Effect of Geohelminthiases on Absenteeism Among School-Age Children in Nairobi County, Kenya

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ABSTRACT

The purpose of this study was to determine the effects of geohelminths on school attendance of children living in slums of Nairobi County, Kenya. A longitudinal study was carried out in children aged 6-18 years in classes 2-7 from schools within 2 slums in Nairobi County. Household socio-economic status questionnaires were administered to cater for potential confounders. Stools were collected and analyzed by modified Ridley and Kato-Katz Thick Stool Smear techniques. Infection intensity was as defined by World Health Organization criteria and 3 terms pre- and 2 terms post-treatment absenteeism records were collected for analysis. Collected data were coded and entered in the Microsoft Excel. Data was analyzed using Statistical Analysis Software, Version 9.4 M8 (2023) for descriptive statistics and Analysis of variance (ANOVA); t-test was used to detect significant differences in pre-treatment, post-treatment absenteeism.

Correlation analysis was used to show associations between intensity of geohelminthiases and absenteeism. The highest prevalence occurred with Ascaris lumbricoides (37.4%) and Trichuris trichiura (33.2%). Highest number of light and moderate infections (16.5%) and (10.4%), respectively, occurred in 11-14 years age-group, pre-treatment. No Strongyloides stercoralis larvae were seen in stools. There was significant difference in infection intensities with T. trichiura and A. lumbricoides between males and females, $p < 0.05$, with females having higher infections. There was significant difference in absenteeism between the infected and non-infected, pre-treatment, $p < 0.05$. Geohelminthic infections significantly correlated with absenteeism, $r = 0.7523$. There was significant correlation between prevalence and absenteeism, pre-treatment ($r = 0.971$; $p < 0.05$). We concluded that geohelminthiases adversely affect school attendance of school-age children and treatment with albendazole was more effective with A. lumbricoides than T. trichura. We recommend that effective control of geohelminths required periodic, regular mass deworming with Albendazole (broad-spectrum athelminthics). In addition, stake holders need to be properly informed on the importance of maintaining proper environmental sanitation and effective health education campaign strategies for control of helmithiases among school age children.

Key words: Absenteeism, geohelminths, geohelminthiases confounders, albendazole,

INTRODUCTION

Soil- transmitted geohelminths are among the neglected tropical diseases (NTDs) affecting more than 2 billion people worldwide. The reported global disability- Adjusted Life Years (DALYs) of the geohelminths was estimated to be as high as 2 million in 2017 (Freeman et al, 2019; Mekonmen et al, 2020), W.H.O., 2020). Socio-economic status, low standard of living and poor personal and environmental hygiene have been linked to an increase risk of helminthes infections (Aemiro et al, 2024) Geohelminths. infections are most prevalently in children and can affect their intellectual development, growth and immunity to diseases; school attendance may also be negatively affected (Tefra et al, 2017; Audargie et al, 2024). The severity of geohelminthic infections has been reported to be higher in children than adults. The high prevalence and severely in children are primarily dues to their frequent contact with geohelminths contaminated soil and less developed immune systems (Tefra et al, 2017). These diseases are a major cause of morbidity and mortality among children in Sub-Saharan Africa (S.S.A.), including Ethiopia (Farrant et al, 2020); Getaneh et al, 2022).

Geohelminthic infections are important cause of morbidity and mortality in many developing countries (Mupfasoni et al, 2019; W.H.O., 2022; Shahrizal et al, 2024; Garba et al., 2025). It is estimated that 1,471 million cases of infection with Acaris. lumbricoides, 1,049 million cases of infection with Tricuris. trichiura and 1,200 million cases of infection with hookworm (Acaris lumbricoides and Necator americanus) occur worldwide (WHO, 2020). School-age children in developing countries bear the greater health burden due to helminthic infections (WHO, 2022). Among the well-described morbidities associated with helminthic infections in children are under-nutrition, anaemia, failure to achieve genetic potential for growth (Drake and Bundy, 2001) and inconsistent school attendance (Velleman and Pugh, 2013; Donkoh et al, 2023). Limited studies have examined the association between helminthic infections and children's poor school attendance (Addisu and Asmamaw, 2015). Most investigators agree that geohelminth control initiatives are beneficial to children' school attendance and academic performance, based on results from well-defined studies. Positive associations between academic performance and treatment of infection with T. trichiura and A. lumbricoides have been reported (Stephenson et al., 2000). However, the mechanism underlying the relationship between helminthic infections and cognitive processes during child development have not been clearly elucidated. Investigators have shown that helminthiases is associated with absenteeism, under-enrollment and attrition in school children (Lustigman et al., 2012). In addition, deworming programs have been shown to improve school attendance by 25% (Taylor-Robinson et al., 2012; Pabalan et al, 2018; Shahrizal et al, 2024). Investigators reported that this may lead to a long-term increase in income and higher literacy rates (Velleman and Pugh, 2013). The current study was conducted in the context of a longitudinal treatment-follow-up assessing the effect of geohelminthiases on school attendance in school-age children attending schools located in Nairobi city slums.

Statement of Problem

School-age children living in slums perform poorly in education partly due to exposure to unhygienic environments and lack of proper sanitation facilities (Bieri et al, 2013; Ibrahim et al, 2018; Truneh et al, 2020; W.H.O., 2022). This pattern was observed especially in countries located within tropics and subtropics (W.H.O., 2022). Moreover, personal and communal hygienic standards are poor and are compounded by harmful sub-cultural traditions, norms and practices (Chen et al, 2024). Most children living in such areas may experience adversely affect growth and cognitive development (Sartorius et al, 2021; de Sousa et al, 2024). Although geohelminthiases is widespread in areas with poor sanitation, empirical data on prevalence, and absenteeism was scanty (Tefra et al, 2027; Farrant et al, 2020; de Sousa et al, 2024). This direly needed data would inform policy in Ministries of Health and Education on targeted Control of geohelminthiases which formed the basis of the study.

Justification of Study

Infections with geohelminths have been associated with mental and muscular fatigue, lethargy ill-health and listlessness in infected persons (W.H.O.; 2022). Further, geohelminthiases continue to wreak havoc on children's physical social, sexual, and educational development (Freeman et al.; 2019; W.H.O. 2020); Getaneh et al., 2022; Andargie et al, 2024). This may adversely affect school attendance, academic performance, personal development and productivity of school –aged children (Mekonnen et al, 2020; W.H.O., 2023; de Sousa et al, 2024). There effects are insidious, indirect and ill-understood and have been under-estimated for many years. Data and information on effects of geohelminths on growth, school attendance and academic performance is scantly (W.H.O., 2020, 2022, 2023; de Sousa et al, 2024). Therefore it was deemed necessary to study the effects of geohelminths on growth, cognitive functions and academic performance in school children Based on available literature, there was limited data in Kenya which has examined the pathological effects of geohelminths school absenteeism (Mwandawiro et al, 2019) and related these variables to academic performance in the same population (Okoyo et al, 2022; de Sousa et al, 2024). The data obtained in the study could be used to influence National policy decisions in the Ministries of Health and Education in Kenya to reduce the prevalence and transmission of geohelminth infections.

Research Questions

The study addressed the following research questions:

What were the prevalence rates of geohelminths in the study population?

What were the infection intensities of geohelminths in the study population?

What were the effects of geohelminthiases on school attendance in the study population?

Research Hypothesis

Geohelminthiases do not affect absenteeism of pupils from selected schools in Nairobi County.

Objectives

The general Objective was to determine the prevalence geohelminthiases and its effects school attendance among pupils of Kibera and Korogocho slums of Nairobi County, Kenya.

Specific Objectives

To determine prevalence rates of geohelminths in the study population.

To determine infection intensities of geohelminths in the study population.

To determine the effects of geohelminthiases on school attendance in the study population.

MATERIALS AND METHODS

This investigation was a longitudinal study conducted in selected, large slums in Nairobi County in which the 4 purposefully selected schools were included in the study. The study population consisted 470 children, 235 of whom were infected with one or more species of geohelminths while 235 children were controls, matched for age and class. All available children in 4 schools in class 2-7 were screened for geohelminths (A. lumbricoides, T. trichiura, hookworms and S. stercoralis). Stools were also screened for Entamoeba histolytica, Giardia lamblia, Taenia species, Hymenolepis nana and Schistosoma species, using Modified Ridley's Method (Allen and Ridley, 1970) was used as follows: 4 mls. of 10% Formol – saline solution were measured and poured into a mortar. Then, 2 gms. of stool were weighed, placed into the mortar bowl and using a pestle the stool was thoroughly emulsified. The stool emulsion was sieved through four layers of wet surgical gauze into a centrifuge tube, using a thistle funnel. 3-4 mls of diethyl-ether were added and a rubber cork placed onto the mouth of the tube. The tube was then shaken thoroughly for twenty seconds, taking care to hold the cork firmly in place. The tube contents were centrifuged at 2,000 revolutions per minute for 3 minutes and using an applicator stick, the plug of debris was removed. The remaining fluid (supernatant) in the tube was decanted into the sink, leaving at the bottom a button of stool for microscopic examinations. Using an applicator stick, the entire button was carefully dislodged from the tube bottom and poured directly onto a clean microscope slide. The entire stool preparation was examined after mixing the film with a drop of 1% Lugol's iodine stain. Microscopy was done using x10 objective and x40 Objective and all the eggs and/or larvae of parasites were counted. Results were divided by 2 to get the number of eggs or larvae per gram of stool and reported accordingly. Blood samples were collected and screened for malaria parasites (Plasmodium species) using Giemsa staining method (Baker and Pallister, 1998) as follows: Thin and thick blood films were prepared and fixed in absolute methanol for 3 minutes. Giemsa stain diluted (1 in 9) in buffered saline (pH 7-7.1) was flooded on slides and stained and allowed to stain for 1 hour. Blood films were washed and differentiated with buffered saline solution by controlling the degree of differentiation microscopically. Stained slides were drained and dried in the air at room temperature for 30 minutes. Stained slides were examined microscopically for Plasmodia species, using x 100 Oil immersion Objective. Then, stool egg counts were performed on 235 children using Kato-Katz quantitative technique (W.H.O., 2012) as follows: 1-2 gms of stool was placed on a sheet of disposable paper. Stool was pressed through the gauze square to obtain an estimated 50 mgs of specimen. 50 mgs of stool were transferred onto a glass slide. A drop of 50% glycerol was added, mixed with the specimen and covered with a glass. Using another slide, the preparation was carefully pressed on the laboratory bench. The preparation was left standing at room temperature for 45-60 minutes to clear faecal debris. Entire preparation was examined microscopically. The number of eggs counted multiplied by a factor of 20 gave the number of eggs per gramme of stool.

Children were then treated with albendazole; socio-economic status was assessed using a structured questionnaires and anthropometric measurements were taken for three terms: Pre-treatment term and two terms post-treatment. Class attendance records for three preceding terms and two immediate post-treatment terms were collected to determine the attendance patterns. Stool parasites were identified using Modified Ridley's Method and egg counts were performed on 235 children using Kato-Katz technique pre- and post-treatment. Data collected were entered in the Microsoft Office excel and analyzed using Statistical Analysis Software, Version 9.4 M8 (2023) for descriptive statistics. The t-test was used to indicate significant differences in pre-treatment and post-treatment absenteeism among the children. Analysis of variance was used to show whether significant differences existed in pre-treatment and post-treatment absenteeism among the children. Correlation analysis was used to show associations between intensity of geohelminthiases and absenteeism.

RESULTS

The study population consisted of 470 pupils; 235 pupils were infected with one or more species of geohelminths while 235 pupils were controls, matched for age and class. However; 106 pupils were lost to follow-up, before data collection period ended. Data analyzed was for remaining 364 children [(182 controls (non- infected) and 182 infected children (n=182) Out of those infected, three groups were identified, based on infection intensity (light, moderate and Heavy infections). Overall, there were 114 (62.6 %) light infections, 60 (33.0%) moderate and 8 (4.4%) heavy infections pre-treatment while 26 (14.3%) light infections, 1 (0.5%) moderate and 2 (1.1%) heavy infections persistently occurred, post-treatment (Fig. 1). Overall, results showed significant reduction in parasite load intensity, after treatment ($p < 0.05$).

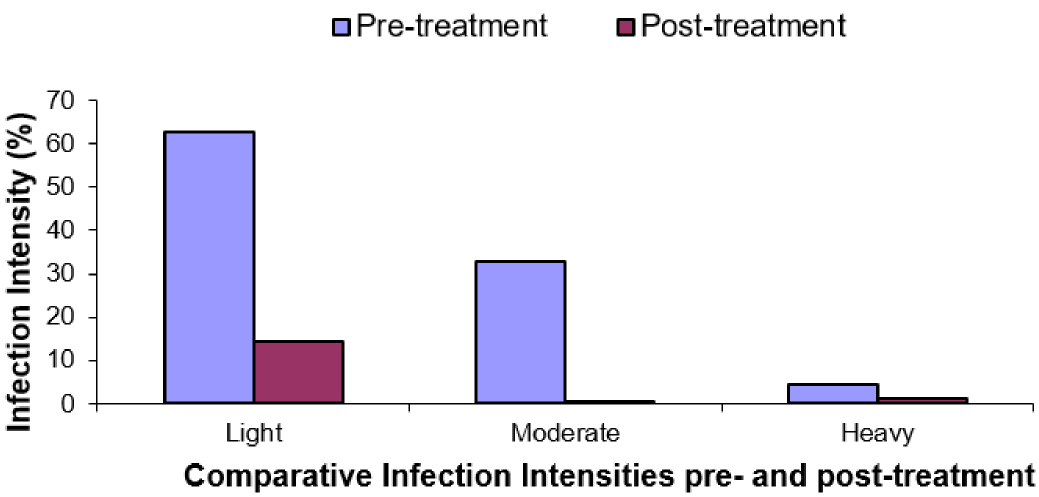

Fig. 1: Comparative infection intensities pre- and post-treatment (n = 182)

Light infection= ; moderate infection = ; Heavy infection= , (W.H.O, 2012)s

The results showed A. lumbricoides caused 39.6% light infections, 31.3% moderate and 4.4% heavy infections while T. trichiura caused 63.7% light and 3.3% moderate infections. There were 1.1% light infections with hookworms (A. duodenale or N. americanus) (Fig. 2). Results showed that there was significant difference in light infection intensities with A. lumbricoides compared to T. trichiura ($p < 0.05$).

In addition, there was significant difference in moderate infection intensities with A. lumbricoides compared

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with T. trichiura ($p < 0.05$).

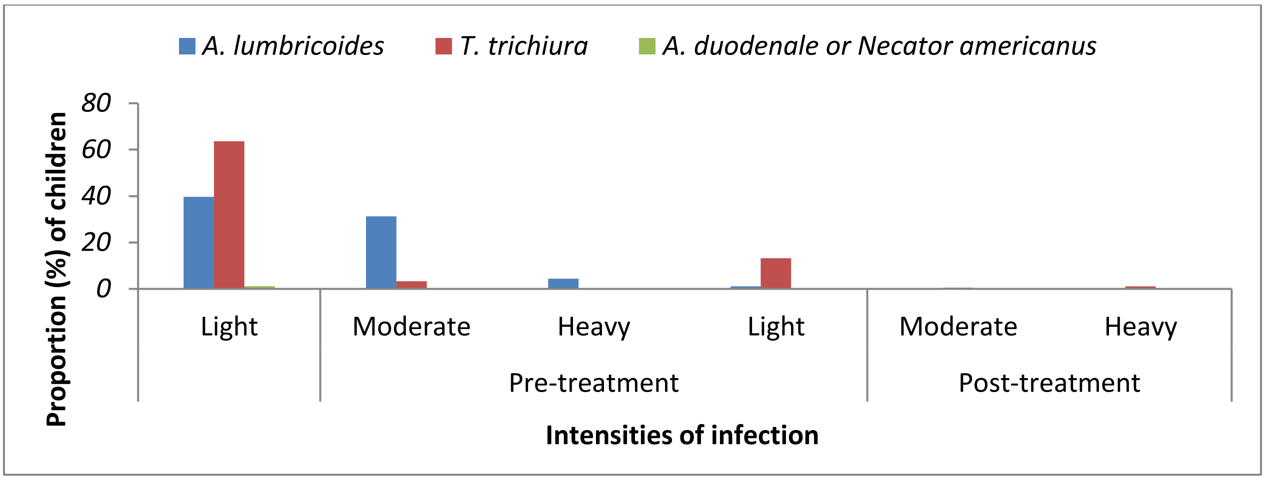

Fig. 2: Comparative infection intensities of geohelminths (n = 182) (pre- and post-treatment)

The study showed (13.2%) light, (0.5%) moderate and (1.1%) heavy infections with T. trichiura and 1.1% light infections with A. lumbricoides post-treatment (Fig. 2). Further, results showed significant difference in light infection intensities between T. trichiura and A. lumbricoides post-treatment ($p < 0.05$). Out of 182 pupils, there were 62.6% light infections, 33.0% moderate and 4.4% heavy infections. There were 31.9 % males and 30.8% females with light infections, 13.2% males and 19.8% females with moderate infections and 0.5% males and 3.8% females with heavy infections. There were more infection intensities among females (55.0%) than males (46.1.%); there were more females (3.8%) with heavy infection intensities than males (0.5%) (Table 1).

Table 1: Geohelminthic infection intensities by sex

Infection intensity	Male n(%)	Female n(%)	Total
Light	58(31.9%)	56(30.8%)	114(62.6%)
Moderate	24(13.2%)	36(19.8%)	60(33.0%)
Heavy	1(0.5%)	7(3.8%)	8(4.4%)
Total	**83(46.1%)**	**99(55.0%)**	**182(100%)**

Out of 364 pupils, A. lumbricoides caused 19.5% light infections 17.5% moderate and 2.2% heavy infections; there were more infection intensities among females (23.4%) than males (16.2%). In addition, more females had moderate (11.5%) and heavy (1.9%) infection intensities compared to males (6.3%) and (0.3%), respectively. However, infection with A. lumbricoides was independent of sex (Table 2; $p > 0.05$).

Table 2: A. lumbricoides and T. trichiura infection intensities by sex

Intensity	A. lumbricoides		T. trichiura	
	Male	Female	Male	Female
Light	35 (19.2%)	37 (20.3%)	57 (31.3%)	59 (32.4%)
Moderate	22 (12.1%)	35 (19.2%)	2 (1.1%)	4 (2.2%)
Heavy	1 (0.5%)	7 (3.8%)	-	-
Total	**58 (31.9)%**	**79 (43.4%)**	**59 (32.4%)**	**63 (34.6%)**

Legend: (-) Denotes no eggs detected (n = 182)

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Out of 364 pupils, there were 32.1% light infections with T. trichiura and 1.6% moderate; more infection intensities occurred in females (17.9%) than in males (15.9%).

Infection with T. trichiura was independent of sex, $p > 0.05$, although more females had moderate (1.1%) infection intensities compared to males (0.5%) (Table 2).

Effects of age on geohelminthic infection intensities

Out of 69 children within 6–10 year age-group, 12.1% had light infections, 5.8% had moderate and 1.1% heavy infections. In addition, out of 102 children within 11–14 year age-group, 16.5% had light infections, 10.4% had moderate and 1.1% heavy infections. Out of 11 children within 15–18 year age-group, 2.7% had light infections and 0.3% had moderate infections (Fig. 1), with pupils aged 11–14 years having the highest overall intensities; the highest light infections (16.5%) occurred in those aged 11-14 years. Overall, the highest infection intensity (28%) occurred in children aged 11-14 years; there was significant difference between light infections in those aged 6-10 years compared to infections 15-18 years, $p < 0.05$). There was significant difference in light infections in 11-14 year age-group compared to infections in 15-18 year age-group, $p < 0.05$); the highest heavy infections (1.1%) occurred in the 6-10 year- and 11-14 year age-group (Fig. 3).

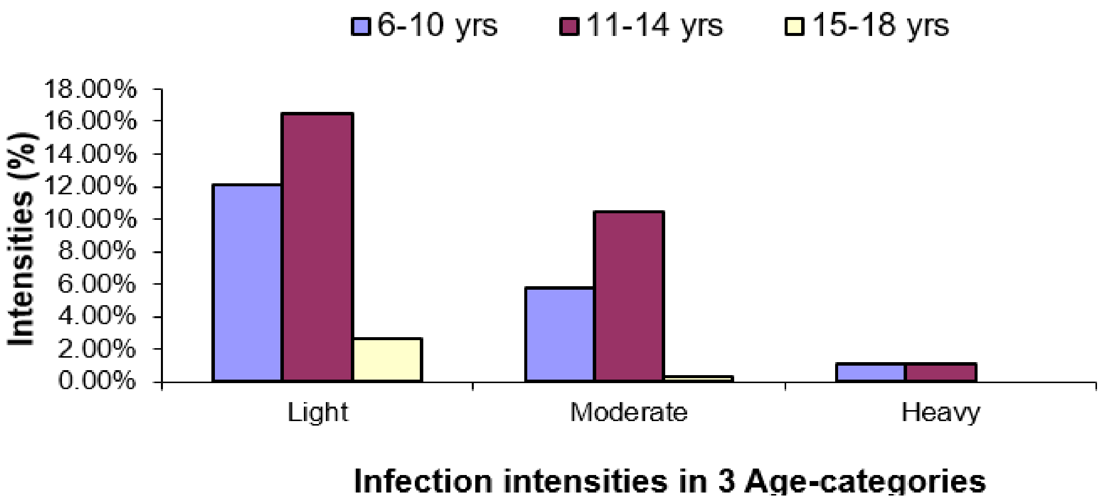
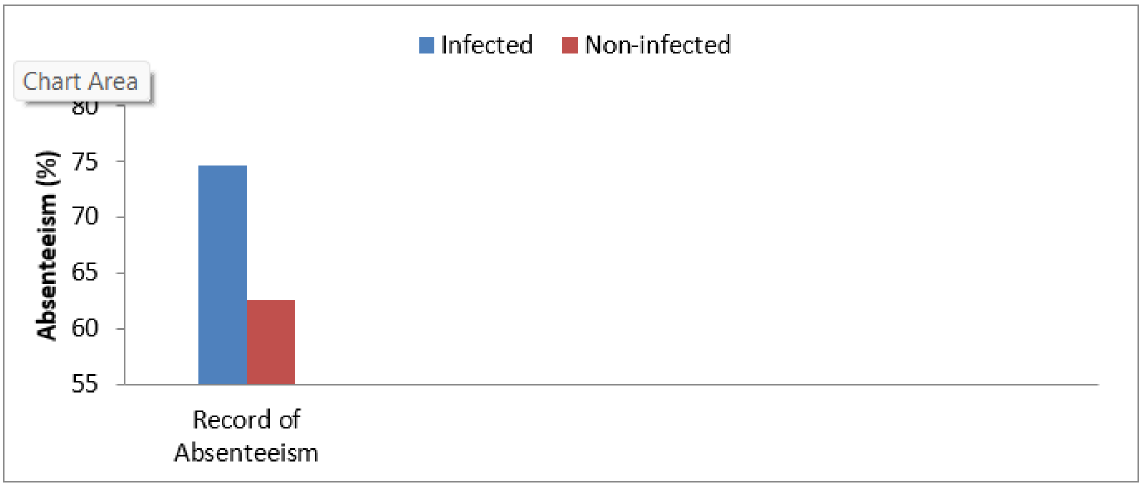


Fig. 3: Distribution of infection intensities within (6-18 yrs) age-categories

There was significant difference in absenteeism, between the infected and non-infected pupils pre-treatment (Fig. 4; $p < 0.05$).

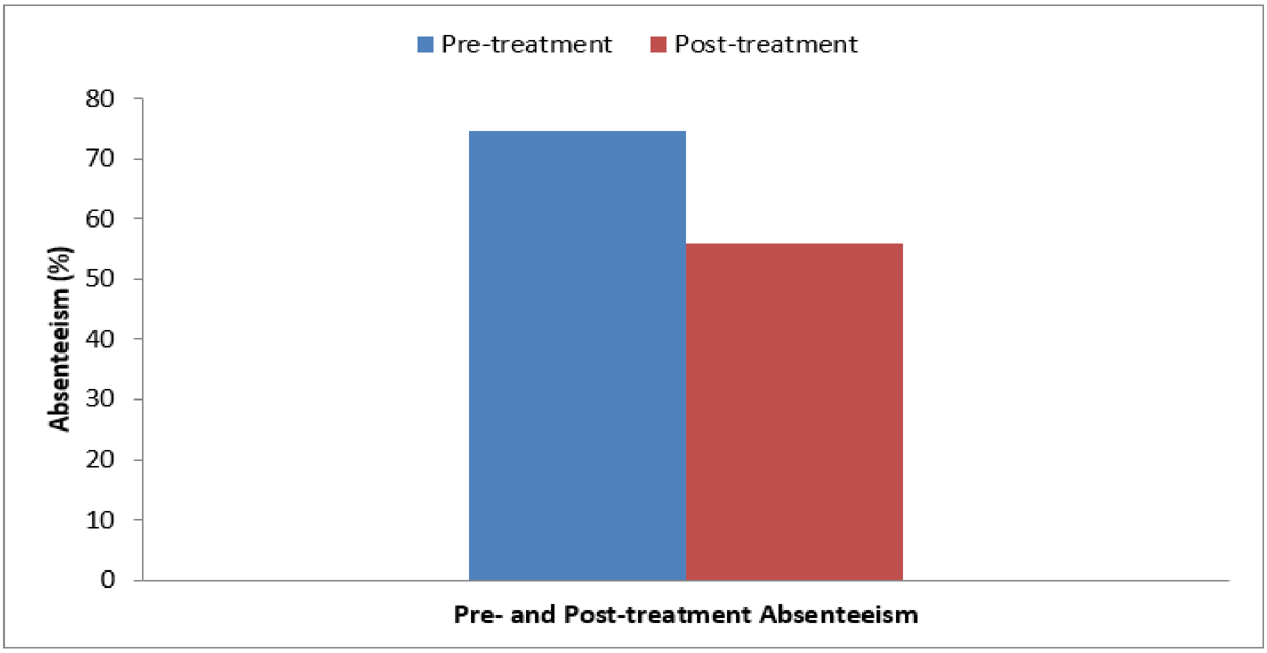


Record of children's absenteeism status pre-treatment

Fig. 4: Infected and non-infected children's absenteeism record pre-treatment

(n = 182)

Among 182 infected children, 74.7% were absent from school pre-treatment, compared to 56.0% post-treatment; results showed there was significant reduction in absenteeism post- treatment (Fig. 5; $p < 0.05$). There was significant correlation between geohelminthic infections and absenteeism ($r = 0.7523$; $p < 0.05$). There was significant correlation between prevalence and absenteeism, pre-treatment ($r = 0.971$; $p < 0.05$). This indicated that geohelminthic infections had significant adverse effect on school attendance among infected children.



Comparison of children's school absenteeism record

Fig. 5: Infected children's absenteeism record pre- and post-treatment (n = 182)

DISCUSSION

The highest prevalence of infections were produced by A. lumbricoides (37.4%) and T. trichiura (33.2%); the highest light and moderate infections (16.5%) and (10.4%), respectively, occurred in 11-14 years age-group. The high infection intensity observed agreed with other reports (Bundy et al., 2013; Mugono et al., 2014; Zelenke et al, 2021). Significant differences occurred in infection intensities with T. trichiura and A. lumbricoides between males and females, with females having higher infections. The issue of sex is controversial because different investigators have reported different results due to interference of other factors involved in females, such as hormonal imbalances and differences in quantity of food nutrients intake between boys and girls of the same age (Jardim-Botelho et al., 2008; Walker et al., 2011).

The high infection intensity in children aged 11-14 years in classes 2-4 agreed with other reports (Bundy et al., 2013; Owada et al., 2017; Pablan, et al., 2018). Significant differences in absenteeism between the infected and non-infected were reported, together with reduction in absenteeism; geohelminthic infections significantly correlated with absenteeism. These reports agree with independent observations by other investigators (Al-Delaimy et al., 2014; Addisu and Asmamaw, 2015). The highest prevalence of geohelminthic infections in this study were produced by A.lumbricoides (37.4%) and T. trichiura (33.2%). These observations agree with reports of investigators in other countries in the tropics and sub-topics (Tefra et al, 2017. Getaneh et al., 2022; Aemiro et al, 2024). Moreover, the highest light and moderate infections (16.5%) and (10.4%) respectively, occurred in 11-14 years age-group. Several investigators have shown that this age-group is the most vulnerable and susceptible to infections with geohelminth specifies (de Sausa et al, 2024). These children are prone to infections with geohelminths because they often walk bare feet, forget or ignore hand-washing before eating food and person-to-person contact is common. Further, indiscriminate defecations in slum areas, poor sanitation and drainage of waste water associated with poverty increase prevalence and infection intensity: Indeed, the high infection intensity observed on this study agreed with other reports (Zelenke et al, 2021, W.

H. O., 2020; Donkoh et al, 2022). Significant differences occurred in infection intensities with T. trichiura and A. lumbricoides, between males and females, with females having higher infections. However, the issue of sex is controversial (C.D.C., 2022; Garba et al, 2025). Moreover, different investigators have reported different results due to interference of other factors involved in females.

These factors include hormonal imbalances and differences in quantity of food nutrients intake between boys and girls of the same age among others (Sartorius et al, 2021; Eyayu et al, 2022; Usang et al, 2025). The high infection intensity in children aged 11-14 years in classes 2-4 agreed with reports of several investigators (Okoyo et al, 2022, Andargie et al, 2024). The high infection intensity in this age-group is often related to children's close contact with solid; soils are frequently contaminated with geohelminth eggs and infective filariform larvae of hookworms (Freeman et al, 2019; W.H.O., 2022; Garba et al, 2025).

Investigators have shown that the cognitive structures responsible for operation of working memory are under-developed in children aged 11-14 years. This phenomenon is responsible for frequent episodes of forgetfulness is closely associated with failure to observe and practice Geohelminth control measures. Hence, increased infection intensities in children aged 11-14 years (Sartorius et al, 2021; Okoyo et al, 2022; de Sousa, 2024). Further, significant differences in absenteeism between the infected and non-infected were reported, together with reduction in absenteeism. The results also showed that geohelminthic infections significantly correlated with absenteeism (Donkoh et al, 2023). However, other investigators reported that some few school children with moderate and heavy infections do not suffer from absenteeism and poor academic performance in the same environment. This resistance to pathological impact of geohelminthic infections may be associated with genetic constitution of individual children; nutrition in children also reduce effects of moderate and heavy infections (Mekonnen et al, 2020; Andargie et al, 2024; de Sousa et al, 2024). Thus, the reports generated in this study show that geohelminthiases can lead to absenteeism in school age children, especially in moderate and heavy infections. Furthermore, these reports also concur with independent observations by other investigators (Mupfasoni et al, 2019; W.H.O., 2022; Garba et al, 2025).

Assumptions / Limitations made in the Study

Furthermore, it was also assumed that treatment with albendazole 400 mgs, single does would clear the infection, which was not the case with some parasites. The study was based on assumption that three months would be sufficient for the recovery of cognitive function following treatment; this was not necessarily true for some subjects. It was assumed that besides the presence of geohelmninths and other parasites, children were healthy. However, there are other factors that can affect cognitive functions, for example diabetes, hypertension, anaemia, pulmonary oedema, renal insufficiency, fever and diarrhea. It was also assumed that absenteeism was largely, due to ill-health contributed by geohelminthiases. However, other factors such as lack of school fees, school uniform and other statutory financial requirements may have contributed to absenteeism.

CONCLUSIONS

We conclude that geohelminthiases caused by geohelminths (A. lumbricoides, T. trichiura, S. stercoralis and A. duodenale or N. americanus) had a significant inverse effect on school attendance among school-age children in Kenya. Regular population-based chemotherapy with broad-spectrum and specific anthelminthics in schools can drastically reduce disease prevalence and intensity. This would result in improved school attendance and increased long-term economic productivity. Three, consecutive oral doses of albendazole, 400 mgs single dose are required for expulsion of T. trichiura. In addition, stake holders need to be properly informed on importance of maintaining proper environmental sanitation practices and effective health education campaign strategies to suppress the transmission of geohelminthiases.

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