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Intestinal parasitic infection with special reference to taeniid tapeworms in school children of Malakand region, Pakistan

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Summary

Diseases caused by intestinal parasites impose a substantial burden on the population of middle-income countries, including Pakistan. This research aimed to assess the risk factors for intestinal parasites in Malakand, Pakistan, school children. Three hundred sixty stool samples were collected from school children, of which 140 (39 %) tested positive for helminth, including taenids. The wet mount preparation in saline/iodine/methods was used for stool examination. The GraphPad Prism of version 5 was used to analyze the data, and the P value was considered significant when it was less than 0.05 % (at 95 % CI). Males were more infected at 40.7 % compared to female students at 33.3 %. (P>0.005 at 95 % CI). Among the helminth *Ascaris lumbricoides* was the most prevalent 30.71 % (n=43), taeniid species 22.85 % (n=32), Hookworms12.14 % (n=17), *Hymenolepis nana* 10 % (n=14), *Enterobius vermicularis* 7.85 % (n=1), *Hymenolupis diminuta* 6.42 % (n=9), and *Trichuris trichiura* 5.71 % (n=8) were reported. Age-wise prevalence was noted as the students aged 11 to 13 years were highly infected at 57.4 %, followed by 8 to 10 years at 48.8 %, while the least prevalence was noted in the age 5 to 7 years at 45.5 %. (P>0.005 at 95 % CI). Regarding the association of intestinal parasitic infection and nutritional status of the students, 53.0 % had 10 to 11 inches in diameter upper arm circumference, and 49.4 % had 8 to 9 inches in upper arm circumference (P>0.05). Information on the students' locality and intestinal parasitic infection shows that students in rural areas were more infected, 54.1 %, compared to urban areas, 41.1 % (P value is 0.023 at 95 % CI). Based on the pattern of infection, 19.44 % (n=70/360) were single, 10.5 % (n=38/360) double, 6.11 % (n=22/360), and 2.77 % (n=10/360) quadruple infections had been recorded. The symptoms were abdominal pain, constipation, nausea or vomiting, stomach pain, blotting, and Diarrhea appearing after the taeniid infection. We conclude that since deworming is insufficient to control parasitic illnesses, there is a need for widespread campaigns to raise awareness about children's health and hygiene, as well as the necessity for the creation of efficient poverty control programs.

Keywords: Parasitic infection; risk factors; Children; Diarrhea; Taeniid Tapeworms; Malakand region

Introduction

Taeniids have a worldwide distribution (Garcia *et al*., 2003). The two groups of taeniid and diphyllobothriid tapeworms, which include *Taenia solium*, *Taenia saginata*, and *Echinococcus granulosus*, respectively, are the most important cestodes that infect hu-

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mans. Both adult and larval forms (of different species) can infect humans and cause taeniasis or cysticercosis, depending on the stage of the infection. People can unintentionally eat eggs or larval stages of *Taenia* by eating undercooked meat. Human neurocysticercosis is the most prevalent cestode infection of the central nervous system in areas where it is endemic. Taeniasis was found in 16 % of neurocysticercoses (NCC) patients with minor to moderate infections and in 82 % of those with substantial infections, providing compelling evidence that persistent autoinfection may be a risk factor for developing NCC (Galman *et al*., 2000). These actions include mass drug administration to treat *T. solium* taeniasis as a preventative step for entire human and pig communities (Haby *et al*., 2020) community health education, meat inspection in slaughterhouses together with mass screens, and vaccination of pigs.

According to (Millago *et al*., 2012; Sahlu e*t al*., 2019), human infections with *Taenia solium*, *Taenia saginata*, and *Taenia asiatica* are the leading causes of taeniosis, which is linked to consuming raw or undercooked beef or pork because proglottids and eggs discharged in the feces can infect humans through environmental pollution and result in lethal neurocysticercosis. In contrast to *T. asiatica* infections, cases of neurocysticercosis brought on by *T. solium* have grown in non-taeniasis endemic regions (Ito *et al*., 2006; Schantz *et al*.,1992; Hira *et al*., 2004). According to Ayalew *et al.* (2011), the incidence of tapeworms of the species *Taenia* was higher in children whose mothers had less education, in children who regularly ate raw or unwashed vegetables, in children who drank unprotected well or spring water, and in children who did not wash their hands before meals. The application of these techniques is still mostly restricted to epidemiological research projects due to a lack of pricey laboratory equipment and state-sponsored screening programs despite *T. solium* infections being a widespread public health concern that affects extensive rural regions across several continents.

Globally distributed tapeworm infection is prevalent in Pakistan and Southeast Asia. There may be a human *Taenia* strain distinct from *Taenia saginata* and *Taenia solium*, according to the epidemiology of Taeniasis in Asia. Most *T. solium* carriers would not seek medical assistance in a communal setting. They would instead continue to provide risks to NCC for themselves, their families, and the society at large. These neglected tropical diseases are generally caused by a lack of access to clean water, better sanitation, adequate hygiene, low socioeconomic position, illiteracy, a hot and humid tropical climate, and inadequate medical care (Wegayehu *et al*., 2013; Strunz *et al*., 2014; Stocks *et al*., 2014). Additionally, sewage units, gutters, and other contaminated areas around human habitations and congested or unsanitary living conditions all contribute to an increase in intestine parasites. Additionally, the living conditions of people in crowded or poor settings and contaminated environments such as trash heaps, gutters, and sewage units in and around human dwellings increase the prevalence of intestinal parasite agents (Wegayehu *et al*., 2013). The symptoms were abdominal pain, constipation, nausea or vomiting, stomach pain, blotting, and diarrhea, which appeared after the taeniid infection and were reported in the study region. This study is designed to identify risk factors associated with taenia infestation.

Some of the work has been conducted In the Malakand area, Pakistan by (Rahman *et al*., 2022; Rahman *et al*., 2022; Ullaq *et al*., 2021; Khan *et al*., 2022; Khan *et al*., 2020; Arshad *et al*., 2019; Khan *et al*., 2019; Khan *et al*., 2018b, Khan *et al*., 2017a, Khan *et al*., 2016; Khan *et al*., 2015; Ullah *et al*., 2014; Khan *et al*., 2012; Khan *et al*., 2011). However, a study on Taniid tapeworm parasites has not yet been conducted. This survey is designed to determine the risk factor associated with Taeniid tapeworm infection in school children of the Malakand region, Pakistan.

Materials and Methods

Study Area

Between October 2021 and October 2023, the current study was accompanied by schoolchildren in the Malakand area of Pakistan to determine the risk factors for intestinal parasites in young people. With a 1420m height, this area is located at 35°29'59.99"N and 72°00'0.00"E. This area is mountainous, with high peaks in the north rising to 6000 meters above sea level. Along the Swat River, the height gradually lowers from north to south. The Malakand region is located in the temperate zone, where summers can be hot and muggy because of heavy monsoon rains, and winters can be frigid with temperatures falling below freezing (Ahmad *et al*., 2010).

Data collection

To identify potential risk factors for IPIs, Environmental sanitation, residing conditions (season, interaction with domestic animals, and dirt), and acute clinical symptoms (diarrhea, dysentery, abdominal discomfort, stomach pain, bloating, vomiting, and nausea) were all included in the questionnaire's design. It also sought information on age, gender, location (urban vs. rural), and demographics for both groups. Before the sampling, each guest gave their informed consent. Children who met the requirements for the study were admitted. The Primary school children who participated in the study were Between 5 and 12 years old, and they had not taken any anti-parasitic drugs in the two weeks before the test. Diarrhea, dysentery diarrhea, stomach discomfort, bloating, and nausea or vomiting) affected children who were not allowed to participate. In addition to asking questions, interviewers looked at the students' footwear and fingernails during the talk. All students' proper stool samples were collected using a labeled, clean plastic container, toilet paper, and pieces of an applicator stick after an examination of the respondents' comments. Laboratory technicians processed the samples in less than 20 minutes after collecting the stool samples. Each specimen's label, quantity, timing, and collection method were examined as soon as the stool samples were delivered. To identify and detect each stage of intestinal parasites, laboratory

Table 1. Sex-wise prevalence of intestinal parasitic infection with special reference to taeniid cestodes among school children.

Variable	Number examined	Number positive	Prevalence (%)	P value
Gender				
Male	270	110	40.7	0.2119 (P>0.05)
Female	90	30	33.33	
Total	360	140	38.8	

technicians used the direct technique (saline and iodine mounts) and the formol-ether concentration technique in less than 20 minutes. Stool samples were emulsified in a 10 % formalin solution after the stool examination. After the stool analysis, 20 % of the stool samples were randomly picked and brought to the lab at the University of Malakand Chakdara in Pakistan to ensure quality control.

Data analysis

The collected samples were sent to Malakand University KP, Pakistan's parasitological laboratory, to investigate the feces. Stool samples were initially observed, and patient information was recorded in the registered office database. The stool was examined macroscopically (with the naked eye) for color, consistency, the presence of mucus, blood or any segments, or adult helminth worms. After macroscopic examination, all stool samples were promptly mounted with normal saline (0.85 % NaCl solution) to look for trophozoites and motile intestinal parasites. The next step was to use Lugol's iodine staining to spot intestinal parasite cysts. The wet mount preparation in saline/iodine/methods was used for stool examination. The Graph Pad Prism of version 5 was used to analyze the data, and the P value was considered significant at less than 0.05. The other side of the slide was then stained with Lugol's iodine to reveal intestinal parasite cysts. The sediments were then stained with iodine, mounted on a slide, and protected with a cover slip to identify cysts or eggs of intestinal parasites precisely.

Ethical clearance

The Abdul Wali Khan University Mardan KP Pakistan's Ethics Committee approved the research. Before collecting samples, all study participants gave written consent to the study's procedures and protocol.

Parasites identification

Under a microscope, intestinal parasites were studied and identified using reliable and standardized criteria based on the morphological traits of the eggs, larvae, and adult stages.

Statistical tests

Where appropriate, the software (GraphPad Version 5) was used to analyze the data. P value was calculated at a 95 % confidence interval and was considered significant when less than 0.05 %.

Ethical Approval and/or Informed Consent

This study was conducted according to ethical guidelines for human-related research at the Abdul Wali Khan University Mardan, Pakistan, and by the declaration of Helsinki. The informed consent was obtained from the respondents at the time of information collection.

Results

Sex wise prevalence

Sex-wise prevalence was observed as males were more infected, 40.7 % (110/270), as compared to female students, 33.3 % (30/90). No significant association was found between the sex of students and intestinal parasitic infection (P value was 0.2119, P>0.005 at 95CI). (Table 1).

Age-wise prevalence

Age-wise prevalence was noted as the students aged 11 to 13 years were highly infected at 57.4 %(n=81/141), followed by 8 to 10 years at 48.8 % (n=44/96), while the least prevalence was noted in the age 5 to 7 years 45.5 %(n=56/123). No significant association was found between the ages of students and intestinal parasitic infection (P value was 0.09, P>0.005 at 95CI). (Table 2)

Table 2. Age-wise prevalence of intestinal parasitic infection with special reference to taeniid cestodes among school children.

Variable	Total number	Positive	Negative	Prevalence (%)	P. Value
Age in years					
5 – 7	123	56	67	45.5	0.09 (P>0.005)
8 – 10	96	44	52	48.8	
11 – 13	141	81	60	57.4	

Table 3. Nutrition-wise prevalence of intestinal parasitic infection with special reference to taeniid cestodes among school children.

Upper arm circumference (in inches)	Number examined	Number infected	Prevalence (%)	
8 – 9	194	52	26.8	0.50
10 – 11	166	88	53.01	
Total	360	140	38.8	

Nutrition-wise prevalence

Regarding the association of intestinal parasitic infection and nutrition status of the students, more of the students 53.0 %(n=88/166) had 10 to 11 inches diameter of upper arm circumference, and 26.8 % (n=52/194) had 8 to 9 inches of upper arm circumference (P>0.05). (Table 3)

Pattern of infection

A total of 360 schoolchildren were examined. Out of these, 38.8 % (n=140/360) were found to be infected with intestinal parasitic infections, with special reference to taeniids cestodes. Based on the pattern of infection, 19.44 % (n=70/360) were single, 10.5 % (n=38/360) were double, 6.11 % (n=22/360), and 2.77 % (n=10/360) quadruple infections were recorded (Table 4).

Locality-wise prevalence

Information on the locality of the students and intestinal parasitic infection shows that students in rural areas were more infected (54.1 %, n=91/168) than in urban areas (41.1 %, n=81/192) (Fig. 1) However, the association was found to be significant (P value is 0.023 at 95 % CI).

Discussion

The transmission of parasitic infection is a serious health problem that is more prevalent in poor nations. The current study sets out to identify the elements that raise a child's risk of becoming infected with harmful parasites. Three hundred and sixty students were included in the study. The study's analysis of the participants' stools revealed a frequency of 38.8 % for intestinal parasitic infection. Our study's findings outperform those of the one conducted by (Khan *et al*., 2017a, Pandya *et al*., 2017; Ansari *et al*., 2018)) who reported that the frequency of intestinal taeniid parasites was 8.98 %, 0.99 %, and 0.4 % respectively. The incidence of single, double, triple, and quadruple infections was 50 %, 27.1 %,15.7 %, and 7.1 %, respectively, which is higher than the study conducted by (Khan *et al*., 2017a, Kosar *et al*., 2017).

This study demonstrated the relationships between parasitic infection and various factors, including the sex and age of the schoolchildren, hand washing after using the washroom and before handling food, preparing food while ill with diarrhea, fingernail health, living circumstances, level of poverty, personal and environmental hygiene, accessibility to clean water supply, suitability of medical facilities, and sanitation practices. Each of the factors studied was

Table 4. Proportion of mono-parasitism and poly-parasitism of Taeniid parasitic infection among schoolchildren, Malakand region, Pakistan.

Type of infection	**Total n=360 (%)**	**Total (%) of taeniid species 32(8.88)**	**Prevalence of tanned species in each type of infection**	
			Species	**Prevalence (%)**
Single infection	70(19.44)	13(3.6)	*Taenia* species	13(3.6)
Double infection	38(10.5)	9(2.5)	*Taenia* species + *Ascaris lumbricoides*	3(0.83)
			E. histolytica/dipar + *Taenia* species	2((0.55)
			T. trichiura + *Taenia* species	2(0.55)
			Hookworm + *Taenia* species	2(0.55)
Triple infection	22(6.11)	8(2.22)	*T. trichiura* + *E. histolytica/dipar* + *Taenia* species	3(0.83)
			Taenia species + *E. histolytica/dipar* + *Ascaris lumbricoides*	2(0.55)
			Taenia species + *H. nana* + *Ascaris lumbricoides*	3(0.83)
Quadruple infection	10(2.77)	2(0.55)	*Ascaris lumbricoides* + *H. nana* + *Taenia* species + *hookworm*	1(0.27)
			T. trichiura + *E. histolytica/dipar* + *Taenia* species + *Ascaris lumbricoides*	1(0.27)
Overall polyparasitism				60(16.66)
Overall infected individuals				140(38.8)
Overall examined				360

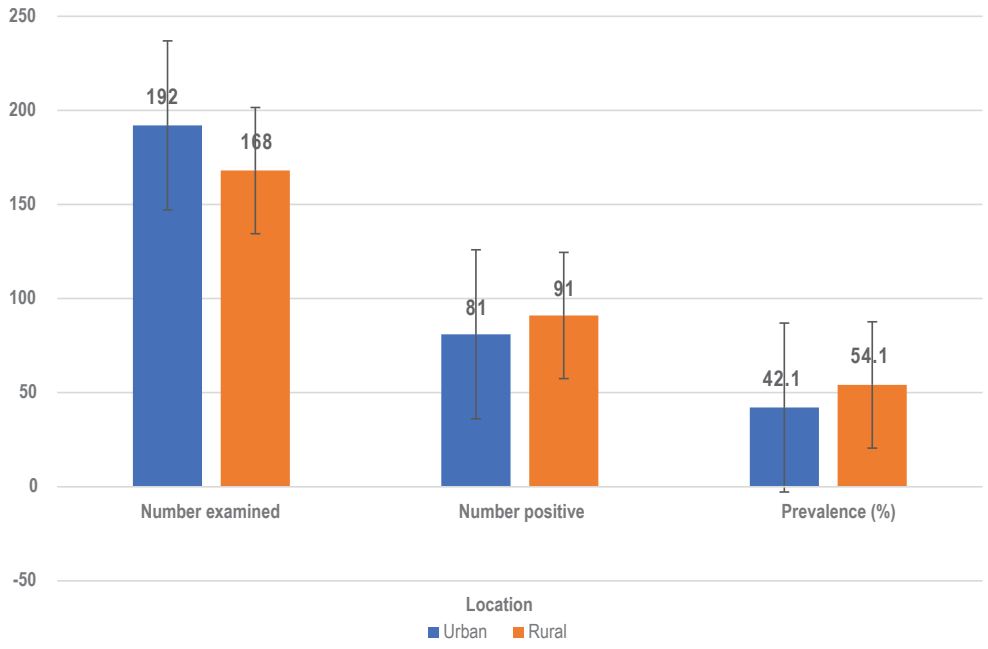

Fig .1. Location-wise prevalence of intestinal parasitic infection with special reference to taeniid cestodes among school children.

of considerable importance and had a high impact on the prevalence of parasites, which may be due to the close association of school children with their practices. Parasitic infections were found in both genders in the current study, 40.7 % in males and 33.3 % in females, which is comparable with a study conducted in Larkana, Punjab, Pakistan, 38.8 % in males and 40 % in females (Ansari *et al*., 2018) and in Rawalpindi (40.33 %) males and 26.67 % in females (Kosar *et al*., 2017). However, a study conducted in an urban slum in Nigeria found that 49 % of males and 17.4 % of females (Gyang *et al*., 2019) were higher than the present study. Another study conducted in Iran was lower than the present study 25.5 % in males and 82.9 % in females (Kiani *et al*., 2016)

The present study was conducted among schoolchildren of different age groups. The most important age group was 8 – 10 years 48.8 %, which is comparable with the study conducted in Rawalpindi 35.97 % (Kosar *et al*., 2017) and higher than the study conducted in an urban slum of Nigeria 23.4 % and lower than the study conducted in Ethiopia 48.4 % (Ayalew *et al*., 2011). It also shows that from 1 – 3 class 46.34 % which is higher than the study conducted in Ethiopia 32.6 % by (Ayalew *et al*., 2011), and from 4 – 5 grade (52.46 %) which is lower than those conducted in Ethiopia 67.4 % by (Ayalew *et al*., 2011)Based on location urban 42.18 % and rural 54.16 % were studied in the present study which is comparable with a study conducted in Rawalpindi 35.06 % in urban and 30.82 % in rural areas (Kosar *et al*., 2017) while the current study is higher than study conducted in western Iran 20.1 % and 23.6 % by (Kiani *et al*., 2016) and lower than study conducted in Ethiopia 63.7 % and 36.3 %.

The current study found that 64.70 % and 64.42 % of mothers and fathers were illiterate or uneducated, which is comparable to studies that found that 59 % (Gyang *et al*., 2019) and 57.8 % (Ayalew *et al*., 2011) of mothers had at least some college education. A similar study by (Kiani *et al*., 2016; Ayalew *et al*., 2011) found that parents who are illiterate or have not completed high school are more likely to have parasite infections. According to (Celiksoz *et al*., 2005), a more significant proportion of babies were born to moms without formal education.

Eating semi-cooked meat and vegetables or raw vegetables, similar to a study conducted, was another factor that exposed kids to intestinal parasite infection (Kosar *et al*., 2017). The current study is lower than the study conducted by (Mahmoudvand *et al*., 2018); 63 % of those who used open-field defecation had a higher infection rate. A similar study was conducted by (Ayalew *et al*., 2011). House conditions of children play a significant role in the transmission of parasite eggs. Earthen and brick-made houses have a higher risk of parasitic infection, comparable to a study conducted (Kosar *et al*., 2017). Animals also play an important role in the transmission and infection of parasites and their eggs. Pet animal keeping has a high risk of parasitic infection, comparable to the study conducted by (Mahmoudvand *et al*., 2018). According to the study's assessment of related symptoms, the majority of the children with intestinal parasite infections exhibited abdominal pain, nausea or vomiting, bloating, diarrhea, and dysentery. In additional studies (Ansari *et al*., 2018; Kosar *et al*., 2017; Kiani *et al*., 2016),

most of the children experienced abdominal pain, nausea or vomiting, diarrhea, and dysentery.

The students used tap water, and parents who had cattle had a 3 times higher rate of taeniid infection than people who used spring water and parents who did not raise cattle. Fewer parasites spread among pupils who wash their hands before eating than among those who don't. The practice of washing hands before and after using the bathroom. The study's findings show that those who wash their hands both before and after defecating are less likely to get the taeniid infection than those who wash their hands before eating. Students who had not used anthelminthic medications were 1.5 times more likely to get the disease than those who did. According to a recent study, children whose fathers worked for the government, as well as their mothers, were more likely to be infected than children whose fathers did not.

Conclusions

Tanied infection is still a major public health issue in Pakistan. Level of education, eating habits, fingernail health, hand washing before and after meals, use of semi-cooked meals, defecation source, BMI, and upper arm circumference were the most important risk factors for taeniid intestinal parasitic infection, along with animal ownership, access to water supplies, and prior drug use. Health education campaigns should be launched to reduce intestinal parasite infection in the local population.

Conflict of Interests

There is no conflict of interest, according to the authors.

Authors' Contributions

WK supervised the study, HR collected the data and wrote the manuscript, NR helped collect the research data, and PDLRE helped write the manuscript.

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Data availability

The datasets generated and analyzed during the current study are not publicly available due to plagiarism but are available from the corresponding author upon reasonable request.

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References

Ahmed, M., Wahab, M., Khan, N. (2010): Dendrochronological potential of gymnospermic species of Pakistan. *Int J Biol Biotech*, 7(30): 159 – 174

Ansari, I.A., Samo, J.A., Soomro, M.A. (2018): Intestinal parasite infections: Identification, frequency and associated factors with intestinal parasite infections in patients with gastrointestinal disorders. *Professional Med J*, 25(10): 1464 – 1468. DOI: 10.29309/TPMJ/18.4691

Arshad, S., Khatoon, N., Warind, J. A., Khan, A., Waheed, S., Khan, W. (2019): The prevalence of human intestinal protozoal and helminthic infection in Karachi. *Int J Biol Biotech*, 16(2): 319 – 323

Ayalew, A., Debebe, T., Worku, A. (2011): Prevalence and risk factors of intestinal parasites among Delgi school children, North Gondar, Ethiopia. *J Parasitol Vector Biol*, 3(5): 75 – 81. DOI: 10.5897/JPVB11.019

Çeliksöz, A., Güler, N., Güler, G., Öztop, A.Y., Degerli, S. (2005): Prevalence of intestinal parasites in three socioeconomically different regions of Sivas, Turkey. *J Health Popul Nutr*, 23(2): 184 – 191

García, H.H., Gonzalez, A.E., Evans, C.A., Gilman, R.H. (2003): *Taenia solium* cysticercosis. *Lancet*, 362(9383): 547 – 556. DOI: 10.1016/S0140-6736(03)14117-7

Gilman, R.H., Brutto, O.D., Garcia, H.H., Martinez, M., The Cysticercosis Working Group in Peru (2000): Prevalence of taeniosis among patients with neurocysticercosis is related to severity of infection. *Neurology*, 55(7): 1062. DOI: 10.1212/wnl.55.7.1062

Gyang, V.P., Chuang, T.W., Liao, C.W., Lee, Y.L., Akinwale, O.P., Orok, A.,Fan, C.K. (2019): Intestinal parasitic infections: current status and associated risk factors among school-aged children in an archetypal African urban slum in Nigeria. *J Microbiol Immunol Infect*, 52(1): 106 – 113. DOI: 10.1016/j.jmii.2016.09.005

Haby, M.M., Sosa Leon, L.A., Luciañez, A., Nicholls, R.S., Reveiz, L., Donadeu, M. (2020): Systematic review of the effectiveness of selected drugs for preventive chemotherapy for *Taenia solium* taeniasis. *PLoS Negl Trop Dis*, 14(1): e0007873. DOI: 10.1371/journal.pntd.0007873

Hira, P.R., Francis, I., Abdella, N.A., Gupta, R., Al-Ali, F.M., Grover, S., Tsang, V.C. (2004): Cysticercosis: imported and autochthonous infections in Kuwait. *Trans R Soc Trop Med Hyg*, 98(4): 233 – 239. DOI: 10.1016/s0035-9203(03)00061-0

Ito, A., Craig, P., Schantz, P. (2006): Taeniasis/cysticercosis and echinococcosis with a focus on Asia and the Pacific. *Parasitol Int*, 55 (Suppl): S1. DOI: 10.1016/j.parint.2005.11.001

Khan, W., Imran, Wahab, A. (2016): Intestinal obstruction by *Ascaris lumbricoides* in a 12-year-old boy: a case report in Pakistan. *J Bacteriol Parasitol*, 7: 262. DOI: 10.4172/2155-9597.1000262

Khan, W., Iqbal, M., Dad, O. (2020): Have we forgotten the threat posed by fascioliasis? A potential threat to public health. *Iran J Public Health*, 49(4): 814 – 815

Khan, W., Khan, A. (2015): Diversity of intestinal parasites in male and female students and workers of the Education Department of

Swat, Pakistan. *Pakistan J. Zool.*, 47(2): 565 – 568
Khan, W., Khan, N.I., Bukhari, S.N.F., Begum, N. (2019): Prevalence of intestinal parasitic infection among drug addicts in District Swat, Khyber Pakhtunkhwa, Pakistan. *Iran J Parasitol*, 14(2): 359 – 361. DOI: 10.18502/ijpa.v14i2.1153
Khan, W., Nawaz, M.A. (2018): Incidence of tapeworm infection in the human population of Swat, Pakistan: an occupation based study. *Pakistan J. Zool.*, 50(2): 639 – 645. DOI: 10.17582/journal.pjz/2018.50.2.639.645
Khan, W., Nisa, N.U., Khan, A. (2017): Prevalence and risk factors associated with intestinal parasitic infections among food handlers of Swat, Khyber Pakhtunkhwa, Pakistan. *J Food Nutr Res*, 5(5): 331 – 336. DOI: 10.12691/jfnr-5-5-7
Khan, W., Nisa, N.U., Khan, A., Naqvi, S.M.H.M. (2012): Endemicity of intestinal parasites with special reference to nematodes in individuals related to education (students, staff & workers) in Swat KP, Pakistan. *Pak J Nematol*, 30(1): 77 – 85
Khan, W., Noor-un-Nisa, Khan, A. (2011): An investigation on incidence of intestinal parasites in under and above 15 years age in farmers of Swat, Pakistan. *Proc. Parasitol.*, 52: 43 – 53
Khan, W., Panhwar, W. A., Mehmood, S. A., Ahmed, S., Ahmed, M. S., Khan, N., Imran (2022): Pinworm infection in school children of four districts of Malakand region, Khyber Pakhtunkhwa, Pakistan. *Braz J Biol*, 82: e238769. DOI: 10.1590/1519-6984.238769
Kiani, H., Haghighi, A., Salehi, R., Azargashb, E. (2016): Distribution and risk factors associated with intestinal parasite infections among children with gastrointestinal disorders. *Gastroenterol Hepatol Bed Bench*, 9(Suppl1): S80 – S87
Kosar, S., Afshan, K., Salman, M., Rizvi, S.S.R., Naseem, A.A., Firasat, S., Jahan, S., Miller, J.E., Qayyum, M. (2017): Prevalence and risk factors associated with intestinal parasitic infections among schoolchildren in Punjab, Pakistan. *Trop Biomed*, 34(4): 770 – 780
Mahmoudvand, H., Taee, N., Faraji Goodarzi, M., Ebrahimzadeh, F. (2018): Prevalence and risk factors of intestinal protozoan infections in children (2-15 yr old) from Lorestan Province, western Iran. *Trop Biomed*, 35(1): 259 – 266
Millogo, A., Nitiéma, P., Carabin, H., Boncoeur-Martel, M.P., Rajshekhar, V., Tarnagda, Z., Cissé, R. (2012): Prevalence of neurocysticercosis among people with epilepsy in rural areas of Burkina Faso. *Epilepsia*, 53(12): 2194 – 2202. DOI: 10.1111/j.1528-1167.2012.03687
Pandya, H.B., Lakhani, S.J., Pandit, N., Hemachander, S.S. (2017): Prevalence and risk factors associated with intestinal parasitic infestations in the rural pediatric population of Piparia, Gujarat - A hospital-based study. *Int J Med Sci Public Health*, 6(10): 1498 – 1502. DOI: 10.5455/ijmsph.2017.0511404082017
Rahman, H.U., Khan, W., Mehmood, S.A., Ahmed, S., Yasmin, S., Ahmad, W., De Los Ríos Escalante, P. (2021): Prevalence of cestodes infection among school children of urban parts of Lower Dir district, Pakistan. *Braz J Biol*, 82: e242205. DOI: 10.1590/1519-6984.242205
Rahman, H.U., Khatoon, N., Arshad, S., Masood, Z., Ahmad, B., Khan, W., Garedaghi, Y. (2022): Prevalence of intestinal nematode infection in school children of urban areas of district Lower Dir, Pakistan. *Braz J Biol*, 82: e244158. DOI: 10.1590/1519-6984.244158
Sahlu, I., Carabin, H., Ganaba, R., Preux, P.M., Cissé, A.K., Tarnagda, Z., Millogo, A. (2019): Estimating the association between being seropositive for cysticercosis and the prevalence of epilepsy and severe chronic headaches in 60 villages of rural Burkina Faso. *PLoS Negl Trop Dis*, 13(1): e0007101. DOI: 10.1371/journal.pntd.0007101
Schantz, P.M., Moore, A.C., Munoz, J.L., Hartman, B.J., Schaefer, J.A., Aron, A.M. (1992): Neurocysticercosis in an orthodox Jewish community in New York City. *N Engl J Med*, 327: 692 – 695. DOI: 10.1056/NEJM199209033271004.
Stocks, M.E., Ogden, S., Haddad, D., Addiss, D.G., Mcguire, C., Freeman, M.C. (2014): Effect of water, sanitation, and hygiene on the prevention of trachoma: a systematic review and meta-analysis. *PLoS Med*, 11(2): e1001605. DOI: 10.1371/journal.pmed.1001605
Strunz, E.C., Addiss, D.G., Stocks, M.E., Ogden, S., Utzinger, J.,-Freeman, M.C. (2014): Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis. *PLoS Med*, 11(3): e1001620. DOI: 10.1371/journal.pmed.1001620
Ulhaq, Z., Khan, W., Khan, M.F., Kabir, M., Ujjan, A.A., Ullah, W., Masood, Z., Khan, S., De Los Ríos Escalante, P. (2021): Prevalence of intestinal parasitic diseases in school children of rural areas of district Lower Dir, Pakistan. *Braz J Biol*, 82: e243150. DOI: 10.1590/1519-6984.243150
Ullah, W., Shah, A., Jamal, Q., Ullah, S., Muhammad, I., Ullah, H. (2014): Prevalence of intestinal parasites among school children in District Upper Dir, Khyber Pakhtunkhwa Pakistan. *Int. J. Biosci.*, 5(1): 1 – 8. DOI: 10.12692/ijb/5.1.1-8
Wegayehu, T., Tsalla, T., Seifu, B.,Teklu, T. (2013): Prevalence of intestinal parasitic infections among highland and lowland dwellers in Gamo area, South Ethiopia. *BMC Public Health*, 13: 151. DOI: 10.1186/1471-2458-13-151