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PREVALENCE AND FACTORS ASSOCIATED WITH SOIL-TRANSMITTED HELMINTH INFECTIONS AMONG PEOPLE LIVING WITH HIV ATTENDING BUGANDO MEDICAL CENTRE, MWANZA, TANZANIA

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ABSTRACT

Objective: Soil-transmitted helminth (STH) infections remain important neglected tropical infections, particularly in settings characterized by inadequate sanitation, unsafe water, and poor hygiene. People living with human immunodeficiency virus (HIV) may experience additional morbidity from intestinal parasitic infections. However, information on STH infections among people living with HIV in Tanzania remains limited. This study determined the prevalence and factors associated with STH infections among people living with HIV attending Bugando Medical Centre (BMC), Mwanza, Tanzania. **Methods:** A hospital-based cross-sectional study was conducted among 300 people living with HIV attending the Care and Treatment Clinic at BMC between May and August 2025. Participants were recruited using convenience sampling. Sociodemographic, behavioural, and potential exposure information was collected using a structured questionnaire administered during an interview. Stool specimens were collected and examined using the formalin-ethyl acetate concentration technique for detection of STH eggs. Data were entered and cleaned in Microsoft Excel and analyzed using Stata version 15.0. Associations between categorical variables and STH infection were assessed using Pearson's chi-square test. A P value <0.05 was considered statistically significant. **Results:** Among 300 participants, 24 had STH infections, giving an overall prevalence of 8.0%. *Ascaris lumbricoides* was detected in 13 participants (4.3%), while hookworm was detected in 11 (3.7%). No *Trichuris trichiura* infection was detected. STH infection was significantly associated with consumption of boiled water (χ^2=10.653, df=1, P=0.001). The prevalence of STH infection was 3.5% among participants who reported drinking boiled water compared with 13.8% among those who reported not drinking boiled water. No statistically significant associations were observed with age, residence, educational status, occupation, awareness of STH infection, shoe-wearing habit, toilet cleanliness, or year of HIV diagnosis. **Conclusions**: STH infections were detected in 8.0% of people living with HIV attending Bugando Medical Centre. *A. lumbricoides* and hookworm were the detected STH species. Consumption of boiled water was significantly associated with lower observed prevalence of STH infection. Strengthening safe-water practices, sanitation, hygiene education, and appropriate clinical consideration of intestinal helminth infections may contribute to reducing STH-related morbidity among people living with HIV.

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INTRODUCTION

Soil-transmitted helminth (STH) infections are intestinal infections caused predominantly by *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms, including *Ancylostoma duodenale* and *Necator americanus*. Transmission occurs primarily through contact with soil contaminated with human faeces. Infection may occur through ingestion of infective eggs or, in the case of hookworm, through penetration of larvae through the skin. STH infections remain an important public health problem, particularly in tropical and subtropical settings where sanitation, water, and hygiene infrastructure are inadequate (1). More than a quarter of the world's population is estimated to be at risk of STH infection, with the greatest burden occurring in tropical and subtropical regions. STH

infections can affect both children and adults and may cause abdominal symptoms, nutritional impairment, anaemia, and other complications, particularly when infections are repeated or of high intensity (1). In sub-Saharan Africa, STH infections remain widespread, although substantial reductions have occurred in some areas following preventive chemotherapy, improvements in sanitation, and socioeconomic development (2). Tanzania continues to experience transmission of STH infections. A large-scale mapping study in north-western Tanzania demonstrated that STH infections remain geographically distributed around the Lake Victoria zone, with *A. lumbricoides*, *T. trichiura*, and hookworm identified among affected populations (3). Such findings indicate that STH infections remain relevant to public health in the Mwanza region. People living with HIV represent an important population for investigation of intestinal parasitic infections. HIV infection is associated with impaired immune function, particularly in individuals with advanced disease, and people living with HIV may experience increased morbidity from a range of gastrointestinal infections. Intestinal parasitic infections may contribute to gastrointestinal symptoms, nutritional problems, anaemia, and other complications that may be clinically important in people receiving HIV care. The relationship between HIV infection and helminth infections is complex. A systematic review and meta-analysis have demonstrated that STH infections occur among people living with HIV, although reported prevalence varies considerably between settings according to geographical, environmental, demographic, clinical, and diagnostic factors (4). The presence of helminth infection may therefore represent an additional health concern in populations already affected by HIV, particularly in settings where sanitation and access to safe water remain challenges.

The burden of intestinal parasitic infections among people living with HIV has been documented in several African settings. In northern Ethiopia, intestinal parasitic infections were reported among HIV-infected patients receiving antiretroviral therapy, while studies from Nigeria have also documented parasitic infections among people living with HIV (5,6). Differences in observed prevalence between settings may reflect variation in environmental conditions, sanitation, water sources, healthcare access, antiretroviral treatment, previous anthelmintic exposure, and laboratory diagnostic methods. In Tanzania, Mwambete et al. reported intestinal helminth infections among patients with HIV/AIDS attending Muhimbili National Hospital, demonstrating that helminth infections remain relevant among people living with HIV in the country (7). However, epidemiological patterns may vary between geographical areas because of differences in sanitation, water infrastructure, socioeconomic conditions, healthcare practices, and patterns of exposure. Despite evidence of STH transmission in north-western Tanzania, limited information is available regarding STH infections specifically among people living with HIV attending healthcare facilities in Mwanza. People living with HIV may have additional clinical and nutritional vulnerabilities, making it relevant to determine whether STH infections occur in this population and to identify potentially associated behavioural and environmental factors. Bugando Medical Centre provides an appropriate setting for investigating this issue because it is a major tertiary healthcare facility serving Mwanza and surrounding regions and provides HIV care and treatment services. Studying people living with HIV attending the facility can therefore provide locally relevant information on the occurrence of STH infections in this clinically important population. Understanding the local prevalence and associated factors may assist clinicians and public health practitioners in identifying relevant preventive measures and determining whether intestinal helminth infections should be considered during routine clinical care. Therefore, this study determined the prevalence and factors associated with STH infections among people living with HIV attending Bugando Medical Centre in Mwanza, Tanzania.

METHODS

Study design and setting: A hospital-based cross-sectional study was conducted among people living with HIV attending the Care and Treatment Clinic at Bugando Medical Centre (BMC) in Mwanza, Tanzania, from May to August 2025. Bugando Medical Centre is a tertiary healthcare facility located in Mwanza, north-western Tanzania, and serves patients from Mwanza and surrounding regions. The hospital provides general and specialized healthcare services, including HIV care and treatment.

The study was specifically conducted within the HIV Care and Treatment Clinic because this clinic provides routine healthcare services to people living with HIV. These services include clinical assessment, follow-up of patients receiving antiretroviral therapy, laboratory investigations, counselling, treatment and management of HIV-related and other clinical conditions, and ongoing patient monitoring. The study setting therefore provided direct access to the target study population: people living with HIV attending the BMC HIV Care and Treatment Clinic during the study period. Participants were recruited from patients attending the clinic rather than from the general population.

Study population: The study population consisted of people living with HIV who attended the HIV Care and Treatment Clinic at BMC during the study period.

Eligibility criteria: Participants were eligible if they were people living with HIV attending the clinic during the study period, were willing to participate, provided written informed consent, and were able to provide a stool specimen.

Participants who were unable to provide a stool specimen were excluded from the study.

Sample size: The initial sample size was calculated using the Kish-Leslie formula for estimating a single population proportion:

$n = Z^2P(1-P)/d^2$

where n is the required sample size, Z=1.96 for a 95% confidence level, P=0.193, and d=0.05.

The calculated minimum sample size was 240 participants. However, 300 participants were ultimately enrolled and included in the analysis (8).

Sampling procedure: Participants were recruited using convenience sampling until the required study sample was reached. Potentially eligible people living with HIV attending the clinic during the study period were approached by the research team and invited to participate. The study procedures were explained to eligible individuals, and those who agreed to participate provided written informed consent before enrolment and collection of study information and stool specimens.

Data collection procedures

Interview and questionnaire procedures: After informed consent was obtained, participants were interviewed using a structured questionnaire. The questionnaire was designed to collect information relevant to the occurrence and potential risk factors of STH infection. Information collected included sociodemographic characteristics such as age, residence, educational status, and occupation. The questionnaire also collected information concerning potential STH-related behavioural and environmental exposures, including awareness of STH infections, water consumption practices, toilet cleanliness, and footwear practices. Information concerning the year of HIV diagnosis was also collected. The interview was conducted by trained members of the research team. Participants were interviewed individually, and clarification was provided where necessary to ensure that questions were understood. Participants were encouraged to provide accurate responses, and information obtained during the interview was treated confidentially. Each participant was assigned a unique study identification number. The identification number was

subsequently used to link questionnaire information with the corresponding laboratory result while avoiding unnecessary use of participants' names in the study dataset. Completed questionnaires were reviewed by the research team for completeness and consistency before data entry.

Stool specimen collection: After the interview, each participant was provided with a clean, labelled stool specimen container and instructed to provide a fresh stool specimen. Participants were instructed to avoid contamination of the stool specimen with urine, water, soil, or other materials. The specimen container was labelled using the participant's unique study identification number. Following collection, stool specimens were submitted to the designated laboratory at Bugando Medical Centre for processing and examination. Specimens were handled according to standard laboratory procedures.

Laboratory examination: Approximately 2 g of stool from each specimen was processed using the formalin-ethyl acetate concentration technique. The stool specimen was emulsified in normal saline and filtered through gauze. The filtrate was centrifuged, after which the sediment was processed using formalin and ethyl acetate. Following centrifugation, the concentrated sediment was examined microscopically for the presence of helminth eggs. The formalin-ethyl acetate sedimentation technique is an established concentration method for the detection of intestinal parasite eggs, cysts, and larvae (9). A participant was considered positive for STH infection when eggs of at least one STH species were detected in the stool specimen. The laboratory examination specifically assessed for the STH species included in the study, namely *A. lumbricoides*, *T. trichiura*, and hookworm.

Laboratory quality control: Quality-assurance procedures were implemented throughout stool specimen collection, processing, and microscopic examination. Standard operating procedures used by the BMC and Catholic University of Health and Allied Sciences laboratories were followed. Each specimen was appropriately labelled and linked to the participant's unique study identification number. Two slides were examined for each participant to improve the reliability of microscopic detection. Laboratory results were recorded using the corresponding study identification number and subsequently linked to questionnaire data during data management.

Data management and statistical analysis: Each participant was assigned a unique identification number. Questionnaire and laboratory data were checked for completeness and entered into Microsoft Excel before cleaning and analysis using Stata version 15.0. Categorical variables were summarized using frequencies and percentages. Associations between potential explanatory variables and STH infection were assessed using Pearson's chi-square test. A P value <0.05 was considered statistically significant. For variables with small expected cell frequencies, the appropriateness of the Pearson's chi-square approximation was considered during statistical verification. Ethical considerations: Ethical clearance was obtained from the CUHAS-BMC Joint Research Ethics and Review Committee (CUHAS/REC-3667/2025). Written informed consent was obtained from all participants before enrolment. Participants were informed about the purpose and procedures of the study and their participation was voluntary. Participant information was treated confidentially, and unique identification numbers were used during data management. The study was conducted in accordance with applicable ethical principles for research involving human participants.

RESULTS

Sociodemographic characteristics: A total of 300 people living with HIV participated in the study. Of these, 69 (23.0%) were from rural areas and 231 (77.0%) were from urban areas. Overall, 235 (78.3%) participants had formal education, while 65 (21.7%) had no formal education. Regarding occupation, 168 (56.0%) participants were farmers and 132 (44.0%) were employed.

Table 1. Sociodemographic characteristics of study participants (N=300)

Variable	Category	Frequency	Percentage (%)
Residence	Rural	69	23.0
	Urban	231	77.0
Occupation	Farmer	168	56.0
	Employed	132	44.0
Educational status	Formal education	235	78.3
	No formal education	65	21.7

Prevalence of soil-transmitted helminth infections: Among the 300 participants examined, 24 were positive for at least one STH species, corresponding to an overall prevalence of 8.0%. *A. lumbricoides* was detected in 13 participants (4.3%), while hookworm was detected in 11 participants (3.7%). No *T. trichiura* infection was detected.

Table 2. Distribution of detected soil-transmitted helminths among study participants (N=300)

STH species	Frequency	Prevalence (%)
Ascaris lumbricoides	13	4.3
Hookworm	11	3.7
Trichuris trichiura	0	0.0
Any STH infection	24	8.0

Factors associated with STH infection: Associations between selected sociodemographic and behavioural characteristics and STH infection were assessed using Pearson's chi-square test. Consumption of boiled water was the only factor significantly associated with STH infection. Participants who reported drinking boiled water had a prevalence of 3.5% (6/170), compared with 13.8% (18/130) among those who reported not drinking boiled water (χ^2=10.653, df=1, P=0.001). No statistically significant association was observed between STH infection and age (χ^2=1.859, df=4, P=0.762), residence (χ^2=0.560, df=1, P=0.454), educational status (χ^2=2.091, df=1, P=0.148), occupation (χ^2=0.447, df=1, P=0.504), awareness of STH infection (χ^2=1.539, df=1, P=0.215), shoe-wearing habit (χ^2=0.453, df=1, P=0.501), toilet cleanliness (χ^2=3.498, df=1, P=0.061), or year of HIV diagnosis (χ^2=0.116, df=1, P=0.733).

DISCUSSION

This study found an overall STH prevalence of 8.0% among people living with HIV attending Bugando Medical Centre in Mwanza, Tanzania. The detected parasites were *A. lumbricoides* and hookworm, with prevalence estimates of 4.3% and 3.7%, respectively. No *T. trichiura* infection was detected. The prevalence observed in the present study was lower than that reported among HIV-infected patients in some other African settings. A study conducted at Debretabor General Hospital in northern Ethiopia reported intestinal parasitic infections among HIV-infected patients receiving antiretroviral therapy, demonstrating that intestinal parasites remain an important concern in HIV care settings (5). Differences between studies may reflect geographical and environmental conditions, sanitation and water infrastructure, socioeconomic characteristics, antiretroviral treatment, previous antiparasitic treatment, and diagnostic methods. The prevalence observed in the present study was also lower than the burden reported in some Nigerian populations. Such differences are not unexpected because STH transmission is strongly influenced by environmental conditions, sanitation, access to safe water, behavioural practices, and local control programmes. In Tanzania, Mwambete et al. reported intestinal helminthiasis among HIV-infected patients attending Muhimbili National Hospital (7). The findings from the present study provide additional information from Mwanza and suggest that STH infections remain detectable among people living with HIV in Tanzania. Differences in prevalence between the two studies may be attributable to differences in geographical location, study population, study period, healthcare setting, diagnostic methods, and exposure patterns.

Table 3. Factors associated with soil-transmitted helminth infection among people living with HIV (N=300)

Variable	Category	STH Neg, n (%)	STH Pos, n (%)	χ^2	df	*P* value
Age (years)	20–31	25 (96.15)	1 (3.85)	1.859	4	0.762
	32–41	59 (93.65)	4 (6.35)			
	42–51	105 (92.11)	9 (7.89)			
	52–61	45 (88.24)	6 (11.76)			
	62–83	42 (91.30)	4 (8.70)			
Residence	Rural	62 (89.86)	7 (10.14)	0.560	1	0.454
	Urban	214 (92.64)	17 (7.36)			
Educational status	Educated	219 (93.19)	16 (6.81)	2.091	1	0.148
	Uneducated	57 (87.69)	8 (12.31)			
Occupation	Employed	123 (93.18)	9 (6.82)	0.447	1	0.504
	Farmer	153 (91.07)	15 (8.93)			
Awareness of STH	Yes	65 (95.59)	3 (4.41)	1.539	1	0.215
	No	211 (90.95)	21 (9.05)			
Shoe-wearing habit	Yes	233 (92.46)	19 (7.54)	0.453	1	0.501
	No	43 (89.58)	5 (10.42)			
Boiled-water consumption	Yes	164 (96.47)	6 (3.53)	10.653	1	0.001
	No	112 (86.15)	18 (13.85)			
Toilet cleanliness	Clean	111 (95.69)	5 (4.31)	3.498	1	0.061
	Dirty	165 (89.67)	19 (10.33)			
Year of HIV diagnosis	2003–2012	128 (91.43)	12 (8.57)	0.116	1	0.733
	2013–2024	148 (92.50)	12 (7.50)			

Note: Percentages are row percentages. Pearson's chi-square test was used to assess associations between categorical variables and STH infection. A *P* value <0.05 was considered statistically significant.

A. lumbricoides was the most frequently detected STH species in the present study, followed by hookworm. This pattern is consistent with the continued occurrence of these parasites in Tanzania and other sub-Saharan African settings (2,3). A large-scale mapping study in north-western Tanzania found that STH infections remain distributed across the Lake Victoria zone, supporting the continued relevance of these infections in the region (3). The absence of *T. trichiura* in the present study does not necessarily indicate that the parasite is absent from Mwanza. Its detection may be affected by local transmission intensity, sample size, diagnostic sensitivity, and examination of a single stool specimen. The most important finding from the analysis was the significant association between STH infection and consumption of boiled water. Participants who reported drinking boiled water had a prevalence of 3.5%, compared with 13.8% among participants who reported not drinking boiled water. This finding is biologically plausible because safe water is an important component of prevention of faecal-oral transmission of intestinal parasites. The association also agrees with broader evidence that improvements in water, sanitation, hygiene, and socioeconomic conditions contribute to reductions in STH transmission (2,3).

However, the observed association should not be interpreted as proof that boiling water independently prevents STH infection. Because the study was cross-sectional, temporal relationships cannot be established. In addition, water-treatment behaviour may be associated with other factors such as socioeconomic status, household sanitation, hygiene practices, education, and health awareness. These potential confounders were not controlled for in a multivariable model. Awareness of STH infection was not significantly associated with infection status in the corrected analysis. Although the observed prevalence was lower among participants who reported awareness of STH infection than among those who did not report awareness, the difference was not statistically significant (4.4% versus 9.1%; χ^2=1.539, df=1, *P*=0.215). Therefore, the present findings do not provide sufficient evidence that awareness alone was associated with STH infection. Similarly, no statistically significant association was observed between STH infection and educational status. The prevalence was 6.8% among participants with formal education and 12.3% among those without formal education. Although the observed prevalence was higher among participants without formal education, the difference did not reach statistical significance (*P*=0.148). Educational status may influence hygiene and health-related practices, but the relationship may be affected by other socioeconomic and environmental factors. No significant associations were observed between STH infection and age, residence, occupation, shoe-wearing habit, toilet cleanliness, or year of HIV diagnosis.

These findings differ from the expectation that some demographic and behavioural characteristics may influence exposure to STH. However, the absence of statistical significance should be interpreted cautiously because only 24 participants were positive for STH, limiting the statistical power to detect modest associations. The relatively low prevalence observed in the present study may reflect several factors, including healthcare access, HIV-related health education, sanitation, safe-water practices, and previous exposure to antiparasitic treatment. Nevertheless, these explanations cannot be confirmed by the present cross-sectional study. Important clinical variables, including CD4 cell count, HIV viral load, duration of antiretroviral therapy, nutritional status, and detailed history of previous deworming, were not incorporated into a multivariable analysis. The present study provides useful local data because most available STH epidemiological studies in Tanzania have focused on school-aged children or general populations rather than people living with HIV. The study therefore contributes to understanding the occurrence of STH infections among a clinically important population in Mwanza.

CONCLUSION

The prevalence of STH infection among people living with HIV attending Bugando Medical Centre was 8.0%. *A. lumbricoides* and hookworm were the STH species detected, while *T. trichiura* was not detected. Among the factors examined, consumption of boiled water was significantly associated with STH infection. Participants who reported drinking boiled water had a substantially lower observed prevalence of STH infection than those who reported not drinking boiled water. No statistically significant associations were observed with age, residence, educational status, occupation, awareness of STH infection, shoe-wearing habit, toilet cleanliness, or year of HIV diagnosis. Because the study was cross-sectional and included a relatively small number of STH-positive participants, the observed association with boiled-water consumption should not be interpreted as causal.

RECOMMENDATIONS

Health education concerning STH transmission and prevention should be strengthened among people living with HIV, with emphasis on safe drinking-water practices, sanitation, hand hygiene, and appropriate footwear. Healthcare providers should consider intestinal helminth infections when clinically indicated among people living with HIV, particularly patients presenting with gastrointestinal symptoms or relevant environmental exposure histories.

Further studies involving multiple healthcare facilities and larger sample sizes are recommended to provide more representative estimates of STH infection among people living with HIV in Tanzania. Future research should incorporate CD4 cell count, HIV viral load, duration of antiretroviral therapy, nutritional status, socioeconomic characteristics, detailed water and sanitation practices, and comprehensive history of anthelmintic treatment. Longitudinal studies would also be useful for determining temporal relationships between behavioural and environmental exposures and STH infection and for assessing reinfection following treatment.

Strengths

This study provides locally relevant information on STH infections among people living with HIV attending a major tertiary healthcare facility in Mwanza, Tanzania, where published data on this specific population remain limited. The study combined questionnaire-based assessment of potential exposure factors with laboratory examination of stool specimens rather than relying solely on self-reported infection. The formalin-ethyl acetate concentration technique was used to concentrate parasite material before microscopic examination, providing a recognized approach for detection of intestinal parasite eggs and other forms (9). The study also assessed several demographic, environmental, and behavioural characteristics potentially relevant to STH transmission, including water consumption practices, sanitation, footwear, awareness, and occupation.

Limitations

First, the cross-sectional design may prevent the determination of temporal or causal relationships between exposure factors and STH infection. Second, convenience sampling may have introduced selection bias and limits the generalizability of the findings to all people living with HIV in Mwanza or Tanzania. Third, although the calculated minimum sample size was 240 participants, only 300 participants were enrolled; therefore, the study had limited power for detecting modest associations, particularly because only 24 participants were STH-positive. Fourth, we collected only a single stool specimen from each participant. Because helminth egg excretion may vary over time, examination of multiple specimens could increase diagnostic sensitivity.

Finally, potentially important clinical and epidemiological confounders, including CD4 cell count, HIV viral load, duration of antiretroviral therapy, nutritional status, socioeconomic status, and detailed history of antiparasitic treatment, were not incorporated into a multivariable analysis.

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Author Contributions

SIK: Conceptualization, Methodology, Data collection, Investigation, Writing – original draft.

JKN: Methodology, Laboratory analysis, Quality control, Data curation.

MZF: Conceptualization, Supervision, Statistical analysis, Validation, Writing – review & editing."

Data Availability Statement: The datasets generated and analyzed during the current study are not publicly available due to participant privacy and institutional ethical constraints, but they are available from the corresponding author upon reasonable academic request.

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