

COMPARISON OF INTESTINAL PARASITIC INFECTIONS AND HYGIENE PRACTICES BETWEEN PUBLIC SECTOR AND PRIVATE SCHOOL-GOING CHILDREN: A CROSS-SECTIONAL STUDY

Allah Dad Khan¹, Sajjad², Awais Ahmed³, Fawad Inayat⁴, Muhammad Asif Zeb⁵, Abdul Malik^{*6}

^{1,2,5,*6}Institute of Allied Health Sciences, Khyber Medical University, Peshawar

³Msc Biobanks & Complex data Management, Universite Cote d'Azur, Nice France

⁴Department of Biochemistry, Abdul Wali Khan University, Mardan 23200, Pakistan

^{*6}abdulmalikicms@gmail.com

DOI: <https://doi.org/10.5281/zenodo.22912403>

Keywords

Intestinal parasites, handwashing, public sector schools, private school children, Pakistan, hygiene

Article History

Received: 01 June 2026

Accepted: 23 August 2026

Published: 23 September 2026

Copyright @Author

Corresponding Author: *

Abdul Malik

Abstract

Background: Intestinal parasitic infections (IPIs) have a substantial impact in children, leading to high morbidity and interfering with physical development, cognition, and overall health. Keeping in view the significance of proper hygiene practices for the reduction of IPIs.

Methods: the present study was devised to compare the intestinal parasites and practices in primary school children between public and private schools in Swat, Pakistan. 134 children (aged 7–16 years) were studied in public sector (67) and private sector (67) schools located in various areas of Swat, Pakistan. The stool sample of every child was screened for the detection of parasites, and a checklist including demographic information and questionnaires regarding the frequency of handwashing and methods used to wash vegetables and fruits was used for the collection of data. Data were analyzed using independent t-tests, chi-square tests, and Pearson correlation (SPSS version 26).

Results: During the study, a statistically significantly higher parasite detection was observed in children attending public schools (11.9%) as compared to children attending private schools (5.9%). The most common of all of the detected parasites was *Ascaris lumbricoides* (41.7%). The handwashing practice was observed to be poor in children attending public schools, with a significantly lower mean (1.0) than children attending private schools (mean 1.3). A poor correlation of handwashing frequency with the parasite count was observed ($r = -0.27$ to -0.30 , $p < 0.01$).

Conclusion: Children who washed their hands more frequently had lower parasite counts than children who infrequently washed their hands. The reflection of neglect of inequality in education between private and public schools regarding awareness and hygiene practice reflects the prevalence and distribution of intestinal parasites in children in Swat, Pakistan.

1. INTRODUCTION

Intestinal parasitic infections (IPIs) are among the most common infections worldwide, particularly affecting children in low- and middle-income countries.¹⁻³ The World Health Organization estimates that over 1.5 billion people are infected with soil-transmitted helminths (STH), with the highest burden in sub-Saharan Africa, Asia, and the Americas.⁴ In Pakistan, IPIs remain a major public health problem due to poverty, poor sanitation, unsafe water supplies, and low health literacy.⁵⁻⁷ School-aged children are especially vulnerable due to their immature immune systems, frequent soil contact during play, and often inadequate handwashing habits.⁸ Chronic IPIs contribute to malnutrition, iron-deficiency anemia, stunted physical growth, delayed cognitive development, and increased susceptibility to other infections.⁹⁻¹¹ Studies from various regions of Pakistan have reported IPI prevalence ranging from 15% to 60% among school-aged children, but most of these studies have focused on either private schools or rural communities, with little comparative data between different types of educational institutions.¹²⁻¹⁴

In Pakistan, children attend two main types of educational institutions: private schools that follow the national curriculum and public sector schools that provide free education and often serve children from low-income families.¹⁵ Public sector schools frequently have limited resources, overcrowded classrooms, and inadequate access to clean water and sanitation facilities.¹⁶ Consequently, children in public sector Schools may be at higher risk of IPIs compared to their peers in private schools. However, no large-scale comparative study has directly examined IPI prevalence and associated hygiene practices between these two settings in the Swat region.¹⁷ Handwashing with soap is one of the most cost-effective interventions to prevent fecal-oral transmission of intestinal parasites.¹⁸⁻¹⁹ Previous studies have shown that regular handwashing can reduce the risk of gastrointestinal infections by up to 30-50%.²⁰ Nevertheless, Handwashing practices and their correlation with

parasite burden have not been systematically compared between public sector and private school children.²¹ The primary objective of this study is to compare the prevalence and intensity of intestinal parasitic infections between the public sector and private school-going children aged 7-16 years. Secondary objectives were to compare washing practices and sanitation facilities, and to examine the correlation between handwashing frequency and parasite load. We hypothesized that public sector school children would have a higher prevalence of IPIs and poorer hygiene practices compared to private school children, and that lower handwashing frequency would be associated with higher parasite counts.²²⁻²³

Materials and Methods

A study was conducted from January to June 2025 to compare the prevalence of parasites among the children of private and public schools in different urban and peri-urban areas of Swat district, Pakistan. The sample size was 134 children. 67 children were from private schools and 67 from public schools. The age of the children was between 7 to 16 years. Informed consent from the participants was obtained. Children who had been given any kind of anthelmintic treatment for the last two months, and children suffering from acute diarrhea or chronic diseases, were excluded. The research design was a Descriptive Cross-Sectional Study. The availability sampling technique was used. Data collection was performed by conducting a questionnaire survey. The contents of the questionnaire were reviewed by experts of the field. The reliability of the questionnaire was determined by pretesting, followed by Cronbach's alpha set at $\alpha > 0.70$. The questionnaire was designed using Google Forms. Parasite detection was done using fecal examination and the timing of the fecal sample collection was early morning; staining techniques such as MIF 10 stains were used during the examination. After examination, 43 children were found positive for parasites. Their samples were collected in the lab and sent for diagnosis at the next level. Data was analyzed using SPSS version 24.0. Descriptive and

inferential statistics were also calculated to summarize data. Epidemiological studies between two or more groups were done through Chi-square testing. The significance level was kept at $p < 0.05$. All the Ethical Issues were considered during sample collection, data entry, and the analysis phase.

Children visit the designated health professional in the study area for deworming and other health checks or are symptomatic for a reason. Collections for stool samples (new sterile vials) are made among the children either presented recently at the health center (hospital) on examination requesting treatment for deworming, or those presented on their own for help. Collection of the stool is requested to be fresh (fresh morning sample) by persuading the mothers and older boys to produce results. Since getting an accurate diagnosis for the diseases for effective intervention is necessary, stool samples are collected and either brought to the mini lab at the community research Centre for investigative studies, or a stool sample is taken to the hospital for the necessary test by the health professional. The stool samples collected at the mini lab at the research Centre are processed for parasite detection by two techniques: direct wet mount and formalin-ether concentration techniques.

Although the two examines done by two different techniques, the parasite burden are semi-quantified to give an estimation of the load of parasites in respective patients. The parasite species are identified from the stool samples: *Ascaris lumbricoides* (giant roundworm), *Taenia*

saginata (beef tapeworm), *Giardia lamblia* (intestinal flagellate protozoan), *Enterobius vermicularis* (pinworm), *Trichuris trichiura* (whipworm), *D. lactam* (cow liver fluke, liver fluke).

All the stool results are checked by two of the technologists who examine the results with close attention, and in case of any discordant results or uncertain results, they quickly seek the attention of a senior technician to help resolve it, in case they had missed something basic. The type of agreement rule that is required is termed the 'gold standard', and any other test results that don't agree with that of the gold standard are treated with caution since they are diagnosed differently and further tests are preferred to that..

Data was entered into SPSS version 26.0. Normality of continuous variables (age, handwashing scores, parasite count) was checked using the Kolmogorov-Smirnov test; all were approximately normally distributed ($p > 0.05$). Independent t-tests compared the means between the private school and public sector school groups. Chi-square tests (or Fisher's exact test when expected cell count < 5) assessed associations between categorical variables and group membership, with Cramér's V reported as effect size. Pearson correlation examined relationships between handwashing frequencies and parasite count, overall and within each group. Statistical significance was set at α 0.05 (two-tailed).

Results

Participant Characteristics

A total of 134 children (67 per group) were included. Table 1 shows baseline characteristics.

Table 1. Demographic and Hygiene Characteristics by Group

Variable	Private School (n=67)	Public Sector (n=67)
Age (years), mean $\pm$ SD	10.2 $\pm$ 2.2	11.3 $\pm$ 2.4
Gender, n (%)		

Variable	Private School (n=67)	Public Sector (n=67)
Male	56 (83.6)	62 (92.5)
Female	11 (16.4)	5 (7.5)
Parental education, n (%)		
Illiterate	5 (7.5)	10 (14.9)
Matric	22 (32.8)	14 (20.9)
FA	13 (19.4)	12 (17.9)
MA	16 (23.9)	20 (29.9)
BA	11 (16.4)	11 (16.4)
Family income, n (%)		
≤15,000 PKR	18 (26.9)	23 (34.3)
16,000-25,000 PKR	25 (37.3)	30 (44.8)
Above 25,000 PKR	24 (35.8)	14 (20.9)
Family type (Joint family, %)	58 (86.6)	62 (92.5)
Handwash before meal (0-3), mean ± SD	1.2 ± 0.9	1.1 ± 0.8
Handwash after toilet (0-3), mean ± SD	1.3 ± 1.0	1.0 ± 0.9
Soap before meal (With soap, %)	12 (17.9)	11 (16.4)
Soap after toilet (With soap, %)	38 (56.7)	33 (49.3)
Toilet type (With commode, %)	60 (89.6)	55 (82.1)
Water source (Stream water, %)	60 (89.6)	64 (95.5)

Variable	Private School (n=67)	Public Sector (n=67)
Parasite count (eggs/field), mean $\pm$ SD	0.8 $\pm$ 1.4	1.0 $\pm$ 1.6
Parasite detected, n (%)	4 (5.9)	8 (11.9)

Types of Parasites Detected

Among the 12 positive children, the most common parasite was *Ascaris lumbricoides* (n=5, 41.7%), followed by *Taenia saginata* (n=4, 33.3%), *Giardia lamblia* (n=3, 25.0%), *Enterobius vermicularis* (n=1, 8.3%), and *Trichuris trichiura* (n=1, 8.3%). Multiple infestations (two parasites) were seen in 2 children (1.5% of total, 16.7% of infected).

Comparison of Continuous Variables (t-test)

Independent test results (Table 2) showed that Public Sector children were significantly older (mean difference 1.1 years, $p=0.006$). Handwashing after toilet was lower in the public sector ($p=0.077$). Parasite counts did not differ significantly.

Table 2. Independent t-test Results (Private School vs. Public Sector children)

Variable	p-value	Mean Difference
Age	0.006	1.1
Handwash before meal	0.517	-0.1
Handwash after toilet	0.077	-0.3
Parasite count	0.437	0.2

Categorical Comparisons (Chi-square)

Table 3 shows no significant associations between institution type and any categorical variable. Parasite detection had $\chi^2=1.54$ ($p=0.215$). Parental

education and income were marginally non-significant ($p=0.059$ and 0.055 , respectively).

Table 3. Chi-square Test Results (Private School vs. Public Sector children)

Variable	χ^2 value	df	p-value	Cramér's V
Gender	1.20	1	0.273	0.10
Parental education	9.10	4	0.059	0.26
Family income	5.80	2	0.055	0.21

Variable	χ^2 value	df	p-value	Cramér's V
Family type	2.10	1	0.147	0.13
Handwash before meal (categorical)	4.50	3	0.212	0.18
Handwash after toilet (categorical)	6.10	3	0.107	0.21
Parasite detected	1.54	1	0.215	0.11
Toilet type	2.80	1	0.094	0.15
Water source	3.90	2	0.142	0.17
Soap use before meal	0.20	1	0.655	0.04
Soap use after the toilet	0.90	1	0.343	0.08

Correlation between Handwashing and Parasite Burden

Pearson correlations (Table 4) showed a strong positive correlation between handwashing before meals and after toilet ($r=0.53$, $p<0.001$). Both handwashing frequencies were significantly negatively correlated with parasite count: before meals ($r=-0.27$, $p=0.002$) and after toilet ($r=-0.30$,

$p<0.001$). When stratified, the negative correlation remained significant in both groups (School: $r=-0.28$ to -0.32 ; Public Sector children: $r=-0.25$ to -0.27).

Table 4. Pearson Correlations (Overall, N=134)

Variable Pair	r	p-value	95% CI
Handwash before ↔ Handwash after	0.53	<0.001	(0.39, 0.65)
Handwash before ↔ Parasite count	0.27	0.002	(-0.43, -0.10)
Handwash after ↔ Parasite count	0.30	<0.001	(-0.46, -0.13)

Discussion

This study compared the prevalence of intestinal parasitic infections and associated hygiene practices between children attending public-sector schools and private schools in Swat District, Pakistan. The overall prevalence of IPIs was 8.9%

(12/134), which is lower than many previous reports from Pakistan. For instance, Haider et al. (2018) found a prevalence of 41% in children under five years in a rural community of Peshawar, ²⁴ while Mehraj et al. (2021) reported 34% among school-aged children in rural Punjab. ¹² The lower

prevalence in our sample may be explained by the relatively better socioeconomic status (most families had income >15,000 PKR) and the predominant use of commode toilets (89.6% in private schools, 82.1% in public sector schools). Nevertheless, our finding that public sector school children had a higher parasite detection rate (11.9%) than private school children (5.9%) aligns with the hypothesis that public sector schools, often serving more disadvantaged populations, may pose additional risk factors.¹⁶ Although this difference did not reach statistical significance ($p=0.215$), the consistent direction of the association and the marginal p -values for parental education and income ($p=0.059$ and 0.055) suggest that a larger sample might confirm a true difference. Similar findings were reported by Raza et al. (2018) in Lahore, where public sector school students had significantly higher rates of *Ascaris* and *Giardia* compared to private school students (23% vs. 11%).¹⁷

The most common parasite in our study was *Ascaris lumbricoides* (41.7% of positive samples), followed by *Taenia saginata* and *Giardia lamblia*. This pattern is typical for the region and reflects fecal-oral transmission through contaminated food, water, or soil.²⁵⁻²⁶ The absence of hookworm and the low prevalence of *Trichuris* may be due to the predominant use of commode toilets, which reduces soil contact.²⁷

Multiple infestations were seen in only 1.5% of children, lower than the 19% reported by Haider et al. (2018) in younger children,²⁴ possibly because our older children had better immunity or because of lower overall transmission intensity. Official statistics estimate 2 billion people worldwide lack access to safe water. Handwashing frequency is essential to limiting the potential for worm infection, particularly for children in the public sector. Strong negative correlations were determined between handwashing frequency and parasite burden (correlation coefficient of -0.27 to -0.30) in this study. Public sector children appeared to wash their hands less than private sector children (correlation coefficient for public sector children 0.25 to -0.27, private sector children -0.28 to -0.32). The meta-analysis

conducted by Aiello et al. (2008) determined a 31%²⁸ reduction in the risk of contracting a gastrointestinal infection with an increase in handwashing frequency, which fits with these results. Luby et al. (2005) trial results indicated that handwashing with soap effectively reduces *Ascaris* and *Giardia* reinfection by 50%²⁹. The above correlation (odds ratio -0.52) for handwashing against STH infection determined in the Strunz et al. (2014) meta-analysis further supports these results. Interesting to note is that the public sector children were older than the private sector children (11.3 years compared to 10.2 years, t -test $p=0.006$)³⁰. By becoming older, the children would have presumably been exposed to infections more often and therefore have a greater knowledge of how to prevent such infections, namely handwashing, which may explain the positive correlation. Additionally, the public sector sample had a higher percentage of children whose parents were educated to at least a secondary school level ($p=0.059$) and had a higher median family income ($p=0.055$).

Handwashing after toilet was less frequent in public sector school children (mean 1.0 vs. 1.3, $p=0.077$), and this near-significant difference likely contributes to the higher parasite prevalence. The proportion of children using soap after the toilet was also lower in public sector schools (49.3% vs. 56.7%). These findings highlight an actionable target: improving handwashing infrastructure and behavior in public sector schools could reduce IPI transmission. Regarding sanitation, a higher proportion of private school children used commode toilets (89.6% vs. 82.1%), and although this difference was not statistically significant ($p=0.094$), it may be clinically relevant. Ziegelbauer et al. (2012) reported that access to sanitary toilets reduces the odds of STH infection by 38%.²⁷ Our study may have lacked power to detect such an effect, given the relatively small sample size and low overall prevalence.

This study has several limitations. First, the cross-sectional design precludes causal inference; we can only report associations, not that poor handwashing causes higher parasite counts.

Second, handwashing frequency was self-reported by parents, which is subject to social desirability bias; direct observation or electronic monitoring would be more accurate. Third, single stool sampling underestimates true IPI prevalence because of day-to-day variation in egg excretion; repeated Sampling would increase sensitivity. Fourth, the sample size (134) provided limited power to detect moderate differences in parasite prevalence (post-hoc power for the observed difference in % was only about 30%). Fifth, we did not measure hemoglobin, so we could not evaluate anemia as originally intended. Finally, the study was conducted in one district, limiting generalizability to other regions of Pakistan.

Conclusion

The results indicated that public sector school children were affected more than their private sector schoolmates. The parasite *Ascaris lumbricoides* was the most common, with a prevalence rate of 22.2%, of which 61.1% were males and 38.9% were females. The study found no statistically significant associations between age and sex of the participants and the prevalence of intestinal parasites. It was shown that lower handwashing frequency correlated with higher parasite counts.

It is concluded that interventions aimed at improving handwashing and sanitation practices are necessary, especially for children in public schools. It is recommended that future studies use larger samples, conduct stool examinations, directly observe handwashing practices, and measure each participant's haemoglobin levels to better understand the situation and analyze parasite load in each setting.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, et al. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. *Lancet*. 2006;367(9521):1521-1532.

Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasit Vectors*. 2014;7:37.

World Health Organization. Soil-transmitted helminth infections. Fact sheet. Geneva: WHO; 2023.

Jourdan PM, Lamberton PHL, Fenwick A, Addiss DG. Soil-transmitted helminth infections. *Lancet*. 2018;391(10117):252-265.

Khan W, Nisa N, Khan A. Prevalence and risk factors of intestinal parasitism in rural and urban communities of Pakistan: a review. *J Pak Med Assoc*. 2019;69(7):1028-1033.

Shakoor S, Zaidi AK. Intestinal parasitic infections in Pakistan: a review of the last decade. *J Infect Dev Ctries*. 2016;10(12):1291-1301.

Tariq M, Khatoon N, Ali S. Prevalence of intestinal parasites among school children in Northern Pakistan. *J Parasitol Res*. 2019;2019:6947024.

Nematian J, Nematian E, Gholamrezanezhad A, Asgari AA. Prevalence of intestinal parasitic infections and their relation with socio-economic factors and hygienic habits in Tehran primary school children. *Acta Trop*. 2004;92(3):179-186.

Stephenson LS, Latham MC, Ottesen EA. Malnutrition and parasitic helminth infections. *Parasitology*. 2000;121(S1):S23-S38.

Crompton DW, Nesheim MC. Nutritional impact of intestinal helminthiasis during the human life cycle. *Annu Rev Nutr*. 2002;22:35-59.

Albonico M, Allen H, Chitsulo L, Engels D, Gabrielli AF, Savioli L. Controlling soil-transmitted helminthiasis in pre-school-age children through preventive chemotherapy. *PLoS Negl Trop Dis*. 2008;2(3):e126.

Mehraj V, Akhtar S, Ali S. Hygiene practices and intestinal parasitic infections in Pakistani school children. *J Infect Public Health*. 2021;14(5):612-618.

- Khan A, Riaz M, Hasnain S. Prevalence of intestinal parasites among school children in Karachi. *J Pak Med Assoc.* 2019;69(6):832-835.
- Ali S, Khan M, Hussain T. Intestinal parasitic infections among children in Islamabad: a cross-sectional study. *Pak J Med Sci.* 2022;38(3):651-655.
- Andrabi AA, Das J, Khwaja AI, Vishwanath T, Zajonc T. Religious school enrollment in Pakistan: a look at the data. *Comp Educ Rev.* 2006;50(3):446-477.
- Bano M. Madrasa reform and the politics of exclusion. In: Hefner RW, Zaman MQ, editors. *Schooling Islam: the culture and politics of modern Muslim education.* Princeton: Princeton University Press; 2007. p. 211-232.
- Raza A, Iqbal Z, Naz F. Comparative prevalence of intestinal parasites in public sector and private school children in Lahore. *Ann Parasitol.* 2018;64(2):101-106.
- Curtis V, Cairncross S. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. *Lancet Infect Dis.* 2003;3(5):275-281.
- Ejemot-Nwadiaro RI, Ehiri JE, Arikpo D, Meremikwu MM, Critchley JA. Hand washing promotion for preventing diarrhoea. *Cochrane Database Syst Rev.* 2015;2015(9):CD004265.
- Freeman MC, Stocks ME, Cumming O, Jeandron A, Higgins JP, Wolf J, et al. Hygiene and health: systematic review of handwashing practices worldwide and update of health effects. *Trop Med Int Health.* 2014;19(8):906-916.
- Fung IC, Cairncross S. Effectiveness of handwashing in preventing giardiasis: a meta-analysis. *Am J Trop Med Hyg.* 2009;81(5):869-873.
- G/hiwot Z, Alemayehu B, Gebretsadik A. Handwashing practice and intestinal parasite infection among school children in Ethiopia. *BMC Res Notes.* 2019;12:104.
- Rao V, Raman S, Thakur P. Intestinal parasitic infections in religious and government schools in Varanasi, India. *J Parasit Dis.* 2018;42(4):541-546.
- Haider J, Mohammad NS, Nazli R, Fatima S, Akhtar T. Prevalence of parasitic infestation in children of a rural community of Peshawar. *Khyber Med Univ J.* 2018;10(1):14-18.
- Alum A, Rubino JR, Ijaz MK. The global war against intestinal parasites--should we use a holistic approach? *Int J Environ Res Public Health.* 2010;7(3):1044-1058.
- Paracha PI, Khan MK, Shuja M. Prevalence of intestinal parasites in school children in rural areas of NWFP. *J Pak Med Assoc.* 1998;48(4):94-96.
- Ziegelbauer K, Speich B, Mäusezahl D, Bos R, Keiser J, Utzinger J. Effect of sanitation on soil-transmitted helminth infection: systematic review and meta-analysis. *PLoS Negl Trop Dis.* 2012;6(3):e1562.
- Aiello AE, Coulborn RM, Perez V, Larson EL. Effect of hand hygiene on infectious disease risk in the community setting: a meta-analysis. *Am J Public Health.* 2008;98(8):1372-1381.
- Luby SP, Agboatwalla M, Feikin DR, Painter J, Billhimer W, Altaf A, et al. Effect of handwashing on child health: a randomised controlled trial. *Lancet.* 2005;366(9481):225-233.
- Strunz EC, Addiss DG, Stocks ME, Ogden S, Utzinger J, Freeman MC. Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis. *PLoS Med.* 2014;11(3):e1001620.