



# Prevalence and Risk Factors of Intestinal Parasite Infection among Schoolchildren in the Peripheral Highland Regions of Huanuco, Peru

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**Objectives:** Schoolchildren in developing countries are at greater risk of intestinal parasitic infections. This study aimed to estimate the prevalence and assess the risk factors of intestinal parasite infection among schoolchildren in rural areas of Peru.

**Methods:** A volunteer team from the Korea International Cooperation Agency (KOICA) conducted a campaign for parasite eradication called “Chao parasitos” at five schools in the peripheral highland regions of Huanuco in October 2013. The study collected questionnaires and stool samples from children of participating schools. *Entamoeba coli*, *Iodamoeba buschii*, and *Chilomastix mesnili* were classified as nonpathogenic parasites.

**Results:** The overall prevalence of intestinal parasite infection in the students was 100% (185/185). Among them, 25.9% (48/185) were infected only with nonpathogenic parasites whereas 74.1% (137/185) were infected with at least one pathogenic parasite. *Ascaris lumbricoides* was the most commonly detected (37.3%, 69/185), followed by *Giardia lamblia* (15.1%, 28/185) and *I. buschii* (11.9%, 22/185). Among lifestyle practices associated with parasitic infection, the rate of washing hands before meals was significantly lower in the students with pathogenic parasites compared to those with nonpathogenic parasites (77.4%, 106/137 vs. 93.8%, 45/48,  $p = 0.025$ ).

**Conclusion:** The prevalence of intestinal parasite was 100%. Both personal hygiene and water supply facilities are required to eradicate parasite infection in rural areas of Peru.

**Key Words:** parasites, volunteers, Peru

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## INTRODUCTION

Intestinal parasite infections are a major public health issue in the developing world [1]. It has been estimated that over 3.5 billion people are infected with intestinal parasites globally. People in developing countries are at greater risk for these infections due to poor hygiene and a lack of sanitation facilities [2]. Schoolchildren are particularly vulnerable to intestinal parasitic infections because of their poor hygiene, hand-mouth activity, and immature immune system [3].

Peru is a well-known developing country on the central Pacific coast of South America. Despite a fast-growing economy, approximately 40% of the population still lives under poor socioeconomic conditions. The bottom 50% of the population, in terms of income, contributes only 13% of the gross domestic product, and 65% of nationals cannot take advantage of health insurance [4]. Additionally, people in poor regions have limited access to sanitation facilities, and young children in such regions suffer from parasitic infections that can cause malnutrition,



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stunting, and even death [5].

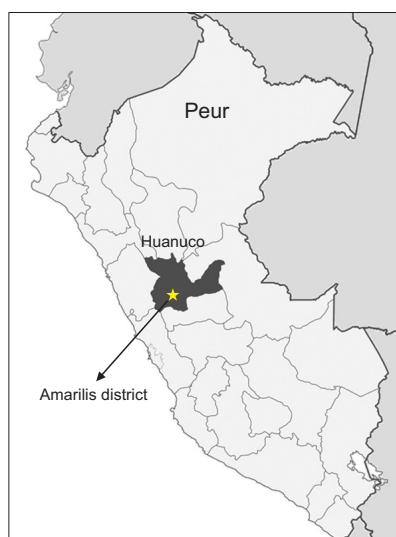
The Korea International Cooperation Agency (KOICA) is a government agency that provides Official Development Assistance (ODA) work and dispatches volunteers including health professionals to Peru [4]. The health sector is one of the principal ODA strategies of the KOICA in Peru; therefore, several campaigns on health promotion have been conducted by volunteers particularly in poor regions [4]. In 2013, KOICA volunteers in Huanuco, a province located in the Andean highland, noticed that many schoolchildren were suffering from parasite infections and organized a campaign for parasite eradication which was called “Chao parasitos.” There are few studies on intestinal parasite infections among schoolchildren in Peru and no relevant statistics for the Huanuco province [5,6].

The objective of this study was to estimate the prevalence and to assess the risk factors of intestinal parasite infections among schoolchildren in the peripheral highland regions of Huanuco, Peru based on data collected from the campaign.

## MATERIALS AND METHODS

### 1. Study setting and population

This study was performed in the highland areas of the Amaris district located in the peripheral region of Huanuco, Peru (Figure 1). The KOICA volunteer team conducted a campaign for parasite eradication, “Chao parasitos,” in October 2013. Five schools in this area (Cachuna, Matamarca, Sariapampa, Shari-cancha, and Paucar) were selected. Primaria students (similar to



**Figure 1.** Map of the Huanuco region. The arrow shows the Amaris district where the study was conducted.

elementary school aged) from all five schools ( $n = 222$ ) and secundaria students (similar to middle and high school aged) from one school (Sariapampa,  $n = 32$ ) participated in this campaign. The campaign program was as follows:

*Day 1.* The KOICA volunteer team visited each school and gave an introduction to all the students that included a description of the proper way to collect a stool sample. Then, they measured the height and weight of each student. Labeled plastic stool containers and questionnaires were distributed thereafter.

*Day 2.* Stool samples and questionnaires were collected by the KOICA volunteer team. They transported the collected stool samples to the laboratory of Centro de Salud (public health center), Peru-Corea, for parasitological examination.

*Day 3.* The KOICA volunteer team explained the results of the parasitological examination to the students and distributed anthelmintic drugs (albendazole, metronidazole, or praziquantel) according to the detected parasite species. Subsequently, education on prevention measures against parasite infections was provided to the students and teachers.

Students who completed questionnaire and submitted proper stool sample were enrolled in this study. We classified *Entamoeba coli*, *Iodamoeba buschii*, and *Chilomastix mesnil* as nonpathogenic parasites and others as pathogenic parasites.

### 2. Laboratory analysis and data collection

All collected stool samples were examined using direct smear method with light microscopy. Lugol's iodine was applied on direct smear slide for the identification of protozoan parasites. All positive results were confirmed by a second observer.

The questionnaire included demographic information (gender, age, weight, height), lifestyle practices associated with parasite infection (number of family members, raising animal at home, washing hands before meals, wearing shoes, drinking water sources, eating raw vegetables, using latrine, cultivating vegetable garden, using fertilizers with human feces) and parent's knowledge of parasite infection (parasite transmission route, parasite infection state in their children).

### 3. Statistical analysis

IBM SPSS Statistics version 24.0 for Windows (IBM Co., Armonk, NY, USA) was used for the statistical analysis. Categorical variables were analyzed by the chi-square test or Fisher's exact test. Continuous variables were analyzed by the independent  $t$ -test. A  $p$ -value of  $< 0.05$  by a two-tailed test was considered to be significant.

### 4. Ethics statement

The study protocol was approved by the institutional review

boards of Eulji University Hospital (IRB number: 2017-04-019), and the requirement for written informed consent from patients was waived.

## RESULTS

Overall demographic data of participants is shown in **Table 1**. The average age was  $10.1 \pm 2.9$  years. Approximately half of the participants were male (51.4%, 95/185) and the average body mass index (BMI) was  $17.2 \pm 2.4$  kg/m<sup>2</sup>. All of the subjects were infected with at least one parasite (100%, 185/185). Among them, 25.9% (48/185) of the subjects were infected with nonpathogenic parasites, and 74.1% (137/185) were infected with at least one pathogenic parasite. Monoparasitism was observed in 91.9% (170/185), and more than two parasites were observed in 8.1% (15/185). Ten parasite species (3 nonpathogenic parasites and 7 pathogenic parasites) were found in the stool samples: *Ascaris lumbricoides* was the most commonly detected (37.3%, 69/185), followed by *Giardia lamblia* (15.1%, 28/185), *I. buschii* (11.9%, 22/185) and *E. coli* (10.3%, 19/185) (**Table 2**).

Risk factors of pathogenic parasite infection are shown in **Table 3**. There was no difference in average BMI between students with pathogenic parasite and students with nonpathogenic

parasite ( $17.2 \pm 2.4$  kg/m<sup>2</sup> and  $17.3 \pm 2.3$  kg/m<sup>2</sup>, respectively;  $p = 0.687$ ). Among lifestyle practices associated with parasite infection, the rate of washing hands before meals was significantly lower in the students with pathogenic parasite compared to those with nonpathogenic parasite (77.4%, 106/137 and 93.8%, 45/48, respectively;  $p = 0.025$ ). There was no significant difference between the two groups in number of family members, raising animals at home, wearing shoes, drinking water sources, eating raw vegetables, using latrine and cultivating vegetable garden. The rate of using fertilizers with human feces was approximately two-fold higher in the students with pathogenic parasites; however, this was not statistically significant (13.9%, 19/137 and 6.3%, 3/48, respectively;  $p = 0.144$ ). There were no significant differences between the two groups on parent's knowledge of parasite transmission route (21.2%, 29/137 and 22.9%, 11/48, respectively;  $p = 0.874$ ) as well as on parent's knowledge of parasite infection state in their children (31.4%, 43/137 and 31.3%, 15/48, respectively;  $p = 0.891$ ).

## DISCUSSION

In the present study, the overall prevalence of intestinal parasite infections was 100% among schoolchildren in the pe-

**Table 1.** Descriptive analysis of demographic data (n = 185)

	Data
Gender	
Male	95 (51.4)
Female	90 (48.6)
Age (y)	10.1 ± 2.9
Body mass index (kg/m <sup>2</sup> )	17.2 ± 2.4
Participating schools	
Paucar	48 (25.9)
Sarapampa primaria	33 (17.8)
Sarapampa scundaria	32 (17.3)
Sharicancha	32 (17.3)
Cachuna	22 (11.9)
Matamarca	18 (9.7)
Parasite infections	
Pathogenic parasite infections	137 (74.1)
Nonpathogenic parasite infections <sup>a</sup>	48 (25.9)

Values are presented as number (%) or mean ± standard deviation.

<sup>a</sup>Infected only with *Entamoeba coli*, *Iodamoeba buschii*, or *Chilomastix mesnil*.

**Table 2.** Parasitological findings

	Mono-parasitism (n = 170)	Poly-parasitism (n = 15)	Total (n = 185)	Prevalence (%) <sup>a</sup>
Nonpathogenic parasite				
<i>Entamoeba coli</i>	11	8	19	10.3
<i>Chilomastix mesnili</i>	16	1	17	9.2
<i>Iodamoeba buschii</i>	19	3	22	11.9
Subtotal	46	12	58	31.4
Pathogenic parasite				
<i>Ascaris lumbricoides</i>	62	7	69	37.3
<i>Blastocystis hominis</i>	8	2	10	5.4
<i>Enterobius vermicularis</i>	1	1	2	1.1
<i>Giardia lamblia</i>	22	6	28	15.1
<i>Hymenolepis nana</i>	14	1	15	8.1
<i>Strongyloides stercoralis</i>	6	0	6	3.2
<i>Trichuris trichiura</i>	11	1	12	6.5
Subtotal	124	18	142	76.8
Total	170	30	200	100

<sup>a</sup>Percentage of children with positive results divided by the total number of children (n = 185).

**Table 3.** Risk factors of pathogenic parasite infection

Variable	Students with		Total (n = 185)	p-value
	Pathogenic parasite (n = 137)	Nonpathogenic parasite (n = 48)		
Body mass index (kg/m <sup>2</sup> )	17.2 ± 2.4	17.3 ± 2.3	17.2 ± 2.4	0.687
Number of family members	5.7 ± 2.1	5.1 ± 1.8	5.5 ± 2.0	0.119
Raising animals at home	132 (96.4)	48 (100)	180 (97.3)	0.547
Washing hands before meals	106 (77.4)	45 (93.8)	151 (81.6)	0.025
Wearing shoes	87 (63.5)	32 (66.7)	119 (64.3)	0.875
Drinking water sources				0.804
Natural water	75 (54.7)	28 (58.3)	103 (55.7)	
Mineral water	3 (2.2)	0 (0.0)	3 (1.6)	
Boiled water	27 (19.7)	9 (18.8)	36 (19.5)	
Tap water	27 (19.7)	11 (22.9)	38 (20.5)	
Non-response	5 (3.6)	0 (0)	5 (2.7)	
Eating raw vegetables	75 (54.7)	26 (54.2)	101 (54.6)	0.790
Using latrine	76 (55.5)	30 (62.5)	106 (57.3)	0.518
Cultivating vegetable garden	119 (86.9)	44 (91.7)	163 (88.1)	0.663
Using fertilizers with human feces	19 (13.9)	3 (6.3)	22 (11.9)	0.144
Parent's knowledge of parasite transmission route	29 (21.2)	11 (22.9)	40 (21.6)	0.874
Parent's knowledge of parasite infection state in their children	43 (31.4)	15 (31.3)	58 (31.4)	0.891

Values are presented as mean ± standard deviation or number (%).

ripheral highland regions of Huanuco. It was higher than the 91.2% prevalence in a previous study conducted in other Peruvian rural highland communities [7]. Furthermore, it seems to be higher compared to that in rural regions of other countries in South America. The prevalence of intestinal parasite infections was 53.4% among agricultural settlements in the Amazon region of Brazil [8], 77% among an indigenous group in the Bolivian Amazon region [9], and 69% among rural public school students in Colombia [10]. In addition, the prevalence of pathogenic parasites in the highland regions of Huanuco was higher than that of the highland regions of Puno (76.8% and 19.8%, respectively). According to Maco Flores et al. [7], *Hymenolepis nana* (6.6%) showed the highest prevalence in the rural highland areas of Puno, followed by *Entamoeba histolytica* (5.5%), *G. lamblia* (3.3%), *Taenia* sp. (2.2%) and *A. lumbricoides* (2.2%). Additionally, *A. lumbricoides* and *Trichuris trichiura*, common soil-transmitted helminths that are known to be highly relevant to malnutrition and growth retardation [11], comprised a great proportion of the intestinal parasite infections in the study area (43.8%, 81/185). Specifically, the prevalence of *A. lumbricoides* in Huanuco was higher compared to other South American coun-

tries such as Brazil (5.8%) [8], Bolivia (7%) [9], and Colombia (21%) [10], as well as other Peruvian provinces (2.2%) [7].

The high prevalence of pathogenic parasite infections may have an important role in the nutritional status of the study region. It is well known that intestinal parasite infections decrease appetite and cause several gastrointestinal symptoms including vomiting, diarrhea, and abdominal pain, which have a detrimental impact on the growth rate, school attendance and cognitive performance of schoolchildren [12]. The nutritional status of the schoolchildren can be classified into four categories according to their BMI; severe malnutrition (< 15.9 kg/m<sup>2</sup>), moderate malnutrition (16–16.9 kg/m<sup>2</sup>), mild malnutrition (17–18.4 kg/m<sup>2</sup>), and normal (18.5–25 kg/m<sup>2</sup>) [13]. With this standard, the average nutritional status of the participants was mild malnutrition (BMI, 17.2 ± 2.4 kg/m<sup>2</sup>).

We suggest that use of infected water is the primary cause of the high prevalence of intestinal parasite infections in the study region [14]. The majority of the participants drank natural or tap water (76.2%, 141/185) rather than boiled or mineral water (21.1%, 39/185). Unfortunately, the study area does not have a standardized water supply system, and unfiltered water is de-

livered to each household. Moreover, the water is likely to be contaminated by human and animal feces. In fact, about 40% of the participants (42.7%, 79/185) did not use latrines, and it is possible they might defecate in the open.

Parents' lack of knowledge about parasite infections was another serious problem in the study region; parents who knew about parasite transmission routes and the parasite infection status of their children were only 21.6% and 31.4%, respectively. Several studies in other countries have shown that an especially low maternal education level is highly correlated with the risk of parasitic infection in children [15–17]. Mothers with a low educational level tend to be less knowledgeable about the controllability of parasitic infections and believe that infections are inevitable in their children [15], and because of this, children are exposed to risky family habits and environments as well as a poor sense of hygiene. Additionally, parents' lack of knowledge about parasite infections disrupts taking prompt, proper measures for their children's infections. Therefore, improving the knowledge and behavior of the parents is necessary to control parasitic infections.

The level of personal hygiene is an important risk factor of parasitic infection. Interestingly, a significantly lower handwashing rate before meals was observed among the schoolchildren with pathogenic parasites compared to those without nonpathogenic parasites in this study. Additionally, hand washing is one of the most effective and simple methods to reduce the risk of infectious diseases; handwashing with plain soap can reduce 53% of gastrointestinal infections in developing countries [18].

Taken together, establishing adequate water supply facilities and education on personal hygiene are essential for the eradication of parasite infections in the study region. To achieve this goal more effectively, cooperation between the Peruvian government and the international community is necessary. In this regard, the role of the KOICA is important. The KOICA began to dispatch volunteers to Peru since 1996, and the health sector has been providing the principal ODA strategies in this country [4]. With support of the Korean government, the KOICA constructed five public health centers and one hospital in Peru; one of these exists in Huanuco. For this reason, Huanuco became a strategic region

for the KOICA, and several health professionals including international cooperation doctors have been dispatched to achieve these ODA works [4]. We expect further sophisticated support for this region.

There are limitations to this study. First, we collected data using written questionnaires. Children who have parents with a low education level may not have completed the questionnaire and thus were excluded from this study. To minimize such bias, we obtained help from local teachers if the parents of students were illiterate. Second, the parasitological examination was performed with samples from the participants, and we could not assess the surrounding environment. Thus, the transmission route was not verified. Further research is necessary to provide additional insight on parasitic infection in this region.

Despite these limitations, this is the first study on prevalence and risk factor analysis of intestinal parasite infections among schoolchildren in the peripheral highland regions of Huanuco, Peru. The prevalence of intestinal parasites was 100% in this region. Both personal hygiene and water supply facilities are required to eradicate parasite infections in this area. Further cooperation between the Peruvian government and international organizations including the KOICA is essential to improve public health in rural Peruvian areas.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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