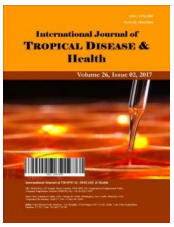

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Persistent Soil-Transmitted Helminth Infections and Associated Risk Factors among Children Aged Between 4 and 12 in Mile 16 Bolifamba, Buea, Cameroon: 6 Months Post-Deworming Campaign

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SEA, AE, TNV and HKK designed the study. Author SEA performed the statistical analysis. Authors SEA and ANA wrote the protocol and wrote the first draft of the manuscript. Author TNV and AE managed the analyses of the study. Author ANA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aims at determining the prevalence, the soil-transmitted helminths (STH) species, and associated risk factors among children aged between four and 12 in the mile 16 community, Buea, through post-deworming intervention.

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Study Design: The Cross-sectional research design was used, involving a total of 465 children in the aforementioned community.
Place and Duration of Study: The study was carried out in the mile 16 community, Buea, from January to May 2018.
Methodology: Socio-demographic data were collected through the use of questionnaires. Stool samples were collected and analysed using the Kato-Katz technique. Data were analysed using SPSS version 21. Descriptive data were calculated with frequencies (n) and proportions (%); meanwhile, Binary logistic regression analysis was performed to explore significant correlations between risk factors and STH infections.
Results: The overall prevalence rate of soil-transmissible infection in mile 16 Bolifamba, Buea municipality, stood at 27 (5.8%, 95% confidence interval (CI): 3.7 – 7.9). The prevalence rate among children who have been previously dewormed was 18 (3.9 %, 95% CI: 2.1 – 5.6). The most prevalent soil-transmitted helminths being *Ascaris lumbricoides* recorded 18 (3.9% CI: 2.1 – 5.8), followed by Hookworm 9 (2%, CI: 0.7 – 3.2). *Trichuris trichiura* recorded 0%. Walking barefoot was significantly associated with STH ($\chi2$= 18.37, p=0.0001), with increased odds of infection (odd ratio [OR] = 3.2; 95% CI: 2.0–5.3). Improper hand-washing was associated with STH infection ($\chi2$= 4.36, p=0.037), with increased odds of ([OR] = 1.7; 95% CI: 1.1–2.7). No awareness on STH and deworming by guardians/parents was significantly associated with increased odds of infection ([OR] = 3.0; 95% CI: 1.7–5.5), P = 0.001. Defecating in bushes and garden showed an association with STH infection ($\chi2$= 5.16, p=0.023), with an increase odd ([OR] = 2.4; 95% CI: 1.2–7.7) and the place of defecation by children showed an association with STH infection ($\chi2$= 13.63, p=0.03).
Conclusion: The findings of this study show that there is an increasingly active transmission of STH at mile 16 Bolifamba, despite the post-deworming campaign. Walking barefoot, improper hand-washing before eating, lack of awareness by guardians/parents on STH, deworming and defecating in bushes and garden increases the likelihood for STH infection. These results suggest among other things that, although community-based deworming programmes have many important benefits, more need to be done to improve on the effectiveness of deworming campaign processes and the combination of other control approaches like education and proper sanitation in the mile 16 Bolifamba community.

Keywords: Persistent; soil-transmitted helminths; children; deworming; risk factors.

1. INTRODUCTION

Soil-transmitted helminth infections are among the most common infections worldwide, and they affect the poorest and most deprived communities. They are transmitted by eggs present in human faeces, which in turn contaminate the soil in areas where sanitation is poor. The main species that infect people are the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*) [1].

The World Health Organisation (WHO) records indicate that approximately 1.5 billion people are infected with soil-transmitted helminths worldwide. The Infections are widely distributed in tropical and sub-tropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. Also, over 267 million pre-school-age children and over 568 million school-age children live in areas where these parasites are intensively transmitted, and they are in need of treatment and preventive interventions [1]. In the South West Region of Cameroon, for instance, soil-transmitted helminths infections have been reported and shown to be endemic in various geographical areas, with rural areas shouldering the highest burden of the infection as compared to urban areas [2–6].

Intestinal parasitic infections remain a serious public health problem [1,7-9]. Soil-transmitted helminths impair the nutritional status of the people they infect in multiple ways. First, worms feed on host tissues, including blood, which leads to a loss of iron and protein. Hookworms, in addition, cause chronic intestinal blood loss that can result in anaemia. Also, worms increase malabsorption of nutrients. Furthermore, roundworms may possibly compete for vitamin A in the intestine. Some soil-transmitted helminths also cause loss of appetite and, therefore, a reduction of nutritional intake and physical fitness [1,9,10]. In particular, *T. trichiura* can cause diarrhoea and dysentery [10]. Heavier infections can cause a range of symptoms, including

intestinal manifestations (diarrhoea and abdominal pain), malnutrition, general malaise and weakness, and impaired growth and physical development in childhood [1,11,12]. Infections of very high intensity can cause an intestinal obstruction that should be treated surgically [1].

Soil-transmitted helminths live in the intestines, and their eggs are passed out through the faeces of infected persons. Infection with these STHs is by ingestion of infective eggs, which can happen when hands that have been contaminated are put in the mouth or, by consuming vegetables and fruits that have not been carefully cooked or washed [1]. Some hatch in the soil, releasing larvae that can penetrate the skin of humans. Hookworm infection is transmitted primarily by walking bare feet on contaminated soil. Though there is an implementation for the distribution of drugs such as mebendazole and albendazole in Cameroon, there are still identified cases of STH infections in the country [2].

Mile 16 Bolifamba is a rural community with so many young and school-age children. The hygienic condition in mile 16, Buea, is very poor, with children found defecating indiscriminately in the open air and around streams that provide water to many who cannot afford the means to subscribe for clean water supply from the national provider, Camwater. Most of the household floors are filled with the ground floor. These children play on the ground, touching each other, and some even pick things that had fallen on the ground and eat as they play. All these predispose them to STH infections. Also, there is lack of good toilets and legislation against indiscriminate disposal of faeces. In the previous years, mass deworming programmes had been used in mile 16 in order to lower the rate of re-infection. Nevertheless, there are still cases being reported at the Mile 16 health centre.

Current strategies for the control of STH infection are primarily based on the periodic treatment of school children with anti-helminthic drugs, educative talks, and improvements in sanitation [1]. Treatment-based control strategies aim at controlling morbidity through reductions in the community transmission of STH infection. In recent years, considerable progress has been made in the use of geographical information system (infection is high, is limited). There have been several data on the epidemiology of STHs infections and risk factors for infection in school children. Such data are really valid for the control of STH infections because school children constitute an important reservoir of infection and are at risk of morbidity.

The objective of this study is to determine the prevalence of soil-transmitted helminth infections among children aged between 4 and 12 in the mile 16 community, 6 months after a deworming campaign was carried out in the area.

Transmitted helminths, despite the preventive chemotherapy (deworming) in mile 16, using albendazole (400 mg) or mebendazole (500 mg) after every 6 months among children in order to reduce the worm burden of soil-transmitted helminths infections, cases of STH are still recorded at the mile 16 health centre. The mounting interest in scaling-up chemotherapeutic control measures against STH in various communities in Cameroon needs effective follow-up measures in order to determine if, after control measures like deworming have been carried out, there are no more cases. Although mass deworming programmes and other control measures have been implemented, the epidemiology after deworming control campaigns of STHs infection in Cameroon are limited, especially in rural areas or where risk factors have been reported.

2. METHODOLOGY

2.1 Study Area & Population

This study was carried out in the mile 16 community, Buea, located in Fako Division of the South West Region of Cameroon.

2.2 Study Design

A cross-sectional study was carried out from January to May 2018, in which samples were collected from children aged between 4 and 12 in the mile 16 community, approximately six months post-deworming against STH, to determine the prevalence of STH infections and associated risk factors in the community. Children were included in the study only if their parents/legal guardians gave their consent by signing the informed consent form and only if the children also gave their assent and were voluntarily willing to participate in the study.

2.3 Sampling Technique

Samples were conveniently obtained from children aged between 4 and 12 in mile 16

Bolifamba, Buea. An announcement was made by a town crier to the entire community. As mentioned earlier, only children whose parents/guardians gave their consent were selected for this study.

2.4 Data Collection

Questionnaires were distributed among the parents/guardians of the participants to fill out. Qualitatively, the questionnaire was used to collect information on demographic characteristics and risk factors such as age, sex and parental occupation, hand-washing practices, walking barefoot, the presence of toilets, their usage and types of water sources available for domestic purposes. Each participant was given disposable sterile leak-proof stool containers, with applicators and tissue papers to provide fresh stool samples. The younger children were assisted in the stool collection process. The samples were put in a mobile cooler container and taken to the Biaka University Institute of Buea Teaching laboratory for analysis.

2.5 Laboratory Analysis

The samples were then taken to the laboratory to be analysed microscopically and macroscopically. All the samples were processed using the Kato-Katz thick smear technique for the quantitative estimation of helminth eggs in stool.

2.6 Data Management

The results obtained were stored in the laboratory logbook, before transferring to excel and later exported to SPSS version 21.

2.7 Data Analysis

Data collected were analysed using SPSS version 21. Demographic data were calculated using descriptive statistics and differences in prevalence for socio-demographic characteristics, while behavioural variables were calculated with Chi-square ($\chi 2$), $p<0.05$. Meanwhile, the odd ratios for risk factors were calculated using binary logistic regression.

2.8 Ethical Consideration

The administrative authorisation was obtained from the South West Regional Delegation of Public Health. An approval was also obtained from the Institutional Review Board of the School of Health Science, BIAKA University Institute of Buea. An additional clearance was obtained from the Chief of mile 16 upon presentation of an authorisation from the Regional Delegation of Public Health.

3. RESULTS

3.1 Socio-demographic characteristics among Children in Mile 16 Bolifamba, Buea

Of the 465 participants, 261 (56.1%) were female, while 204 (43.9%) were males. The majority 204 (43.9%) of the study's participants were between 7 and 9 years old. The majority of the participants were at the primary level of education 297 (63.9%). The common sources of drinking water in the community were Pipe born water 387 (83%) and spring 78 (17%). Defecation places mostly used by participants were pit latrines 348 (74.8%), open defecation in bushes and gardens 93 (20%) and flushing systems 24 (5.2%) (See Table 1)

3.2 Prevalence of Soil-transmitted Helminths Infections among the Study Population

The overall prevalence of soil-transmitted infections in the mile 16 Bolifamba community in Buea, South West Region of Cameroon, stood at 27 (5.8% 95% CI: 3.7 – 7.9). The prevalence rate among children who have been previously dewormed was 18 (3.9%, 95% CI: 2.1 – 5.6). The STH infection was more common among children between the ages of 4 and 6 (2.58%), and between the ages of 7 and 9 (2.58%), with females (3.22%) having the highest infection rate. (SeeTable 2). The most prominent STH species were *Ascaris lumbricoides* (4%) and hookworm (2%) (see Figure 1). *Trichuris trichiura* recorded a 0%.

3.3 Risk Factors of Soil-transmitted Helminths Infections among Children in Mile 16 Bolifamba

Socio-demographic risk factors and behavioural risk factors associated with STH infection were assessed with odd ratio.

We found a significant association ($p=0.037$) of not washing hands before eating with STH infection ([OR] = 1.7; 95% CI: 1.1–2.7). Walking barefoot in the environment also recorded a

significant association (p=0.0001) with STH infection ([OR] = 3.2; 95% CI: 2.0–5.3). Guardians/parents who had limited awareness about STH infection showed a significant association (p= 0.001) between their children's positive status and STH infection ([OR] = 3.0; 95% CI: 1.7–5.5). Children who did not partake during the deworming campaign showed a significant association (p= 0.003) with STH infection ([OR] = 2.6; 95% CI: 1.4–4.6). Defecating in bushes and gardens was significantly associated (p = 0.023) with STH infection ([OR] = 2.4; 95% CI: 1.2–7.7). The above risk factors were found to increase the odds of STH infection in the mile 16 Bolifamba community (See Table 3)

Table 1. Socio-demographic characteristics of the study population

Socio-demographic characteristics	Frequency	Percentages (%)
Gender		
Male	204	43.9
Female	261	56.1
Age range (years)		
4-6	144	30.9
7- 9	204	43.9
10- 12	117	25.2
Education level		
Nursery	63	13.5
Primary	297	63.9
Secondary	105	22.6
Source of drinking water		
Pipe borne water	387	83.0
Spring	78	17.0
Well	0	0
Toilet types		
Open defecation	93	20.0
Pit Latrine	348	74.8
Flushing system	24	5.2

Table 2. STH prevalence among children with respect to age and gender 6 months post-deworming campaign

Demographic characteristics	Positive n(%) [95% CI]	Negative n(%)
Gender		
Male	12 (2.58) [1.1 – 4.0]	192 (41.3)
female	15 (3.22) [1.6 – 4.8]	246 (52.9)
Total	27 (5.8) [3.7 – 7.9]	438 (94.2)
Age (years)		
4-6	12 (2.58) [1.1 – 4.0]	132 (28.4)
7- 9	12 (2.58) [1.1 – 4.0]	192 (41.3)
10- 12	3 (0.64) [0.0 – 1.4]	114 (24.5)
Total	27 (5.8)) [3.7 – 7.9]	438 (94.2)
Dewormed status		
Yes	18 (3.9) [2.1 – 5.6]	381 (81.9)
No	9 (1.9) [0.7 – 3.2]	57 (12.3)
Total	27 (5.8)) [3.7 – 7.9]	438 (94.2)

Table 3. Risk factors associated with soil-transmitted helminth infections at mile 16 Bolifamba

Variables	Infected	uninfected	p-value	OR	95% CI
No washing of hands before eating	12	114	0.037	1.7	1.1 – 2.7
Walking barefoot in the environment	12	60	0.0001	3.2	2.0 – 5.3
Not aware of STH (guardians)	18	390	0.001	3.0	1.7 – 5.5
Not Dewormed	9	57	0.003	2.6	1.4 – 4.6
Defecating in bushes and gardens	6	39	0.023	2.4	1.2 – 7.7

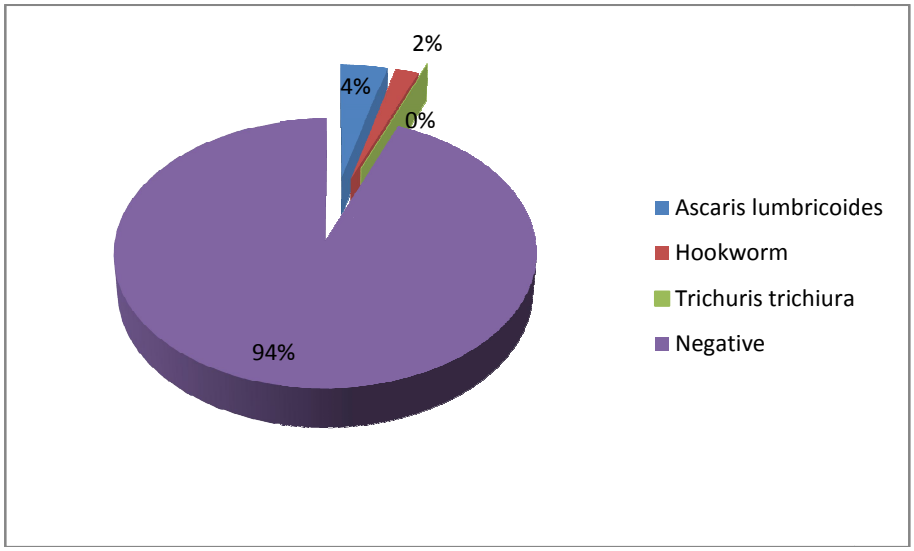

Fig. 1. Prevalence of STH species among children 6months post-deworming campaign

4. DISCUSSION

The overall prevalence of soil-transmitted Helminths at the mile 16 Bolifamba community was 5.8%, which is lower than that reported in other areas in the division [5,13,14]. However, lower prevalence has been recorded in other areas of the division [6]. The low prevalence recorded in this study when compared with previous studies is probably an indication of improved hygienic conditions and regular deworming campaigns in the community. Our study revealed a prevalence of 3.9% for STHs among children who were previously dewormed, which is higher than that reported in other parts of the division [15] and other areas of Africa [16] after post-deworming campaign. Our findings were lower than that reported by Njua-Yafi et al. [17] six months after deworming. The high prevalence of STH infection in the mile 16 Bolifamba community after intervention may be attributed to ineffective deworming approaches at the community level, some socio-demographic and behavioural risk factors and, possible drug-resistant STH. The scale-up of chemotherapy programmes that are underway in various parts of Africa and other parts of the world, particularly targeting school children, is likely to exert increasing drug pressure on parasite populations, a circumstance that is likely to favour parasite genotypes that can resist anthelmintic drugs [18]. Given the paucity of suitable alternative antihelmintics, it is imperative for monitoring programmes to be introduced, both to assess progress and to detect any changes in therapeutic efficacy that may arise from the selection of worms carrying genes responsible for drug resistance [18].

In relation to gender, the prevalence of STH was similar in females and males, which is similar to the findings of a previous study in the South West Region of Cameroon [6], but in contrast to the study carried out by Ntonifor et al. [15] around Mount Cameroon, Buea, who found out that the prevalence of STH was higher in males than in females [14]. *Ascaris lumbricoides* (4%) and hookworm (2%) were found among the study participants. This was in accordance with a low prevalence of hookworms recorded by Nkuo-Akenji et al. [3] in the Mount Cameroon area. The prevalence of the STH eggs in soil varies greatly depending on the study area, as well as the type of STHs [19,20]. These findings were lower than that reported in other studies [21], and were contrary to that of Ndamukong et al. [6], Makoge et al. [22], who reported no hookworm infection with a lower prevalence of *Ascaris lumbricoides*. The prevalence of STH eggs in soil is also dependent on the type of soil. Studies by Appleton et al. [23] found out that infections with hookworm were higher in areas with sandy soils of the coastal plains in the region.

With regard to risk factors, our study showed that no washing of hands before eating, walking barefoot in the environment, lack of STH awareness by guardians/parents, no deworming and defecating in bushes and gardens increase the odds of infection with STH. We found out that

the sources of drinking water supply in the Mile 16 Bolifamba community (pipe-borne water and spring) were not a risk for STH. Hand-washing before eating and after defecating is associated with lower odds of 0.38 (95% CI 0.26–0.55) and 0.45 (95% CI 0.35–0.58) for *Ascaris lumbricoides* infections [24], and also hand-washing is associated with lower transmission of ascariasis [25]. Walking barefooted could result in exposure to the infective larvae of hookworms and thereby increasing the risks of infections [26]. Wearing of shoes, as expected, was found to be associated with lower odds of hookworm infections (OR 0.29, 95% CI 0.18-0.47) [24]. Access to sanitation is associated with reduced STH infection, and it is a key component of integrated STH control programmes [25,27]. The likelihood of STH infections with access to sanitation was found to be lower (OR 0.66, 95% CI 0.57–0.76) [24]. The highest reduction in STH infection with access to improved sanitation has been reported for *A. lumbricoides*, and *T. trichiura* [27,28], but did not result in lower hookworm infections [24], which may be due to the different mode of transmission. Lack of STH awareness by guardians/parents, increases the odds of STH. Jimam et al. [29] had reported limited knowledge on Helminths and poor attitude towards deworming in their study. Improve awareness on STH and deworming among guardians and parents will help limit the recurrent infection with STH in the community.

5. CONCLUSIONS

Based on the findings of this study, we conclude that the prevalence of soil-transmitted helminth infections among school children in the Mile 16 Bolifamba community was 5.8%. A prevalence rate of 3.9 % was reported for children who have recently been dewormed against STH. This portrays a re-infection rate which might have been as a result of continuous exposure. The study shows that there is an increasingly rising active transmission of STH in the Mile 16 Community, despite the post-deworming campaign. Also, walking barefoot, improper hand-washing before eating, lack of awareness by parents/guardians on STH and deworming, as well as defecating in bushes and gardens increase the likelihood of STH infection. These results suggest, among other things, that even though community-based deworming programmes have many important benefits, more need to be done to improve on the effectiveness of deworming campaign processes and the combination of other control approaches like education, behavioural and improved proper sanitation in the mile 16 Bolifamba community in order to effectively eradicate the STH. Further studies are needed to test for drug resistance STH genes among the population.

CONSENT

Participants were issued consent/assent forms to seek for their parents'/guardians' approval. Participants were accepted for screening only when their parents/guardians brought back signed informed consent/assent forms indicating their approval for their children to take part in the study.

ETHICAL APPROVAL

Administrative authorisation was obtained from the South West Regional Delegation of Public Health. An approval was also obtained from the Institutional Review Board of the School of Health Science, BIAKA University Institute of Buea. An additional clearance was obtained from the Chief of mile 16 upon presentation of an authorisation from the Regional Delegation of Public Health.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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