

Environmental Contamination by *Taenia* Eggs in Iringa Rural District, Tanzania

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Abstract: Cysticercosis and Taeniosis are global health problems with impacts on human beings and the development of the livestock industry. This study tested the presence of *Taenia* eggs in the soil of two villages in Iringa rural district, Tanzania. No recognizable *Taenia* egg was found, though those found were difficult to identify due to absorption of the flotation fluid which made them dark with difficulties to see the innermost structures. In view of their sizes (30 - 40 microns in diameter) these eggs were considered to be of *Taenia* spp. In addition, eggs from four geo-helminth species were identified namely; *Ascaris lumbricoides*, *Schistosoma mansoni*, *Strongyloides stercoralis* and *Trichuris trichiura* eggs. The frequency of *T. trichiura* was 81.97%, *Ascaris lumbricoides* was 8.2%, unidentified eggs 6.01%, *Strongyloides stercoralis* 3.3% and *Schistosoma mansoni* was 0.5%. The most contaminated sites were backyard with a prevalence of 30.1% followed by west disposal site (WDS) 25.7%, open defaecation area (ODA) 24.0% and the least was toilet 20.2%. About 31 (31%) samples had no eggs. The findings revealed that the environment of Izazi village was more contaminated by geo-helminth eggs (19.4%) than that of Migoli village (12.1%) and that higher moisture content in soils favors the growth, development, spread and transmission of geo-helminth eggs.

Keywords: Environment, *Taenia* eggs, Iringa rural, Tanzania.

INTRODUCTION

Taeniasis is a parasitic disease of the human intestinal tract caused by the adult stage of the closely related tapeworms *Taenia solium*, *Taenia saginata saginata*, and *Taenia saginata asiatica*. After ingestion, the cyst reaches the human intestine, where it develops into an adult tapeworm, releasing proglottids filled with eggs that are passed in the stools [1]. Environmental contamination with *Taenia* eggs results therefore when human stools are not properly disposed. Consequently, the eggs are further ingested by the intermediate hosts ending in development of cysts in soft tissues, a disease known as cysticercosis in cattle and pigs [2, 3]. Unlike *T. saginata* eggs, humans may serve as intermediate hosts for *T. solium* via contaminated environment causing neurocysticercosis, a major cause of seizures and epilepsy in developing countries [4].

Neurocysticercosis is highly endemic in Latin America, Asia, and Africa, especially in those countries where domestic pig husbandry is practiced [5]. In Tanzania porcine cysticercosis was detected in the late 1980s. Since then several studies have been conducted in the northern highlands (Arusha, Moshi, Mbulu) and in the southern highlands (Iringa, Chunya and Songea) where more than 60% of the

country's pigs are raised [6]. In the northern highlands, a retrospective study of slaughter slab records in Mbulu district from 1985 to 1989 indicates a prevalence ranging from 0.41 to 4.88% [6]. Another study by postmortem survey of pigs slaughtered at different slabs indicated that 4.5-37.7% were infected [7]. In a recent study conducted in Mbulu district of northern Tanzania revealed the overall prevalence of porcine cysticercosis to be 7.3% [8] which is lower than that of 17.4% reported previously in 21 villages of Mbulu district [9]. In this study it was observed that out of the six wards included in the clusters, three (Sanu, Kainam, Murray) and one (Gehandhu) were at a very high or high risk of infection, respectively, while two wards (Bargish, Tlawi) were at a low risk of infection. The prevalence study also identified Sanu and Kainam as risky wards (Risk Rate (RR) = 4.2 and 2.0, respectively) while the remaining four wards were identified by this method as low risk wards [8].

The risk factors associated with *Taenia solium* transmission in humans and pigs in rural areas include; lack of pork inspection at slaughter, free-range husbandry system and indiscriminate defaecation. The present study aimed at investigating the extent of environmental contamination by *Taenia* eggs and other geohelminths in Iringa rural district. The study compared the occurrence of geo-helminth eggs between different sampling localities (i.e. Backyard, around toilets, open air defecation areas and waste disposal sites) of the study sites and further determined the effects of organic matter on the isolation of *Taenia* eggs.

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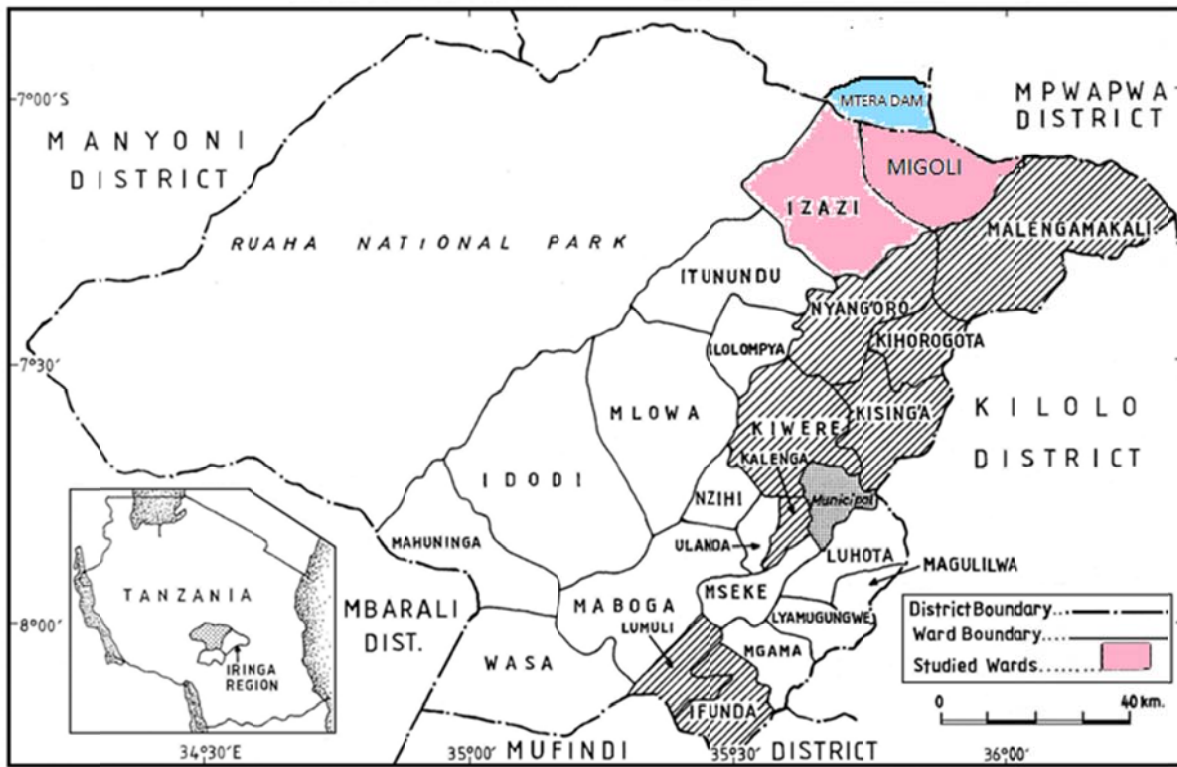


Fig. (1). Iringa rural district showing the location of Izazi and Migoli villages.

Table 1. Prevalence of Geo-Helminths Eggs in Soil Samples from the Two Villages

Village	No. of <i>A. Lumbricoides</i> Eggs.	No. of <i>S. Mansoni</i> Eggs.	No. of <i>S. Stercoralis</i> Eggs/Larvae	No. of <i>T. Trichiura</i> Eggs.	No. of Unidentified Eggs.
Izazi	10.47%	0	3.49%	81.40%	4.65%
Migoli	6.19%	1.03%	3.09%	82.47%	7.22%

A brief explanation on how the current study differs from the previous literature included. Most of the previous studies dealt mainly with porcine cysticercosis rather than environmental contamination. Environmental contamination is a simple way to measure the levels of geohelminth infection in a given population.

MATERIALS AND METHODS

Study Area

The study was conducted in an area with a high density of sprawling pigs in Izazi and Migoli villages in Iringa rural district. Izazi village was established in 1974 and the total population and number of households in 1999 village council estimate were 3560 inhabitants distributed among 712 households. The total population of Migoli by 1999 was 3867 with 724 households (Fig. 1).

Soil Sample Collection

Households for soil sample collections in the two villages were selected based on presence of pigs. Altogether, 96 soil samples were collected from 24 households. Four soil samples (backyard, around toilets, open air defecation areas and waste

disposal sites) were collected per household and 12 households were visited per village. The samples were kept in sterile 500ml plastic bags in cool boxes and transported for analysis to the laboratory of Zoology, University of Dar es salaam.

Isolation of Taenia Eggs from Soil Samples

Geo-helminth eggs were recovered by the centrifugal flotation method as described in [10], but the flotation fluid (sucrose solution) used had a specific gravity of 1.14 instead of the recommended 1.2 and above. Soil moisture content was determined by the oven drying standard method.

RESULTS

General Observation

Eggs from four geo-helminth species were identified in the examined soil samples. These were *Ascaris lumbricoides*, *Schistosoma mansoni*, *Strongyloides stercoralis* and *Trichuris trichiura*. Prevalence of the recovered geohelminths eggs per village is shown in Table 1. A large number of parasite eggs were recovered from Migoli village. Among the sampling sites, many parasites eggs were recovered in soil samples from the backyards (Table 2).

Table 2. Prevalence of Geo-Helminths Eggs in Soil Samples of Different Sampling Sites

Site	No. of <i>A. Lumbricoides</i> eggs.	No. of <i>S. Mansoni</i> Eggs.	No. of <i>S. Stercoralis</i> Eggs/Larvae	No. of <i>T. Trichiura</i> Eggs.	No. of Unidentified Eggs.
Backyard	7.27%	0	5.45%	74.54%	12.73%
ODA	6.82%	2.27%	6.82%	77.27%	6.82%
Toilet	10.81%	0	0	86.47%	2.70%
WDS	8.51%	0	0	91.49%	0

Table 3. Prevalence of Geo-Helminths Eggs in Izazi and Migoli Villages Showing Extent of Environmental Contamination

Village	Positive Samples	Samples Contaminated by One Species of Geo-Helminths Eggs.	Samples Contaminated with More than One Species of Geo-Helminths Eggs.
Izazi	36	80.56%	19.44%
Migoli	33	87.88%	12.12%

Table 4. Summary of Average Moisture Content and the Recovered Eggs

Sites	Average Moisture Content	Total Number of Eggs.
Backyard	1.11%	55
ODA	0.65%	44
Toilet	0.55%	37
WDS	0.52%	47

The extent of Environmental Contamination in Migoli and Izazi Villages

The results of the present study show that soil samples from Izazi and Migoli villages were contaminated by one or more species of geo-helminths eggs. Eggs of *Trichiura*, *Ascaris*, *Schistosoma* and *Strongyloides* were found as individuals or multiple contaminations. A total of 29 soil samples from Izazi and Migoli were each contaminated with a single species of geo-helminth eggs. At Izazi village seven samples (n=7) had more than one species of geo-helminths eggs, whereas at Migoli village only four samples had more than one species of geo-helminths (n=4). The difference however, was statistically insignificant (t=0.0917; p=0.005). Izazi village was generally found with more geo-helminths positive soil samples (n=36) than Migoli village (n=33) Nevertheless the extent of contamination between the two villages were statistically similar (t=0.0947; p=0.005) (Table 3).

Environmental Distribution of Geo-helminths Eggs

The occurrence of eggs from samples were backyard 55 (30.1%), ODA 44 (24.0%), toilet 37 (20.2%) and WDS 47 (25.7%). About 31 (31%) of the samples had no eggs. However, the distributions of eggs in all sites sampled were more or less similar (F=1.417; p=0.19). The frequency of *Ascaris lumbricoides* was 15 (8.2%), *T. trichiura* 150 (81.97%), *Strongyloides stercoralis* 6 (3.3%), *Schistosoma mansoni* 1 (0.5%) and unidentified eggs 11 (6.01%). The frequency of *T. trichiura* was significantly higher than *A. lumbricoides* (t=0.0004; p=0.05); unidentified eggs (t=0.001; p=0.05) and *Strongyloides stercoralis* (t=0.002; p=0.05).

Egg Distribution Per Sampling Site

The backyard and WDS samples were more contaminated by *T. trichiura* than those from toilets. However, the degree of contamination in backyard and WDS samples were insignificantly higher compared to that from ODA (t=0.3969; p=0.05) and toilet (t=0.07; p=0.05). The contamination rate in backyard and WDS were statistically similar (t=0.4612; p=0.05). The distribution of *Strongyloides stercoralis* was significantly more observed in backyard samples than those in WDS (t=0.135; p=0.05) and toilet (t=0.0345; p=0.05) samples. However, the total counts in backyard and ODA samples were statistically insignificant (t=0.1285; p=0.05). While the distribution of *A. lumbricoides* was significantly higher in backyard samples than those from WDS (t=0.0188; p<0.05), it was similar in ODA (t=0.3454; p=0.05) and toilet (t=0.0818; p=0.05) samples. *Schistosoma mansoni* ova was the least observed in all samples, again, backyard samples revealed high significant contamination by the particular worm eggs than ODA (t=0.0116; p=0.05), toilet (t=0.0306; p=0.05) and WDS (t=0.0118; p=0.05). Regardless of the type of geo-helminths eggs observed, all collection sites were equally contaminated. The assorted distribution of geo-helminths shows that backyard samples were slightly more contaminated than ODA (t=0.0706; p=0.05), toilet (t=0.0678; p=0.05) and WDS (t=0.699; p=0.05).

Moisture (Organic Matter) Content and Eggs Distribution

The backyard soil samples were moister than those from ODA (t=0.0678; p=0.05), though the difference was statistically insignificant. The moisture content from toilet soil

samples were significantly less than those from backyard ($t=0.0118$; $p = 0.05$), similarly those from WDS ($t=0.00069$; $p = 0.05$). Furthermore, backyard samples contained significantly high number of eggs than ODA ($t=0.0233$; $p = 0.05$); toilet ($t=0.0002$; $p= 0.05$) and WDS ($t=0.0038$; $p = 0.05$), however, egg recovery between ODA and WDS were statistically similar ($t=0.1254$; $p= 0.05$) (Table 2). The correlation between moisture content and the number of eggs was positive (observed rate (OR) = 0.0125) (Table 4).

DISCUSSION

The present study found a considerable population of pigs raised under free range system in households whose environment was highly contaminated by geo-helminths eggs. The study further observed that some of the households had no toilets, if any, were bare/ non-walled, increasing the risk of environmental contamination. Children were found to dispose their wastes in backyards during day plays and when sweeping those grounds they finally dispose off wastes in the waste disposal sites (WDS). Adults defecate on shrubby areas (ODA) during early mornings and nights. Even if children decide to go to toilets, they heap their faeces around the hall or around the wall foots where pigs chew the soil due to the salt taste of urine. Under such circumstances, roaming pigs are likely to feed on fecal materials that at times may contain geo-helminths and or *T. solium* eggs.

The present study however, did not find any *T. solium* egg from all four sampling sites i.e. backyard, ODA, toilets and WDS in the two villages sampled. Conversely, soil contamination by *Trichuris trichiura*, *Ascaris lumbricoides*, *strongyloides stercoralis* and *Schistosoma mansoni* were observed. 74% of the 96 samples were contaminated with more than one species of geo-helminths eggs, whereas 26% of the examined samples had no egg. This could be due to indiscriminate defecation by either adult people when drunk or children in play grounds during their day plays. About 7.6% of the eggs were unidentified; the methodology used might be the source to zero occurrences of *T. solium* eggs.

It is estimated that about one-sixth of the world population is infected by *Ascaris lumbricoides* [11]. Ascariasis is transmitted when human ingest parasite's infective egg in contaminated food, water or hands. Matured parasites in infected individuals shed eggs which are released out in faeces to the environment where they can persist for more than 10 years [12]. The parasite is distributed in different regions of the world as in Indonesia the prevalence of 73.7% [13] in Cameroon 54.9% [14] in Zaria, northern Nigeria [15] and 54.1% from stool samples and 24.0% from soil samples of primary school children in Ebenebe town, Anambra state Nigeria [16] were reported. In the present study a prevalence of 10.5% and 6.2% were observed from Izazi and Migoli villages respectively.

Schistosoma mansoni are the agents of intestinal schistosomiasis. Human-dwelling parasites release eggs in faeces to the environment, ripe miracidium hatches out of the egg and searches for a suitable freshwater snail. An infected snail can release thousands of cercariae that are capable of infecting man [17]. The parasite is estimated to infect about 83.31 million people worldwide [18]. One sample from Migoli

village was found to be contaminated with *Schistosoma mansoni* egg suggesting the presence of individuals infected with the parasite. The parasite infection is aided by the presence of Mtera Dam where people swim freely and some defecate in the nearby surroundings. In Ghana, a study done in Atonsu, Kumasi reported presence of *schistosoma* spp eggs from examined soil samples [19].

Strongyloides stercoralis adult parasitic lives in tunnels in the mucosa of the small intestine of infected individuals and causes strongyloidiasis [20]. These adult parasites lay eggs which are released out in faeces to the environment. *Strongyloides stercoralis* occurrence were reported in Indonesia with a prevalence of 1.6% [13] and 5.9% from stool samples of primary school children in Ebenebe town, Anambra state Nigeria [16]. The present study found the presence of these parasites larva in soil samples from Izazi and Migoli village with the prevalence of 3.5% and 3.1% respectively.

Trichuriasis infection occurs through ingestion of *Trichuris trichiura* eggs which hatch in the small intestines and then move into the wall of the small intestine where it develops into adult worm. The thinner end of the adult worm burrows into the large intestine and the thicker end hangs into the lumen and mates with nearby worms. They then shed eggs which are released in faeces to the environment. Eggs are infective about 2–3 weeks after they are deposited in the soil under proper conditions of warmth and moisture [21]. In this study a large number of *Trichuris trichiura* eggs were recovered from soil samples of Izazi (81.4%) and Migoli (82.4%). Similar findings were reported from soil samples in Atonsu Kumasi, Ghana [19] and in rural areas of Lodz district Poland with the prevalence of 3.5 % [22].

There were difficulties on identifying several eggs in the present study. These eggs were recovered from soil sample of the two villages Izazi and Migoli. It was difficult to identify these eggs possibly due to absorption of the flotation fluid which made the eggs dark, hence difficulties in examining clearly the innermost structures. It was still difficult to examine them even at higher power magnification, 40X. Considering their sizes (30 - 40 microns in diameter) these eggs were probably of *Taenia* spp [23]. The occurrence of the four human parasites eggs and larva in the environment of Izazi and Migoli villages could be attributed by improper use of toilet facilities by the inhabitants of the two villages surveyed. Izazi and Migoli villages are bordered to the north by the Mtera Dam, with fishing as a major economic activity of the area. Unfortunately fishers have a tendency of moving from one location to another in search of fish, and in most cases the new locations have no toilet facilities. This further encourages the habits of indiscriminate disposal of human wastes in Open defecation areas such as in bushes and shrubby areas. Hence the wide spread of geo-helminths eggs observed in the two villages.

The burden of disease due to soil-transmitted helminth infections (*Ascaris lumbricoides*, *Trichuris trichiura*, and the hookworms) may be classified as a lower threshold above which there are detrimental effects on physical and school performance, which might be temporary or permanent and a higher threshold above which there is a risk of clinically overt illness [24]. The results from this study revealed high

prevalence of the two worm species i.e. *A. lumbricoides*, and *T. trichiura* and hence a need to intervene.

The occurrence of more than one species of geo-helminth eggs per sample was higher in Izazi village than in Migoli village. This was due to the complex nature of the ethnic situation of the village. The village population includes indigenous people who mostly do crop cultivation and the newcomers migrated to the area to exploit the fishing potential of the Mtera Dam. These newcomers had established fishermen camps as temporary settlements forming a community with people moving in and out. Due to lack of permanent settlement there are no better sanitary facilities and thus the fishermen have developed habits of indiscriminately disposing off their wastes in shrubby areas surrounding the village. These are the open defecation areas (ODA) whereby adults visit during nights and early morning hours. This habit aided faecal contamination of the surrounding village environment with different species of geo-helminth eggs from infected individuals harboring different species of intestinal parasites from different localities where they originate from.

T. trichiura eggs had the highest frequency followed by *A. lumbricoides*, *S. stercoralis* and finally *Schistosoma mansoni*. With the exception of *Schistosoma mansoni* which was only found in ODA samples, the backyard, ODA, WDS and toilet were equally contaminated by the rest of the detected worm eggs. Even though the results from the present study contradicts with that by [25] who found high prevalence of *Taenia* spp. eggs in backyard, toilet, kitchen and washboards, the highest prevalence of intestinal worms eggs from this study area signifies environmental contamination by human faeces. Nevertheless, these findings comply with those of [26] who found no single egg of *Taenia* spp. other than a high prevalence of *A. lumbricoides* and *T. trichiura* in south-west Cameroon.

Contamination of the environment by these potentially harmful parasites is currently high probably due to the increased population and traditional practices of human waste disposal. Oral faecal age children in the study area depend most of their days playing in backyards as their common play grounds. Some of these backyards are meant for subsistence farming, thus accessible for pet and other livestock. Nevertheless, they are the main sources for vegetables and spices in most of the households. Intermingling of these activities make the environment favourable for geo-helminth development. The fact that *Ascaris* causes kwashiorkor to children due to inappetence and competing with the host for nutrients in the body, its presence in high prevalence in the study area is of public health concerned.

High moisture content of the backyard also favors development, growth, spread and transmission of geo-helminths. The high moisture content of the backyard sampling site could be due to day to day activities such as washing clothes, household utensils, and small scale cultivation of vegetables for daily uses whereby all these activities involve the use of water which at the end is spilled over the ground as the traditional method to control dust. This habit leaves backyard site moist for most of the time hence providing favorable condition for survival of geo-helminthes [27]. In their study also

found moisture content to the soil favor parasite eggs development, growth, spread and transmission. Waste disposal site (WDS) apart from having the lowest moisture content compared to all other sites it was more contaminated than ODA, and toilet sites. This was because all the waste materials including contaminated soil of the backyard site after being swept they are usually disposed/thrown into the WDS. This provided the chance for recovery of most eggs which some of them might had not originated from the WDS.

The presence of the four species of human parasitic helminthes in the examined backyard, ODA, toilets and WDS indicate the potential health risk among the oral faecal age children. Furthermore, backyard samples being more contaminated poses more health risks because it is the place where kitchen and other households refuse are damped. It is the place grown with subsistence seasonal and or annual horticultural crops like amaranthus, spinach, carrots, chinese, and cucurbitaceae to mention a few. While these vegetables are consumed daily, its preparation again is questionable, thus subjecting human onto the cycle of reinfection by geo-helminthes eggs.

CONCLUSIONS

This study aimed at examining the extent of *Taenia* spp. eggs in soil samples collected from rural settings of Iringa region. All sites i.e. backyard, ODA, toilets and WDS revealed none of the *Taenia* spp. Eggs, though those found were difficult to identify due to absorption of the flotation fluid which made them dark with difficulties to see the innermost structures. However, in view of their sizes (30 - 40 microns in diameter) these eggs were considered to be of *Taenia* spp. Furthermore the findings revealed that the environment of Izazi village was more contaminated by geo-helminthes eggs (19.4%) than that of Migoli village (12.1%). Among the four sampling sites of the study area, the Backyard site was the most contaminated by 30.1% followed by Waste disposal sites by 25.7% then Open defecation areas by 24.0% and the least contaminated was Toilet site by 20.2%. Moisture content was found to favor growth, development, spread and transmission of geo-helminthes eggs. Most eggs were recovered from Backyard soil samples with the highest moisture content of 1.11%.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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