Tropical Biomedicine 30(4): 718–726 (2013)

Prevalence of intestinal parasitic infections and associated risk factors among Kigali Institute of Education students in Kigali, Rwanda

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Received 28 June 2013; received in revised from 2 September 2013; accepted 5 September 2013

Abstract. Intestinal parasitic infections (IPIs) are a significant public health problem in sub-Saharan Africa (SSA) and Rwanda is not spared. While eradication programs towards preschool-aged and school-aged children are undertaken, important gaps regarding IPIs among students attending tertiary learning institutions remain. The aim of this study was to determine the prevalence of IPIs and associated risk factors among Kigali Institute of Education (KIE) students who attended its medical clinic for stool examination. A cross-sectional study was carried out during the 2010 academic year, from February to July. Fresh stool samples were collected from 109 students chosen randomly and were examined for the presence of eggs, cysts and parasites using direct saline smear under light microscopy. A questionnaire was also used to assess water consumption habits, eating and living places. More than half (50.5%) of the stools examined were infected with an intestinal parasite. Among the infected students, prevalence of *Entamoeba histolytica* was 54.5%, *Trichomonas intestinalis* and *Ascaris lumbricoides* were 20.0%, *Giardia duodenalis* was 3.6% and *Ancylostoma duodenale* was 1.8%. The prevalence of IPIs was strongly associated with drinking any kind of water ($p<0.001$) and eating outside of the KIE cafeteria ($p<0.001$) and significantly related to living outside of the KIE campus ($p=0.026$). The study showed that IPIs of public health relevance are prevalent among students attending tertiary schools. The importance of living and eating in hygienic environments as well as drinking safe water is crucial and all efforts need to be sustained.

INTRODUCTION

Intestinal parasitic infections (IPIs) are amongst the most common infections worldwide (WHO, 2012). Caused by helminths and protozoans, they are a major concern, mostly in developing countries, particularly in sub-Saharan Africa (SSA) (Harhay *et al*., 2010). Every year, millions of disability-adjusted life years (DALYs) are lost and as a consequence, they represent a persistent burden on social and economic development (WHO, 2002; Hotez & Kamath, 2009; Jia *et al*., 2012). Moreover, apart from causing morbidity and mortality, IPIs pose a serious threat, mainly to schoolchildren as they have been associated to delayed intellectual development and cognition, low educational performance and low school attendance (Nokes *et al*., 1991; Nokes *et al*., 1992; Nokes & Bundy, 1994).

Among IPIs, the global burden of soil-transmitted helminths (STH) is horrendous. According to WHO (2002), an estimate of 3.5 billion people are infected worldwide. Among them, *Ascaris lumbricoides* and Hookworms, such as *Ancylostoma duodenale*, are estimated to infect more than a billion people with a high number of people in SSA (Brooker *et al*., 2006; Hotez & Kamath, 2009).

Regarding the morbidity and mortality scale of IPIs caused by protozoans, the portrait is as scabrous. Indeed, *Entamoeba histolytica*, the causative agent of amoebiasis, is estimated to infect 40–50 million people and to kills up to 100 000 people each year, thus ranking as the second deadliest parasitic infections worldwide second only to malaria (WHO, 1997; Stanley, 2003; Harhay *et al.*, 2010). Concurrently, *Giardia duodenalis* (*syn. Giardia intestinalis*, *Gardia lamblia*), causing giardiasis, is the most prevalent protozoan parasite worldwide with about 200 million people being currently infected, and East Africa is considered to be among the most endemic regions (Ignatius *et al.*, 2012).

High prevalence of these intestinal parasites is intimately related to low education, poverty, poor environmental conditions, overcrowding, limited access to clean water and improper faecal disposal (Bethony *et al.*, 2006; Ziegelbauer *et al.*, 2012). But among the people facing those conditions, children are the first victims (Harhay *et al.*, 2010).

In Rwanda six species of intestinal helminths with an overall prevalence of 65.8% have been identified among schoolchildren 10-16 years old from 136 primary schools in 2008. The predominant parasite were *A. lumbricoides* observed in 38.6% of children, followed by *A. duodenale* in 31.6% of the children (Mupfasoni *et al.*, 2008). Another study performed in 2010 among children under five years of age revealed that 20% and 60.1% of them were infected by *G. duodenalis* using the microscopic or the PCR method respectively (Ignatius *et al.*, 2012).

To overcome the burden of the disease, control measures such as the introduction of preventive chemotherapy aimed at at-risk populations of preschool-aged and school-aged children have been initiated in many targeted countries, including Rwanda (WHO, 2012). Targeting the STHs, the Rwandan Ministry of Health in collaboration with its health sector development partners launched a Mass Drug Administration (MDA) program of anthelminthic in 2008 (MOH & Access Project, 2010).

While many studies and initiatives have been done in regard to children less than five years old and to students attending primary and secondary institutions, little is known about students attending tertiary institutions. Therefore, it is in this aim that this study was undertaken, in order to assess the main intestinal parasites infecting students attending a tertiary institution, the Kigali Institute of Education (KIE) and the associated risk factors.

MATERIALS AND METHODS

Study area and population

This cross-sectional study was conducted at Kigali Institute of Education (KIE) from February to July 2010. KIE is an institution of higher education producing professional qualified teachers. The institution hosts a medical clinic attended by its students and staff. It offers a variety of laboratory tests, such as stool, urine and serology testing. More specialized tests are referred to the district hospital. KIE institution is situated in Kigali city, in Gasabo district, Rwanda. Rwanda is part of the East African Community (EAC) and is bordered by Burundi, the Democratic Republic of the Congo, Tanzania and Uganda. It is one of the smallest countries of Africa, but supports the densest population of the continent.

One hundred nine students enrolled in the institution who attended its medical clinic and whose stool was referred for examination were chosen randomly. They were invited to participate voluntarily after explanation of the objectives of the study was provided and oral informed consent obtained.

Stool sample collection and examination

A total of 109 stool samples were collected for laboratory examination. Students were supplied with appropriate plastic containers and fresh stools were collected by students. After stool collection, the samples were transported to be processed in the laboratory of KIE medical clinic. First, physical examination of stool samples was carried out to assess for the following features: watery or bloody diarrhoea and mucous in stool

sample. Then, 10% stool suspension in physiological saline was mounted on microscopic slide and examined under light microscopy (NRL, 2011). Direct microscopic examination for ova, cysts and parasites was carried out by the experienced medical laboratory technician and diagnosis was made on the basis of morphology and size.

Questionnaire

A questionnaire was distributed to each student whose stool sample was examined which included information about the type of water he/she used to consume and whether or not the student lived and ate on the KIE campus.

Statistical analysis

The data were analysed using Microsoft Excel 2007 Software and descriptive statistics were presented as counts and percentages. All data derived from questionnaires were entered and analysed using GraphPad Software. Chi-square tests and Fisher's exact test were used to assess the significance of the observed associations and a significant level of 0.05 was adopted for all tests.

Ethical considerations

This study was approved by the institutional review board committee of KIE Faculty of Sciences. Informed verbal consent was obtained from the students prior to enrolment.

RESULTS

A total of 109 students attending the KIE medical clinic for stool examination were investigated. Results show in Table 1 that the majority of the students 86 (78.9%) had watery stools including 46 (42.2%) who had also mucus in their stools, five (4.6%) who had also blood and nine (8.3%) who had both mucus and blood in their stools. Only about one-fifth 23 (21.1%) of the students had consistent stools.

Overall, 55 of the students out of 109 (50.5%) were found to be infected by an intestinal parasite and none of the students were found to be infected by more than one parasite species. Among them, three species of intestinal protozoans (*E. histolytica*, *G. duodenalis* and *Trichomonas intestinalis*) and two species of STH (*A. duodenale* and *A. lumbricoides*) were observed as shown in Table 2. Also, the proportion of protozoan infections was higher compared to helminth infections by about 3.58 times; among the infected students, 43 (78.2%) were infected by intestinal protozoans and 12 (21.8%) were infected by STH. Among the intestinal protozoans, the predominant species identified were *E. histolytica* which was observed in 30 (54.6%) of the infected students followed by *T. intestinalis* and *G. duodenalis* observed in 11 (20.0%) and in two (3.6%) of the infected students respectively. Among the STH species, *A. lumbricoides*

Table 1. Aspect of stool samples among KIE students attending the institution medical clinic

Aspect of stools	Number (n=109)	Prevalence (%)
Consistent	23	21.1
Watery	86	78.9
Watery only	26	23.8
Watery + mucus	46	42.2
Watery + blood	5	4.6
Watery + mucus + blood	9	8.3

Table 2. Prevalence of IPIs among infected KIE students attending the institution medical clinic

Intestinal parasitic infection	Number infected (n=55)	Prevalence (%)
Protozoans	43	78.2
Entamoeba histolytica	30	54.6
Giardia duodenalis	2	3.6
Trichomonas intestinalis	11	20.0
Helminths	12	21.8
Ancylostoma duodenale	1	1.8
Ascaris lumbricoides	11	20.0
Polyparasitism	0	0.0

Table 3. Risk factors associated to IPIs among KIE students attending the institution medical clinic

	Intestinal parasitic infection			$\chi 2$	*P*–Value
	Positive (n=55)	Negative (n=54)	Total (n=109)		
	n (%)	n (%)	n (%)		
Water consumed					
Always boiled	16 (27.6)	42 (72.4)	58 (53.2)	24.024	< 0.001
Any water found	39 (76.5)	12 (23.5)	51 (46.8)		
Eating place					
KIE cafeteria	21 (32.8)	43 (67.2)	64 (58.7)	17.638	< 0.001
Outside KIE cafeteria	34 (75.6)	11(24.4)	45 (41.3)		
Living place					
KIE campus	24 (40.0)	36 (60.0)	60 (55.0)	4.947	0.026
Outside KIE campus	31 (63.3)	18 (36.7)	49 (45.0)		

was the most prevalent identified in 11 (20.0%) of the infected students followed by *Ancylostoma duodenale* observed in one (1.8%) of the infected students.

Demographic and associated risk factors were assessed and are shown in Table 3. Overall, 58 students (53.2%) reported that they were always drinking boiled water, 64 (58.7%) reported to eat on the school compound at the KIE cafeteria and 60 (55.0%) of the students reported to live on the KIE campus.

Interestingly, our results showed that the rate of IPIs among students, who didn't always drink boiled water, who ate outside of the KIE cafeteria and who didn't live on KIE campus, were 2.44, 1.62 and 1.29 times higher respectively than among those who did. The results confirmed that the prevalence of IPIs among KIE students was strongly associated with drinking any kind of water ($p<0.001$) and eating outside of KIE cafeteria ($p<0.001$) and was significantly related to living outside of KIE campus ($p=0.026$).

DISCUSSION

The results of the present study showed that 78.9% of the students who seek medical care in KIE medical clinic had abnormal stools aspect. Indeed, watery stools, bloody diarrhea and mucus in stools are common features observed among people infected by IPIs, but not restricted to it (Parry *et al.*, 2004).

Many studies were done among school-aged children living in SSA and have found rates of IPIs higher than 20% in many communities, with prevalence as high as 83.8% in southeast Ethiopia (Legesse & Erko, 2004), 74.7% in Tanzania (Speich *et al.*, 2013), 65.8% in Rwanda (Mupfasoni *et al.*, 2008), 44.0% in Nigeria (Asinobi *et al.*, 2007), 34.2% in northern Ethiopia (Gelaw *et al.*, 2013), 28.1% in Cameroon (Mbuh *et al.*, 2010) and 27.2% in eastern Ethiopia (Tadesse, 2005). However, up to now, most of the studies were carried toward under-aged children. As the epidemiology of IPIs among students attending tertiary institutions is still mostly unknown, our study aimed to shed new light on this situation. Similarly, our research have shown that students attending a tertiary institution, the KIE, and its medical clinic for stool examinations, also harbour various intestinal parasites of public health importance and a high percentage (50.5%) of them were found to be infected. Among the intestinal parasites identified, various species of intestinal protozoans (*E. histolytica*, *G. duodenalis* and *T. intestinalis*) and STH (*A. duodenale* and *A. lumbricoides*) were observed. The proportion of protozoan infections was more than 3 times the helminth infections 78.2% vs 21.8%. Even though many studies have found higher prevalence of intestinal helminth infections (Mahfou *et al.*, 1997; Legesse & Erko, 2004; Sinniah *et al.*, 2012; Abera *et al.*, 2013; Gelaw *et al.*, 2013), our results are similar to those obtained in Yemen (Alyousefi *et al.*, 2011) and Nigeria (Asinobi *et al.*, 2007), where intestinal protozoans were observed in 88.7% and 77.5% of the subjects with an IPI.

Among the infected students, *E. histolytica* was the most common intestinal parasite and was present in 30 students' stools (54.5%), followed by *T. intestinalis* and *A. lumbricoides*, both present in 11 (20%) of the student's stools. Similar studies done among schoolchildren in Ethiopia (Gelaw *et al.*, 2013) and among students studying in tertiary institutions in Nigeria (Omorodion *et al.*, 2012) had also identified *E. histolytica* and *A. lumbricoides* as the main intestinal parasites. *E. histolytica* was present in 40.4% and 29.9% of the infected students in Ethiopian and Nigerian schools respectively, while *A. lumbricoides* was found in 26.9% and 39.6% of the infected students respectively. Moreover, *A.lumbricoides* was also found to be the predominant intestinal helminth infecting schoolchildren of Rwanda (Mupfasoni *et al.*, 2008).

Interestingly, *T. intestinalis* was the second most prevalent IPI among KIE students. *T. intestinalis* has poorly been described and has not retained much attention so far. Its pathogenic impact is still unclear, even though it has previously been identified in diarrheic stools, in many cases of co-infections with other intestinal protozoans and that its prevalence could reach up to 40% of the population in tropical zones (Chomicz *et al.*, 2009). Also, similar to our results, a study done among the population of N'Djamena in Tchad showed that *T. intestinalis* was found to be the main intestinal parasite second to *E. histolytica* and ahead of *G. duodenalis*, with a prevalence of 11.9% among the infected subjects enrolled (Hamit *et al.*, 2008).

In the present study, *G. duodenalis* and *A. duodenale* were found to be the less represented intestinal parasites among infected students' stools. *G. duodenalis* was identified in two (3.6%) of the infected students and *A. duodenale* has been found in one (1.8%) infected student' stool. In regard to *G. duodenalis*, similar results were also reported in Ethiopia (6.2%) (Legesse & Erko, 2004) and in Cameroon (0.6%) (Mbuh *et al.*, 2010). However, both intestinal parasites presences were less than the prevalence observed for the southern provinces of Rwanda reported by Ignatius *et al.* (2012). The differences in findings could be explained by variation in geography, age of participants and socio-economic conditions. Indeed, poverty estimation, access to improved water source and access to improved sanitation fluctuate across the country, with a darkest picture in rural areas (NISR, 2012). Moreover, concerning *A. duodenale*, since wearing shoes is an important factor to lower hookworm infection rate (Tadesse, 2005), we might therefore logically presume that students attending KIE institute are not barefoot and aren't in contact

with contaminated soil as often as children can be.

The most prevalent species observed in our study are those transmitted by the faecal-oral route, dirty hands and contaminated foods and water (Bethony *et al.*, 2006; Ziegelbauer *et al.*, 2012). The intestinal parasites identified may reflect the exposure of KIE students to poor sanitary conditions and confirm the trend of high risk infections seen elsewhere in SSA countries (WHO, 2012). In order to assess risk factors associated with IPIs among KIE students, three simple questions were asked regarding to the water they used to consume and whether or not they lived and ate on the KIE campus. Our results showed that the prevalence of IPIs among KIE students was strongly associated with drinking any kind of water ($p<0.001$) and not eating at the KIE cafeteria ($p<0.001$) and was significantly related to not living on KIE campus ($p=0.026$).

As expected, our results regarding the kind of water consumed are consistent with previous studies (Mahfouz *et al.*, 1997; Gamboa *et al.*, 1998; Gyawali *et al.*, 2009; Ouattara *et al.*, 2010; Alyousefi *et al.*, 2011). In regard to food, the results obtained by Tadesse (2005) had also shown that students who didn't eat on the school compound had a higher prevalence of IPIs. In previous studies, living or not on school campus is generally not included among the risk or protective measures evaluated. Our result is therefore an interesting finding. Despite the fact that living on a campus also means to live in close contact with many other students and sharing of communal facilities, our results show that university campus could act as a protective measure. Several studies have pin down schools and daycares to be responsible for a number of infections outbreaks (Lee & Greig, 2010; Harhay *et al.*, 2012). However, these studies were mainly done in developed countries, where schools are considered as more overcrowded and at-risk environments for infections than what is usually seen among households. Our result suggests that the situation may be different in developing countries. Positive and significant correlations have been described previously between the number of inhabitants in household and the prevalence of infections (Hamit *et al.*, 2008). Also, bad conditions of existing latrines and animal meanderings are well known risk factors of parasite transmission (Gamboa *et al.*, 1998; Corrales *et al.*, 2006; Hamit *et al.*, 2008; Gyawali *et al.*, 2009; Alyousefi *et al.*, 2011). Rwanda is known for its dense population with an average of household size of 4.8, where lack of adequate sanitation and lack of access to potable water is seen in 42% and 19.6% of the population (MININFRA, 2012; NISR, 2012). Furthermore, cultural habits of sharing foods from communal plate, eating with fingers and the presence of meandering animals are still present in Rwanda. However, the KIE institution provides to students living on the campus reinforced water supply and sanitation. The institution provides access to tap water, safe disposal of faeces, waste water disposal, daily toilet cleaning with soap and an animal-free environment. Also, at KIE cafeteria, each client is served with a single portion and utensils are provided. All these factors combined can play a role in the observed difference of IPIs between students living or not on KIE campus. Rwanda Bureau of Standard (RBS) is a public institution established by Rwanda Government Legislation undertaking all activities pertaining to the development of Standards Quality Assurance and Metrology in the country (Government of Rwanda, 2006). Although RBS aims at effective implementation of Rwanda standards for the purpose of consumer protection and perform restaurant, market and industrial premises inspection, we may hypothesis that KIE sanitary regulations are followed more rigorously than the ones found elsewhere. Indeed, all these measures have been found to reduce foodborne illnesses in population and schools (Cairncross *et al.*, 2010; Lee & Greig, 2010).

Therefore, our results point out that in developing countries, learning institutions instead of being seen as environments fostering the propagation of IPIs, they could be considered as a more protective environment, as they may provide reinforce sanitary conditions. Our study encourages for other more in-dept researches regarding

the importance of learning and working environments in promoting or not the propagation of IPIs. Also, regarding to the impact of IPIs among students attending tertiary institutions on successful completion of their programme of study. Although important risk factors were discussed, other risk factors (e.g.: students programme of study), were not evaluated in the current study and would be useful in addressing other issues and gaps for further studies.

In conclusion, the study showed that IPIs of public health relevance are found to be prevalent among KIE students. The importance of safe water consumption as well as eating and living in sanitary environments are crucial to tackle IPIs among students. This calls for the institutions to sustain their efforts to provide safer and safer environments to their students and treatment of infected individuals and the country to keep up with mass scale control measures to overcome the burden of IPIs.

Acknowledgements. We are thankful to all students who participated in the study, to Marcellin Rutegwa from KIE and Dr. Jean-Frédéric Flandin from National Reference Laboratory (NRL) of Rwanda for their helpful discussion.

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