protozoan and helminth parasites are the oldest pathogens and remain as an important part of

Table 4. The mean height, weight and BMI according to age group of adolescent girls.

Age groups (In year)	Total no. of girls	Positive infection				Negative infection			
		No. of girls	Mean Height (cm)	Mean Weight (kg)	Mean BMI (kg/m^2)	No. of girls	Mean Height (cm)	Mean Weight (kg)	Mean BMI (kg/m^2)
10-11	514	180	129.85	24.95	15.18	334	130.9	25.6	14.94
12-13	402	196	141.84	32.4	17.6	206	143.85	35.4	17.11
14-15	297	89	145.7	35.55	17.69	208	146	42	19.7
16-17	208	40	146.3	38.8	20.04	168	150.3	47	20.81
18-19	149	21	148.25	41.2	20.66	128	150	52	23.11

Table 5. Nutritional status of the adolescent girls by Z-score classification.

Indicators	Nutritional status	Positive infection	Negative infection	Chi-square (χ^2), Odds Ratio (OR) Relative Risk (RR)
Height for age Z-score (HAZ)	HAZ ≤ - 2 SD (stunted)	396 (75.28%)	474 (45.40%)	χ^2 =125.2 p<0.000 OR=3.66 RR=2.45
	HAZ > - 2 SD (not stunted)	130 (24.72%)	570 (54.60)	
Weight for age Z-score (WAZ)	WAZ ≤ - 2 SD (underweight)	370 (70.34%)	444 (42.53%)	χ^2 =107 p<0.000 OR=3.20 RR=2.20
	WAZ > - 2 SD (not underweight)	156 (29.66%)	600 (57.47%)	
Weight for height Z-score (WHZ)	WHZ ≤ - 2 SD (wasted)	346 (65.78%)	424 (40.61%)	χ^2 =87.6 p<0.000 OR=2.81 RR=2.0
	WHZ > - 2 SD (not wasted)	180 (34.22%	620 (59.39%)	

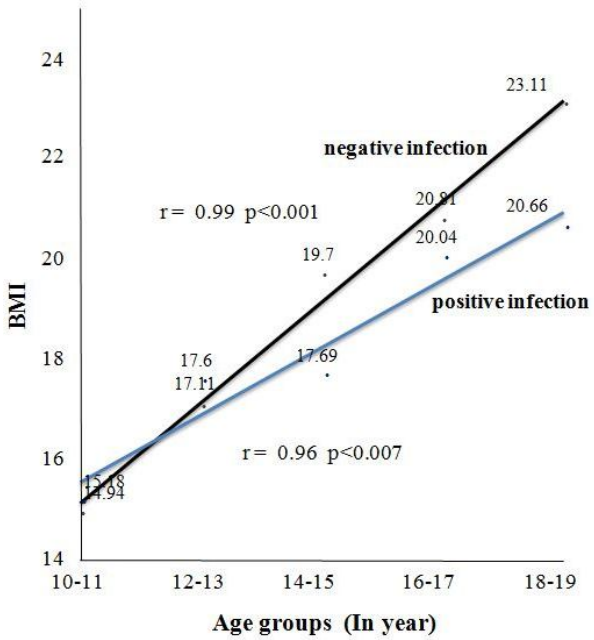

Figure 2. Relationship between parasitic infection and BMI in different age groups of the adolescent girls.

infectious diseases among the world's poor communities which are the most susceptible population. Adolescent girls are particularly susceptible to parasitic infection in developing countries due to poor living condition and existing malnutrition among themselves.

Rahman (2009)[19] reported overall infection as 33% in his study among the people of Chittagang and Chittagang Hill Tracts which was almost similar with the present study.[18] Hyder *et al.* (1998)[20] reported the gross prevalence (33.3%) of parasites among the adolescents and adult population in different rural areas of Mymensingh district of Bangladesh, which was also closely related with our findings. Rao *et al.* (2003)[21] reported the overall prevalence 57% among tribal adolescent girls of Nepal. The findings were higher than the present work due to differences in study population and prevailing socioeconomic condition.

Among all age groups the highest prevalence (48.74%) was observed among 12-13 years of age category in the present study.[16] In another study by Uddin *et al.* (2005),[22] highest prevalence (87.50%) was also recorded among female adolescents aged 12-14 years. So, it was evident that adolescents of this particular age group were more vulnerable for parasitic infestation than other age groups.

Mean weight of the adolescents without infection was 40.40 kg which was higher than that of the girls with positive infestation (34.58 kg), although the values were not statistically significant. Similar trend was also noticed in terms of the height of the two groups where the mean height of the non infected adolescent girls was 144.12 cm against the 142.38 cm of the girls with positive infestation.

Ahmed (1993)[23] studied the nutritional status of adolescent school girls in Dhaka city where mean weight and height was reported as 41.5 kg and 151.4 cm respectively. The mean weight of the adolescent girls

(40.40 kg) without infection is almost similar with his study, but mean height of the infected and non infected girls were lower by 9.02 cm and 7.28 cm respectively. Greater height of their study may be attributed to the higher socioeconomic status of the urban adolescent girls. BMI of the adolescent girls (19.13 kg/m^2) without infection was above the cut off value of 18.5 kg/m^2 but that of the girls with positive infection was below this cut off value (18.23 kg/m^2).So, the mean of all three variables such as height, weight and BMI was better in the non infected group than the group with positive infection.

It was specifically notable in the age group of 18-19 years where adolescents of the non infective groups had 52 kg of weight against the 41 kg of their infected counterpart. A notable difference of 11 kg between these groups was recorded and the results indicate a spectacular higher weight gain among the adolescent girls who were without parasitic infestation. Similarly, the mean height of the adolescent without parasitic infestation was much better in all age groups than the infected groups. Difference was particularly notable in the 16-17 years age group, where adolescent with negative infection had the mean height of 150.3 cm against 146.3 cm of the infected group, a clear difference of 4 cm between the groups. The height of the two groups of the present study was compared with the Ahmed and Hasan (1983)[24] and Bangladesh Adolescent Nutrition Survey (BANS, 1994)[25] study. It was evident that the height of the non infected adolescent girls (130.9-150 cm) and the height of the infected adolescent girls (129.85-148.25 cm) were closely matched with the findings of BANS (1994)[25] study (127-151 cm). BMI of the adolescent girls without infection was also higher in 14 years and above which also indicate better weight gain in the non infected adolescent girls.

The indicators such as stunting, underweight and wasting used to determine nutritional status of the adolescent girls showed the better of nutritional status of the girls without infection than girls having infection. In 1997, Bangladesh Demographic and Health Survey (BDHS) revealed the prevalence of stunting as 43.3% among the adolescent of age group 10-14 years and 55.3% among the adolescent of age group 15-19 years.[26] These values are somewhat closer to the prevalence of stunting of the girls with negative infection of the present study. Medhi *et al.* (2007)[27] studied the nutritional status of adolescent among the tea garden workers in Assam, India and reported prevalence of stunting among adolescent girls as 51.91%. In 9 of the 11 International Center for Research on Women (ICRW) studies, stunting was highly prevalent in adolescent boys and girls.[28] In contrast, the rate of low BMI, indicative of current under nutrition was relatively low, and exceeded 20% in only 3 sites.

Evidence from animal studies demonstrates that *Ascaris* infection causes a reduction in growth rate, reduces food consumption, interferes with absorption of fat and protein, and produces intestinal damage resulting in reduction of mucosal lactase deficiency.[29] There is now general agreement that under certain conditions, infection with *A. lumbricoides* associated with impaired growth and poor nutritional status in children.[29] It may well be that *Ascaris* exerts its growth impairment effects via subtle changes in host nutritional status, *Trichuris* on the basis of inflammatory cytokines, and hookworm through iron deficiency and plasma protein loss.

The height of the growing adolescent is affected by inadequate intake of food for long time. Furthermore, parasitic infestation reduces the absorption of food contributing to the existing malnutrition. So, the high rate of stunting (75.28%) was noticed among the infected adolescent girls in the present investigation.

Under nutrition or underweight was also higher (70.34%) in the infected group than the non infected group (42.53%) in the present study. Ahmed (1993)[23] reported the prevalence of under nutrition among the urban affluent adolescent school girls. They used much lower cut off value (<75% of the NCHS standard Weight for age). Usually weight is affected by short time inadequate intake of calorie.

Similar trend of malnutrition was observed among the adolescent with positive infection when weight for height was used to determine nutritional status of the adolescent girls. About 66% of the adolescent with infection were found to be wasted against 40.61% of the non infected girls. In another study of Rao *et al.* (2003)[21] among tribal adolescent of Madhya Pradesh observed wasting in nearly one third (32.8%) of the adolescent. Comparatively higher prevalence of under nutrition has also been reported from other areas.[30-32]

CONCLUSION

The most important and striking findings of the present study was the influence of parasitic infestation on the nutritional status of the growing adolescent girls. Parasitic infestation adversely affects the growth of adolescent girls which was reflected in the low height, weight and BMI of the infected girls than that of non infected adolescent girls. When nutritional status of the adolescent girls was classified according to Z-score, the percentage of stunting, underweight and wasting was higher among the infected girls than the non-infected ones. Food intake behaviors of the girls may be better explained by the dual burden of anemia and parasitic infestation.

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