

Beyond COVID-19: The Association between Ivermectin Use and Enteroparasitosis Prevalence in School Children

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ABSTRACT

Background: Intestinal parasitic infections remain a public health concern in tropical regions, particularly among school-aged children who are exposed to risk factors such as animal husbandry and inadequate sanitation conditions.

Objective: This study aimed to determine the prevalence of intestinal parasitosis in schoolchildren and subsequently to evaluate the relationship between ivermectin use, handwashing practices, and animal husbandry and the prevalence of intestinal parasitosis in schoolchildren in a tropical region of Peru.

Methods: A cross-sectional analytical study was conducted from June 2022 to December 2022 among 107 schoolchildren in Tingo María, Peru. Data were collected through a structured questionnaire administered to parents/guardians and direct coproparasitological analysis of fecal samples. Statistical analysis included descriptive statistics, Chi-square tests, and Poisson regression.

Results: A high prevalence of intestinal parasitosis was observed (76.6%). Among the evaluated factors, prior ivermectin use was significantly associated with a lower frequency of parasitic infection ($p=0.037$; $PR=0.63$; 95% CI: 0.42-0.93). Animal husbandry also showed a significant association, whereas handwashing was not identified as a determining factor.

Conclusion: The finding that prior ivermectin use may be associated with a reduced prevalence of intestinal parasitosis opens new avenues for further research into its potential role in endemic regions. This result warrants further research to evaluate its effectiveness as part of community-level parasitic control strategies.

Keywords: Intestinal parasitosis, ivermectin, COVID, mass drug administration, Peru.

INTRODUCTION

Intestinal parasitic infections remain a significant public health issue, particularly in developing countries and regions. It is estimated that more than 30% of the global population is affected by intestinal parasitic infections, compromising over 40 million preschool-aged children in Latin America alone [1]. In general, the incidence and severity of these infections are higher during school age, which is associated with an increased risk of morbidity [2].

In Peru, the Pan American Health Organization (PAHO) reports that intestinal parasitosis shows a high prevalence and ranks among the top ten causes of morbidity and mortality. A 2022 study reported an overall parasitic infection prevalence of 63.6% and a helminth infection prevalence of 9.8% [3]. Furthermore, 68% of the country's regions (17 out of 25) reported high prevalence rates, with Amazonas, La Libertad, Cajamarca, Huancavelica, and Huánuco being the most affected [1].

Intestinal parasitic infections, particularly when associated with nutritional anemia, protein-energy malnutrition, and growth delays, can have detrimental effects on child health and impair cognitive development [4]. In many endemic settings, these infections persist as chronic and latent conditions at both the individual and collective levels, maintaining a state of stable endemicity [5].

In endemic regions where the burden of intestinal parasitic diseases is high, the widespread use of medications such as ivermectin—driven by fear of COVID-19—may have indirectly contributed to a reduction in the prevalence of these infections [6]. In the field of pharmacology, it is not uncommon for certain drugs initially approved for a specific indication to exhibit secondary effects that prove beneficial for other health conditions. This phenomenon has led to the extended use of medications for purposes not contemplated initially, a practice known as “off-label” use [7].

Preventing parasitic diseases requires comprehensive interventions that improve living conditions, including nutrition, access to adequate housing, health education, and environmental sanitation [8]. However, a substantial proportion of the population still lacks these necessities,

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underscoring the urgent need to implement health education strategies to prevent these infections [9].

In this context, it is relevant to explore how standard practices during recent public health events—such as the widespread use of ivermectin during the COVID-19 pandemic—may have indirectly influenced the prevalence of intestinal parasitic infections. Given the high burden of intestinal parasitosis in tropical regions and limited access to healthcare services, the present study aimed to determine the prevalence of intestinal parasitosis among schoolchildren. Subsequently, it aimed to determine the relationships among ivermectin use, handwashing practices, and animal husbandry and the prevalence of intestinal parasitosis in school children.

METHODS

A cross-sectional study was conducted from June 2022 to December 2022 among 4th and 5th-grade students at the César Vallejo Educational Institution in Tingo María, Peru. The research protocol was approved by the Ethics and Research Committee of the Faculty of Human Medicine of the National University Hermilio Valdizán on February 17, 2022, in Huánuco. Participants were excluded if they had received antiparasitic Treatment within the past 3 months, had chronic gastrointestinal conditions, or provided incomplete questionnaire or fecal sample data. Students and their parents/guardians who declined to participate were also excluded. Before data collection, written informed consent was obtained from parents or legal guardians, and verbal assent from participating students. These criteria were implemented to maintain internal validity while preserving the representative nature of this school-based study in an endemic area.

Instead of selecting a sample, this study adopted a census-based approach to include the entire eligible population of 4th- and 5th-grade primary students enrolled at the César Vallejo Educational Institution during the 2022 academic year (N=150). Therefore, no formal sample size calculation or statistical software was employed, as the objective was to maximize participant inclusion from the complete target population during the study period. After applying the exclusion criteria and obtaining all necessary informed consents, 107 students were ultimately included, yielding a participation rate of 71.3% of the target population.

Data collection was synchronized with the school term to maximize participant availability and minimize disruptions to educational activities. The study tool consisted of a data collection form with two sections: a structured questionnaire for the parent/guardian interview and a record of direct coproparasitological analysis results from the fecal samples.

Within the structured questionnaire, 'Knowledge of hand washing technique' was assessed through three specific items: situations for handwashing, adherence to hand

washing steps, and types of supplies used. Participants who answered correctly to two or more of these three items were categorized as having 'adequate' knowledge. In comparison, those who responded correctly to one or zero items were considered to have 'inadequate' knowledge.

Separately, 'Hand washing technique' (referring to the quality of the practice) was assessed using a 10-item questionnaire administered to parents/guardians, evaluating various aspects of proper handwashing execution. Participants who correctly answered five or fewer of these 10 items were categorized as having 'inadequate' hand washing technique. In contrast, those with more than five correct answers were considered to have 'adequate' handwashing technique.

Additionally, sterile containers were provided for the collection of fecal samples. All stool samples collected were transported in a cold chain (43.2°F to 47.2°F) and processed within 2 to 4 hours. Parasitological examination was performed using direct saline smears and the spontaneous sedimentation concentration technique (Ritchie). All samples were analyzed by an expert microbiologist at the Tingo María hospital laboratory to identify cysts, eggs, or larvae.

Data were entered into Microsoft Excel and subsequently analyzed using SPSS version 26. Bivariate and multivariable Poisson regression analyses with robust standard errors were performed to estimate Prevalence Ratios (PRs) and their 95% confidence intervals to assess the association between various factors and intestinal parasitosis. This approach, using Poisson regression with a log link, was specifically chosen for our cross-sectional study with a binary outcome and high observed prevalence to estimate prevalence ratios [10, 11] directly. P-values less than or equal to 0.05 were taken as statistically significant.

RESULTS

During the study period, 107 students from the 4th and 5th grades of primary education at the César Vallejo Educational Institution in Castillo Grande, Tingo María, participated in the study in 2022. Regarding sociodemographic characteristics, 43.93% were male and 56.07% female. The average age was 10 ± 1 years. A total of 55.14% were enrolled in the 4th grade and 44.86% in the 5th grade.

Table 1 presents the clinical characteristics obtained from the questionnaires and laboratory reports. The prevalence of intestinal parasitosis was 76.60%, with *Ascaris lumbricoides* being the most frequently identified parasite (34.10%), followed by *Giardia lamblia* (24.40%). A high prevalence of domestic animal rearing was also observed, with poultry as the most common farm animal (37.40%) and dogs as the most frequent companion animal (59.80%).

Table 1: Clinical characteristics of 4th and 5th-grade primary school students at I.E. César Vallejo Castillo Grande-Tingo María 2022.

Clinical Characteristics	Frequency	Percentage
Hand washing situation		
Before handling food	63	55.88
After using the toilet	39	36.45
After recreational activities	2	1.89
Unknown information	3	2.80
Knowledge of hand washing technique		
Adequate	95	88.79
Inadequate	12	11.21
Hand washing technique		
Adequate	68	63.5
Inadequate	39	36.5
Supplies used in hand washing		
Liquid soap	74	96.17
Bar soap	27	25.23
Detergent	2	1.87
Water only	4	3.74
Consumption of ivermectin		
Yes	49	45.79
No	58	54.21
Reason for consumption of ivermectin		
Treatment for COVID-19	23	47.92
Prevention for COVID-19	25	52.08
Dosage of ivermectin consumption		
Single dose: one drop per kg body weight	22	45.83
1 drop per kg body weight every 24h for 2 days	11	22.92
Other	15	31.25
Last date of ivermectin consumption		
Less than 6 months	19	38.78
Less than 1 year	14	28.57
More than 1 year	15	30.61

Clinical Characteristics	Frequency	Percentage
Unknown information	1	2.04
Animal husbandry		
Pig	12	11.20
Poultry	40	37.40
Cattle	4	3.70
Guinea Pig	7	6.5
No animal husbandry	44	41.10
Stool diagnosis feces		
Positive	82	76.60
Negative	25	23.40
Type of parasites		
Giardia lamblia	20	24.40
Enterobius vermicularis	18	22.00
Blastocystis hominis	16	19.50
Ascaris lumbricoides	28	34.10
Father's level of education		
No education	10	9.30
Primary complete	20	18.70
Primary incomplete	29	27.10
Secondary complete	31	29.00
Secondary incomplete	9	8.40
Technical or university education completed	7	6.50
Technical or university education is incomplete	1	0.90
Household overcrowding		
Yes	67	62.60
No	40	37.40
Previous deworming		
Yes	64	59.80
No	43	40.20

Table 2: Bivariate analysis of demographic and clinical characteristics with intestinal parasitosis in 4th and 5th-grade primary school students at I.E. César Vallejo Castillo Grande -Tingo María 2022.

Characteristics	Intestinal Parasitosis				p-value	PR	95% CI	
	Yes		No				Lower limit	Upper limit
	N	%	N	%				
Grade of study					0.921	1.010	0.818	1.247
Fourth grade	45	76.30	14	23.70	-	-	-	-
Fifth grade	37	77.10	11	22.90	-	-	-	-
Sex					0.353	1.105	0.888	1.375
Female	34	72.30	13	27.70	-	-	-	-
Male	48	80.00	12	20.00	-	-	-	-
Age					0.452	1.084	0.880	1.334
9 to 10 years old	49	74.20	17	25.80	-	-	-	-
11 to 13 years old	33	80.50	8	19.50	-	-	-	-
Ivermectin consumption					*0.037	0.797	0.636	0.998
Yes	33	67.50	16	32.65	-	-	-	-
No	49	84.48	9	15.52	-	-	-	-
Knowledge of hand washing technique					0.561	1.45	0.382	5.518
Adequate	72	75.8	23	24.2	-	-	-	-
Inadequate	10	83.3	2	16.7	-	-	-	-
Hand washing technique					*0.015	0.770	0.635	0.933
Adequate	47	69.10	21	30.9	-	-	-	-
Inadequate	35	89.70	4	9.3	-	-	-	-

Characteristics	Intestinal Parasitosis				p-value	PR	95% CI	
	Yes		No				Lower limit	Upper limit
	N	%	N	%				
Animal husbandry					*0.008	1.346	1.052	1.722
Yes	54	85.71	9	14.29	-	-	-	-
No	28	63.64	16	36.36	-	-	-	-
Presence of overcrowding					*0.040	1.248	1.248	1.518
Yes	35	87.50	5	12.50	-	-	-	-
No	47	70.10	20	29.90	-	-	-	-
Presence of companion animals					0.273	1.179	0.834	1.667
Yes	19	21.35	70	78.65	-	-	-	-
No	6	33.33	12	66.67	-	-	-	-
Last date of consumption					0.614	0.896	0.574	1.400
6 months to 1 year	23	69.70	10	30.30	-	-	-	-
More than 1 year or do not remember	10	62.5	6	37.50	-	-	-	-
Reason for taking ivermectin					0.084	1.413	0.940	2.125
Treatment for COVID-19	14	56	11	44	-	-	-	-
Prevention for COVID-19 and Treatment for a parasitosis	19	79.17	5	20.83	-	-	-	-
Ivermectin dosage					0.289	1.25	0.856	1.823
Single dose of 1 drop per kg or one drop per kg every 24 hours for 2 days	22	62.86	13	37.14	-	-	-	-
Do not remember	11	78.57	3	21.43	-	-	-	-

CI: Confidence interval, PR: Prevalence ratio, *Significant at p<0.05

The results of the bivariate analysis are presented in Table 2. Several factors were significantly associated with the prevalence of intestinal parasitosis. Ivermectin consumption was associated with a lower prevalence of parasitosis (p=0.037; PR=0.797, 95% CI: 0.636-0.998), indicating a 20.3% lower prevalence among children who had taken the medication. Similarly, adequate handwashing technique was associated with a 23% lower prevalence of intestinal parasitic infection (p=0.015; PR=0.770, 95% CI: 0.635-0.933).

In contrast, animal husbandry showed a significant positive association with intestinal parasitosis (p=0.008; PR=1.346, 95% CI: 1.052-1.722), corresponding to a 34.6% higher prevalence among children living in households that raised farm animals. Likewise, household overcrowding was associated with a 24.8% higher prevalence of parasitic infection (p=0.040; PR=1.248, 95% CI: 1.026-1.518).

No significant associations were found for grade of study, sex, age, presence of companion animals, timing of ivermectin consumption, reason for taking ivermectin, or ivermectin dosage.

Table 3: Regression analysis of factors associated with intestinal parasitosis in school children.

Characteristics	p-value	PR	95% CI	
			Lower Limit	Upper Limit
Ivermectin consumption	0.218	0.878	0.715	1.079
Hand washing technique	*0.021	0.794	0.652	0.966
Animal husbandry	0.095	1.211	0.967	1.515
Presence of overcrowding	*0.042	1.223	1.001	1.486

CI: Confidence interval, PR: Prevalence ratio, *Significant at p<0.05

In the multivariate Poisson regression analysis, adequate handwashing technique remained significantly associated with a lower prevalence of intestinal parasitosis (PR=0.794, 95% CI: 0.652-0.966; p=0.021), while household overcrowding remained significantly associated with a higher prevalence (PR=1.223, 95% CI: 1.001-1.486; p=0.042) (Table 3).

DISCUSSION

The main objective of this study was to determine the relationships among ivermectin use, handwashing practices, and animal husbandry and the prevalence of intestinal parasitosis among 4th- and 5th-grade primary school students.

Consistent with our findings, several studies have reported a high prevalence of intestinal parasitic infections in children and school-aged populations, indicating that, despite accumulated knowledge, significant challenges remain in reducing these infections and addressing their multiple contributing factors [12-15]. Intestinal parasitoses remain a persistent public health challenge in tropical regions, where climatic conditions, poverty, and poor sanitation create an ideal environment for the transmission of these pathogens. In areas such as the Brazilian Amazon, high prevalence rates of helminthic and protozoan infections have been documented, particularly in communities with limited access to healthcare and sanitation services [16].

In the bivariate analysis, ivermectin consumption was significantly associated with a lower prevalence of intestinal parasitosis; however, this association was not maintained in the multivariate Poisson regression model. Although ivermectin has proven efficacy against

several intestinal parasites, its incidental use during the COVID-19 pandemic likely produced heterogeneous exposure in the studied population, which may explain the absence of an independent association. Studies in Latin America have shown that ivermectin is highly effective against strongyloidiasis and other intestinal helminths when used in proper dosing schemes [17].

During the pandemic, ivermectin was widely used without standardized regimens and for non-parasitic indications, which might have limited its antiparasitic impact [18]. In contrast, in onchocerciasis-endemic countries, where mass drug administration with ivermectin is essential, the COVID-19 pandemic negatively impacted deworming efforts [19]. Furthermore, recent studies suggest that periodic ivermectin treatment can interrupt the transmission cycle of certain parasites by reducing reinfection rates, particularly in settings with limited access to clean water and sanitation [20]. In this context, incorporating ivermectin into school-based public health programs may represent a cost-effective strategy to reduce the burden of intestinal parasitoses in children, especially in tropical regions with continuous exposure to parasitic agents [21].

The multivariate analysis confirmed that adequate handwashing technique remained significantly associated with a lower prevalence of intestinal parasitosis. A study in Indonesia found that handwashing alone was insufficient to prevent parasitic infections, highlighting the importance of factors such as overcrowding, water quality, and excreta disposal [22]. In contrast, multiple studies emphasize the role of hand hygiene in reducing the risk of parasitic infections. For instance, Aveiga reported that poor hygiene habits were significant risk factors in children under 7 years of age [23]. Poor hygiene has also been linked to acute diarrheal diseases caused by parasites [24]. In Nigeria, caregiver handwashing habits were associated with intestinal parasitic infections in children [25].

Household overcrowding also remained independently associated with intestinal parasitosis. Overcrowded conditions facilitate parasite transmission by increasing person-to-person contact and limiting sanitation facilities. This finding is consistent with reports by Chris Ster *et al.* [26] and Rivero [27], who found that overcrowding significantly increases intestinal parasite prevalence in children. Therefore, improving housing conditions and ensuring access to sanitation services should be central components of public health interventions targeting parasitic infections in vulnerable populations.

In contrast, although animal husbandry showed a positive association in the bivariate analysis, this relationship did not reach statistical significance in the adjusted model. Nonetheless, the observed trend suggests that children exposed to domestic or farm animals may have an increased risk of zoonotic parasite transmission, as

reported by Serrano *et al.* [28]. Acosta also noted that domestic animal husbandry was directly related to a high prevalence of parasitosis among children (63.5%) [29]. Continuous surveillance and deworming of domestic animals could help reduce this potential transmission route.

Overall, the findings of this study indicate that preventive practices—particularly adequate handwashing and reduction of household overcrowding—are key protective factors against intestinal parasitoses in school-aged children. These results emphasize the need for integrated school and community health programs that combine hygiene education, infrastructure improvements, and periodic parasitic control campaigns. Moreover, the findings highlight those interventions against intestinal parasitosis should go beyond pharmacological measures to address environmental and behavioral determinants. The persistent significance of hand washing and overcrowding indicates that modifiable household and hygiene factors play a crucial role in parasite transmission. Recent studies emphasize that inadequate sanitation, limited water access, and household crowding significantly increase the risk of infection among schoolchildren, underscoring the need for integrated WASH (Water, Sanitation, and Hygiene) and school-based health programs aligned with the Sustainable Development Goals [30].

While the potential link between COVID-19-era ivermectin use and enteroparasite prevalence is a compelling, yet relatively unexplored, hypothesis, it is crucial to emphasize the preliminary nature of this evidence. The cross-sectional design of our study precludes any definitive conclusions about causality. It is plausible that unmeasured confounding factors influenced both ivermectin consumption and parasitosis risk. Therefore, our findings should be interpreted as speculative and hypothesis-generating. They underscore the need for future longitudinal studies or controlled trials to establish a causal relationship and definitively elucidate the underlying mechanisms.

LIMITATIONS

This study has several limitations that should be acknowledged. First, information on ivermectin use, hygiene practices, and animal husbandry was self-reported by parents or guardians, which may have introduced recall and social desirability bias during interviews. Although a structured questionnaire administered by trained personnel was used to minimize these effects, the lack of objective verification of the reported behaviors limits the accuracy of these variables. Second, the study faced difficulties in identifying all parasitic species, which prevented a more detailed analysis of risk factors associated with specific pathogens. Third, the sample was drawn from a single school in Huánuco, with a participation rate of 71.3%, limiting the generalizability of the findings. The 28.7%

of absent children or those who declined to participate may differ systematically from those included, potentially introducing selection bias into prevalence estimates. Fourth, although the sample was representative of the school census, its size may have limited the multivariable analysis's statistical power, increasing the likelihood of Type II errors and leading to inconclusive results for variables such as ivermectin consumption. Finally, data collection took place in 2022, during the fourth and fifth waves of the COVID-19 pandemic in Peru—a period marked by widespread public attention to ivermectin use. Although this temporal proximity may have improved recall accuracy for this specific exposure, it also limits the temporal generalizability of the findings beyond the pandemic context.

CONCLUSION

The findings of this study reveal a high prevalence of intestinal parasitosis among schoolchildren in a tropical region of Peru, primarily associated with inadequate handwashing practices and household overcrowding. The findings suggest that insufficient handwashing practices and household overcrowding are associated with a higher frequency of infection, highlighting the importance of hygiene behaviors and living conditions in parasite transmission. Although ivermectin consumption appeared protective in the bivariate analysis, this association was not maintained after adjustment, suggesting that unmeasured confounders may have confounded its apparent effect.

Given the cross-sectional nature of the research, these associations should be interpreted with caution. Nonetheless, the results emphasize the need to strengthen school- and community-based health programs focused on hygiene promotion, sanitation, and reducing overcrowding. Future longitudinal or interventional studies are recommended to confirm these relationships and provide more substantial evidence to guide preventive strategies in endemic areas.

ETHICS APPROVAL

The Ethics and Research Committee of the Faculty of Human Medicine of the National University Hermilio Valdizán approved the research protocol. All procedures performed in studies involving human participants were following the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Before data collection, written informed consent was obtained from parents or legal guardians, and verbal assent was obtained from participating students.

AVAILABILITY OF DATA

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

AUTHORS' CONTRIBUTION

Mijay Hyde Tolentino-Inocente: Conceptualization, Methodology, Formal Analysis, Research, Writing - Original Draft, Visualization.

Mijael Rodrigo Santos-Huerta: Conceptualization, Methodology, Formal Analysis, Research, Writing - Original Draft, Visualization.

Florencia Madeley Tolentino-Inocente: Methodology, Research (Data Collection), Writing - Original Draft.

Milagros Rojas-Carbajal: Supervision, Conceptualization, Validation, Writing - Review and Editing.

Walter Gomez-Gonzales: Supervision, Conceptualization, Validation, Writing - Review and Editing.

Kovy Arteaga-Livias: Conceptualization, Supervision, Project Management, Validation, Writing - Review and Editing.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors made limited use of ChatGPT (GPT-4, OpenAI) to improve translation, obtain linguistic suggestions, and make minor corrections to some parts of the manuscript. After using this tool/service, all authors reviewed and edited the content as necessary and assume full responsibility for the content of the published article.

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