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Prevalence and Risk Factors of *Entamoeba histolytica* amongst Children Attending Primary Schools in Kyuso Zone, Kyuso District, Kitui County, Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. Authors JAS and MMG designed and supervised the study, wrote the protocol, and reviewed the manuscript. Authors DMK and JNM managed the literature searches carried out the data collection and analyses and wrote the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The occurrence of *Entamoeba histolytica* as a human intestinal parasite is a serious problem especially in developing countries. *Entamoeba histolytica* frequently infects as a commensal within the human large intestine with no overt clinical manifestations. However, trophozoites can invade the colonic epithelium and produce ulcers and dysentery, a condition known as Amoebiasis. Amoebic infections in Kyuso Zone, Kyuso District are common. The ecological aspects in the area and particularly water-related ones allow endemicity. There have been efforts to provide treatment and control of amoebic infections but the prevalence of the disease in this area has never been established. This study was aimed at determining the prevalence of *E. histolytica* in school children aged 6-12 years in Kyuso Zone and establish the relationship between the prevalence and risk factors. A cross-sectional study design was used where 354 randomly selected pupils aged 6-12

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years provided stool specimen which were taken to Kyuso District Hospital Laboratory for examination. There was no significant association between prevalence and gender (χ^2=0.9653, df=1, P>0.05) and no significant association between prevalence and age (χ^2=3.5649, df=2, P>0.05). A significant association was found between the use of dry riverbed wells and high prevalence (OR= 2.351, P=0.02) and the use of earth dam water and high prevalence (OR=2.828, P=0.0000). A significant association was found between high prevalence and use of latrines (χ^2=4.7199, df=1, P=0.0298). In this study there was a clear indication that *E. histolytica* infections are a problem in schools in Kyuso Zone. It is therefore recommended to the ministry of education and the ministry of Public health that public health education programmes should be formulated and carried out in schools and within the community so as to inform people of good sanitation and hence reduce infections and morbidity. It is further suggested that school children be considered for chemotherapy treatment to reduce morbidity.

Keywords: Amoebiasis; asymptomatic; diarrhoea; dysentery; prevalence; risk factors; water source; zone.

1. INTRODUCTION

Entamoeba histolytica is an intestinal protozoan of humans. Several species of the genus *Entamoeba* infect humans. These include: *Entamoeba histolytica, Entamoeba dispar, Entamoeba coli, Entamoeba hartmani, Entamoeba polecki, and Entamoeba gingivalis* [1]. Among these, only *E. histolytica* is considered pathogenic and the disease it causes is called amoebiasis or amoebic dysentery [2]. *Entamoeba histolytica* is an enteric parasite that colonizes the human intestinal lumen and has the capacity to invade the epithelium. Amoebic dysentery occurs when *E. histolytica* trophozoites invade the walls of large intestine and multiply in the mucosa, forming ulcers. Most frequent manifestations of infection are dysentery, colitis, flatulent stomach, weight loss, fatigue and abdominal pain. A common outcome of invasion of the amoeba into tissues is liver abscesses which can be fatal. The pathogen secretes histolysin [3], which digest the gut of the infected individual hence the Latin name, histo (tissue) lytica (destruction) [4].

Environmental, socio-economic, demographic and hygiene-related behaviour is known to influence the transmission and distribution of intestinal parasitic infections [5]. A study in Brazil identified place of residence, age, ingestion of raw vegetables and drinking water quality as important risk factors [6]. Socio-economic factors as well as unpredictable factors such as food insecurity, droughts, and floods contribute to the problem [7]. Unavailability of safe domestic water and low education on sanitation also contribute to transmission [8]. *Entamoeba histolytica* gains entry into the intestines through the fecal-oral route. Transmission may also be through mechanical vectors such as flies [9]. Many tropical developing countries lack adequate supply of clean domestic water; contamination may occur at the source of water or at home due to poor sanitation [10]. Infection rate is high amongst persons aged 5-40 years [11] but according to Tawasar et al. [12] infection is higher in children than adults. According to UNICEF, more than 3 billion people, which translate to half of the global population, do not have access to proper sanitation which leads to high rate of infection with *E. histolytica* [10]. About 3 million children die each year from diseases associated with poor sanitation worldwide. According to WHO, intestinal amoebiasis caused by *Entamoeba histolytica* is the third principal parasitic disease responsible for mortality of about 100,000 people annually in the world [13]. It is a frequent cause of diarrhoea in children, and can have a negative impact on their growth and development. Unfortunately, these intestinal protozoa are taken into account in only a few epidemiological studies. Although amoebiasis seems to raise much less interest than do AIDS and Malaria, it is a major public health problem in tropical regions [14]. In 2001, WHO estimated the number of people infected by digestive tract parasites, of which amoebiasis ranks high, at 3.5 billion and the number of people made ill by them at 450 million [15].

In Kenya, which is also a tropical country, the situation is not any better. The bulk of the population lives in rural areas or in slum dwellings in towns. Sanitary facilities provision is only about 43% with 57% going without safe water and proper excreta disposal [8]. The semi-arid areas of Kenya to which Kyuso District belongs, have chronic shortage of domestic water. In 2004, through Sweden International Development Agency funding, the District Public Health Officer carried out a survey on water and

sanitation and established that the larger Kyuso District had poor water and sewerage systems, with only 15% latrine coverage. Most of the water sources are contaminated due to sharing the water points with domestic animals and also due to the fact that latrine coverage is low at 15% [16].

A large part of the population relies on surface or sub-surface water sources exemplified by dry riverbed wells, shallow water wells, rock catchments and Earth dams. Most of these sources are highly contaminated [16]. Collection of epidemiological data is necessary to develop effective strategies against this parasite. The results should facilitate evaluation of the endemic level of amoebiasis, and consequently whether massive or focal measures of control are required.

To contribute to a better comprehension of the epidemiology of this intestinal protozoan, the prevalence and distribution of *Entamoeba histolytica* and its association with drinking water supplies was determined in primary school children in Kyuso Zone, Kyuso District of Kitui County. The investigation carried out to determine prevalence of these infections revealed the importance of this parasite in the arid and semi-arid areas to which Kyuso Zone belongs.

In addition, the description of the relationship between sources of drinking water with infections with *E. histolytica* will contribute to the development of an integrated treatment program for this parasite in this area of Kenya.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in Kyuso Zone, Kyuso District. A Zone is an Educational administrative unit comprising of several schools. Kyuso is part of the larger Mwingi District in Kitui County of Kenya. Kyuso District is located about 198 km East of Nairobi. It lies between latitude 0°03' and 1°12'S and longitude 38°47' and 39°57' E and occupies an area of 804.4 km². The population density is 46 people per km² [16]. It borders Mwingi District to the south, Embu and Tharaka-Nithi counties to the West, Garissa and Tana River counties to the East. It is a semi arid area and has challenges of acquisition of clean water for domestic use. Temperatures range between 26°C and 34°C. Kyuso Zone where this study was carried out has a total of 19 primary schools with approximately 5700 pupils. Of these 3610 (63%) are aged 6-12 years [as per the records in Ministry of Education in the Zone, unpublished, 2011], and was the targeted population. Eight schools out of the 19 were selected for this study using cluster random sampling. These included Ngaaie, Itulu, Nzaalani, Gai, Mikwa, Ndathani, Kyuso and Kalole primary schools.

Kyuso Zone was purposely selected for this study because it has both urban and rural settlements [16]. Water sources in the Zone include; two seasonal rivers (Mughoo and Thunguthu), several bore holes, rock catchments and several Earth dams (which include Gai, Kyuso, Kaghui amongst others). The main economic activity is subsistence crop growing and livestock keeping. They grow maize, sorghum, millet, cowpeas and a few other drought- resistant crops. They mainly keep cattle and goats. Kyuso Zone has several health facilities. These include; Kyuso District Hospital, Ngaaie dispensary, Marisi dispensary, all of which are government facilities. Faith-based facilities include Tei wa Yesu Family Care Centre and Hospital and Kimangao Catholic mission Health Centre. There are few private ones including The Neema Hospice.

2.2 Study Design

This was a cross sectional study aimed at capturing the population aged between 6-12 years in Kyuso Zone, Kyuso district. Cluster random sampling was used to sample the schools and the pupils, [17].

2.3 Sampling Techniques

Kyuso zone has a total of 19 primary schools. A cluster random sampling was used to sample the schools. They were clustered into 4 centres (Ngaaie, Kimangao, Kyuso and Marisi Centres) and then 2 schools picked randomly from each centre. Likewise, pupils aged 6 to 12 years from each sampled school were clustered in terms of classes and picked randomly until the calculated sample size was realized.

2.4 Sample Size Determination

The sample size was determined by the method as used by Fisher *et al.* [18] and Wayne [19] for calculating sample size.

Thus: $n = \frac{Z^2 pqD}{d^2}$

Where;

n = Sample size where population <10,000 (Kyuso Zone has approximately 3610 pupils aged 6-12).
Z = Standard normal deviate (1.96) which corresponds to 95% confidence interval.
P = Proportion of the target population estimated to have a characteristic (this is approximated at 0.36 in consideration of the medical records at Kyuso District Hospital).
q = 1-p; hence 1-0.36=0.64
d = Degree of accuracy desired for the study = 0.05.
D = Design effect = 1

$$n = \frac{1.96^2 x 0.36 x 0.64}{0.05^2} = 354$$

In this regard, 354 pupils were sampled in 8 schools out of the 19 in the Zone. The schools included Ngaaie, Itulu, Nzaalani, Gai, Mikwa, Ndathani, Kyuso and Kalole primary schools. Forty four pupils aged between 6-12 years were sampled randomly from each school except Kyuso Primary school from which 46 pupils were sampled due to a relatively higher population.

2.5 Inclusion and Exclusion Criteria

All the pupils aged 6-12 years were included in the study despite their class. These are the ages most exposed to intestinal parasites [20]. Those who were unwilling to participate in the study and those who were absent from school on the initial day were excluded.

2.6 Data Collection

2.6.1 Parasitological survey: Collection of stool samples

Sampling was done from all volunteering school children of the ages 6-12 in the sampled 8 out of the 19 schools in the Zone. Cluster random sampling of the schools from the Zone's 4 centers was done. After the children were given an explanation of the stool sample collection, they received polypots bearing serial numbers into which they were to place their samples, applicator sticks and tissue papers as apparatus for stool collection. Each school was allocated a day for the sample collection. The sample collection was done at around 8.00 a.m and it took about 30 minutes to obtain the samples. The samples were transported to the Kyuso District Hospital laboratory which is about 15 kilometers from the furthest school for examination.

2.6.2 Questionnaire survey

Questionnaires were distributed to all the sampled 8 schools where the class teachers were requested to interview their pupils of ages 6-12 years and fill the questionnaires. The questionnaire took into account several aspects but only data on water supply sources, hygienic situation at home and presence and use of latrines at home were considered for this study. The teachers followed the instructions that accompanied the questionnaire and interviewed pupils separately, one after another, in an empty classroom to avoid the influence of others on their responses. Most of the questions required "Yes" or "No" responses but where elaboration was needed, the teacher gave options to the pupil to ease recollection.

2.6.3 Observational check list

Observation was done during the visits to each school to determine other factors that may be associated with transmission of amoebiasis. The factors sought included water sources, presence of toilets, and system of feeding pupils amongst others. Checklists were filled.

2.6.4 Focus group discussion

A focus group discussion was held with health providers in the zone to assess the control strategies against amoebiasis in the community in general, since if the control strategies have an impact in the community they will also affect the children. The discussions also focused on the epidemiological factors that lead to infection in the community. In the discussion were the Medical Officer of Health Kyuso District; the medical superintendent, Kyuso District Hospital; 2 nurses from Kyuso District Hospital and one from Tei Wa Yesu family care centre and hospital; 1 medical lab technologist and the public health officer Kyuso District. Discussions were also held with teachers in the schools visited to evaluate transmission factors, health education matters and how they have impact on the school children. 3 teachers from each school were involved. A group discussion guide was used to guide the discussion and the results of the discussion helped to furnish the information about the control measures of amoebiasis in the zone.

2.6.5 Hospital records

Medical records were accessed in Kyuso District Hospital for relevant data on the disease status in the general population.

2.6.6 Laboratory analysis techniques

The collected stool specimen was first observed physically for consistency, presence of blood stains and any macroscopic parasites [21]. Direct smear and staining methods were used to process the stool as described by Cheesbrough [22] and then observed microscopically using x10 orx40 objective for cysts or trophozoites. Formal ether concentration technique was also employed for more quantitative examination [23].

2.7 Data Analysis

Data was stratified using such variables as age, sex, number infected and number uninfected. The Children ages were divided into three age-groups (6-8, 9-10, and 11-12 years). Chi-square (χ^2) tests were conducted with SPSS statistical package [19] to determine the relationship between the prevalence and children's age and sex with a confidence interval (CI) of 95%. Associations between the parasite prevalence and water sources were examined by logistic regression conducted with SPSS statistical package [19].

2.8 Ethical Approval

This study was approved by the graduate school board of Kenyatta University. This is an internal ethical oversight committee at Kenyatta University. Permission to conduct the study was sought from the Ministry of Public Health and Sanitation, the Medical Superintendent Kyuso District hospital and the Ministry of Education and approval was obtained. For this study only the approval of the ministry of Health and Ministry of Education were required. The authorities of all the sampled schools gave consent to the study. Before sampling, all pupils, parents / guardians in each particular school were met and an explanation of the study was done where they generally consented to participation. All the parents/guardians signed a consent form on behalf of the pupils before sampling. The pupils and their parents/guardians were fully informed that participation was voluntary and that they could withdraw at any time from the study. After sampling of the consenting pupils another meeting was held with the pupils and their parents/guardians and then they gave both verbal and written consent by filling the prescribed consent form again. The reaffirming of the consent was necessary because the earlier consent had been given prior to sampling. All work was done according to the principles expressed in the declaration of Helsinki and the guidelines for human experimentation in clinical research as stipulated by the Ministry of Health of Kenya.

3. RESULTS

3.1 Demographic Characteristics of the Respondents

3.1.1 Study sample

Three hundred and fifty four pupils were sampled out of the 3610 aged 6-12 years. All the sampled pupils provided stool samples for examination and filled the questionnaire with the assistance of their teachers.

3.1.2 Distribution of respondents per age and sex

Out of the 354 pupils that participated in the study 186 (52.5%) were females and 168 (47.5%) were males. Within the 3 age groups used in the study, 115 (32.5%) were aged 6-8 years, 135 (38.1%) were aged 9-10 years and 104 (29.4%) 11-12 years (Table 1).

Data by gender indicated a higher number of females than males while by age, more of the of the children were within the 9-10 age group.

3.1.3 Prevalence of *E. histolytica* in children attending primary schools in Kyuso Zone

3.1.3.1 Overall prevalence

The over-all prevalence of *E. histolytica* in school children aged 6-12 years in primary schools in Kyuso Zone was 42.1% (Table 1). Out of the 354 pupils sampled, 149 were found to be infected with *E. histolytica* while 205 were not infected.

3.1.3.2 Prevalence by gender

Out of the 186 female pupils, 79 (42.5%) were found to be infected. One hundred and seven female pupils were uninfected. Out of 168 male pupils 70 (41.6 %) were found to be infected with *E. histolytica* (Table 1).

Table 1. Distribution and prevalence of respondents by age and gender (N=354)

Variable	Category	No of respondents	Percentage of the total respondents	% of uninfected	% of infected/prevalence
Gender	Female	186	52.5	57.5	42.5
	Male	168	47.5	58.3	41.6
Age (years)	6-8	115	32.5	64.4	35.6
	9-10	135	38.1	57.1	42.9
	11-12	104	29.4	51.9	48.1
Overall prevalence					**42.1**

3.1.3.3 Prevalence by age

Out of the 115 pupils aged 6-8 years, 41 (35.6%) were found to be infected. Out of the 135 aged 9-10 years 58 (42.9%) pupils were found to be infected. Out of the 104 pupils aged 11-12 years, 50 (48.1%) were found to be infected (Table 1).

3.1.4 The relationship between the prevalence of *E. histolytica* and gender and age

3.1.4.1 The relationship between the prevalence of E. histolytica and gender

The *E. histolytica* status was observed to be independent of gender. No significant association was found between prevalence and gender (χ^2=0.9653, df=1, P=0.3259) (Table 2).

3.1.4.2 The relationship between the prevalence of E. histolytica and children's age

The *E. histolytica* status was observed to be independent of age. No significant association was observed between the *E. histolytica* prevalence and Children's age. (χ^2 = 3.5649, df=2, P>0.05) (Table 3).

3.1.5 Factors contributing to transmission of *E. histolytica* amongst school children in Kyuso Zone

3.1.5.1 Association between E. histolytica prevalence and water sources

Users of Dry river bed wells and Earth dams had the highest prevalence rates amongst the water sources at 29.5% and 40.3% respectively (Table 4). A significant association was found between the use of Dry riverbed wells and high prevalence of *E. histolytica* (χ^2 =10.042, df=1, P=0.02) (Table 4). A significant association was also found between use of Earth dam water and prevalence (χ^2 =13.489, df=1, P=0.000) (Table 4).

3.1.6 Association between *E. histolytica* prevalence and other risk factors

3.1.6.1 Latrines

Of the 354 respondents 136 (38.4%) did not have latrines in their homes, preferring to relieve themselves in the bushes while 61.6% had latrines at home. Through observational checklists it was observed that 70% of the latrines observed had very low standards of cleanliness. When Chi-square test was done to determine the association between latrine use and the status of *E. histolytica* (Table 4), a computed value of χ^2 =4.7199 was obtained against the tabulated χ^2, 0.05, df=1, = 3.841. Hence there was a significant association between the use of latrines and *E. histolytica* status (χ^2 =4.7199, df=1, P=0.0298).

3.1.6.2 Water treatment

Of the 354 respondents 223 (62.9%) had their drinking water treated in their homes (Table 4). Of these 6% were found to be infected. Of the 37.0 % who did not have their drinking water treated at home, 25% were found to be infected (Table 4). A significant association was found between treatment of drinking water and high prevalence (χ^2=11.645, df=1, *P*=0.002).

3.1.6.3 Protection of water sources

Of the total respondents, 232 (65.5%) had their water sources protected either by fencing or covering. Of these, 17% were found to be infected with *E. histolytica*. Of the 34.5% whose water sources were not protected 11% were found to be infected (Table 4). No significant association was observed between protection of water sources and prevalence (χ^2=1.286, df=1, *P*=0.257).

Table 2. The relationship between prevalence and gender (N=354)

Gender	Status (n=354)			
	% Positive	% Negative	Total	*P* -value
Male	41.6	58.3	99.9	
Female	42.5	57.5	100	*P*=0.3259
Total	**84.1**	**115.8**	**200**	

Table 3. The relationship between prevalence and children's age (n=354)

Status	% Infection rate within the age categories (n=354)			
	6-8 years	9-10 years	11-12 years	p- value
Positive	35.6	42.9	48.1	P=0.424
Negative	64.4	57.1	51.9	P=0.533
Total	**100**	**100**	**100**	

Table 4. Demographic factors of the respondents and the risk factors for *E. histolytica* (n=354)

Variable	Category	No of respondents	% infected	Odds ratio(OR)	Chi-square (χ^2)	P-Value
Age (years)	6-8	115	35.6	0.593		
	9-10	135	42.9	0.286	3.5649	0.424
	11-12	104	48.1	0.76		
Gender	Female	186	42.5			
	Male	168	41.6	1.26	0.9653	0.3259
Source of water	Riverbed wells	159	29.5	2.351	-	0.002
	Bore hole	24	16.6	1.609	-	0.076
	Tap	42	9.5	0.968	-	0.278
	Rock catchment	20	15	1.484	-	0.120
	Earth dam	57	40.3	2.828	-	0.000
	Storage tanks	52	3.8	-	-	>0.05
Distance to water source	<1km	123	41	0.364	3.24	0.072
	1-5km	157	13	1.901	54.76	0.0000
	>5km	74	9	2.314	67.24	0.0000
Water source protected	Yes	232	17			
	No	122	11	0.435	1.286	0.257
Treatment of water at home	Yes	223	6	1.427	11.645	0.002
	No	131	25			
Presence of latrine at home	Yes	218	14.7	0.54	4.7199	0.0298
	No	136	24.3			
Garbage/ Refuse disposal	Garbage pit/dustbin	194	10	0.24	11.524	0.001
	Outside compound	161	32			

3.1.6.4 Distance from the water sources

Of the total respondents, 34.7% had their water sources less than one Kilometer away, 41% of these were found to be infected. Some other 44.3% had their water sources 1 to 5km away, of these 13% were infected. Those who had their water sources more than 5 km away were 20.9%. Of these, 9% were infected (Table 4). A significant association was observed between

prevalence and the distance to water source, (χ^2=3.24, 54.76, 67.24, df=2, P<0.05).

3.1.7 General morbidity rate due to *E. histolytica* among patients attending Kyuso district hospital by hospital records

3.1.7.1 Overall morbidity rate

Medical records in the Kyuso District Hospital laboratory between April and September 2011 were studied. Within this period, a total of 337 patients across all ages from Kyuso Zone had been tested for gastrointestinal infections using stool as a test specimen during the routine clinical tests. Of the total number of patients, 19.6% were aged between 6 and 12 years. Out of the 337 patients 149 (44.2%) were found to be infected with *E. histolytica* while the uninfected were 188 (55.8%). Amongst the children aged 6-12 years, 31 (46.9%) were found to be infected while 53% were uninfected. Hence the overall morbidity rate due to *E. histolytica* among those aged between 6 and 12 years was 46.9%.

3.1.7.2 Morbidity rate by gender

Of the 337 patients, of various ages 60.5% were female while 39.5% were male. Of the 204 females, 88 (43.1%) were found to be infected while 116 (56.9%) were uninfected. Of the 133 males, 61 (45.8%) were found to be infected with *E. histolytica* (Table 5*)*. Out of the 149 infected cases, 88 (59.1%) were females while 61 (40.9%) were males. Of the 31 infected children aged 6-12 years, 17 (54.8%) were females while 14 (45.2%) were males (Table 5).

3.1.7.3 Morbidity rate by age

The largest proportion of the patients was aged between 1-20 years 53.1% (Table 5). They showed a morbidity rate of 45.9%. Patients aged above 40 years showed relatively lower infection rates.

3.1.7.4 The relationship between morbidity rate and patients' gender

Chi-square test (χ^2) done to determine the relationship between the morbidity rate due to *E. histolytica* and the patients gender revealed that no significant association between morbidity rate and gender was found (χ^2 = 0.1448, df =1, P>0.05).

4. DISCUSSION

4.1 Socio-demographic Information

This study is the first to document the prevalence of *Entamoeba histolytica* in school children in Kyuso Zone, Kyuso District. The study was carried out among school children because they are one of the high risk groups to get infected with intestinal parasites and was generally accessible. Kyuso is a semi-arid area with erratic rainfall, consequently the poverty index is high [16]. The distance from these pupils' homes to water sources was generally observed to be long with some families having to walk 10 km to get to water sources (Table 4). The most common sources of water were the dry river bed-wells whose water is usually contaminated due to animal and human faeces [20]. Latrine coverage in the Zone was observed to be 38.6% and [16] reported that it could be as low as 15% in the larger Kyuso District. This low coverage makes people to defecate in the bushes, a factor that leads to transmission of *E. histolytica.*

4.2 Prevalence of *E. histolytica*

This study showed an overall prevalence of 42.1% among the school children aged 6-12 years in Kyuso Zone. This high infection rate in the zone confirms the high morbidity rate of 46.9% for amoebiasis observed in the hospital records. The prevalence was slightly below the prevalence of 44.6% observed by Otula (unpublished) in a study to determine the factors associated with prevalence of parasites causing intestinal infection among primary school children aged 6-15 years in Bondo District Kenya. However, the prevalence was way up above the prevalence of 20.83% reported by Kinuthia [24] in a study on selected practices among rural residents versus the prevalence of amoebiasis and Giardiasis in Njoro District, Kenya. Ngonjo [25] found the prevalence of *E. histolytica* amongst school children in Thika District, Kenya to be 14.6% while Mamandou [20] reported an 18.8% prevalence of *E. histolytica* in school children in Agboville area in Côte d'Ivoire. Duc [26] in a study in an Agricultural community in Vietnam reported a 34.8% prevalence of *E. histolytica* amongst primary school children. This relatively high prevalence in Kyuso Zone was attributed to poor sanitary conditions within these rural areas and majorly to lack of safe domestic water.

Female pupils were more infected (42.5%) than the male pupils (41.6%) but with no significant

difference. This was attributed to the fact that due to socio-cultural life style of the area, girls are more likely to interact with contaminated environment (food, water, among others) than boys [27]. It was also observed that the older pupils (11-12 year bracket) had a higher prevalence rate (48.1%) than the younger ones. This was attributed to the fact that being older, they are more likely to be involved in chores involving contaminants; for example, manual activities such as collecting fire wood in nearby bushes. Comparatively they also have relatively poorer hygiene measures since their younger counterparts are washed but these ones wash themselves [28].

4.3 Factors contributing to transmission of *E. histolytica* amongst school children in Kyuso Zone

Adoption of practices that may predispose an individual to infectious agents can promote the spread of parasitic infections amongst humans (Kinuthia [24]. These include but are not limited to consumption of contaminated water and general sanitation negligence. In Kyuso zone it was observed that such practices are common among the residents and corresponded to increased prevalence amongst school children.

Use of water that is likely to be contaminated was one of such factors. Dry river bed wells and Earth dams are the main water sources in Kyuso Zone. There was a significant association between use of dry riverbed wells and earth dams and prevalence an indication that the water sources were more contaminated compared to the lower prevalence in those who used other sources such as bore holes and tap water. Since dry river bed wells and earth dam water sources are both surface-open, they are often likely to be contaminated by human and animal excreta, unhygienic practices such as bathing and washing clothes in the water sources among other practices. Mail [29] in a study to determine the factors associated with high prevalence of intestinal parasites in Yemen identified the use of well water as a predictor of *E. histolytica* infections. Other sources where water is usually enclosed such as bore holes and tap water; there was no significant association between the use of the water and prevalence.

In Kyuso zone, significant association was found between the use of latrines and prevalence of *E. histolytica* (*P*=0.0298). This was attributed to the fact that those who had no toilets often defecated in the bushes and this led to contamination of water sources and foodstuffs such as vegetables. Most of the toilets had very low standards of cleanliness leading to many flies which occasionally settle on foodstuffs and water as reported by Kinuthia [24]. Water contamination could also occur at home because of the 37.0% who did not have their drinking water treated at home, 25% were found to be infected. A significant association was found between treatment of drinking water and high prevalence (χ^2=11.645, df=1, *P*=0.002). Mail [29] in a study to determine the factors associated with high prevalence of intestinal parasites in Yemen reported that drinking untreated water was significantly associated with high prevalence. Another study in Malaysia to determine the prevalence of *E. histolytica* indicated a prevalence of 22.9% amongst members of an ethnic group who drunk untreated water.

No significant association was observed between protection of water sources and prevalence in Kyuso Zone (χ^2=1.286, df=1, *P*=0.257).

Table 5. Morbidity rate by age (N=337)

Variable	Category	Total no	% Uninfected	% of Infected	*P* - value
Gender	Female	204	56.9	43.1	
	Male	133	54.1	45.8	
	1-5	55	72.7	27.2	
	6-10	46	56.5	43.4	
	11-15	34	41.2	58.8	
Age (years)	16-20	44	45.5	54.5	
	21-25	27	51.9	48.1	**P=0.274**
	26-30	27	59.3	40.7	
	31-35	21	38.1	61.9	
	36-40	21	71.4	28.5	
	Above 40	62	56.5	43.5	
Total		337	55.8	45.1	
Overall morbidity rate					**44.2**

However as reported by Al-Malik [30] protection of wells and other water sources reduces chances of contamination and hence reducing infection rates. Mamandou [20] also reported in a study in Côte d' ivoire that the unprotected water sources are usually highly polluted by human and animal excreta due to rainfall run off making them carry a population of parasitic cysts. The distance to water source was observed to be another factor that was significantly associated with prevalence (χ^2=3.24, 54.76, 67.24, df=2, P<0.05), with 20.9% of the respondents' households obtaining their domestic water more than 5km away. However this as reported by Mamandou [20] may largely be due to the containers used and the methods of water transportation and not on the actual distance.

4.4 Morbidity Rate Due to *E. histolytica* in Children Aged 6 to 12 years amongst the Patients Attending Kyuso District Hospital by Hospital Records

Children aged 6 to 12 years who were taken to Kyuso District Hospital for diarrhoeal complaints showed a morbidity rate of 46.9% for *E. histolytica*. This confirms the observed prevalence in the schools (42.1%). The high morbidity rate compared to the prevalence was probably because as was observed, many residents of Kyuso zone don't often seek treatment for what they consider minor ailments such as stomach aches and hence those who did had higher chances of testing positive for *E. histolytica* since they were already symptomatic. The morbidity rate was noted to be higher in these ages than in adults; this was attributed to the fact that this age group has a relatively poorer hygiene and engages more in risky practices [20].

A study carried out by Ibrahim [31] amongst children aged less than 12 years in an hospital in Iraq observed a prevalence of 9.8% and associated this with factors such as; low immunity against various pathogens as these age groups are comparatively less resistant to diseases, poor hygiene and toilet training, overcrowding, low socioeconomic status. Additionally, the children feel free to play anywhere irrespective of the cleanliness or dustiness of play grounds [31]. Moreover, the sale of adulterated and impure edibles also adversely affects the health of young ones as they are likely to buy edibles on their way to and from school and they have least observance of hygiene measures on the edibles [31].

An overall morbidity rate of 44.2% among the patients of all ages was observed in the patients who visited Kyuso district hospital with stomach complains. This was way up above the 20.32% prevalence reported by Kinuthia [24] in a study at Njoro PCEA Health Centre in Njoro District, Kenya, and 11.9% prevalence reported by Nyarango [9] in a study conducted at Kisii District Hospital in Kisii Municipality, Kenya. The high prevalence as noted is attributed to poor sanitary practices and also to lack of safe domestic water in Kyuso Zone. This was also observed by Kinuthia [24] where he identified such practices as lack of washing hands and lack of toilets as being significant to high prevalence. Dhanabal [32] in a study on the prevalence of intestinal parasites in low socioeconomic areas from south Chennai, India, reported that good hand washing which ordinarily should interrupt the transmission of some of the parasites is expectedly inadequate in situations where water supply takes a lot of manual effort and the tendency is to use water sparingly. This eventually results in further transmission by direct and indirect contact.

In Kyuso Zone, the Morbidity rate by gender was 43.1% in females and 45.8% in males. Al-Malki [30] in a study of prevalence of *E. histolytica* in Jeddah Saudi Arabia, reports that a higher morbidity rate in males compared to females may be associated with the higher risks for infection in males due to daily activities carried out. It was observed that in Kyuso zone most men do manual jobs far from their homesteads where they are most likely to eat and drink water from outlets such as road side kiosks hence increasing their chances of infection. Dhanabal [32] also observed a higher prevalence in males than females but also pointed out that the infections are likely to be linked to the everyday activities of the individuals rather than gender.

5. CONCLUSIONS

The findings of this study point out to a high prevalence of *Entamoeba histolytica* infections in Kyuso Zone. Indeed almost half of the children were infected with this pathogenic intestinal protozoon.This agrees with the hospital morbidity records. The following conclusions were therefore drawn; *Entamoeba histolytica* infections are common in school children aged 6-12 years in Kyuso Zone. This is indicated by the high prevalence (42.1%) observed. Prevalence is also high in the general population as indicated by hospital morbidity records. A significant association was observed between water

sources and prevalence where particularly the use of dry river bed wells and Earth dams were significant. The parasite's prevalence decreases when tap water is used and increases when surface water is used. Age and gender variables are not relevant for prevalence of *E. histolytica*. Where some minor variations occurred in the prevalence amongst the different gender and age groups, it was associated to socio-economic behaviours.

6. RECOMMENDATIONS

The impact of control measures would be maximized if health education programs could be formulated and directed to school children in particular and to the community in general. Urgent chemotherapy treatments should be delivered to the most infected segment of the population especially school children. There is urgent need for provision of safe domestic water in Kyuso Zone and suggestively to broaden the Kiambere piped water project to reach all the homesteads. There should also be efforts by the government agencies to fund community based sanitation projects like public toilets in all shopping centres and other public places in order to improve the level of sanitation in Kyuso Zone and environs. The general population should be encouraged to construct and use toilets. Proper use of the toilets should also be encouraged.

7. SUGGESTIONS FOR FUTURE STUDIES

Whereas this study was focused on prevalence in School Children, further work is needed to establish the prevalence in the general population without reliance on Hospital records alone. Further work is necessary to establish the extend of morbidity in School Children due to amoebiasis. Studies should be carried out on the prevalence of other intestinal parasitic diseases within Kyuso Zone so as to help in laying strategies of reducing morbidity in the populations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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