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Prevalence of intestinal helminths, anemia, and malnutrition in Paucartambo, Peru

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ABSTRACT

Objective. *To evaluate the prevalence of soil-transmitted helminth infections, anemia, and malnutrition among children in the Paucartambo province of Cusco region, Peru, in light of demographic, socio-economic, and epidemiologic contextual factors.*

Methods. *Children from three to twelve years old from six communities in Huancarani district in the highlands of Peru were evaluated for helminth infections, anemia, and nutritional status. Data collected included demographic variables, socioeconomic status, exposures, complete blood counts, and direct and sedimentation stool tests.*

Results. *Of 240 children analyzed, 113 (47%) were infected with one or more parasites.* Giardia *(27.5%) and* Fasciola *(9.6%) were the most commonly identified organisms. Eosinophilia was encountered in 21% of the children. Anemia (48.8%) was associated with age (3–4 vs 5–12 years old; odds ratio (OR): 5.86; 95% confidence interval (CI): 2.81–12.21). Underweight (10%) was associated with male sex (OR: 5.97; CI: 1.12–31.72), higher eosinophil count (OR: 4.67; CI: 1.31–16.68) and education of the mother (OR: 0.6; CI: 0.4–0.9). Stunting (31.3%) was associated with education of the mother (OR: 0.83; CI: 0.72–0.95); wasting (2.7%) was associated with higher eosinophil count (OR: 2.75; CI: 1.04–7.25).*

Conclusions. *Anemia and malnutrition remain significant problems in the Peruvian highlands. These findings suggest that demographic factors, socio-economic status, and possibly parasitic infections intertwine to cause these health problems.*

Key words Parasites; anemia; malnutrition; helminths; Peru.

Soil-transmitted helminth (STH) infections are among the most common infections, primarily affecting the poorest sectors of the population. In 2010, an estimated 819 million people worldwide were infected with *Ascaris lumbricoides*, 464 million with *Trichuris trichura*, and 438 million with hookworm (1). In Peru, the observed prevalence of STH infections among school-aged children ranges from 1.6 to 77.9 percent (2). Infection prevalence varies greatly with geography, with prevalence lower in urban areas of Lima (3) and higher in rural areas of the Amazon (4). Briones-Chavez et al. (5) reported higher risk for STH infections among settlers than among indigenous populations from isolated regions of Peru, indicating that variations may also depend on the specific population groups tested. In contrast, little information is available about the prevalence and impact of STH infections in the Peruvian Andes region.

STH infections are rarely fatal but cause chronic morbidity. The global burden of STHs is estimated at nearly 5 million years lived with disability (1). Children are at highest risk of infection and carry the highest disease burden (1, 6, 7). Malnutrition and anemia are associated with infection and arise from a combination of mechanisms that involve chronic inflammation, malabsorption, and blood

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loss (1, 6, 8). These short term sequelae can lead to adverse consequences such as impaired physical and cognitive development (1, 6, 7).

The World Health Organization's (WHO) current strategy for control of STHs focuses on periodic treatment with antihelminthic drugs in endemic areas. The aim is to reduce parasite burdens, the ultimate cause of morbidity (9). In Peru, 3 to 3.5 million children from one to fifteen years of age required preventative STH chemotherapy from 2009 to 2012. According to WHO, 90% of at-risk school-aged children received treatment in 2009, but only 11% of the same population was treated in 2010 (10). Inconsistent treatment can contribute to chronic morbidity, including from malnutrition and anemia (9, 11). Consistent antiheminthic administration combined in an integrated approach with health education and sanitation has controlled the burden of STH infections in some endemic regions (6, 12, 13). Nonetheless, the lack of information on prevalence and distribution of STH infections hinders the planning of appropriate community interventions, particularly in the Peruvian Andes, where poverty and access to healthcare are significant problems. This study evaluated the prevalence of STH infections, anemia, and malnutrition among children in the Paucartambo province of Cusco region, accounting for demographic and socio-economic factors.

MATERIALS AND METHODS

A cross-sectional study was undertaken to evaluate the prevalence of helminth infections, anemia, and malnutrition in otherwise asymptomatic children three to twelve years old, enrolled in six communities (Ohuay, Piscohuata, Huayllapata, Queunacancha, Chinchayhuasi, Huaqaycancha) in the Huancarani district of Paucartambo province in the region of Cusco, Peru (Figure 1). Paucartambo experiences a rainy season between November and March, with average monthly rainfall from 75 to 150 mm, and a dry cold season between April and October, with average monthly rainfall from 8 to 45 mm. The annual maximum temperature ranges from 16 °C to 24 °C and minimum temperature from –8 °C to 12 °C. All study villages are at altitudes of approximately 3 800 m. Children included in the study were enrolled in preschool or primary school between June and September of 2012, and were receiving mass chemotherapy with albendazole from a non-profit organization twice a year. Parents were interviewed about demographics (i.e. sex, age, family composition), socio-economic status (parents' education, livestock ownership), and potential exposures (i.e. source of drinking water, dietary habits). Height, weight, a blood sample, and one or two stool samples were collected from children within two weeks of enrollment.

Stool samples were preserved in 10% formalin for transportation. Direct examination and rapid sedimentation methods were used to detect protozoa and helminth ova or larvae (14). All positive tests were confirmed by a second observer. Children were considered infected if at least one parasite was identified by direct or sedimentation tests. *Blastocystis hominis* was not considered a pathogen.

Hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), leukocyte count with differential (including eosinophil count), and platelet count were measured using an automated analyzer (BC-5300 Auto Hematology Analyzer, MindRay, Shenzhen, China). Hemoglobin levels were adjusted for chronic high altitude exposure using the formula proposed by the US Centers for Disease Control and Prevention (15). WHO age- and sex-adjusted hemoglobin level cutoff points were used to define anemia (16). Eosinophilia was defined as an eosinophil count of greater than or equal to 500 cells/µL.

Age, sex, height, and weight were used to evaluate nutritional status. Weight for age, height for age, and body mass index for age were compared with WHO Growth Reference Standards using Anthroplus open access software (AnthroPlus v1.0.4, WHO, Geneva, Switzerland) (17). Children were defined as underweight, stunted, or thin, respectively, where their z-scores fell two or more standard deviations below the mean.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS

FIGURE 1. Map of Peru; Inset shows the Paucartambo province (red shaded area) and the location of Huancarani district

Source: Adapted from Google maps.

v.18, SPSS Inc., Chicago, Illinois). Frequencies, means with standard deviations (± SD), and medians with interquartile range (IQR) were used to describe variable distributions. T-tests, Spearman's correlation coefficients, and chi square tests were used in bivariate analyses of characteristics of children with and without eosinophilia, anemia, or malnutrition. Backward logistic regression analyses were used to calculate adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Clinically- and epidemiologically-relevant (i.e., socio-economic and demographic) variables and variables for which $P \leq 0.1$ in bivariate analysis were entered in the models. Variables were excluded from the logistic models using likelihood ratio tests. Given the relatively low prevalence of *Ascaris*, *Trichuris,* and hookworm, these parasite infections were grouped for the multivariate analysis. *P*-values < 0.05 were considered statistically significant. Data on *Fasciola* infection was analyzed separately and published elsewhere (18).

The study protocol was approved by the Institutional Review Board for human subjects research of the University of Texas Medical Branch, but was not reviewed by a local institutional review board. Study protocols and aims were explained to community authorities and parents by bilingual field workers, and those interested in allowing their children to participate underwent the consent process. Verbal informed consent and assent were obtained from parents and children, in Quechua or Spanish, prior to any study procedure. Verbal consent was sought because most parents' primary language was Quechua, which is not a written language, and because the study was considered to be of minimal risk. Subjects were assigned a study code and all identifiers were removed from the study forms and database before analysis.

RESULTS

Of the 334 children evaluated, 295 (88.3%) provided a blood sample and 290 (86.8%) provided at least one stool sample, with 109 (32.6%) providing a second. Children missing information about community of residence, age, gender, or stool or blood tests results were excluded from analysis. A total of 240 (71.8%) children were included. The mean age of participants was 7.6 years (SD: ± 2.7 years) and 127 (52.9%) were female. The median duration of school attendance was three years for mothers (IQR: 2–6 years) and five for fathers (IQR: 3–6 years). Families of most participants (188/194, 96.9%) owned livestock, including cattle, sheep, horses, pigs, and/or goats. The main source of residential drinking water was the municipal reservoir (176/190, 92.6%). Demographic characteristics of the participants are shown in Table 1.

Many children were infected with intestinal parasites, including *Ascaris lumbricoides* (34, 14.2%), *Fasciola hepatica* (23, 9.6%), *Hymenolepis nana* (22, 9.3%), *Trichuris trichiura* (3, 1.3%), hookworm (4, 1.7%), *Strongyloides stercoralis* (2, 0.8%), and *Giardia intestinalis* (66, 27.5%). Overall, 113 (47.1%) children were infected with at least one pathogenic helminth or protozoa. There were no differences between those providing one or two stool samples for testing with respect to the prevalence of STH infections (26/150 versus 15/90, $P = 0.89$) or any parasitic infection (70/150 versus 43/90, $P = 0.86$). The prevalence of *Ascaris*, *Fasciola,* and *Giardia* varied significantly by community (Table 2). There were no differences between 3 to 4-year-olds and 5 to 12-year-olds with respect to the prevalence of STHs (11/48 versus 28/192, $P = 0.16$) or any parasitic infections (26/48 versus 87/192, $P = 0.27$). Children that reported eating lettuce had less STH infections than those that did not eat lettuce (29/190 versus 3/5, $P = 0.032$). No significant differences in STH infection were associated with other food items, source of drinking water, livestock ownership, or socioeconomic status (number of siblings, parent's education).

Eosinophilia was identified in 51 (21.2%) children. The prevalence of eosinophilia varied significantly ($P < 0.01$) by community; it was highest in Ohuay (18/38, 47.4%), followed by Huayllapata (14/50, 28%), Chinchayhuasi (9/33, 27.3%), Huaqaycancha (6/58, 10.3%), Piscohuata (4/43, 9.3%), and Queunacancha (0/18, 0%). Eosinophilia was not significantly associated with any of the intestinal helminths found in stool.

Anemia was diagnosed in 117 (48.8%) children. Children with anemia were younger than children without anemia (7.1 ± 2.7 versus 8.2 ± 2.5 years, $P < 0.01$). Anemia was diagnosed in

TABLE 1. Demographic characteristics of surveyed participants, Paucartambo, Peru

Characteristic	Mean	± SD[a]
Age in years	7.6	±2.6
Number of people in the household	6.2	±1.7
Number of siblings	4.1	±1.9
Years of school attendance	Median	IQR[b]
Mother	3	(2–6)
Father	5	(3–6)
Sex	No.	%
Male	127	52.9
Female	113	47.1
Community		
Huaqaycancha	58	24.2
Huayllapata	50	20.8
Piscohuata	43	17.9
Ohuay	38	15.8
Chinchayhuasi	33	13.8
Queunacancha	18	7.5
Owns livestock		
Yes	188	96.9
No	6	3.1
Source of drinking water at home		
Municipal reservoir	176	92.6
Well	8	4.2
Stream	4	2.1
Irrigation channel	2	1.1

Source: Author's calculations.
[a] SD: Standard deviation.
[b] IQR: Interquartile range.

TABLE 2. Prevalence of helminth and protozoan infections by community, Paucartambo, Peru

	Total (*n* = 240)		Huayllapata (*n* = 50)		Piscohuata (*n* = 43)		Huaqaycancha (*n* = 58)		Chinchayhuasi (*n* = 33)		Ohuay (*n* = 38)		Queunacancha (*n* = 18)		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	*P*
Fasciola hepatica	23	9.6	9	18.0	7	16.2	5	8.6	2	6.0	0	0	0	0	0.02
Ascaris lumbricoides	34	14.2	8	16.0	0	0	11	19.0	8	24.2	5	13.2	2	11.1	0.04
Trichuris trichura	3	1.3	1	2.0	1	2.3	1	1.7	0	0	0	0	0	0	0.86
Hookworm	4	1.7	3	6.0	0	0	0	0	0	0	1	2.6	0	0	0.13
Strongyloides stercoralis	2	0.8	1	2.0	0	0	1	1.7	0	0	0	0	0	0	0.77
Hymenolepis nana	22	9.3	3	6.0	0	0	8	13.8	2	6.1	6	15.8	3	16.7	0.07
Giarda intestinalis	66	27.5	20	40.0	12	27.9	8	13.8	7	21.2	15	39.5	4	22.2	0.02
All parasites	113	47.1	28	56.0	13	30.2	26	44.8	17	51.5	22	57.9	7	38.9	0.10

Source: Authors' calculations.

77.1% (37/48) of children 3 to 4 years old and in 36.5% (70/192) of children 5 to 12 years old (OR: 5.86, 95% CI: 2.81–12.21). Children with anemia had a lower mean MCV (87.4 ± 3.4 versus 88.7 ± 3.9 fL, $P < 0.01$), lower mean MCH (28.4 ± 1.1 versus 28.8 ± 1.2 pg/cell, $P < 0.01$), and higher mean absolute eosinophil count (478 ± 831 versus 316 ± 276 eosinophils/mm^3, $P = 0.04$). Age (adjusted OR: 1.02, 95% CI: 1–1.03, $P < 0.01$) and absolute eosinophil count (adjusted OR: 1.66, 95% CI: 0.83–3.35, $P = 0.15$) were retained as predictors of anemia in the logistic regression model, but eosinophil count did not attain statistical significance (Cox and Snell R^2: 0.098, Hosmer-Lemeshow test: $P = 0.45$). Low uncorrected hemoglobin levels correlated with age (Spearman's rho = 0.41, $P < 0.01$) and inversely with absolute eosinophil counts (Spearman's rho = 0.18, $P < 0.01$).

Mean z-scores among all children were –0.71 (± 0.89) for weight for age, –1.62 (± 1.24) for height for age, and –0.29 (± 1.32) for BMI for age. Nearly 10% (17/167) of children were significantly underweight. The prevalence of underweight children varied significantly ($P < 0.01$), from 3.1% (1/32) in Huaqaycancha to 29.6% (8/27) in Ohuay. Mean years of education were lower in the underweight group for both mothers (2.2 ± 2.4 versus 4.2 ± 2.9 years, $P = 0.02$) and fathers (3.2 ± 2.5 versus 5.1 ± 2.6 years, $P = 0.01$). Sex, mother's years of school attendance, and absolute eosinophil count remained associated with underweight in the logistic regression analysis (Table 3).

Stunting was diagnosed in 70/224 (31.3%) children. The prevalence of stunting varied significantly by community ($P < 0.01$), ranging from 21.4% (9/42) in Piscohuata to 62.1% (23/37) in Ohuay. Similarly, mean years of school attendance were lower for parents of children with stunting than for either mothers (3 ± 2.9 versus 4.1 ± 2.9 years, $P = 0.02$) or fathers (4.1 ± 2.5 versus 5.2 ± 2.7 years, $P = 0.02$) of children without stunting. In the backward logistic regression analysis, only mother's years of school attendance remained associated with stunting (Table 3). Decreased weight for height was identified in 6/224 (2.7%) of the children. In the backward logistic regression analysis, only absolute eosinophil count remained associated with decreased weight for height (Table 3).

DISCUSSION

Children in rural areas of developing countries experience poor growth, anemia, and STH infections. The latter are strongly associated with long-term nutritional stress which manifests in anemia, retarded growth, and cognitive impairment (6, 19). Children are particularly at risk for long-term sequelae due to the importance of micronutrients in physical and cognitive development from birth through adolescence (7). The association of worm infection with malnutrition and impaired growth suggests the potential benefits of deworming. However, recent studies cast doubt on the idea that deworming alone is sufficient to resolve this complex issue (20, 21). The population studied here, which received mass chemotherapy with albendazole, had a low prevalence of STH

TABLE 3. Variables associated with indicators of poor nutritional status among children aged 3–12 in Huancarani, Peru, based on backward logistic regression analysis[a]

	Underweight[b]			Stunting[c]			Wasting[d]		
Variable	Adjusted OR	95% CI	*P*	Adjusted OR	95% CI	*P*	Adjusted OR	95% CI	*P*
Male sex	5.97	(1.12–31.72)	0.03	NIM[e]		n/a[f]	NIM		n/a
Absolute eosinophil count	4.67	(1.31–16.68)	0.01	NIM		n/a	2.75	(1.04–7.25)	0.04
Years of schooling of the mother	0.6	(0.4–0.9)	0.01	0.83	(0.72–0.95)	0.01	NIM		n/a

Source: Authors' calculations.

[a] Variables entered in the full models: Community, age, sex, number of people in the household, years of schooling of the mother and the father, fascioliasis, STHs, and absolute eosinophil count.

[b] Underweight model: Cox and Snell $R^2 = 0.208$, Hosmer-Lemeshow test $P = 0.62$.

[c] Stunting model: Cox and Snell $R^2 = 0.047$, Hosmer-Lemeshow test $P = 0.44$.

[d] Wasting model: Cox and Snell $R^2 = 0.055$, Hosmer-Lemeshow test $P = 0.34$.

[e] NIM: not in the model.

[f] n/a: not available.

infections (14% *Ascaris*, 1.7% hookworm, and 1.3% *Trichuris*) compared to country and regional estimates (22). Compliance with albendazole therapy in the study population cannot be confirmed, yet the prevalence of STH infections is consistent with declining risk in South America (22). Nevertheless, anemia and malnutrition remained common. Of note, *Giardia spp.* was also common among children (27%). Recent evidence suggests that not only acute but chronic *Giardia* infections have an effect on children's nutrition and health status (23). Chronic intestinal protozoan infections are increasingly recognized as causes of malnutrition in children and have been proposed for consideration as neglected tropical diseases, causing morbidity in children comparable to STH infections (24).

One in five children had eosinophilia (> 500 eosinophils/µL), raising concerns that tissue parasites may have been present. Eosinophilia was not associated with helminth eggs in the stool. The tissue migratory phase of certain parasites (e.g. *Ascaris lumbricoides*, hookworm) induces elevated eosinophil counts up to 12 weeks before stool microscopy diagnosis can be made (25). Similarly, strongyloidiasis can often be overlooked unless stools are optimally processed and suitable tests are used. Unfortunately, serology for toxocariasis, which could also cause anemia, was unavailable. Eosinophilia could also indicate the presence of other recent undetermined parasitic infections (25, 26).

Half of the children studied had anemia, with a higher prevalence among the youngest. The prevalence of anemia was significantly higher in three to four-year-olds compared with regional and national levels for the same age group (77% versus 46% versus 34%, respectively) (27). In contrast, 36% of children five to twelve years old had anemia, a lower prevalence for the same age group than in other areas of Peru. For example, 51% of school-aged indigenous children in the Corrientes River in the Amazon basin were anemic in one study (28). The main causes of anemia are malnutrition and STH (9, 10). Other studies in Peru reporting similar prevalence of anemia also demonstrate high prevalence of STH infections (29). While anemia was not associated with helminth infections in the present study, the association with eosinophilia suggests a parasitic cause. These results could also indicate other behavioral or dietary causes of anemia in this population.

The prevalence of malnutrition in the study area was high, and varied by community. Underweight ranged from 3% in Huanqaucancha to 30% in Ohuay and stunting varied from 21% in Pisconhuata to 62% in Ohuay. Prevalence of chronic malnutrition in this region was higher than WHO's national estimate (19.5%) for children under five years old. In 2012, recognizing the severity of this number and the impact of chronic malnutrition, the Peruvian government set a goal to reduce the prevalence of malnutrition in children under five to 10% by 2016 (30). Education of the parents (a surrogate indicator of socio-economic status) was found to be strongly associated with malnutrition in the current study. Research on malnutrition in other regions of the world is consistent with this conclusion. While the issue of malnutrition in developing countries is multifaceted, studies demonstrate that it is strongly rooted in poverty. Thus interventions should also encompass strategies for poverty alleviation (31).

It is not possible to draw firm conclusions about the impact of mass chemotherapy on STH infection levels from this study. The number of STH infections was fairly low, likely reflecting ongoing chemotherapy. However, the prevalence of specific helminth infections, such as *Ascaris lumbricoides*, was noteworthy in some communities (e.g. 24% in Chinchayhuasi). Other studies suggest cure rates > 90% for patients with *Ascaris lumbricoides* infections when treated with albendazole (32, 33). These numbers raise concerns about the coverage of preventive chemotherapy in some communities and/or the effectiveness of mass chemotherapy. Factors influencing effectiveness are not well known. For example, an unexpected difference in drug response across two comparable villages suggested that the benefits of mass chemotherapy might vary between communities (34). Also, malnutrition seems to play a role in decreased response. Questions about the level of effectiveness in individual communities indicate the need for monitoring and evaluation of deworming programs (34). Furthermore, while evidence for antihelminthic resistance in humans is limited, resistance seen in veterinary nematodes raises concerns for the emergence of resistance in populations repeatedly exposed to these interventions. Thus, resistance should be carefully monitored in areas where the fight against poverty depends on chemotherapy (35, 36). These results also highlight the need for comprehensive interventions, including improvements in sanitation and education on prevention, in order to more strongly impact worm prevalence and health outcomes (37, 38).

High prevalences of anemia and malnutrition were observed, despite mass chemotherapy. A recent large clinical trial of mass deworming with albendazole among 1 million children in India showed no effects on anemia, nutritional status, or mortality (19). Similarly, a 2012 Cochrane review on deworming drugs for STH in children suggests that mass chemotherapy, even in high-risk populations, has no effect on hemoglobin and only a limited effect on nutritional indicators (11). While perhaps important in individuals with high worm burden, mass chemotherapy alone may not resolve the complex issue of anemia and malnutrition. The importance of decreasing anemia and improving nutrition to increase productivity and decrease mortality in children is well understood. Unfortunately, limited evidence exits on optimal interventions to improve these health indicators (39, 40). The most successful interventions are multi-faceted, focusing on the most undernourished regions and incorporating socio-economic factors such as maternal education (41). More research is needed to identify the most important combinations of interventions for effective treatment of children in regions, such as the Huancarani district, with a high prevalence of anemia and malnutrition.

The present study has limitations that may prevent more robust conclusions from being drawn. The small sample size and geographic area studied limited the power of the analysis and affected the generalizability of results. Most participants (63%) provided only 1 stool sample for testing which probably led to an underestimation of the prevalence of helminth infections. Nevertheless, no statistically significant differences in STH or any-parasite infection prevalence were observed between those providing 1 or 2 stool samples. No environmental data or animal specimens were collected. However, community-level differences in environmental characteristics like altitude, temperature, and rainfall are probably small given the

limited geographic area studied. Thus, environmental characteristics are unlikely to have played a significant role in observed differences in parasite, anemia, and malnutrition prevalence. Current studies in Cusco are addressing the association between human, environmental, and animal factors in the prevalence of these illnesses among children. Despite limitations, the current data add to the scarce literature about anemia and malnutrition in the Peruvian highlands and highlight the need for further research and comprehensive interventions to improve these health indicators.

In conclusion, this study demonstrated a high prevalence of eosinophilia, anemia, and malnutrition in communities of the Paucartambo province in Cusco despite mass albendazole administration. Results suggest that socio-economic and epidemiologic factors, and potentially other parasite infections, intertwine to cause anemia and malnutrition in this rural population. A comprehensive approach to the study of these interactions is required to generate creative and effective interventions. Further studies including a larger number of children and more exhaustive evaluation of other factors like education, micronutrients, enteric disease, and other parasites are needed in the highlands of Peru. Evaluation of eosinophilia in this group of children should include tissue parasites like toxocariasis.

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RESUMEN

Prevalencia de helmintiasis intestinal, anemia y desnutrición en Paucartambo, Perú

Objetivo. Evaluar la prevalencia de geohelmintiasis, anemia y desnutrición en los niños de la provincia de Paucartambo (departamento de Cusco, Perú), teniendo en cuenta los factores contextuales demográficos, socioeconómicos y epidemiológicos.

Métodos. Se determinó la presencia de helmintiasis y anemia y el estado nutricional de niños de 3 a 12 años de edad de seis comunidades del distrito de Huancarani, en la sierra peruana. Se documentaron las variables demográficas, el nivel socioeconómico, la exposición, los hemogramas y pruebas de observación directa y de sedimentación de parásitos en materia fecal.

Resultados. De los 240 niños estudiados, 113 (47%) estaban infectados por uno o más parásitos. Los organismos encontrados con mayor frecuencia fueron de los géneros *Giardia* (27,5%) y *Fasciola* (9,6%). El 21% de los niños presentaban eosinofilia. La anemia (48,8%) se asoció con la edad (3–4 años frente a 5–12 años; razón de posibilidades [OR]: 5,86; intervalo de confianza [IC] de 95%: 2,81–12,21). El peso inferior al normal (10%) se asoció con el sexo masculino (OR: 5,97; IC: 1,12–31,72), con un recuento de eosinófilos más alto (OR: 4,67; IC: 1,31–16,68) y con el nivel educativo de la madre (OR: 0,6; IC: 0,4–0,9). El retraso del crecimiento (31,3%) se asoció con el nivel educativo de la madre (OR: 0,83; IC: 0,72–0,95), y la emaciación (2,7%) se asoció con un recuento de eosinófilos más alto (OR: 2,75; IC: 1,04–7,25).

Conclusiones. La anemia y la desnutrición siguen siendo problemas importantes en la sierra peruana. Estos resultados sugieren que estas enfermedades se deben a una interacción de los factores demográficos, el nivel socioeconómico y, posiblemente, las parasitosis.

Palabras clave Parásitos; anemia; desnutrición; helmintos; Perú.