Received: 9 October 2023 | Revised: 4 April 2024 | Accepted: 7 May 2024

DOI: 10.1002/hsr2.2146

ORIGINAL RESEARCH

Health Science Reports Open Access WILEY

Prevalence and contributing factors of intestinal parasitic infections among school children with malnutrition in Hetauda, Nepal: A cross-sectional study

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Funding information

Higher Education Reform Project (HERP) DLI-7B Research Grant, Nepal,
Grant/Award Number: HERP DLI-7B

Abstract

Background and Aims: With existing undernutrition in the developing world, the prevalence of obesity is increasing rapidly. Some studies reported an association of intestinal parasitic infection (IPIs) with undernutrition while few recent studies reported an inverse association of IPIs with overweight and obesity. This study evaluated the comparative risk and associated factors of IPIs among under (body mass index [BMI] < 18.5), normal (BMI: 18.5–24.9) and overweight (BMI > 24.9) school-aged adolescents.

Methods: A total of 105 fecal samples were collected, with 35 samples from each group. The collected samples were tested for the presence of intestinal parasites via concentration method, and the parasites were identified morphologically.

Results: Overall prevalence of IPIs was 5.71% with 3 protozoa viz *Giardia lamblia* (2.86%), *Entamoeba histolytica* (1.90%) and *Endolimax nana* (0.95%). Univariate and multivariable regression analysis indicated none of the nutritional, socioeconomic status, demographic, lifestyle and behavioral characteristics were significantly associated with the prevalence of overall IPIs. Yet, significant numbers of male reported undernutrition and elevated risk of IPIs in this study population.

Conclusion: Despite low prevalence of IPIs in this study, risk of IPIs is attributable to individual differences in behavior like "not using soap for hand washing". Relatively elevated malnutrition with risky hygiene behaviors, male adolescents appeared as risky cluster of school age population.

KEYWORDS

associated factors, double burden of malnutrition, intestinal parasitic infection, intensity, prevalence, school aged adolescents

1 | INTRODUCTION

In the context of a shifting global sustenance landscape, predisposed by economic and income growth, urbanization, demographic change and globalization, nutritional epidemiology has seen a significant swing in recent decades. Malnutrition comprises undernutrition as well as overweight and obesity (OWOB) and affects all countries of the world.[1] Many countries face a double burden of malnutrition (DBM), where both undernutrition and OWOB exist in the same population, even in the same household.[2] Globally, until 2020, 1.9 billion adults were OWOB, more than 600 million were obese, while 462 million were underweight.[3–5] DBM mostly occurs in low- and middle-income countries like Nepal.

Although studies conducted in Nepal have shown the diminished prevalence of undernutrition over the last decades but the prevalence of OWOB has increased considerably.[6,7] Earlier three National surveys of Nepal (Demographic Health Survey 2016,[8] Micronutrient Survey 2016,[9] and the WHO STEPwise approach to surveillance survey 2019[10] calculated that overall, 14.5%–17% of the Nepali adult women were underweight, while 22%–25% were OWOB.[11,12] Among men, 17% were underweight and 17%–23.4% were OWOB.[11,12] In Nepal, there was no difference in the prevalence of OWOB between ecological zones or between rural versus urban populations.[13] A nationwide survey of Nepal in 2016 showed that 31.16% population (women 38.87% and men 28.77%) were obese.[8]

Many earlier studies reported an inconsistent association between intestinal parasitic infections (IPIs) and different nutritional profile/status. Some studies reported an inverse association of IPIs with undernutrition while few recent studies reported association of IPIs with OWOB in different directions.[14] Not only BMI but hygiene habit and co-morbidities underlying disease also play role on parasitic infection risk.[15] The high occurrence of these IPIs is closely associated with overall poverty, poor environmental hygiene, and inadequate health care.[16] Earlier studies have suggested that many socioeconomic and behavioral factors are associated with gastrointestinal parasites such as hygiene behaviors,[17,18] eating raw or unwashed fruits and vegetables,[19–21] drinking water quality,[22,23] parents' occupation and education,[24] family income,[25] children's hygiene and food habits[22] and malnutrition.[26,27] IPIs prevalence has been decreasing since the adoption of the national deworming program initiated in 2004. Yet, some earlier studies among ethnic groups still reported a high prevalence.[18,28]

Worldwide, 450 million individuals are suffering from IPIs, the majority of them are children, and approximately 3.5 billion people are affected.[29] Many studies on IPIs among school-aged children in Nepal have found prevalence rates ranging from 15% to 60%, with significant fluctuation over time and across the country.[30] Considering high prevalence of IPIs in Nepal with high DBM, this study aims to evaluate the comparative risk and associated factors of IPIs among underweight (body mass index [BMI] < 18.5), normal weight (BMI: 18.5–24.9) and overweight (BMI > 24.9) school-aged adolescents. This study also aims to find IPIs in overweight, normal, and underweight school-aged (i.e., 6–19 years) adolescents. Further, studies have suggested an association of intestinal parasites with poor performance at school.[31,32] Hence, this study will also see the effect of IPIs on school performance.

2 | MATERIALS AND METHODS

2.1 | Study area

This study was carried out in four schools of Hetauda sub-metropolitan city in the Makwanpur District of Bagmati Province in central Nepal (Figure 1). It lies in the Tarai region and extends within 27°25′ N 85°02′ E (with an area of 261.59 km^2). Four schools (randomly selected one public and three private; A, B, C, D) were selected from Hetauda after consultation and approval with school authorities. Three schools are situated in Ward Number 3, while one school is located in ward number 11. All four schools run their classes from grade 1 to grade 10.

2.2 | Study population

First of all, all the selected schools (i.e., 4) were visited frequently to set up study camps in each school with minimum hinder in their study schedules. Each participant was explained about the study protocol and asked if he/she and/or his/her parents (i.e., in the case of nonadult participants) agreed to participate in our study. An informed consent was distributed to them for their parents/guardians signature at home. Once signed informed consents were collected the day after distribution, questionnaires were then presented to the participants separately in a different isolated place within the school premises. The questionnaire survey was conducted to obtain socioeconomic and socio-demographic data. Participants were included in the study if they were of 6–19 years old and had lived in Hetauda for the last 3 years. While if potential participants reported recent (i.e., 1 month or less) intake of anthelmintics, or diagnosis of chronic disease like diabetes, they were excluded from study.

2.3 | Methods

Study was conducted between January and May 2022. Assessment of nutritional status (height, weight, and BMI) was carried out by taking anthropometric measurements. BMI was evaluated with measured height and weight by using formula BMI = Weight (kg)/Height (m^2). Out of 319 eligible and agreed participants, 105 study participants were selected based on measured BMI following the screening criteria (i.e., 35 students with body mass index [BMI] < 18.5, 35 students with normal BMI 18.5–24.9, and 35 overweight BMI > 24.9) matching their grade, age, and gender equally from both public and private schools. The ethical approval for this study was obtained from the Ethical Committee of the Institute of Science and Technology of Tribhuvan University (Approval no. 22-0024) and the selected schools supported our study.

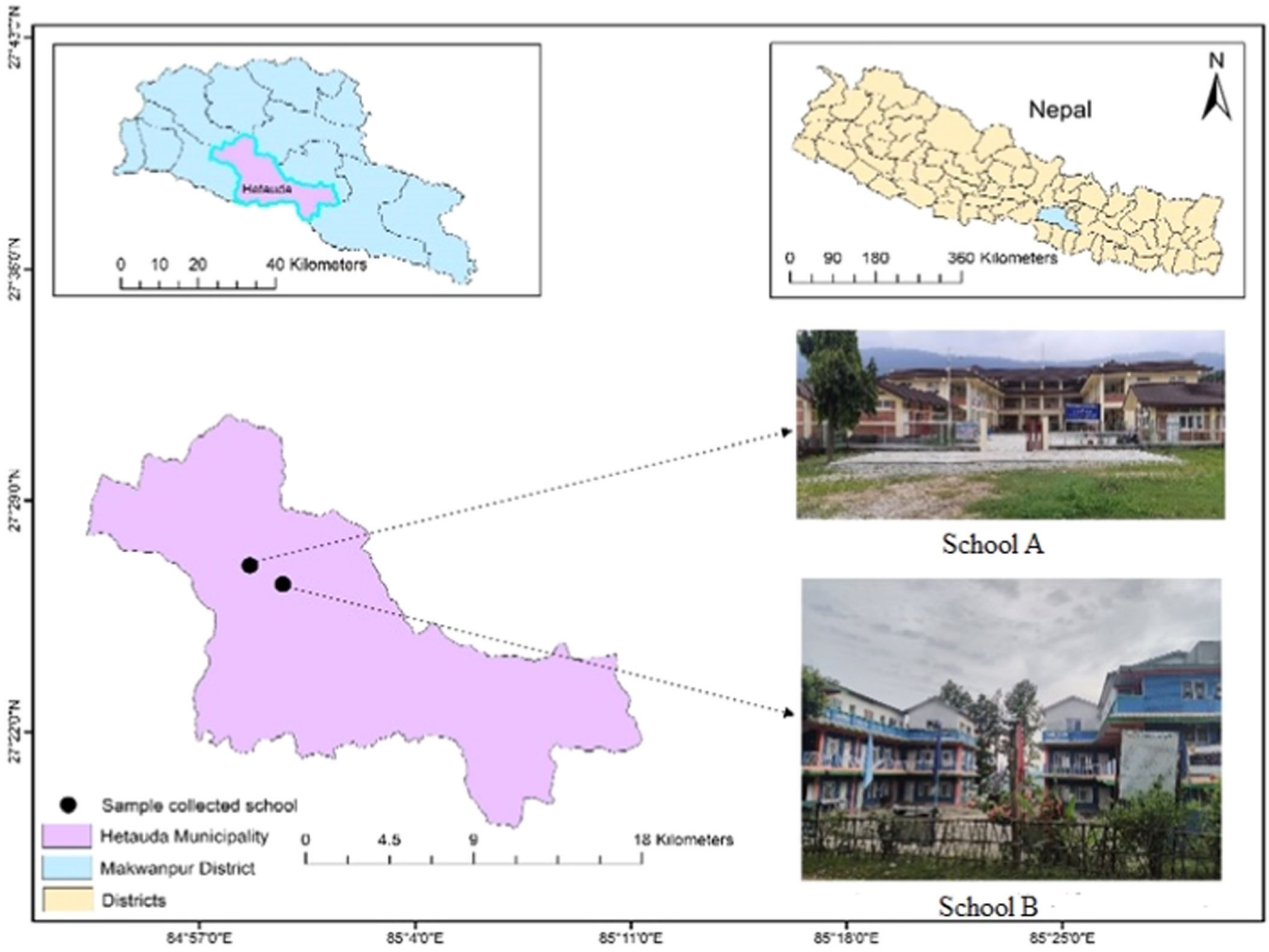

FIGURE 1 Location map of the study area, Hetauda submetropolitan and location of schools.

2.4 | Sample collection and examination

The recruited students were asked to collect stool samples in the given vial with the help of wooden spatula and transfer it to the zipper bag. All vials were given unique code before the vial distribution. Each collected sample was preserved in 2.5% potassium dichromate solution until laboratory analysis. All the fecal samples were macroscopically examined for their consistency and to see if any adult worms were present. The presence of IPIs was determined by direct wet mount, concentration technique (floatation and sedimentation) and acid-fast staining as described earlier.[28,33,34] The parasitic stages were identified on the basis of morphometric characteristics examined at 10×, 40×, and 100× under the compound microscope (Olympus). The microscopic images of parasites (Figure 2) were compared with the images provided by Center for Disease Control and Prevention in its website (CDC - DPDx - Parasites A-Z Index, 2019; accessed in June 2022 https://www.cdc.gov/dpdx/az.html). The parasite egg/oocyst intensity was categorized according to Erdman[35] as 0 for absence of any IPIs egg/oocyst, one for few eggs/oocysts (i.e., 1–5 eggs/oocysts per high power field (HPF)), two for moderate eggs/oocysts (i.e., 6–20 eggs per HPF), and three for many eggs (>20 eggs/HPF).

2.5 | Data analysis

For multiple group comparisons (Tables 1 and 2), independent *t* test was used for continuous data while a Chi-square or Fisher's Exact test was used for analyzing categorical data. Multivariable logistic regression was used to investigate the association between prevalence of overall IPIs and potential contributing factors, (i.e., hygiene behaviors, nutritional status, socio-demographic characteristics, and community). The level of significance was set at $p < 0.05$. All analyzes were performed using the Statistical analyzes were performed using IBM SPSS Statistic v25.

3 | RESULTS

Table 1 illustrates that study participants mostly were teenagers male with the mean age of 14.24 years in the study. Female participants rated their health better than male participants though BMI, BMI category or other parameters were comparable with the male participants. Yet, height of male was higher than that of female, though age was similar between male and female participants. Similarly, none of the socioeconomic factors were differed between male and female participants. Grade point average

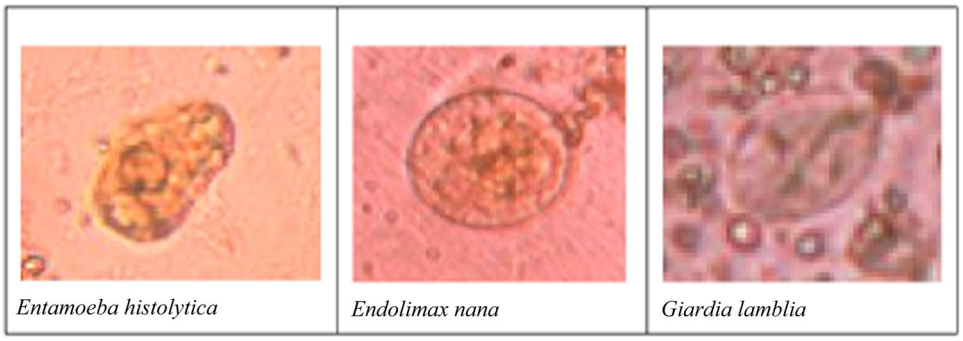

FIGURE 2 Identified intestinal protozoan parasites in school children.

(GPA) and perception about GPA were also similar between male and female participants and were from both private and public school, equally. Most of the participants reported households with less than 5 members in households, both parents can read and write with normal socio-economic status (SES) and frequent consumption of meat and fruits. Distribution of participants was not differed by schools and BMI category.

Table 2 shows behavioral and lifestyle characteristics of study participants, with risky behavioral and lifestyle characteristics (i.e., more than half of the participants did not use soap for hand washing before eating and walk barefoot while outdoor and did not trim nail regularly) in the study. Yet, most of participants reported recent consumption of anthelminthic drug, mostly covered food, did not consume dropped food, wash fruits and vegetables before eating. There was no significant different between male and female participants in different hygiene and lifestyle characteristics except consumption of pork and their mother's occupation. Male participants reported more pork consumption than female ($p = 0.05$). More mother of female participants reported the farming as their main occupation than that of male participants ($p < 0.05$).

Table 3 shows prevalence of IPIs among study participants. A total of 105 fecal samples were evaluated under the microscope with different methods as described in method. Only 6 samples (5.71%) were found shedding three species of protozoa (i.e., *Giardia lamblia*, *Entamoeba histolytica* and *Endolimax nana*) (Table 3). Overall, *G. lamblia* has a higher prevalence (2.86%) followed by *E. histolytica* (1.9%), and *E. nana* (0.95%). Neither overall prevalence nor egg density differed by gender. Because of the small number of prevalence, statistical analysis was not run for individual parasites.

Table 4 shows the association between parasitic infections and the potential contributing factors. Presence of any parasitic infection was higher among participants from crowded household, who consumed pork, going to public school, who consumed raw meat, who do not use soap for hand washing before eating, underweight participants and male participants compared to their counterparts. Yet, none of the evaluated factors achieve statistical significance in univariate or multivariate model before or after adjustment to gender or BMI categories. This study also indicates that the prevalence of IPIs was significantly high among the undernutrition category compared to normal or overweight category. None of the evaluated demographic, SES, lifestyle, behavioral characteristics indicated any association with prevalence of IPIs in either univariate or multivariate model (Table 4).

4 | DISCUSSION

This study investigated the prevalence of IPIs among school aged adolescent from both private and public schools of Hetauda, Nepal. Prevalence of IPIs in our study (i.e., 5.71%) is comparable with prevalence of IPI reported from different study. For example, Kunwar et al.[30] reported a 4.12% prevalence of *E. histolytica* and 9.40% prevalence of *G. lamblia*. Similarly, Tandukar et al.[36] reported 7.4% prevalence of *G. lamblia* followed by 3.4% prevalence of *E. histolytica* among more than 1300 stool samples evaluated from school children of Lalitpur district of Nepal. Comparable results were reported by Shrestha et al.[37] among school children in Baglung districts of Western Nepal (i.e., *E. histolytica* (9.23%), *G. lamblia* (5.76%). In contrast, quite high prevalence of IPIs has also been reported by many previous studies. For example, a recent study[38] among schoolchildren in Dolakha and Ramechhap districts, Nepal reported quite high prevalence of IPIs. Such a discrepancy in the prevalence of IPIs might be due to the difference in the climatic conditions and different levels of awareness.[28] The lower prevalence of IPIs in our study participants may be partially explained by ongoing routine deworming programs. In addition, most of participants reported healthier behavioral and lifestyle characteristics (i.e., frequent consumption of anthelminthic drug, mostly covering food, did not consume dropped food, wash fruits and vegetables before eating). However, small sample size limits us for any conclusion. Hence, further study needs to be conducted to confirm this finding.

Prevalence of overall IPIs was higher among males compared to females. Yet, females indicated higher egg density compared to male, but both could not achieve statistical significance. A few earlier studies reported similar finding with elevated IPI prevalence among male compared to female. For example, in a study done among HIV patients it was found out that gender difference, that is, being male and diarrhea were strongly associated with an increased prevalence of intestinal parasites.[31] Also, another study done in Islamic Republic of Iran found out that male gender was more infected with GI parasites in comparative to the female gender. Mainly, *G. lamblia* was seen higher in male gender and

TABLE 1 Characteristic features of study participants ($n = 105$).

Characteristics	Male ($n = 63$) Mean (SD)/n (%)	Female ($n = 42$) Mean (SD)/n (%)	p value	Total Mean (SD)/n (%)
Demographic characteristics				
Age (in year)	14.27 (1.59)	14.19 (1.04)	NS[$]	14.24 (1.39)
Weight (Kg)	54.27 (18.16)	49.54 (12.60)	NS[$]	52.38 (16.26)
Height (Meter)	1.58 (0.11)	1.53 (0.06)	**0.010**[$]	1.56 (0.09)
Body Mass Index (BMI) (Kg/m^2)	21.60 (6.24)	21.01 (4.76)	NS[$]	21.36 (5.67)
Self-rated health (Poor 1 to excellent 5)	3.38 (1.01)	3.71 (0.71)	**0.049**[$]	3.51(0.91)
School parameter				
Grade (years)	8.08 (1.64)	8.38 (0.91)	NS[$]	8.19 (1.24)
GPA	2.49 (1.13)	2.21 (1.03)	NS[$]	2.37 (1.09)
Schools participated				
A (Private)	38 (36.19)	17 (16.19)		55 (52.38)
B (Public)	17 (16.19)	19 (18.09)	NS[*]	36 (34.28)
C (Private)	2 (1.9)	2 (1.90)		4 (3.80)
D (Private)	6 (5.71)	4 (3.80)		10 (9.52)
What do you think about your GPA?				
Ok	56 (53.33)	35 (33.33)	NS[*]	91 (86.67)
Not good	7 (6.66)	7 (6.67)		14 (13.33)
Socioeconomic (SES) characteristics				
Household (HH) crowding				
Yes (≥5 members in HH)	12 (11.42)	10 (9.52)	NS[*]	22 (20.95)
No (<5 member in HH)	51 (48.57)	32 (30.47)		83 (79.05)
Reported SES				
Normal	59 (39.33)	38 (36.19)	NS[*]	97 (92.39)
Low	4 (2.67)	4 (2.67)		8 (7.61)
Do you consume meat?				
Rarely	8 (7.61)	4 (2.67)	NS[*]	12 (11.43)
Frequently	55 (52.38)	38 (36.19)		93 (88.57)
Do you consume fruits?				
Rarely	14 (13.33)	9 (8.57)	NS[*]	23 (21.91)
Frequently	49 (46.67)	33 (31.42)		82 (78.09)
Type of school now studying?				
Private	25 (23.80)	25 (23.80)	NS[*]	50 (47.62)
Public	38 (36.19)	27 (25.71)		55 (52.38)
BMI category				
BMI < 18.5 (Underweight)	22 (20.95)	13 (12.38)	NS[*]	35 (33.33)
BMI: 18.5–24.99 (Normal)	18 (17.14)	17 (16.19)		35 (33.33)
BMI > 25 (Overweight)	23 (21.91)	12 (11.43)		35 (33.34)

Note: Bold values indicate statistically significant.

*Chi square test.

[$]Independent t test.

TABLE 2 Behavioral, and lifestyle characteristics of study participants ($n = 105$).

Characteristics	Male ($n = 63$) n (%)	Female ($n = 42$) n (%)	Chi-Square p value	Total n (%)
Behavioral/lifestyle characteristics				
Use of soap for hand washing				
Yes	24 (22.86)	16 (15.23)	NS*	40 (38.10)
No	39 (37.14)	26 (24.76)		65 (61.90)
Walk bare foot while outdoor				
No	26 (24.76)	23 (21.90)	NS*	49 (46.67)
Yes	37 (35.23)	19 (18.10)		56 (53.33)
Mother's occupation				
Other	**48 (45.71)**	**24 (22.86)**	**0.039***	**72 (68.57)**
Farmer	**15 (14.29)**	**18 (17.14)**		**33 (31.43)**
Father's occupation				
Other	53 (50.47)	29 (27.62)	NS*	82 (78.10)
Farmer	10 (9.52)	13 (12.38)		23 (21.90)
Did you consume raw meat?				
No	57 (54.28)	41 (39.05)	NS*	98 (93.33)
Yes	6 (5.71)	1 (0.95)		7 (6.67)
Did you take anthelminthic within 6 months?				
Yes	54 (51.43)	35 (33.33)	NS*	89 (84.77)
No	9 (8.57)	7 (6.67)		16 (15.23)
Did you trim nails regularly?				
Yes	26 (24.76)	18 (17.14)	NS*	44 (41.90)
No	37 (35.23)	24 (22.86)		61 (58.09)
Did you notice worm in stool?				
No	29 (27.62)	23 (21.90)	NS*	52 (49.52)
Yes	34 (32.38)	19 (18.10)		53 (50.47)
Do you cover food regularly?				
Yes	55 (52.38)	37 (35.23)	NS*	92 (87.62)
No	8 (7.62)	5 (4.76)		13 (12.38)
Do you know about intestinal parasite?				
Yes	21 (20.00)	15 (14.29)	NS*	36 (34.28)
No	42 (40.00)	27 (25.71)		69 (65.71)
Do your pet entered to kitchen?				
No	40 (38.09)	32 (30.47)	NS*	72 (68.57)
Yes	23 (21.90)	10 (9.5)		33 (31.42)
Do you consume dropped food?				
No	45 (42.86)	35 (33.33)	NS*	80 (76.19)
Yes	18 (17.14)	7 (6.67)		25 (23.81)
What type of water do you drink?				
Boiled or filtered	30 (28.57)	15 (14.28)	NS*	45 (42.86)
Jar	33 (31.42)	27 (25.71)		60 (57.14)

TABLE 2 (Continued)

Characteristics	Male (n = 63) n (%)	Female (n = 42) n (%)	Chi-Square p value	Total n (%)
Do you wash fruits or green to eat raw?				
Yes	52 (49.52)	39 (37.14)	NS[†]	91 (86.67)
No	11 (10.48)	3 (2.86)		14 (13.33)
Do you consume pork?				
No	**38 (36.19)**	**33 (31.42)**	**0.05**[*]	**71 (67.62)**
Yes	**25 (23.80)**	**9 (8.57)**		**34 (32.38)**

Note: Bold values indicate statistically significant.

*Chi square test.

[†]Independent t test.

TABLE 3 Prevalence of gastrointestinal parasites in school aged participants (n = 105).

Parasite species	Male Mean (SD)/n (%)	Female Mean (SD)/n (%)	Fisher's exact test p value	Total Mean (SD)/n (%)
Giardia lamblia	1 (0.95)	2 (1.90)	NS[*]	3 (2.86)
Entamoeba histolytica	2 (1.90)	0 (0)	NA	2 (1.90)
Endolimax nana	1 (0.95)	0 (0)	NA	1 (0.95)
Infection density[#]	1 (0.50)	2.00 (0.00)	0.541[$]	1.83 (0.41)
Total infection	4 (3.81)	2 (1.90)	NS[*]	6 (5.71)

[$]Independent t test.

*Fisher's exact test.

[#]According to Erdman.[35]

younger age group had more prevalence of infection than the older ones.[39] Yet, few studies reported similar risk of IPIs between male and female.[40] In this study, majority of female reported healthier behavioral and lifestyle characteristics (i.e., less consumption of pork) compared to male participants ($p < 0.05$), which may explain such discrepancy in IPIs infection by gender. Another study carried out in rural Nepal showed contrasting results to our study where younger girls were more infected (55.2%) than boys (44.8%). This study also found out that rural areas population were more infected by IPIs (52.3%) than urban areas (32.4%).[41] Further, male indicated higher prevalence undernutrition and reported lower self-rated health compared to female, which may indicate weak nutritional as well as immunity for elevated IPIs infections. Yet, further study needs to be conducted to confirm this association.

This study indicated elevated risk of any parasitic infections (IPIs) among participants from crowded household, who consumed pork, going to public school, who consumed raw meat, who do not use soap for hand washing before eating, underweight participants and male participants compared to their counterparts. But none of the associations achieved statistical significance. Small sample size (n = 105) might be behind such lack of statistical significance but consistent pattern in direction of association urges further study to confirm this association. Among the variables evaluated, only variables with highest odd ratio (OR) (i.e., higher range of 10) were entered forcibly in multivariate model for mutual adjustment. Yet, association remains insignificant with consistent direction of association and adjusted odd ratio (AOR). Hence, the variables like "do not use soap to wash hand before eating" with highest OR or AOR in both univariate as well as adjusted multivariate model may represent as proxy measures of poor hygiene in general. Nutritional status (i.e., BMI categories) did not explain any variation in risk of IPIs. But study indicated elevated risk of IPIs among undernutrition category (BMI < 18.5) compared to normal BMI (i.e., BMI 18.5 to 24.99) or overweight BMI categories (BMI > 24.99). Further study with larger sample size is needed to confirm this association.

This study has a few limitations like small sample size and cross-sectional study design. Yet, design of the study from both public and private school with matched, age, gender, and BMI categories (i.e., 35 participants in each BMI categories) enabled us to compare relative prevalence and associated risk factors. Further, low prevalence of parasites limits us for statistical evaluation causing lack of association and risk of individual parasites. Ongoing deworming program with enhance hygiene behaviors might have been contributing to such decreased prevalence of IPIs in human population. Though we assumed IPIs might have some association in reported GPA, such association was not evident in our analysis in both univariate and multivariate models

TABLE 4 Prevalence and odds ratio of IPIS with behavioral and individual characteristics on logistic regression analysis ($n = 105$).

Socioeconomic (SES) characteristics	%	Any IPIs ($n = 105$) Univariate OR (95% CI)	Multivariate* AOR (95% CI)
Household (HH) Crowding			
No (<5 member in HH)	4.82	Ref	Ref
Yes (≥5 member in HH)	9.09	1.98 (0.34–11.56)	1.79 (0.29–10.90)
Can mother read and write?			
Yes (Literate)	6.49	Ref	
No (Illiterate)	3.57	0.53 (0.06–4.78)	
Mothers occupation			
Others	6.94	Ref	
Farmer	3.03	0.42 (0.05–3.73)	
Fathers occupation			
Others	6.09	Ref	
Farmer	4.35	0.70 (0.08–6.31)	
Do you consume pork?			
No	5.63	Ref	
Yes	5.88	1.05 (0.18–6.02)	
Types of school?			
Private	4.0	Ref	Ref
Public	7.27	1.88 (0.33–10.75)	3.08 (0.46–20.67)
Do you exercise regularly?			
Yes	5.55	Ref	
No	5.88	1.06 (0.20–5.52)	
Do pet enter in Kitchen?			
No	5.55	Ref	
Yes	6.06	1.10 (0.19–6.31)	
Do you consume raw meat?			
No	5.10	Ref	Ref
Yes	14.28	3.10 (0.31–30.93)	3.37 (0.29–39.13)
Do you consume fruits?			
Frequently	6.09	Ref	
Rarely	4.34	0.70 (0.08–6.31)	
Use of soap for hand washing			
Yes	2.5	Ref	Ref
No	7.69	3.25 (0.37–28.88)	4.16 (0.43–39.82)
Walk bare foot while outdoor			
Yes	6.12	Ref	
No	5.35	0.87 (0.17–4.51)	
BMI category			
Underweight	8.57	3.19 (0.32–32.24)	
Normal	2.86	Ref	
Overweight	5.71	2.06 (0.18–23.83)	

TABLE 4 (Continued)

Socioeconomic (SES) characteristics	%	Any IPIs (n = 105) Univariate OR (95% CI)	Multivariate* AOR (95% CI)
Did you trim nails regularly?			
Frequently	6.82	Ref	
Rarely	4.92	0.71 (0.14–3.68)	
Gender			
Male	6.34	Ref	
Female	4.76	0.74 (0.13–4.22)	
Do you know about intestinal parasite?			
Yes	8.33	Ref	
No	4.35	0.50 (0.10–2.61)	
What type of water do you drink?			
Boiled or filtered	6.67	Ref	
Jar	5.00	0.74 (0.14–3.83)	

Abbreviations: %, prevalence percentage; 95% CI, 95% confidence interval; AOR, adjusted odds ratio; OR, odds ratio; ref, reference.

(data not shown). Again, low prevalence of parasites might have caused lack of association.

5 | CONCLUSION

IPIs among school aged populations may pose a serious health problem. Though school aged adolescent indicated low prevalence of IPIs but risk of IPIs is attributable to individual differences in behavior like "not using soap for hand washing". Relatively elevated malnutrition (reported under nutrition) with risky hygiene behaviors indicated male as risky cluster of school age population. However, small sample size limits us for generalization. An in-depth health education and higher emphasis on IPIs should be given to school aged adolescents to minimize risk of IPIs.

AUTHOR CONTRIBUTIONS

Rameshwor Parajuli: Writing–original draft; conceptualization; investigation; data curation. **Pitambar Dhakal**: Methodology; writing–review and editing; supervision. **Sandeep Thapa**: Investigation; methodology; writing–review and editing. **Tirth Raj Ghimire**: Investigation; methodology; writing–review and editing. **Rajendra Prasad Parajuli**: Conceptualization; methodology; data curation; investigation; formal analysis; supervision; funding acquisition; project administration; resources; writing–review and editing.

ACKNOWLEDGMENTS

Our sincere appreciation also goes to the funding sources for their invaluable support throughout this research endeavor. We are very thankful to the participating students, supporting teachers, and respective principals of the schools recruited for this study for their participation in the study, support, and cooperation for sample collection and questionnaire survey. This work received support from the "Higher Education Reform Project (HERP) DLI-7B Research Grant, Nepal". The funders played no role in the study's design, data collection, analysis and interpretation, manuscript composition, or the determination to publish. Funding sources were not involved in study design; collection, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this article. All authors have read and approved the final version of the manuscript (corresponding author: RPP) had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis. The manuscript guarantor (RPP) affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The ethical approval for this study was obtained from the Ethical Committee of the Institute of Science and Technology (IOST) of Tribhuvan University (Approval no. 22-0024) and the selected schools supported our study.

TRANSPARENCY STATEMENT

The lead author Rajendra Prasad Parajuli affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Parajuli R, Dhakal P, Thapa S, Ghimire TR, Parajuli RP. Prevalence and contributing factors of intestinal parasitic infections among school children with malnutrition in Hetauda, Nepal: a cross-sectional study. *Health Sci Rep*. 2024;7:e2146. doi:10.1002/hsr2.2146