Prevalence of Intestinal Protozoa Infections and Associated Risk Factors Among Preschool Aged Children in Mkuranga District, Tanzania: A Community Based Cross-Sectional Study

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Abstract

Background: Intestinal protozoa infections are among the serous public health problems in preschool aged children (PSAC) and can lead to considerable health problems such as growth retardation, anemia, nutrition deficiency, physical weakness and mental health problems. In Tanzania, there is a paucity of data on intestinal protozoa infections though the evidence shows that PSAC can be infected. Therefore, this study aimed to determine the prevalence of intestinal protozoa infections among PSAC and their associated risk factors in Mkuranga district, Tanzania.

Methodology: A community based cross-sectional study was conducted between April and June 2019 to determine the prevalence of intestinal protozoa. A total of 525 stool samples were collected from PSAC and processed using formal-ether concentration method. Risk factors were identified using questionnaire interview conducted among parents/guardians. All participants were randomly selected from two villages (one located in rural and another in suburban settings). Data were entered and analysed by using SPSS version 23.

Results: A total of 20 (3.8%) out of 525 PSAC were infected with intestinal protozoa (*Entamoeba coli* or *Giardia lamblia*). Among the assessed risk factors the following were significantly associated with intestinal protozoa: age of PSAC (AOR = 1.05, p = 0.048), age group of parents/guardians (AOR $_{30\text{-}39\ years/50\ \text{-}59years}$ = 0.16, p = 0.031), household population (AOR $_{1\text{-}5/11+}$ = 0.15, P = 0.018 and AOR $_{6\text{-}10/11+}$ = 0.10, P = 0.010) and source of water ((AOR $_{tape\ within\ household/spring}$ = 0.004, p = 0.015), (AOR $_{protected\ well/spring}$ = 0.006, p = 0.023), (AOR $_{bore\ hole/spring/spring}$ = 0.006, p = 0.012), (AOR $_{tape\ away\ of\ home/spring}$ = 0.009, p = 0.020) and (ARO $_{tape\ at\ home/spring}$ = 0.004, p = 0.015)).

Conclusion: There was a low prevalence of intestinal protozoa infection among PSAC in the two communities studied. Despite low prevalence of intestinal protozoa, the transmission is present hence the need to initiate control measures. Health education should be provided to parents/guardians of PSAC on protecting water sources, treatment of drinking water and supervision of latrine usage by PSAC and introduction of hand washing facilities are crucial.

1 Background

Intestinal protozoa infections are caused by protozoan species and are endemic worldwide especially in developing countries where there is limited access to clean water, poor sanitation and hygiene (1). The intestinal protozoa infections are more prevalent to preschool and school aged children where they contribute to significant morbidity and mortality (2, 3). Children are more susceptible to intestinal protozoa infections because of less developed immune system and their behaviors such as playing in fecal contaminated soil, eating with unwashed hands, drinking unsafe water, eating contaminated food and unpeeled fruits (4). Intestinal protozoa infections in children can cause growth retardation, anemia, nutrition deficiency, physical weakness and mental health problems (5). The intestinal protozoa

infections in children can be asymptomatic or with mild symptoms; protozoa such as *Entamoeba histolytica, Giardia* and *Cryptosporidium parvum* can cause severe dysentery and diarrhea (6).

There is significant burden of intestinal protozoa globally. Data collected in 2010 showed that 64 million people suffered from *Cryptosporidium* species, 104 million people suffered from *Entamoeba histolytica* and 184 million people suffered from *Giardia* species leading to more than 30000 deaths (7). Additionally, 0.43 and 4.0% of global deaths in children less than five years were due to amoebiasis and cryptosporidiosis respectively (8). Moreover, amoebic colitis account for 9% of all underfive children deaths in low-income counties (9). In Sub-Saharan Africa the prevalence of intestinal protozoa in children has been reported to range from 16%-90% in different geographical settings with different distribution of protozoan species. Evidence shows that preschool aged children (PSAC) are infected with intestinal protozoa and are capable of maintaining transmission in the community (10).

In Tanzania, little is known about the prevalence of intestinal protozoa in PSAC and their associated risk factors. Also epidemiological data on intestinal protozoa on several parts of Tanzania is lacking. Few studies were conducted to collect information on intestinal protozoa especially in PSAC. A study conducted on school aged children in Pemba (Island Tanzania) showed high prevalence of intestinal protozoa (74.7%) (11). Another study conducted on diarrhoic underfive children in three hospitals in Dar es Salaam revealed an overall prevalence of 41% due to *Giardia lamblia, Entamoeba histolytica* and *Cryptosporidium spp* infections (12). Therefore this study was conducted to determine the prevalence of intestinal protozoa infections and associated risk factors among PSAC in rural and suburban communities of Mkuranga district, Tanzania.

2 Methods

2.1 Description of the study area

Mkuranga is one of the six districts of Coast region; the district boarders with Dar es Salaam region, Indian Ocean, Rufiji district and Kisarawe district to the north, east, south and west respectively. According to the population and housing census of 2012, the district has a total population of 222,921 of which males were 108,024 and females were 114,897 (13). Mkuranga was selected because of high prevalence of underfive diarrhea and inadequate water, sanitation and hygiene conditions among many households in the district (14). Additionally, Mkuranga district have both rural and suburban settings providing ideal study site based on our objective. Mwarusembe and Kazole villages were selected from Mwarusembe and Vikindu wards respectively. As per 2012 census, Mwarusembe and Vikindu wards had a population size of 11,706 and 34,762 with an average of 4.2 and 4.5 members per household respectively (13). Mwarusembe village is a rural setting located 70.5 km south of Dar es Salaam, the country's largest economy city. Kazole village is suburban setting located 27.2 km south of Dar es Salaam (15).

2.2 Study design and sampling procedure

A community based cross-sectional study involving quantitative methods was carried out from April to June 2019. This study was part of the large study that investigated intestinal parasitic infections among PSAC in Mkuranga District. Study participants were PSAC for the prevalence of intestinal protozoa and parents/guardian for assessing risk factors associated with transmission of intestinal protozoa. Participants were obtained through four stage cluster sampling technique as indicated in Fig. 1. In a household with more than one eligible child, only one was selected using the lottery method.

2.3 Sample collection and laboratory analysis

To determine the prevalence of intestinal protozoa; stool samples were collected, processed and examined for presence or absence of intestinal protozoa oocysts, cysts and/or trophozoites. Consented parents were instructed to let the child defecate on the provided clean piece of paper, and use an applicator stick to put a portion of stool into a given clean, dry and wide mouthed stool container. Then store collected sample in a safe place (out of reach of children) to wait for research assistance to pick. Collected samples were immediately transported to Parasitology laboratory at the Muhimbili University of Health and Allied Sciences for examination in the same day of collection. In situations where samples could not be examined in the day of collection, they were preserved in 10% formalin. A single stool sample was collected per each PSAC. Stool specimens were processed using formol-ether concentration techniques as described in the World Health Organization (WHO) bench aids for the diagnosis of parasitic diseases (16). Examination for the presence of intestinal protozoa oocysts, cysts and/or trophozoites were done using Olympus CX 31 microscope.

2.4 Questionnaire survey

A structured questionnaire containing questions adopted and modified from (17, 18) supported with observation checklist was used to collect demographic characteristics of participants and possible risk factors associated with protozoa transmission such as water, hygiene and sanitation conditions. All sections of questionnaire were administered to interviewee (mother or other person taking care of a child) by a well trained interviewer.

2.5 Inclusion and exclusion criteria

PSAC (1–5 years) living in the study area for the past six months and whose parents or legal guardians signed the written consent were eligible to participate. Those who received anti-intestinal protozoa drugs within one month prior to data collection, children having diarrhea at the time of stool collection, children whom their parents refused to sign a written consent and children aged 5 years but attending primary schools were excluded from the study.

2.6 Data analysis

Data collected were cleaned, coded and entered into Statistical Package for Social Sciences version 23 for analysis. The categorical data were summarized using frequency and proportion while mean and standard deviation used for continuous data. Univariate logistic regression was performed to determine association between prevalence of intestinal protozoa and socio-economic, water, hygiene and sanitation

variables. P-value less than 0.05 were considered statistically significant. Variables shown to have statistical significant association during univariate logistic regression analysis were subjected to multivariate logistic regression test.

2.7 Ethical considerations

Ethical clearance was sought from the Muhimbili University of Health and Allied Sciences Ethical Review Board. Permission was obtained at all administrative units involved in this study, from the regional level to the hamlet level where this study was conducted. A written consent was requested from parent or legal guardian of each participant. At the end of the study, a brief report was prepared and sent to the District health officers so that infected children will receive treatment.

3 Results

A total of 525 households from the two selected villages were surveyed, each household provided one PSAC with the parent/guardian. The mean age of PSAC was 36.7 (± 14.3) months ranged from 12 to 60 months with the majority (76.8%) of PSAC participants belonged to the age group 36–60 months. Female PSAC participants were more than half (52.4%) of all participants. The mean age of parents/guardians was 30.8 (± 9.1) years ranged between 16 to 70 years. Age group 20–29 years contributed high number (44.4%) of parents/guardians compared to other four groups. Occupations of the interviewed parents/guardians descend in the following order: house wives, self-employed, peasant and private or public employee. Sixty three percent of all parents/guardians attained primary school education level and 19.6% lacked any kind of formal education (Table 1).

The prevalence of intestinal protozoa infection was 20 (3.8%) in which two species were identified. The two species were *Entamoeba coli* (2.3%) and *Giardia lamblia* (1.5%). The prevalence was 5.0% among children in age group 36–60 months with no case in age group 12–24 months. Females were more infected than males with prevalence of 4.7% and 2.8% respectively. However, none of the children was found co-infected with the two intestinal protozoa species. The prevalence of intestinal protozoa was high in PSAC raised by parents/guardians aged 50–59 years, employed, with at least secondary school education level and economically good. The high prevalence was also found in children living in households with high number of household members (11+), households without latrines and households without hand washing facilities. One out of 2 PSAC whose parents/guardians reported that they use spring water were infected with *Giardia lamblia* (Table 1). All infected PSAC were from households with easy access of water, do not treat drinking water and without hand washing facilities after toilet.

Table 1
presents social-demographic characteristics of study participants and assessed risk factors

Characteristic	Categories	No of PSAC	No of Infected PSAC (%)
Age groups of PSAC	12–35 months	122	0 (0.0)
	36–60 months	403	20 (5.0)
Sex of PSAC	Female	275	13 (4.7)
	Male	250	7 (2.8)
Study settings	Rural	254	9 (3.5)
	Suburban	271	11 (4.1)
Age groups of parents/guardians	≤ 19 years	36	0 (0.0)
	20–29 years	233	10 (4.3)
	30–39 years	168	4 (2.4)
	40–49 years	66	3 (4.5)
	50–59 years	22	3 (13.6)
Occupation of parents/guardians	Public or private employee	29	2 (6.9)
	Self- employee	158	6 (3.8)
	Peasant	96	3 (3.1)
	House wife	242	9 (3.7)
Economic status of parents	Weak	195	5 (2.6)
	Good	330	15 (4.5)
Education level of parents/guardians	Never attended school	103	3 (2.9)
	Primary education	332	12 (3.6)
	Secondary education	67	4 (6.0)
	Tertiary education	23	1 (4.3)
Households' population	11+	13	3 (23.1)
	6–10	194	5 (2.6)
	1–5	318	12 (3.8)
Water availability	Difficult	32	0 (0.0)

Note: PSAC = preschool aged children

Characteristic	Categories	No of PSAC	No of Infected PSAC (%)
	Easy	493	20 (4.1)
Source of water for domestic activities	Spring	2	1 (50.0)
	Unprotected well	24	0 (0.0)
	Protected well	27	1 (3.7)
	Tube well or bore hole	207	8 (3.9)
	Tape away of home	224	9 (4.0)
	Tape at home	41	1 (2.4)
Drinking water treatment	No	28	1 (3.6)
	Yes	497	19 (3.8)
Hand washing facility	Present	7	0 (0.0)
	Absent	518	20 (3.9)
Nails of PSAC	Untrimmed	87	2 (2.3)
	Trimmed	458	18 (3.9)
Latrine availability	Not available	14	2 (14.2)
	Available	493	18 (3.7)
Latrine use by PSAC	Use latrine	245	17 (6.9)
	Not use latrine	280	3 (1.1)
Note: PSAC = preschool aged children			

Table 2 summarizes the results of univariate and multivariate logistic regression tests. The test indicated statistically significant association between protozoa prevalence and age of preschool children, age group of parents/guardians, households' population and latrine use by PSAC ($p < 0.05$). When these factors were analysed using multivariate logistic regression, all were significantly associated with intestinal protozoa prevalence ($p < 0.05$) except for the latrine use.

Table 2
Association between intestinal protozoa infection and risk factors (socioeconomic, behavioral, water, hygiene and sanitations)

Variable	Categories	Univariate logistic regression		Multivariate logistic regression	
		OR (95% CI)	P-value	AOR (95% CI)	P-value
Age (PSAC)	Age in months	1.09 (1.04–1.14)	< 0.001	1.05 (1.00–1.13)	0.048
Sex of PSAC	Male	1		NA	NA
	Female	1.72 (0.68–4.39)	0.254		
Study settings	Rural	1		NA	NA
	Suburban	0.87 (0.35–2.13)	0.758		
Age groups of parents or guardians	50–59 years	1		1	
	40–49 years	0.30 (0.06–1.62)	0.162	0.33 (0.05–2.02)	0.229
	30–39 years	0.15 (0.03–0.74)	0.020	0.16 (0.03–0.85)	0.031
	20–29 years	0.28 (0.07–1.12)	0.072	0.33 (0.07–1.47)	0.146
	≤ 19 years	0.000	0.998	0.000	0.998
Occupation of parents or guardians	House wife	1		NA	NA
	Self-employee	1.02 (0.36–2.93)	0.968		
	Peasant	0.84 (0.22–3.15)	0.790		
	Public/private employee	1.92 (0.39–9.34)	0.420		
Economic status	Good	1		NA	NA
	Low	0.55 (0.20–1.55)	0.258		
Level of education of parents or guardian	Tertiary education	1		NA	NA

Note: OR = odd ratio, CI = confidence interval, AOR = adjusted odd ratio, PSAC = preschool aged children and NA = not applicable.

Variable	Categories	Univariate logistic regression		Multivariate logistic regression	
		OR (95% CI)	P-value	AOR (95% CI)	P-value
	Secondary education	1.40 (0.15–13.13)	0.770		
	Primary education	0.83 (0.10–6.64)	0.857		
	Never attended school	0.66 (0.07–6.65)	0.724		
Households' population	11+	1		1	
	6–10	0.09 (0.02–0.42)	0.002	0.10 (0.02–0.57)	0.010
	1–5	0.13 (0.03–0.54)	0.005	0.15 (0.03–0.72)	0.018
Source of water for domestic activities	Spring	1		1	
	Unprotected well	0.000	0.998	0.000	0.998
	Protected well	0.038 (0.001–1.2)	0.062	0.006 (0.000–0.5)	0.023
	Tube well/bore hole	0.040 (0.002–0.7)	0.028	0.006 (0.000–0.3)	0.012
	Tape away of home	0.042 (0.002–0.7)	0.029	0.009 (0.000–0.5)	0.020
	Tape at home	0.025 (0.001–0.8)	0.034	0.004 (0.000–0.3)	0.015
Nails of PSAC	Trimmed	1		NA	NA
	Untrimmed	0. 75 (0.17–3.32)	0.707		
Latrine availability	Available	1		NA	NA
	Not available	4.57 (0.95–21.92)	0.058		
Latrine use by PSAC	Not use	1		1	
	Use	6.89 (1.99–23.79)	0.002	3.12 (0.52–18.56)	0.214

Note: OR = odd ratio, CI = confidence interval, AOR = adjusted odd ratio, PSAC = preschool aged children and NA = not applicable.

4 Discussion

Findings of this study indicated that overall prevalence of intestinal protozoa is low among PSAC children in Mkuranga district. The overall intestinal protozoa prevalence in this study is lower compared to the prevalence recorded on PSAC in Dar es Salaam, a region located few kilometers from Mkuranga district (12). However, the prevalence reported in Dar es Salaam was based on PSAC already with symptoms of intestinal protozoa infection (diarrhea) unlike asymptomatic PSAC recruited in our study. The prevalence of non-pathogenic intestinal protozoa (*Entamoeba coli*) was high compared to that of pathogenic intestinal protozoa (*Giardia lamblia*). Similar results were found in a study conducted on school-going children in Zanzibar whereby non-pathogenic intestinal protozoa were predominantly found compared to the pathogenic one (11). The predominance of non-pathogenic intestinal protozoa was most likely because parents or guardians of infected children did not seek treatment as the children were asymptomatic. The presence of non-pathogenic intestinal protozoa is an indicator of poor sanitary and hygienic condition in a studied community (19).

Infection with intestinal protozoa were reported to be associated with several factors such as socio-demographic characteristics, economic status, place of residence, water source for domestic activities, personal hygiene and sanitation conditions (6, 20–22). In the current study 13 variables describing the above mentioned risk factors were assessed for their contribution on the prevalence of intestinal protozoa (Tables 1 and 2). The risk of intestinal protozoa infection was observed to significantly increase with an increase in the age of preschool children. None of the young children (≤ 2 years) was infected while older PSAC (≥ 3 years) had a prevalence of 5%. This complies with the results obtained from studies conducted in Ethiopia whereby intestinal parasitic infections (including protozoa) were found to increase with age of the PSAC (23, 24). The reason could be due to the fact that, parents/guardians are less concerned with older children compared to young children. PSAC raised by older parents/guardians (above 50 years) were significantly infected than those raised by parents/guardians in other age groups. This adheres to the hypothesis that older mothers/parents/guardians are less concerned with the health of their children compared to young mothers/parents/guardians (25). This is because the majority of older mothers/parents/guardians have many children hence it is difficult for them to take care of each child. Additionally, older parents are more experienced compared to those in low age groups. Therefore, they are not serious with issues of hygienic care compared to the younger ones with low experience. Increase in number of household members was seen to increase the risk of intestinal protozoa infection which is similar to the findings from a study conducted in Ethiopia (26). The higher risk of intestinal protozoa in households with a large number of family members possibly was attributed to the fact that health-seeking behaviors in large-sized families are low compared to small-sized families (25). The decreased in health-seeking behaviors in large-sized families could be due to limited available resources which should be invested in all family members.

In the two study communities, water availability and latrine coverage were very high. A total of six water sources were reported by study participants. Moreover, about half of the PSAC population was observed to utilize latrines during defecation (Table 1). However, both water sources and latrine utilization were

significantly associated with the prevalence of intestinal protozoa. The PSAC who reported to use spring water had a significantly high prevalence of intestinal protozoa than those reported to use piped water. Majority of PSAC parents/guardians declared that they didn't treat water for drinking (Table 1). This behavior increases the chance of intestinal protozoa transmission especially if the sources of water are not safe. The similar results were found in a study conducted in Iran (27). We expected that PSAC who utilized latrines for defecation to be less infected with intestinal protozoa than those not using (attempt open defecation). But our findings showed that the PSAC using latrine was significantly affected by intestinal protozoa than those not using the latrine. The possible reason for this could be that, PSAC who used latrines were not supervised by their parents/guardians during the process and therefore didn't adhere to the hygienic practices such as proper handwashing after latrine use and anal cleansing. Latrine use and care by themselves (PSAC) was associated with high intestinal parasitic infection (including protozoa) elsewhere (23). In addition, more than 90% of latrines in the two studied communities were not incorporated with handwashing facilities that have water and soap either inside or outside of the latrine. The presence of handwashing facilities surrounding the toilets influences the behavior of hand washing. Moreover, it is difficult for PSAC to find water and soap for washing their hands if it is not located nearby.

Conclusion And Recommendation

The results of this study show that the prevalence of intestinal protozoa among PSAC is low. Despite the low prevalence, it's clear indication that the transmission is ongoing. Water availability and latrine coverage is not a problem in the two studied communities and they are not associated with intestinal protozoa prevalence. The main possible factors which were associated with intestinal protozoa infection were the quality of water (water sources and treatment) and hygienic latrine usage. Therefore, health education on the transmission of intestinal protozoa is required among the parents/guardians of PSAC in the two communities. The health education package should include how to assist children during latrine use, water treatment for drinking and introduction of handwashing facility after defection.

Abbreviations

AOR – adjusted odd ratio

OR – odd ratio

PSAC – preschool aged children

WHO – The world health organization

Declarations

Ethics approval and consent to participate

Ethical clearance was approved by Muhimbili University of Allied and Health Sciences Ethical Review Board. Permission was sought from all government administrative level (regional to village level). Informed written consent was obtained from children parents/guardians after clarifying the aim of the study. The respondents have the right to respond fully or partially to the questionnaire. All data given by the respondents were kept confidential and used for research purposes only and confidentiality was maintained by omitting the name of the respondents.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

UM designed the study and collected data, UM and AZ performed laboratory analysis, AZ and VM performed statistical analysis, AZ and VM wrote the manuscript. All authors read and approved the final manuscript.

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Figures

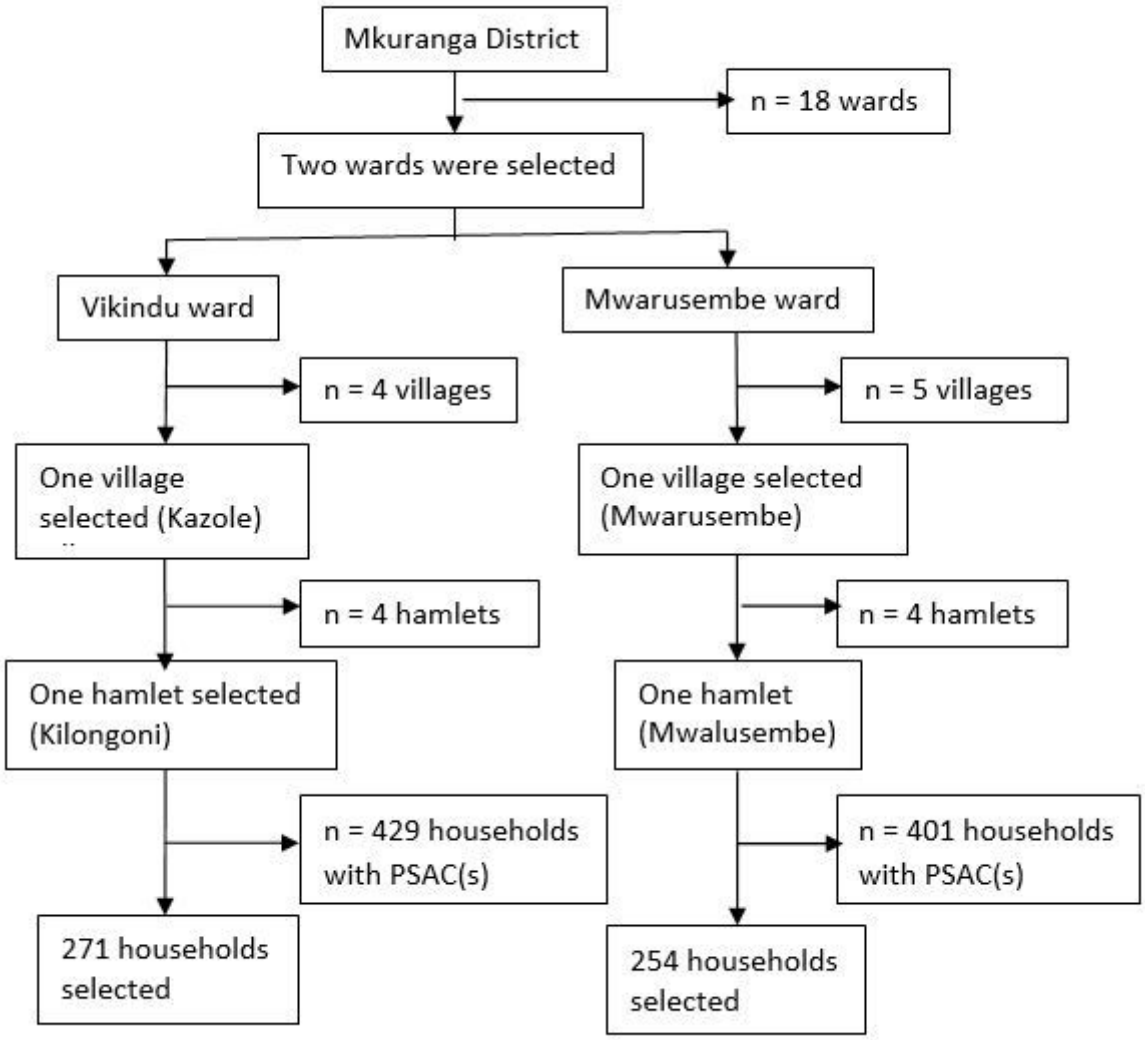

Figure 1

Flow chart showing sampling stages