



## PREVALENCE OF GASTROINTESTINAL PARASITES FOLLOWING THE 2015 EARTHQUAKE IN NEPAL: THE ROLE OF WASH FAILURES AND GENDER

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### ABSTRACT

The 2015 Gorkha earthquakes severely disrupted water, sanitation and hygiene (WASH) infrastructure in Nepal, placing displaced populations at elevated risk of gastrointestinal (GI) parasitic infections. This study aimed to determine the prevalence of GI parasitic infections and assess associated risk factors among earthquake survivors residing in temporary shelters in Byasi Tole, Bhaktapur. A cross-sectional study was conducted from January to June 2016 among 82 individuals randomly selected from 224 earthquake survivors. Stool specimens were collected in sterile, labelled 25 ml leak proof vials containing 2.5% potassium dichromate preservative and transported to the Central Department of Zoology, Tribhuvan University, for laboratory analysis. Each sample underwent macroscopic examination for consistency, color and presence of visible parasites, followed by microscopic examination using saline wet mounts and Lugol's iodine-stained smears to identify parasitic ova, cysts and trophozoites. Parasites were identified based on standard morphological criteria. WASH practices and knowledge of parasitic infections were assessed through structured questionnaires. GI parasites were detected in 51 of 82 participants (62.2%). Soil-transmitted helminths predominated; *Ascaris lumbricoides* was the most prevalent species (60.8%), followed by *Trichuris trichiura* (19.6%) and *Entamoeba histolytica* (15.7%). Female infection prevalence (77.1%) was significantly higher than in males (51.1%) ( $\chi^2 = 4.90$ ,  $p = 0.027$ ). Statistically significant differences in infection prevalence were also observed across age groups ( $\chi^2 = 51.3$ ,  $p < 0.001$ ); infection rates reached 100% in children (0–10 years), adolescents (11–20 years) and middle-aged adults (41–50 years). While most respondents demonstrated adequate knowledge of disease causes (79.3%), symptoms (84.1%) and prevention (73.2%), major WASH deficiencies were recorded: 63.4% consumed untreated water, 11% practiced open defecation and deworming prophylaxis coverage was only 15.9%. The high prevalence of GI parasitic infections in this post-earthquake setting is attributable to disrupted WASH infrastructure and low prophylaxis coverage. As Nepal remains highly earthquake-prone, these findings provide a baseline for disaster preparedness planning and future epidemiological studies.

**Keywords:** Earthquake, Gastrointestinal parasite, Prevalence, Soil helminth

### INTRODUCTION

Intestinal parasitic infections, which primarily affect people in low and middle-income countries, are one of the most important diseases among other neglected tropical diseases (Hotez et al., 2007; Strunz et al., 2014). The infections usually flourish in areas with poor sanitation, contaminated water and where the population lacks access to healthcare, common among developing areas (Haque, 2007; Hakizimana et al., 2023).

Soil transmitted helminths including *Ascaris lumbricoides* along with *Ancylostoma duodenale* appear frequently as triggers. Infection often moves through fecal-oral route by eating or drinking

contaminated food and water such as *Giardia intestinalis*, *Cryptosporidium parvum*, or *Entamoeba histolytica* (Slifko et al., 2000; Pozio, 2003).

During events like earthquakes, chances of getting parasitic infection are high. Earthquake not only affect water and sanitation facilities but also force people to crowded shelters demand destroy health care service that produce perfect condition for distribution of diseases (Ivers & Ryan, 2006; Watson et al., 2007; Besli & Sancak, 2023). Post-earthquake diarrhea and parasitic outbreak was experienced by Iran (2003), Pakistan (2005) as well as Haiti (2010) and Turkey (2023), highlighting the endemic status of this global health threat (Bai & Liu, 2009; Piarroux et al., 2011; Avcu, 2023; Mavrouli et al., 2023a).

Nepal is one of the most seismically active countries in terms of fatalities, as it lies between two massive tectonic plates, the Indian plate and the Eurasian plate. The Gorkha Earthquakes of April 25 and May 12, 2015, stand among the deadliest and most destructive in the country's history killing over 8,800 people and leaving half a million homeless (Adhikari et al., 2015; Okamura et al., 2015; Liang and Zhou, 2016).

As a result of the disaster 446 public health facilities and 220,000 toilets were destroyed having major consequences for the sanitation and health delivery (Shah et al., 2024). Such settings would have had a greater burdens of gastrointestinal infection in their displaced population.

Following the earthquake, various types of pathogens have been detected in stool samples from affected districts by National Public Health Laboratory and Epidemiology and Disease Control Division Nepal including *Salmonella* spp., *Shigella dysenteriae*, and Rotavirus (Shakya et al., 2018). Environmental studies showed waterborne parasitic transmission risk associated with microbial contamination of drinking water sources, including that by *Acinetobacter* and *Aeromonas* as well as by opportunistic pathogen groups (Uprety et al., 2017). Indeed, the early post-traumatic period after an earthquake provides fertile ground for rapid dissemination of infectious diseases (mainly those transmitted through fecal-oral pathway) (Besli & Sancak, 2023; Mavrouli et al., 2023b).

Disease surveillance and emergency health response had continued to be implemented however controlling the outbreak was difficult because of disrupted vaccination, restricted access to healthcare and social inequalities (Asokan & Vanitha, 2016; Renson et al., 2022; Shah et al., 2024). It has been reported that incidents of GI system infections were substantially increased worldwide after earthquakes, based on findings from several studies (Kouadio et al., 2012; Najafi et al., 2022).

The study was conducted during January to June, 2016 which is less than a year since the occurrence of the 2015 Gorkha earthquake among people inhabiting temporary shelters on Byasi Tole, Bhaktapur due to lack of any previous similar WASH integrated parasitology study from this setting and hence acts as an early disaster point service provision rather than comparison with pre-earthquake period data. Notably there is no pre-earthquake data from that region to directly determine how much the earthquake itself changed the epidemiology of gastrointestinal parasitic infection, but both its very high prevalence and severe WASH-reversals indicate important post-earthquake

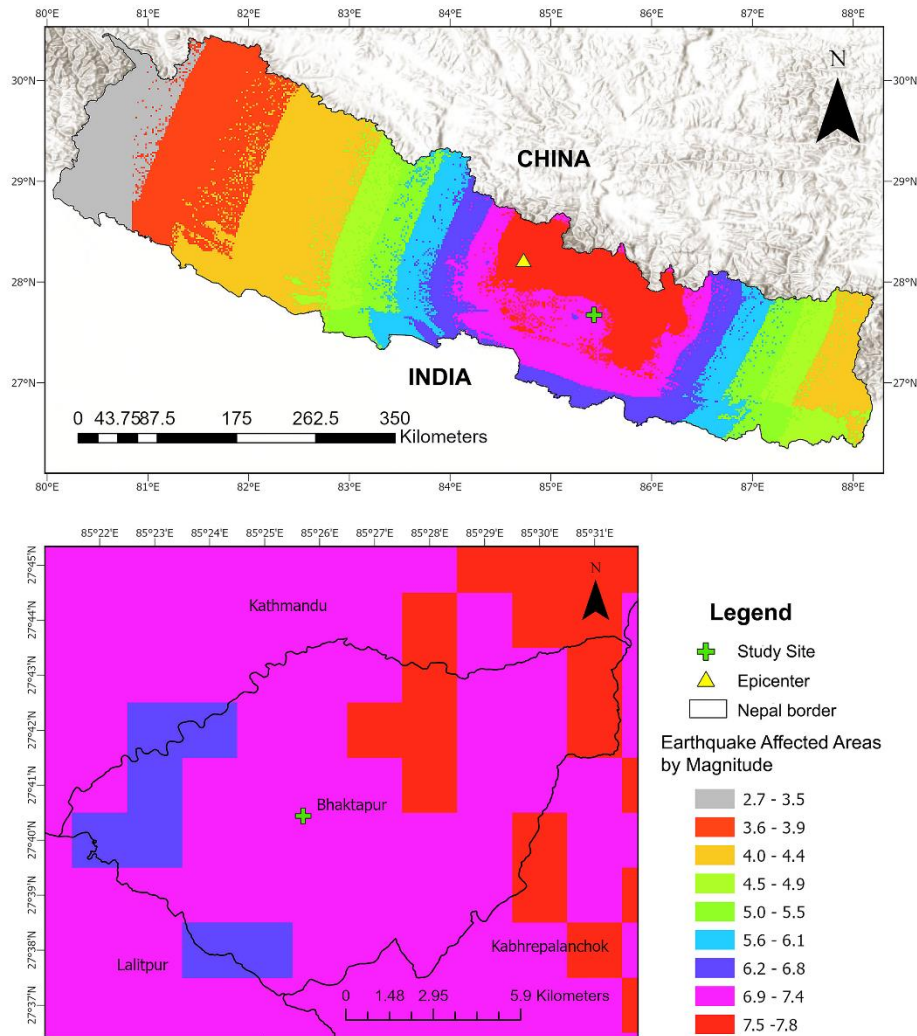
vulnerability. As such, the objectives of this study are to study the prevalence and risk factors of gastrointestinal parasitic infection in this post-earthquake camp and provide baseline data that can be used for preparedness and response during future earthquakes in Nepal as well as other regions prone to earthquakes.

Gastrointestinal parasitic infections remain a major public health concern in Nepal, where reported prevalence rates in various communities have ranged from 30% to over 70%, with soil-transmitted helminths such as *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms being the most identified species (Shrestha et al., 2014). The burden is disproportionately borne by children, rural communities and populations with limited access to safe water and sanitation. Despite national deworming programs targeting school-age children, coverage remains uneven and adult populations are largely unaddressed (Mulaw et al., 2021). Nepal's limited health infrastructure and low sanitation coverage create persistent conditions for parasite transmission, which are further compounded during disasters when WASH systems collapse, and populations are concentrated in temporary settlements with inadequate sanitation facilities.

## MATERIALS AND METHODS

### Study area

This research was carried out in Byasi Tole, Ward No. 10, Bhaktapur Municipality, Nepal (27°40'26.46"N and 85°25'42.02"E). Byasi Tole and surrounding area were extensively exposed to April 25 and May 12 earthquake (2015) that destroyed 18,900 buildings, damaged traditional Newari architecture impacting the life of 83,916 peoples (Government of Nepal, 2015; Disaster Preparedness Network-Nepal, 2021). 224 earthquake survivors from Byasi Tole were immediately accommodated to transitional structure constructed so closely to their original homes. These crowded conditions included poor sanitation facilities, limited availability of water and community toilet blocks which were often unclean and poorly maintained. It was in the makeshift accommodations where the survivors lived, constructed from temporary materials and offering inadequate protection against environmental pollutants, that the transmission of parasitic infections occurred.



**Figure 1.** Geographical setting of the study site in Bhaktapur, Nepal, overlaid with 2015 earthquake intensity data. The map highlights the proximity of the study site (green cross) to the high-magnitude impact zones (red/pink) relative to the earthquake epicenter (yellow triangle)

This study used ShakeMap product for 25th April 2015 Gorkha earthquake downloaded from USGS (United State Geological Survey) ShakeMap metadata page (<https://earthquake.usgs.gov/earthquakes/eventpage/u20002926/shakemap/metadata>). This provides gridded estimates of peak ground motion and instrumental intensity derived from recorded strong motion data, both empirical ground motion prediction equations and site amplification corrections; it is commonly used for rapid post event impact assessment and scientific analysis (Wald et al., 2011). The original ground shaking raster product and associated metadata were downloaded and brought into QGIS version 3.44 for spatial analysis and cartographic design. The ShakeMap grid is in WGS 84 geographic coordinate system and the project

coordinate reference system in QGIS assigned accordingly not to distort the image and to correctly fit administrative areas or base map (Wald et al., 2011). In QGIS, National level ShakeMap intensity raster for Nepal was loaded and visually checked for completeness. Second, the raster was clipped to the boundary of Nepal and additionally to Kathmandu Valley including neighboring districts for the inset panel that is used to identify Bhaktapur and surroundings.

### Study design and sample collection

Cross-sectional study design was used in January–June 2016, 8 to 9 months after the first earthquakes. The study sample consisted of 82 randomly selected individuals (36.61%) among 224 earthquake victims from the temporary shelters. The sample size was

selected based on availability of participants and their cooperation. Site visits and in-depth discussions continued with shelter management on 20 January 2016 to discuss cooperation and alignment. On Jan 22–23, 2016 all participants were provided with detailed explanation orally and in writing about how to take the fecal samples properly. Participants were given small wooden sticks and sterilized leak proof 25 ml vial containing 2.5% potassium dichromate solution. Stool samples were inspected for adequate volume and properly labelled before being transported to the laboratory for analysis.

### Laboratory analysis

Stools were carried to Central Department of Zoology, Tribhuvan University for macroscopic and microscopic examination. The first macroscopic examination of each stool faced an evaluation of its consistency, color and odor, presence of blood, mucus and visible helminth larvae (Zajac & Conboy, 2012). Microscopic examination was performed both with saline wet mounts and iodine-stained smears according to standard parasitological procedures (Garcia, 2009). Stained and unstained smears were observed under microscope from low-power objective lens (10X) and confirmed at 40X high-power lens for detailed identification and morphologic characterization. Parasitic identification was based on morphological characteristics including shape, size and color, using reference materials (Chatterjee, 2009; Arora and Arora, 2012).

### WASH assessment and questionnaire survey

Structured questionnaires were administered to all 82 participants covering: (1) socio-demographic data (age, sex and family composition); (2) handwashing practices and hygiene behavior; (3) WASH practices (water source, treatment method, defecation habits) and (4) knowledge of parasitic infection causes, symptoms and prevention. Interviews were conducted in Newari language with the assistance of a bilingual interpreter to ensure comprehension. Data were collected in a uniform fashion to facilitate comparative analysis.

### Statistical analysis

Statistical analysis was performed using R version 4.4.0. The prevalence of intestinal parasites was described as the proportion (%) of positive samples to the total number analyzed. Associations between parasitic infection and demographic variable (age,

sex), WASH practices (water source, defecation habits, deworming history) and infection knowledge were assessed using chi-square ( $\chi^2$ ) tests. A two-tailed p-value < 0.05 was considered to be statistically significant. The results were described using tables, figures and graphs to give a general overview of parasite infection among the subjects studied according to important demographic characteristics and behavioral data.

## RESULTS

### Prevalence and species identification of parasitic infections

Among the 82 stool specimens analyzed, 51 individuals (62.2%) showed signs of one or multiple intestinal parasitic infections demonstrating a high burden of disease in this population affected by earthquake. The parasites detected were *A. lumbricoides*, *T. trichiura*, *Hymenolepis nana* and *Ancylostoma duodenale*; protozoan: *E. histolytica*. The most predominant infection was soil transmitted helminths (STH), 35 samples for *A. lumbricoides*, 68.6% (60.8% of the entire sample). This proved to be the most identified parasite species in the study. *T. trichiura* was found in 10 positive samples (19.6% of infected individuals) and represent the second more frequent parasite. *E. histolytica*, a protozoan parasite, was identified in 8 infected samples (15.7% of the infected individuals). *H. nana* was found in 4 samples (7.8% of infected individuals) and *A. duodenale* was observed in 2 sample (3.9% of infected individuals).

### Infection patterns: single and multiple infections

Most infections were single, detected in 43 individuals (84.3% of infected sample). Remarkably, single infections were dominated by *A. lumbricoides* alone in 52.9% (n = 27) of infected persons followed by *T. trichiura* in a proportion of 11.8% (n = 6), *E. histolytica* with a prevalence of 7.8% (n = 4), *H. nana* at an occurrence rate of 7.8% (n = 4). Furthermore, *A. duodenale* in 3.9% (n = 2) of positive samples.

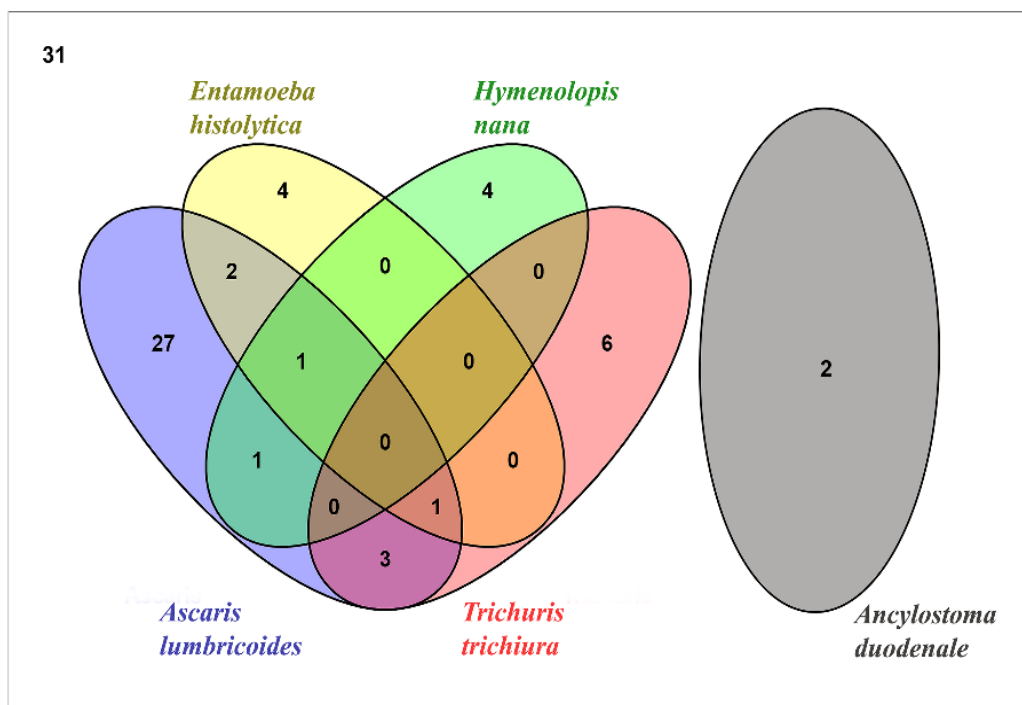
Polyparasitism was recorded on 8 individuals (15.7% of infected samples). Polyparasitism included *Ascaris lumbricoides* as part of the mixed infection with other parasite species. In particular, 5 individuals (50% of mixed infections) were co-infected with *A. lumbricoides* and *E. histolytica*, 2 individuals (25% of mixed infections) had *A. lumbricoides* and *T. trichiura* and 1 individual (12.5% of mixed infection) was triple infected by *A. lumbricoides*, *E. histolytica* and

*Hymenolepis nana* (Fig. 2). The mixed infections are indicative of the common transmission routes by contaminated water and food, as well as overlapping post-earthquake eco-niches with their severely damaged WASH facilities.

**Gender-based differences in infection prevalence**

Infection levels differed greatly between the two sexes. In 47 males (57.3% of the total sample), 24 were found to be positive, representing an infection prevalence of 51.1% in males. In contrast, out of the

35 females (42.7% of total sample), 27 individual tested positive indicating notably higher infection in females of 77.1 %. The nearly 26% points gap between infections in female and male suggests that females were at about 1.5 times more likely to be infected than males in this population (Fig. 3). In the statistical analysis, a significant association between infection and sex ( $\chi^2 = 4.90, p = 0.027$ ) was established which means female were much more at risk of parasitic infection than males.



**Figure 2.** Patterns of co-infection among the identified five intestinal parasite species. The figure shows the overlaps between *A. lumbricoides*, *E. histolytica*, *H. nana* and *T. trichiura*, where numbers represent the frequency of infected individuals

**Age-related differences in infection prevalence**

The distribution of the prevalence of infection varies significantly by age in these seven age groups ( $\chi^2 = 51.3, p < 0.001$ ) 0-10 age group had 100% infections (n = 10) by one or more parasite and all were found infection positive for any of parasite species. Likewise, all the children from 11 to 20 years old were infected (100%; n = 8). The 41–50 years age group of middle-aged adults also had the high infection rate of 100% (n = 5). Conversely, the

infection rate severely decreased for young adult 21–30 age group, with only 33.3% (n = 2 out of 6 individuals) testing positive. In most cases, the intermediate prevalence for the 31–40-year-old group was of around 50% (n = 3 out of 6 individuals). Prevalence in the 51–60 age category was reported to be 60% (n = 3 of 5 individual). All individuals subjects within the oldest group (> 61 years old) were negative for parasitic infection (n = 0/5 individuals tested) (Fig. 4).

## Water, sanitation and hygiene (WASH) assessment

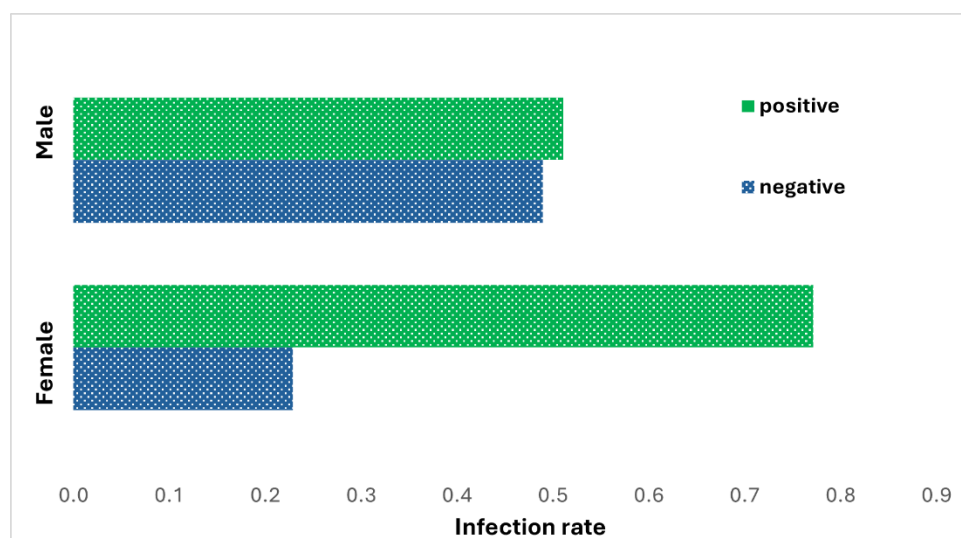
### Sanitation and defecation practices

The most common place of defecation reported by the respondents was toilet (89.02%, n = 73). Respondents who openly defecate in the open areas were 11% (n = 9) of the study population (Table 1). This suggests that large sanitation gaps remained even after the disaster, despite having temporary communal toilets. According to field observations made during the survey, community toilets were generally not well maintained regularly and had no water for flushing or only minimal handwashing facilities. Fecal-oral transmission of parasites is highly contagious in overcrowded communities where toilets used are communal.

### Water source and treatment methods

Evaluation of water use and treatment practices identified a significant public health issue. Most of the

respondents (63.41%, n = 52) drank untreated drinking water directly from the source without any treatment process which was the direct exposure to possibly contaminated water source. This untreated water must have been rich in parasitic cysts and protozoan forms. Unexpectedly, a similar proportion of patients (30.48%, n = 25) report the use of chlorine-based treatment methods for the treatment of drinking water (Table 1). One of the key household-level water safety interventions recommended by the World Health Organization is boiling. Only 6.09% (n = 5) reported drinking boiled water. Dependence on untreated water was a significant risk factor for parasitic transmission. The 2015 earthquake damaged water supply systems across Bhaktapur, which left many survivors dependent on other sources of water supplies that typically were contaminated with fecal matter.

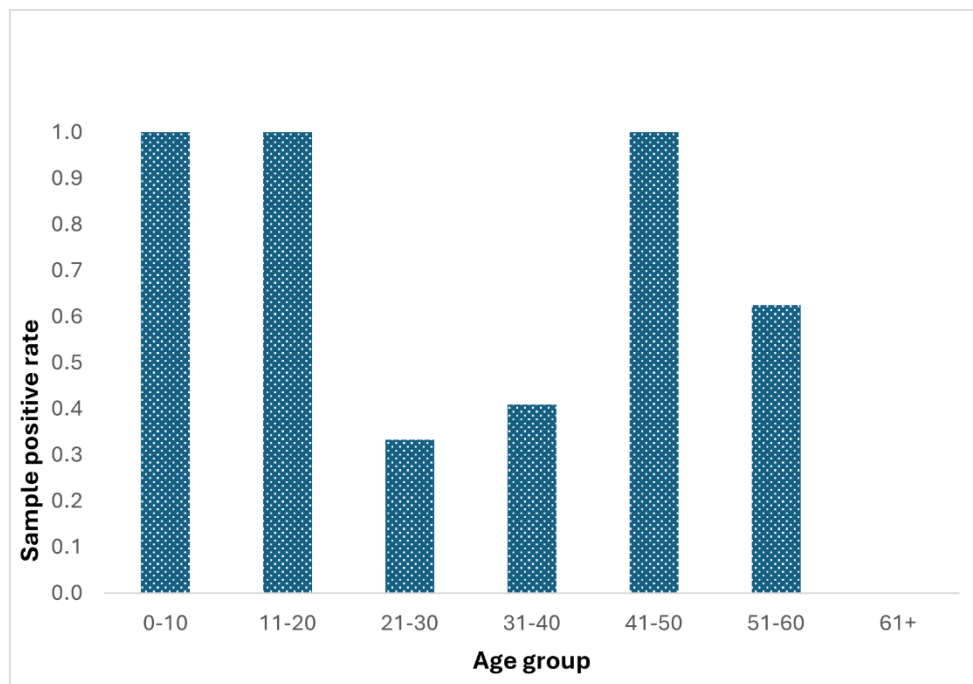


**Figure 3.** Intestinal parasite infection rates of male and female (Parasite infection positive-green; Parasite infection negative-blue)

### Hand hygiene practices

Majority of the respondents (70.73%, n = 58) reported that hand-wash was done with soap and this is consistent positive practice. However, the remaining 29.27% used unhygienic handwash methods: 21.95% (n = 18) washed their hands using water only and 7.31

(n=6%) used soil as a cleansing agent (Table 1). It appears that handwashing practice was almost perfect before meals and after toilet; all respondents (n = 82) claimed to always wash their hands on these critical times. However, the observed behavioral adherence varies from self-reported behavior in the study area.



**Figure 4.** Age-wise prevalence of intestinal parasitic infections. The graph shows the infection rate across seven distinct age group, ranging from 0–10 years to 61+ years

**Table 1.** Frequency patterns for hygiene and sanitation behaviors of earthquake victims

Variable	Category	Number (n) [Total (N) = 82]	Percentage (%)
Defecation place	Toilet	73	89.02
	Field	9	10.97
	Direct	52	63.41
Drinking water type	Chlorinated	25	30.48
	Boiled	5	6.09
	Soap	58	70.73
Hand wash material	Water only	18	21.95
	Soil	6	7.31
Hand washing time	Before meal	82	100.00
	After toilet use	82	100.00
Taken deworming tablet (Before/After earthquake)	No	69	84.14
	Yes	13	15.85

#### Deworming prophylaxis coverage

Deworming tablet utilization was very low, which is a significant deficiency in the preventive and control measures of parasitic diseases. Only 15.85% (n = 13) of respondents said they have taken deworming tablets in the past before and after the quake (Table 1). Of

#### Knowledge of parasitic infections among respondents

Knowledge assessment on parasitic infection provided valuable information on awareness and knowledge level of the camp residents. The awareness

course, this also implies that the vast majority (84.14%, n = 69) had not been given prophylactic anthelmintics. This very low coverage of deworming prophylaxis is especially concerning given the high prevalence of soil-transmitted helminths and a missed opportunity for primary prevention.

on cause of parasitic disease was most frequently reported by the participants (79.3%; n = 65). While 84.14% (n = 69) know the symptom of infection by parasite. However, level of information regarding methods of infection prevention was much lower: only 73.17% (n = 60) were aware of methods to prevent

parasitic infection (Table 2). There was a significant gap between knowledge and preventive behavior. Although those aware of the causative agents and symptoms, as well as prevention were reported to be

known in most participants, a significant proportion seemed not to know that they can avoid an infection despite being able to recognize its cause and symptoms.

**Table 2.** Frequency of earthquake victims' knowledge varies depending on the causes, signs, or ways to avoid infection

Variables for parasitic infection	Knowledge	No. of respondents (N = 82)	Frequency (%)
Cause	Aware	65	79.26
	Unaware	17	20.73
Symptoms	Aware	69	84.14
	Unaware	13	15.85
Methods of prevention	Aware	60	73.17
	Unaware	22	26.82

## DISCUSSION

### Prevalence and epidemiological context

The current study observed the high proportion (62.2%) of gastrointestinal parasitic infection in earthquake survivors in response to 2015 Nepal earthquakes within a period of less than one year. This finding reflects the substantial public health burden resulting from these natural disasters, particularly in resource limited regions where reconstruction of water, sanitation and hygiene (WASH) infrastructure is slow or inadequate (Charnley et al., 2021; Shah et al., 2024). Although it is not possible to directly compare pre-post-earthquakes within the same population due to study design. The most prevalent type of parasitic infection detected was helminth with *A. lumbricoides* as the most predominant among infected patients (60.78% prevalence) followed by *H. nana*, *T. trichiura* and *E. histolytica*. These results indicate that infection with STHs still predominates in post-earthquake areas and cross-infection (Yu & Blackburn, 2019; Akindele, 2022) shows a high prevalence of polyparasitism. The result of this work is in line with global and local literature, which reports the recurrence or worsening of helminth infections post natural disaster (Najafi et al., 2022; Shah et al., 2024). The dominance of *Ascaris* in Nepal and neighboring countries can likely be attributed to an overlapping combination of factors: exposure to soil contaminated with human feces, ingestion of unwashed or inadequately washed vegetables use of untreated water and crowded unhygienic living

conditions (Shakya et al., 2018; Yu & Blackburn, 2019).

### Gender-based difference in infection

Females (77.1%) had a significantly greater probability of being infected with parasites than male (51.1%), suggesting complex biological and social factors. Although there are reports of sex differences in immunity (Simon et al., 2015), a gap that wide (26% points) is likely due more from daily activities than inherent vulnerability. In a variety of traditional contexts in Nepal, including among Newari communities in Bhaktapur, women are generally involved in fetching water, cooking (meals), caring for young and elder family members, along with keeping household area clean (Bertoncello et al., 2021; Guragain & Pokharel, 2024). The time spent collecting water also means less time for personal hygiene, such as hand washing. If these conditions continue to be overlooked in health-focused recovery efforts, vulnerability may increase.

### Age-related patterns and immune considerations

The high infection rates (100%) observe in child (0–10 age) and adolescents (11–20 age) are consistent with well-established patterns in parasitic disease epidemiology, particularly for soil-transmitted helminths, reflecting both the immaturity of acquired immune responses in young age groups (Simon et al., 2015) and the higher behavioral exposure risk associated with playing in contaminated soil and inadequate handwashing (Beijnen et al., 2023). The 100% infection rate observed in middle-aged adults

(41–50 age) is unusual, this pattern may reflect either chronic reinfection despite acquired resistance, or it may represent a cohort effect wherein individuals of this age in this particular population had sustained high exposure to parasites throughout their lives and/or had different behavioral practices compared with the 21–30 age group. Older individuals (>61 age) typically have restricted mobility within the overcrowded environment and may spend more time in designated shelter areas away from contaminated soil. They may have reduced access to communal facilities or distinct patterns of toilet usage. Also, survivor bias may play a role, older individual with serious health conditions resulting from parasitic infections may have been less likely to be included in the temporary camp setting, instead having been referred to hospitals or other care settings.

#### **WASH infrastructure failure and parasitic transmission**

The earthquake destroyed 220,000 toilets across Nepal and 446 public health facility, straight impairing sanitization and health services in affected districts (Shah et al., 2024). The reality is that in the Byasi Tole camp, survivors lived under severe WASH constraints characterized by limited water supply, unequal sanitization and overcrowding in temporary shelter structures. So, this means that 63.4% did not treat water and only 6.1% used boiling is clear evidence for post disaster water safety failure and infrastructure collapse. Plus, boiling of water was inaccessible for most of camp dwellers because fuel was limited and camps were overcrowded (Lantagne & Clasen, 2012; World Health Organization, 2017). The population who reported open defecation despite availability of community toilets suggests that either toilet facilities are inadequate or information on sanitation was not available. Open defecation will contaminate the soil and may directly contribute to groundwater source of drinking and household water contamination, thereby substantially accelerating parasite transmission (Avcu, 2023; Mavrouli et al., 2023b).

#### **Knowledge-practice gap**

While 79.3% of respondents identify the cause, 84.1% know the symptoms of parasitic disease and 73.2% describe knowledge about prevention methods. Most importantly, knowledge of prevention did not translate into consistent prophylactic behaviors. This knowledge-practice gap is not specific to this setting; it also has been noted in previous post-disaster

research (Tian et al., 2016). With, access to basic preventive measures (soap and clean water) and (functional) sanitary facilities were strongly limited in the context of the post-earthquake situation. Even a person with full knowledge of the importance of handwashing cannot practice this effectively without admission to water and soap. In emergency settings, populations may prioritize meeting immediate survival needs (food, shelter, safety) over health-promoting behavior that require resources or effort (Tian et al., 2016). This study is in contrast with the findings of post-earthquake in China, which reported comprehensive health teaching programs and enhanced washing infrastructure leading to improved hygiene standards and documented reductions in infections rates (Tian et al., 2016), highlighting that knowledge alone is insufficient without accompanying infrastructure and resource support.

#### **CONCLUSION**

Intestinal parasitic infections are still one of the most important public health problems facing population affected by earthquake disaster. The community-based perspective of public health has substantial implications for addressing the time-sensitive needs that emerged due to the earthquake, as well as in other post-disaster settings. The critical need for a rapid, multisectoral and holistic response cannot be overemphasized. An intervention seeking leverage existing complementary strengths across sectors, including access to clean water, ensuring construction and maintenance of functioning sanitation infrastructure, deploy mass deworming campaign to lower parasitic load among affected populations with easily accessible hygiene resources is particularly relevant given reports suggest heightened vulnerability during disasters (Shah et al., 2024). In addition, the control of post-disaster parasitic diseases is effective only with long-term investment for disease surveillance system that can detect and monitor infection trends. It is possible that combining WASH improvements with mass drug administration and health promotion could have synergistic effects for disease control. The current study has presented the first detailed and comprehensive insight about the type and extent of post-disaster exposures to urban dwellers in Nepal in the aftermath of 2015 Gorkha earthquake. The findings may be used to pave the way for new strategies for disaster preparation and response, resource allocation in public health and to

advocate for increased investment to protect communities affected by earthquakes.

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#### AUTHORS CONTRIBUTION

Conceptualization: LKT; Methodology: LKT, BA; Validation: LKT, BA; Investigation: LKT; Data analysis: LKT, BA; Writing-original draft: LKT; Writing-review & editing: BA; Supervision: BA

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#### CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article.

#### ETHICAL STATEMENT

This study was reviewed and approved by the Central Department of Zoology, Tribhuvan University, Nepal. The committee doesn't issue formal approval numbers. The committee granted a waiver for written informed consent due to the logistically challenging and emergency context of the post-earthquake setting, where literacy materials and private spaces were limited. Verbal informed consent was obtained from all adult participants or from the guardians of minors after a detailed explanation of the study's purpose, procedures, risks and benefits. All samples were irreversibly anonymized at the point of collection, with all personal identifiers removed, making it impossible to link the data back to any individual.

#### DATA AVAILABILITY STATEMENT

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

#### SUPPLEMENTARY INFORMATION

None

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