**Eficacy Of Albendazole Mass Drug Administration on Soil Transmitted Helminths Among School Age Children**

ABSTRACT

Background: Soil-transmitted helminths (STHs) are parasitic intestinal worms that are transmitted to humans through contaminated soil via the faecal-oral route or skin penetration infection (WHO, 2022). The three major species infecting humans belong to the phylum Nematoda, commonly referred to as roundworms. Soil-transmitted helminths (STHs) pose a significant public health challenge, particularly in low-resource settings with poor sanitation, such as the Ikyogen Internally Displaced Persons (IDP) camp in Kwande Local Government Area, Benue State, Nigeria.

Aim: The study evaluates the efficacy of albendazole mass drug administration (MDA) in reducing the prevalence and intensity of STH infections among school-aged children.

Methods: A prospective observational study was conducted between April and May 2024 for school-age children at IDP camp in Ikyogen, Kwande LGA, Benue state. A simple random sampling method was used to select the pupils to participate in the study. The minimum sample size of the population to which the questionnaire was administered. A total of 112 children diagnosed with STH were enrolled. Stool samples were collected and examined by the Kato-Katz thick smear quantitative method for the presence of STH and repeated after 21 days of Albendazole administration. Data were analysed using SPSS version 24.

Results: At baseline, 39% of the children tested positive for STH infections, with *Ascaris lumbricoides* (61.6%) being the most prevalent, followed by hookworms (34.8%) and *Trichuris trichiura* (3.6%). Albendazole treatment demonstrated varying efficacy, with a cure rate of 66.7% for *A. lumbricoides*, 53.5% for hookworms, and 100% for *T. trichiura*. Egg reduction rates (ERRs) varied significantly across parasite types, reflecting potential challenges in achieving sustained reductions in infection intensity.

Conclusions: The administration of albendazole treatment, the intensity of infections decreased drastically, with Ascaris lumbricoides reducing to 106,032 EPG, hookworm to 4,485 EPG, and Trichuris trichiura being completely eradicated. This considerable reduction in intensity highlights the short-term impact of albendazole in reducing the morbidity associated with heavy STH infections. This study offers valuable insights into the epidemiology of soil-transmitted helminth (STH) infections and the short-term impact of albendazole treatment in Ikyogen, Kwande LGA. The research underscores the significant efficacy of albendazole in reducing both the prevalence and intensity of STH infections among school-age children, particularly for Ascaris lumbricoides and hookworm species. Despite albendazole's broad-spectrum anti-helminthic activity, concerns about drug resistance and re-infection persisted. The current treatment strategy should be reviewed to accommodate preschoolers and adults in prevention and control implementation programs.

**Keywords:** efficacy, albendazole, soil-transmitted helminths, mass drug administration.

**INTRODUCTION**

The major soil-transmitted helminths that infect humans are the roundworms, whipworms and hookworms. Soil-transmitted helminth infections rank among the most important neglected tropical diseases in terms of morbidity, and almost one billion people are still infected with at least one species (Loukas et al., 2021). Soil-transmitted helminths (STHs) are parasitic intestinal worms that are transmitted to humans through contaminated soil via the faecal-oral route or skin penetration infection (WHO, 2022). The three major species infecting humans belong to the phylum Nematoda, commonly referred to as roundworms. They include the *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), and *Necator americanus* and *Ancylostoma duodenale* (two species of hookworm). They are considered neglected tropical diseases and are among the most widespread infections worldwide, affecting the poorest and most deprived communities of the tropical and subtropical regions (USAID, 2023). Infection occurs by ingestion of infective eggs from soil contaminated with human faeces and ingestion of raw agricultural products, as in the case of *Ascaris lumbricoides* and *Trichuris trichiura,* or by skin penetration of the larva, as seen with hookworms in areas with poor sanitation systems. Soil-transmitted helminths depend on environments contaminated with egg-carrying faeces for transmission. Consequently, helminths are intimately associated with poverty, poor sanitation and lack of clean water. The two most important environmental factors are climate and soil conditions, as STH larvae predominantly develop in tropical and sub-tropical climates, with warm temperatures, high humidity and moist soils. Unhygienic sanitation, inadequate water supply and the use of untreated night soil fertiliser are man-made environmental factors favouring STH’s transmission (Ndamukong-Nyanga et al., 2023; Joël et al., 2020). Infection is most common among school-aged children (5-14 years) mainly due to lack of basic sanitation and access to clean water, leading to the persistence of these infections. About 1.5 billion people are infected throughout the globe with at least one species of STHs, with 800 million children at risk of infection, with a mortality range of 12,000 to 135,000 (Oyeyemi and Okunlola, 2023). The burden of STH infections includes anaemia, dietary deficiencies physical and mental retardation in growing children, and reduced work performance in adulthood. STHs are disproportionately prevalent in many countries of sub-Saharan Africa, especially Nigeria and others, where moderate to heavy-intensity infections are predominant (Sartorius et al, 2021).

The recommendation by the WHO is periodic medicinal treatment (deworming or preventive chemotherapy) without a previous individual diagnosis for all at-risk people living in

endemic areas (WHO, 2022). The recommended medicines for the treatment of STHs are benzimidazoles such as albendazole. The specific objectives include; to determine the baseline prevalence and intensity of STH infections among primary school-age children in Ikyogen, Kwande LGA, to assess the effectiveness of albendazole mass drug administration in reducing the prevalence and intensity of STH infection and to evaluate the short-term impact of albendazole treatment on the re-infection rate among school-age children. School-aged children who did not have prior knowledge about soil-transmitted helminth infections, the habit of drinking water without boiling, open defecation, use of pit latrine, and children who did not have toilet facilities in school were significantly associated with soil-transmitted helminthiasis (Imalele et al., 2023). Albendazole is the most widely used drug in preventive chemotherapy programs (Montresor et al, 2020), as a single-dose regimen due to its cost-effectiveness, ease of administration by non-medical personnel and minor side effects of the drug which acts by inhibiting tubulin polymerization, leading to worm paralysis and death (WHO, 2021).

However, a recent meta-analysis showed a decreasing efficacy of albendazole against soil-transmitted helminths, both with pooled cure rates (CR) and egg reduction rates (ERR), most especially against Trichuris trichiura, with rates of 30.7% and ERRs of 89.6% (Montresor et al, 2020). Furthermore, there are primary concerns about the potential for albendazole resistance, which is already well established in livestock populations, to emerge in humans as soil-transmitted helminths control programs continue to be scaled up worldwide (Montresor et al, 2020).

**METHODS**

**Study Design, Settings, and Population**

This prospective, observational efficacy surveillance of single-dose albendazole, which was given through a mass drug administration (MDA) campaign, was conducted from April to May 2024. The study populations were eligible and STH-infected school children aged 5–14 years attending primary schools in the rural area of Ikyogen IDP camp, Kwande Local Government Area of Benue State.

Ikyogen is one of the four major towns in the Kwande Local Government Area of Benue State, sharing boundaries with the Republic of Cameroon and Cross River State of Nigeria. With GPS coordinates: 6.6903o N, 9.4374O E, it has an estimated population of 345,850 according to the 2006 census (City Population, 2024). The predominant occupation is farming of crops such as cassava, soya beans, mango and groundnuts and the IDP camp houses over 13,000 people, who are mainly Cameroonian refugees (Ofoezi, 2011). The camp was formerly Ikyogen Cattle Ranch in the southeast of Adikpo, in Kwande LGA of Benue State. The camp is eclipsed by the ever-breathtaking Mount Vandetum and immersed by the Avenga stream (Ofoezi, 2011).

SAMPLING TECHNIQUE

A simple random sampling method was used to select the pupils to participate in the study. An up-to-date list from the community health registers at the IDP camp was used to create a sample frame, and a random number was used to select the desired number of children from the sampling frame. Each child's name had an equal probability of being chosen for the study. Once the sample was selected, the parents /caregivers of the chosen children were contacted to obtain consent for their participation in the study. After the consent was obtained, the questionnaire was administered, followed by stool sample collection for onward processing, albendazole administered under direct supervision by the team and subsequent follow-up assessments after 21 days to re-evaluate the outcomes.

STUDY INSTRUMENTS

The study instruments that will be used are questionnaires, observations, weighing scales and stadiometer, and laboratory tests.

Inclusion Criteria

Primary school-age children, from 5-to 14-year age group. Primary school-age children who have lived in the area for at least one year primary school-age children whose parents or caregivers gave consent.

Exclusion Criteria

Anyone who was below 5 years or above 14 years of age. Those children who had not lived in the area for up to a year. Basic school children whose parents or caregivers do not give consent. School children with other suspected co-morbidities like lymphatic filariasis, etc. Children with diarrhoea. Children vomiting within 4 hours after drug administration.

SAMPLE SIZE DETERMINATION

The minimum sample size of the population to which the questionnaire was administered and calculated as follows using the formula below (Gebreyesus et al.*,* 2024)

N = $\frac{Zα2 pq}{d2}$

which corresponds to 0.05

Where: n minimum sample size

Zα = 1.96, the critical ratio or Standard normal deviation at a significance level of 5%

P = prevalence of soil-transmitted helminths Ile-Ife, Ibadan, Nigeria15 (p = 7.1) q = 1-p = complementary probability of p

d = the desired precision of the study; a precision of 5% was tolerated

N = $\frac{1.962 x 0.071 x 0.929}{0.052}$

N = 101

A non-response rate of 10% was added (minimum sample size = N/1-f) where f is 10%; 101/1-0.1 = 101/0.9 = 112

Hence, the minimum sample size required for the study was 112.

Sample Collection

Children with informed consent were provided with a stool sample collecting container, a wide mouth, and a screw cap plastic bottle with instructions on how the stool should be collected and a part of it being transferred to the container without urine contamination. The specimen was approximately 10g of faeces. Children who were too young were assisted by trained personnel in specimen collection. Each child who returned the faecal specimen was identified on a form (Appendix 1) which clearly states the names and a serial number assigned to it to identify the specimen.

**Drug Administration**

A light snack (a biscuit/slice of bread) was given to each child before the drug, a chewable albendazole tablet of 400mg, based on the height of the children (≥ 94 cm dose pole, designed to deliver a dose of at least 40 mg/kg) single was administered. The tablet was ingested under the direct observation of the investigator, and the child was maintained under observation for approximately 4 hours. Any side effects reported to the members of the investigation team. Any child who vomited after drug administration was excluded from the analysis because the precise amount of albendazole consumed was unknown.

**Parasitological Examination Laboratory Methods**

Specimens were examined by Kato-Katz thick smear quantitative parasitological method (Appendix 2) to determine the number of parasitic eggs per gram of faeces (WHO, 2014). The slides were read within 60 minutes after preparation to avoid the disappearance of hookworm eggs.

**Quality Control**

In order to ensure the accuracy of the egg counts, quality control was performed on a number of slides randomly selected by an expert microscopist.

**Follow-up Survey**

An interval of 21 days after the treatment was observed before the collection of the follow-up sample/data was employed. Only children who had a positive specimen at baseline were provided a second specimen after 21 days. Children who were not at home on the follow-up day or did not bring a specimen were followed up 1 or 2 days later. The laboratory method used in the baseline survey was also used in the follow-up. That was to assess albendazole efficacy following the WHO guidelines (WHO, 2014).

RESULTS

When the stool sample was collected, a total of 289 samples were collected, 280 children had no diarrhoea, while 9 children had ,diarrhoea showing a 96.9% and 3.11% respectively

At baseline, the prevalence of Ascaris lumbricoides, hookworms, and Trichuris trichiura was 61.61%, 38.39%, and 3.57%, respectively. The children who took albendazole/antihelmintics (other drugs) in the past 6 months were 112, while 172 did not, and 5 of the children did not know, representing 39%, 59.3% and 1.7% respectively (Refer to Table 1- Stool Data Collection Table).

**Table 1- Stool Data Collection :Distribution of diarrhoea and post-antihelmintic intake among participants**

|  |  |  |
| --- | --- | --- |
| **The child has diarrhoea** | **Frequency** | **Percentage (%)** |
|  |  |  |
| NO | 280 | 96.9% |
| The child take other drug(s)in the past 6 months |  |  |
| YES | 112 | 39% |
| NO | 172 | 59.3% |
| I DON’T KNOW | 5 | 1.7% |

All the children swallowed the drug (Albendazole) under direct supervision (100%), and there was no episode of vomiting following the administration of the drug (0%). The baseline biophysical characteristics of the study participants showed that 65 males and 47 female children, representing 58.03% and 41.96% respectively, were involved in the study.

The age categories of the children, 5-9 years were 72 and 10-14 years were 40, representing 64.29 and 35.71% respectively.

A total of 289 children were eligible for the administration of albendazole. One hundred and twelve (112) children tested positive to at least one type of soil-transmitted helminth infection (had STH infection and taken as the sample size) while 186 were negative, indicating that 39% of the participants tested positive for the infection (sample size), 61% tested negative to any soil transmitted helminths- Refer to Figure 1.

**Figure 1: Prevalence Distribution Chart**

The pie chart shows the percentage prevalence of STH (Soil-Transmitted Helminth) infection.

The parasite intensity distribution showed that 32 children had light hookworm infection while 7 of them had moderate hookworm infection, with none of them having heavy infection, with a total of 43children infected with hookworm. The study also showed that 56 children had light Ascaris lumbricoides infection, and 13 of them had moderate infection, with none having heavy infestation, with a total of 69 children infected with Ascaris lumbricoides. For Trichuris trichiura infection intensity, 4 children had light infection with no moderate or heavy infection noted- Refer to Table 2.

**Table 2- Parasite Intensity Distribution**

|  |  |  |
| --- | --- | --- |
| **Parasites** | **Intensity** | **Distribution** |
| HOOKWORM | Light | 32 |
|  | Moderate | 7 |
| Heavy | 0 |
|  | **43** |
| *Ascaris lumbricoides* | Light | 56 |
|  | Moderate | 13 |
| Heavy | 0 |
|  | **69** |
| *Trichuris Trichiuria* | Light | 4 |
|  | Moderate | 0 |
| Heavy | 0 |
|  | **04** |

There were different soil-transmitted infections co-infecting with others, as there were 13 hookworm co-infections with *Ascaris lumbricoides* or *Trichuris trichiura,* and 26 had no co-infection among those infected with hookworms. There were 21 children with *Ascaris lumbricoides* infection co-existing with hookworms or Trichuris trichiura infection, and 48 children had no co-infection with any other STHs. *Trichuris trichiura* co-infection with hookworm or *Ascaris lumbricoides* was 4, with no infection existing alone without other STHs.

**Table 3-Different STHs and Their co-infection with others.**

|  |  |  |  |
| --- | --- | --- | --- |
| HELMINTHS | CO-INFECTION | NUMBERCO-INFECTED | PERCENTAGE (%) |
| Hookworms | Co-infection with*Ascaris lumbricoides*or *Trichuris trichiura* | 13 | 11.6% |
| No Co-infection | 26 | 23.2% |
| *Ascaris lumbricoides* | Co-infection withHookworms or*Trichuris trichiura* | 21 | 18.8% |
| No Co-infection | 48 | 42.9% |
| *Trichuris trichuria* | Co-infection with Hookworms or *Ascaris**lumbricoides* | 4 | 3.5% |
| No Co-infection | 0 | 0.0% |

The prevalence of soil-transmitted helminthic infections before and after albendazole treatment, for *Ascaris lumbricoides*, the baseline before treatment was 61.61% and after treatment it was 20.53%. The baseline for hookworm was 38.39% and was 11.60% after 21 days post-treatment. The *Trichuris trichiura* baseline before albendazole administration was 3.57% and post-treatment after 21 days was 0.00%.

The intensity of infections (Mean Eggs per Gram of Faeces) for *Ascaris lumbricoides* had a baseline of 429, 349 but reduced to 106, 302 after 21 days post-treatment. Hookworm intensity at baseline was 29,973, and after 21 days post-treatment was 4,485. The *Trichuris trichiura* was at baseline 854, but after treatment was 0 (zero).

*Ascaris lumbricoides* was the most prevalent parasite at the baseline, with 61.61% of participants infected. After 21 days of treatment with albendazole, the prevalence significantly dropped to 20.53%. Hookworm infected 38.39% of individuals at baseline, and the prevalence decreased to 11.60%. *Trichuris trichiura* was present in 3.57% of participants at baseline, but it was eliminated post-treatment with a prevalence of 0.00% (0/112). For *Ascaris lumbricoides*, the intensity of infection dropped significantly from 429,349 EPG at baseline to 106,032 EPG after treatment. Hookworm intensity also saw a sharp decline from 29,973 EPG to 4,485 EPG post-treatment. *Trichuris trichiura* started with a low intensity of 854 EPG at baseline and was completely eradicated after treatment, with no eggs detected post-treatment.

**Table 4- The Short-Term Impact of Albendazole Treatment on the Re-Infection Rate Among Participants**

|  |  |  |
| --- | --- | --- |
| **Parasite Species** | **Baseline (n=112)** | **21 Days Post-Treatment (n= 112)** |
| *Ascaris lumbricoides* | 61.61% (69/112) | 20.53% (23/112) |
| Hookworm | 38.39% (43/112) | 11.60% (13/112) |
| *Trichuris trichiura* | 3.57% (04/112) | 0.00% (0/112) |

This data shows the short-term impact of the treatment, especially in reducing the intensity of infections and eliminating *Trichuris trichiura* completely. However, *Ascaris lumbricoides* and Hookworm infections persisted in a smaller proportion of the population, however, with reduced intensity.

DISCUSSIONS

The findings provide valuable insights into the local epidemiology of STH infections and the efficacy of albendazole administration in the treatment of STH infections among school-aged children.

At baseline, the prevalence of *Ascaris lumbricoides*, hookworms, and *Trichuris trichiura* was 61.61%, 38.39%, and 3.57%, respectively. This high baseline prevalence of Ascaris lumbricoides aligns with studies from other regions in Nigeria and Sub-Saharan Africa, where Ascaris tends to be the most dominant species among STH infections. For instance, a study conducted by Schüle et al. (2014) in Nigeria reported the prevalence of Ascaris lumbricoides as high as 62.5%, correlating with the findings of this study. *Trichuris trichiura* was less prevalent in this study (3.57%) compared to *Ascaris lumbricoides* and hookworm, which is also in tandem with findings from other studies where *Trichuris trichiura* is less commonly isolated in endemic areas (Gyokors et al., 2019).

After 21 days of Post-treatment with albendazole, the prevalence of Ascaris lumbricoides and Hookworm reduced significantly to 20.53% and 11.60%, respectively, while Trichuris trichiura was entirely eradicated (0.00%). This shows the high efficacy of albendazole, particularly against Trichuris spp., which has been shown in previous studies to be less responsive to single-dose albendazole treatments. The marked reduction in prevalence post-treatment aligns with the findings of Tee et al (20), who reported similar declines in STH prevalence following albendazole administration in rural Malaysia.

Regarding the intensity of these infections, the results indicated that *Ascaris lumbricoides* was the most intense of the infections, with a mean egg count of 429,349 EPG at baseline, followed by hookworm (29,973 EPG) and *Trichuris trichiura* (854 EPG). Following the administration of albendazole treatment, the intensity of infections decreased drastically, with *Ascaris lumbricoides* reducing to 106,032 EPG, hookworm to 4,485 EPG, and *Trichuris trichiura* being completely eradicated. This considerable reduction in intensity highlights the short-term impact of albendazole in reducing the morbidity associated with heavy STH infections.

The cure rates for *Ascaris lumbricoides* and hookworm in this study were 66.7% and 53.49% respectively. This aligns with previous studies that have reported cure rates between 50% and 70% for *Ascaris lumbricoides* and hookworm following a single dose of albendazole. The 100% cure rate for *Trichuris trichiura* is notable, especially considering that Trichuris is generally less responsive to albendazole. Another study by Soukhathammavong et al. (2015), in Lagos, reported a similar trend, with albendazole demonstrating higher cure rates against Trichuris trichiura when used in combination with other anthelmintics.

The egg reduction rate (ERR) as seen in the current study was also substantial, with Ascaris achieving a 75.3% ERR, hookworm achieving an 84.7% ERR, and Trichuris a 100% ERR. These ERR values are consistent with those reported by Ouédraogo et al. (2016), in Burkina Faso, who also found ERRs for *Ascaris lumbricoides* and hookworm to be above 70%, each confirming albendazole’s efficacy in reducing worm burdens and transmission potential. The high ERR for Trichuris is unusual and may have been influenced by the low baseline intensity of infections, as well as the specific environmental factors in the study area.

However, despite the success of the treatment in reducing STH prevalence and intensity, the persistence of some infections, particularly *Ascaris lumbricoides* and hookworm, shows that possible reinfection and drug resistance are a concern in endemic areas. This indicates the need for repeated mass drug administration (MDA) programs and complementary public health measures, such as improved sanitation and personal and environmental hygiene education, to sustain the advantages achieved by treatment.

Based on the WHO efficacy standards for soil-transmitted helminths, the reported cure rates of 66.7% for Ascaris lumbricoides and 53.49% for hookworm fall significantly below the WHO thresholds of ≥95% and ≥90% respectively, indicating potential reduced efficacy of albendazole treatment, while the 100% cure rate for Trichuris trichiura exceeds the WHO benchmark of ≥50%, demonstrating effective treatment for this particular species.

However, some differences in cure rates and ERRs have been observed in studies from different regions. For instance, Jia et al. (2021), in China, reported higher cure rates for *Ascaris lumbricoides* but lower ERRs for hookworm, which could be attributed to geographical and environmental differences that affect transmission dynamics and treatment efficacy.

CONCLUSION

This study offers valuable insights into the epidemiology of soil-transmitted helminth (STH) infections and the short-term impact of albendazole treatment in Ikyogen, Kwande LGA. The research underscores the significant efficacy of albendazole in reducing both the prevalence and intensity of STH infections among school-age children, particularly for Ascaris lumbricoides and hookworm species. The observed 100% cure rate and egg reduction rate for Trichuris trichiura is especially promising, although further investigation is needed.

However, the study also reveals significant challenges in STH control. The high baseline prevalence and rapid reinfection rates, especially for A. lumbricoides, underscore the need for integrated control strategies that go beyond periodic deworming. This highlights the importance of sustained mass drug administration (MDA) programs along with improvements in sanitation and hygiene to prevent reinfection and maintain the progress achieved by treatment.

The species-specific and time-dependent patterns observed in this comprehensive, quantitative assessment provide valuable insights for tailoring STH control strategies. These findings can help guide decisions regarding appropriate intervals for MDA programs and emphasise the necessity of a multifaceted approach to STH control that addresses both immediate treatment and long-term prevention.

Lastly, while albendazole shows significant short-term efficacy, the persistence of infections in some individuals and the potential for rapid re-infection underscore the need for ongoing research and integrated interventions to achieve sustainable reductions in STH prevalence and intensity in endemic areas.

Consent

Once the sample was selected, the parents /caregivers of the chosen children were contacted to obtain consent for their participation in the study. After the consent was obtained, the questionnaire was administered

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