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RELATIONSHIPS BETWEEN ANAEMIA AND PARASITIC INFECTIONS IN ADOLESCENT GIRLS OF BANGLADESH

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Abstract: A total of 1570 adolescent girls (aged 10-19 years) of rural, urban and slum areas in and around Dhaka city were investigated to determine the association of anaemia with parasitic infection. About one third (33.50%) of the adolescent girls were found to be infected with one or more protozoans (*Entamoeba histolytica*, *Giardia lamblia*) and helminths (*Ascaris lumbricoides*, *Trichuris trichura*, *Strongyloieds stercoralis*, hookworms). Anaemia (32.22%) was reported among the adolescent girls and 39.52% anaemic girls were infected with intestinal parasites against the 30.63% non anaemic cases. Anaemia was significantly associated with parasitic infestation (χ^2 =11.76, p<0.000). Percentage of anaemic cases was higher in slum area (38.75%) and lower in urban area (24.11%) respectively. Socioeconomic status of the adolescent girls had also impact on the prevalence of parasites and anaemia. Parasitic infestation was much lower (16.10%) among the literate compared to the illiterate respondents (47.58%). The prevalence of parasite infection was positively associated with illiterate adolescent girls (χ^2=171.27, OR=4.73, p<0.000). The level of education was inversely related (r = -0.98, p<0.01) with the prevalence of anaemia. Unhygienic latrine users were associated with parasite infection (OR=2.80) and anaemia (OR=2.16) respectively. The present study revealed that parasitic infection and socioeconomic status may be responsible for anaemia among the adolescent girls.

Key words: Anaemia, parasitic infection, adolescent girls, Bangladesh.

INTRODUCTION

Adolescents are important segments of the whole population but the nutritional issues regarding the proper growth and development of the adolescent which might be influenced by parasitic infestation, presence of anaemia, dietary behaviour and prevailing socioeconomic condition. Anaemia is a global public health problem that affects both developing and developed countries with major consequences for human health. Anaemia can be defined as a reduction of hemoglobin concentration per unit volume of peripheral blood below the normal level (12g/dL) (WHO 1992). WHO (2002) estimated the number of anaemic people worldwide to be a staggering two billion with approximately 50% of all anaemia attributable to iron deficiency. The most common causes of

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anaemia are deficiency of iron, mal-nutrition and parasitic infestation. On the other hand, intestinal parasites are producing detrimental effects on health of millions of people mainly children and adolescents in Bangladesh (Karim *et al.* 1998).

The frequent occurrence of infectious diseases and parasitic infestation among developing countries further increases requirements for iron and increases the chances of negative iron status and iron deficiency anaemia. Infections interfere with food intake, absorption, storage and use of many nutrients such as iron, vitamin A, vitamin B12, vitamin C, folic acid, etc. which contribute to anaemia (WHO 2011).

WHO (1994) estimated that approximately 1.4 billion, 1.2 billion and 1 billion persons are currently infected with various species of intestinal helminths such as round worm (*Ascaris lumbricoides*), hookworm (*Ancylostoma duodenale/ Necator americanus*) *and* whip worm (*Trichuris trichiura*) respectively. Several studies showed that intestinal parasitic infections are present all the time everywhere in Bangladesh (Shakur and Ehsan 1993). In Bangladesh, among the helminths and protozoan parasites, *A. lumbricoides*, *A. duodenale, T. trichura*, *Enterobius vermicularis* and *Etaboeba histolytica*, *Giardia lamblia* are common (Banu *et al.* 2003, Khanum *et al.* 2008). The protozoan and helminthic infection creates different public health problems among the hosts directly or indirectly and can cause nutritional impairment, retard physical and mental development of children and adolescents.

Only few studies dealt with biochemical indices of nutritional status of Bangladeshi adolescent girls. Uddin *et al.* (2005) reported high prevalence of anaemia (96.87%) among the parasite infested adolescent girls in two areas of Bangladesh. Helen Keller International/ Institute of Public Health Nutrition (1999) through National vitamin A survey (nationally representative sample) suggest that 43% of adolescent girls were anaemic. Begum (1993) found 17% of the girls are (Hb<12g/dL) anaemic.

Reports from various clinical trials, field research and laboratory based studies, it is demonstrated that nutritional anaemia and iron deficiency (NAID) are great problem that is faced more particularly by the so called third world countries with lower socioeconomic strata. Therefore, the present study was undertaken to investigate the prevalence of parasitic infestation, anaemia, socioeconomic condition of the adolescent girls in rural, urban and slum settings of Bangladesh and to correlate the relevant parameters in order to find out the real causes of malnutrition among them.

MATERIAL AND METHODS

The present investigation was a cross sectional study with a sample size of 1570 adolescent girls (aged 10-19 years). This study was conducted during the period of June 2006 to May 2009. The six study areas were located in Dhaka district, Bangladesh 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 and carried out to 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 Formol-ether Concentration Method (Cheesbrough 2004) was applied on fresh or preserved stools/faeces and finger prick blood was collected from each adolescent to measure their hemoglobin level instantly in the field with Sahli's hemoglobinometer according to WHO (1994). Anaemia was determined according to WHO (1998) criteria as follows. Mild anaemia: 10-11.9 g/dL, Moderate anaemia: 7-9.9 g/dL and Severe anaemia: <7 g/dL. The data were collected by face to face interview of the adolescent girls.

Chi-square test (x^2) was done to find out the association between dependent and independent variables. Odds Ratio (OR) was done to find out the association of exposure (infected/anaemic/ malnourished adolescent girls) with the disease causing factors. Relative Risk (RR) was done to find out the risk of exposure (infected/anaemic/ malnourished adolescent girls) than non exposure/ (not infected/not anaemic/ not malnourished adolescent girls) to develop disorder or diseases. Correlation coefficient (r) was done to find out the degree of relationship among the variables.

RESULTS AND DISCUSSION

The study was conducted with 1570 adolescent girls in rural (Kamrangirchar and Zinjira), urban (Lalbag and Savar) and slum (Mohammadpur and Mirpur) areas in and around Dhaka city to determine the level of anaemia and gastrointestinal parasitic infestation as well as socioeconomic aspects with their personal hygiene. Two protozoan parasites (*E. histolytica* and *G. lamblia*) and four helminthes parasites (*A. lumbricoides*, *T. trichura*, *S. stercoralis* and Hookworm) were identified during the present investigation (Banu *et al.* 2011, Banu and Khanum 2013). Out of 1570 samples, 526 (33.50%) girls were found to be infected with these intestinal parasites (Table 1). Adolescent girls are generally more infected than their younger peers with intestinal parasites, like *A.*

lumbricoides, *A. deodenale/ N. americanus*, *T. trichiura, E. histolytica*, *G. lamblia* (WHO 1994).

The role of hookworm in causing anaemia is well documented. Hookworms injure their human host by causing intestinal blood loss leading to iron deficiency and protein malnutrition (Hotez and Pritchard 1995, Stoltzfus *et al.* 1997). The parasite induces blood loss directly through mechanical rupture of host capillaries and arterioles followed by the release of a battery of pharmacologically active polypeptides including anticoagulants, antiplatelet agents, and antioxidants (Pritchard 1996, Furmidge *et al.* 1996). Hookworms subsequently digest host hemoglobin by employing a carefully orchestrated cascade of hemoglobinases that align the brush border membrane of the parasite's alimentary canal (Loukas *et al.* 2000, Bundy 1995). Although the threshold might be expected to be well established because of the accurate estimates of blood loss caused by each hookworm species (Martinez-Torres *et al.* 1967), the precise value is actually community dependent because the onset of anaemia is dependent on the iron-status and reserves of the host (Lwambo *et al.* 1991). This in turn depends on a number of factors including dietary iron intake and overall level of nutrition.

Percentage of anaemia was found to vary in different places and age groups of the adolescent girls. According to the status of hemoglobin level of the adolescent girls, a number of anaemic cases were identified in different selected study areas. The highest percentage of anaemic cases (38.75%) was determined among slum dwellers of Mohammadpur followed by 35.34, 34.81 and 31.11% in Mirpur slum, Kamrangirchar and Savar areas, respectively. On the contrary, the least cases (24.19%) were found in Lalbag urban area (Fig. 1). From the analysis it was appeared that, overall percentage of anaemic and non anaemic cases was recorded as 32.22 and 67.77%, respectively. Except 10-11 years, about 40% adolescent girls of all age groups were found to be anaemic. The highest prevalence (42%) of anaemic cases was found in the 18-19 years age group. Statistically the age groups were significantly associated with anaemia (x^2=93.75, $p<0.000$). It was also noted that the percentages of non anaemic respondents were much higher than anaemic cases in all age group (Table 1). Peak parasitic infection occurs in 12-13 years age group among the anaemic (59.87%) and non anaemic (41.63%) cases but in all age groups, comparatively higher percentage was found in anaemic cases than non anaemic cases (Table 1).

Table 1. Relationship between intestinal parasitic infections and anaemia among the adolescent girls of different age groups

Age groups (year)	Total no. blood samples of the respondents examined	Total parasite positive cases (%)	Status of anaemia and parasite positive cases					
			Anaemic cases			Non-anaemic cases		
			No. anaemic cases n (%)	No. parasite positive cases	Prevalence (%)	No. non anaemic Cases n (%)	No. parasite positive cases	Prevalence (%)
10-11	514	180 (35.01)	82 (15.95)	30	36.58	432 (84.04)	150	34.72
12-13	402	196 (48.75)	157 (39.05)	94	59.87	245 (60.94)	102	41.63
14-15	297	89 (29.96)	122 (41.07)	49	40.16	175 (58.92)	40	22.85
16-17	208	40 (19.23)	81 (38.94)	18	22.22	127 (61.05)	22	17.32
18-19	149	21 (14.09)	64 (42.95)	9	14.06	85 (57.04)	12	14.11
Total	1570	526 (33.50)	506 (32.22)	200	39.52	1064 (67.77)	326	30.63

χ^2 = 93.75, p<0.000

Out of 1570 blood samples, 506 (32.22%) were anaemic in the present study. Ahmed *et al.* (1998) reported prevalence of anaemia 22% among the urban school girls. A few studies carried out among adolescent girls in Nepal reported that prevalence ranges from 42-60% (Regmi and Adhikari 1994, Tiwari 2000, Baral 2003, Rikimaru *et al.* 2003).

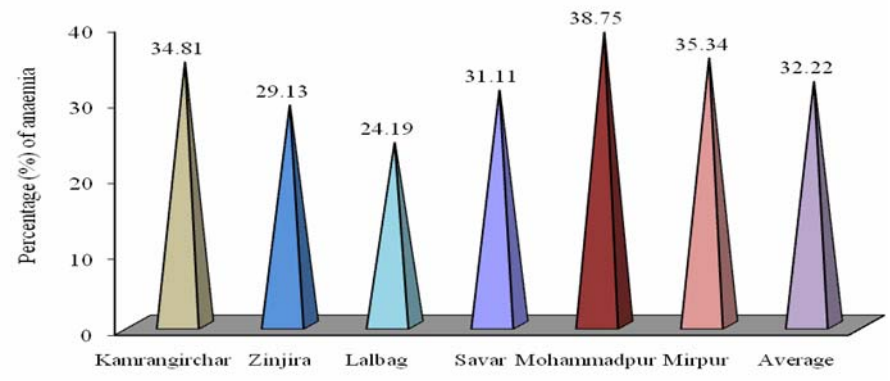

Fig. 1. Status of anaemia among the adolescent girls in different study areas.

The level of anaemic cases was classified as mild, moderate and severe according to WHO (1998) cut off values. The level of anaemia (mild, moderate and severe) of the adolescent girls was recorded from six study areas of Dhaka city. It was found that prevalence of intestinal parasite among anaemic cases were higher than non anaemic cases in all study areas. It may be mentioned here in anaemic cases, the highest rate of infection was found 55.31% in Kamrangirchar and the second highest rate 50.74% in Zinjira (Fig. 2). Out of total 506 (32.22%) anaemic cases in the present study, 59.12% were mildly anaemic, 33.20% were moderately and 7.50% were severely anaemic. It was important to observe the prevalence of severe anaemia raised with the increase of age. Notably, 15.62% severe cases of anaemia were observed in 18-19 years age group but none of the adolescents in 10-11 years were found severely anaemic (Table 2). In the upper age group married girls were dominating and most of them experienced pregnancy which was the contributory factors for severe anaemia amongst them. It was found that prevalence of intestinal parasite among anaemic cases were higher than non anaemic cases in all study areas. It may be mentioned here in anaemic cases, the highest rate of infection was found 55.31% in Kamrangirchar and the second highest rate 50.74% in Zinjira (Fig. 2). Fuseini *et al.* (2010) and Ahmed *et al.* (1998) reported on anaemia and intestinal helminth infections during pregnancy.

The prevalence of anaemia is disproportionately high in developing countries, due to poverty, inadequate diet, risky and high frequency of pregnancy and lactation and poor access to health services (WHO 2011). Adolescent girls are particularly susceptible because of their rapid growth and associated high iron requirements (WHO 2002, BEARD 2000).

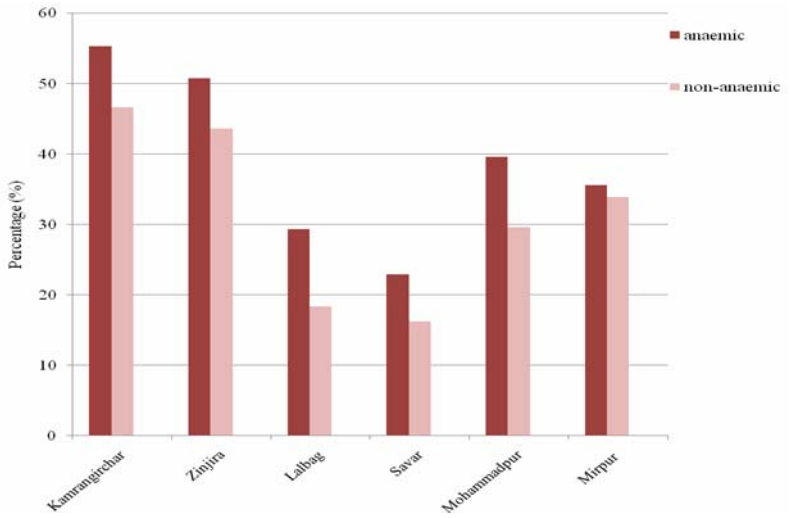

Fig. 2. Percentage of parasitic infection among anaemic and non anaemic girls in different study areas.

Table 2. Levels of anaemia according to age groups of the adolescent girls

Age groups (year)	Total anaemic cases (%)	Level of anaemia		
		Severe anaemic cases (%)	Moderate anaemic cases (%)	Mild anaemic cases (%)
		<7 g/dL (Hb)	7- 9.9 g/dL (Hb)	10-11.9 g/dL (Hb)
10-11	82 (15.95%)	0 (0.00%)	25 (30.48%)	57 (69.51%)
12-13	157 (39.05%)	7 (4.45%)	54 (34.39%)	96 (61.14%)
14-15	122 (41.07%)	12 (9.83%)	33 (27.04%)	77 (63.11%)
16-17	81 (38.94%)	9 (11.11%)	30 (37.03%)	42 (51.18%)
18-19	64 (42.95%)	10 (15.62%)	26 (40.62%)	28 (43.75%)
Total	506 (32.22%)	38 (7.50%)	168 (33.20%)	300 (59.28%)

Hb = Hemoglobin

Parasitic infections were higher (39.52%) amongst anaemic cases than the non anaemic cases (30.63%). Anaemia was significantly associated (x^2=11.76, p<0.000) with parasite infection. Odds Ratio (OR=1.48) showed that exposure (anaemic cases) was positively associated with parasitic infection. Relative Risk (RR=1.29) showed that risk of exposure was 1.29 times higher than non exposure (not anaemic) to form positive parasitic infection (Table 3).

Other studies reported that parasitic infestation is one of the causes of anaemia (Banu *et al.* 2011, Banu and Khanum 2013). Shah and Baig (2005) reported that anaemia significantly related with helminth infection.

Table 3. Association of anaemia with intestinal parasitic infection

Status of anaemia	Parasitic infection	
	Positive infection (%)	Negative infection (%)
Anaemic	200 (39.52%)	306 (60.48%)
Not anaemic	326 (30.63%)	738 (69.37%)

Chi-square (x^2) = 11.76, p< 0.000, Odds Ratio (OR) = 1.48, Relative Risk (RR) = 1.29.

The main window of disease transmission may be contributed by our socio economic condition (education, income, occupation etc.) and personal hygiene (habit of hand washing, use of latrine, footwear, nail clipping etc.). The level of education showed a great impact on the prevalence of parasitic infection (Fig. 3). As the level of education goes up parasitic infection comes down. Out of the total sample, highest prevalence (47.58%) was in illiterate group and the lowest (9.16%) among the respondent whose education level was above secondary. The educational level of the adolescent girls was negatively correlated (r = - 0.90, p<0.05) with intestinal parasite infection. This implies that educational level increased as intestinal parasite infection tends to decrease. Like parasitic infestation, anaemia was also higher (37.21%) among the illiterate compare to the 15.26% whose education level was above secondary. Educational level of the adolescent girls was also inversely related (r = -0.98, p<0.01) with prevalence of anaemia. This implies that when educational level increased the prevalence of anaemia tends to decreased (Fig. 4).

The level of education of the adolescent girls and parasitic infection was highly significant (x^2 =171.27, p<0.000). The exposure (Illiterate) was positively associated with parasitic infection (OR=4.73). Risk of exposure was 2.96 times higher than non-exposure (literate) to form positive parasitic infection (Table 4). The educational level of the adolescent girls was significantly associated (x^2=21.56, p<0.000) with anaemia. The exposure (illiterate) was positively associated with anaemia (OR=1.68). Risk of exposure was 1.43 times higher than non-exposure (literate) to occur anaemia (Table 4).

Level of education of the adolescents was found to influence greatly on the prevalence of parasitic infestation among the adolescent girls irrespective of the areas (Gilgen 1998). Ahmed (1993) reported higher hemoglobin level among the adolescent girls when the education level of their mother found increased.

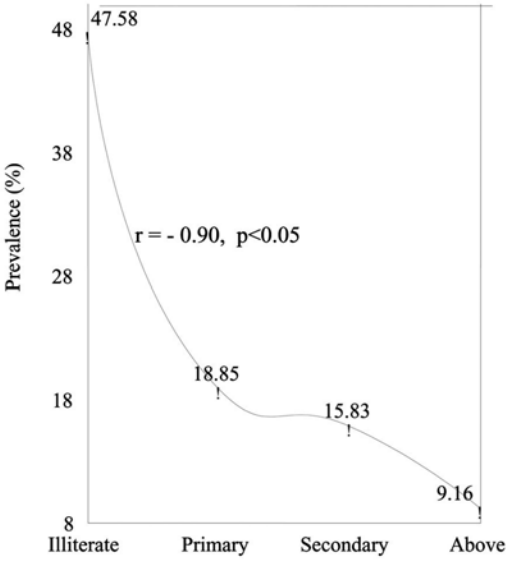

Fig. 3 Relationship between parasitic infection and educational status of the adolescent girls.

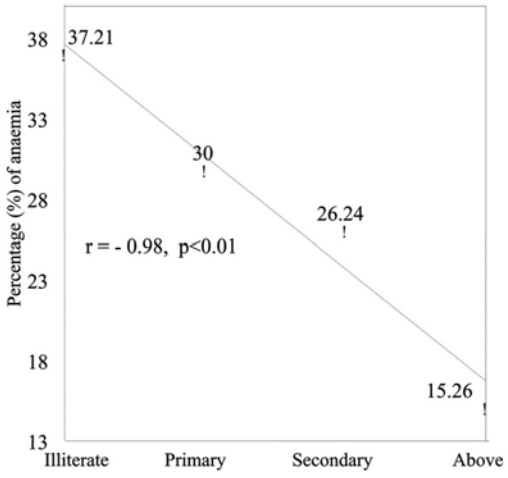

Fig. 4 Relationship between anaemia and educational status of the adolescent girls.

Parasitic infestation was much lower (24.26%) among the hygienic latrine users compared to the unhygienic latrine users (47.30%). The result was highly significant (x^2=88.89, p< 0.000). It was also showed that unhygienic latrine users were positively associated with intestinal parasitic infection (OR=2.80). Relative risk (RR=1.95) showed that risk of exposure (unhygienic latrine users) was 1.95 times higher to cause parasite infection than non-exposure (hygienic latrine users) (Table 4). Types of latrine used by the girls was significantly associated (x^2=38.87, P<0.000) with anaemia. The present study explored that showed that exposures (used unhygienic latrine) were positively associated with anaemia (OR=2.16). Relative risk showed that risk of exposure was 1.67 times higher to cause anaemia than non-exposure (hygienic latrine users) (Table 4).

Luong (2003) reported that school children aged 5-15 years suffer the highest infection rate and worm burden that attributes to poor sanitation and hygiene. About 400 million school-age children are infected with roundworm, whipworm and hookworm worldwide, a large proportion are found in the East Asia region (Cambodia, China, Lao PDR, Thailand and Vietnam). These parasites consume nutrients from children they infect, thus retarding their physical development. They destroy tissues and organs, cause abdominal pain, diarrhoea, intestinal obstruction, anaemia, ulcers and other health problems. Roy (2000) investigated that very high prevalence of *Ascaris* infection where children used mostly open field, drain or katcha pit latrines for defaecation.

Table 4. Association of parasitic infection and anaemia with different variables

Variables		Status of parasitic infection			Status of anaemia		
		Positive infection (%)	Negative infection (%)	Chi-square (x^2) Odds Ratio (OR) Relative Risk (RR)	Anaemic (%)	Not anaemic (%)	Chi-square (x^2) Odds Ratio (OR) Relative Risk (RR)
Education level	Illiterate	413 (47.58%)	455 (52.42%)	x^2 =171.27* OR = 4.73 RR = 2.96	323 (37.21%)	545 (62.79%)	x^2 = 21.56* OR = 1.68 RR = 1.43
	Literate	113 (16.10%)	589 (83.90%)		183 (26.07%)	519 (72.9%)	
Types of latrine user	Unhygienic latrine users (Open filed, Hanging latrine)	298 (47.30%)	332 (52.70%)	x^2 = 88.89* OR = 2.80 RR = 1.95	267 (42.38%)	363 (57.62%)	x^2 = 48.87* OR = 2.16 RR = 1.67
	Hygienic latrine users (sanitary and Pit)	228 (24.26%)	712 (75.74%)		239 (25.43%)	701 (74.57%)	

*p< 0.000

Yusuf and Hussain (1990) stated that sanitary condition in rural communities of Bangladesh was unsatisfactory. They observed that more than 75% families to have insanitary latrines and they were mostly infected with helminthes. Contaminated food and water, inadequate sanitation and poor personal hygiene may be the major sources of intestinal parasite infection.

In countries where anaemia prevalence exceeds 40% (WHO 2011) in pregnant women, universal iron supplements for adolescent girls (particularly those aged 12 to 16 years) and bar on women of childbearing age is necessary. Measures to improve socioeconomic conditions, sanitary practice and rate of literacy in the slum and rural areas are recommended and intervention approaches will help to control the extent of parasitic infestation and anaemia. Furthermore, results of the study will allow the planners, professionals and researchers of the country to take appropriate preventive and remedial measures to control parasitic infestation and henceforth improve the extent of anaemia and overall nutritional status, health and wellbeing of the adolescent female population of the country.

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