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Assessment of Antihelminthic Efficacy of Mebendazole 500 mg against Soil- Transmitted Helminths in a High Risk Area of Cameroon

Ngo Ngué Thérése Nadyne[1,2], Nkengazong Lucia[2,3*], Nkoa Thérése[4], Adamou Mfopa[3], Ngué Monique[3], Motsebo Amede[3], Moyou- Somo Roger[3] and Nukenine Elias Nchiwan[1]

[1]Faculty of Science, University of Ngaoundere, Cameroon.
[2]Laboratory of Parasitology and Ecology, Faculty of Science, University of Yaounde I, Cameroon.
[3]Institute of Medical Research and Medicinal Plants Studies (IMPM), Yaounde, Cameroon.
[4]Faculty of Medicine and Biomedical Science, University of Yaounde I, P.O.Box 1364, Cameroon.

Authors' contributions

This work was carried out in collaboration between all authors. Authors NL and MSR conceived and designed the experiments. Authors NL, NNTN and NM did recruitment and enrolment of patients and parasitological examinations. Authors NL, NNTN, NM and MA performed the experiments. Authors NL, NNTN and AM analyzed the data. Authors NL, MSR, NNTN and AM contributed reagents/ materials/ analysis tools. Authors NL and NNTN wrote the paper. Authors NL, MSR, NEN and AM built up the paper. All authors read and approved the final manuscript.

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ABSTRACT

Background: The three major soil-transmitted helminths (STHs) (*Ascaris lumbricoides*, *Trichuris trichiura* and *Necator americanus*/*Ancylostoma duodenale*) cause the highest burden on public health particularly in the sub-saharian regions of Africa. Although albendazole (ABZ) or mebendazole (MEB) is widely used as preventive antihelminthic treatment, there still exist variation in the efficacy of these drugs and standard threshold efficacy limits are not yet well established for all the three STHs.

**Corresponding author: Email: nkenglu@yahoo.com;*

Aim: The objective of this study was to evaluate the efficacy of single dose Mebendazole (500mg) against these three STHs.
Methodology: A random control trial was conducted among school children residing in a high risk area of Cameroon. A toatal of 410 school-aged children in the Lolodorf neighbourhood were screened using the Kato katz technic followed by treatment of participants with a single dose of mebendazole (500 mg).Ten weeks post-treatment, children provided a single stool sample which was examined using the same diagnostic method. Efficacy was assessed by the Cure Rate (CRs) and Egg Reduction rate (ERRs).
Results: Globally, 259 (63.2%) were infected for one or more STHs.The highest CRs were observed for *A. lumbricoides* (93.9%) followed by hookworms (70.8%) and *T. trichiura* (60.7%), for an overall CR of 59.1%. CRs varied considerable by age for hookworms and by type of infection for *T. trichiura* and hookworms. The prevalence reduction rate was highiest for *A. lumbricoides* (91.4%) followed by hookworms (61.0%) and *T. trichiura* (46.3%). ERRs were highiest for *A. lumbricoides* (94.5%) while this values were low for hookworms (52.9%) and *T. trichiura* (39.9%). The ERRs were affected for *T. trichiura* and hookworms by pre-treatment egg count for sex, different classes of infection intensity and types of infection.
Conclusion: Our findings suggest the efficacy of single dose mebendazole 500 mg against *A. lumbricoides* and to a lesser extent on hookworms with low drug effect on *T. trichiura.* Further development and validation of standard protocols for antihelminthic drugs efficacy has to be established.

Keywords: Ascaris lumbricoides; Trichuris trichiura; Hookworm; Radomised control trial; Mebebdazole; drug efficacy; Cameroon.

1. INTRODUCTION

Among Neglected Tropical Diseases (NTDs), soil-transmitted helminths (STHs) cause the highest burden on public health particularly in the sub-saharian regions of Africa [1]. It is estimated that about 2 billion people are infected with at least one of the four STH species: the roundworm *Ascaris lumbricoides*, the whipworm *Trichuris trichiura* and the two hookworm species *Necator americanus* and *Ankylostoma duodenale*, resulting in a global burden of approximately 5.2 million disability- adjusted life years (DALYs) (20% of the total number of DALYs attributable to NTDs) [2,3]. One of the morbide effects of STHs is nutritional deficiency like anemia, nutrients malabsorption, dysentery and growth trouble. Related manifestations can often include reduced global functioning, decreased physical performance, and impaired cognition, resulting to decreased human capital among adults in affected populations, with a related loss in years of healthy life [4-6]. These infections provoke serious consequences on the physical and intellectual development of children and those aged 5 to 14 years are the most affected [7]. In this vulnerable group, the morbidity linked to these pathologies is closely linked to eggload [7]. Endemic zones are classified as low (prevalence < 20.0%), moderate (prevalence >20.0% <50%) and high (prevalence ≥50.0%) infection risk areas [8]. To control the morbidity caused by STHs, mass drug administration (MDA) is recommended in communities where the prevalence of any STHs exceeds 20% [9]. Four antihelminthics (albendazole, mebendazole, levamisole, and pyrantel pamoate) are currently on the World Health Organization model list of essential medicines for the treatment and control of STHs. Albendazole and Mebendazole which are widely used against these infections have showed some degree of variability in their efficacy [10].

In Cameroon, more than 10 million persons have intestinal worms with prevalence fluctuating from one region to another [11-13]. The National Control Program of Schistosomiasis and Intestinal Helminthiasis which targets school aged children is effective in all the ten regions since 2007 and the principal objective is to reduce morbidity and mortality rates caused by these infections by administering MDA once a year using albendazole 400 mg [12]. However, despite these control measures, transmission is still intensive in some areas of the country among which include the south region, where a prevalence rate of up to 75.9% has been recorded in some districts [14]. This calls for the necessity to regularly evaluate the therapeutic impact of antihelminthics on STHs. The present study aims thus to evaluate the efficacy of single dose Mebendazole on parasitic

indices among school children of the Ngovayang health area of the south region. Specifically, it aims to:

i) Asses the prevalence and parasite intensity at pre-treatment and at post-treatment;
ii) Asses the cure rate and eggs reduction rate at post treatment;
iii) Asses the effect of treatment on single and multiple infected individuals and on different infection intensities at post-treatment.

The results obtained from this study will provide recommendations for the development of more appropriate control strategies against these diseases nationwide.

2. METHODS

2.1 Study area

The study was conducted in the Ngovayang health area which is located approximately 15 Km from Lolodorf in the Ocean division of the south region of Cameroon. This study focused on school children (aged 3 to 15 years) from 6 primary schools belonging to 8 villages of the area (Ngovayang 1, Ngovayang 2, Ngovanyang 3, Bikala, Bingambo, Mbikiliki, Mougue, and Mvile). At the time of this trial, these schools were not included in any MDA program. The area was selected based on previous STHs prevalence, and their involvement in previous drug efficacy trials [3,14,15]. The area is a rural locality with a tropical humid climate and a low demographic density which is estimated at about11.94 inhabitants/Km^2 [16]. The entire area is characterized by the absence of electricity, with the presence of water sources (wells and non functional forages) which the entire populations carryout the activities necessitating water. The community members practice agriculture work, fishing, hunting and trading. One health center exists in the entire area at Ngovayang 1 (Ngovayang mission) with three agents of community health. The six primary schools included in the study were:

Mbikiliki (3°10.147'N, 10°32.572'E), Bikala (3°11.850'N, 10°34.934'E), Ngovayang 2 (3°14.783'N, 10°38.550'E), Bingambo (3°13.709'N, 10°38.254'E) and Mougue (3°13.332'N, 10°36.982'E) are characterized by the absence of water sources, pit toilets with poor maintenance and garbage piles on which children play on and; Ngovayang Mission (3°13.067'N, 10°36.221'E) which is situated beside the unique health center of the area and is characterized by the presence of forages, adequate toilets and a site for garbage disposal. Defecation in ponds, streams or bushes around the school premises and the habit of walking barefooted is a common practice of school children in the area.

2.2 Study Subjects

The study was conducted from March to May 2015. Of the 483 school children contacted, 410 (201 boys: 49.02% and 209 girls: 50.98%) participated in the first prospection and 300 (136 boys: 45.3% and 164 girls: 54. 7%) participated in the second. The sampled population was between the ages of 3-15 years and was divided into 3 classes of age interval (3-5years, 6-10 years and 11-15 years). A summary of the number of subjects recruited, enrolled, lost at follow-up and included in the statistical analysis is presented in the flowchart (Fig. 1).

2.3 Ethical Considerations

This study was ethically approved by the Ethical Committee of the Institute of Medical Research and Medicinal Plant Studies (IMPM) of the Ministry of Scientific Research and Innovation, Cameroon and the Ethics Review Committee of Lolodorf hospital. Permission to conduct the study was obtained from the community leaders and the school administrators and they were duly informed on the objectives and benefits of the study. Parents/guardians were informed about the aim and the procedure of the entire clinical trial. All children whose parents or guardians gave informed consent for their participation were included in the study. Participants were recruited on a voluntary basis and their personal information was treated privately and was not divulged to a third party. Treatment with mebendazole 500 mg (2 tablets X 2/3 days consecutively) was administered under the direct supervision of a clinical nurse.

2.4 Samples Collection and Processing

Stool samples were collected at baseline in March 2015 and after ten weeks in May 2015 in

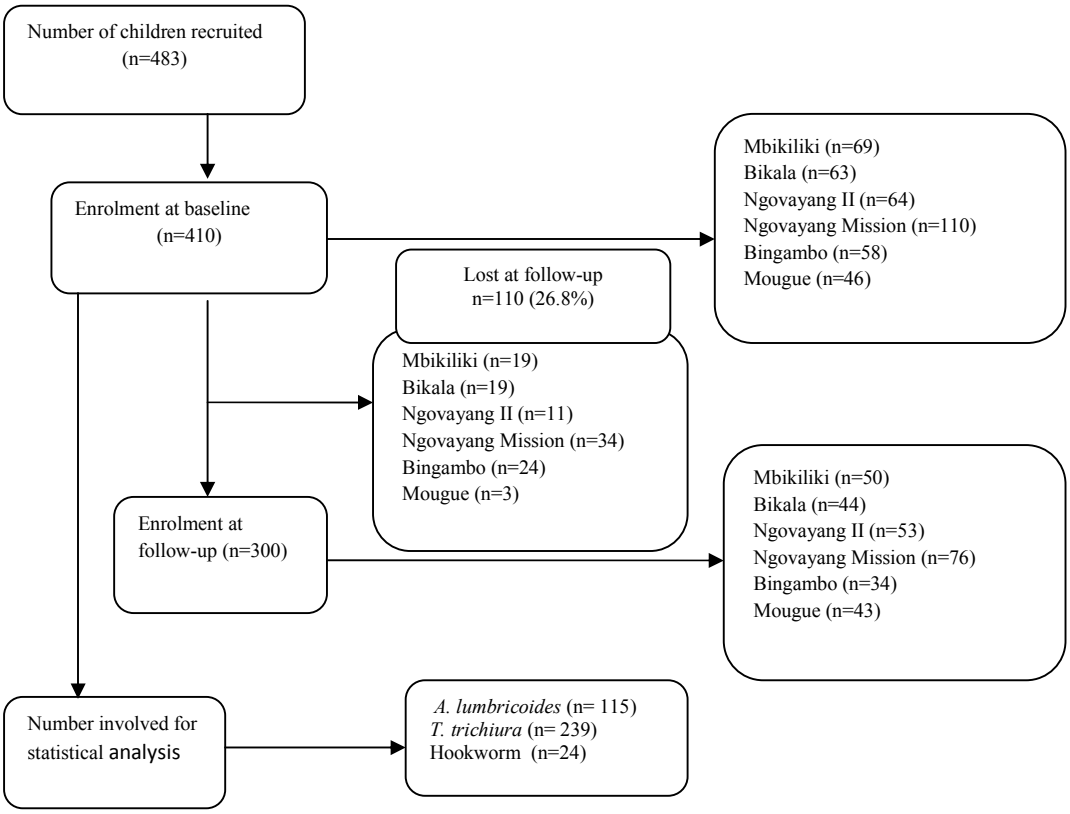

Fig. 1. Trial diagram showing the number of subjects recruited, enrolled, lost at follow-up and included in the statistical analysis during the study

six randomly selected primary school. Following registration, one stool sample was collected from each participant in 50 ml screw-cap vial between 7:30 a.m and 10:00 am. Collection of samples was done during two days by three groups of person (one group per village) comprised of two persons per group. Following registration, one stool samples was collected from each participant in 50 ml screw-cap vial between 7 :30 am and 10 h am. Samples collected the first day were conserved in a cooler containing ice blocks and were immediately transported by one person to the Parasitology laboratory at Nkomo (situated at about 150km from the study area) of the Medical Research Centre of IMPM, Yaounde for subsequent analysis by two technicians the same day.

The quantitative Kato-Katz technique was used for the identification of helminths eggs following their morphology (*A. lumbricoides, T. trichiura*, and hookworm) [17]. To minimize the measurement bias on the parasitological data, all Kato slides were prepared and read the same day following stool samples collection to avoid the degradation of hookworm eggs. Eggs were counted under a light microscope at 10X magnification and their number expressed in eggs per gram of stool (epg). Intensity of helminthes infection was done at pre-treatment and at post-treatment following the WHO threshold limits: low (1-4999 epg, 1-999 epg, and 1-1999 epg); moderate (5000-49999 epg, 1000-9999 epg and 2000-3999epg) and high (≥50000 epg, ≥10000 epg and ≥4000 epg) infection intensity respectively for *A. lumbricoides, T. trichiura* and Hookworms [18]. Stool samples were collected ten weeks after drug administration. Control of drug efficacy was done by analyzing results of children who were positive during the initial survey, using the same technique mentioned above.

2.5 Data Management and Statistical Analysis

Parasitological data were analyzed using Statistic logistic PC DOS Version 2.0. The efficacy of the treatment for each of the three STHs was assessed based on the cure rate

(CRs) and the egg reduction rate (ERRs). ERRs was calculated as the ratio of the difference between the average parasite load before and ten weeks after treatment on the pre-treatment parasite load, expressed as a percentage. CRs was calculated as the percentage of individuals who became parasitologically negative after treatment. CRs and ERRs were calculated for children who were infected with STHs at pre treatment.The Chi-square test was used to compare the prevalence of parasites in relation to sex, age groups, villages and different classes of infection intensity. The one - way ANOVA or Kruskal-Wallis tests were used to compare the parasite intensity in relation to sex, age groups, villages and infection intensity at pre and post treatment. The Kruskal-Wallis test was used when the conditions of parametric ANOVA were not fulfilled. The level of statistical significance was at 95% (P <0.05).

3. RESULTS

3.1 Pre-treatment Prevalence of STHs Infections

Of the 410 samples analysed using the Kato Katz technique, 259 (63.2%) were found positive for one or more STHs. Of this number, 62.7% boys and 63.6% girls were infected. The respective prevalence of the different parasites were 28.0% (*A. lumbricoides*), 58.3% (*T. trichiura*) and 5.9% (hookworm). Children of age group 3-5 years (75.0%) were more infected compared to those of other age groups, same as those from Ngovayang I (Table1). Cases of single (58.7%) and multiple (41.3%) infections were recorded in the total number of samples examined. Single and multiple infections varied between sex and the different age groups with significantly high values obtained among children of 6-10 years old in the two cases (P<0.05).

3.2 Pretreatment Eggload and Infection Intensity

The global mean parasite load for each parasite species was 12854.4 eggs/gram of stool for *A. lumbricoides*, 2345.7 eggs/gram for *T. trichiura,* and 378.0 eggs/gram for hookworm. As regards sex, girls presented high mean egg loads for the three STHs than boys, with a significant difference observed for *T. trichiura* (P=0.04). In relation to age, children aged 3-5 years had statistical high mean eggload for *T. trichiura* (P=0.0001) and hookworm (P=0.0001) while statistical high values were obtained in Ngovayang II (P=0.002) for *A. lumbricoides* and in Ngovayang I for *T. trichiura* (P=0.001) and for hookworm (P=0.01) (Table 1). Among infected children, majority had light infections followed by moderate infections for the different STHs: *A. lumbricoides* (61.7%/30.4%), *T. trichiura* (77.0%/17.2%) and hookworm (91.7%/8.3%). Heavy infections which did not exceed 7.8% was observed only for *A. lumbricoides* and *T. trichiura* (Table 2 and Fig. 2).

3.3 Post-treatment Prevalence of STHs Infections

A significant reduction of any STHs infection prevalence (63.2% versus 34.7% resulted at three months postreatment using 500mg mebendazole (P= 0.0001) for an overall prevalence reduction rate of 45.1%. The prevalence of the different parasites reduced significantly: 2.3% for *A. lumbricoides* (p= 0.0001), 31.3% for *T. trichiura* (P=0.0001) and 2.3% for hookworm (P=0.002). The overall CRs observed was 59.8% with the respective values of 93.9%, 60.7 %and 70.8% for *A. lumbricoides, T. trichiura and* hookworm. The CRs varied between the different classes of infection intensity for any of the STHs with high values observed for moderate and heavy intensity**.** The CRs were statistically high in males for *T. trichiura* (P= 0.002). Globally, the CRs varied significantly between the different age groups for any STHs and more precisely in children of 11-15 years for *T. trichiura* (P= 0.01) and hookworm (P= 0.03). Considering any STHs, CRs were significantly high in children having single infections compared to those with multiple infections (P= 0.00001). Also, high CRs values were observed for *A. lumbricoides, T. trichiura* and hookworm in the case of multiple infections but no significant difference was observed, same as in children infected with only *A. lumbricoides*, *T. trichiura* or hookworm. (Table 3 and 4). Few individuals remained positive after treatment for the three STHs with the mean egg count being significantly lower for *A. lumbricoides* (P= 0.03) and hookworm (P=0.02) when compared with the mean egg counts before treatment. ERRs were 94.5%, 39.9% and 52.9% respectively for *A. lumbricoides, T. trichiura* and hookworm. Considering infection intensity, ERRs was 100.0% for moderate and heavy infection (*A. lumbricoides*) and100.0% for heavy infection (Hookworm). A negative ERRs was obtained for *T. trichiura* in children of 4-5 years (-86.9%),

females (-2.8%), moderate infection (-17.8%) heavy infection (-78.6%) and single infections (-36.5%), same as in 11-15 years old children (-22.2%) for hookworm. The three participants who had heavy infections for *T. trichiura* at postreatment were coinfected with either *A. lumbricoides* or hookworm before treatment. Two of them egually had moderate infections before treatment. Ten out of the13 individuals who had moderate infections for *T. trichiura* were coinfected with ethier *A. lumbricoides* or hookworm before treatment and after treatment, coinfection was observed in 5 idividuals (four for hookworm and one for *A. lumbricoides*). ERRs were significantly high in males for *T. trichiura* compared to females while no significant differences were observed as regards age groups and different clases of infection intensity. All the 7 children who remained positive for *A. lumbricoides* and hookworm after treatment had light infections intensity (Table 4 and Fig. 2).

4. DISCUSSION

The present study is one of the recent studies conducted in Cameroon as regards the efficacy of menbendazole (500 mg) against STHs. The treatment of children infected with STHs using this drug resulted to a significant reduction of prevalence of any of the STHs. The global CRs were high for *A. lumbricoides* and hookworm but very low for *T. trichiura*. The drug resulted in high ERRs and CRs for *A. lumbricoides* even though the values were sligthly below the threshold limits [9]. Our study is in comformity with previous studies where a high CR (95.0%) was obtained using 500 mg mebendazole in the treatment *of A. lumbricoides* infections and in other studies where albendazole 400mg was used [3,10,19,20].

Therapeutic efficacies against hookworm are not consistent as some studies have reported low CR of up to 15% and17.6% and others reported a high CRs of up to 100% and ERRs of up to 76.3% and 100% using menbendazole 500mg [10,21,22]. Similar observations have been reported for other antihelminthic drugs (Albendazole 400 mg and pyrantel pamoate) against STHs [3,10-20]. This variability could be as a result of abnormal physiology or healthy status of patients. According to previous results, efficacy of mebendazole in the treatment of helminths infections varies in patients as a function of pre-existing diarrhea, gastrointestinal diseases and transit time, pre-treatment infection intensity, coinfection with other helminths, helminth strain, malnutrition and immunodeficiency. Cure rates are usually lower than average in patients who have massive infections and in patients with hypermotility of the gastrointestinal tract [19,23,24]. Factors related with the parasites such as treatment history and geographical location (differences in strain and species susceptibility/resistant) of the study participants, the presence of different hookworm species, and the amount of eggs released by the parasite might have also affected the efficacy of the drug. Variation in the quality of the antihelmintic such as: intrinsic quality, bioavailability and degradation during storage or transport in association with concomitant therapy (anti-inflammatory or antibiotic drugs) could also explain the differences in the efficacy of mebendazole observed among the different studies [24].

The drug effect against *T. trichiura* was low with the respective CRs and ERRs of 60.7% and 39.9%. Several studies have reported low efficacy, indicating that this dosing regimen may not be sufficient [21,25]. Also, the ERRs obtained in the present study is quite low (39.9%) compared to that obtained (55.3%) in previous studies. High pretreatment infection intensity (2345.5 e/g of stool) could also have contributed to the low CRs recorded in the present study as compared to that obtained in previous studies (252.4e/g of stool) [21]. However, other reasons like drug resistance and coinfection with other comorbidities can not be ruled out [24]. Eventhough albendazole is the most currently used in most areas of Africa than mebendazole, the low efficacy observed in both drugs in treating *T. trichiura* requires some attention. Effective treatment of *T. trichiura* has been obtained using abendazole for three consecutive days, while other works recommend the combination of albendazole and mebendazole or ivermectin to achieve a high CR [26-29].

The prevalence reduction rates of *A. lumbricoides* (91.4%) and *T. trichiura* (46.3%) are comparable to results of previous studies [30,31,32]. These results however disagree with some results, where low values were obtained for *A. lumbricoides* (7.2%) and *T. trichiura* (20.8%) and high value for hookworm (100.0%) [21].

Table 1. Baseline prevalence and mean eggload of intestinal helminths infection in the study population

Variables	Prevalence of any infection	Prevalence of parasite species (%)		
		A. lumbricoides	*T. trichiura*	Hookworm
Sex				
Boys (n=201)	62.7	29.9 (9291.72±17424.12)	57.7 (1473.44±3502.04)	6.0 (190±271.04)
Girls (n=209)	63.6	27.3 (16479.58±39325.9)	58.8 (3182.16±8177.43)	5.7(56±1013.72)
Age group				
1-5 years (n=12)	75.0	16.7 (7008,00±237.59)	75.0 (12120.00±22078,43)	8.3 (3480.0)
6-10 years (n=260)	61.2	25.4 (11168,73±31228.22)	56.5 (2371.92±5396.17)	5.0 (264.0±422.22)
11-15 years (n=138)	65.9	34.1 (15470,30±30010.95)	60.1 (1239.33±2649,98)	7.2(216.0±291.97)
Village				
Mbikiliki (n=69)	55.1	29.0 (15055,20±30668.90)	50.7 (1196.57±2817.65)	2.9 (24.0±0.00)
Bikala (n=63)	54.0	17.5 (5480.73±5747.84)	54.0 (852.71±2478.61)	3.2(144.0±0.00)
Ngovayang II (n=64)	70.3	37.5 (18688.00±41547.02)	62.5 (1809.00±2333.67)	4.7 (40.0±27.71)
Ngovayang I (n=110)	80.9	37.3 (14205.66±33129.41)	75.5 (4547.86±9934.49)	12.7 (594.86±933.85)
Bingambo (n=58)	62.1	24.1 (4961.14±6532.16)	53.4 (1206.19±3025.63)	5.2 (96.0±104.61)
Mougue (n=46)	37.0	10.9 (3292.80±5477.77)	34.8 (157.50±208.49)	0
Total (n=410)	63.2	28.0 (12854.40±30406.02)	58.3 (2345.67±6380.23)	5.9 (378.00±750.66)

Table 2. Pre- and post-treatment infection intensity of STHs among the study population

Infection intensity	Percent (number) infected					
	A. lumbricoides		*T. trichiura*		Hookworms	
	Pretreatment	Postreatment	Pretreatment	Postreatment	Pretreatment	Postreatment
Light	61.7 (71)	100 (7)	77.0 (184)	83.0 (78)	91.7 (22)	100 (7)
Moderate	30.4 (35)	0.0 (0)	17.2 (41)	13.8 (13)	8.3 (2)	0.0 (0)
Heavy	7.8 (9)	0.0 (0)	5.8 (14)	3.2(3)	0.0 (0)	0.0 (0)

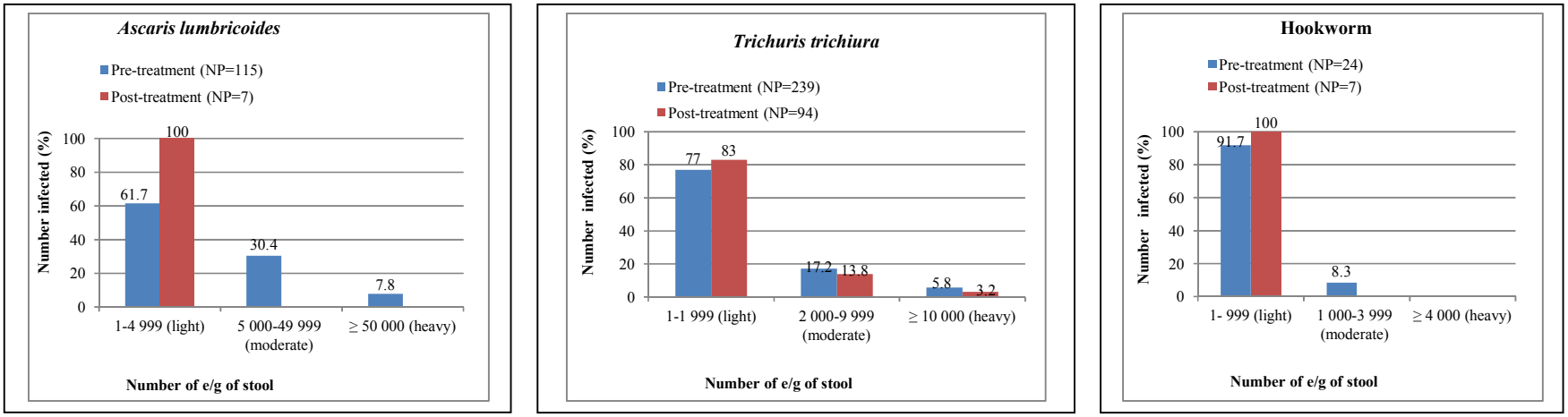

Fig. 2. Prevalence of infected children in different classes of infection intensity at pretreatment and post treatment

Table 3. Efficacy of albendazole against STHs in the study population

STHs	Percentage (number) infected		CR (%)	PRR (%)	Infection intensity (geometric mean epg)		ERR(%)
	Pre-treatment (n= 410)	Post treatment (n= 300)			Pre-treatment	Post treatment	
A. lumbricoides	28.0	2.3	93.9	91.4	12854.4±17163.0	706.3±93.4	94.5
T. trichiura	58.3	31.3	60.7	46.3	2345.7±5002.9	2252.2±3735.3	39.9
Hookworm	5.9	2.3	70.8	61.0	378.0±237.4	178.2±68.3	52.9
Overall	63.2	34.7	59.1	45.1	-	-	-

PRR: prevalence reduction rate.
CR: cure rate.
ERR: egg reduction rate.
Geometric mean epg: geometric mean egg per gram.

Table 4. Cure rate and egg reduction rates of Mebendazole (500 mg) against STHs in study population by age, gender, infection type and pretreatment infection intensity classes

Variable	*Ascaris lumbricoides*		*Trichuris trichiura*		Hookworm	
	CR (NPBT/NPAT)	***ERR (MECBT/MECAT)***	***CR*(NPBT/NPAT)**	***ERR (MECBT/MECAT)***	***CR*(NPBT/NPAT)**	***ERR(MECBT/MECAT)***
Age						
4-5 years	100 (2/0)	100 (7008/0)	66.7 (9/3)	-86.9 (12120/22664)	0.0 (1/1)	88.3 (3480/408)
6-10 years	92.4 (66/5)	91.7(11168.7/931.2)	54.1 (146/67)	21.2 (2387.8/1882)	53.8 (13/6)	37.9 (264/164)
11-15 years	95.7 (47/2)	99.1 (15470.3/144)	71.1 (83/24)	40.8 (1239.3/734)	90.0 (10/1)	-22.2 (216/264)
Sex						
Female	96.5 (57/2)	99.7 (16479.6/48)	50.8 (122/60)	-2.8 (3182.2/3270.8)	66.7 (12/4)	68.2 (566/180)
Male	91.4 (58/5)	89.6 (9291.7/969.6)	70.9 (117/34)	69.1 (1473.4/454.6)	75.0 (12/3)	7.4 (190/176)
Infection intensity						
Light	90.1 (71/7)	58.9 (1716.5/706.3)	57.6(184/78)	13.7 (440.1/380)	68.2 (22/7)	4.9 (187.6/178.3)
Moderate	100 (35/0)	100 (11895.1/0)	68.3(41/13)	-17.8 (3943.6/4644.9)	100 (2/0)	100 (2472.0/0)
Heavy	100 (9/0)	100 (104450.6/0)	78.6(14/3)	-78.6 (22710.8/40560)	-	-
Type of infections						
Single	83.3 (18/3)	97.9 (8769.3/184)	42.4 (132/76)	-36.5 (1176.3/1608.6)	-200 (1/3)	74.6 (504/128)
Multiple	93.8(97/6)	95.1 (7081/345.6)	79.2 (106/22)	65.5(6396.6/2204.7)	17.4 (23/17)	71.0 (345.3/100)
Overall	93.9 (115/7)	94.5 (12854.4/706.3)	60.7 (239/94)	39.9 (2345.7/2252.2)	70.8(24/7)	52.9 (378.0/178.2)

Single: infected only with the specified helminth species.
Multiple: co-infected with other helminth species.
NPBT = number positive before treatment.
CR: cure rate.
ERR: egg reduction rate
MECBT:Mean egg count before treatment
MECAT:Mean egg count after treatment

As earlier mention, therapeutic efficacy of antihelminthic drugs is related to infection intensity and coinfection with other helminths, and the drug is active both against the larva and adult forms of the worm [24,32]. This confirms the high ERRs observed in children having single infection of *A. lumbricoides*. Eventhough efficacy for *A. lumbricoides* and hookworm was moderate (CRs) and low (ERRs) for light infections, the drug effect was totally efficacious in terms of moderate and heavy infections (*A. lumbricoides*) and moderate infection (hookworm) where 100% ERRs and CRS were obtained [9]. It could likely be that, individuals with light infections were co-infected by other STHs or the worm burdens in these individuals were high, what could lead to inadequate elimination of adult worms [33]. Certainly, high egg count may not be attributed to high worm burden and vice versa, or high/low CR does not reflect single or multiple infections. This is confirmed by the 100.0% ERRs obtained for moderate (11895.1 e/g of stool) and heavy (104450.6 e/g of stool) infection intensity and the low CRs obtained for single infections compared to multiple infections for (*A. lumbricoides*) at post treateament. Also, the egg laying capacity of adult worms could also be in function of the health status of infected individuals. Earlier reports showed that, treatment of children co-infected with hookworm and *Opisthorchis viverrini* had a reduced CRs (24.2%) and moderate ERRs (78.2%) [22]. Also, fecundity increases in female hookworms when infections become light. This could explain the high egg count observed at post treatment, which led to a negative ERR in children of 11-15 years.The observed negative ERRs in some variables (sex, age, infection intensity and types of infection) for *T. trichiura* could be related to co-infection of this parasite with other STHs which led to low drug effect on the adult worms and consequently contributed to high egg laid at post treatment. Also, new pre-treatment infections in addition to the already existing drug resistance on *T. trichiura* could also explain the high mean eggload recorded at post treatment, which could consequently lead to a negative ERRs. Thus, post treatment evaluation was done after ten weeks, the period during which pre-treatment infected individuals with new infections could start excreting eggs.

Reports of some studies have showed that helminths infections and fecal egg count could be underestimated when only one stool sample is analysed using the Kato–Katz thick smears, especially after treatment when infection intensities are light, as helminth eggs found within a stool and the number of eggs excreted over days are not uniformly distributed [34,35]. This observation has been attributed to overestimation of true efficacy of single dose antihelminthic used in treating STHs infection [24,36]. Such observations migth not bind with the present study, since the fecal eggcount recorded at post treatment were not very much different from that obtained at pre-trearment for *T. trichiura* and hookworms. Also high values of eggload of *T. trichiura* were obtained at post treatment for moderate and high infection intensities. The results of the present study could probably have some shortcomes. Retrial done after ten weeks could have given bias in data interpretation, as the prepatent period of hookworm goes between three weeks and one month. Thus, the evaluation of drug efficacy within a shorter time interval at post treatment will give more appropriate results.

5. CONCLUSION

The present results confirm the therapeutic efficacy of single dose mebendazole in the treatment of *A. lumbricoides* and to a lesser extend on hookworms, while efficacy is low against *T. trichiura*. Also, efficacy varied on infection intensity and type of infections. ERRs was very low for *T. trichiura*. The use of multiple dose of mebendazole or in combination with other antihelminthic drugs could lead to posible high CRs of *T. trichiura* at post treatment. Also, evaluating the therapeutic of this drug at shorter time interval could better determine the duration of protective effect of drug in infected individuals. This study also emphasize on the need to revise the WHO recommended efficacy threshold for the different antihelmintic drugs. Considering the morbidity and mortality caused by these infections in children, futher operational research will be necessary to evaluate the morbidities factors (anemia and malnutrition) associated to theses affections, evaluate the drug impact at a reduced time interval, evaluate the risk factors associated to transmission in the study area and evaluate the impact of infection on public health by determining the contribution of parents in the maintenance of disease transmission.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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