Research Article

Associated Risk Factors and Prevalence of Gastrointestinal Parasites in School Children

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Abstract | In the world, particularly in developing countries intestinal parasitic infections are still major public health problems. The present study was carried to find out risk factors associated with pathogenic protozoans and helminth parasitic infections among school children. For microscopic study in this project a total of 750 stool samples were collected and preserved in 70% ethanol. All the samples were carried to the laboratory of parasitology department of zoology university of Malakand Chakdara Dir Lower for examination. Samples were examined macroscopically to observe any larvae, blood, mucus, worm segments or any whole worm. Questionnaires were given to be completed. Data were statistically analyzed by using Chi-Square test (X^2) test and <0.05 P value was considered statistically significance. By using logyls iodine solution, slides were prepared to examine all the stool samples with the help of electric compound microscope.In this study, a total of 750 students 430 (57%) male and 320 (43%) female) provided stool samples. Among them 233 (31% grade 1-5) were pre-school 388 (52% grade 6-8) were primary school and 129 (17% grade 9-10) were high school children. The overall prevalence of intestinal parasite infections was 246(32.8%) from the stool examined of 750 students. 102(13.6%) were female and 144(19.2%) were male among them. About 246(32.8%) students were infected with intestinal protozoans and helminthes. These included *Enterobius vermicularis* (pin worm), *Ascaris lumbricoides* (round worms) *Trichuris trichiura* (whip worm), *Hymenolepis nana* (rat tapeworm) and *Giardia lamblia* (pathogenic protozoan). The highest prevalence was observed for *A.lumbricoides* %(108 cases) followed by *E.vermicularis* %(61 cases). Among them 130 (17.3%) males and 96(12.8%) females were single infections and 14(1.9%) males and 6(0.8%) females had double infections. A relatively high prevalence of intestinal parasitic infections was observed in the children of the selected study area and has contrary effects on their overall health status. To reduce the rate of intestinal parasitic infections, there is need to aware people about these infections and to enhance the quality of personal and environmental hygienic conditions and nutritional status of these children.

Keywords | Rural area, Nutritional status, Night soil, Awareness, Poor hygienic conditions

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INFORMATION

Intestinal parasitic infections are great problem affecting the health of children in developing countries (Pakistan). Parasite infections is the major health issue faced by most of the children in the distant and rural areas of Pakistan (Khan *et al*., 2017). According to a report published by WHO in 1999 there are at least 3.5 billion human beings are affected with the infection caused by intestinal parasites world widely (Crompton,1999). In Pakistan the intestinal parasitic infections are widely prevalent, with variable distribution in different parts of the country (Khan *et al*., 2017). A large number of this infected population consists upon children of lower ages. This is because of poor hygienic conditions, lack of education about parasitic infections, homelessness etc. So due to these factors the parasitic infections become a challenge to these countries.

Children's anthropometric measuring (BMI, growth etc.) and nutritional status are best indicator of children's overall health conditions and important indicators of intestinal parasitic infections. The most active and developmental period of the children is the preschool and school age. At this age lake of carefulness, infections caused by intestinal parasites, poor hygienic conditions, improper intake dietary products, environmental (both natural and home environments) situations are commonly known risk factors which affect adversely the growth of children and also the BMI (Khan and Khan, 2018).

Severe under nutrition and repeated parasite infections are associated with delayed body normal growth and mental development, in lower aged children mostly in primary school children (Waterlow *et al*., 1977). The common health problem of developing countries (Pakistan) children is malnutrition which is caused by insufficient food intake and mostly also by infections caused by intestinal parasites (Walker and Walker, 1997). Due to malnutrition and repeated intestinal parasitic infections the nutritional requirements of these children are not fulfill properly and thus these children fail to grow normally.

Malnutrition in children, is caused by a variety of reasons, some of which linked to food intake, poor food quality, and severe and recurrent parasitic infractions. Intestinal parasite infection is also associated to disability adjusted life years (DALYs), which cost the economy roughly 39 million DALYs (Chan, 1997). Due to repeated intestinal parasitic infections children in developing countries (Pakistan) suffer from poor educational performance, physical and mental weakness, lesser growth problems and stunting apart from morbidity and mortality.

Nematodes (Soil transmitted), helminthes and some protozoa infect approximately 50% children in less developed countries (Pakistan) per year (Glew *et al*., 2003). According to a report soil transmitted worms infected about one billion people chronically (De-Silva *et al*., 2003). According to a survey, 280 million children have hook worms and 478 million have nematodes in their intestines (especially *A. lumbricoides*) (Bethony *et al*., 2006).

Intestinal parasites have variable distribution. Some are more prevalent than other. These species belong to protozoa and helminthes. Some of human intestinal protozoan are *G. lamblia/intestinalis*, *E. histolytica/dispar*, *Cryptosporidium* and *Cyclospora* species. Helminthes parasites (worms) that infect human beings consist upon these two phyla, Platyhelminthes and Nematode.

The prevalence of Intestinal helminthes is more throughout the tropic. Among these helminthes, some common helminthes are the soil-transmitted helminthes (STHs) such as: *Trichuris trichiura, A. lumbricoides,* hookworms, *Hymenolepis nana* and *Schistosomia mansoni*. Among them *Schistosomia mansoni* causes "Schistosmi asis" which is endemic in 74 tropical countries and affecting over 200 million people worldwide while there is a risk of 500 to 600 million people to be infected worldwide (Rozendaal, 1997).

There is a reciprocal relationship between age and exposure to intestinal parasite infections. Older children take more care about their health. They use shoes, avoid playing in night soil, washing hands before meal and after using toilet, cut their nails regularly, brush their teeth regularly, avoid to eat raw vegetables and fruits and thus improve their hygienic conditions. In this way they reduce intestinal parasite infections.

Mostly parasite infections occur at the preschool and school age. At this age, children take less care about their health. They play in night soil, eat raw vegetable and fruits, usually not wash their hands after using toilet and before meal, usually do not wear shoes and thus their hygienic conditions are not as good as older children. In this way they face with frequent and repeated intestinal parasitic infections.

Approximately 25 and 35% of the children are infected with one or more worms of the major species of protozoans and helminthes (De-Silva *et al*., 2003). Among girls and boys aged 5–14 Intestinal parasitism accounts for 12% and 11% of the total disease burden in that age group, respectively in developing countries (Drake and Bundy, 2001).

They may affect the intake of food, its ensuing digestion and absorption, metabolism, and the maintenance of nutrient pools (Hesham *et al*., 2004). At preschool and

school age, children have high requirements of both micro and macronutrients due to growth. But high burden of intestinal parasitic infectious diseases causes multiple micronutrients as well as macronutrients deficiencies among these children. Most commonly studied nutrients deficiencies in relation to intestinal parasitic infections in children among other nutrients are iron, zinc and copper deficiencies.

MATERIALS AND METHODS

Study area and duration

This study was carried out in the rural area of Dir Lower which is located in the Northwest of Pakistan at 71° 02´ and 72° 30´ East, 34° 22´ and 35° 50´ North. Winter season is somewhat cold while summer is moderately hot. The average temperature is about 32°C and 11° C maximum and minimum respectively. In winter season heavy rainfall occurs and on the mountain, snowfall is also occur. This research was carried out in Dir Lower's rural area from August 2020 to September 2021.

Study design

This cross-sectional study was carried out for the estimation of the risk factors associated with pathogenic protozoans and helminth parasitic infections among school children.

Sampling size

The size of total participants in this study consist of totally 750 school children from different schools of the rural area of Dir Lower under the age of fourteen and I have not any record about intestinal complaint during the time of stool collection. Over all 1230 students took part in this study but only 750 of them provided stool samples for microscopic examination.

Data collection methods

Information about family background, eating habits, sources of income, age, family size, sex, water sources and its handling, educational level of their parents, absence or presence of toilets in their homes, building materials of their homes, par, life style, personal hygienic conditions, playing in night soil, awareness level about intestinal parasitic infections and barelegged walking or wearing shoes were collected using proper questionnaires designed in the local languages before the examination of samples in the study area. The students were asked to answers all questions properly and return all questionnaires along with stool samples. All information were examined and then tabulated properly.

Sample collection and examination

For the collection of stools, small plastic bottles were given to the study subjects. The bottles were labeled with age, sex, BMI and date of collection. The students were briefed to collect their fresh stool (nearly 10g of stool). Stool samples were observed macroscopically by naked eye for firmness, smell, and coloring, presence of any fatty substance and blood, and presence of adult worms.

All samples were preserved in 70% ethanol and were arranged age wisely and sex wisely and packed. The collected stool samples were brought to the laboratory of parasitology, Department of Zoology, University of Malakand district Dir lower Pakistan for microscopic examination. Intestinal parasite species identification was carried out on the basis of size and morphology (with available keys).

Statistical analysis

Graph pad Prism 5 was used for statistical analysis. All the collected data from questionnaires and laboratory results were entered into Graph pad prism 5 for statistical analysis. For frequency and percentage calculating of dependent and independent variables descriptive statistics were used. For the verification of the relationship between independent factors and the outcome variables Pearson chi-square (x^2) test was used.

Ethical approval and ethical consent

The department of zoology at University of Malakand Lower Dir provided ethical approval. Written as well as oral consent was obtained from each of the students and their parents. The aims and objective of this work were explained to the participants. The stool collection method would not cause any harm to the participants.

RESULTS

Socio-demographic characteristics of study subjects

In this study, a total of 750 students (from different schools of the rural area of Dir Lower) provided stool samples. Among them 430 (57%) were male and 320 (43%) were female. Age ranges of the study subjects were 4 to 14 years. Among them 233 (31% grade 1-5) were pre-school 388 (52% grade 6-8) were primary school and 129 (17% grade 9-10) were high school children. Table 1 shows the socio-demographic characteristics of students in Dir Lower's rural region (n = 750) who were tested for stool samples.

The comprehensive prevalence of intestinal parasite infections was 246(32.8%) from the stool examined of 750 students. 102(13.6%) were female and 144(19.2%) were male among them (Table 2).

Table 1: The socio-demographic characteristics of students in Dir Lower's rural region (n = 750) who were tested for stool samples.

Socio-demographic data	Category	Number N (%)
Sex	Male	430(57%))
	Female	320(43%)
Age	0–4	122(16.2%)
	5–8	240(32%)
	9–12	210(28%)
	13-14	178(23.7%)
Education level	1-5	233 (31%)
	6-8	388 (52%)
	9-10	129(17%)

From the total sample size of 750, 246(32.8%) intestinal parasites infected students were found. In this study, the highest prevalence was observed for *A. lumbricoides* (108 cases) followed by *E.vermicularis* (61 cases). Over all 246 students were infected with intestinal parasites. Among them 130 (17.3%) males and 96(12.8%) females were single infections and 14(1.9%) males and 6(0.8%) females had double infections. Table 3 shows the distribution of intestinal parasite prevalence and types of infections among school children in the rural area of Dir Lower (n = 750).

Examination of the stool samples of these school children from different schools resulted in identification of five parasites of zoonotic importance. These included *E.vermicularis* (pin worm), *A.lumbricoides* (round worms) *T.trichuria*, *H.nana,* and *G.intestinalis.*

In this study home conditions of the children were also taken in account. Those children who live in non-cemented (which are made of stones, mud etc.) homes have greater intestinal parasite prevalence as compare to cemented homes. This is because the conditions (humidity, temperature, light intensity, pH etc.) which are responsible for the survival and transmission of intestinal parasites are more suitable in the non-cemented houses.

Mode of defecation is also taken in account in this study. It was observed that in the study area toilet availability is less and most of the people use to defecate in open areas. The people of the study area usually use water from streams, wells and springs (result obtained from questionnaires). These water sources are frequently polluted by human and animals extras which are defecated in fields and other parts of open environment.

Intestinal parasites are more common in younger children than in older children, according to this study. In young age the children have low resistance to intestinal parasites, play in mud and in night soil, don't wash their hand before eating and after toilet, usually walk without shoes and lake of basic life skills. But when the age of the child increases the rate of intestinal parasitic infection decreases. This may be as the child grows and his age increases, its immunity system become fully aware about the parasitic infections and fully developed to the parasites. With the increase of age, the child starts to care of his health properly. His personal hygienic conditions improved and reduction of his contact with soil. So due to increase in the strength of immunity system, good hygienic conditions, proper mode of defecation and awareness of intestinal parasitic infections, the rate of intestinal parasitic infections decreases with the increase of age.

Table 2: The prevalence of intestinal parasites among schoolchildren (n = 750) gender wise and age wise.

Age	Male students (N=430)		Female students (N = 320)		Total
	Positive N (%)	Negative N (%)	Positive N (%)	Negative N (%)	N (%)
<4	27(3.6)	48(6.4)	11(1.5)	29(3.9)	115(15.3)
5–8	50(6.7)	73(9.7)	42(5.6)	72(9.6)	237(31.6)
9–12	35(4.7)	90(12)	29(3.9)	64(8.5)	218(29.1)
13–14	32(4.2)	75(10)	20(2.7)	53(7.1)	180 (24)
Total	144(19.2)	286(38.1)	102(13.6)	218(29.1)	750 (100)

Table 3: Distribution of intestinal parasite prevalence and types of infections among school children in the rural area of Dir Lower (n = 750).

Parasites identified	Male N (%)	Female N (%)	Total N (%)	Single infection		Double infection	
				Male N (%)	Female N (%)	M N (%)	F N (%)
A.lumbricoides	70(9.3%)	38(5.1)	108(14.4)	63(8.4)	36(4.8)	7(0.9)	2(0.3)
E. vermicularis	32(4.3%)	29(3.9)	61(8.1)	30(4)	28(3.7)	2(0.3)	1(0.1)
G.lamblia/ intestinalis	12(1.6)	15(2)	27(3.6)	11(1.5)	13(1.7)	1(0.1)	2(0.3)
H. nana	17(2.3%)	14(1.9)	31(4.1)	13(1.7)	14(1.9)	4(0.5)	0(0.0)
T. trichuria	13(1.7%)	6(0.8)	19(2.5)	13(1.7)	5(0.7)	0(0.0)	1(0.1)
Total	144 (19.2)	102 (13.6)	246 (32.8)	130 (17.3)	96 (12.8)	14 (1.9)	6 (0.8)

Table 4: Risk factors associated with the intestinal parasitic infection among school children in the rural area of Dir Lower.

Variables	Categories	Parasitic infection		X^2	p-value
		Positive N (%)	Negative N (%)		
Gender	Male	253	177	1.860	0.1726
	Female	204	116		
Wearing of shoes	Regularly	176	347	26.3	<0.0001
	Sometimes	92	103		
	Not at all	23	9		
Fingernail status	Trimmed	122	277	85.8	<0.0001
	Not trimmed	226	125		
Washing of hands before meal	Always	67	256	53.5	<0.0001
	Sometimes	112	281		
	Not at all	27	7		
Drinking water source	Pipe	182	201	10.6	0.004
	Well	94	113		
	Spring	52	108		
Fruit washing	Sometimes	89	147	212.3	<0.0001
	Not at all	166	72		
	Always	21	255		
Toilet availability	Yes	127	243	33.2	<0.0001
	No	210	170		
Toilet using	Sometimes	95	163	20.1	<0.0001
	Always	106	386		
Source of water for bathing	Well	74	129	9.92	0.007
	Spring	104	117		
	Pipe	111	215		
Washing of hands after defecation	Always	105	288	12.1	0.002
	Sometimes	86	136		
	Not at all	33	102		

Table 4 highlights the risk factors associated with the intestinal parasitic infection among school children in the rural area of Dir Lower.

DISCUSSION

The intestinal parasitic infections cause the deficiency of some important nutrients and thus lead to malnutrition. Generally, intestinal parasitic infections are recognized as a major cause of malnutrition which could affect the height and weight (BMI) of the infected children. About 12.8% rate was observed for *T. saginata* in the rural regions of Pakistan (Khan et al., 2017). Intestinal protozoan's infections *E. histolytica* cause amoebic dysentery. Ascariasis which is cause by *A. lumbricoides* is a lingering and deadly parasite disease (Khan et al., 2022).

In this study, the overall prevalence rate of intestinal parasite in the rural area of Dir Lower was observed. Many factors such as less develop body defense system, lack of proper water system, poor hygienic conditions and some unhealthy habits are responsible for this high rate of intestinal parasite infections. Children who were not washed their hands before meal and after defecation had high prevalence rate of intestinal parasitic infections (feco-oral parasite transmission) as compared to those who were washed their hands before eating and after defecation regularly. As a result of their dirty hands, feco-oral transmission of intestinal parasites occurs, resulting in a high rate of intestinal parasite illnesses in young children.

A study conducted in district Swat (The neighbor district of Dir Lower located in North of KPK Pakistan) by Khan *et al* showed that the prevalence of *A. lumbricoides,* (Nematode infection) was (39.8%) (Khan et al., 2017). Likewise in the district Dir Upper a study conducted by Ullah et al. (2014) reported that the prevalence rate of the *A. lumbricoides* is 54.5% in school children (Ullah *et*

al., 2014). Similar studies about the prevalence rate of intestinal parasitic infections and its effects on a child's health were also conducted worldwide. Chukwuma, *et al* carried out a study in Anambra state, Nigeria and observed high prevalence of intestinal parasitic infections in the primary school pupils and reported the prevalence rate of intestinal parasitic infections was 75% in Obuno primary school, 87.5% in Umuji primary school and 95.5% in Umuoghehi primary schoo (Chukwuma *et al*., 2009). A study conducted by Akingbade *et al*. had showed about 25.8% prevalence in Abeokuta Ogun state, Nigeria (Akingbade *et al*., 2013). While in Edo state Mordi et al. (2017) observed much lower prevalence of about 0.7% prevalence (Mordi and Ngwodo, 2007).

Akingbade *et al*. (2013) observed a high prevalence rate of *A. lumbricoides* of roughly 54.8 percent in their investigation (Akingbade *et al*., 2013). Many researchers in the world studied the prevalence of intestinal parasites gender wisely. The prevalence was sex determinant and reported that the girls were more commonly infected with intestinal parasites (58.9%) than that occurred in boys (57.4%), in Enugu (Ogbaini-Emovon *et al*., 2014). Similarly other reports such as those of Adeyeba et al. (2002) also showed that the prevalence of the intestinal parasites in school children was higher in boys than girls (Adeyeba et al., 2002). In Nepal studies were carried out among school children showed that both sexes (Boys+ Girls) were almost similarly infected (Tsuyuoka *et al*., 1999) in Nigeria conducted a study and reported that there was no consequential difference between gender and intestinal parasite infection in Osun state (Awolaju and Morenikeji, 2009).

Anthropometric assessments (Body Mass Index) have become a useful technique for assessing the nutritional status of populations, especially children in less developed nations (Pakistan) (Carvalho-Costa *et al*., 2007). And for the global well-being of children nutritional status is the best indicator (Onis et al., 2000). The present study indicated that malnutrition has been associated with intestinal parasitic infections. Malnutrition and intestinal parasitism both are very important for public health. This study work which is conducted in the rural area of Dir Lower showed that the rate of malnutrition is very high in the pre-school and school children. The results of this study work consented to the research works of other researchers such as Adekunle (Nigeria), Croptom et al (1999) (Seri Lanka), Carvalhocosta et al (2007) (Brazilian Amazon).

CONCLUSION

The present study provides information about the prevalence of intestinal parasitic infections, and its prevalence among school children of the rural area of Dir Lower. A total of 750 students provided stool samples. The analysis of the results was based on these samples examination.

In this study, the highest prevalence was observed for *A.lumbricoides* (108 cases) followed by *E.vermicularis* (61 cases). Other parasites including *G.intestinalis*, (27 cases) *H. nana* (31 cases) and *T. trichuria* (19 cases).

From total of 750 students over all 246 students were infected with intestinal parasites. And in these infected students, 144 (19.2%) were male and 102 (13.6%) were female students. Out of 246 infected students, 130 (17.3%) males and 96(12.8%) females were single infections and 14(1.9%) males and 6(0.8%) females had double infections. The result showed a significance relationship between intestinal parasitic infections with hand washing habits, fingernail cutting habits, source of water (for both drinking and bathing), wearing of shoes, availability of toilets and using manner etc.

These findings provide basic information for future research work. This study also provide information and investigation about the intestinal parasitic infections and important risk factors in the selected study area. Important measures (hygiene both personal and environmental) supply water treatment etc. should be taken into account. Furthermore the local government and the health department of Dir Lower have to provide basic facilities to all schools of the area and also to provide basic medical treatment of the intestinal parasitic infections in the school children of the rural area of Dir Lower. There is a need to include courses about the basic parasitology (especially intestinal parasitic infections) in the curriculum of primary, secondary and higher secondary level. Also, to arrange seminars at school level to aware the children about the intestinal parasitic infections, its transmission, control and treatment. The local government has to provide basic facilities to the researchers who are working on the intestinal parasitic infections in the selected area.

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NOVELTY STATEMENT

This study uniquely combines laboratory diagnosis with detailed risk-factor assessment to reveal new behavioral and environmental contributors to gastrointestinal parasite infections among school children in the study area.

AUTHOR'S CONTRIBUTION

The corresponding author performed the study design, data collection, laboratory work, data analysis, and manuscript writing. The co-author reviewed the manuscript.

Generative AI and AI-assisted technology statement

AI-assisted tools were used solely for language editing, grammar correction, and improving the readability of the manuscript. These tools did not contribute to the study design, data collection, data analysis, interpretation of results, or the drawing of scientific conclusions. The authors take full responsibility for the content and accuracy of the manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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