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Prevalence and Burden of Gastrointestinal Parasites among University Students at Dar es Salaam University College of Education, Tanzania

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Abstract

Gastrointestinal parasites cause major health problems in many tropical and sub-tropical countries including Tanzania. However, information on the status of these infections is often scanty, especially among young adults including students in higher learning institutions. During December 2020 to June 2021, a total of 272 faecal samples from university students at Dar es Salaam University College of Education (DUCE) were examined for parasites using the Kato Katz technique and analysed for infection levels based on standard guidelines. Detected parasites were identified as *Schistosoma mansoni* (8.1%), hookworms (1.5%), *Trichuris trichiura* (0.4%) and *Hymenolepis diminuta* (0.4%), with an overall prevalence of 10.4%. *S. mansoni* had the highest mean intensity of 792 eggs per gram (epg) of faeces, while *H. diminuta* was the least intense parasite (120 epg). While infection levels of most parasites were generally low, *S. mansoni* intensity was categorized as heavy based on standard criteria. The findings indicated the public importance of parasitic infections among young adults who are often excluded from most intervention programmes. Thus, further studies to elucidate the magnitude of the infections among young adults in higher learning institutions in Tanzania is warranted alongside regular prescriptions of anthelminthics and sanitation and hygiene education to reduce parasite transmissions.

Keywords: Soil-transmitted helminths, Prevalence, Intensity, Students, DUCE.

Introduction

Gastrointestinal parasites are a group of organisms (helminths or protozoans) that reside in the intestines of humans and other vertebrates where they can cause illness to the host. Gastrointestinal parasitic infections are of great public health concerns in many developing countries including Tanzania. The infections are among the neglected tropical diseases (NTDs) that commonly occur in tropical and sub-tropical areas especially in Sub-Saharan Africa, Asia and South America (WHO 2017). These areas also support the growth and survival of the parasites due to existing conducive conditions such as warm weather, unclean water supply and poor sanitation (WHO 2017, Njeru et al. 2019, Eltantawy et al. 2021). Notable gastrointestinal parasitic infections include soil-transmitted helminthiases (STHs), which are caused by round worms (Phylum Nematoda) whose life cycle stages involve life in the soil, hence their common name, soil-transmitted helminths (Suchdev et al. 2014). Four main species of the worms that cause STHs are *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms (*Necator americanus* and *Ancylostoma duodenale)* (Loukouri et al. 2019).

The World Health Organization (WHO 2017) has estimated that more than two billion people worldwide are infected with one or more STHs (1 billion for *A. lumbricoides*, 800 million for *T. trichiura* and 740 million for hookworms). Up to 300 million of the infected people experience severe morbidity and up to 10,000–135,000 of them die each year due to complications related to the diseases (Shumbej et al. 2015, WHO 2017). People acquire STHs through ingestion of food or soil contaminated with infective eggs of *A. lumbricoides* and *T. trichiura* or through skin penetration by infective larvae of hookworms (WHO 2017).

Parasitic diseases cause serious health problems in humans, such as abdominal pain, diarrhoea, stunted growth and impaired cognitive abilities in children (King et al. 2005, WHO 2017). For instance, STHs whose adult stages live in the host intestine can cause various morbidities such as diarrhoea, loss of micronutrients and macronutrients, intestinal obstruction, malabsorption and loss of appetite (WHO 2017). Some STHs such as hookworms feed on host blood in the intestinal mucosa and can therefore cause anaemia due to blood loss. Furthermore, the parasites can cause mechanical damage to the intestine due to STH-induced inflammation of the intestinal lumen, while in children, they can cause growth retardation and stunting due to accruing nutritional deficiencies (WHO 2017, Djuardi et al. 2021). Other parasitic infections of public health importance in tropical areas are flatworms such as schistosomes (Phylum Platyhelminthes) that cause schistosomiasias, a debilitating chronic infection largely of the urinary and intestinal systems (WHO 2017). Infection prevalences of schistosomes of up to 80%, have for instance, been reported in some areas in Tanzania (Mazigo et al. 2012, Bakuza et al. 2017).

Many parasitic infections, particularly STHs, often occur in people of all ages, although children are more affected than adults as the former are likely to engage in risky behaviours such as playing in water or soil without protection (Shumbej et al. 2015, WHO 2017, Chege 2020). Due to this and other reasons, most studies on parasitic infections in endemic countries have often focused more on pre-and school-aged children and less so on other age groups. This is likely to hamper the efforts aimed at controlling the diseases in endemic areas. However, in recent times, some interest and justification for including all other age groups in epidemiological studies and treatment of parasitic diseases, particularly STHs, has gained momentum, with most stakeholders calling for more inclusive studies (Niyizurugero et al. 2013, Dada and Aruwa 2015, Ejinaka et al. 2019). Nonetheless, current information on the infection status of intestinal parasites among students in higher learning institutions in Tanzania had been lacking. This study was initiated to determine the magnitude and distribution of STH and other parasitic infections among university students at Dar es Salaam University College of Education (DUCE) with the view of generating information to facilitate health management on the campus and possibly beyond.

Materials and Methods

Description of the study area

The study was conducted at DUCE, a constituent of the University of Dar es Salaam, Tanzania. The college is a public higher learning institution located along Taifa Road in Miburani area in Temeke Municipality, Dar es Salaam Region (Figure 1). The College was chosen for this study due to the greater likelihood of the students there carrying STH eggs and larvae, given that most of them come from upcountry regions in Tanzania, most of which are endemic for STHs (Mwambete et al. 2013, Siza et al. 2015, Mazigo et al. 2017, Mhimbira et al. 2017, Eltantawy et al. 2021).

Sampling design and stool collection

The study participants were first, second and third-year students from DUCE. The participants were enrolled into the study after signing written consent as appropriate. A total of 272 students participated in the study.

Participants were selected by convenience sampling technique as only those turning up for the study voluntarily were enrolled. Upon registration, each participant was provided with a labelled sterile plastic vial (placed in a paper bag) for stool sample collection. Samples were processed and examined in the research laboratory at DUCE according to the procedure described in Alemu et al. (2016) and WHO (2019).

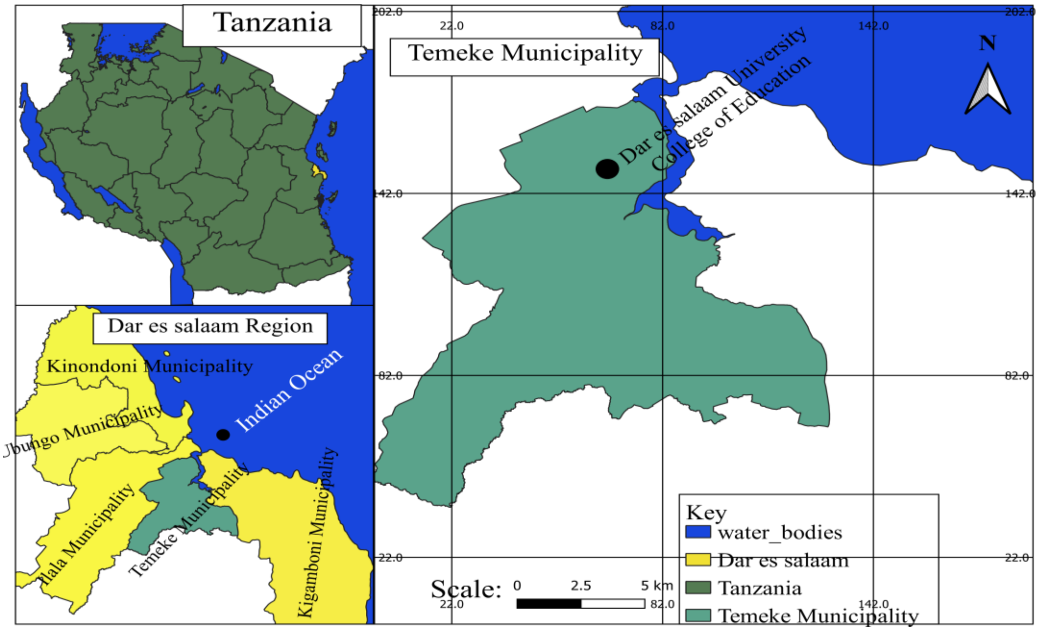

Figure 1: Location of the study area (DUCE) in Temeke District Dar es Salaam Region.

Ethical considerations and study clearance

The study was carried out as part of the study project with Research Clearance NO: AB3/12-B) and Ethical Clearance No. DUCE-20013 issued by the University of Dar es Salaam. As per ethical guidelines, informed consent was obtained from the participants while also ensuring confidentiality as appropriate.

Sample examination

Collected stool samples were examined for parasites in the Postgraduate Research Laboratory at DUCE using the Kato Katz smear method (Bio-Manguinhos, Rio de Janeiro, Brazil) as used elsewhere (Alemu et al. 2016). Briefly, a thick smear of Kato Katz slide was prepared by pressing a small portion of the stool through a wire screen to remove large particles. A small filtrate stool was placed into a template hole on a labelled microscope slide. After the template hole was fully filled, the template was removed, and the remaining faecal sample was covered with cellophane previously soaked in a mixture of methylene blue and glycerine as recommended (WHO 2019). A clean slide was then placed onto the cellophane and pressed hard to spread out the stool. The top slide was removed, and the bottom slide (with stool) was left to dry for 1-2 hours. Dried slides were then examined under a compound microscope, first using a 10x objective for scanning the parasites and then a 40x objective for parasite identification as recommended (WHO 2019). The numbers of detected eggs for each STH and other parasites present in the stool were recorded in laboratory notebooks as appropriate. Observed parasite eggs and larvae were identified using morphological characteristics and other guidelines (Garcia et al. 2017, WHO 2019). The samples were processed and examined on the same day they were collected to ensure viability as recommended (Khurana et al. 2021).

Data processing and analysis

Collected data were analysed using SPSS version 21. The intensity of parasite infections or the number of eggs per gram of faeces (epg) for each parasite species was obtained by multiplying the number of eggs observed for each slide by a factor of 24 as suggested (WHO 2019) and as shown in the manufacturer's manuals accompanying the product (Kato Katz kit used). This is also because the Kato Katz template used during the sample examination could hold 41.7 mg of stool (as per manufacturer's guidelines). The intensities of infections were categorized as light, moderate or heavy depending on the number of eggs of each parasite species examined in each Kato Katz slide following WHO's guidelines (Ojja et al. 2018). The prevalence of infection was obtained as the percentage of infected over the number of examined participants (Montresor et al. 1998, WHO 2019). The chi-square test was used to assess the associations between parasite prevalence and demographic characteristics (Menjetta et al. 2019).

Results

Demographic characteristic of the study population

A total of 272 students participated in the study, with 115 (42.3%) females and 157 males (57.7%). The majority of the participants were aged between 19–23 years (76.2%) with an average age of 22 years, while 22.8% of the participants were 24–28 years old (average 25 years) and the remaining 1.1% aged 29–33 years old (average 30 years). For participant's year of study, 38.6% were first year students, 37.9% were third year students, while 23.5% belonged to the second-year of their study.

Overall prevalence and intensity of parasitic infections

Four (4) types of parasites were identified, including two STHs, namely hookworms and *T. trichiura* and two non-STH parasites, namely *S. mansoni* and *H. diminuta* (Figure 2). The prevalence of the parasites in decreasing order was; S. *mansoni* (8.1%), hookworms (1.5%), T. *trichiura* and *H. diminuta* each (0.4%) (Figure 3). All participants were infected with a single parasite species; none had co-infections. Since only one participant was infected by *T. trichiura* and *H. diminuta*, no further analysis was performed on the infections. The infection intensity at individual level for hookworm parasites ranged 144–176 epg, 312 epg for *T. trichiura* and 120 epg for *H. diminuta*. The egg intensity for non-STH parasites detected were 24–792 epg for *S. mansoni*.

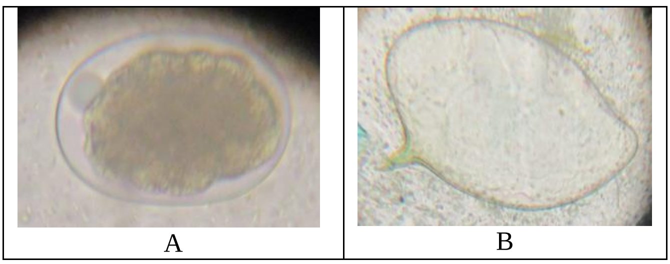

Figure 2: Representative parasite species identified from study participants are hookworm (A) and *S. mansoni* (B).

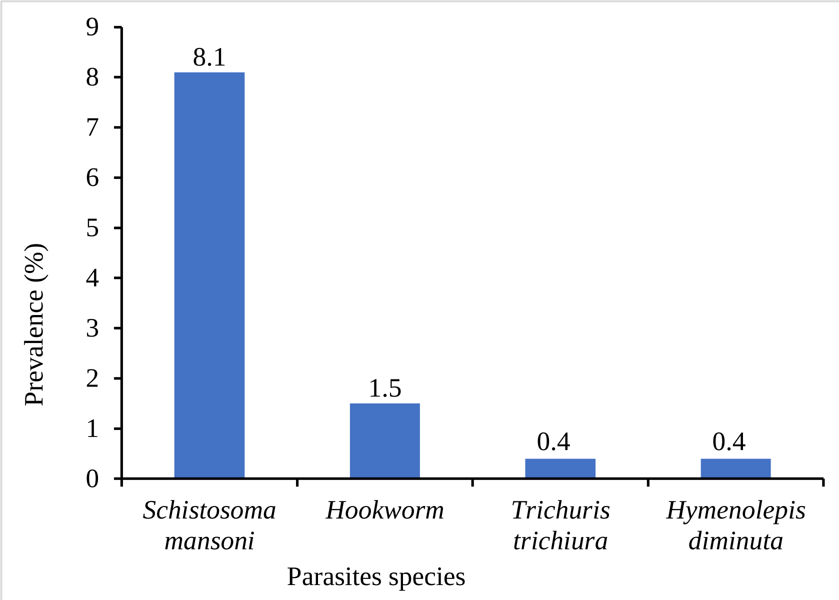

Figure 3: Prevalence of observed parasites among study participants.

Variations of parasitic infections with participants' demographic characteristics

Of the 272 studied participants, only 4 (all males) were detected with hookworm parasites (Table 1). Two of the infected participants were first-year students and one student each being from second and third years, respectively) giving a prevalence of 2.55%. There was no statistically significant difference in the prevalence of hookworms between participants' age groups ($\chi2$ = 19.340 and p = 0.06). The prevalence of *S. mansoni* was higher in male participants (8.92%) compared to female (6.96%) although the variation was not statistically significant ($\chi2$ = 0.579, p = 0.447). Participants aged 19–23 years old were infected with *S. mansoni* at the prevalence of 7.73% (16/207), those with 24–28 years at 8.06% (5/62) while those aged 29–33 years old had a prevalence of 1.62% (1/3). Variations between *S. mansoni* prevalence and participants' age was not statistically significant ($\chi2$ = 13.094, p = 0.287, Table 2).

Table 1: Variations of hookworm prevalence with participant's age and year of study

Variables		**Hookworm infections**				
		Number examined	Number positive (+)	Prevalence (%)	χ2	P-value
Sex	Female	115	0	0		
	Male	157	4	2.55		
Age	19–23	207	2	0.97	19.340	0.06
	24–28	62	2	3.23		
	29–33	3	0	0		
Year of study	1	105	2	1.9		
	2	64	1	1.56		
	3	103	1	0.97		

Table 2: Prevalence of *S. mansoni* infections among students at DUCE in relation to sex, age and year of study

Variables		Schistosoma infection				
		Number examined	Number positive (+)	Prevalence (%)	$\chi 2$	P-value
Sex	Female	115	8	6.96	0.579	0.447
	Male	157	14	8.92	df = 1	
Age	19–23	207	16	7.73	13.094	0.287
	24–28	62	5	8.06		
	29–33	3	1	1.61	df = 11	
Year of study	1	105	9	8.57	2.275	0.321
	2	64	7	10.94		
	3	103	6	5.83	df = 2	

Discussion

Prevalence and intensity of STHs among study participants: General observations

This study has assessed the epidemiological significance of parasitic infections of STHs and other parasites among undergraduate students at DUCE. It is the first cross-sectional study to evaluate the importance of such infections in students of higher learning institutions in Tanzania. The observed overall prevalence of STH infections was of the low category according to the WHO's classification (WHO 2017). Of the two most prevalent STH parasites, hookworms were more common than *T. trichiura,* although both parasites were detected at low levels of infections (Figure 3). The findings corroborate those reported from adults in other endemic areas, such as central Kenya where a prevalence of 0.2% for STH was detected among adults (Masaku et al. 2017). Different explanations can be given for the observed low prevalence of STH infections in the present study. Firstly, it is possible that the students are not highly infected because they are less at risk to STHs and other parasitic diseases. They are educated people with reasonable levels of awareness on the risks involved in STH transmission and can therefore take some preventive measures. They can also practice reasonable personal hygiene and environmental sanitation, which minimizes the chances for them to contract or spread STHs. Adults are generally less susceptible to STH infections because of their high body immunity and are, therefore, not as vulnerable as children (WHO 2017).

Nonetheless, the observation of low STH infections among DUCE students is in contrast with findings from other studies among students in higher learning institutions. For instance, at the Federal School of Medical Laboratory Science in Jos Nigeria, participants were found infected with hookworms at an overall prevalence of 15.4% (Ejinaka et al. 2019). In another study at Kigali Institute of Education in Rwanda, a prevalence of 1.8% of STH infections was recorded, which is close to the level reported in the present study (1.9%). It was urged that the students in Kigali were less likely to be infected with STHs because they had access to clean water, and the overall environmental health on campus was satisfactory (Niyizurugero et al. 2013). In Southern Ethiopia, a study by Menjetta et al. (2019) at Hawassa University students' clinic reported the presence of STHs, including *A. lumbricoides* (15%), hookworm species (2%) and *T. trichiura (*0.2%). Moreover, in another study among undergraduate students at the Michael Okpara University of Agriculture in Umudike Abia State, Nigeria, prevalences of 20.4% and 3.0% were observed for hookworms and *T. trichiura*, respectively (Ohaeri and Orji 2013). Furthermore, a study at Bugando Medical Centre in Mwanza reported a high prevalence of STH infections among adult participants that was also linked to low socio-economic status (poverty) and poor hygienic conditions (Mazigo et al. 2010).

Elsewhere in other endemic countries, studies have reported varying levels of STH infections among adults. This includes a study on households in Tonga Sub-Division Cameroon that reported 23.7% as the overall prevalence of STH infections among young adults (Igore et al. 2020). It was argued in the Cameroonian study that, poverty among the participants, who were mostly young adults, was one of the factors for the occurrence and maintenance of STH in the area (Igore et al. 2020). Poverty and the overall low living standards, including the use of contaminated food and water and the lack of regular medical care, keep individuals in endemic countries at greater risks of acquiring and suffering severely from preventable parasitic infections (WHO 2017). Generally, varying levels of STH infections across endemic countries in Sub-Saharan Africa have been associated with various factors such as different methods used in detecting the parasites, variations among sample sizes used by investigators and the local climatic conditions of the studied areas (Jovani and Tella 2006, Gregoire and Affleck 2018, Ejinaka et al. 2019). For example, during a study at Jos, Nigeria, the formol-ether concentration technique was used for parasite diagnosis (Ejinaka et al. 2019), which is very sensitive compared to the Kato Katz method used in the present study. According to Soppa et al. (2019), the formol-ether concentration technique is superior to the Kato Katz in detecting STH and other parasites in faecal samples. However, the latter is preferred in most field conditions over the former due to its high capacity for the detection (sensitivity) of many parasites, the relative ease of operation and the ability to quantify infection intensity (Endris et al. 2013). In terms of sample size, normally, the larger the sample size, the greater the chances of detecting infections and obtaining higher parasite prevalence (Jovani and Tella 2006, Taherdoost 2017, Gregoire and Affleck 2018). Furthermore, although the sample size in the present study was larger than that used among Nigerian students at Jos, parasite prevalence in the latter was higher possibly due to poor environmental conditions which likely facilitated parasite transmissions and maintenance as noted by the investigators (Jovan and Tella 2006).

Prevalence and intensity of other observed parasites

Some participants in the present study were diagnosed with parasites other than STHs including *S. mansoni* and *H. diminuta* (Figure 3, Table 2). *S. mansoni* and *H. diminuta* are flatworms which unlike STHs which are directly transmitted (Garcia 2009, WHO 2017, Njeru et al. 2019), their transmissions require intermediate hosts. For example, *S. mansoni* needs a specific snail species (Genus *Biomphalaria*) in which it matures before entering humans (WHO 2017), while *H. diminuta* lives in various insect species as intermediate hosts before infecting humans or rats. Furthermore, detecting *S. mansoni* among DUCE students from different parts of Tanzania is of significant epidemiological importance. This is because, the students may have lived on DUCE Campus for a short period of time (1–3 years) compared to the period they had spent in their areas of domicile. Moreover, DUCE campus cannot be the main area for active *S. mansoni* transmissions as there are no streams and other water bodies that are necessary for sustaining snails required as indispensable intermediate hosts for *S. mansoni*. As such, the positive diagnosis of the parasite suggests that the students might have contracted the parasite elsewhere, particularly in their home areas. This is in agreement with the observation by Ejinaka et al. (2019) of up to 15.4% *S. mansoni* prevalence among undergraduate students at Federal University of Technology, Nigeria and concluded that the infections were linked to their places of domicile. Furthermore, S. *mansoni* transmissions are common in many areas in Tanzania especially in endemic zones where 30–56% prevalence of the parasite has been reported (Mazigo et al. 2012, 2017, Bakuza et al. 2017).

Variations of parasitic infections with participants' demographic characteristics

STH infections were highly associated with participants' age, where younger participants were more infected compared to older ones (Table 1). This observation is similar to the results from students in Jos, Nigeria and Hawassa University, Ethiopia where higher STH infections were reported among younger participants (Ejinaka et al. 2019). However, a study at Bugando hospital in Mwanza, Tanzania, found higher STH infections among individuals aged 45 years and above (Mazigo et al. 2010). Elsewhere, studies have reported different levels of STH infections among adults and the variations have been linked to factors such as inadequate personal hygiene together with the environmental factors (conducive environmental conditions) which support the survival and transmission of the parasites (Igore et al. 2020). At Ijinga Island in northwestern Tanzania, for instance, young adults were found to be infected with *S. mansoni* at a relatively high prevalence compared to adults (Mueller et al. 2019). The absence of notable demographic influence on parasitic infections among DUCE students could be because of the nature of the participants enrolled on the study. Most of them are a cohort of almost of the same age who are also possibly endowed with strong immunity to ward off parasitic infections. There are possibly other factors that might influence the patterns of parasitic infections among the students that, due to costs and other logistical issues were not assessed during the present study including hand washing, health education or knowledge about the parasites causes.

Conclusion

The study has indicated that parasitic infections, particularly STHs and *S. mansoni* are common among students at DUCE. Despite their low prevalence among DUCE students, STHs and *S. mansoni* still constitute significant health problems. This is because not only are the infections capable of causing clinical morbidity among the infected, but they can also be transmitted and maintained in the community. As such, reasonable levels of control for the parasite, including regular treatment and awareness-raising campaigns, should be implemented among the students at DUCE and other higher learning institutions in Tanzania. In addition, further studies should be conducted to elucidate the patterns and magnitude of parasitic infections among young adults in colleges and universities in Tanzania.

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Conflict of interest statement: There is no conflict of interests related to this work.

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