VETERINARIA ITALIANA
RIVISTA DI SANITÀ PUBBLICA VETERINARIA

Paper

Exploration of faecal prevalence of internal parasite eggs in children and dogs from three rural high-altitude hamlets in the Peruvian northern Andes

Jennifer Lerida Cuzcano Anarcaya[1*], Luis Vargas-Rocha[2], Jierson E. Mendoza-Estela[3], María Cabrera[1]

[1]Facultad de Ciencias Veterinarias, Universidad Nacional de Cajamarca - PE
[2]Grupo de Investigación en Enfermedades Parasitarias y Vectoriales: Control Integral y Terapéutica Afín, Universidad Nacional de Cajamarca, Cajamarca, Perú - PE
[3]Círculo de Estudios e Investigación en Ciencias Veterinarias - CEICIVET, Universidad Nacional de Cajamarca, Cajamarca, Perú - PE

[*]Corresponding author at: Facultad de Ciencias Veterinarias, Universidad Nacional de Cajamarca - PE
E-mail: jlcuzcanoa@unc.edu.pe

Veterinaria Italiana, Vol. 61 No. 2 (2025) DOI: 10.12834/VetIt.3515.24186.2
Available on line: 14.04.2025

Abstract

This study aimed to identify and determine the prevalence of intestinal parasites through faecal egg detection in children and dogs from three rural hamlets - La Chorrera, Cruz Pampa, and Chugurmayo - located in the Sorochuco district, Celendín province, Cajamarca region, Peru, at an altitude exceeding 3,400 meters above sea level. Faecal samples were collected from school-aged children and domestic dogs and analysed using direct smear, natural sedimentation, Faust, and Sheather techniques. Parasitic infection was detected in 59.80% of children (95% CI: 50.29–69.32) and 55.00% of dogs (95% CI: 44.10–65.90). No statistically significant differences in prevalence were observed between hamlets ($p = 0.630$). Among children, the highest prevalence was noted in males aged >6 to 9 years; in dogs, it was observed in males aged 0 to 1 year. However, age and sex were not significantly associated with infection in either group ($p > 0.05$). Parasitic stages identified in children included *Giardia* spp., *Hymenolepis* spp., *Fasciola hepatica*, *Ascaris lumbricoides*, and *Diphyllobothrium* spp. In dogs, *Giardia* spp., *Ancylostomatidae*, *Sarcocystis* spp., *Toxocara* spp., and *Taenia* spp. were found. One parasite - *Giardia* spp. - were common to both species, although no significant overall correlation of infection between children and dogs was observed ($p > 0.05$). These findings highlight the need for enhanced epidemiological surveillance, medical attention, and further research in these underserved rural communities. Increased awareness and integrated public health efforts are essential to address the burden of parasitic infections in these high-altitude areas.

Keywords

helminth, high attitude, parasite infection, rural area, public health

Introduction

Intestinal parasitic infection constitutes a global health concern affecting inhabitants of socioeconomically disadvantaged communities across many developing countries (Wong et al., 2020). The spread of intestinal parasites into new areas has been attributed to human activities such as emigration, immigration, displacement, internal and external migration, and labour migration (Steverding, 2020). Pregnant women have been noted to be particularly vulnerable (Taghipour et al., 2021). Furthermore, parasitic infections can adversely affect children, including alterations in haematological profiles and resulting anaemia (Demeke et al., 2021).

Parasites are frequently transmitted to humans through contaminated food, leading to significant morbidity in vulnerable populations, particularly in low- and middle-income countries (Torgerson et al., 2015). Various parasite cysts have been found in fresh vegetables sourced from farms and supermarkets (El Bakri et al., 2020; Hajipour et al., 2021). The ingestion of raw vegetables contaminated with infective forms of parasites is one of the most significant factors in the epidemiology of gastrointestinal endoparasites, primarily due to the resilience of cysts, oocysts, and eggs to environmental conditions (González et al., 2018). The use of contaminated water for irrigation and vegetable washing also contributes to parasitic infections (Slany et al., 2019).

The environmental stages of parasites can persist for extended periods in water, soil, and on contaminated farmland, primarily due to human excrement, polluted water sources, and handling by infected individuals. These elements contribute to the transmission and dissemination of parasitic diseases (González et al., 2018). Several risk factors for parasitism have been identified, including low parental education levels among schoolchildren, consumption of non-potable water, living in houses with earthen floors (Mejía-Delgado et al., 2014), improper disposal of excreta, and lack of handwashing before eating (Ticona-Bayta and Martínez-Barrios, 2016).

In particular, poor hygiene conditions and residence in rural areas are significant risk factors (Nakandakari et al., 2016). Age also plays a role, with children being the most affected group. Additional contributing factors include failure to wash hands after defecation, having dirty nails, not wearing shoes, rural residence, and overcrowding (Damtie et al., 2021). Moreover, breeding and contact with certain animals such as dogs have been indicated as possible risk factors for parasitic infections (Mejía-Delgado et al., 2014). The protozoan Giardia lamblia is widely distributed among the Peruvian human population (Cabrera et al., 2023). In Cajamarca (Peru), Fasciola hepatica is among the most frequently reported parasites in both humans (Rodríguez-Ulloa et al., 2018; Fernández-Holguín et al., 2023; Silva-Caso et al., 2024) and domestic animals (Vargas-Rocha et al., 2021; Rázuri et al., 2023; Torrel et al., 2023). In the same region, Sarcocystis spp. has been identified in dogs (Ydrogo et al., 2024); however, the presence of other parasites in this species and in humans remains unknown due to the paucity of studies.

In Peru, prevalence studies on parasitosis are often limited to specific geographic areas, such as annexes or districts. Multiple parasites have been diagnosed in individuals from all regions of the country and across all age groups, from children to the elderly, who have sought care at health facilities (Vidal-Anzardo et al., 2020). Given that intestinal parasitosis is more common in rural areas—primarily due to precarious living conditions—the present exploratory study was conducted to identify and determine the prevalence of internal parasites in school-age children and dogs from three hamlets located in the Sorochuco district, Celendín province, in the Cajamarca region of Peru.

Materials and methods

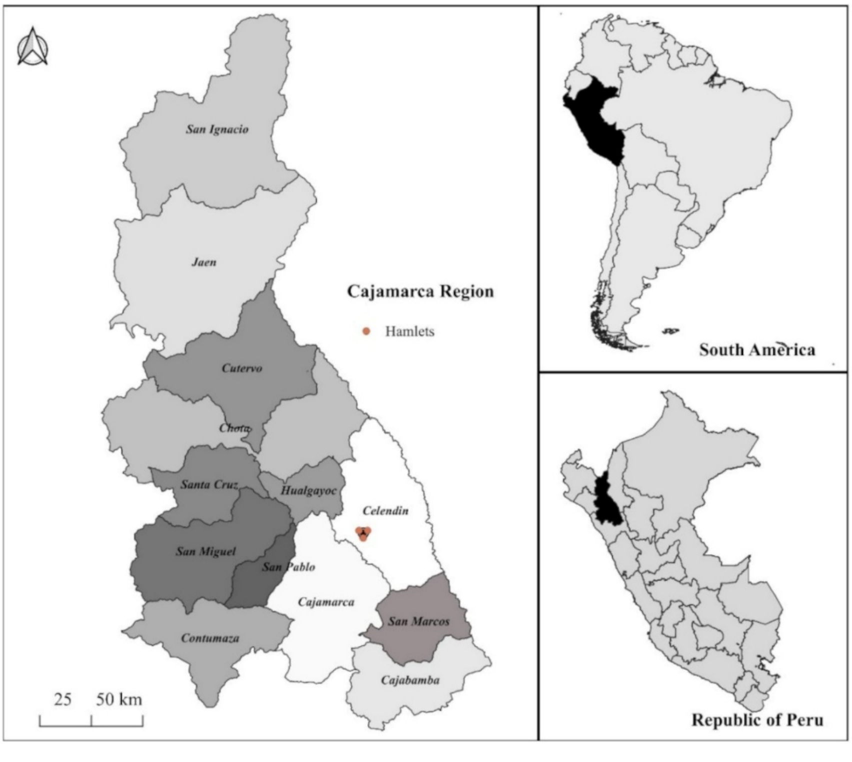

Figure 1. Geographical location of the hamlets in the Celendín province, Cajamarca - Peru.

Place

The study was conducted in three extremely impoverished hamlets in the Sorochuco district—La Chorrera (3,726 masl), Cruz Pampa (3,606 masl), and Chugurmayo (3,669 masl)—located in the province of Celendín, approximately 71 km from the city of Cajamarca, in the Cajamarca region (Figure 1).

Sampling

Initially, following coordination with local authorities, healthcare personnel, and school directors, informative sessions were held at the educational centres of each hamlet to raise awareness among parents about the importance of parasitic infections and their impact on children's health. The sessions also addressed the role of hygiene habits, the consumption of improperly washed food, and cohabitation with companion animals such as dogs lacking any form of health control. The study's objectives, the methodology to be employed, and the potential risks and benefits were clearly explained. Subsequently, informed consent for participation was obtained from each parent and child.

The study exclusively involved children enrolled in the educational centres of each hamlet, whose parents had authorised their voluntary participation. Faecal samples were collected from school-aged children (2–10 years old), of both sexes, from the hamlets of Chugurmayo (n = 30), La Chorrera (n = 30), and Cruz Pampa (n = 43). Additionally, faecal samples were collected from domestic dogs of both sexes. While there were ample populations of dogs in the hamlets, they were not very docile; nonetheless, efforts were made to collect as many samples as possible from each location: Chugurmayo (n = 20), La Chorrera (n = 30), and Cruz Pampa (n = 21).

Participants living conditions

The families cooked with firewood, and their diet primarily consisted of locally grown products such as potatoes, ollucos, barley, wheat, peas, and vegetables. The water in all three hamlets was non-potable; instead, residents used water treated with sodium hypochlorite, sourced from springs, channels, or natural ponds, and stored in concrete reservoirs. However, most families were unaware of the importance of boiling water. As a result, they often consumed untreated water, occasionally heated (but not boiled), and vegetables washed directly with tap water. Waste disposal was carried out through pit latrines, as there were no drainage systems in place.

Residents were mainly engaged in agriculture and animal husbandry, including trout farming. They permanently raised animals such as guinea pigs, chickens, cats, and dogs within their homes. In the fields, due to the absence of latrines, defecation occurred openly. Similarly, dogs were kept as companion animals and allowed to roam freely throughout the hamlets, defecating anywhere—including roads, communication routes, crop fields, and grazing pastures. These dogs were of mixed breed, fed a diet similar to that of their owners, including household food scraps.

Moreover, animal owners rarely visited healthcare centres for routine medical care, limiting their access to health services and health education. The local healthcare centres lacked parasitological diagnostic laboratories and did not provide scheduled health checks or deworming programs for animals.

Faecal samples collection

Disposable gloves and sterile, screw-cap, wide-mouthed 30 mL plastic containers equipped with spatulas were provided to participants. The correct method for faecal sample collection was clearly explained and emphasised during the awareness sessions. Labelled containers bearing unique identification codes were distributed at the end of the sessions. Parents were instructed to collect the first-morning faeces from their children and deposit the samples at the local Health Post in each hamlet. From there, the samples were retrieved for laboratory analysis. Only one faecal sample per child was collected, with each parent responsible for their own child's sample.

Faecal samples from dogs were obtained directly from the rectum. Each owner was instructed to properly restrain their pet to ensure the safety of both the animal and the handler. Latex gloves were worn, and the operator's hand was covered with a transparent polyethylene plastic bag (10 × 15 cm). External massage of the anal sphincter using the index finger was performed to stimulate defecation, yielding approximately 50–60 g of faeces. Once the sample was collected, the polyethylene bag was inverted and tightly sealed with a knot. Each sample was labelled sequentially with a marker, including the owner's name and the collection date.

Faecal samples from both children and dogs were stored separately in polystyrene foam thermal boxes containing cooling gel packs, maintaining an internal temperature of 4 °C. The boxes were transported to the*Laboratorio de Inmunología* at the Faculty of Veterinary Sciences, Universidad Nacional de Cajamarca. The transfer to the laboratory took approximately 2.5 hours, after which sample processing commenced.

Sample processing and analysis

An initial analysis was performed using direct smear microscopy with physiological saline solution. Subsequently, a portion of each sample was processed via the natural sedimentation method (Rojas-Moncada et al., 2024) and examined under a stereoscope equipped with halogen light at 2× to 4× magnification for the detection of trematode eggs. Another portion was processed using the technique described by Faust et al. (1939) to observe protozoa such as *Giardia* spp. or *Sarcocystis* spp. For nematode detection, samples were processed using the Sheather flotation technique (Sheather, 1923). Observations were conducted under an optical microscope at 40× magnification. Parasite eggs, cysts, oocysts, and sporocysts were identified based on their morphological and morphometric characteristics, following established descriptions (Dubey et al., 2015; Bogitsh et al., 2018; Miró and Bowman, 2018; Leventhal and Cheadle, 2019).

In Faust's technique, approximately 3 g of faeces were mixed with 20 mL of 33% zinc sulphate solution (density: 1.30 g/mL) in a flexible plastic beaker. The mixture was homogenised using a stirrer and filtered through a tea strainer into a second beaker. The filtrate was poured into centrifuge tubes until full, and a coverslip was placed on top. Centrifugation was carried out at 1,500 rpm for 1 minute. After centrifugation, the coverslips were carefully removed, placed onto glass slides, and examined microscopically.

The Sheather technique followed the same general procedure, with the exception that a saturated sugar solution (density: 1.27 g/mL) was used instead of zinc sulphate.

Statistical analysis

The results were compiled in Excel spreadsheets, and the prevalence percentages were calculated along with 95% confidence intervals (CIs). For small sample sizes (< 30 cases), the CI was determined using the Clopper-Pearson method. As the data were non-parametric ($p < 0.05$), statistical differences in parasite prevalence between children and dogs across the hamlets were analysed using the Kruskal-Wallis test, followed by Dunn's post hoc test to identify specific group differences, with InfoStat v.2020. The variables age and sex were analysed in relation to infection status (positive/negative) using the Chi-square test to assess their potential influence. Additionally, the Phi correlation coefficient, also known as the Matthews correlation coefficient, was calculated using the same software to evaluate the association between common parasite eggs found in children and dogs. A significance level of $p < 0.05$ was adopted for all statistical tests.

Results

Children were the most frequently infected individuals across the three hamlets in the Sorochuco district, Celendín (Cajamarca, Peru), with a prevalence of 59.80% (95% CI: 50.29–69.32), compared to dogs, which showed a prevalence of 55.00% (95% CI: 44.10–65.90). No statistically significant differences in parasite prevalence were observed among the hamlets for either children or dogs ($p > 0.05$) (Table I).

Host	Hamlet	Positives*	Prevalence (95% CI)			
			By hamlet		Global	
Children ($n = 102$)	La Chorrera ($n = 30$)	20	66.67 (49.80 - 83.54)	$p = 0.661$	59.80 (50.29 - 69.32)	$p = 0.630$
	Cruz Pampa ($n = 42$)	24	57.14 (42.18 - 72.11)			
	Chugurmayo ($n = 30$)	17	56.67 (38.93 - 74.40)			
Dogs ($n = 80$)	La Chorrera ($n = 21$)	11	52.38 (31.02 - 73.74)	$p = 0.733$	55.00 (44.10 - 65.90)	
	Cruz Pampa ($n = 30$)	15	50.00 (32.11 – 67.89)			
	Chugurmayo ($n = 29$)	18	62.07 (44.41 - 79.73)			

Table I. Prevalence (%) of individuals infected with parasites in the three hamlets of the Sorochuco district, Celendín (Cajamarca, Peru). *An individual was considered positive if one or more developmental stages of any parasite species were detected. No statistically significant differences in parasite prevalence were found between hamlets or host groups (Kruskal-Wallis test, $p > 0.05$).

The ages of the evaluated children ranged from 1.5 to 9 years (mean ± standard deviation: 4.90 ± 2.13; median: 5; mode: 6). The highest parasite prevalence was observed among children aged 6 to 9 years and among males. However, no statistically significant association was found between parasite presence and either age or sex ($p > 0.05$).

In dogs, age ranged from 0.17 to 8 years (mean ± standard deviation: 2.14 ± 1.71; median: 2; mode: 1). The highest prevalence occurred in dogs younger than one year and in males; nevertheless, neither age nor sex was significantly associated with parasite presence in this species (p > 0.05) (Table II).

Based on their typical morphological characteristics, various types of parasites were identified. In children, the parasites with the highest percentage of eggs were *Hymenolepis* spp. and *Fasciola hepatica*, along with *Giardia* spp. cysts (Figure 2), while in dogs, *Giardia* spp. cysts and *Ancylostomatidae* family eggs prevailed (Table III).

Host	Variable	Covariable	Positives (% [95% IC])	Negatives	*p-value*
Children	Age (years)	0 - 3 (*n* = 33)	16 (48.48 [31.43 - 65.54])	17	*0.550*
		>3 - 6 (*n* = 47)	29 (61.70 [47.80 - 75.60])	18	
		>6 - 9 (*n* = 22)	16 (72.73 [49.78 - 89.27])	6	
	Sex	Male (*n* = 54)	37 (68.52 [56.13 - 80.91])	17	*0.057*
		Female (*n* = 48)	24 (50.00 [35.85 - 64.15])	24	
Dogs	Age (years)	0 - 1 (*n* = 35)	22 (62.86 [46.85 - 78.87])	13	*0.431*
		>1 - 2 (*n* = 22)	12 (54.55 [32.21 - 75.61])	10	
		>2 - >3 (*n* = 23)	9 (39.13 [19.71 - 61.46])	14	
	Sex	Male (*n* = 55)	30 (54.55 [41.39 - 67.71])	25	*0.832*
		Female (*n* = 25)	13 (52.00 [31.31 - 72.20])	12	

Table II. Prevalence (%) and association of parasite positivity with age and sex in children and dogs from three hamlets in the Sorochuco district, Celendín (Cajamarca, Peru). Statistical significance was assessed using the Chi-square test, with a significance level set at p < 0.05.

Host	Place				Global		
	Hamlet	Parasite	Positive	Prevalence (95%CI)	Parasite	Positive	Prevalence (95%CI)
Children	La Chorrera	*Giardia* spp.	14	66.67 (46.50 - 86.83)[a]			
		Fasciola hepatica	5	23.81 (5.59 - 42.03)[b]	*Giardia* spp.	41	55.41 (44.08 - 66.73)[a]
		Ascaris lumbricoides	1	4.76 (0.00 - 13.87)[b]			
	Cruz Pampa	*Giardia* spp.	15	42.86 (26.46 - 59.25)[a]	*Hymenolepis* spp.	18	24.32 (14.55 - 34.10)[b]
		Fasciola hepatica	3	8.57 (0.00 - 17.85)[b]			
		Hymenolepis spp.	15	42.86 (26.46 - 59.25)[a]	*Fasciola hepatica*	11	14.86 (6.76 - 22.97)[b]
		Ascaris lumbricoides	1	2.86 (0.00 - 8.38)[b]			
		Diphyllobothrium spp.	1	2.86 (0.00 - 8.38)[b]	*Ascaris lumbricoides*	2	2.70 (0.00 - 6.40)[c]
	Chugurmayo	*Giardia* spp.	12	66.67 (44.89 - 88.44)[a]			
		Fasciola hepatica	3	16.67 (0.00 - 33.88)[b]	*Diphyllobothrium* spp.	1	1.35 (0.00 - 3.98)[c]
		Hymenolepis spp.	3	16.67 (0.00 - 33.88)[b]			
Dog	La Chorrera	*Giardia* spp.	8	57.14 (31.22 - 83.07)[a]	*Giardia* spp.	20	36.36 (23.65 - 49.08)[a]
		Ancylostomatidae	3	21.43 (0.00 - 42.92)[ab]			
		Sarcocystis spp.	2	14.29 (0.00 - 32.62)[b]	*Ancylostomatidae*	28	50.91 (37.70 - 64.12)[a]
		Tenia spp.	1	7.14 (0.00 - 20.63)[b]			
	Cruz Pampa	*Giardia* spp.	6	31.58 (10.68 - 52.48)[a]	*Sarcocystis* spp.	4	7.27 (0.41 - 14.14)[b]
		Ancylostomatidae	9	47.37 (24.92 - 69.82)[a]			
		Sarcocystis spp.	2	10.53 (0.00 - 24.33)[ab]	*Toxocara* spp.	2	3.64 (0.00 - 8.58)[b]
		Toxocara spp.	2	10.53 (0.00 - 24.33)[b]			
	Chugurmayo	*Giardia* spp.	6	27.27 (8.66 - 45.88)[a]	*Tenia* spp.	1	1.82 (0.00 - 5.35)[b]
		Ancylostomatidae	16	72.73 (54.12 - 91.34)[b]			

Table III. Identification of parasite stages in children and dogs from the three hamlets in the Sorochuco district, Celendín (Cajamarca, Peru). a, b, c: Different superscript letters within the same column for each hamlet and host indicate statistically significant differences in parasite occurrence (Kruskal-Wallis test followed by Dunn's post hoc test, p < 0.05).

How to cite: Cuzcano Anarcaya et al. Exploration of faecal prevalence of internal parasite eggs in children and dogs from three rural high-altitude hamlets in the Peruvian northern Andes. Veterinaria Italiana, Vol. 61 No. 2 (2025) DOI: 10.12834/VetIt.3515.24186.2

Figure 2. Microphotographs of parasitic structures identified in children's faecal samples: (a) Hymenolepis spp. egg, (b) Fasciola hepatica egg, and (c) Giardia spp. cyst. Images captured under light microscopy at 40× magnification. Scale bar: 40 µm.

Polyparasitism was also observed, with up to four distinct parasitic stages identified in a single child. The most frequently recorded co-infection in children was the combination of *Giardia* spp. and *Hymenolepis* spp., whereas in dogs, the most common association wasbetween *Giardia* spp. and members of the *Ancylostomatidae* family (Figure 3).

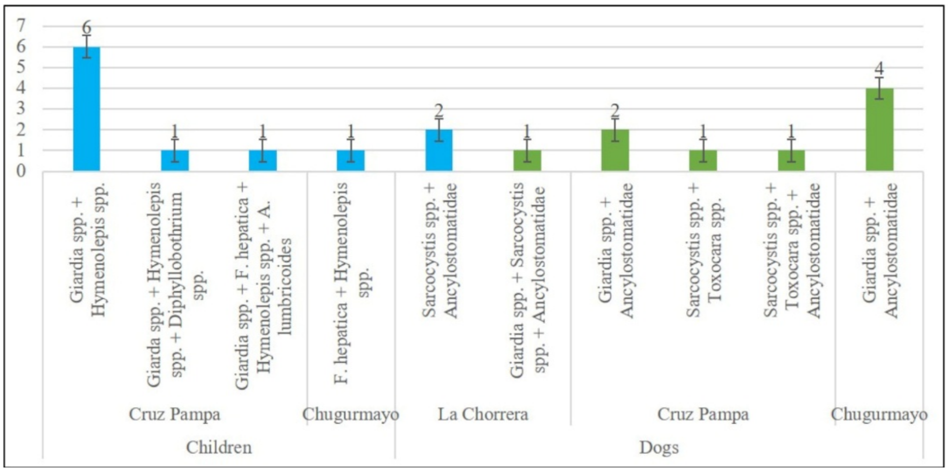

Figure 3. Occurrence of polyparasitism—defined as the presence of two or more types of parasites—in children and dogs from the three evaluated hamlets in the Sorochuco district, Celendín (Cajamarca, Peru).

Three parasite types were identified in both children and dogs, with Giardia spp. cysts being the most prevalent, followed by eggs of the *Ancylostomatidae* family and *Sarcocystis* spp. A significant correlation between parasite infections in children and dogs was observed within individual hamlets: *Giardia* spp. in Cruz Pampa and Chugurmayo, and *Ancylostomatidae* and *Sarcocystis* spp. in La Chorrera ($p < 0.05$). However, when considering all hamlets collectively, the overall analysis did not show a statistically significant correlation between parasite infections in children and dogs ($p > 0.05$) (Table IV).

Hamlet	Parasite	Children	Dogs	Phi correlation (φ)	
				Value	*p-value*
La Chorrera	*Giardia* spp.	14	8	-0,355	*0,104*
Cruz Pampa	*Giardia* spp.	15	6	0,367	*0.044**
Chugurmayo	*Giardia* spp.	12	6	0,478	*0.010**
Global	*Giardia* spp.	41	20	-0,030	*0,790*

Table IV. Correlation between the occurrence of common parasitic stages in children and dogs from three hamlets in the Sorochuco district, Celendín (Cajamarca, Peru). *Statistically significant correlations are indicated ($p < 0.05$).

How to cite: Cuzcano Anarcaya et al. Exploration of faecal prevalence of internal parasite eggs in children and dogs from three rural high-altitude hamlets in the Peruvian northern Andes. Veterinaria Italiana, Vol. 61 No. 2 (2025) DOI: 10.12834/VetIt.3515.24186.2

Discussion

Faecal analysis revealed that over 50% of both children and dogs in the three evaluated hamlets of the Sorochuco district, Celendín (Cajamarca, Peru) were infected with one or more intestinal parasites. *Giardia* spp. cysts were the most prevalent in both hosts, followed by eggs of the *Ancylostomatidae* family and *Sarcocystis* spp. sporocysts. Age and sex were not significantly associated with the presence of parasites in either children or dogs ($p > 0.05$), likely due to group homogeneity and the limited sample size within each category.

The detection of *Fasciola hepatica* eggs in children's faeces was an unexpected finding, as human fascioliasis cases have not previously been reported in remote rural areas outside the Cajamarca valley. Earlier studies documented fascioliasis in humans (Rodríguez-Ulloa et al., 2018; Fernández-Holguín et al., 2023; Silva-Caso et al., 2024) and in domestic animals (Vargas-Rocha et al., 2021; Rázuri et al., 2023; Torrel et al., 2023), but this is the first indication of its presence in more isolated communities. This lack of documentation likely reflects insufficient epidemiological surveillance rather than the absence of favourable environmental conditions for transmission. Conversely, the other parasitic stages identified—such as *Giardia* spp., *Ancylostomatidae*, and *Sarcocystis* spp.—are widely recognised as common in both humans and dogs worldwide (Bogitsh et al., 2018; Miró and Bowman, 2018; Leventhal and Cheadle, 2019).

The high prevalence and diversity of parasitic infections observed may be attributed to several interconnected environmental and behavioural factors. Primarily attributable to drinking water contaminated with *Giardia* spp. and the presence of *F. hepatica* intermediate snails. Notably, community members in the evaluated hamlets typically do not boil drinking water or rigorously wash vegetables—practices known to mitigate parasite transmission. Several studies have highlighted the significant health risks posed by the consumption of contaminated vegetables (El Bakri et al., 2020; Hajipour et al., 2021), especially in the absence of proper hygiene practices (Kudah et al., 2018).

Proper faecal management is a critical factor in reducing environmental contamination with parasitic stages. Human faeces may carry various pathogens, including protozoa with zoonotic potential (Wagner and Lanoix, 1958). When excreta are not disposed of in sanitary locations—especially near agricultural fields—vegetables can become contaminated, exacerbating the transmission cycle. This risk is heightened in the studied rural zones, where households generally lack sewage systems and adequate waste disposal mechanisms. Several studies have demonstrated that the absence of sanitation infrastructure correlates with increased parasitic infection rates (Berendes et al., 2017; Ticona-Bayta and Martínez-Barrios, 2016).

Moreover, inadequate sanitation contributes to the contamination of water sources with faeces, facilitating the spread of infection through untreated water consumption (Gichuki et al., 2019). In affected communities, the consumption of such water is closely associated with intestinal parasitosis (Barkhori et al., 2016; Ayed et al., 2018; Mejía-Delgado et al., 2014).

To address these public health risks, it is essential to implement education campaigns on food hygiene and the proper handling of raw vegetables (El Bakri et al., 2020). Although washing vegetables can reduce parasite presence, attention must also be paid to the water used for irrigation and washing, particularly in areas lacking domestic drainage systems. In these contexts, water from fields or irrigation channels may sustain environmental stages of parasites over extended periods (González et al., 2018).

In addition, backyard animal husbandry is common in rural areas, with dogs and cats often used for pest control. However, these practices may increase zoonotic risks, as dog ownership has been linked to a higher likelihood of parasitism (Mejía-Delgado et al., 2014). For instance, a study in rural Puno (Peru) identified *Giardia* spp. infections in both children and dogs, suggesting a potential zoonotic transmission route (Pablo et al., 2012). The unregulated defecation of dogs in fields, irrigation ditches, and public areas further contributes to environmental contamination and the parasite transmission cycle.

Health education plays a fundamental role in promoting disease prevention and improving overall community well-being. Unfortunately, the inhabitants of the evaluated hamlets have limited access to healthcare services and rarely visit health centres. This results in poor awareness of personal hygiene and sanitation practices, including basic habits such as handwashing and the safe handling of human and animal excreta. These deficiencies have been cited as major risk factors for parasitic infections in several studies, with children being particularly vulnerable (Ticona-Bayta and Martínez-Barrios, 2016; Nakandakari et al., 2016; Damtie et al., 2021). It is imperative to implement culturally adapted, community-based education programs to increase awareness and encourage healthy practices.

In Peru, particularly in rural areas, public health remains a neglected priority. This lack of investment and attention contributes to the persistence of parasitic infections, which disproportionately affect socioeconomically disadvantaged communities (Wong et al., 2020). In the studied hamlets, the combination of poor sanitation, lack of potable water, and the use of earthen-floor dwellings creates an environment conducive to parasite transmission.

All individuals diagnosed with parasitic infections received antiparasitic treatment. Nevertheless, control strategies in rural settings should adopt an integrated approach that includes antiparasitic therapy, nutritional support, and health education. In line with WHO recommendations (2020), mass drug administration (MDA) represents a key strategy to reduce parasite burden and prevent reinfection in populations at high risk for helminthiasis and other neglected tropical diseases. When implemented periodically, MDA has demonstrated effectiveness in reducing morbidity and mitigating the negative impacts of parasitic infections on child development (Webster et al., 2014). However, its success depends on being combined with improvements in water quality, sanitation infrastructure, and hygiene promotion to break the cycle of transmission and ensure sustainable public health outcomes.

Conclusion

This study revealed a high prevalence and diversity of intestinal parasites in both children and dogs across the three hamlets of the Sorochuco district, Celendín province, Cajamarca region, Peru. These findings are particularly significant as they offer a detailed perspective on the parasitic burden in a remote, high-altitude area that has been largely overlooked in previous research compared to the Cajamarca valley. The results highlight the urgent need for the implementation of appropriate sanitary interventions (particularly the quality of water accessible to the villagers), strengthened epidemiological surveillance, and improved access to medical care in these underserved rural communities. Preventive and therapeutic measures are essential to address this pressing public health concern and to enhance the quality of life and well-being of the affected populations in these marginalised regions.

References

Ayed, L. B., Belhassen, K., Sabbahi, S., Karanis, P., & Nouiri, I. (2018). Assessment of the parasitological quality of water stored in private cisterns in rural areas of Tunisia. Journal of Water and Health, 16(5), 737–749. https://doi.org/10.2166/wh.2018.117.

Barkhori, M. M., Rezaeian, M., Kia, E. B., Raeisi, A., Khanaliha, K., Tarighi, F., & Kamranrashani, B. (2016). Prevalence of Intestinal Parasitic Infections in Jiroft, Kerman Province, Iran. Iranian Journal of Parasitology, 11(2), 232–238.

Berendes, D. M., De Mondesert, L., Kirby, A. E., Yakubu, H., Adomako, L., Michiel, J., Raj, S., Robb, K., Wang, Y., Doe, B., Ampofo, J., & Moe, C. L. (2020). Variation in E. coli concentrations in open drains across neighborhoods in Accra, Ghana: The influence of onsite sanitation coverage and interconnectedness of urban environments. International Journal of Hygiene and Environmental Health, 224, 113433. https://doi.org/10.1016/j.ijheh.2019.113433.

Bogitsh, B.J., Carter, C.E., & Oeltmann, T.N. (2018). Human Parasitology. 5th ed. Academic Press.

Cabrera, R., Vargas-Herrera, J., & Whittembury, A. (2023). Prevalencia de Giardia lamblia en escolares y en otras subpoblaciones peruanas (1990-2018): una revisión sistemática y metaanálisis. Revista de Investigaciones Veterinarias del Perú, 34(2), e21263. https://doi.org/10.15381/rivep.v34i2.21263.

Damtie, D., Sitotaw, B., Menkir, S., Kerisew, B., & Hussien, K. (2021). Human Intestinal Parasitic Infections: Prevalence and Associated Risk Factors among Elementary School Children in Merawi Town, Northwest Ethiopia. Journal of Parasitology Research, 2021, 8894089. https://doi.org/10.1155/2021/8894089.

Delgado, E. M. M., Arce, M. Z., Ravelo, M. A., Uceda, T. C., & Aredo, L. H. (2018). Factores de riesgo de enteroparasitosis en escolares de la Institución Educativa N° 82629 del Caserío Totorillas, distrito de Guzmango, provincia Contumazá, 2014. Revista Médica de Trujillo, 13(2), 80-91. https://revistas.unitru.edu.pe/index.php/RMT/article/view/1947.

Demeke, G., Mengistu, G., Abebaw, A., Toru, M., Yigzaw, M., Shiferaw, A., Mengist, H. M., & Dilnessa, T. (2021).

Effects of intestinal parasite infection on hematological profiles of pregnant women attending antenatal care at Debre Markos Referral Hospital, Northwest Ethiopia: Institution based prospective cohort study. PloS One, 16(5), e0250990. https://doi.org/10.1371/journal.pone.0250990.

Dubey, J. P., Calero-Bernal, R., Rosenthal, B., Speer, C., & Fayer, R. (2015). Sarcocystosis of Animals and Humans. In Taylor & Francis Group: CRC Press eBooks. https://doi.org/10.1201/b19184.

El Bakri, A., Hussein, N. M., Ibrahim, Z. A., Hasan, H., & AbuOdeh, R. (2020). Intestinal Parasite Detection in Assorted Vegetables in the United Arab Emirates. Oman Medical Journal, 35(3), e128. https://doi.org/10.5001/omj.2020.46.

Faust, E. C., Sawitz, W., Tobie, J., Odom, V., Peres, C., & Lincicome, D. R. (1939). Comparative Efficiency of Various Technics for the Diagnosis of Protozoa and Helminths in Feces. Journal of Parasitology, 25(3), 241. https://doi.org/10.2307/3272508.

Fernández-Holguín, C., Canales-Rojas, E., Gutiérrez, C., & Valencia, E. (2023). Fasciola hepatica en preescolares de un centro poblado en una región altoandina del Perú. Anales de la Facultad de Medicina, 84(1), 81-85. https://doi.org/10.15381/anales.v84i1.24638.

Gichuki, P. M., Kepha, S., Mulewa, D., Masaku, J., Kwoba, C., Mbugua, G., Mazigo, H. D., & Mwandawiro, C. (2019). Association between Schistosoma mansoni infection and access to improved water and sanitation facilities in Mwea, Kirinyaga County, Kenya. BMC Infectious Diseases, 19(1), 503. https://doi.org/10.1186/s12879-019-4105-1.

González, K. L., Rivas, R. E., & Sandoval, N. (2018. Aguas, suelos y hortalizas como fuente potencial de enteroparásitos en niños de la escuela Majara, Capira. Tecnociencia, 20(1), 5-26. https://revistas.up.ac.pa/index.php/tecnociencia/article/view/73.

Hajipour, N., Soltani, M., Ketzis, J., & Hassanzadeh, P. (2021). Zoonotic parasitic organisms on vegetables: Impact of production system characteristics on presence, prevalence on vegetables in northwestern Iran and washing methods for removal. Food Microbiology, 95, 103704. https://doi.org/10.1016/j.fm.2020.103704.

Kudah, C., Sovoe, S., & Baiden, F. (2018). Parasitic contamination of commonly consumed vegetables in two markets in Ghana. Ghana Medical Journal, 52(2), 88–93. https://doi.org/10.4314/gmj.v52i2.5.

Leventhal, R., & Cheadle, R.F. (2019). Medical Parasitology: A Self-Instructional Text. 7th ed. F.A Davis Company.

Miró, G., & Bowman, D.D. (2018). Atlas of Parasitological Diagnosis in Dogs and Cats. Volume I: Endoparasites. 1st ed. Grupo Asís.

Nakandakari, M. D., De la Rosa, D. N., & Beltrán-Fabián, M. (2016). Enteroparasitosis en niños de una comunidad rural de Lima-Perú. Revista Médica Herediana, 27(2), 96. https://doi.org/10.20453/rmh.v27i2.2845.

Pablo, O., Chávez, A., Suárez, F., Pinedo, R., & Falcón, N. 2012. Giardia spp. en caninos y niños de comunidades campesinas de tres distritos de Puno, Perú. Revista de Investigaciones Veterinarias del Perú, 23(4), 462-468. https://doi.org/10.15381/rivep.v23i4.953.

Rázuri, B., Murga-Moreno, C., Vargas-Rocha, L., Rojas-Moncada, J., & Torrel-Pajares, T. (2023). Primer reporte de Fasciola hepatica en caballos criollos del norte andino de Perú. Ciencia y Tecnología Agropecuaria, 24(3). https://doi.org/10.21930/rcta.vol24_num3_art:3190.

Rodríguez-Ulloa, C., Rivera-Jacinto, M., Del Valle-Mendoza, J., Cerna, C., Hoban, C., Chilón, S., & Ortiz, P. (2018). Risk factors for human fascioliasis in schoolchildren in Baños del Inca, Cajamarca, Peru. Transactions of the Royal Society of Tropical Medicine and Hygiene, 112(5), 216–222. https://doi.org/10.1093/trstmh/try049.

Rojas-Moncada, J., Torrel-Pajares, T., & Vargas-Rocha, L. (2024). Validation of the natural sedimentation technique in the diagnosis of chronic fasciolosis. Parasitology International, 101, 102889. https://doi.org/10.1016/j.parint.2024.102889.

Sheather, A. L. (1923). The detection of intestinal protozoa and mange parasites by a floatation technique. Journal of

Comparative Pathology and Therapeutics, 36, 266-275. https://doi.org/10.1016/s0368-1742(23)80052-2.

Silva-Caso, W., Carrillo-Ng, H., Aguilar-Luis, M. A., Tarazona-Castro, Y., Valle, L. J. D., Tinco-Valdez, C., Palomares-Reyes, C., Urteaga, N., Bazán-Mayra, J., & Valle-Mendoza, J. D. (2024). Parasitosis by Fasciola hepatica and Variations in Gut Microbiota in School-Aged Children from Peru. Microorganisms, 12(2), 371. https://doi.org/10.3390/microorganisms12020371.

Slany, M., Dziedzinska, R., Babak, V., Kralik, P., Moravkova, M., & Slana, I. (2019). Toxoplasma gondii in vegetables from fields and farm storage facilities in the Czech Republic. FEMS Microbiology Letters, 366(14), fnz170. https://doi.org/10.1093/femsle/fnz170.

Steverding D. (2020). The spreading of parasites by human migratory activities. Virulence, 11(1), 1177–1191. https://doi.org/10.1080/21505594.2020.1809963.

Taghipour, A., Ghodsian, S., Jabbari, M., Olfatifar, M., Abdoli, A., & Ghaffarifar, F. (2021). Global prevalence of intestinal parasitic infections and associated risk factors in pregnant women: a systematic review and meta-analysis. Transactions of the Royal Society of Tropical Medicine and Hygiene, 115(5), 457–470. https://doi.org/10.1093/trstmh/traa101.

Ticona-Bayta, L., & Martínez-Barrios, E. (2016. Prevalencia y factores de riesgo del parasitismo intestinal en escolares del distrito de Cabanaconde, provincia de Caylloma, Arequipa, Perú. Neotropical Helminthology, 10(2), 151-161. https://doi.org/10.24039/rnh2016102737.

Torgerson, P. R., Devleesschauwer, B., Praet, N., Speybroeck, N., Willingham, A. L., Kasuga, F., Rokni, M. B., Zhou, X. N., Fèvre, E. M., Sripa, B., Gargouri, N., Fürst, T., Budke, C. M., Carabin, H., Kirk, M. D., Angulo, F. J., Havelaar, A., & de Silva, N. (2015). World Health Organization Estimates of the Global and Regional Disease Burden of 11 Foodborne Parasitic Diseases, 2010: A Data Synthesis. PLoS Medicine, 12(12), e1001920. https://doi.org/10.1371/journal.pmed.1001920.

Torrel, S., Rojas-Moncada, J., Saldaña, K., Silva, M., Gallardo, I., Cadenillas, R. del R., Alfaro, D., Irigoín, C., Murga-Moreno, C. A., & Vargas-Rocha, L. (2023). Trematodos del ganado vacuno lechero al pastoreo en Cajamarca, Perú: Fasciola hepatica y Calicophoron microbothrioides. Revista de Investigaciones Veterinarias del Perú, 34(4), e24296. https://doi.org/10.15381/rivep.v34i4.24296.

Vargas-Rocha, L. A., Malpartida, E., & Murga-Moreno, C. (2021). Prevalencia de trematodos y nematodos en asnos comercializados en la Plaza Pecuaria Iscoconga de la provincia de Cajamarca, Perú. Revista de Investigaciones Veterinarias del Perú, 32(3), e18846. https://doi.org/10.15381/rivep.v32i3.18846.

Vidal-Anzardo, M., Moscoso, M. Y., & Fabian, M. B. (2020). Parasitosis intestinal: Helmintos. Anales de la Facultad de Medicina, 81(1), 26-32. https://doi.org/10.15381/anales.v81i1.17784.

Wagner, E.G., & Lanoix, J.N. (1958). Excreta disposal for rural areas and small communities. Monograph series. World Health Organization, 39, 1–182.

Webster, J. P., Molyneux, D. H., Hotez, P. J., & Fenwick, A. (2014). The contribution of mass drug administration to global health: past, present and future. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 369(1645), 20130434. https://doi.org/10.1098/rstb.2013.0434.

Wong, L. W., Ong, K. S., Khoo, J. R., Goh, C. B. S., Hor, J. W., & Lee, S. M. (2020). Human intestinal parasitic infection: a narrative review on global prevalence and epidemiological insights on preventive, therapeutic and diagnostic strategies for future perspectives. Expert Review of Gastroenterology & Hepatology, 14(11), 1093–1105. https://doi.org/10.1080/17474124.2020.1806711.

World Health Organization. (2020). Ending the neglect to attain the sustainable development goals: a road map for neglected tropical diseases 2021–2030. World Health Organization. https://iris.who.int/handle/10665/338565.

Ydrogo, M., Cabrera, M., Cuzcano-Anarcaya, J. L., Vargas-Rocha, L., & Torrel, T. 2024. Evaluation of the presence of Sarcocystis spp. in dogs raised in alpaca farm enterprises in Cajamarca, Peru. The Thai Journal of Veterinary

Medicine, 54(4), 1. https://doi.org/10.56808/2985-1130.3632