

## Original Research Article

# EFFICACY OF ANTHELMINTIC DRUGS IN SCHOOL GOING CHILDREN: AN INTERVENTIONAL STUDY

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**ABSTRACT**

**Background:** Intestinal helminth infections continue to pose a significant public health challenge among school-going children, adversely affecting growth, nutrition, and cognitive development. Periodic deworming with albendazole remains a cornerstone of control programs, though treatment outcomes are influenced by environmental and behavioral factors. The objective is to assess age- and sex-wise distribution of intestinal helminth infection, evaluate prevalence in relation to sociodemographic and environmental factors, determine the efficacy of albendazole, and quantify parasitic load before and after treatment.

**Materials and Methods:** An interventional school-based study was conducted among 410 children aged 5–18 years in rural and urban areas of Bareilly district. Stool samples were examined using standard microscopic and egg-counting techniques. Infected children received a single supervised dose of albendazole (400 mg), with follow-up stool examination after 10–14 days.

**Results:** The prevalence of intestinal helminth infection was 37.1%. Infection was not significantly associated with age or sex but showed strong associations with open defecation and barefoot walking. Albendazole achieved an overall cure rate of 90.8%, with highest efficacy against *Ascaris lumbricoides* (94.9%), followed by hookworm (87.5%) and *Trichuris trichiura* (83.9%), accompanied by substantial reductions in mean egg counts. Treatment outcomes were significantly better among children using sanitary latrines, wearing footwear, and residing in urban areas.

**Conclusion:** Single-dose albendazole is highly effective in school-aged children, and its impact is enhanced by improved sanitation and hygiene practices.

**Keywords:** Intestinal helminthiasis, Albendazole, School children, Cure rate, Sanitation.

**INTRODUCTION**

Soil-transmitted helminth (STH) infections remain among the most prevalent neglected tropical diseases worldwide, disproportionately affecting children living in low- and middle-income countries. These infections are primarily caused by *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms, and they contribute significantly to morbidity rather than mortality. A comprehensive systematic review and network meta-analysis demonstrated that although currently recommended anthelmintic drugs such as albendazole and mebendazole are

widely used, their efficacy varies considerably depending on parasite species, intensity of infection, and local epidemiological factors, raising concerns about suboptimal treatment outcomes in endemic regions.<sup>[1]</sup> School-going children are particularly vulnerable to helminth infections due to frequent exposure to contaminated soil, inadequate sanitation, and limited access to health education. A prospective cohort study from Rwanda evaluating single-dose albendazole among school children showed variable cure rates across different helminth species, highlighting the need for continuous evaluation of drug performance in real-world

settings.<sup>[2]</sup> These findings emphasize that while mass drug administration remains a cornerstone of control strategies, treatment efficacy cannot be assumed to be uniform across populations. The burden of STH infections among school-aged children is further influenced by environmental, behavioral, and socioeconomic determinants. Evidence from northwestern Ethiopia has shown a high prevalence of helminth infections among schoolchildren, with risk factors such as poor hygiene practices, lack of latrine access, and unsafe water sources playing a significant role in sustained transmission.<sup>[3]</sup> Such contextual factors may also influence treatment response and reinfection rates, underscoring the importance of region-specific interventional studies. Beyond parasitological outcomes, helminth infections have important clinical implications. Studies conducted among primary school children in northeastern Nigeria have documented a wide range of clinical manifestations, including abdominal pain, diarrhea, malnutrition, and anemia, with infection intensity closely correlating with symptom severity.<sup>[4]</sup> These clinical consequences can adversely affect physical growth, cognitive development, and academic performance, reinforcing the need for effective therapeutic interventions in this age group.

Accurate diagnosis and appropriate treatment are critical for successful helminth control. Current diagnostic approaches and treatment protocols, as outlined in pharmaceutical and clinical literature, rely heavily on benzimidazole derivatives due to their broad spectrum of activity, favorable safety profile, and low cost.<sup>[5]</sup> However, emerging concerns regarding reduced drug sensitivity and inconsistent efficacy necessitate ongoing monitoring and evaluation of these agents, particularly in endemic school settings. Large-scale school-based deworming programs have demonstrated substantial benefits in reducing helminth prevalence and intensity. Data from Kenya's national deworming programme over a five-year period revealed significant declines in STH infections and schistosomiasis following repeated rounds of mass drug administration.<sup>[6]</sup> Despite these successes, variations in treatment response and persistence of infection in certain subgroups indicate that programmatic coverage alone may not fully address efficacy-related challenges. Compliance and feasibility of school-based interventions are also critical determinants of success. Recent evidence from Bangladesh assessing school-based health interventions showed that structured programs can significantly improve compliance with mass drug administration, thereby enhancing overall treatment effectiveness.<sup>[7]</sup> These findings suggest that drug efficacy must be interpreted in conjunction with implementation strategies and adherence patterns.

In addition to programmatic factors, drug quality and formulation may influence therapeutic outcomes. An assessment of two commonly used albendazole brands in Ethiopia demonstrated

differences in efficacy against STH infections among school children, highlighting the potential impact of pharmaceutical quality on treatment success.<sup>[8]</sup> Such observations underscore the importance of evaluating not only drugs themselves but also their formulations in real-world use. Methodological advancements in measuring anthelmintic efficacy have further refined our understanding of treatment response. Novel parasitological assessment approaches have been proposed to capture more accurate efficacy estimates, particularly in pediatric populations with schistosomiasis and other helminth infections.<sup>[9]</sup> These approaches may be valuable in strengthening interventional studies focused on school-aged children. Importantly, anthelmintic treatment has benefits beyond parasite clearance. Studies from northwestern Ethiopia have shown that effective treatment of helminth infections in school-age children leads to improvements in hemoglobin levels and reductions in helminth-related anemia.<sup>[10,11]</sup> This highlights the broader public health impact of efficacious deworming interventions.

Randomized controlled trials evaluating drugs such as praziquantel and ivermectin in children have further contributed to understanding age-specific efficacy and safety profiles.<sup>[12,13]</sup> Additionally, systematic reviews have emphasized that drug combinations may offer improved efficacy against certain STH species compared to monotherapy.<sup>[14]</sup> Variability in diagnostic methods has also been shown to influence measured treatment outcomes, as demonstrated by comparative diagnostic studies in pediatric populations.<sup>[15]</sup> Evidence from India, including studies from East Sikkim, confirms that despite ongoing deworming efforts, STH infections persist among school-going children, and continuous assessment of albendazole efficacy remains necessary.<sup>[16]</sup> Collectively, these findings highlight the need for localized interventional studies to evaluate anthelmintic drug efficacy under specific epidemiological and programmatic conditions. The present study aims to address this need by assessing the efficacy of anthelmintic drugs among school-going children in an interventional framework.

## MATERIALS AND METHODS

**Study Design:** An interventional study was conducted.

**Study Setting:** The study was carried out in schools located in the Bareilly district of Uttar Pradesh (U.P.), India.

**Sample size:** 410

**Inclusion Criteria**

All children meeting the following criteria were included in the study:

1. Children aged between 5 and 18 years.

- Children who had not used any anthelmintic medication within six months prior to the commencement of the study.

#### Exclusion Criteria

The following children were excluded from the study:

- Children suffering from diarrhoea or dysentery.
- Children with a history of allergy to anthelmintic medication (albendazole).

**Methodology:** The study was initiated following approval from the Institutional Ethics Committee of Rohilkhand Medical College and Hospital, Bareilly. Multistage sampling was employed to select study participants from both urban and rural areas of Bareilly.

**Stage 1** – Selection of Study Population Distribution: Considering the school infrastructure in Bareilly district, 70% of participants (287) were selected from rural areas and 30% (123) from urban areas across each block of the district.

**Stage 2** – Selection of Rural and Urban Areas and Schools (Probability Proportion to Size Sampling): From both urban and rural regions, 10% of blocks were randomly selected. Subsequently, 10% of villages (rural) and mohallas (urban) were chosen. Similarly, 10% of schools were randomly selected from the list provided by the District Education Officer (DEO) in both rural and urban areas.

**Stage 3** – Selection of Study Participants (Simple Random Sampling): From the list of students in each selected school, participants were chosen using a simple random sampling (lottery) method, based on willingness to participate.

During school visits, students and their guardians were counseled regarding stool examinations. Stool samples were collected after obtaining informed consent, and a pre-validated, pre-tested pro forma was completed. The samples were processed immediately and examined using concentration

techniques (formalin-ether concentration) and microscopic methods (saline and iodine mount).

Stoll's egg counting method was used to evaluate the stool samples. Children infected with soil-transmitted helminths were administered a single supervised oral dose of albendazole (400 mg tablet or syrup). A follow-up stool sample was collected 10–14 days after drug administration. The total egg count was determined using Stoll's egg counting method, and the fecal egg count reduction test was used to assess the egg reduction rate.

**Consent:** Written informed consent was obtained from the guardians of all enrolled children in a language they could understand. Anonymity was offered as optional, and confidentiality was assured throughout the study.

**Statistical Analysis:** The collected data were coded, compiled, and analyzed using Microsoft Excel.

- Appropriate statistical tests were applied according to the type and distribution of the data.
- Results were presented in the form of tables and figures.
- A p-value less than 0.05 was considered statistically significant.

## RESULTS

The study comprised 410 school-going children, of whom 287 (70.0%) were from rural areas and 123 (30.0%) from urban areas. The largest proportion of participants belonged to the 9–11-year age group (115; 28.0%), followed by 12–14 years (108; 26.3%), 5–8 years (102; 24.9%), and 15–18 years (85; 20.7%). There was a near-equal gender distribution, with 216 males (51.7%) and 194 females (47.3%). Overall, 152 children (37.1%) were found to have intestinal helminth infection, while 258 (62.9%) were uninfected, reflecting a moderate prevalence of intestinal helminthiasis in the study population.

**Table 1: Environmental characteristics distribution of participants (n=410)**

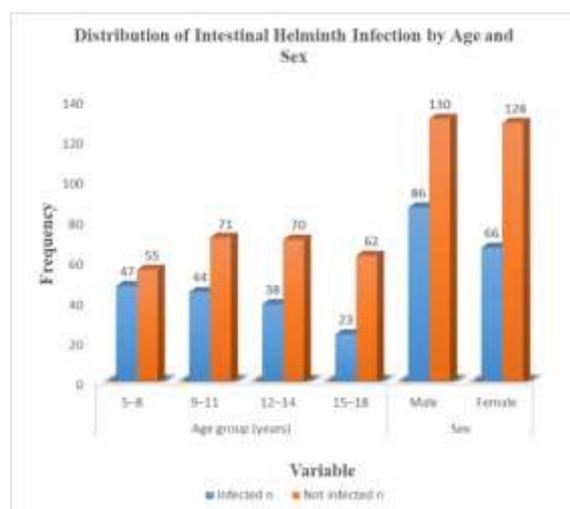
Parameters	Frequency	Percentage
Type of housing		
Pucca	244	59.5
Kutchha	166	40.5
Source of drinking water		
Government supply	238	58
Sanitary well/ tap	101	24.6
Pond/river	71	17.3
Sanitation		
Sanitary latrine	368	89.8
Open defecation	42	10.2
Barefoot walking habit		
Yes	173	42.2
No	237	57.8

In [Table 1], the environmental characteristics of the study population showed that 244 children (59.5%) resided in pucca houses, while 166 (40.5%) lived in kutchha houses. The primary source of drinking water was government supply for 238 participants (58.0%), followed by sanitary wells or taps for 101

(24.6%), and pond or river water for 71 (17.3%). In terms of sanitation practices, the majority of children 368 (89.8%) reported using sanitary latrines, whereas 42 (10.2%) practiced open defecation. Regarding behavioral factors, 173 children (42.2%) reported a habit of walking

barefoot, while 237 (57.8%) wore footwear regularly.

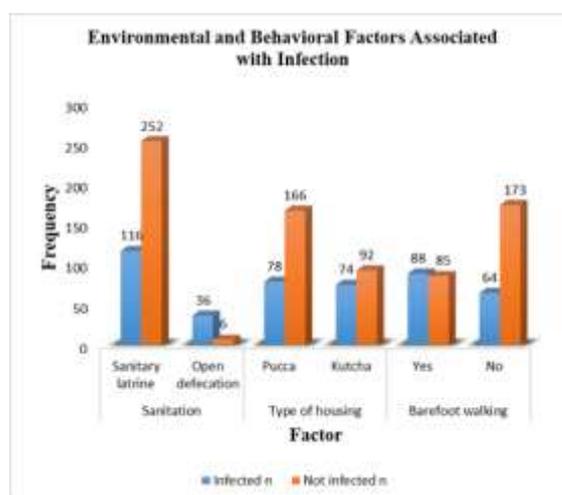
In [Figure 1], Intestinal helminth infection was distributed across all age groups, with the highest proportion observed in children aged 5–8 years (47; 30.9%), followed by those aged 9–11 years (44; 28.9%), 12–14 years (38; 25.0%), and 15–18 years (23; 15.1%); however, the differences in infection distribution across age groups were not statistically significant ( $p = 0.726$ ). With respect to sex, 86 males (56.6%) and 66 females (43.4%) were infected, while 130 males (50.4%) and 128 females (49.6%) were not infected, indicating a slightly higher proportion of infection among males, though this difference was also not statistically significant ( $p = 0.726$ ).



**Figure 1: Distribution of Intestinal Helminth Infection by Age and Sex (n = 410)**

In [Figure 2], a significant association was observed between sanitation practices and intestinal helminth infection, with 36 children (23.7%) practicing open

defecation being infected compared to 6 (2.3%) who were not infected, while among those using sanitary latrines, 116 (76.3%) were infected and 252 (97.7%) were not infected, and this difference was statistically significant ( $p < 0.001$ ). Regarding housing type, 74 infected children (48.7%) resided in kutcha houses compared to 92 (35.7%) uninfected children, whereas 78 infected (51.3%) and 166 uninfected (64.3%) children lived in pucca houses; however, this association was not statistically significant ( $p = 0.076$ ). Barefoot walking showed a significant relationship with infection status, as 88 infected children (57.9%) reported walking barefoot compared to 85 (32.9%) among the non-infected group, while 64 infected (42.1%) and 173 non-infected children (67.1%) reported wearing footwear, with the difference being statistically significant ( $p = 0.011$ ).



**Figure 2: Environmental and Behavioral Factors Associated with Infection (n = 410)**

**Table 2: Overall and Determinants of Albendazole Treatment Efficacy (n = 152)**

Variable	Category	Infected	Cured	Cure rate (%)	p-value
Overall		152	138	90.8	
Age group	5–8 yrs	47	41	87.2	0.189
	9–11 yrs	44	41	93.2	
	12–14 yrs	38	36	94.7	
	15–18 yrs	23	20	87.0	
Sex	Male	86	78	90.7	0.964
	Female	66	60	90.9	
Residence	Rural	108	96	88.9	0.041*
	Urban	44	42	95.4	
Housing	Pucca	78	72	92.3	0.058
	Kutcha	74	66	89.2	
Sanitation	Sanitary latrine	116	110	94.8	<0.001*
	Open defecation	36	28	77.8	
Barefoot walking	Yes	88	74	84.1	<0.001*
	No	64	64	100	

In [Table 2], albendazole administration, 138 out of 152 infected children were cured, resulting in an overall cure rate of 90.8%. Cure rates across age groups ranged from 87.2% in children aged 5–8 years (41/47) and 87.0% in those aged 15–18 years

(20/23) to 93.2% in the 9–11 years group (41/44) and 94.7% in the 12–14 years group (36/38), with no statistically significant difference ( $p = 0.189$ ). Treatment response was comparable between sexes, with cure rates of 90.7% in males (78/86) and 90.9%

in females (60/66) ( $p = 0.964$ ). A statistically significant difference in efficacy was observed by residence, with urban children showing a higher cure rate (95.4%; 42/44) compared to rural children (88.9%; 96/108) ( $p = 0.041$ ). Housing type did not significantly influence treatment outcome, as cure rates were 92.3% (72/78) in pucca houses and 89.2% (66/74) in kutcha houses ( $p = 0.058$ ). In contrast, sanitation and barefoot walking habits

showed a strong association with treatment efficacy, with children using sanitary latrines achieving a significantly higher cure rate (94.8%; 110/116) compared to those practicing open defecation (77.8%; 28/36) ( $p < 0.001$ ), and children who consistently wore footwear attaining a 100% cure rate (64/64) versus 84.1% (74/88) among those who walked barefoot ( $p < 0.001$ ).

**Table 3: Efficacy of anti-helminth treatment after follow-up (n=152)**

Parasite	Infected	Cured	Cure rate (%)	Mean egg count baseline	Mean egg count at follow-up
Ascaris lumbricoides	78	74	94.9	10420±2840	510±220
Trichuris trichiura	31	26	83.9	4230±1120	690±240
Hookworm	32	28	87.5	3760±960	450±180
Mixed infection	11	10	90.9	-	-
Total	152	138	90.8	-	-

In [Table 3], albendazole therapy, 138 of the 152 infected children were cured, resulting in an overall cure rate of 90.8%. The highest efficacy was observed against *Ascaris lumbricoides*, with 74 of 78 children cured (94.9%), accompanied by a marked reduction in mean egg count from 10,420 ± 2,840 at baseline to 510 ± 220 at follow-up. For *Trichuris trichiura*, 26 of 31 children were cured (83.9%), with the mean egg count declining from 4,230 ± 1,120 to 690 ± 240, while hookworm infection showed a cure rate of 87.5% (28/32) and a reduction in mean egg count from 3,760 ± 960 to 450 ± 180. Mixed infections demonstrated a high cure rate of 90.9% (10/11). Overall, the findings indicate substantial effectiveness of albendazole in reducing both infection prevalence and parasitic load among the treated children.

## DISCUSSION

The present study, conducted among 410 school-going children with a rural predominance (70.0%), demonstrated a moderate overall prevalence of intestinal helminth infection of 37.1%, with near-equal gender distribution and maximal representation in the 9–11-year age group. A broadly comparable burden of helminth infection among school-aged children has been documented in large programmatic and community-based settings, where school-based deworming has been shown to substantially reduce prevalence over time, as reported by Mwandawiro et al. (2019),<sup>[6]</sup> who observed a baseline STH prevalence of 32.3% prior to repeated mass drug administration. Similarly, the age-wide distribution of infection without marked sex predilection aligns with observations from Kabatende et al. (2023),<sup>[2]</sup> where infection affected children across the 5–15-year range, and treatment response was not primarily driven by sex. The absence of statistically significant differences in infection prevalence across age groups ( $p = 0.726$ ) and between males and females ( $p = 0.726$ ) in the present study is also consistent with Tesfie et al.

(2020),<sup>[17]</sup> who reported no significant association of treatment outcomes with age or sex. Environmental and behavioral characteristics in this study, including substantial use of sanitary latrines (89.8%) and government water supply (58.0%), provide a plausible explanation for the moderate prevalence observed and parallel protective factors such as footwear use and access to sanitation highlighted by Khan et al. (2025).<sup>[18]</sup> In contrast, studies from settings with higher baseline transmission, such as the very high pre-treatment prevalence reported by Tesfie et al. (2020),<sup>[17]</sup> demonstrate markedly greater infection burdens, underscoring geographic and ecological heterogeneity. Notably, the relatively high proportion of children residing in pucca houses and the high latrine coverage in the present study represent contextual findings unique to this population and likely contributed to the lack of significant age- or sex-based differences in infection distribution. A strong and statistically significant association between environmental and behavioral factors and intestinal helminth infection, with open defecation ( $p < 0.001$ ) and barefoot walking ( $p = 0.011$ ) markedly increasing infection risk, while housing type showed no significant association ( $p = 0.076$ ). Similar patterns emphasizing sanitation and hygiene as key determinants have been reported in community and school-based settings, where behavioral and environmental exposures substantially influence transmission dynamics, as highlighted by Khan et al. (2025),<sup>[18]</sup> who identified footwear use, access to washrooms, and safe water as protective factors against ascariasis. Comparable findings supporting the role of sanitation-linked interventions in reducing helminth burden were also evident in large-scale programmatic evaluations, such as Mwandawiro et al.,<sup>[6]</sup> (2019) where sustained school-based deworming combined with improved sanitation contributed to significant reductions in STH prevalence over time. Following albendazole administration, the overall cure rate of 90.8% observed in this study is consistent with high efficacy reported for albendazole against soil-

transmitted helminths, particularly *Ascaris lumbricoides*, as documented by Kabatende et al.<sup>[2]</sup> (2023) who reported cure rates exceeding 95% for ascariasis. The species-specific efficacy in the present study, with cure rates of 94.9% for *A. lumbricoides*, 87.5% for hookworm, and 83.9% for *Trichuris trichiura*, parallels pooled estimates from Bekele et al.<sup>[19]</sup> (2024) which demonstrated high egg reduction and cure rates for *Ascaris* and comparatively lower efficacy against *Trichuris*. The substantial reduction in mean egg counts across all species in the current study further aligns with these observations, indicating effective reduction in parasitic load. In contrast, studies focusing specifically on *Trichuris trichiura*, such as Patel et al.<sup>[20]</sup> (2020) reported considerably lower cure rates even with higher albendazole doses, underscoring geographic and species-specific variability in drug response. The significantly higher cure rates observed among children using sanitary latrines (94.8%) and those consistently wearing footwear (100%) in the present study represent population-specific findings that reinforce the synergistic role of hygiene practices alongside chemotherapy, a dimension not uniformly quantified across all comparative studies.

## CONCLUSION

This interventional school-based study conducted among 410 children aged 5–18 years in Bareilly district demonstrates that intestinal helminthiasis remains a moderate but clinically relevant public health problem, with an overall prevalence of 37.1%, predominantly affecting younger age groups without significant gender predilection. The findings establish that environmental and behavioral determinants, particularly open defecation, barefoot walking, and rural residence, are significantly associated with both infection risk and treatment response, while housing type alone did not exert an independent effect. Administration of a single supervised 400 mg dose of albendazole resulted in a high overall cure rate of 90.8%, with excellent efficacy against *Ascaris lumbricoides*, substantial effectiveness against hookworm, and comparatively lower but meaningful efficacy against *Trichuris trichiura*, accompanied by marked reductions in mean egg counts across all species. Treatment outcomes were uniform across age and sex but were significantly influenced by sanitation practices, footwear use, and urban residence, underscoring the synergistic role of hygiene and chemotherapy. Collectively, these results affirm that albendazole is an effective anthelmintic in school-aged children and that sustained reductions in helminth burden require integration of periodic deworming with targeted improvements in sanitation, hygiene behaviors, and school-based health interventions.

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