Prevalence of Intestinal Parasites and Association with Malnutrition at a Ghanaian Orphanage

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ABSTRACT: Parasitic infections particularly neglected tropical diseases affect millions of individuals in sub-Saharan Africa. It is associated with poverty and limited resources, which is a key characteristic of orphanages. Unfortunately, there is very scarce baseline data about the prevalence of parasitic infections within orphanages and other institutions with limited resources and special needs in Ghana. We conducted a cross-sectional survey among 101 inhabitants of one of the major orphanages in Ghana. We collected demographic and anthropological data to assess living conditions as well as nutritional status and how these relate to parasitic infections. Parasitic infections were detected from stool samples collected and analyzed by standard parasitological techniques. The prevalence of parasitic infections was 15.8%. Parasites isolated were *Ascaris lumbricoides* (5%), *Trichuris trichiura* (1%), hookworm (1%), *Clonorchis sinensis* (2%), *Fasciola hepatica* (2%), *Hymenolepis nana* (2%), *Schistosoma mansoni* (3%), *Taenia* spp. (1%), *Strongyloides stercoralis* (2%), and *Giardia duodenalis* (1%). There was a significant association between malnutrition and parasitic infections. The prevalence of intestinal parasites among inmates is high. With the exception of *S. stercoralis*, which infects via skin penetration, all others have some association with water either drunk or for play. The need for proper evaluation of water supply and its safety is strongly encouraged.

KEYWORDS: orphanage, intestinal parasites, malnutrition, Ghana, prevalence

CITATION: Duedu et al. Prevalence of Intestinal Parasites and Association with Malnutrition at a Ghanaian Orphanage. *Human Parasitic Diseases* 2015:7 5–9 doi:10.4137/HPD.S30059.

TYPE: Original Research

RECEIVED: May 28, 2015. **RESUBMITTED:** June 22, 2015. **ACCEPTED FOR PUBLICATION:** June 26, 2015.

ACADEMIC EDITOR: Ashley Croft, Editor in Chief

PEER REVIEW: Three peer reviewers contributed to the peer review report. Reviewers' reports totaled 531 words, excluding any confidential comments to the academic editor.

FUNDING: Authors disclose no funding sources.

COMPETING INTERESTS: Authors disclose no potential conflicts of interest.

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Paper subject to independent expert blind peer review. All editorial decisions made by independent academic editor. Upon submission manuscript was subject to anti-plagiarism scanning. Prior to publication all authors have given signed confirmation of agreement to article publication and compliance with all applicable ethical and legal requirements, including the accuracy of author and contributor information, disclosure of competing interests and funding sources, compliance with ethical requirements relating to human and animal study participants, and compliance with any copyright requirements of third parties. This journal is a member of the Committee on Publication Ethics (COPE).

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Introduction

Intestinal parasitic infections are a major public health challenge in developing countries. The World Health Organization (WHO) estimates that about 3.5 billion people are affected and most of these are children. The WHO-established Parasitic Diseases Task Force has identified and prioritized parasites that could be transmitted by food to humans as well as produce a substantive burden of disease.[1] Some of the parasites prioritized by the taskforce were *Cryptosporidium* spp., *Entamoeba*, *Giardia*, *Fasciola* spp., *Trichinella* spp., *Echinococcus* spp., *Opisthorchis* spp., *Clonorchis* spp., *Taenia solium*, *Anisakis simplex*, and *Ascaris lumbricoides*. From a total of 495 studies reviewed and analyzed by the taskforce, *Giardia* was found to have the highest global prevalence (median 10.8%), followed by *Entamoeba* and *Cryptosporidium* with median values 4.3% and 4.0%, respectively. While Africa had the highest median prevalence for *Cryptosporidium,* the Americas had highest median prevalence for *Entamoeba* and *Giardia*. From the vast data reviewed, children between 1 and 14 years had the highest burden due to parasitic infections. In Ghana, the prevalence of parasitic infections have been reported to be between 2% and 78% for various parasites.[2–4] Some studies have reported *Giardia lamblia* as a major cause of childhood diarrhoea.[5,6] Ascaris, schistomiasis, and other infections have also been reported.

Parasitic infections are associated with conditions such as iron-deficiency anemia, diarrhea, growth retardation, and poor mental and brain development.[6,7] Diarrhea is a major cause of morbidity and mortality in under-five children in developing countries.[8,9] A vicious cycle ensues between intestinal parasitic infections, diarrhea, and malnutrition, leading ultimately to impaired physical and cognitive development of children.[10,11] The activities of intestinal parasites and other pathogens cause damages to intestinal epithelium, leading to a reduction in adsorptive function and then to malnutrition.[11] With this interplay, incorporation of malnutrition measurements into routine clinical examinations as well as health checks will give a head start to the fight against these conditions. Unfortunately, such measurements are not routinely performed in Ghana and many other countries burdened with the conditions.[12,13]

Orphanages in Ghana have poor infrastructure and are faced with limited resources. Overcrowding, inadequate sanitation facilities, and poor access to safe water are common features of orphanages in Ghana. These conditions place inhabitants at high risks of infectious diseases. There are efforts to curb the risk of transmission of infectious diseases, although these are inadequate. For example, there are occasional deworming exercises, but these are not regular. The aim of this study was to identify the prevalence of intestinal parasites and their associations with malnutrition in one of

the major orphanages run by the Department of Social Welfare in Accra, Ghana.

Materials and Methods

Study design and population. A prospective cross-sectional study was carried out on half of the population of inhabitants of the Osu Orphanage in Accra between April and June 2012. Prior to the start of the study, permission was sought from authorities and caregivers of the facility. Although the children in the facility are dewormed almost every three months, at the time of the study, there had not been any deworming exercise in the preceding three months. A questionnaire was used to collect demographic, behavioral, and health data. All inhabitants who were taking antiparasitic medication or antibiotics were excluded from the study. Study participants were selected by simple random sampling.

Anthropometric measurements and assessment of nutritional status. Height and weight measurements were measured for all study participants according to the WHO child growth standards (http://www.who.int/childgrowth/standards/en/). Height was measured in centimeters to the nearest one decimal place. Weight was also measured to the nearest kilogram to one decimal place. Body mass index-for-age (BMI-for-age) was determined and compared to WHO child growth standards. We chose the WHO charts as a standard for comparison because Ghana was one of the sites for the reference study, making it more relevant for us. Children or adolescents whose BMI-for-age fell below −2 *Z*-scores (thinness and severe thinness) were classified as underweight or malnourished. Overweight and obesity were classified if the BMI-for-age was above 1 and 2 *Z*-scores respectively.

Sample collection, processing, and analysis. A stool specimen from each participant was collected into a sterile container and transported on ice to the laboratory for processing. Samples were examined macroscopically for the consistency, presence of blood, worms, or segments of cestodes. Direct wet mounts as well as wet mounts following stool concentration using the formol ether method were prepared according to Cheesbrough.[14] Slides were prepared for both concentrated and nonconcentrated specimen for direct viewing as well as prestaining with iodine or with the modified Ziehl–Neelsen stain for coccidian parasites as reported previously.[4,14]

Statistical analysis. Data obtained from the study were analyzed using Microsoft Office Excel 2013 and IBM SPSS v21. Statistical significance was set at $P < 0.05$ for 95% confidence limit. Chi-square test was used to determine the relationship between parasitic infections and malnutrition. Means and standard deviations (SDs) were also determined for quantitative data.

Ethical approval. The study was approved by the Ethics Committee of the School of Allied Health Sciences, University of Ghana (ethics identification number: ET./10284485/AA/26A/2012-2013). Permission was also sought from the management of the orphanage and caregivers as well as children who were old enough to consent to the study participation. This study complied with the principles of the Declaration of Helsinki.

Results

Demographics and nutrition. The institution houses in total about 200 orphans. Stool specimen and associated data were obtained from 101 children, adolescents, and young adults. There were 70 (69.3%) males and 31 (30.7%) females. Participants of the study were aged between 5 and 22 years (median 11 years) drawn from the three houses of the institution. The mean age was 11.6 years (SD = ±4.6). All the study participants attended school and were either in kindergarten (KG), primary, junior high school (JHS), or senior high school. The age distributions and educational data are presented in Figure 1. Most of the participants were in the primary school and JHS (ages 6–16). Inhabitants of the orphanage attended school in the neighborhood to offer them the opportunity of meeting with other people as well as promote their community integration.

The entire orphanage was constructed with concrete. It had access to electricity and pipe-borne water. Due to the erratic nature of the water supply, storage tanks have been provided. There are, however, no backup power generators. Water-closet toilet facilities are present in the facility for use by the inhabitants. Playing in the sand outdoors was a common practice among the children. More than half (58.3%) of the study participants were in the habit of biting their nails. All participants wore footwear almost all the time. Exceptions are when children were playing outdoors.

Contrary to the general perception that majority of the children in Ghanaian orphanages are malnourished, we recorded 94.1% of the study subjects falling within the normal BMI-for-age range. None of the study participants were overweight or obese. The 6 (5.9%) underweight children recorded in this study were within the age range 5–10 years. Of these, four were males and the other two females.

Prevalence of intestinal parasites. Ten different intestinal parasites were isolated from the stool specimens of 16 (15.8%) study participants. These included ova of *A. lumbricoides* (5%), *Trichuris trichiura* (1%), hookworm (1%), *Clonorchis sinensis* (2%), *Fasciola hepatica* (2%), *Hymenolepis nana* (2%), *Schistosoma mansoni* (3%), and *Taenia* spp. (1%). Also identified were *Strongyloides stercoralis* larvae (2%) and *Giardia duodenalis* trophozoites (1%). Pictures of some of the parasites identified are shown in Figure 2B. There was no significant difference between the distributions of infection across the various houses. Among the males, the prevalence of intestinal parasites was 17.4%, whereas among females, the prevalence was 12.9%. The prevalence of parasites within the various age groups is shown in Figure 2A. One person (1%) was infected with two parasites. Of the underweight/malnourished children, three were infected with parasites. The chi-square test indicated there was a significant relationship between the BMI-for-age and parasitic infection ($P = 0.018$).

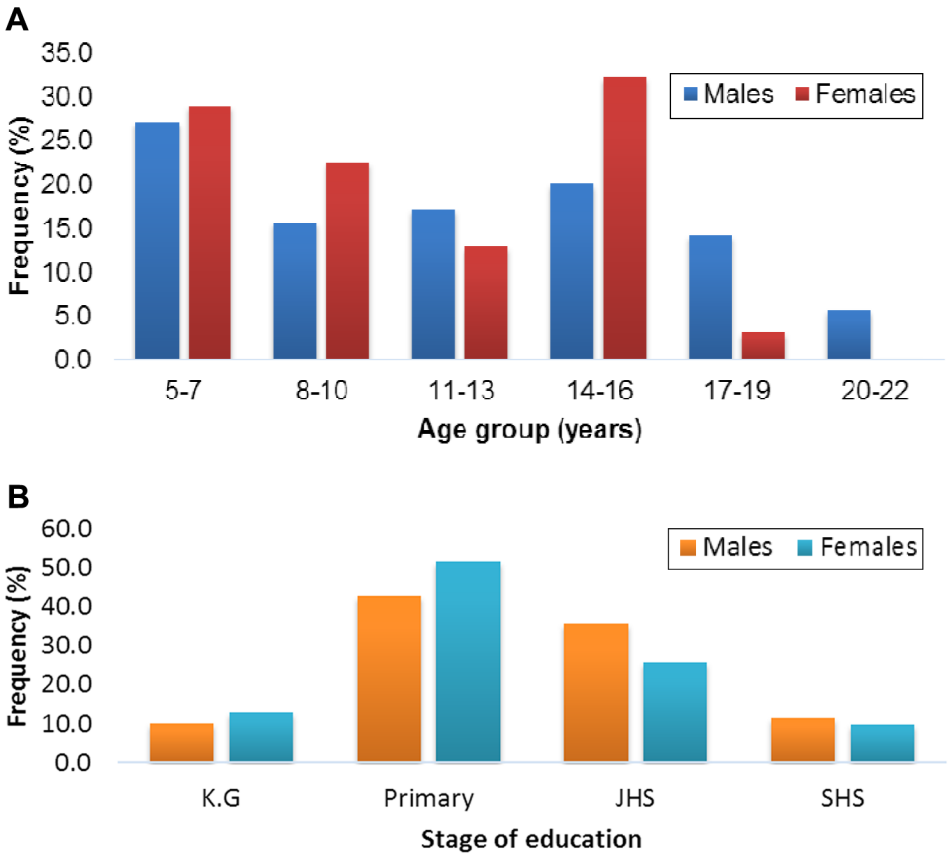

Figure 1. (**A**) Frequency and distribution of study participants according to age and gender. (**B**) Educational status of the study participants indicating stages of attendance.

Discussion

Although there are reports of studies of parasitic infections among Ghanaian children, most work has focused on populations where active intervention strategies are about to start, ongoing, or have just ended. By contrast, very little is known about the prevalence of intestinal parasites among populations with special needs. To address this gap in baseline information, we conducted this cross-sectional study to delimit the epidemiology within an orphanage. At the time of the study, the institution had some basic infrastructure like shelter, although it was described as inadequate by the care providers. The environment was kept clean and there was provision of potable water. All the study participants were at some stage of education.

The spectrum of parasites identified in this study was largely composed of helminths with only a single occurrence of the protozoan flagellate, *G. duodenalis*. In Ghana, soil-transmitted helminths (STHs) remain a major health threat to humans especially children as reported throughout the world. In response to this threat, the government sponsors periodic deworming exercises in schools. Other interventions that have resulted in reduction of the prevalence of STHs particularly schistosomiasis include installation of a water recreation area and integration of control measures within the regular health services in Ghana.[15,16] Apart from schistosomiasis, hookworm infections are also a major threat to the health of Ghanaian children. Across the sub-Saharan African region, the prevalence of hookworm infections has been reported to be approximately 29%.[17] In a national cross-sectional school-based parasitological survey, prevalence of hookworm infection was 3.2%. In this study, however, the prevalence was lower (1%). This lower prevalence could be attributed to the periodic deworming exercises offered to inhabitants of the orphanage as well as the relatively well-kept and hygienic environment. Parasitic infections are usually associated with malnutrition, and results from this study are not exceptions. Of the six underweight/malnourished children, three had parasitic infections.

Another highlight of this study is that the parasites identified were predominantly platyhelminths (tapeworms and flukes). The biology and distribution of these parasites are key indicators of possible sources of or routes of transmission. The infective stages of the sheep and oriental liver flukes (*F. hepatica* and *C. sinensis*) as well as *S. mansoni* are free-living water snail–associated cercariae. All these findings suggest a probable exposure to contaminated water. During the study, we were told by authorities that the inhabitants of the orphanage relied on pipe-borne water for daily chores and packaged (sachet) water for drinking. However, during times of shortage, water is supplied by tankers whose sources could not be verified. These arrangements implied the children in the orphanage did not have to visit streams to fetch water, which could

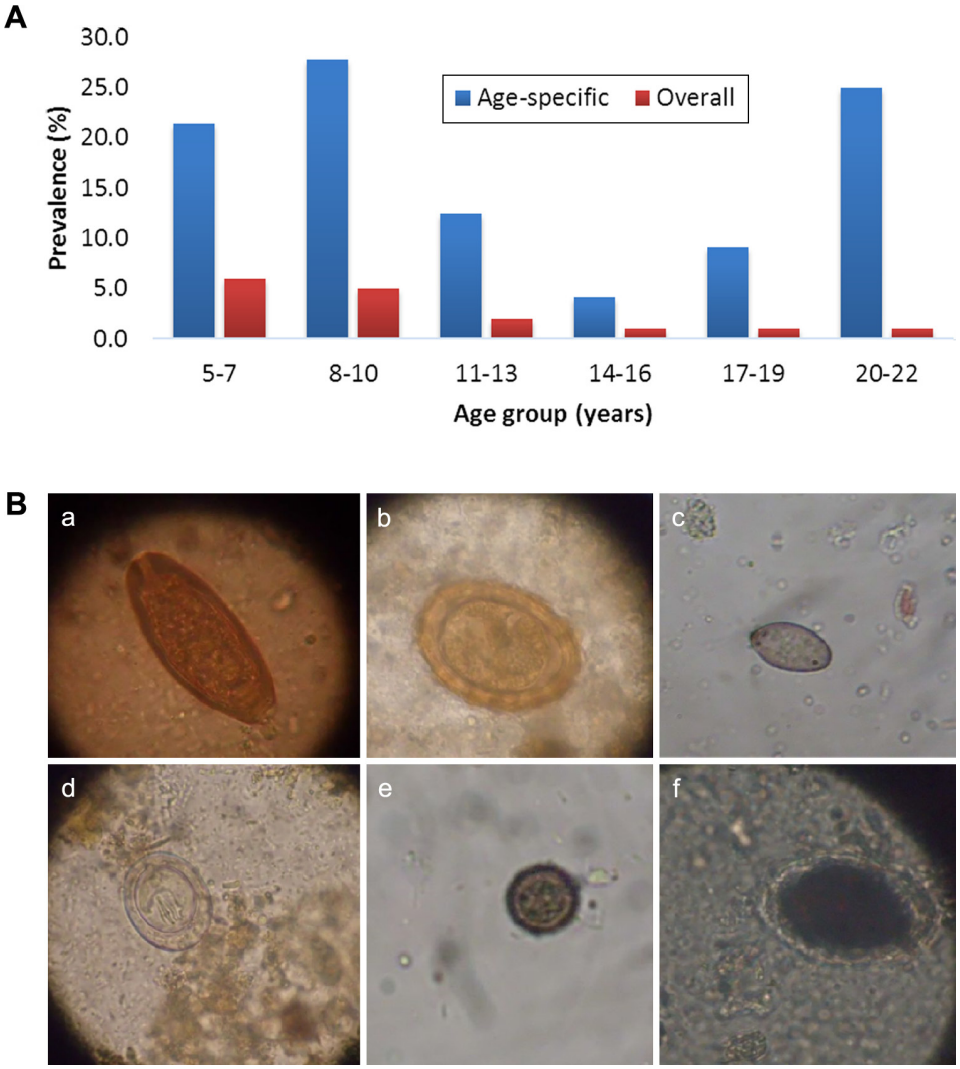

Figure 2. (**A**) Age-specific prevalence of parasitic infections. Overall prevalence is the prevalence in relation to the entire study population, whereas age-specific prevalence is the prevalence in relation to just that group. (**B**) A section of the parasites isolated in the study. Not to scale. Pictures were taken with a digital camera through the eye piece of the microscope. In the panels are ova of: a = *Trichuris trichiura*, b = Ascaris, c = *Clonorchis sinensis*, d = *Hymenolepis nana,* e = *Taenia* spp., and f = *Schistosoma mansonii.*

be a source of infection with cecariae. In Accra, the supply of pipe-borne water is erratic; hence, the services of these tankers are sort frequently. The infective stages of the other parasites could infect humans by ingestion. In the light of these observations, there is concern and need to verify the sources and safety of the water supplied by these tankers as well as exclude any possibilities of the children visiting nearby streams for play or other purposes not known to us. We recently reported a high prevalence of parasites in vegetables[18,19] sold within the Accra metropolis, and these could be potential sources of infection if not handled properly.

Conclusions

The data demonstrate that intestinal parasitic infection is a problem in the orphanage and the need for improvement in the periodic deworming exercises is thus encouraged. There is a relationship between parasitic infections and malnutrition. The predominance of parasites that are transmitted mainly via contact with contaminated water calls for investigations into possible ways to which children in the orphanage could have been exposed.

Acknowledgments

The authors would like to thank staff of the Osu Children's Home as well as the Microbiology Teaching Laboratory of the School of Allied Health Science, University of Ghana.

Author Contributions

Conceived and designed the experiments: KOD, PFA-K. Analyzed the data: KOD, EP. Wrote the first draft of the manuscript: KOD. Contributed to the writing of the manuscript: EP, IA-B. Agree with manuscript results and conclusions:

KOD, EP, IA-B, PFA-K. Jointly developed the structure and arguments for the paper: KOD, PFA-K. Made critical revisions and approved final version: KOD, IA-B, PFA-K. All authors reviewed and approved of the final manuscript.

Supplementary Information

Questionnaire used to obtain demographic and clinical data for this study.

REFERENCES

1. World Health Organization. *First Formal Meeting of the Foodborne Disease Burden Epidemiology Reference Group (FERG): Implementing Strategy, Setting Priorities and Assigning the Tasks*. Geneva: World Health Organization; 2007. Available from: http://apps.who.int/iris/bitstream/10665/43905/1/9789241596763_eng.pdf?ua=1. Accessed January 31, 2015.
2. Annan A, Crompton DW, Walters DE, Arnold SE. An investigation of the prevalence of intestinal parasites in pre-school children in Ghana. *Parasitology*. 1986;92(pt 1):209–217.
3. Ayeh-Kumi PF, Tetteh-Quarcoo PB, Kwakye-Nuako G, Kretchy JP, Osafo-Kantanka A, Mortu S. Prevalence of intestinal parasitic infections among food vendors in Accra, Ghana. *J Trop Med Parasitol*. 2009;32:1–8.
4. Ayeh-Kumi PF, Nit SA, Duedu KO, et al. Intestinal parasitosis among pregnant women in Accra, Ghana. *Ghana J Allied Health Sci*. 2009;3(1):9–14.
5. Nkrumah B, Nguah SB. Giardia lamblia: a major parasitic cause of childhood diarrhoea in patients attending a district hospital in Ghana. *Parasit Vectors*. 2011; 4:163.
6. Opintan JA, Newman MJ, Ayeh-Kumi PF, et al. Pediatric diarrhea in southern Ghana: etiology and association with intestinal inflammation and malnutrition. *Am J Trop Med Hyg*. 2010;83(4):936–943.
7. Evans AC, Stephenson LS. Not by drugs alone: the fight against parasitic helminths. *World Health Forum*. 1995;16(3):258–261.
8. Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease, as estimated from studies published between 1992 and 2000. *Bull World Health Organ*. 2003;81(3):197–204.
9. Bryce J, Boschi-Pinto C, Shibuya K, Black RE; Group WHOCHER. WHO estimates of the causes of death in children. *Lancet*. 2005;365(9465):1147–1152.
10. Lima AA, Moore SR, Barboza MS, et al. Persistent diarrhea signals a critical period of increased diarrhea burdens and nutritional shortfalls: a prospective cohort study among children in northeastern Brazil. *J Infect Dis*. 2000;181(5): 1643–1651.
11. Guerrant RL, Oria RB, Moore SR, Oria MO, Lima AA. Malnutrition as an enteric infectious disease with long-term effects on child development. *Nutr Rev*. 2008;66(9):487–505.
12. Akugizibwe R, Kasolo J, Makubuya DB, Damani AM. Missed opportunities in the diagnosis and management of protein energy malnutrition among children under 5 years in Wakiso district, Uganda. *J Public Health Epidemiol*. 2013;5(11): 463–470.
13. Antwi S. Malnutrition: missed opportunities for diagnosis. *Ghana Med J*. 2008; 42(3):101–104.
14. Cheesbrough M. *District Laboratory Practice in Tropical Countries*. 2nd ed. New York: Cambridge University Press; 2005.
15. Kosinski KC, Adjei MN, Bosompem KM, et al. Effective control of *Schistosoma haematobium* infection in a Ghanaian community following installation of a water recreation area. *PLoS Negl Trop Dis*. 2012;6(7):e1709.
16. Danso-Appiah A, De Vlas SJ, Bosompem KM, Habbema JD. Determinants of health-seeking behaviour for schistosomiasis-related symptoms in the context of integrating schistosomiasis control within the regular health services in Ghana. *Trop Med Int Health*. 2004;9(7):784–794.
17. Hotez PJ, Kamath A. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution, and disease burden. *PLoS Negl Trop Dis*. 2009; 3(8):e412.
18. Ayeh-Kumi PF, Tetteh-Quarcoo PB, Duedu KO, et al. A survey of pathogens associated with *Cyperus esculentus L* (tiger nuts) tubers sold in a Ghanaian city. *BMC Res Notes*. 2014;7:343.
19. Duedu KO, Yarnie EA, Tetteh-Quarcoo PB, Attah SK, Donkor ES, Ayeh-Kumi PF. A comparative survey of the prevalence of human parasites found in fresh vegetables sold in supermarkets and open-aired markets in Accra, Ghana. *BMC Res Notes*. 2014;7:836.