ORIGINAL ARTICLE

Epidemiology of parasitism and poly-parasitism involving intestinal helminths among school children from different residential settings in Nandi County, Kenya

Jimmy Ruto, Chrispinus Siteti Mulambalah

Department of Medical Microbiology and Parasitology, College of Health Sciences, Moi University, Eldoret, Kenya

ABSTRACT

Background: Intestinal helminthiases present a major public health problem worldwide. In Africa, the prevalence varies in countries and within regions. The study aimed at assessing the prevalence of parasitism and poly-parasitism due to intestinal helminths in rural and urban settings. **Settings and Design:** A 6-month cross-sectional school-based study was undertaken in Nandi County, Kenya, to determine the prevalence of intestinal helminthiases in school children. **Materials and Methods:** A total of 2967 fecal samples were collected and analyzed to detect the presence of helminth ova, larvae, segments, or adults. Modified formal-ether concentration technique was used. **Results:** The study findings revealed that three helminth species were prevalent and were associated with intestinal helminthiases with an overall prevalence of ascariasis 55.8%, trichuriasis 26.9%, and hookworm disease 24.8%. There was no significant difference in the prevalence of intestinal helminth single infestations among the study sites and between sexes ($P > 0.05$). The prevalence of multiple infestations was established as 34.7% and was common in estates and villages (40–50%) than in towns (18%). Poly-parasitism involving 2–3 helminths was prevalent in 8.4–25.4% than those with 4–5 species of 0.07–0.7%. A statistically significant difference among the different types of poly-helminthic infestations was established ($P < 0.05$). However, no significant difference was established in the prevalence of poly-helminthism in the study sites ($P > 0.05$). **Conclusion:** The study confirmed that single and multiple helminth intestinal infestations were prevalent in rural and urban areas. Residential area was found not to be associated with multiple parasitism. The findings support the view that intestinal helminthiases require intervention. **Recommendation:** Strategic intervention in the form of mass diagnosis and treatment by the use of effective broad spectrum anthelmintic(s) and public health education are recommended.

Keywords: Infection, infestation, poly-parasitism, prevalence

INTRODUCTION

Intestinal helminth infestations are a persistent and neglected global public health problem. These infestations result in high mortality and morbidity in developing countries.[1] In Africa, the prevalence of intestinal helminthiases is high due to many factors. These include poor hygiene practices, endemic and widespread poverty, indiscriminate defecation, and lack of public health education. These combined contribute to environmental contamination with infective stages and enhances parasite transmission.

Corresponding Author: Prof. Chrispinus Siteti Mulambalah, Department of Medical Microbiology and Parasitology, College of Health Sciences, Moi University, P. O. Box 4606-30100 Eldoret, Kenya.
E-mail: csmulambalah@gmail.com

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Most intestinal helminths are acquired from contaminated soil, water, and vegetation. The infective stages for instance viable ova and or filariform stages are either passively ingested or actively penetrate human skin to enter general circulation before settling in the intestines. Helminth species associated with intestinal infestation in Africa include nematodes: *Ascaris lumbricoides*, *Trichuris trichiura*, *Strongyloides stercoralis* and hookworms *Necator americanus* and *Ancylostoma duodenale*; trematodes: *Schistosoma mansoni*; and various cestode species. Each species is responsible for specific infestation. Hookworms cause hookworm disease (HWD); *A. lumbricoides* causes ascariasis; *T. trichuris* cause trichuriasis; *S. stercoralis* cause strongyloidiasis; *S. mansoni* causes intestinal schistosomiasis whereas cestodes are associated with cestodiases.

The global prevalence of intestinal helminthiases is estimated at over 1 billion cases of ascariasis, 740 million cases of HWD, and 795 million cases of trichuriasis.[2] Ascariasis and trichuriasis are the two most prevalent helminthiasis reported to infect approximately 2 billion adults and children globally.[3] Children worldwide are a vulnerable segment of the population easily infected by helminths. Approximately, over 500 million children in rural and urban areas are infected with intestinal helminths worldwide.[4] A large proportion of these, about 90 million school children, are infected in sub-Saharan Africa including Kenya.[2] In many African countries, intestinal helminthiases are endemic in rural and urban regions where sanitation facilities are poor, inadequate or nonexistent, and with minimal hygiene.[2] These offers conditions suitable for sustained exposure to repeated infections that result in high infection prevalence.

Intestinal helminthiases in children are linked to infection severity. In many cases, there is often with no specific symptoms, but heavy infections result in significant morbidity and mortality.[5-8] The main form of morbidity is the negative effect on nutritional status including mal-absorption of nutrients, loss of appetite, and reduction in food intake in children.[9] The other adverse effects such as intestinal bleeding in HWD, rectal prolapse in trichuriasis, and complications requiring operation for instance intestinal and biliary blockage associated with ectopic ascariasis have been reported in children.[2]

The aim of the study was to assess the prevalence of single and multiple intestinal helminthiases in school children from rural and urban areas in Nandi County. The purpose of the study was to provide a basis for formulating relevant intervention strategies against intestinal helminthiases.

MATERIALS AND METHODS

Ethical consideration

The study was approved by relevant review and Ethics Committees and consent was obtained from guardians or parents of all pupils before undertaking the study. Confidentiality was observed throughout the study, and positive cases were immediately referred for treatment and management at Kapsabet County referral hospital, Nandi County. Severe cases were referred to Moi Teaching and Referral Hospital, Eldoret.

Study area and sites

The study was carried out at the Nandi-Hills, Kaptumo locations, Nandi County, Kenya. The study area is located at latitudes 35° 15' E and 0° 08' N-0° 5' N. It is topographically hilly with an average altitude of 1998 m above the sea level and receives mean annual rainfall of 1600 mm and has a mean annual temperature of 18°C.

The area has many large scale tea estates run by various companies where latrines are communally shared and are not well maintained. Sampling sites were primary schools within tea estates, urban centers/towns, and in villages outside estates and urban centers.

Study design and sampling procedure

A 6-month cross-sectional school-based study was undertaken from July to December 2015. The study area was divided into three study sites comprising estates, villages, and one town. All schools within each study site were identified, coded, and four schools were randomly selected except town study site which had one representative school, thus making an overall total of 9 schools. A total of 3000 children were randomly selected from 8 schools and 500 from the only school in town study site.

Specimen collection, processing, and data analysis

Each pupil was provided with a labeled sterile stool specimen container (polypot), wooden spatula, polythene bag, and a data form to record details on age, sex, and residence. They were instructed to deposit approximately 2 g of fresh morning stool on polypot. The samples were collected and transported to the Moi University Teaching laboratories for laboratory analysis.

Helminth ova and/or larvae were isolated by a modified formal-ether concentration technique.[10]

For each sample specimen, the entire sediment formed after centrifugation was transferred onto a glass slide using a Pasteur pipette and covered by cover slip before microscopic examination. The sediment was examined at ×10 objective with the condenser sufficiently closed for good contrast. All helminth ova, larvae, segments, and adult stages recovered from the samples were identified based on morphological features and enumerated. Chi-square statistic test was used to analyze and make comparisons on variables.

Quality control

Each fecal specimen was examined microscopically by three trained and experienced laboratory technicians. In cases where the results were different, the slide preparation was examined by a fourth technician. Ten percent of the slide preparations were randomly selected and sent to the Department of Medical Microbiology and Parasitology, School of Medicine, Moi University, Eldoret, Kenya, to confirm the reproducibility of the study results.

RESULTS

Participants' characteristics and economic status

A total of 3500 primary school children residing in estates, urban centers, and villages were enrolled in the study. The age range was 5–19 years with a mean age 12.5 years and both male and female pupils were included prior to obtaining the parent/guardian's consent. Sex distribution of the participants was 48.9% (n = 1420) males and 52.1% (n = 1547) females with an almost 1:1 sex ratio. Fecal samples were received from 2967 pupils for parasitological analysis representing 84.8%. Some 533 (15.2%) pupils declined to provide fecal samples.

Pupils from estates resided in labor camps with parents who worked as farm laborers within extensive tea plantations. Housing made of bricks and communal latrines was provided, but not well-maintained. Families in urban center were considered well-off economically. Most of them had access to modern sanitary facilities, piped water, and sewerage system. However, those on the outskirts of town lacked similar facilities and resorted to sharing of privately owned or communally shared latrines. In villages, families were economically disadvantaged, lived in mud-built, and thatch roofed houses. There was no piped water, the main water sources were streams and rivers. Majority shared few poorly maintained latrines.

Prevalence of helminth species-specific infestations

The prevalence of major helminth species-specific intestinal infestation in the study sites is presented in Table 1. Ascariasis was the most prevalent accounting for 55.8% (n = 1655) compared to trichuriasis 26.9% (n = 798) and HWD 17.3% (n = 514). Other occasional helminths species encountered at low prevalence were *Trichostrongylus* spp., *Hymenolepis nana* spp., *Taenia* spp., *S. stercoralis*, *and Schistosoma* spp. In all study sites, lower intestinal helminth infestations were recorded in pupils from the villages and the highest in those from the tea estates. There was no significant difference in the prevalence of intestinal helminth infestations among the sites and between sexes ($P > 0.05$).

Prevalence of poly-parasitism

Poly-parasitism was detected in all age groups and sexes in all study sites. A total of 1028 of pupils positive for intestinal helminthiases were confirmed to suffer multiple infestations representing 34.7% of all positive cases. The prevalence of poly-parasitism in pupils from the estates, villages, and town schools was 50.5%, 40.4%, and 18.3%, respectively. The prevalence of confirmed mixed intestinal infestations is indicated in Table 2.

Poly-parasitism involving double infestations were the most prevalent comprising 25.4% (n = 754) of

Table 1: Prevalence of species-specific intestinal helminth infestations

Study site	Sex	Number examined	Ascariasis prevalence +ve (%)	Trichuriasis prevalence +ve (%)	Hookworm disease prevalence +ve (%)
Villages	Male	615	265 (43.1)	95 (15.5)	95 (15.5)
	Female	735	305 (41.5)	125 (17)	45 (6.1)
Town	Male	120	75 (62.5)	20 (16.7)	45 (37.5)
	Female	220	115 (52.3)	82 (37.3)	55 (25)
Estates	Male	685	510 (74.5)	251 (36.6)	164 (23.9)
	Female	592	385 (65)	225 (38)	110 (18.6)
Total		2967	1655	798	514

+ve: Positive cases, %: Percentage prevalence

Table 2: Prevalence of mixed intestinal helminth infestation

Study sites	Prevalence of mixed intestinal helminth infestations				
	Number examined	Double (%)	Triple (%)	Quadruple (%)	Pentadruple
Villages	1350	208 (15.4)	32 (2.4)	6 (0.4)	0
Town	340	98 (28.8)	32 (9.4)	0	0
Estates	1277	448 (35.1)	186 (14.6)	16 (1.3)	2 (0.2)
Total	2967	754	250	22	2

cases examined. The helminth species involved in this category of infestations were *A. lumbricoides* and *T. trichiura* (11.7%), *A. lumbricoides* and hookworm (9.4%), hookworm and *T. trichiura* (1.2%), *A. lumbricoides* and *S. mansoni* (0.1%), and *A. lumbricoides* and *S. stercoralis* (0.1%). Confirmed triple helminth infestation combinations were 8.4% ($n = 250$). The species involved were *A. lumbricoides*, *T.trichiura*, and hookworm (6.8%) and *A. lumbricoides*, *T. trichiura*, *Taenia* spp. (0.1%).

There were 0.7% ($n = 22$) quadruple combinations of parasitism involving *A. lumbricoides*, *T. trichiura*, hookworm and *Trichostrongylus* spp. (0.3%) and *T. trichiura*, hookworm, *H.nana* and *Taenia* spp. (0.1%). Pentadruple helminthism was detected in two (0.07%) participants from estates who had a combination of *A. lumbricoides*, *T. trichiura*, hookworm and *Trichostrongylus* spp., *Taenia* spp. infestations.

The species *A. lumbricoides* was the most prevalent in both single and poly-parasitic cases and was involved in all cases of poly-parasitism infestations encountered in the study. A statistically significance difference among the different types of poly-helminthic infestations was established ($P < 0.05$).

DISCUSSION

The prevalence of intestinal helminth infestation due to *A. lumbricoides*, *T. trichuris*, and hookworms was high in both single and multiple cases. This is explained by the presentation of ascariasis, trichuriasis, and HWD. These are usually chronic infestations characterized by nonspecific signs and symptoms. In many cases involving low to moderate infestations, individuals do not normally show signs and symptoms. Therefore, there is a probability that both adults and children could harbor the parasites without knowing until when they visit a medical facility. This may be necessitated by the need for a medical examination or routine medical check-up. Comparable high prevalence have been reported in related cross-sectional studies conducted in neighboring Counties in Kenya.[11,12]

Ascariasis and trichuriasis were predominant in comparison to other helminth infestations confirmed in the study area. This has several possible explanations. The two intestinal parasites (*A. lumbricoides* and *Trichuris trichura*) are feco-orally transmitted and the epidemiology of both is largely determined by individual and community hygienic habits and human waste disposal methods which subsequently affect the level of environmental contamination.[13] Ova of both species have tough outer coat that enable them to resist adverse external environmental conditions which enhances their survival and higher probability of transmission. Furthermore, the two helminth species are known to share the same environment and locations inside and outside the host in addition to their similar mode of transmission. In this regard, conditions that influence the survival of *A. lumbricoides* in the host and outside environment similarly influence *T. trichiura*.[14,15] Therefore, the two infestations often have high prevalence and are commonly reported as co-infestations in communities resident in endemic areas.

Ascariasis was the most prevalent as single infection and in cases of multiple intestinal helminth infestations encountered in the study. Comparable findings have been reported in many tropical developing countries.[16-18] In Kenya, intestinal ascariasis has been reported in school-going children in rural areas of the Lake region and Nairobi city as the most prevalent intestinal helminth infestation.[19,20] The probable explanation is that unlike other helminths, the ova of *A. lumbricoides* are known to adhere and stick on hands, fruits, vegetables, utensils, and many other shared articles.[21] In this regard, the ova are much more likely to be spread far and wide and be ingested by children through contact, sharing of food, contaminated utensils, pens, and books.[22]

The prevalence of HWD, schistosomiasis, and strongyloidiasis caused by skin penetrating helminths such as *N. americanus*, *Schistosoma* spp., and *S. stercoralis*, respectively, was low. The study area is a highland area and generally experiences low temperatures (25°C–15°C) most the year round. Such low temperatures may be detrimental to the successful hatching of hookworm and schistosome ova, and subsequently, the growth and survival of infective larval stages in the soil and water, respectively. Hookworm and schistosome eggs hatch at optimum temperature range of 30°C–40°C. An alternative explanation is that the study area being predominantly an agricultural area, there is a likelihood of heavy use of chemical fertilizers in crop production. This is likely to affect the soil and water chemical composition which may have deleterious effect(s) on the survival of hookworm and schistosome ova and infective larval stages. The same effect may extent to schistosome snail intermediate host survival. The net effect is low or no transmission of the three helminth species.

A high prevalence of intestinal helminth multi-parasitism was evident in all the study sites. Since intestinal helminths in general do not usually replicate in the host, the high prevalence of poly-parasitism is indicative of repeated exposure in children irrespective of their residential setting. This suggests that similar infestation determinants occur in study area and demonstrates evidence of general poor environmental contamination and hygiene in rural and urban settings.

CONCLUSION

The intestinal helminth infestation prevalence was high in this study area with ascariasis, trichuriasis, and HWD as the most prevalent infestations and strongyloidiasis, schistosomiasis, and taeniasis as the least prevalent.

The presence of high prevalence of single and multiple helminth infestation in all the study sites was indicative of sustained environmental contamination and general poor hygiene in rural and urban settings.

Recommendation

Public health education on environmental sanitation must be undertaken at all levels including schools, villages, and homes. Construction and maintenance of latrines in schools, urban centers, and homes should be encouraged. To reduce the high prevalence of single and multiple intestinal helminth infestations, it requires mass diagnosis and de-worming campaign with broad spectrum single dose chemotherapy.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Harhay MO, Horton J, Olliaro PL. Epidemiology and control of human gastrointestinal parasites in children. Expert Rev Anti Infect Ther 2010;8:219-34.
2. Crompton DW, Peters P, editors. World Health Organization. Working to Overcome the Global Impact of Neglected Tropical Diseases: First WHO Report on Neglected Tropical Diseases. Geneva: WHO, 2010; p. 172.
3. de Silva NR, Brooker S, Hotez PJ, Montresor A, Engels D, Savioli L. Soil-transmitted helminth infections: Updating the global picture. Trends Parasitol 2003;19:547-51.
4. Olsen A, Samuelsen H, Onyango-Ouma W. A study of risk factors for intestinal helminth infections using epidemiological and anthropological approaches. J Biosoc Sci 2001;33:569-84.
5. Ghaffar A. Nematodes, Microbiology and Immunology Online. University of South Carolina School of Medicine; 2010. Available from: http://www.pathmicr.med.sc.ed/parasitology/nematodes. htm. [Last accessed on 25 Oct 2015].
6. Wagbatsoma UA, Eisien MB. Helminthiasis in selected children seen at the University of Benin City, Nigeria. Niger J Parasitol 2000;113:87-95.
7. World Health Organization. Prevention and control of intestinal parasite infections. Tech Rep Ser 2002;749:86.
8. Montresor A, Crompton DW, Gyorkos TW, Savioli L. Helminth Control in School-age Children: A Guide for Managers of Programmes. Geneva: World Health Organization; 2002.
9. El-Nofely A, Shaalan A. Effect of Ascaris infection on the nutritional status IQ of children. Int J Anthropol 1999;14:55-9.
10. Cheesebrough M. Medical Laboratory Manual for T ropical Countries. Vol 1. Cambridge, UK. Butterworth and Company (Pub) Ltd., Cambridge University Press; 1987. p. 185-6.
11. van Eijk AM, Lindblade KA, Odhiambo F, Peterson E, Rosen DH, Karanja D, *et al.* Geohelminth infections among pregnant women in rural western Kenya; a cross-sectional study. PLoS Negl Trop Dis 2009;3:e370.
12. Luoba AI, Wenzel Geissler P, Estambale B, Ouma JH, Alusala D, Ayah R, *et al.* Earth-eating and reinfection with intestinal helminths among pregnant and lactating women in western Kenya. Trop Med Int Health 2005;10:220-7.
13. Bhutta ZA, Sommerfeld J, Lassi ZS, Salam RA, Das JK. Global burden, distribution, and interventions for infectious diseases of poverty. Infect Dis Poverty 2014;3:21.
14. Cissé M, Coulibaly SO, Guiguemdé RT. Epidemiological features of intestinal parasitic infection in Burkina Faso from 1997 to 2007. Med Trop (Mars) 2011;71:257-60.
15. O'Lorcain P, Holland CV. The public health importance of *Ascaris lumbricoides*. Parasitology 2000;121Suppl:S51-71.
16. Adeyeba OA, Akinlabi AM. Intestinal parasitic infestations among school children in a rural community, South West Nigeria. Niger J Parasitol 2002;23:11-8.
17. Agbolade OM, Akinboye DO, Awolaja A. Intestinal helminthiasis and urinary schistosomiasis in some villages of Ijebu North, Ogun State, Nigeria. Afr J Biotechnology 2004;3:206-9.
18. Widjana DP, Sutisna P. Prevalence of soil-transmitted helminth infections in the rural population of Bali, Indonesia. Southeast Asian J Trop Med Public Health 2000;31:454-9.
19. Peterson LS, Ondiek M, Oludhe DO, Naul BA, Vermund SH. Effectiveness of a school-based deworming campaign in rural Kenya. J Trop Pediatr 2011;57:461-3.
20. Mwanthi MA, Kinoti MK, Wamae AW, Ndonga M, Migiro PS. Prevalence of intestinal worm infections among primary school children in Nairobi city, kenya. East Afr J Public Health 2008;5:86-9.
21. Ashtiani MT, Monajemzadeh M, Saghi B, Shams S, Mortazavi SH, Khaki S, *et al.* Prevalence of intestinal parasites among children referred to Children's Medical Center during 18 years (1991-2008), Tehran, Iran. Ann Trop Med Parasitol 2011;105:507-12.
22. Avcioglu H, Soykan E, Tarakci U. Control of helminth contamination of raw vegetables by washing. Vector Borne Zoonotic Dis 2011;11:189-91.