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Original Article

Prevalence of Intestinal Parasitic Infection Among School Children of Bajawar, Pakistan

Fazal Subhan[1*], Wali Khan[2*], Hafeez Ur Rahman[1], Shabir Ahmed[3], Sardar Azhar Mehmood[3], Yousef Abdal Jalil Fadladdin[4]

[1]Department of Zoology, Abdul Wali Khan University, Mardan, Pakistan
[2]Department of Zoology, University of Malakand, Lower Dir, Pakistan
[3]Hazara University Mansehra, Department of Zoology, Mansehra, Pakistan
[4]Department of Biological Sciences, Faculty of Sciences, King Abdul Aziz University Jeddah, Kingdom of Saudi Arabia

Abstract

Introduction: Intestinal parasitic infections (IPIs) are caused by protozoan and helminths and are among the most widespread infection in poor populations. The current study aimed to investigate factors affecting the prevalence IPI among children going to school at the primary level in District Bajaur.

Methods: After obtaining official approval from the school administration, a formal consent questionnaire was filled out by the selected children based on age, education level, and parents' income. A total of 687 fecal samples were collected from August 2019 to December 2019 in seven subdivisions of Bajaur and were examined through normal saline and Lugol's iodine solutions (direct smear method).

Results: The prevalence of infection was noticed in 58.5% (n=402/687) of samples, in which the highest prevalent parasite was *Ascaris lumbricoides* (39.8%, n=160/402), followed by *Taenia saginata* (18.1%, n=73/402), *Entamoeba histolytica* (15.4%, n=62/402), *Enterobius vermicularis* (8.70%, n=35/402), *Giardia lamblia* (7.46%, n=30/402), and *Trichuris trichiura* (5.47%, n=22/402). On the other hand, the lowest prevalence rate was noted for *Hymenolepis nana* in only 7 samples, including 2 cases (28.57%) in males and 5 cases (71.43%) in females, respectively. The students of grade 5 were more adapted to hand washing (90.9%), while the lowest rate of hand washing was observed in kindergarten and 1st class children ($P>0.05$). The children of the low classes were found to eat raw food materials more than those of the high classes ($P>0.05$). The same case was also detected for water sources ($P>0.05$), while the children of the 1st and 2nd classes were found more associated with pet animals than the other students ($P>0.05$). Mon parasitism and polyparasitism were observed at 76.6% (n=308/402) and 4.95% (n=20/402), respectively.

Conclusion: The current study calls for the control of IPI among children of the study region as polyparasitism as an alarming reason.

Keywords: Helminth, Infection, Prevalence, Cestodes, Protozoan, School children

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Introduction

Intestinal parasites are organisms that live at the expense of their host in the intestinal tract. Intestinal parasites are divided into two groups of protozoan and intestinal helminths. These groups are the most widespread disease-causing agents in the human population. In developed countries, protozoan parasites are the major cause of digestive problems as compared to helminths (1). The intestinal protozoan is identified by recognizing trophozoites or cysts in fecal samples, or biopsy samples by visualizing cysts or intestinal mucosal secretion (2).

Intestinal parasitic infection (IPI) is most common in developing countries all over the world. People become infected by the ingestion of eggs and cysts from the polluted areas where feces had been placed (3). Transmission in dry and hot climates is recurrent and most often occurs throughout rainy months (4). Suboptimal sanitation is also an important aspect that results in the increased contamination of the water and soil (4). The infection of these parasites is the most dominant in developing tropical countries and subtropical countries of the world. *Ascaris lumbricoides* can infect more than a billion people all over the world, including 795 and 740 million people infected by *Trichuris trichiura* and hookworms, respectively. Intestinal helminths are the leading source of death in remote parts of the world.

The most common intestinal parasites are *A. lumbricoides*, *Ancyclostoma duodenale*, *Necator americanus*, and *T. trichiura*. They reside and develop in the small intestine ileum, and occasionally in the jejunum. About more than one billion human population is infected by *A. lumbricoides*. Roundworm is considered

*Corresponding Author: Fazal Subhan, Email: fazalbjr1122@gmail.com and Wali Khan, Email: walikhan.pk@gmail.com

a children's parasite, but all ages of people can get infected with it (5). Other intestinal helminth species are not broadly widespread (1). An adult typically causes slight or no symptoms; however, severe infections can lead to metabolic problems, especially among children.

Preschool-age children, school-aged children, and women of the child-bearing age were the risk groups in the human population; however, all age groups can be infected with it. The intestinal process includes bloating and abdominal discomfort, followed by vomiting, nausea, diarrhea, and pain (3). The parasitic infections are directly transferred to humans through contaminated food and water when they pass into an environment in feces, while helminth parasites need a maturation period until becoming infectious to humans in the soil.

IPIs are widely prevalent with variable distribution in different parts of the country. Although studies about intestinal parasites were performed in different areas of the Malakand region (6-20), no study was published on the intestinal parasites in the human segment of Bajaur. Therefore, the current study was conducted to investigate the prevalence of intestinal parasites in school-aged children of district Bajaur Pakistan.

Materials and Methods

Study Area

District Bajaur is situated at 34.856902° E, 71.429936°N. This is linked to Malakand Agency in the southeast, and district Dir joins it in the northwest. In the southwest, it is Mohmand Agency, and Afghanistan is located in the northwest of Bajaur. The total given area is 1,290 km^2 with approximately 1093684 population (Figure 1). The normal rainfall and annual hotness were reported as 800 mm and 20.2°C, respectively. January is the coldest, while June is the hottest month of the year recorded at 8.3 and 42°C temperature, respectively.

Fecal Sample Collection and Handling

This survey was performed from August 2019 to December 2019. A questionnaire was used before specimen collection to collect information related to children's gender, age, family size, getting raw food, weight, height, source of water, hand washing, and whether they have an association with pet animals or not. After obtaining official approval from the administration of the school, a special consent questionnaire was filled out, and the information was collected from the students according to their responses to the above questions. Special consent from parents was also obtained to allow their children to participate in this survey. For fecal sample collection, sterile open-mouth plastic bottles, labeled by name, gender, age, and class, as well as a woody spatula, tied with a band of rubber in a small plastic bag were provided to each of the participants enrolled in a fecal sample collection. The students were briefed as to how to collect the fecal sample. In addition,

Figure 1. Map of Bajaur Agency Showing Different Areas for Sample Collection. *Note*. The areas are highlighted in green color

they were advised to collect a fresh fecal sample of about 10 g through a wooden spatula given to them and save it in the sterile plastic bottles and to write their gender, age, and class on the label stick to the bottle. After the collection, all the samples were stored in coolers and fixed in 10% formalin before transportation to the Parasitology Laboratory of Malakand University for examination and analysis of IPIs.

Fecal Sample Examination

Initially, the collected fecal samples were examined through the naked eye to observe any segmental or mature stage of the parasite. Then, the fecal samples were submitted for microscopic analysis through the direct smear method (Lugol's iodine solution and saline solution). About a drop of the saline solution was placed in the center of the left half of the slide, while a drop of Lugol's solution was out on the right half's center of the slide, which was labeled as the student's name, age, and class. Next, a small amount of the feces sample (about 2 g) was picked up through a match and mixed with saline drop placed on a slide to form a suspension. Likewise, another 2 g of the feces sample was picked through the match and mixed with Lugol's solution placed on the right half center of the slide to form a suspension. Each drop was covered with a cover slip, and the cover slip was pressed gently to reduce the possibility of air bubbles in the smear. The slide was put under a microscope for the examination of parasites. Initially, the slide was examined with a 10x objective. As the suspected parasites were detected, the 40x objective lenses were switched. Depending on the results obtained from the examination of collected fecal samples under a microscope, the samples were classified as positive and negative for IPI .

Data Management

The collected data of IPI from different school-going children of primary level were separated based on their age, sampling areas, and types of identified parasites. The collected data were stored in the form of a table in a Microsoft Excel sheet for further analysis and to get absolute results of the study.

Statistical Analysis

The statistical analysis for this data was performed by using Graph Pad, version 5. The Different variables were statistically assessed with the help of one-way analysis of variance (ANOVA) and two-way ANOVA. The prevalence was calculated in percentage as the total number of infected individuals multiplied by 100 divided by the total number of examined.

Results

A total of 687 fecal specimens were collected from school-going children in different schools of district Bajaur, Khyber Pakhtunkhwa. Four hundred and two samples were infected by different intestinal parasites such as *T. saginata, E. histolytica, A. lumbricoides, T. trichiura, H. nana, E. vermicularis, G. lamblia,* and a hookworm species.

Age-wise Prevalence of Parasitic Infection

Of the total samples, 358 were collected from male children of which 221 were infected, while 329 samples were collected from female children of which 181 demonstrated an infection of different parasites. The age-wise prevalence was noticed during this study, but the most prevalent age of children was found to be the 7-9 age group of which 151 samples were examined (37.5%) compared to 4-6 in which 149 (37.06) and 10-12 age group from which 102 samples (25.37%) were examined, and their details are provided in Table 1.

Single Intestinal Parasitic Infection in School Children

The total samples collected during this study demonstrated that most samples were carrying a single parasite (n = 308), including *A. lumbricoides*, which had the highest rate and was found in 132 samples (70 in males and 62 in females) with a ratio of 32.83%, while the lowest number of samples of *H. nana* was found only in 5 samples (3 in males and 2 in females) with a ratio of 2.13% (Table 2).

Poly Parasitism in School-going Children

Poly parasitism was less in number during this study. During an examination of poly parasitism in infected samples, *A. lumbricoides*, *T. saginata,* and *E. histolytica* were found in 5 samples (3 in males and 2 in females), and a similar ratio was shown by *T. trichiura, E. vermicularis, G. lamblia,* and *T. saginata* (2 in males and 3 in females both showing the same ratio of 1.24%. However, the lowest poly parasitic infection was also found in 2 samples of *T. Trichiura*, *A. lumbricoides,* and *G. lamblia* (2 in males and 1 in female), as well as *A. lumbricoides, T.*

Table 1. Age-wise Prevalence of Intestinal Parasitic Infection in Children of Different Schools of Bajaur (n = 402)

Parasites	Children Age (No., %)			Total (%)
	4-6	7-9	10-12	
Ascaris lumbricoides	70 (43.75)	55 (34.37)	35 (21.87)	160 (39.8)
Taenia saginata	25 (34.24)	28 (38.35)	20 (27.39)	73 (18.15)
Entamoeba histolytica	20 (32.25)	23 (37.09)	19 (30.64)	62 (15.42)
Enterobius vermicularis	10 (28.57)	16 (45.71)	9 (25.71)	35 (8.70)
Giardia lamblia	8 (26.66)	10 (33.33)	12 (40)	30 (7.46)
Trichuris trichiura	10 (45.45)	6 (27.27)	6 (27.27)	22 (5.47)
Hookworm	6 (46.15)	7 (53.84)	0 (0)	13 (3.23)
Hymenolepis nana	0 (0)	6 (85.71)	1 (14.28)	7 (1.74)
Total number	149 (37.0)	151 (37.7)	102 (25.3)	402

P value = 0.0001.

trichiura, E. histolytica, and *G. lamblia* (1 in males and 2 in the females) with the same ratio of 0.74% (Table 3).

Overall Prevalence in School Children

Regarding the overall rate of prevalence in all the infected 402 samples, the highest number of samples (n = 160) was found which was infected by *A. lumbricoides* in 53.12% (85/160) and 46.87% (75/160) of male and female children, respectively. The total ratio was calculated as 39.80% of the whole study. *T. saginata* was detected in 73 samples [41 (56.16%) in males and 32 (43.83%) in females] with a ratio of 18.15% examined for the mentioned parasite. The lowest parasite *H. nana* was found in only 7 samples [2 (28.57) in males and 5 (71.43%) in females) with a total ratio of 1.74% (Table 4).

Factors Involved in Intestinal Parasitic Infection in School Children

Different environmental factors are involved in the IPI, as well as a different number of responses from the children. Hand washing is one of the most important factors before and after meals in children. In the current study, hand washing behavior was increasing in high groups than lower ones progressively. The students of grade 5 were more adapted (90.9%), while those in KG and 1st class represented less adaption. It may be due to unawareness in school children of low classes. The children of the low classes were found to eat raw food materials more than those of the high classes. The same case was also observed for water sources, while the children of 1st and 2nd classes were found to be more associated with pet animals than the other students (Table 5).

Discussion

As mentioned earlier, various environmental factors are involved in IPI and a different number of responses are recorded from the children. Hand washing is one of the most essential factors before and after meal in children.

Ascaris lumbricoides is one of the leading pathogenically important neglected tropical soil-transmitted helminths in the Malakand region, Pakistan. It ranked 1st, and the region was considered endemic for this nematode infection. In the present study, *A. lumbricoides* was reported as the most prevalent parasite (39.80%), which is closely comparable with the findings of some other studies (6,9,13,17). The present prevalence rate was found high when compared with the findings of other studies (12,13). The present prevalence rate was low compared with the results of some studies (11,13). *A. lumbricoides* infection was mainly observed in school children. It was more common in boys than girls of the same age.

Hookworm infection is the commonest in the northern parts of Pakistan; however, this infection has also been reported in other areas and shows a variable rate of prevalence and geographic distribution. Human hookworms were reported at 3.23% in the present study, which is consistent with the results of other studies (6,7,9,20). Conversely, the prevalence rate in the present study was higher than that of some other studies

Table 2. Gender-wise Prevalence of the Pattern of Single Intestinal Parasitic Infection Among School Children (n = 402)

Parasites	Single Infection		Total No. (%)
	Male	Female	
Ascaris lumbricoides	70	62	132 (32.8)
Taenia saginata	33	28	61 (15.1)
Entamoeba histolytica	27	20	47 (11.6)
Enterobius vermicularis	12	8	20 (4.97)
Giardia lamblia	11	7	18 (4.48)
Trichuris trichiura	8	7	15 (3.74)
Hookworm	6	4	10 (2.48)
Hymenolepis nana	3	2	5 (2.13)
Total number	170/221 (76.0)	138/181 (76.2)	308 (76.6)

P value = 0.52

Table 3. The Pattern of Poly Parasitism Among School Children (n = 402)

Parasites	Poly Infection		Total No. (%)
	Male	Female	
Ascaris lumbricoides + *Taenia saginata* + *Entamoeba histolytica*	3	2	5 (1.24)
Trichuris trichiura + *Ascaris lumbricoides* + *Giardia lamblia*	2	1	3 (0.74)
Trichuris trichiura + *Enterobius vermicularis* + *Giardia lamblia* + *Taenia saginata*	2	3	5 (1.24)
Ascaris lumbricoides + *Trichuris trichiura* + *Entamoeba histolytica* + *Giardia lamblia*	1	2	3 (0.74)
Hymenolepis nana + Hookworm + *Entamoeba histolytica* + *Ascaris lumbricoides* + *Trichuris trichiura*	2	2	4 (0.9)
Total number	10/21 (4.52)	10/181 (5.52)	20/402 (4.95)

Note: *P* Value at 95% confidence interval = 1.0 (-1.031 to 1.031)

Table 4. Overall Prevalence of Intestinal Parasitic Infection Among School Children's

Parasite	Male	Female	Total
	No. (%)	No. (%)	No. (%)
Ascaris lumbricoides	85 (53.12)	75 (46.8)	160 (39.8)
Taenia saginata	41 (56.1)	32 (43.8)	73 (18.1)
Entamoeba histolytica	35 (56.4)	27 (41.5)	62 (15.4)
Enterobius vermicularis	20 (57.1)	15 (42.8)	35 (8.70)
Giardia lamblia	16 (53.3)	14 (46.6)	30 (7.40)
Trichuris trichiura	15 (68.8)	7 (31.8)	22 (5.47)
Ancylostoma duodenale	7 (53.8)	6 (46.1)	13 (3.23)
Hymenolepis nana	2 (28.5)	5 (71.4)	7 (1.74)
Total	221 (54.9)	181 (45.0)	402

Note: *P* Value at 95% *confidence interval = 0.01 (-22.04 to 32.04.*

Table 5. Risk Factors Involved in Intestinal Parasitic Infection Among School Children

Class	Response	Kindergarten (99)	1st (77)	2nd (65)	3rd (62)	4th (55)	5th (44)	*P* Value
Hand washing	Yes	81 (81.8)	63 (81.8)	55 (84.6)	55 (88.7)	49 (89.0)	40 (90.9)	0.98
	No	18 (18.18)	14 (18.18)	10 (15.38)	7 (18.42)	6 (10.90)	4 (9.09)	
Eating raw food	Yes	25 (25.25)	17 (22.07)	15 (23.07)	14 (22.58)	10 (18.18)	7 (15.90)	0.97
	No	74 (74.74)	60 (77.92)	50 (76.92)	48 (77.41)	45 (81.81)	37 (84.90)	
Water source	Tape	14 (14.14)	7 (9.09)	5 (7.69)	6 (9.6)	5 (9.09)	4 (9.09)	0.99
	Well	85 (85.85)	70 (90.90)	60 (92.30)	56 (90.32)	50 (90.90)	40 (90.90)	
Association with pet animal	Yes	7 (7.07)	10 (12.98)	8 (12.30)	7 (11.29)	6 (10.90)	5 (11.36)	0.98
	No	92 (92.92)	67 (77.01)	57 (87.69)	55 (88.70)	49 (89.09	39 (88.63)	

(12,13) while being lower than that of other studies (11,15,17,21,22). Lack of education, improper sanitation, and drinking water facility play a major role in causing infection.

Enterobius vermicularis is one of the most common human helminths found in children. This parasite transmits through behavioral factors; however, the status of infection is unknown in the children of the study area. Based on the finding of the current study, the prevalence rate was 8.70%, which is in line with the results of some studies (9,12,22), while being higher than (11,13,17) and lower than (7,21,23) the results of the other studies. This pin worn has a wide range of geographic distribution and deals with social customs and personal cleanness of the population.

Taenia saginata is commonly known as the beef tapeworm. This is a meat-born zoonotic infection of medical importance. The finding of the present study revealed that the rate of prevalence was 18.15%, which conforms to the result of different studies (6,7,9,12,15,17,20,22) but higher than that of other studies (11,15,24). The infection rate was low in other studies (12,21). Diseases caused by cestodes were a community health problem in poor recourse economic countries, including Pakistan (12).

Entamoeba histolytica was the most prevalent pathogenically important protozoan parasite. The rate of prevalence was 15.42%, which is in conformity with the findings of some studies (7,22). The current prevalence rate is lower than that of some studies (12,25) while being higher than that of other studies (9,13).

In the current study, hand washing behavior was increasing in high groups than in lower ones. The students of grade 5 were more adapted at 90.9%, while KG and 1st class children showed less adaption. It may be due to unawareness in low classes' school children. According to some studies (26,27), most of the children (57.1%) were found with no hand washing habit, while 25.9% of them were observed with hand washing practice. The children of low classes were found to eat raw food materials more than the children of the high classes. The findings of one study (26) revealed that 31.3% of the school children were noted with eating raw food materials, while 25.7% of them were eating well-prepared food. The same case was also observed for water sources, while the children of the 1st and 2nd classes were found to be more associated with pet animals than the other students. In another study (26), it was noted that most of the school children used river water than tap water for drinking purposes. An important impact of parasitic infection and hand washing was determined by the time they were studying the effect of hand washing and nail clipping on intestinal parasites among school children. Some studies were conducted on food handlers as a source of IPI (28,29). The prevalence of intestinal nematode infection was reported in the school children of the urban areas of district Lower Dir, Pakistan (30,31).

Conclusion

It was concluded that male children were found highly infected than females. *A. lumbricoides* was the most prevalent helminth in helminths, and *E. histolytica* was reported the most abundant among protozoan parasites. Lack of awareness and poverty were the factors involved in the prevalence of these infections. The availability of drinking water sources should be provided, and campaigns on awareness among the general masses and students should be launched accordingly.

Authors' Contribution

Conceptualization: Wali Khan.
Data curation: Fazal Subhan.
Formal analysis: Yousef Abdal Jalil Fadladdin, Hafeez Ur Rahman.
Investigation: Wali Khan, Fazal Subhan.
Methodology: Wali Khan.
Project administration: Wali Khan.
Resources: Shabir Ahmed, Sardar Azhar Mehmood
Supervision: Wali Khan.
Validation: All authors.
Visualization: Wali Khan, Fazal Subhan.
Writing–original draft: Fazal Subhan.
Writing–review & editing: All authors.

Competing Interests

All authors declared that they have no conflict of interests. All the authors read the manuscript critically and approved it for publication.

Ethical Approval

This study was conducted according to ethical guidelines for

human-related research at the University of Malakand, Khyber Pakhtunkhwa, Pakistan. The section head and the school principal received an official letter for information. The parents/guardians of the student were educated through a consent letter. Stool samples were collected from school children only. Those children who were infected with any of the protozoan or helminth infections were informed to be treated with relevant drugs.

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