



**Intestinal Parasites and Nutritional Status of Children in
Public and Private School in Sarlahi District, Nepal**

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Kirtipur, Kathmandu
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A dissertation submitted

**In partial fulfilment of the requirements for the award of the degree
of Master of Science in Zoology with special paper Parasitology**

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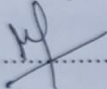
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Declaration

I hereby declare that the work presented in this dissertation “Intestinal parasites and nutritional status in public and private school in Sarlahi district, Nepal.” has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).


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Recommendation

This is to recommend that the dissertation entitled “Intestinal parasites and nutritional status in public and private school in Sarlahi district, Nepal” has been carried out by Merina Lama for the partial fulfilment of Master’s Degree of Science in Zoology with special paper (Parasitology). This is her original work and has been carried out under my supervision. To the best of my knowledge, this dissertation work has not been submitted for any other degree in any institutions.

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Letter of approval

On the recommendation of supervisor “Mr. Janak Raj Subedi” this dissertation submitted by Merina Lama entitled “Intestinal parasites and nutritional status in public and private school in Sarlahi district, Nepal” is approved for the examination in partial fulfilment of the requirements for Master’s Degree of Science in Zoology with special paper (Parasitology).

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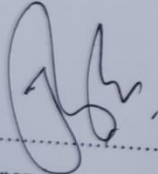
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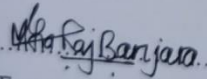
Certificate of acceptance


This dissertation work submitted by Merina Lama entitled "Intestinal parasites and nutritional status in public and private school in Sarlahi district, Nepal" has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper (Parasitology).

Evaluation committee

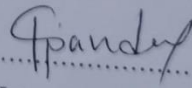

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Abstract

It is known that maximum of the world's population suffers from intestinal parasitic illnesses, mainly with *hookworms*, *Ascaris lumbricoides*, and *Trichuris trichiura*. Apart from this, intestinal parasites also cause inflammation of intestinal wall that leads to indigestion, malabsorption, diarrhoea, and nutritional complications that results in the slow growth and affect the nutritional status of the children. To fulfill this gap regarding the nutritional status and intestinal parasite infection in children older than five years old, this study aims to associate the relationship between intestinal parasites and nutritional status of the school children from 6 to 17 years old in public school and private school of Sarlahi district, Nepal. The data was collected by interviewing the children, assessing anthropometric markers and taking stool samples from the children. The microscopic examination was done using a direct wet mount and concentration techniques. The overall parasitic prevalence was 30.8% (74/240), among which more females (35.3%) were infected than male children (25.20%). The prevalence of parasites were found more in public school (35.80%) than private school (24.55%). The age group of children 6 to 11 years (38.20%) were highly infected followed by 12 to 14 years (26.6%) and the least prevalence was found among 15 to 17 years children (25.70%). *Ascaris lumbricoides* was the most prevalent with a prevalence of 78.95% while the least prevalent parasites were *G. lamblia* (11.83%), *E. coli* (3.95%), *Entamoeba histolytica* (3.95%) and *Hymenolepis nana* (1.32%). The prevalence of overall stunting, underweight and thinness among children were 27.5%, 67.6% and 11.7% respectively. There was no significant association between intestinal parasites and nutritional status. Poverty, poor sanitation, personal hygiene and drinking water facility are the contributing factors for the prevalence of parasitic infections. A good nutrition and regular health intervention should be conducted in school.

शोध सार

विश्वको सबैभन्दा बढी जनसंख्यामा आन्द्राको परजीवी रोगहरू छन्, मुख्यतया हुकवार्मस, *Ascaris lumbricoides* र *Trichuris trichiura*। यसबाहेक, आन्द्राको परजीवीहरूले ढिलो विकासको परिणाम दिन्छ र बच्चाहरूको पोषण स्थितिलाई असर गर्छ। कुपोषणले बारम्बार पखाला, आन्द्राका परजीवीहरू जस्ता संक्रमणहरूको बारम्बार जोखिम निम्त्याउँछ, जसले गर्दा प्रतिरक्षा प्रणालीमा कमी आउँछ। धेरैजसो अध्ययनहरूमा, पोषण स्थिति र आन्द्राको परजीवी संक्रमणहरू पाँच वर्षभन्दा कम उमेरका बालबालिकाहरूमा मात्र मूल्याङ्कन गरिएको थियो। यस अन्तरलाई पूरा गर्न, यस अध्ययनले सर्लाही जिल्लाको सामुदायिक विद्यालय र निजी विद्यालयमा ६ देखि १७ वर्षसम्मका विद्यालयका बालबालिकाको आन्द्राको परजीवी र पोषण अवस्थाबीचको सम्बन्धलाई जोड्ने लक्ष्य राखेको छ। बालबालिकासँग अन्तर्वार्ता लिएर, एन्थ्रोपोमेट्रिक मार्करको मूल्याङ्कन गरी र बालबालिकाबाट दिसाको नमूना लिएर तथ्याङ्क सङ्कलन गरिएको थियो। सूक्ष्म परीक्षण एकाग्रता प्रविधिको साथ प्रत्यक्ष भिजेको माउन्ट प्रयोग गरी गरिएको थियो। समग्र परजीवी प्रकोप ३०.८ % (७४/२४०) थियो, जसमध्ये पुरुष बच्चाहरू (२५.२ %) भन्दा बढी महिलाहरू (३५.३ %) संक्रमित थिए। निजी विद्यालय (२४.५५%) भन्दा सार्वजनिक विद्यालय (३५.८%) मा परजीवीको प्रकोप बढी पाइयो। ६ देखि ११ वर्ष उमेर समूहका बालबालिका (३८.२०%) अत्यधिक संक्रमित थिए त्यसपछि १२ देखि १४ वर्ष (२६.६%) र १५ देखि १७ वर्षका बालबालिकामा (२५.७०%) सबैभन्दा कम प्रकोप पाइएको थियो। *Ascaris lumbricoides* ७८.९५% को व्यापकतासंग सबैभन्दा प्रचलित थियो जबकि कम प्रचलित परजीवी *Giardia lamblia* (११.८३%), *Entamoeba coli* (३.९५%), *Entamoeba histolytica* (३.९५%) र *Hymenolepis nana* (१.३२%)। बालबालिकामा समग्र स्टन्टिड, कम तौल र पातलोपनको प्रचलन क्रमशः २७.५%, ६७.६% र ११.७% थियो। आन्द्राको परजीवी र पोषण स्थिति बीच कुनै महत्त्वपूर्ण सम्बन्ध थिएन। हालको अध्ययनले निजी विद्यालयको तुलनामा सामुदायिक विद्यालयका बालबालिकामा आन्द्राको परजीवीको उच्च प्रचलन रहेको देखाएको छ। गरिबी, कमजोर सरसफाइ, व्यक्तिगत सरसफाइ र खानेपानीको सुविधा, परजीवी संक्रमणको फैलावटका लागि योगदान कारकहरू हुन्। विद्यालयमा राम्रो पोषण र नियमित स्वास्थ्य सर्वेक्षण गरिनुपर्छ।

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List of abbreviations

Abbreviated form	Details of abbreviations
WHO	World Health Organization
IPI	Intestinal Parasitic Infection
BMI	Body Mass Index
NNMSS	Nepal National Micronutrient Status Survey
HIV	Human Immuno-Deficiency Virus
AIDS	Acquired Immuno-Deficiency Virus
TB	Tuberculosis
SES	Socio-Economic Status
CBS	Central Bureau of Statistics
CDZ	Central Department of Zoology
TU	Tribhuvan University
NHRC	National Health Research Council
IRC	Institutional Review Committee
IOST	Institute of Science and Technology
BMI	Body Mass Index
HAZ	Height for Age Z-Scores
WAZ	Weight for Age Z-Scores
BMIZ	BMI for Age Z-Scores

1. Introduction

1.1 Background

School children are the vulnerable group because of their high physical activities and high chances of exposure to contaminated intestinal parasitic infections surfaces. They are in the phase of extreme growth, however susceptible to infection and immune deficits. Apart from this, intestinal parasites also cause inflammation of intestinal wall that leads to indigestion, malabsorption, diarrhoea, and nutritional complications that results in the slow growth and affect the nutritional status of the children. Malnutrition again can cause the children to suffer from infections like diarrhoea, intestinal worms and compromised immune system (Shrestha et al., 2020). The children belonging to age group 5 to 19 years which are around 1.8 billion and among them 90% live in low and middle income nations. There are few studies which study about the prevalence and malnutrition of these children who occupy 27% of the population in those countries (Galloway, 2017). These age group children also experiences the high burden of parasitic infection that have connection with poor sanitation and hygiene (Gebretsadik et al., 2020).

Around 24% (1.5 billion) of the population in the world suffers from intestinal parasitic illnesses, mainly hookworms, *Ascaris lumbricoides* and *Trichuris trichiura* in which the highly infected are sub-Saharan Africa, the Americas, China and East Asia with tropical and subtropical regions being commonly infected (WHO, 2022). The symptoms are just shown by 450 million and more than 200,000 deaths are reported annually (Hajare et al., 2021). IPIs are mostly prevalent in many countries and widely distributed throughout the world. It is also reported to occurring in 40.17% of school-age children (Bertoncello et al., 2017).

In Nepal, the mostly occurring intestinal parasites among the school children are *Entamoeba histolytica*, *Giardia lamblia*, *Ascaris lumbricoides*, *Hymenolepis nana*, *Hookworm*, and *Trichuris trichiura* (Pandey et al., 2015) and the incidence of hookworm, *Schistosoma mansoni*, *Trichuris trichura* and *Ascaris lumbricoides* infections are in consistent with undernutrition (Hailegebriel, 2018). Hookworm infected patients are likely to eat less and waste more nutrients through vomiting, diarrhea or blood loss. Along with these anemia, protein energy deficiency, and other nutrient deficits worsen the conditions further. There are also an ample of evidences that *Giardia lamblia*, *Coccidia*, *Plasmodium* spp., *Schistosoma* spp., soil-transmitted helminthes also change the nutritional status by

affecting the food intake, metabolism and absorption of micronutrients in the gut (Mrimi et al., 2022).

In the report of Nepal National Micronutrient Status Survey (NNMSS) 2016, 32% of the adolescents in Nepal of 10 to 19 ages have stunted growth in which male children are thinner than the female children (boys: 23.3% versus girls: 14.0%) (Ministry of Health and Population Nepal, 2018). The major contributing factors for high prevalence of IPIs are lack of clean water, poor hygiene, unsanitary practices, inappropriate fecal disposal and low socioeconomic level (Ojha et al., 2014) and poor nutritional status in children (Acharya et al., 2021). Most of the earlier studies in Nepal focus children under the age of five to see prevalence of IPIs and effect of IPIs in nutritional status (Feleke, 2016). Yet, none of the studies in our notice evaluated prevalence and intensity of IPIs in school age adolescents (i.e., 6-17 years old) and evaluated associated factors with IPIs. This study aims to evaluate prevalence, intensity of IPIs in school age children, and further evaluate association of IPIs burden with socioeconomic, sociodemographic and behavioral factors. We explore if IPIs are associated with BMI (i.e., proxy of nutritional indicator).

1.2 Statement of the Problem

The intestinal parasites not only cause the nutritional deficiencies and illness (Ross et al., 2017); it also retards growth, cause high school absenteeism that again cause cognitive decline, and even produce host's increased vulnerability to diseases like HIV/AIDS and TB and reduce child and adult productivity. As a result, they may have a negative socioeconomic influence on a country's growth (Feleke, 2016). Public school in urban areas get most of the children from low SES who live with poor sanitations, water and nutritionally inadequate food. I assume, lots of students coping with IPIs in such areas limiting them to attain full cognitive potential to be ready for competitive future.

1.3 Objectives of the study

1.3.1 General objective

- To determine the prevalence and associated factors of IPIs, its intensity and nutritional status.

1.3.2 Specific objectives

- To determine the prevalence and intensity of IPIs and nutritional status among schoolchildren.
- To identify the associated factors of prevalence of intestinal parasites.

1.4 Research questions

- What is the prevalence of IPIs and undernutrition among school children?
- What is the association between IPIs and risk factors?

1.5 Significance of the study

The role of IPIs for undernutrition is feasible in developing countries with high rate of IPIs typically among low SES setting. Children are more susceptible to IPIs than adults as they have greater dietary needs, immature immune systems, sicknesses and poor hygienic practices (Subedi et al., 2020). IPIs and undernutrition can affect their cognitive level and their quality of life. Thus, this study tends to link the risk variables involved in intestinal parasites with the nutritional status. This study may help policy makers, non-governmental organizations, and health professionals to create health plans and implement intervention programs at the school level to improve children's health status to attain full cognitive potential. Additionally, the results of this study might serve as a foundation for further investigation.

2. Literature review

2.1 Prevalence of intestinal parasites among school children

Intestinal parasites are common in developing nations, but other countries show different patterns of infection. To ascertain the prevalence of parasitic infection among public and private school from age 2 to 16 years in Ota, Ogun state, Nigeria whose prevalence was 46.1% (Armstrong et al., 2013). Also similar study in Amalapuram, India which observed 49% (98/200) IPIs rate (Sai, 2014). Another study carried out in Nigeria reported high prevalence 52.5% (105/200) which has direct correlation with personal hygiene (Agwu et al., 2016). Another study done by Ulhaq et al., 2023 in Pakistan reported high prevalence of IPIs 82% (266/324).

The study was conducted to determine the frequency of intestinal parasite distribution of school-aged children in Dadeldhura district, Nepal which reported 31.13% (165/530) of stool samples to be positive (Rijal, 2013) whilst another study was carried out at Everest English School and Prabhat English Higher Secondary School in Bhaktapur district, Nepal in which 27.67% (137) of the samples was positive (Shrestha & Maharjan, 2013). Similarly, to find the IPIs among school children, a study was carried out in Kalaiya, Nepal which also reported the prevalence of 31.7% (Regmi et al., 2014) and another study conducted in Dharmastali VDC in Kathmandu, Nepal discovered only 5% (15/300) IPIs rate (Pandey et al., 2015) and 12.4% (24/194) only in Kathmandu by Dahal et al., 2018 which might be due to the deworming campaign organized by the government. Intestinal parasitic infections are more likely to occur in communities with low socioeconomic level and poor hygienic status and the study in Bhaktapur also reported the high prevalence of parasitic infection i.e. 42.9% (79/184) (Shrestha et al., 2016). In the same way, the overall prevalence of parasites was 18.66% (28/150) among the children attending public and private school was observed (Subedi et al., 2020). A descriptive cross-sectional survey was carried out in Duwakot VDC which also observed 13.40% (26/194) of IPIs rate (Sharma et al., 2020). In the same manner, a prospective study conducted in Janakpurdham, Nepal reported 10.96% (17/155) of positive samples which suggested more active intervention measures and modification of hygienic lifestyle among school children (Sah et al., 2021). The study done among students of Kirtipur Municipality, Kathmandu reported 17.8% (73/409) IPIs rate

(Dahal et al., 2022). All these study reported significant rate of intestinal infection that is regarded as a public health concern.

The most common organisms discovered among 2 to 16 years children in Ota, Ogun state, Nigeria were *Giardia lamblia* (11.92%) and *Entamoeba histolytica* (10.15%), whilst *Trichuris trichiuria* (1.01%) and *Strongyloides stercoralis* (1.01%) were the least common. Children who attended the public school were greatly infected with intestinal parasites ($P = 0.0028$; $P < 0.05$) (Armstrong et al., 2013). Moreover, the study done by Agwu et al., 2016 in Nigeria that reported *A. lumbricoides* and *T. trichiura* (28, 14.0%) as the dominant parasites while *G. lamblia* had the lowest prevalence (17.5%). The other study in Nigeria also reported *Ascaris lumbricoides* (19.5%), *Ancylostoma duodenale* (9.5%), *Trichuris* spp. 6%, *Strongyloides* spp. 4.5%, *Enterobius* spp. 1%, *Taenia solium* 1.5%, *Taenia saginata* 1%, *Entamoeba histolytica* 4.5%, *Giardia lamblia* 4%, and *Schistosoma mansoni* 2% were the most frequently found intestinal parasites (Chukwu et al., 2023).

Similarly, study from school-aged children in the Dadelhdura area of western Nepal reported *Giardia lamblia* (7.47%) and *Hymenolepis nana* (46.56%) (Rijal, 2013). Furthermore, the study from Bhaktapur, Nepal which employed the direct smear to analyse the stool samples from 495 school children observed *Ascaris lumbricoides* (22.63%), *Trichuris trichiura* (6.06%), *Strongyloides stercoralis* (1.82%), Hookworm (1.62%), *Taenia* sp. (1.01%), *Hymenolepis nana* (0.81%), and *Enterobius vermicularis* (0.40%) (Shrestha & Maharjan, 2013). Another study from Kalaiya, Nepal (near India's border) also reported the most prevalent parasite to be hookworm (28.5%), which was followed by *Fasciolopsis buski* (2.8%), *Ascaris lumbricoides* (17.1%), *Trichuris trichiura* (20.0%), and *Hymenolepis nana* (22.8%). *Giardia lamblia* (45.7%) was the most common protozoan parasite, followed by *Entamoeba histolytica* (44.0%) and *Entamoeba coli* (10.1%) (Regmi et al., 2014). Similarly, another study in Kathmandu, Nepal that followed direct microscopy and concentration techniques discovered *Entamoeba histolytica*, *Giardia lamblia*, *Ascaris lumbricoides*, *Hymenolepis nana* and *Cyclospora* (Pandey et al., 2015). Similarly, the study in Bhaktapur observed *G. lamblia* (35.7%) as the highly dominant parasites followed by *Taenia* spp. (22.6%) and *Blastocystis hominis* (14.3%) as the low prevalent (Shrestha et al., 2016). The similar study was conducted among the school children (6 to 14 years) in Kathmandu, Nepal reported *E. histolytica* (33.3%) and *Taenia* spp. (16.7%) (Dahal et al., 2018). Another study in Kathmandu reported 32.7% of *Giardia duodenalis* and (21.8%) *Ascaris lumbricoides* (Shrestha et al., 2019). Similarly, another study observed four genera of *Ascaris lumbricoides*, *Trichuris trichiura*, hookworms, and *Taenia* sp. (Subedi et al.,

2020). In the similar way, the study done in Kirtipur Municipality, Kathmandu also reported *A. lumbricoides* (34.2%) as the dominant parasites *H. nana* (1.37%) as the least prevalent parasites. The other parasites reported were *G. lamblia* (23.3%), *E. histolytica* (15.1%), *T. trichiura* (10.96%), Hookworm (6.8%), *Enterobius vermicularis* (4.11%), *Taenia solium* (4.11%) (Dahal et al., 2022). Thus, several studies worldwide and in nation detected different cysts and ova of intestinal parasites which require continuous study and investigation.

Regarding age-group wise prevalence among school children, several studies reported young age children to be highly infected with IPIs than that of older ones. In a study conducted by Rijal, 2013 observed children of age 4-6 years (30%, 159) to be infected most than other age group. However the result was not statistically significant. While in a study carried out in Kathmandu, Nepal. The most infected age group was 9-11 years (58.33%) (Dahal et al., 2018). Moreover, the study done in Rumuodogo Community in Nigeria observed 3-6 years children to be most infected which was significantly associated with the parasitic infection ($P = 0.01$) (Chukwu et al., 2023).

2. 2 Prevalence of nutritional status and intestinal parasites

Undernutrition may have detrimental effects on the prevalence of intestinal parasites among school children. The study was conducted in the northwest of Addis Ababa, Ethiopia to compare the prevalence of intestinal parasite infection and underweight found that 24.8% of the students were underweight which was linked with intestinal parasite illness (61.7%) (AOR 2.67; 95% CI = 2-3.55) (Feleke, 2016) while in a study conducted in Osun state, Nigeria reported 24% if IPIs and the nutritional status of the children was 95.8% normal weight, 3.6% underweight and 0.5% overweight. There was no significant association between nutritional status and intestinal parasites among school children (Olopade et al., 2018).

In the same way, another cross-sectional study carried out in South Jakarta, Indonesia reported 38.2% (60/157) IPIs rate and 28.3% (17) of the children were malnourished. It was found that the nutritional status of school children is statistically correlated with intestinal parasite infection ($P 0.05$) (Sari et al., 2021). However, a cross-sectional study conducted in Jeddah, Saudi Arabia observed no significant association between IPIs and undernutrition which reported only 5.3% positive for IPIs (Bakarman et al., 2019). Another study among 780 children, the prevalence of undernutrition was 15.7% which suggested that children infected with intestinal parasitic infection has poor nutritional status.

In Nepal there are currently few studies in children that investigate about both nutritional status and intestinal parasites, however in a study done in Surkhet, Achham and Dailekh districts of Nepal in which 35.9% of the children had nutritional deficiencies, 55.5% were undernourished and the overall parasitic prevalence was 51.1% and the prevalence of undernutrition and presence of intestinal parasites had no significant association (Shrestha et al., 2020)

2.3 Association of socio-demographic factors and intestinal parasites

A study from Bushehr, Iran observed that the number of family members was significantly correlated with the IPIs (Barazesh et al., 2016). Another school-based cross-sectional study was carried out in Bahir Dar, Ethiopia in which IPIs was prevalent in 52.4% and students with unclean fingernails fingernails (AOR=4.96; 95% CI: 2.79-8.82) and inconsistent hand washing behavior (AOR=8.05; 95% CI: 4.66-13.89) were found as significant risk factors for parasitic infection (Hailegebriel, 2018). In the similar manner, a descriptive study conducted in Buner district, Pakistan reported 23.63% (104/440) samples positive for intestinal parasites. The major risk factors associated with parasitic infection were inadequate personal and environmental hygiene, contaminated food and water supplies, child behaviors like nail biting and finger sucking, illiterate mothers and low socioeconomic status of the children (Khan et al., 2022).

Intestinal parasites increases morbidity and mortality especially in impoverished countries like Nepal. The study was set to determine the prevalence of and risk factors of intestinal parasites among school-age children in Lalitpur district, Nepal in which 1392 samples were taken from two government, two private and two community schools that employed direct microscopy and concentration method to examine the samples reported the type of drinking water and the frequency of hand washing as the significant factors associated with IPIs (Tandukar et al., 2013). Another cross-sectional study was conducted in Saptari, Nepal reported 33% (94/285) IPIs rate in which family income, hand-washing habit, type of drinking water and availability of toilet facility at home were statistically significant with the intestinal parasitosis among the study population ($P < 0.05$) (Gupta et al., 2020). Similarly, a cross-sectional study carried out in Bhairahawa, Nepal reported 46.5% of parasitic infection in which IPIs had significant association with variables such the children's academic year, age, religion, current illness, sources of water in the home, meat consumption, presence of domestic animals, and recent history of anti-helminthic medication use (Raut et al., 2021). Furthermore, another cross-sectional study was

conducted in which parasitic prevalence rate was 11.5% (46/400) and the statistical significant factors associated with IPIs were biting one's nails, a reliable source of drinking water, biannual deworming, thumb sucking, hand hygiene before and after using the restroom, parental knowledge of health and sanitation, owning a dog or cat as a pet, and wearing protective shoes while playing (P value 0.001) (Shrestha et al., 2021). Thus all these study suggested the implementation of strict health intervention and hygiene improvements among the children to uplift their living standards and quality health life.

The intestinal parasitic infection is considered as the top ten diseases in Nepal and the most common parasites include taeniasis, amoebiasis, ancylostomiasis, ascariasis and giardiasis (Jaiswal, 2014). Most of the recent studies among children focussed on the prevalence and associated risk factors among school children under five years and further intensity of parasitosis are also evaluated less in the recent studies. Children under five years' nutritional status is also investigated regularly but the older children who are in peak age of growth and development also needs a regular screening and assessed their nutritional status. Thus the present study investigates the prevalence and intensity of intestinal parasites among school children from age 6 to 17 years along with assessing their nutritional status and evaluating the intensity of parasitic infection.

3. Materials and methods

3.1 Study area

The study conducted was of descriptive cross-sectional type and quantitative in nature. The study was conducted among school children studying in classes 1- 10 in community school and private school of Sarlahi district, Nepal. Sarlahi is located in the southeastern part of Nepal. According to the 2021 AD census, the district, which has Malangwa as its district capital, has a total area of 1,259 km² and a population of 857360 people. The population of Lalbandi Municipality is 15960 (male:33555 and female:33952 (CBS Nepal, 2022).

A total of 240 samples were collected from public school (134) and private school (106) each by randomly selecting students by using lottery method by putting roll number in lottery. From each school even section of the grade was randomly selected.

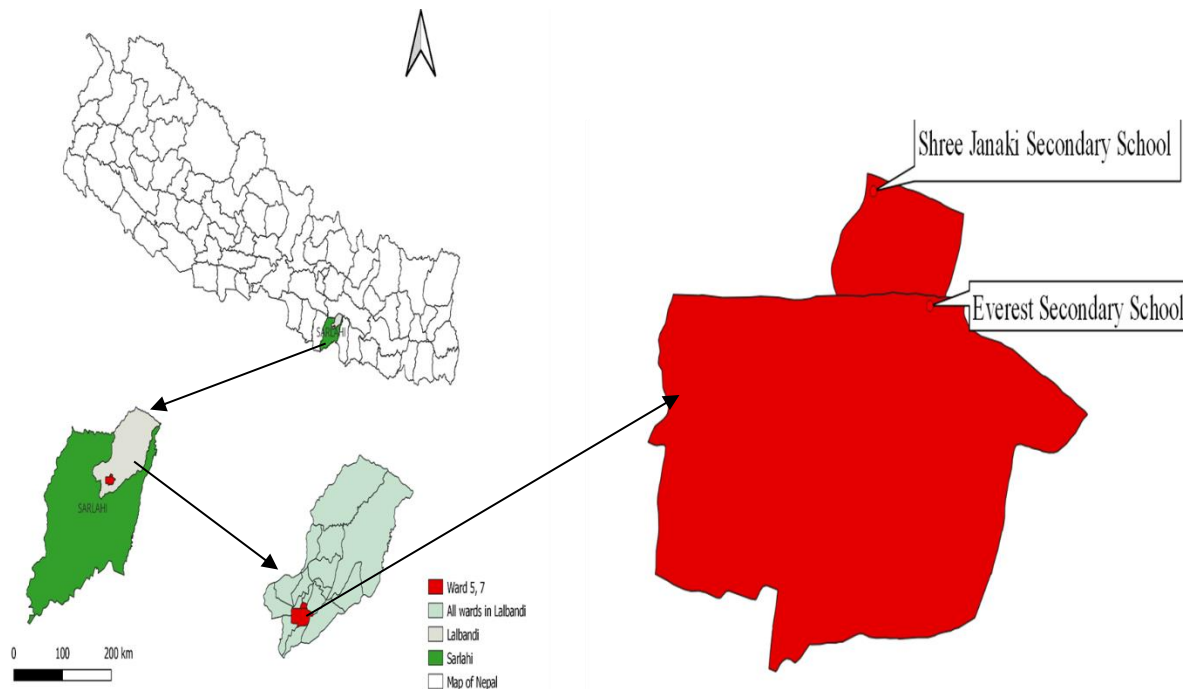


Figure 1. A map showing study location

3.2 Methods

The data collection technique involved interviewing the students from grade 1-10 by assessing anthropometric markers and by taking stool samples from the children. The questionnaires were filled by asking the children who were capable of giving answers while juniors were interviewed with the help of their parents. A structured questionnaire was

administered to the respondents or their parents/guardians which included socio-demographic factors (age, gender, ethnicity, parents' occupation etc.), sanitation behaviors (hand washing habits, shoes wearing etc.) and other behavior factors.

3.2.1 Anthropometric measurement:

To measure the weight and height of the children, WHO-recommended techniques were employed (De Onis & Habicht, 1996). Height was taken by using a measuring tape while weight was measured by using a weighing scale. BMI was calculated by using the formula: $\text{Body mass index} = \text{weight} / (\text{height in meter})^2$

The obtained BMI for age was compared with the 2007 WHO reference. The WHO reference 2007 was used to assess malnutrition among school children. Height for age, weight for age and thinness was used to measure stunting, underweight and thinness respectively. A Z scores of less than -2 was considered as stunted, underweight or thin, Z scores between -2 and -3 were considered moderate and Z scores less than -3 was considered severe while the Z scores between -2 and 2 were considered normal. WHO 2007 growth chart has Z score for "weight for age" for 5 to 10 years as WAZ does not distinguish body mass and relative height that is not sufficient for children beyond 10 years, so BMI for age is used for children from 11 to 17 years. Beyond 10 years of age, BMI for age complemented height for age. Overnutrition was defined as BMI for age greater than + 1 Z score, overweight was defined as BMI for age greater +1Z and less than +2Z score and obesity was defined as BMI for age greater than +2Z score (WHO, 2024).

3.2.2 Sample collection, preservation and transportation

The participants were provided with a dry, screw-capped, wide-mouthed container and were instructed to bring about 5 gm of stool which were later on store in 2.5% potassium dichromate solution. Then the obtained samples were marked and brought to the parasitology lab, Central Department of Zoology, TU at Kirtipur, Kathmandu for further processing.

3.3 Laboratory processing and examination

3.3.1 Macroscopic examination

The consistency of the stool and any mucus, blood present were marked which might lead to the presence of trophozoites and cysts of the protozoa.

3.3.2 Microscopic examination:

By employing direct wet mount with normal saline (0.9%), lugol's iodine (0.5%) mount and concentration method, and microscopic inspection was conducted.

In direct wet mount method, a drop of saline or lugol's iodine was placed over a clean slide and about 2 mg of stool was taken with the help of wooden toothpick and mixed thoroughly with the solution and then covered with a coverslip. Then the slide was observed under a microscope.

Concentration technique

In this technique, around two spatula of sample was mixed along with the 5 ml saline (0.9% sodium chloride) solution. Then the mixture was filtered with the help of a tea strainer. The filtrate was further evaluated by floatation and sedimentation techniques to identify the trophozoites, cysts, oocysts, eggs, and larval stages of the endoparasites.

Floatation technique

13 ml of normal saline (sodium chloride) and around 1 ml of filtrate was taken in a 15 ml centrifuge tube which was then subjected to centrifuge at 2000 revolutions per minute (rpm) for 5 minutes. Then it was kept on the test tube stand. The concentrated solution of sodium chloride was filled up to the whole brim of the tube until it forms a convex surface. The coverslip was placed over the tube so that it might come in contact with the solution. After that the cover slip was taken off after 15 to 20 minutes and kept on a glass slide. Subsequently the slide was observed under a microscope.

Sedimentation technique

In a 15 ml centrifuge tube, 1 ml of filtrate, 10 ml of 10% formal saline and 3 ml of ether was taken which was then mixed thoroughly for 5 minutes at 2000 rpm. After that the sediment was employed for the microscopic examination instead of the supernatant fluid which was discarded. The two drops of the solution was kept on a clean glass slide with Lugol's iodine to view the different parasitic stages and viewed under a microscope (Zajac et al., 2012).

3.4 Intensity of infection

For the positive samples, the eggs of *A. lumbricoides* were counted separately by using McMaster slide. The positive samples were mixed with 13 ml saline and poured into the McMaster chamber with the help of dropper and the slide was observed under the microscope.

Eggs per grams (Epg) were determined by: $\{x \text{ (in chamber 1)} + y \text{ (in chamber 2)}\} \times 50$

Here, x and y denotes the number of parasites egg detected in each slide of McChamber (Sultan et al., 2010).

3.5 Data analysis

The SPSS trial version 27 was used to analyze the findings statistically. Tables, frequency, and percentages were used to illustrate the findings. Chi-square test was used to evaluate association between prevalence of IPIs, nutritional status, intensity of IPIs and associated factors. At a P value of 0.05 or below with a 95% confidence interval, the test was regarded statistically significant.

3.6 Ethical considerations

Ethical approval was taken from the Institutional Review Committee (IRC) (Ref. No. 143/080/081) of the Institute of Science and Technology (IOST). Participants were fully informed, and written inform consent of parent and assent of school aged children was taken. All procedures were done with standard protocols.

4. Results

4.1 Prevalence and intensity of intestinal parasites

Intestinal parasites are the public health concerns in developing nations. Out of 240 school children, 30.8 % (74) were positive for the parasitic infections (Fig 2).

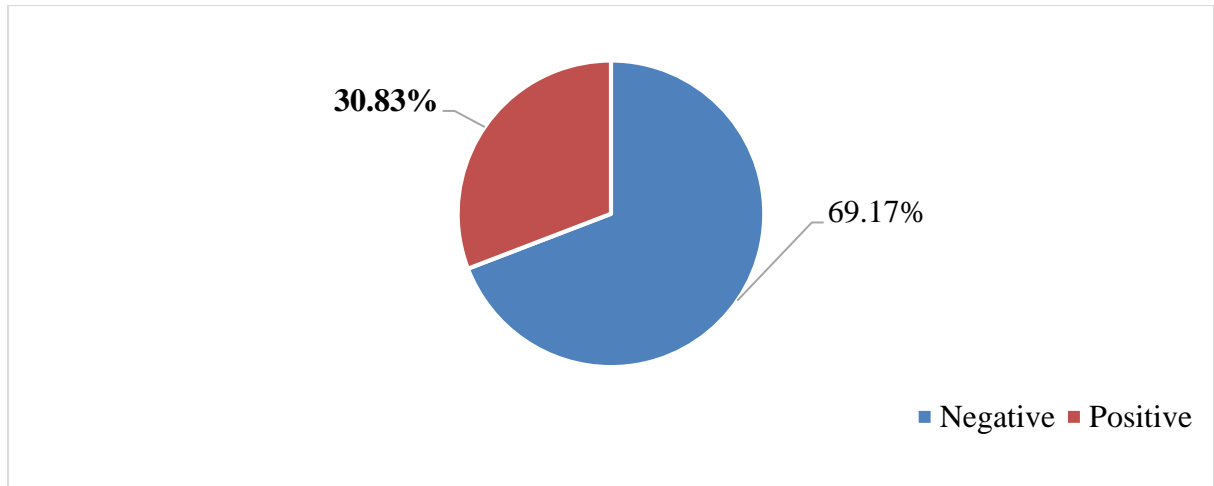


Figure 2. Prevalence of parasitic infection among school children

Out of 240 respondents, in government school, children had high prevalence of parasitic infection of 35.80 % (48/134) while private school children had the least IPI's 24.5% (26/106) (Fig 3)

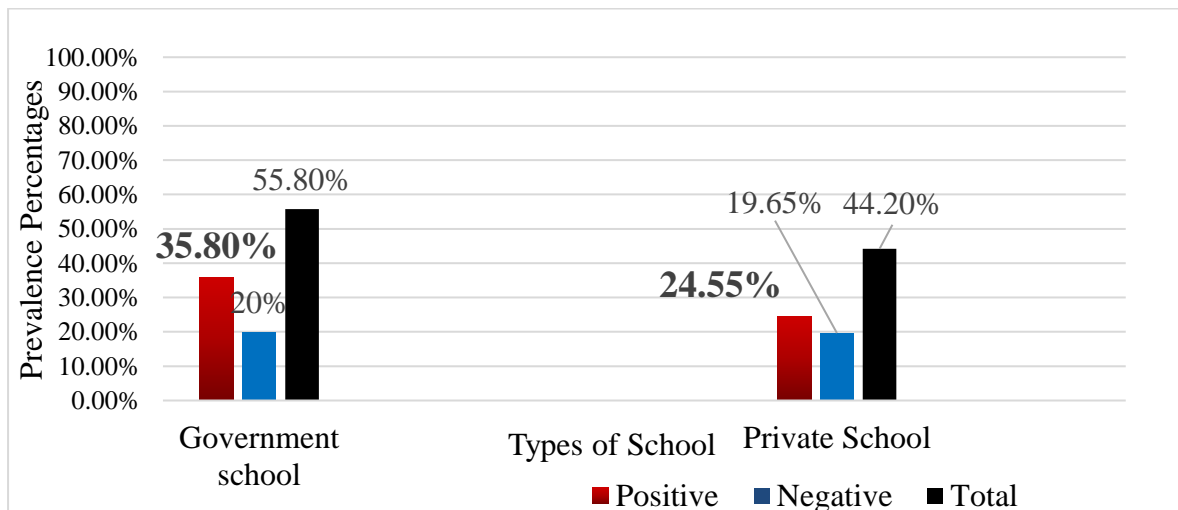


Figure 3. Distribution of parasitic prevalence by the types of school

In this study, female school children had a high parasitic prevalence of 35.30% (47/134) than the male children whose prevalence was 25.20% (27/107) in both public and private school. Similarly, female had a high IPIs of 42% (34/81) and 25% (13/52) in public and

private school respectively than that of male in public and private school with IPIs rate of 26.40% (14/53) and 24.10% (13/54) respectively (P 0.0892) (Fig 4).

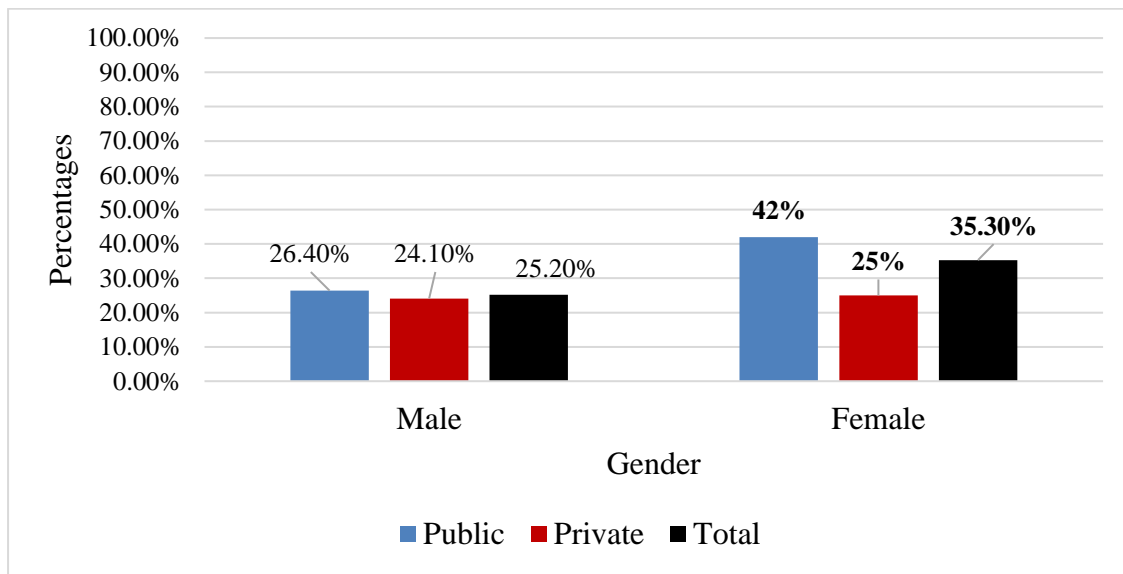


Figure 4. Gender-wise distribution of prevalence of parasitic infection

Out of 74 positive samples, the highest prevalence of intestinal parasites was found among the age group 6 to 11 years (middle childhood) (38.20%, 26/68) followed by 12 to 14 years (early adolescence) (26.60%, 29/109) while the least prevalence was found among 15 to 17 years (late adolescence) (25.70%, 19/63) school children. There was no significant difference between age group and parasitic infection (P = 0.263) Fig 5.

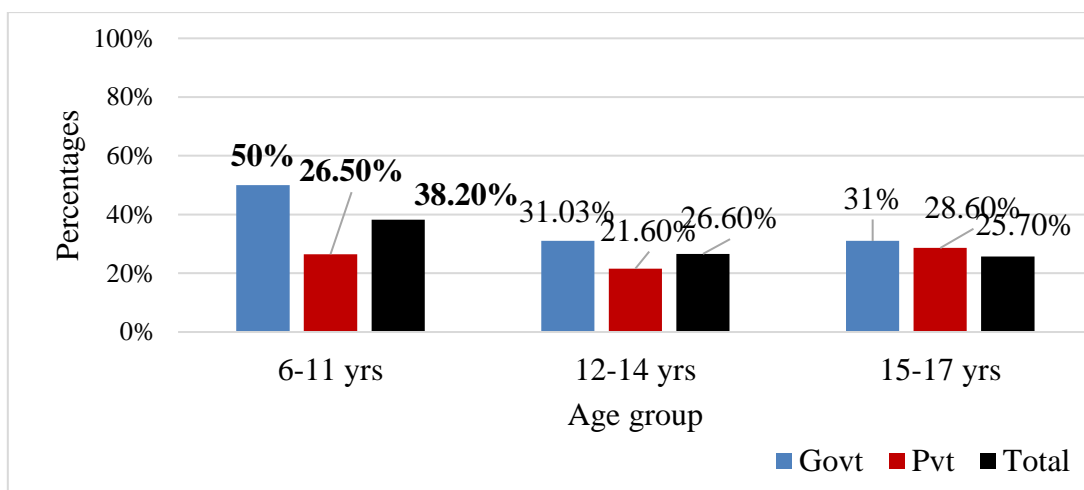


Figure 5. Age-wise distribution of prevalence of parasitic infection among children

Table 1. Socio-demographic characteristics and parasitic infection among school children

Variables	Public School			Private School			Total		
	Total (134)	Infected (48)	P-value	Total (106)	Infected (26)	P-value	Total (240)	Total (74)	P-value
Religions									
Buddhist	17.2% (23)	21.7% (5)	0.412	1.9% (2)	100% (2)	0.610	10.4% (25)	28% (7)	0.889
Christian	1.5% (2)	50% (1)		1.9% (2)	0% (0)		1.7% (4)	25% (1)	
Hindu	76.9% (103)	37.9% (39)		95.3% (101)	23.8% (24)		85% (204)	30.9% (63)	
Muslim	4.5% (6)	50% (3)		0.9% (1)	0% (0)		2.9% (7)	42.9% (3)	
Types of house									
Cemented	67.9% (91)	34.1 % (31)	0.448	86.8% (92)	22.8% (21)	0.426	75.8% (182)	28% (51)	0.209
Mud	31.3% (42)	40.4% (17)		13.2% (14)	35.7% (5)		23.7% (57)	40.3% (23)	
Both mud and cement	0.7% (1)	0%		0	0		0.4% (1)	0% (0)	
Ethnic group									
Brahmin	6.7% (9)	33.3% (3)	0.842	17.9% (19)	21.1% (4)	0.386	11.7% (28)	25% (7)	0.325
Chhetri	7.5% (10)	30% (3)		17.9% (19)	10.5% (2)		12.1% (29)	17.2% (5)	
Dalit	11.9% (16)	25% (4)		3.8% (4)	25% (1)		8.3% (20)	25% (5)	
Janajati	41% (55)	40% (22)		31.1% (33)	24.2% (8)		36.7% (88)	34.1% (30)	
Madhesi	32.8% (44)	36.4% (16)		29.2% (31)	35.5% (11)		31.3% (75)	36% (27)	
Family type									
Joint	29.9% (40)	40% (16)	0.510	48.1% (51)	19.6% (10)	0.257	37.9% (91)	28.6% (26)	0.553
Nuclear	70.1% (94)	34% (32)		51.95 (55)	29.1% (16)		62.1% (149)	32.2% (48)	
Father academic level									
Illiterate	9.7% (13)	38.5% (5)	0.285	0.9% (1)	100% (1)	5.502, 0.240	5.8% (14)	42.9% (6)	0.803
Literate	17.3% (23)	34.8% (8)		19.8% (21)	33.3% (7)		18.3% (44)	34.1% (15)	
Primary	47% (63)	28.6% (18)		15.1% (16)	31.3% (5)		34.6% (83)	28.9% (24)	
Secondary	25.4% (34)	50% (17)		60.4% (64)	18.8% (12)		39.2% (94)	29.8% (28)	
Bachelor	0.7% (1)	0% (0)		3.8% (4)	25% (1)		2.1% (5)	20% (1)	
Mother academic level									
Illiterate	31.3% (42)	38.1% (16)	0.936	7.5% (8)	25% (2)	0.400	20.8% (50)	36% (18)	0.422

Literate	20.9% (28)	35.7% (10)		17.9% (19)	31.6% (6)		19.6% (47)	34% (16)	
Primary	36.6% (49)	32.7% (16)		13.2% (14)	42.9% (6)		26.3% (63)	34.9% (22)	
Secondary	11.2% (15)	40% (6)		57.5% (61)	19.7% (12)		31.7% (76)	23.7% (18)	
Bachelors	0	0		2.8% (3)	0% (0)		1.3% (3)	0%	
Masters	0	0		0.9% (1)	0% (0)		0.4% (1)	0%	
Father's occupation									
Business	20.9% (28)	42.9% (12)	0.676	42.5% (45)	24.4% (11)	0.582	30.4% (73)	31.5% (23)	0.520
Farmers	20.9% (28)	25% (7)		12.3% (13)	23.1% (3)		17.1% (41)	24.4% (10)	
Foreign Employment	8.2% (11)	36.4% (7)		5.7% (6)	50% (3)		7.1% (17)	41.2% (7)	
Workers	26.1% (35)	40% (14)		9.4% (10)	30% (3)		18.8% (45)	37.8% (17)	
others	23.9% (32)	34.4% (11)		30.2% (32)	18.8% (6)		26.7% (64)	26.6% (17)	
Mother's occupation									
Business	14.2% (19)	42.1% (8)	0.825	9.4% (10)	30% (3)	0.814	12.1% (29)	37.9% (11)	0.801
Farmer	16.4% (22)	27.3% (6)		77.4% (82)	23.2% (19)		9.2% (22)	27.3% (6)	
Household	47% (63)	38.1% (24)		11.3% (12)	25% (3)		60.4% (145)	29.7% (43)	
Workers	11.9% (16)	37.5% (6)		1.9% (2)	50% (1)		7.5% (26)	9.5% (7)	
Others	10.4% (14)	28.6% (4)		11.3% (12)	25% (3)		10.8% (26)	26.9% (7)	

In this study, on the basis of religion, intestinal parasitic infection was high among the Muslim (42.9%, 3/7) followed by Hindu (30.9%, 63/204) and Buddhist (28%, 7/25) while the least prevalence was found in Christian (25%, 1/4). There is no association between religion and IPIs among children. In public school, IPIs was high among Muslim children (50%, 3/6) and Christian children (50%, 1/2) while in private school, IPIs was high among Buddhist children (100%, 2/2) and in private school, Christian and Muslim children (0) had no prevalence of intestinal parasites (Table 1).

The prevalence of parasitic infection was found high among children living in mud house (40.3%, 23/57) while the least prevalence was found in children living in cemented house (28%, 51/182) but there was no IPIs among children living on both mud and cemented house (0). In public and private school, the children living in mud house had high prevalence of parasites i.e. 40.4% (17/42) and 35.7% (5/14) respectively while the least prevalence was found among children living in cemented house with a prevalence of 34.1% (31/91) and 22.8% (21/92) respectively (Table 1).

Based on Ethnicity, Madhesi children (36%, 27/75) had higher prevalence of parasitic infection followed by Janajati children (34.1%, 30/88), Dalit children (25%, 5/20), Brahmin (25%, 7/28) and Chhetri had least prevalence of 17.2 % (5/29). In public school, intestinal parasitic infection was high among the Janajati children (40%, 22/55) followed by Madhesi (36.4%, 16/44), Brahmin (33.33%, 3/9) and Chhetri 30% (3/10) while the least prevalence was found in Dalit children (25%, 4/16). In private school, the high prevalence was observed in Madhesi children (35.5%, 11/31) followed by Dalit children (25%, 1/4), Janajati children (24.2%, 8/33) and Brahmin children (21.1%, 4/19). The least prevalence was found in Chhetri children (10.5%, 2/19) (Table 1).

In both school, the children whose father were illiterate had high prevalence of 42.9% (6/14) followed by children whose father were literate had prevalence of 34.1% (15/44) followed by the children whose father had passed secondary level (29.8%, 28/94) and primary level (28.9%, 24/83) whilst the least prevalence was found among children whose father had passed bachelor level had least prevalence of IPIs (20%,1/5) (Table 1). In public school, the prevalence of parasites was found more in children whose father's academic level is Secondary (50%, 17/34) followed by illiterate (38.5%, 5/13) and literate (34.8%, 8/23) while the least prevalence was found in children whose father had passed primary level (28.6%, 18/63). Similarly, there was high IPIs among children whose fathers' are illiterate (100%, 1/1) followed by literate (33.3% (7/21), primary (31.3%, 5/16), bachelor (25%, 1/4) while the least prevalence was found in children whose father had passed secondary level qualification (18.8%, 12/64) in private school (Table 1).

In both school, the prevalence of parasites was found more in children whose mother were illiterate (36%, 18/50) followed by children whose mother's academic level is primary (34.9%, 22/63) followed by literate (34%, 16/47), secondary (31.7%, 18/76) while there was no prevalence of parasites among children whose mother had a bachelor and master level qualification (0%). In public school, the children whose mother had completed secondary level education had high prevalence of 40% (6/15) followed by children whose mother were illiterate had prevalence of 38.1% (16/42) followed by the children whose father were literate (35.70%, 10/28) and primary (32.7% 16/49). Similarly, none children' mothers had passed bachelors and masters. There was high IPIs among children whose mothers' had primary level qualification (42.9% (6/14) followed by literate (31.6%, 6/19), illiterate (25%, 2/8) while the least prevalence was found in children whose mother had passed secondary level qualification (19.7%, 12/61) in private school. (Table 1).

In this study, the parasitic infection was highest among the children whose fathers were involved in foreign employment (41.2%, 7/17), followed by workers (37.8%, 17/45), business (31.5%, 23/73) and others (26.6%, 17/64) while the least prevalence was found among children whose father were farmers (24.4%, 10/41). In public school, there was high prevalence of IPIs among children whose father was involved in business (42.9%, 12/28) and workers (40%, 14/35) followed by foreign employment (36.4%, 7/11) and others (34.4%, 11/32). The least prevalence was found among children whose father were involved in foreign employment (50%, 3/6) followed by workers (30%, 3/10), business (24.4%, 11/45) and farmer (23.1%, 3/13). The least prevalence was found among children whose father was involved in others (18.8%, 6/32) (Table 1).

In this study, the parasitic infection was highest among the children whose mothers were involved in business (37.9%, 11/29) whereas the least prevalence was found among children whose mothers were workers (9.5%, 7/26). In public school, there was high prevalence of IPIs among children whose mothers were involved in business (42.1%, 8/) and household (38.1%, 24/63) followed by workers (37.5%, 6/16) and others (34.4%, 11/32). The least prevalence was found among children whose mothers were involved in others (28.6%, 4/14) followed by farmers (27.36%, 6/22) (Table 1). There were no significant associations between socio-demographic factors and parasitic infections among school children.

In both school, *Ascaris lumbricoides* was the most prevalent with a prevalence of 78.95% while the least prevalent parasites were *G. lamblia* (11.83%), *E. coli* (3.95%), *E. histolytica* (3.95%) and *H. nana* (1.32%). In public school too, *A. lumbricoides* was the most prevalent while *G. lamblia* (15.68%), *E. coli* (1.95%), *E. histolytica* (3.93%) and *H. nana* (1.95%) were the least prevalent. Furthermore, in private school, *Ascaris lumbricoides* was the highly prevalent parasites while the least prevalent parasites were *G. lamblia* (4%), *E. coli* (8%) and *E. histolytica* (4%) in private school (Fig 6).

Regarding the intensity of obtained parasites, among 134 positive samples, 59 samples were selected for detection of intensity of *A. lumbricoides* which had high numbers (more than three) during microscopic examination, according to WHO Criteria for infection intensity for *Ascaris* it is found that 24.2% (58) of the respondents have light infection (1-99 Epg) while 0.4% (1) had heavy infection (>400 Epg).

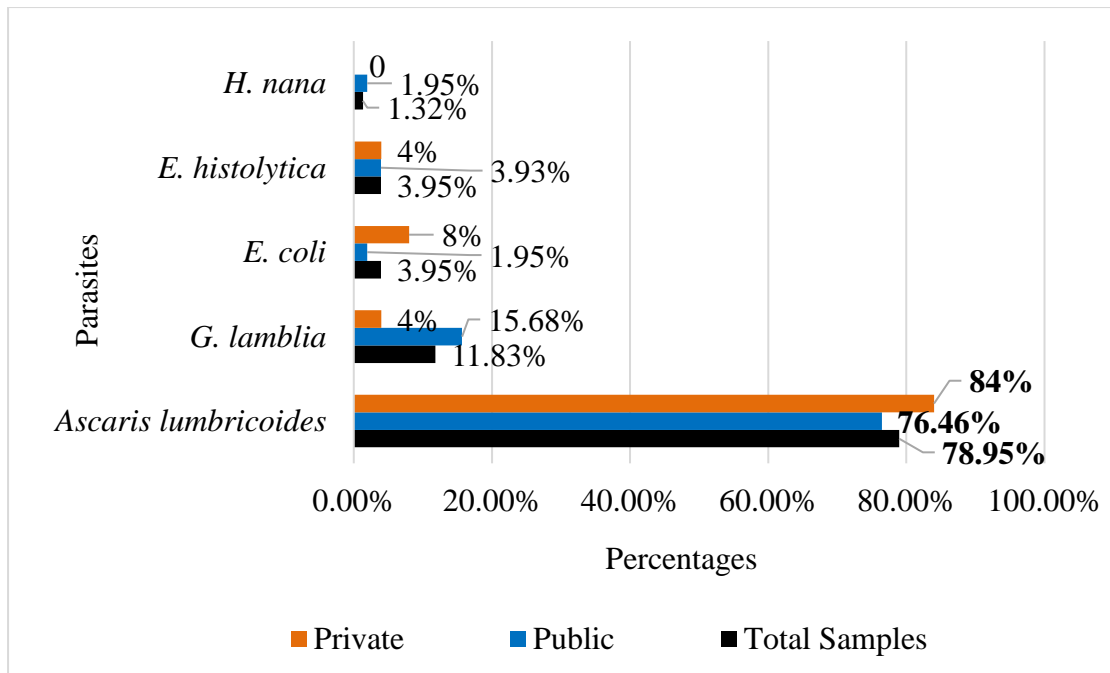


Figure 6. Prevalence of mono-parasitism among school children

Table 2. Prevalence of double parasitism among school children

Parasites	Public School	Private School	Total
	Percentages (n = 134)	Percentages (n = 106)	Percentage (n = 240)
<i>Ascaris lumbricoides</i>	26.8% (36)	20.75% (22)	24.17% (58)
<i>G. lamblia</i>	4.5% (6)	0.9 % (1)	2.9% (7)
<i>E. coli</i>	-	1.9% (2)	0.8% (2)
<i>E. histolytica</i>	0.7% (1)	0.9% (1)	0.8% (2)
<i>H. nana</i>	0.7% (1)	-	0.4% (1)
<i>Ascaris + G. lamblia</i>	1.5% (2)	-	0.8% (2)
<i>Ascaris + E. coli</i>	0.7% (1)	-	0.4% (1)
<i>Ascaris + E. histolytica</i>	0.7% (1)	-	0.4% (1)

It is observed from the table 2, public school had reported double parasitism while private school had not reported double parasitism.

4.2 Association of nutritional status and intestinal parasites among school children

Table 3. Prevalence of malnutrition among school children

Variables	Public school	Private school	Total	P value
Stunting (HAZ)	(n =134)	(n = 106)	(n = 240)	0.554
Normal	74.6% (100)	69.8% (74)	72.2% (174)	
Moderate stunting	17.9% (24)	18.8% (20)	18.35% (44)	
Severe stunting	7.4% (10)	11.3% (12)	9.2% (22)	
Underweight (WAZ)	(n = 35)	(n = 30)	(n = 65)	0.205
6-10 years				
Overweight	2.8% (1)	0% (0)	1.5% (1)	
Normal	37.1% (13)	23.3% (7)	30.7% (20)	
Moderate underweight	28.5% (10)	56.6% (17)	41.5% (27)	
Underweight	31.4% (11)	20% (6)	26.1% (17)	
Thinness (BMIZ)	(n = 99)	(n = 76)	(n = 175)	
11 to 17 years				
Obesity	1.0% (1)	5.2% (4)	2.1% (5)	
Overweight	5.1% (5)	6.5% (5)	4.2% (10)	
Normal	79.7% (79)	69.7% (53)	55% (132)	
Thinness	10.1% (10)	14.4% (11)	8.8% (21)	
Severe thinness	4.0% (4)	3.9% (3)	2.9% (7)	

The prevalence of stunting is found more in private school (11.3%) than in public school (7.4%) for HAZ. Similarly, the prevalence of underweight and severe thinness for BMIZ for private school are 20% and 3.9% respectively while in public school they are 31.4% and 4.0% respectively. There is no significant difference in the nutritional status among public and private schools (Table 3).

Table 4. Distribution of nutritional status and prevalence of parasites among children

Nutritional status	Public school (Infected)	Private school (Infected)	Total	P-value
Stunting (HAZ)				
Normal	39% (39/100)	20.3% (15/74)	31% (54/174)	0.319
Moderate stunting	33.3% (8/24)	40% (8/20)	16% (16/44)	
Severe stunting	10% (1/10)	25% (3/12)	18.2% (4/22)	
Underweight (WAZ)				
6-10 years				
Overweight	0% (0/1)	0% (0/0)	0% (0/1)	0.244
Normal	53.8% (7/13)	28.5% (2/7)	45% (9/20)	
Moderate underweight	50% (5/10)	23.5% (4/17)	33.3% (9/27)	
Underweight	54.5% (6/11)	33.3% (2/6)	47% (8/17)	
Thinness (BMIZ)				
11 to 17 years				
Obesity	0% (0/1)	0% (0/4)	0% (0/5)	0.153
Overweight	20% (1/5)	20% (1/5)	20% (2/10)	
Normal	32.9% (26/79)	28.3% (15/53)	31.1% (41/132)	
Thinness	20% (2/10)	9% (1/11)	14.2% (3/21)	
Severe thinness	25% (1/4)	33.3% (1/3)	28.5% (2/7)	

Table 4 shows that in terms of HAZ, normal children (31%) are highly infected with intestinal parasite while for WAZ the underweight children had high prevalence (47%) followed by normal children (45%). In public school for HAZ, the normal children had high prevalence of 39% followed by the moderate stunting children (33.3%) while severe stunting children had low prevalence of 10%. Moderate stunting children (40%) and severe stunting (25%) children had high infection rate in private school than in public school. While children from public school with moderate underweight (50%) and underweight (54.5%) for WAZ, and thinness (20%) and severe thinness (25%) for BMIZ had high prevalence of parasitic infection rate than that of private school. There was no significant association between nutritional status and parasitic prevalence among school children ($p > 0.05$) (Table 4).

4.3 Association of risk factors and intestinal parasites among school children

Table 5. Risk factors associated with intestinal parasites among school children

Variables	Public school			Private school			Total		
	Total samples (134)	Infected (48)	P-value	Total samples (106)	Infected (26)	P-value	All samples (240)	All (infected) (74)	P-value
Nail trimming									
No	33.6% (45)	33.33% (15)	0.554	13.2% (14)	-	0.296	24.6% (59)	33.9% (20)	0.381
Weekly	0.7% (1)	100% (1)		-	-		0.4% (1)	100% (1)	
Yes	64.2% (86)	36.0% (31)		86.8% (92)	22.8% (21)		74.2% (178)	29.2% (52)	
Yes but dirty	1.5% (2)	50% (1)					0.8% (2)	50% (1)	
Nail biting									
No	79.1% (106)	35.8% (38)	0.897	62.3% (66)	9.1% (6)	0.001	74.6% (179)	28.5% (51)	0.229
Sometimes	14.9% (20)	40.0% (8)		18.9% (20)	25% (5)		19.2% (46)	41.3% (19)	
Yes	6.0% (8)	25.0% (2)		18.9% (20)	75% (15)		6.3% (15)	26.7% (4)	
Play with soil									
No	83.6% (112)	35.7% (40)	0.998	64.2% (68)	19.1% (13)	0.088	74.6% (179)	29.1% (52)	0.554
Sometimes	8.2% (11)	36.4% (4)		33.0% (35)	31.4% (11)		19.2% (46)	32.6% (15)	
Yes	8.2% (11)	36.4% (4)		2.8% (3)	66.7% (2)		6.3% (15)	46.7% (7)	
Sources of water									
Pump	17.2% (23)	47.8% (11)	0.274	1.9% (2)	50% (1)	0.308	10.4% (25)	48% (12)	0.59
Tap	75.4% (101)	34.7% (35)		93.4% (99)	25.3% (25)		83.3% (200)	30% (60)	
Well	7.5% (10)	20% (2)		4.7% (5)	0% (0)		6.3% (15)	13.3% (2)	
Drinking water									
Boiled	0.7% (1)	0% (1)	0.298	4.7% (5)	0%	0.386	2.5% (6)	16.7% (1)	0.666
Direct	90.3% (121)	36.4% (44)		72.6% (77)	24.7% (19)		82.5% (198)	31.8% (63)	
Filtered	9% (12)	33.33% (4)		22.6% (24)	29.2% (7)		15% (36)	27.5% (10)	
Always use soap									
No	0.7% (1)	0%	0.453	0.9% (1)	0%	0.606	0.8% (2)	0%	0
Yes	99.3% (133)	36.1% (48)		97.2% (103)	25.2% (26)		98.3% (236)	31.4% (74)	
Water only	-	-		1.9% (2)	0%		0.8% (2)	0%	

Anti-helminths taken									
Yes	82.8%	35.1%	0.716	74.5%	24.1%	0.845	79.2%	30.5%	0.841
	(111)	(39)		(79)	(19)		(190)	(58)	
No	17.2%	39.1%		25.5%	25.9%		20.8%	32% (16)	
	(23)	(9)		(27)	(7)		(50)		
Livestock									
No	49.3%	36.4%	0.897	62.3%	24.2%	0.930	55%	30.3%	0.844
	(66)	(24)		(66)	(16)		(132)	(40)	
Yes	50.7%	35.3%		37.7%	25%		45%	31.5%	
	(68)	(24)		(40)	(10)		(108)	(34)	
Diarrhoea or abdominal discomfort									
no	49.3%	30.3%	0.041	35.8%	26.3%	0.820	43.3%	28.8%	0.232
	(66)	(20)		(38)	(10)		(104)	(30)	
Once a month	20.1%	40.7%		30.2%	18.8%		24.6%	28.8%	
	(27)	(11)		(32)	(6)		(59)	(17)	
Twice a month	191.4%	26.9%		22.6%	29.2%		20.8%	28%	
	(26)	(7)		(24)	(7)		(50)	(14)	
Thrice a month	11.2%	66.7%		11.3%	25%		11.3%	48.1%	
	(15)	(10)		(12)	(3)		(270)	(13)	

From the table 5 it is observed that the prevalence of parasites was found more in children who bite nail sometimes (41.3%) followed by who do not bite nails (28.5%) than the children who bite nails regularly (26.7%) in both school. In public school, the prevalence of parasites was found more in children who bites nail sometimes (40%) followed by who do not bite nail (35.8%) than the children who bites regularly. the prevalence of parasites was found more in children who bite nail sometimes (42.3%) followed by who bites regularly (28.6%) than the children who do not bite nail (17.8%) in both school.

There is high prevalence of parasites among children who play with soils (46.7%) followed by who play sometimes than the children who do not play with soils (29.1%). In public school, there is high prevalence of parasites among children who play with soil (66.7%) followed by who play soils sometimes (31.4%) than the children who do not play with soils (19.1%). In private school, the children who play with soils and play soils sometimes had high prevalence of 36.4% than the children who do not play with soils (35.7%) (Table 5).

The prevalence of intestinal parasites was high among children who drink pump water (48%) followed by the children who tap water (30%) while the least prevalence was observe among children who drink well water (13.3%). In public school, the prevalence of parasites was high among children who drink pump water (47.8%) followed by who drink tap water (34.7%) than the children who drink well water (20%). In private school, the prevalence of parasites was high among children who drink pump water (50%) than the children who drink tap water (25.3%) while the children who drink well water had no prevalence of intestinal parasites (Table 5).

The prevalence of parasites was found more among the children who drink direct water (31.7%) followed by who drink filtered water (27.5%) than the children who drink boiled water (2.5%). In public school, the prevalence of parasites was high among children who drink boiled water (100%) followed by who drink direct water (36.44%) than the children who drink filtered water (25%). In private school, the prevalence of parasites was high among the children who drink filtered water (29.2%) than the children who drink direct water (24.7%) (Table 5).

All the respondents reported of washing hands with soap and water but also overall the prevalence of IPIs was found 30.8%. In public school, IPIs is 35.8% while in private school, IPIs rate is 24.5%.

The prevalence of parasitic infection was found high among the children who have taken anthelmintic drugs (32%) than who have not taken anthelmintic drugs (30.5%). Similarly, in public school, the prevalence of parasitic infections was found high among children who have taken anthelmintic drugs (39.1%) than who have not taken anthelmintic drugs (35.1%). In private school, the prevalence of parasitic infection was found high among the children who have taken anthelmintic drugs (25.9%) than who have not taken anthelmintic drugs (24.1%) (Table 5).

The IPIs rate was high among the children having livestock in their home (31.5%) than who don't have livestock (30.3%). Similarly, in public school, the IPIs rate was high among children who don't have livestock (36.4%) than the children who have livestock (35.3%). In private school, the prevalence of parasitic infection rate was high among children who have livestock (25%) than the children who don't have livestock (24.2%) (Table 5).

The parasitic infection rate was high among the children who had abdominal discomfort or diarrhoea thrice a month (48.1%) than who had abdominal discomfort once a month or not at all (28.8%) followed by who had abdominal discomfort twice a month with a prevalence of 28%.

The prevalence of parasitic infection was more among children who had past history of infection (67.6%) than the children with no past infection (32.4%). In public school, children with past infection had more parasitic prevalence (45.3%) than the children with no infection in the past (23.7%). In contrast, in private school, children with no past infection had more prevalence of parasitic infection (27%) than the children with past infection (23.2%) (Table 5). There were no statistical associations between presence of intestinal parasites and other risk factors such as nail trimming, nail biting, sources of drinking water and its purification methods.

5. Discussion

5.1 Prevalence of intestinal parasites among school children

The overall prevalence of parasitic infection is 30.8% (Fig 2) which is less than the study by Feleke, 2016 i.e. 61.7% while this is greater than the study done in Pakistan by Khan et al., 2020 with a prevalence rate of 23.63%. The study done in different districts like Surkhet, Achham and Dailekh in Nepal by Shrestha et al., 2020 reported 51.1% which is not in conformity with the present study. The present study is in compliance with the study done by Shrestha & Maharjan, 2013 in Bhaktapur district of Nepal (27.67%) and similar to study by Regmi et al., 2014 with prevalence rate 31.7% observed in Kalaiya, Bara district, Nepal and Gupta et al., 2018 in Saptari district with prevalence rate 33%. The prevalence rate obtained in this study is greater and also not similar to the studies done by Shrestha et al., 2019 in Kathmandu's public and private schools whose prevalence rate was 19.9% and Subedi et al., 2020 in public and private schools whose prevalence rate was 18.66%. However the prevalence rate in the present study is lesser in comparison to the prevalence rate of 61.8% study done in hilly regions of Nepal by Rai et al., 2004. This variation in the prevalence rate might be attributed to the various study settings with different study location and other various study settings.

The present study reported that the children of government school (55.80%) were more infected than the children in private school (24.55%) (Fig 3) which is similar to the study done at the DAV College Microbiology Laboratory in Dhobighat, Lalitpur which also reported kids from government school (71%) were infected more than the kids in private school 29% conducted by Mishra et al., 2020. The present study is also similar to the study conducted by Shrestha et al., 2019 in Kathmandu's public and private school which reported that children attending public schools had a greater rate of IPIs (26.1%) than those attending private school (12.1%) but is lower than the present study. This study is also in agreement with the study done by Subedi et al., 2020 which reported that children of public school (22.66%) were highly infected than the children of private school (14.66%) however the prevalence rate is lesser than the present study. This might be due to the enrolment of students with low socio-economic strata, poor hygiene and lack of awareness among children in public school than in private school.

The present study reported that the female school children (35.30%) were more infected than the male children (25.20%) (Fig 4). This findings is in contrast to the study conducted at Ota, Ogun State in Nigeria by Armstrong et al., 2013 in which 41.2% male and 41.9%

female were infected. However this study is in agreement with a study conducted by Rijal, 2013 in Dadeldhura district, Nepal where 32.20% female were infected with IPIs more than male 30.40%. On the other hand, this study is also not in agreement with the study conducted by Tandukar et al., 2013 in Lalitpur, Nepal where more males (17.8%) were infected than males (15.5%). This study is in contrast with the study conducted by Bakarman et al., 2019 in Jeddah Western Saudi Arabia where more males (87.10%) were infected than females (12.90%). This study also does not resemble with the study by Mishra et al., 2020 in which more boys (57%) were infected than girls (43%) and the study done by Khan et al., 2022 in Pakistan in which more males (54.5%) were infected than females (45.5%). However this study is in agreement with the study done by Chukwu et al., 2023 in Nigeria in which more males (60%) were infected than males (43.2%). However, this study is not in compliance with the study done by Subedi et al., 2021 conducted in public and private school in Rupandehi district, Nepal where more boys (45.72%) were infected than girls (29.43%). The prevalence of high IPIs among female might be due to helping of female in household works and fields which makes them close with contaminated soil and food.

In case of age group wise prevalence, age group 6 to 11 years had high prevalence of 38.20% followed by 26.60% in 12 to 14 years while the least prevalence was found in 25.70% in 15 to 17 years (Fig 5). This study is in agreement with the study done by Muharram, 2023 in Sana'a Yemen which also reported high prevalence of parasites in 6 to 9 years old (33.1%) followed by 10 to 13 years (31.5%) while the least prevalence of parasites was found in 14 to 16 years (26.1%). The present study is also in agreement with the study by Chukwu et al., 2023 in Nigeria which reported high prevalence (55.5%) in 7 to 10 years while least prevalence was found among 15 to 18 years (24.1%) and the study done by Alemu et al., 2019 which reported high IPIs among 6 to 10 years (38.9%) whereas low IPIs among above 15 years (24.5%) but not in compliance with the study done by Ulhaq et al., 2022 in Lower Dir, Pakistan reported high IPIs among 10 to 12 years (94.2%) while least prevalence is found among 4 to 6 years (72%), the study by Ahmed & Abu-Sheishaa, 2022 in Egypt also reported high IPIs among 11 to 14 years (37.3%) while least prevalence was reported among 15 to 18 years (27.4%), the study conducted by Shiferaw et al., 2021 in Northwest Ethiopia also reported high IPIs among 11 to 14 years (51%) while the least prevalence was found among 15 to 18 years (16.8%) and the study reported by Kumar Sah et al., 2021 in Janakpurdham reported high IPIs among 9 to 11 years (12.7%) while low prevalence among below 8 years (9.09%). However, the present study is not in

agreement with the study by Gupta et al., 2020 which reported the high IPIs among 11 to 15 years (44.2%) while the least prevalence was found among less than 5 years (23.2%) Such high prevalence in young kids (6 to 11 years) might be due to the negligence of these children in their personal hygiene while the older kids are aware about their hygiene and sanitation and might have received health education in their school curriculum.

The present study high prevalence of *A. lumbricoides* (78.95%) followed by *G. lamblia* (11.8%) and *E. histolytica* (3.93%) while the least prevalence is *H. nana* (1.32%). *A. lumbricoides* was found to be highly prevalent in many studies like Shrestha & Maharjan 2013, with 22.63%, Dib et al., 2015 with 38.9%, Jaiswal et al., 2017 with 50%, Alemu et al., 2019 with 33%, Subedi et al., 2020 with 46.42%, Shiferaw et al., 2021 with 31.8%, Dahal et al., 2022 with 34.2%, Ulhaq et al., 2022 with 57.7% and Chukwu et al., 2023 with 19.5% while other studies reported Panti-May et al., 2019 with *Blastocystis* sp. with 44.6%, Mishra et al., 2020 with *Ancylostoma duodenale* (57%), Gupta et al., 2020 with *G. lamblia* 15.4%, Ahmed & Abu-Sheishaa, 2022 with *E. histolytica* 12.3%, Khan et al., 2022 *T. saginata* with 8.4%, Muharram, 2023 with *E. histolytica* (46.2%). The high prevalence of *A. lumbricoides* might be due to the fact that its eggs can survive on land for more than 10 years and single worm can lay 200000-250000 eggs at a time and also the poor hygiene and sanitary conditions (Subedi et al., 2020). The prevalence of *Giardia lamblia* may be due to contamination of drinking water by the cysts (Sharma et al., 2020).

5.2 Association of nutritional status and intestinal parasites among school children

In this study, the prevalence of stunting, underweight and thinness were 27.5%, 67.6% and 11.7% respectively in both schools (Table 3) while the study by Umeokonkwo et al., 2020 reported 9.9% stunted, 8% underweight and 7.2% thinness in children respectively in Nigeria. The prevalence of undernutrition in this study is more than the prevalence of underweight 28.3% in the study done by Sari et al, 2021 and the study done by Feleke, 2016 in Ethiopia and Umeokonkwo et al., 2020 in Nigeria with prevalence of undernutrition 15.7% and it is also way higher than the study done by Olopade, 2018 which recorded only 3.7% of underweight children while it is in closer to the study done by Shrestha, 2020 which had overall prevalence of undernutrition 55.5% and less than the study by Dhobi & Giri, 2021 done in Malangwa district, Sarlahi, Nepal which reported 37.6% underweight children.

Underweight children had a prevalence of 25.7% which is less in comparison to the study done by Sari et al., 2021 in Indonesia which reported 28.3% infection rate among

underweight children. In a study by Maskey et al., 2020 in Pokhara Nepal observed 26.29% stunting among children which is in accordance with the present study while it reported 24.65% underweight children which is not in compliance and lower than the present study. Similarly, there is no association between nutritional status and parasitic prevalence among school children (Table 4) which is in agreement with the study by Olopade et al., 2018 in Osun State, Nigeria and Bakarman et al., 2019 and Shrestha et al., 2020 conducted in Surkhet, Achham and Dailekh district in Nepal but not in accordance with Feleke, 2016 and Sari et al., 2021 in Indonesia in which intestinal parasite illness was linked with being underweight. This might be due to the interaction of nutritional factors as well as other socioeconomic factors (Bemnet et al., 2013) but repeated intestinal infections can lead to undernutrition by preventing the body from properly absorbing calories and nutrients (Shrestha et al., 2020).

5.3 Association of intestinal parasites and risk factors

In the present study, the risk factors like nail biting, nail trimming, hand washing habits, drinking water and livestock rearing is not found to be statistically associated with the parasitic prevalence (Table 5). While the past history of abdominal discomfort in public school children is strongly associated with intestinal parasites ($P < 0.05$) (Table 5) which is also in agreement with the study by Khan et al., 2022 done in Pakistan.

This study is not in accordance with the study done by Bakarman, 2019 in Saudi Arabia which reported drinking water from tanks and washing hands with water only as significant factors associated with IPIs, Tandukar et al., 2013 in Nepal which also stated drinking water and handwashing habit as significant factors. Similarly, the study conducted by Hailegebriel, 2018 in Ethiopia also claimed that students' unclean fingernails and handwashing behavior is significantly associated with parasitic infection which is also not in conformity with the present study. The study also is not in compliance with the study by Babakhani et al., 2017 in Iran which reported male gender as significant risk factor, Gupta et al., 2020 in Saptari district (handwashing habit and gastrointestinal symptoms as significant risk factors) and Khan et al., 2022 which reported nail biting and finger sucking behavior as statistically significant factors associated with intestinal parasites. The study by Raut et al., 2021 also reported significant association of different variables like children's year, age, religion, current illness, sources of water and presence of domestic animals were significantly associated with IPIs which is also not in agreement with the this study.

6. Conclusions and recommendations

6.1 Conclusions

The present study reported high prevalence of intestinal parasites among children of public school than in private school. Female children were infected more than the male children. Also the study reported high prevalence of undernourished children (stunted, underweight and thin) but intestinal parasitic infection had no significant with the prevalence of undernutrition. Lack of education among parents, occupational status, poor sanitation and drinking water facility are the contributing factors for the prevalence of parasitic infections.

6.2 Recommendations

A good nutrition and strong regular health intervention should be conducted in school which may include widespread deworming and treatment to break the transmission chain of illnesses, health education to promote personal hygiene, environmental sanitation and improved water supply system are required in the community.

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Appendix 2. Consent form

मन्जुरिनामा फारम (सहमति पत्र)

यो फारम, (पार्टिसिपेन्ट)को उमेर समूह (ट तय जठ) वर्षको, आधारमा तयार गरिएको छ।

मिति: दिन: महिना:
समुदाय: सहभागी कोड:
वर्ष: लिङ्ग:

म यस “ INTESTINAL PARASITES AND NUTRITIONAL STATUS OF CHILDREN IN PUBLIC AND PRIVATE SCHOOL IN SARLAHI DISTRICT, NEPAL, अनुसन्धान कार्यक्रममा कुनै खर्च नगरी, निःशुल्क रूपमा सहभागि भएको छु। मैले यो अनुसन्धान फारमको सबै कुरा पढे सुने र बुझे। मैले यसको लक्ष्य, अनुसन्धानको समय, तरिकाहरु, विवरण तथा जाँचका तरिकाहरु जुन मैले अबलम्बन गर्नु पर्छ राम्रोसँग बुझेको छु। मैले दस ग्राम (5 gm) कतयर्था ककउभि भहकप्लवतप्यल को लागि, त्यसमा सहयोग गरेको छु।


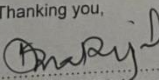
यस अनुसन्धानको लागि दिसा लिदा हुने फाइदा जोखिम मैले राम्रोसँग बुझेको छु। मलाई यो पनि थाहा छ कि, मेरो दिसा (Stool sample examination analysis for Gastro-intestinal Parasites) को लागि प्रयोग गरिनेछ।

तथा, यदि मेरो दिसा नमुनालाई अनुसन्धानमा बाहेक अन्य रूपमा प्रयोग भएमा म यस अनुसन्धानमा जुनसुकै बेला सहभागि नहुने निर्णय गर्न सक्नेछु। मैले मेरो व्यक्तिगत सुचना यो अनुसन्धानको लागि उपलब्ध गराएको छु। मेरो व्यक्तिगत सुचना गोप्य रहने छ भनि म विश्वस्त छु।

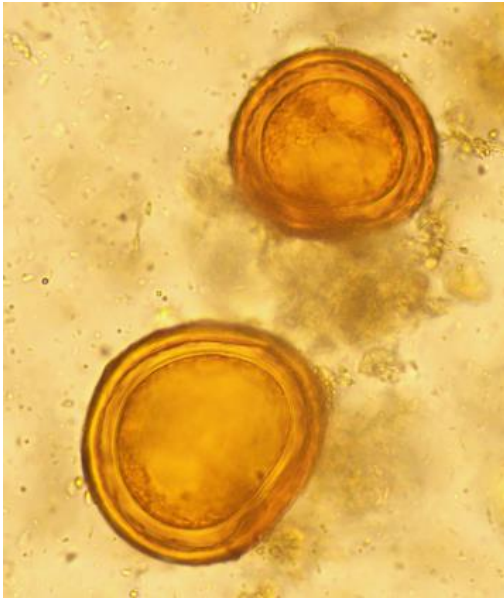
तर, म सम्बन्धित अनुसन्धान र क्लिनिकल सुचनाहरु अनुसन्धानत्मक पत्रिका, प्रबचनमा प्रयोग गर्न मेरो मन्जुरी छ तर, त्यसमा मेरो नाम उल्लेख गरिने छैन। मैले यो अनुसन्धानको लागि स्वयम्सेवीको रूपमा काम गर्नेछु। माथि उल्लेखित कुराहरु राम्रोसँग पढे र बुझे भन्दै सहमतिका साथ मेरो हस्ताक्षर गरेको छु।

नाम अभिभावकको नाम:
हस्ताक्षर हस्ताक्षर
मिति

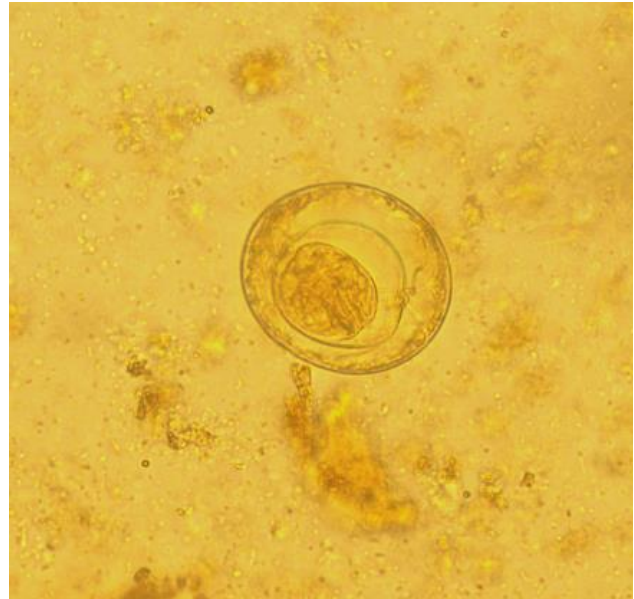
Appendix 3. Ethical permissions letter

 <p style="text-align: center;">Tribhuvan University Institute of Science and Technology Kirtipur, Kathmandu, Nepal</p> <p style="text-align: center;">Institutional Review Committee</p>	
<p>IRC/IoST Chairperson Assoc. Prof. Dr. Surendra Gautam Asst. Dean-Academics, IoST</p> <p>IRC/IoST Members Prof. Dr. Rajani Malla Prof. Dr. Sangeeta Rajbhandary Prof. Dr. Shankar P Khanal Prof. Dr. Kumar Sapkota Prof. Dr. Amar Prasad Yadav Prof. Dr. Prakash Ghimire Assoc. Prof. Dr. Megha R Banjara Assoc. Prof. Dr. Nirmal Kumar Raut Dr. Supriya Sharma</p> <p>Member Secretary Assoc. Prof. Dr. Komal Raj Rijal</p> <p>Head, Central Department of Microbiology</p> <p>IRC/IoST Secretariat Central Department of Microbiology Phone: 4331869</p>	<p>Ref. No.: <u>143/082/1081</u> Date: 09 October, 2023</p> <p>PI: Dr. Rajendra Parajuli M.Sc student: Merina Lama Central Department of Zoology Tribhuvan University Kirtipur, Kathmandu</p> <p>Ref.: IRC Ethical Approval of research proposal entitled "Intestinal parasites and nutritional status of children in public and private school in Sarlahi district, Nepal"</p> <p>Dear Dr. Parajuli,</p> <p>It is our pleasure to inform you that the above mentioned proposal submitted on 20 September, 2023 (Regd. No IRCIOST-23-0087), following independent expert review and discussion in the IRC/IoST meeting held on 08 October, 2023 has been approved for implementation [start date 09 October, 2023 and end date 08 March, 2024], maintaining ethical principles, set by the Nepal Health Research Council.</p> <p>The investigators have to strictly follow the protocol stipulated in the proposal. Any change in objective(s), problem statement, research question or hypothesis, methodology, implementation procedure including deviation of the protocol, data management and budget need to be submitted in detail with justification for seeking prior approval to implement the proposed change including extension of the date, in the protocol.</p> <p>Further, the researchers are also directed to follow the national ethical guidelines published by Nepal Health Research Council during the implementation of research. You are required to submit the final report to the IRC within a month of completion of the research, as planned in the approved proposal.</p> <p>If you have any questions, please contact the Institutional Review Committee of Institute of Science and Technology, Tribhuvan University.</p> <p>Thanking you,</p> <p style="text-align: center;"> Assoc. Prof. Dr. Komal Raj Rijal Member Secretary Institutional Review Committee Institute of Science and Technology Tribhuvan University</p>

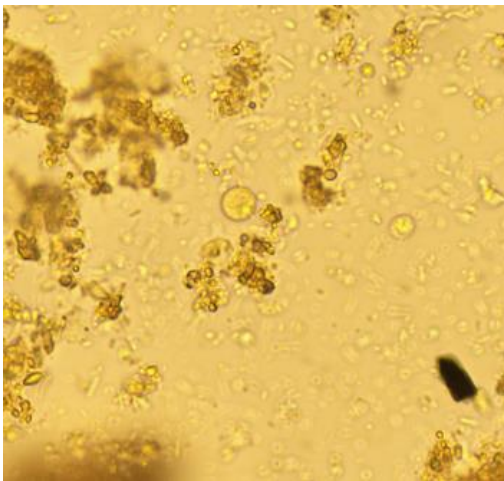
Appendix 4. List of photographs of parasites



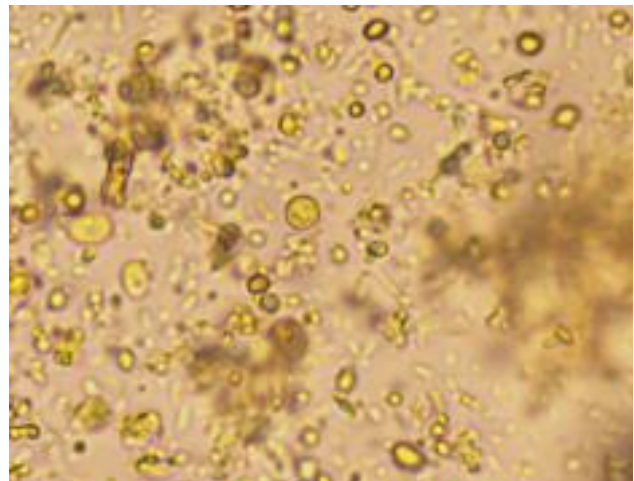
Ascaris lumbricoides (50X51 μm)



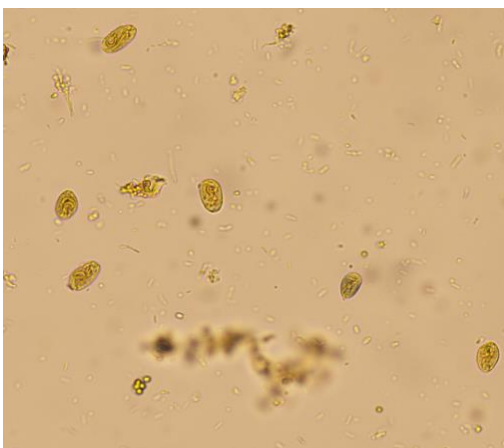
Hymenolepis nana (43X48 μm)



Entamoeba coli (15X20 μm)



Entamoeba histolytica (6X10 μm)



Giardia lamblia (12 X 7 μm)

Appendix 5. List of photographs at field

