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Soil-Transmitted Helminth Infections and Associated Risk Factors in a Neglected Region in the Upper Nkongho-mbo Area, South-west Region, Cameroon

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Authors' contributions

This work was carried out in collaboration between all authors. Authors NHN and TJE did the study design and wrote the protocol. Author NHN wrote the first draft of the manuscript and managed literature searches. Authors TJE and IUNS managed the statistical analysis and literature searches. Author TJE did the laboratory work and entered the data. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Soil-transmitted helminth (STH) infections are among the most prevalent chronic human infections worldwide and affect the poorest and most deprived communities. Few studies have been carried out to evaluate the state of STH infections in the Upper Nkongho-Mbo region of Cameroon; hence levels of infection remain unknown.

Methodology: A cross-sectional study on the prevalence and intensity of soil-transmitted helminth infections as well as the influence of risk factors was carried out in the Upper Nkongho-Mbo area, South-West Region, Cameroon, between November 2012 and July 2013. Faecal and soil samples were collected and analysed using the formol-ether concentration technique and the sucrose

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floatation centrifugation technique respectively. Information on hygienic standards was also obtained.

Results: Results obtained showed that out of 327 people sampled, 145 were infected with one or more STHs giving an overall prevalence of 44.34%. The prevalence of round worm infection (39.14%, 128) was significantly higher (χ^2 = 26.95; p ≤0.001) than that of whipworm (8.26%, 27) and hookworm (13.46%, 44). The prevalence of infection varied with age group (p ≤0.001). The 21-50 years age group had the highest prevalence (55.44%) while the 6-12 years age group had the lowest prevalence (30.38%). Intensity of infection also varied significantly with age groups (p < 0.001). The highest intensity was observed in the 21-50 years age group (113.5±24.8), and the lowest in the 6-12 years age group (20.95±9.33). Soil samples examined had a prevalence of 26.79% (30) compared with 44.34% observed in the faecal samples. The proportion of soils contaminated was statistically different from the proportion of faecal samples contaminated (χ^2 = 4.307; p = 0.038). Age and toilet type were found to be important predictors of infection (p = 0.041and p= 0.01).

Conclusion: These findings provide evidence for the high risk of acquiring STH infections from the middle age group in the Upper Nkongho-Mbo region of Cameroon. Effective measures are therefore necessary to reduce contamination of the region.

Keywords: Soil transmitted helminthes; co-infection; prevalence; Cameroon.

1. INTRODUCTION

Thousands of rural and impoverished villagers throughout the tropics and subtropics are often chronically infected with several different species of parasitic worms [1] About 2 billion people harbour these infections worldwide, of which 300 million suffer associated severe morbidity and even death. The World Health Organization estimates indicate that geohelminthiases account for more than 40% of the disease burden due to all tropical diseases [2-4]. In developing countries, where control measures are often difficult to implement, STHs remain a significant health problem. Approximately one third of the world's population is infected with at least one species of STH, with Ascaris lumbricoides infecting 800 million people, Trichuris trichiura 600 million, hookworm 600 million and resulting in up to 135,000 deaths annually [5]. STHs have also been classified among the most prevalent neglected tropical diseases as they persist exclusively in the poorest populations and thus are often forgotten [6]. Important contextual determinants for human infection are poverty, lack of sanitation and inadequate hygiene [7,8] Efforts at controlling STHs are principally directed at school children because they are at the greatest risk of morbidity [9]. This may not be the best control strategy, and may not achieve the goal of eradication by 2020. Adults have been known to have a higher infection rate than school children and to harbour a greater variety of intestinal helminths [10]. Engagement in agricultural practices puts adults at a greater risk of infection with hookworm [11]. Thus, in many communities adults constitute an important reservoir of infection which is largely neglected by most current control programs. Due to a high rate of re-infection, despite long periods of intervention, it has been found that many communities that are subjected to routine targeted deworming still maintain a low level of infection [12]. In Cameroon, STH infections are endemic with rural areas being more infected than urban areas [13-15]. Despite more than a decade of serious intervention following the MDAI (combination therapy with albendazole and ivermectin) targeted chemotherapy protocol [16]. STH infections persist in many rural areas. As a result, it can be concluded that STH infections contribute significantly to the vulnerability of our rural populations. This study was conducted to determine the prevalence and intensity of STHs in the Upper Nkongho-Mbo area and also identify, in real time, the role of risk factors in transmission in the study area.

2. MATERIALS AND METHODS

2.1 Study Population and Design

The study was carried out between November 2012 and July 2013 in the UpperNkongho-Mbo area. This area is found in the Kupe-Manenguba division of the South-West region of Cameroon. The terrain is mountainous and has numerous streams which are the only source of water for the people. It has a characteristic dense equatorial rainforest. The village settlements are inaccessible and can only be reached by motorcycle and by trekking. Faecal samples were collected from participants in three villages using clean dry wide-mouth specimen bottles with tight covers. This was a cross sectional study where sample collection was selectively purposive, since the study aimed at targeting a wide age range within the defined study area [17]. Equally, 112 soil samples were collected from toilet areas, community playing grounds and school yards (20 gms of top soil each).

2.2 Ethical Considerations

This study was carried out with the approval of the Ethical Review Committee on Health Research, regional delegation of health for the South West Region Buea, Cameroon. Informed written consent was obtained from each study participant. Each participant was free to withdraw consent at any time. All personal information of the participants was treated strictly confidential.

2.3 Sample Size and Sampling Techniques

Fresh faecal samples were collected from 327 participants during the study period using sterile dry, clean, air tight, wide mouth screw cap labelled containers and analyzed within 24 hours of collection, following standard procedures. Stool samples were analyzed using the formal-ether concentration method while soil samples were analysed using the sucrose floatation-centrifugation technique [18,19]. Equally a semi-structured questionnaire was administered to all the 327 participants to elicited demographic information, toilet type, safety of water source, social determinants, health seeking behaviours and health education.

2.4 Data Analysis

Data was entered into Microsoft Excel 2007 and analysed using Minitab version 16. Descriptive analysis was performed on the data and the results presented in tables and graphs. Statistical tests were carried out at 95% confidence interval ($\alpha = 0.05$). The data was classified by age, sex and village for statistical comparison. The data was tested for normality using the Kolmogorov-Smirnov test for normality and counts were found to be not normally distributed. Mean parasite intensities between sites and between groups were compared using non-parametric Kruskal-Wallis test (H) or the Mann-Whitney U test (W). Chi square Goodness-of-Fit test was used to compare proportions. Binary logistic regression was used to test the determinants of infection.

3. RESULTS

3.1 Characteristics of the Study Population

A total of 327 participants provided samples for the study. This included 164 males (50.15%) and 163 females (49.85%). Out of the three villages included in the study, 91 respondents were from Lebok, 49 from Mbefe, and 187 from Njungo (Table 1). Participants were distributed into five principal age groups broken down as follows: 0-5 years, 6-12 years, 13-20 years, 21-50 years and >50 years. The proportion of each age group is presented in Table 1.

3.2 Prevalence and Intensity of Infection with STHs in the Study Area

Out of the 327 stool samples examined, 145 (44.34%) of them were infected with one or more species of helminth ova shown in Plate 1. Overall prevalence of infection was similar ($P > 0.05$) in Mbefe (46.94%), Njungo (45.46%) and Lebok (40.66%). However, the prevalence of whip worm varied significantly from village to village ($\chi2 = 8.95$, $P < 0.05$), being highest in Mbefe (14.29%) and lowest in Lebok (2.2%) as shown in Table 2. Prevalence of roundworms was significantly higher than whipworm and hookworm ($\chi^2 = 26.95$, $P < 0.01$). This overall pattern was consistent in all three villages in the study area (Table 2).

Overall prevalence of co-infections with two or more STHs was 15.0% (Table 3). Co-infection was most common in Njungo (16.6%) than in Lebok and Mbefe. Co-infection with roundworm and hookworm showed the highest prevalence (7.7%) while the lowest was with whipworm and hookworm (0.9%) as shown in Table 3.

3.3 Intensity of Infection with Soil-transmitted Helminths in the Study Area

Overall, roundworm had the highest intensity of infection in the study area with mean egg load being 59.9±10.0 epg while whipworm had the lowest intensity (3.07±0.91 epg). While intensity of infection with roundworm and hookworm did not differ between the communities, intensity of infection with whipworm was statistically different with intensity in Njungo being higher than in Lebok (Table 4).

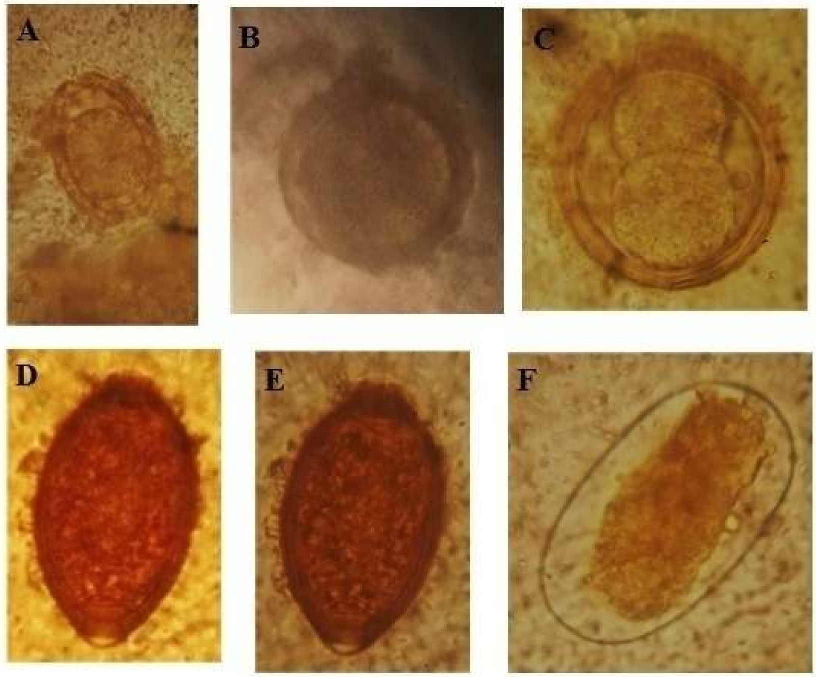

Plate 1: Eggs of soil-transmitted helminths identified during the parasitological survey. A and B, *A. lumbricoides*, one cell stage; C, *A. lumbricoides*, blastula; D and E, *T. trichiura*; F, hookworm.

Table 1. Demographic characteristics of the study population

Variable		Villages			Total N (%)
		Lebok N (%)	Mbefe N (%)	Njungo N (%)	
Sex	Male	52 (15.9)	21 (6.42)	91 (27.83)	164 (50.15)
	Female	39 (11.93)	28 (8.56)	96 (29.36)	163 (49.85)
Age groups in Years	0-5	4 (4.4)	3 (6.12)	27 (14.44)	34 (10.4)
	6-12	53 (58.24)	12 (24.49)	39 (20.89)	101 (31.8)
	13-20	4 (4.4)	10 (20.41)	35 (18.72)	49 (14.99)
	21-50	18 (19.78)	13 (26.53)	61 (32.62)	102 (31.19)
	>50	12 (15.9)	11 (22.45)	25 (13.37)	58 (17.75)
Total		91 (27.83)	49 (14.99)	187 (57.19)	327 (100)

Table 2. Prevalence of soil-transmitted helminth infections among subjects in three principal communities in the study area

Village	N	No infected (Prevalence (%))			Overall prevalence% (N)	χ^2	P-value
		Roundworm % (N)	whipworm% (N)	Hookworm% (N)			
Lebok	91	34 (37.36)	2 (2.2)	10 (10.99)	37 (40.66)	39.74	< 0.001
Mbefe	49	22 (44.9)	7 (14.29)	4 (8.16)	23 (46.94)	34.51	< 0.001
Njungo	187	74 (39.57)	15 (8.02)	29 (15.51)	85 (45.46)	25.84	< 0.001
Total	327	128 (39.14)	27 (8.26)	44 (13.46)	145 (44.34)	26.95	< 0.001
χ^2		0.74	8.95	2.38	0.49		
P-value		0.69	0.011	0.30	0.784		

(Chi-square Goodness-of-Fit Test; χ^2 = Chi-square statistic)

Table 3. Prevalence (%) of co-infections in the study area

Village	Number infected (Prevalence (%)					χ^2	P-value
	Round worm and whipworm	Roundworm and hookworm	whipworm and hookworm	All three STHs	Total		
Lebok	1.1 (1)	6 (6.6)	0 (0)	1 (1.1)	8.8 (8)	12.1	0.007
Mbefe	8.2 (4)	2 (4.1)	0 (0)	2 (4.1)	8 (16.3)	8.2	0.04
Njungo	4.8 (9)	17 (9.1)	3 (1.6)	2 (1.07)	31 (16.6)	9.9	0.02
Total	4.3 (14)	25 (7.7)	3 (0.9)	5 (1.5)	47 (15.0)	8.1	0.05
χ^2	5.366	1.894	3.2	2.8998	2.8101		
P-value	0.07	0.39	0.202	0.24	0.25		

Table 4. Intensity of infection with STH in the different villages

Village	Intensity of infection (epg ± SE)		
	Roundworm	Whipworm	Hookworm
Lebok	34.6±15.3	1.29±1.16	4.35±2.47
Mbefe	56.1±20.2	2.12±0.91	3.10±1.64
Njungo	73.2±14.9	4.19±1.46	3.87±0.89
Total	59.9±10.0	3.07±0.91	3.87±0.89
H	1.67	6.85	2.48
p	0.433	0.032	0.289

(Kruskal-Wallis test; H = Kruskal-Wallis statistic)

Table 5. Sex-related intensity of infection with soil-transmitted helminths in the study area

	Mean intensity of infection (epg) ±SE					
	Roundworm		Whipworm		Hookworm	
	Males	Females	Males	Females	Males	Females
Lebok	51.3±26.5	14.91±4.44	2.25±2.03	0.000±0.000	5.31±4.09	2.88±1.73
Mbefe	41.6±14.5	67.0±33.8	0.33±0.33	3.46±1.54	2.95± 2.17	3.21±2.40
Njungo	73.1±22.5	73±19.7	5.81±2.76	2.66±1.13	3.58±1 .09	4.15±1.41
Significance	W = 26849.5, p = 0.88		W = 26955.5, p = 0.79		W = 26758.0, p = 0.98	

(Mann-Whitney test; W = Mann-Whitney statistic).

Table 6. Age-related Prevalence of STH infections in the study area

		Number infected (%) in each age group						
Village	N	0-5	6-12	13-20	21-50	>50	χ^2	P-value
Lebok	91	2 (50)	13 (26.4)	3 (75)	10 (55.6)	8 (66.7)	25.2077	<0.001
Mbefe	49	3 (100)	7 (58.3)	6 (60)	5 (38.5)	2 (18.18)	67.0749	<0.001
Njungo	187	11 (40.7)	10 (28.2)	16 (45.7)	37 (60.7)	10 (40)	12.8633	0.01
Total	327	14 (31.2)	30 (28.9)	26 (53.1)	55 (59.8)	20 (41.7)	8.515	0.07
χ^2		32.003	17.067	7.1277	5.2407	28.373		
P-value		< 0.001	< 0.001	0.03	0.07	<0.001		

Roundworms remained the most implicated worm type. However Mann-Whitney test showed that the intensity of infection with STHs was roughly comparable among males and females (Table 5). In contrast to trends observed in Lebok and Njungo, women tended to harbour higher worm burdens than men in Mbefe.

Overall, the 21-50 years age group appeared to have the highest prevalence of infection (56.5%) followed by the 13-20 years age group (51.02%). These differences however were not statistically significant (Table 6). In all three villages, prevalence of STH infection differed significantly with respect to age. Apart from the 21-50 years age group, the prevalence of infection with STHs differed significantly for each age group across the three villages. In addition, apart from the 21-50 years age group where the prevalence was similar in all the villages, each age group differed significantly from village to village.

Table 7. Rate of soil contamination with STHs in the upper Nkongho-Mbo area

Village	Prevalence (%)			Total	χ^2	P-value
	Roundworm	Whipworm	Hookworm			
Lebok	15.56 (7)	6.67 (3)	13.33 (6)	31.11 (14)	3.610	0.164
Mbefe	16.67 (4)	8.33 (2)	16.67 (4)	33.33 (8)	3.338	0.188
Njungo	11.63 (5)	2.33 (1)	9.30 (4)	18.61 (8)	6.040	0.049
Total	14.29 (16)	5.36 (6)	12.5 (14)	26.79 (30)	4.166	
χ^2	0.959	3.323	2.079	4.550		
P-value	0.619	0.190	0.354	0.103		

Table 8. Predictors of STH infection

Variable	Coefficient	Odds ratio	95% CI		P-value
STH			Lower	Upper	
Sex	- 0.108999	0.9	0.57	1.4	0.634
Age	0.0106227	1.01	1.00	1.06	0.041
Toilet	- 0.682883	0.55	0.3	0.85	0.01

Out of 112 soil samples, 30 (26.79%) were infected with one or more species of STHs. The most common STH in the soil was rroundworm (14.29%) while the least was whipworm (5.36%). Although not statistically significant, soil samples from Mbefe were most infected (33.33%) when compared with the infection rate of soils in Lebok (31.11%) and Njungo (18.61%) (Table 7).

3.4 Predictors of Soil-transmitted Helminth Infections

Binary logistic regression between STH infection and a number of determinants revealed that age and toilet type were significant predictors of STH infections ($p = 0.041$ and $p = 0.01$ respectively). Soil-transmitted helminth infections tended to increase as age increased; while the use of the jetty toilet (a locally made staircase with a sitting on top of a pig fence) increased the risk of infection with STHs. Possession of a pit toilet was negatively associated with STH infection (Table 8).

4. DISCUSSION

The prevalence and intensity of intestinal helminth infections among different populations are functions of many different factors, most importantly environmental factors, parasitic factors, and host factors. The study revealed an overall prevalence of 44.04% for STHs. Prevalence rates were higher than those reported in other parts of Cameroon [20-22]. However, other researchers found much higher prevalence rates among the Orang Asli in rural Malasia [23], although this study was not restricted to children. The prevalence of STH infections was similar in Lebok, Mbefe and Njungo, probably because the villages are ecologically similar.

Ascaris infections occurred at higher prevalence than whipworm and hookworm infections, consistent with findings of Ntonifor et al. [8]. This is probably because ecological determinants such as humidity and altitude favour the development of Ascaris spp while hampering the development of whipworm. Hookworm infections were more prevalent than infections with whipworms. Findings in Kotto_Barombi and Marumba II villages similarly indicated higher prevalence of whipworm than hookworm [13]. The higher prevalence of hookworm noted in this study is probably because hookworm infections usually increase during the rainy season and also it is a typical rural farming population where most of them work bear footed in their farmlands. In addition, whipworm is less common at high altitudes [24].

Intensity of infection was generally low, consistent with the findings of Allen et al. [12] who explained that in regions where STHs are targeted for elimination with periodic deworming, high worm burdens are not very common. The data showed extreme variability supporting the fact that STHs are typically over-dispersed in the population with a few individuals harbouring infections of high intensity. Roundworm occurred at the highest intensities in the region while whipworm occurred at the lowest intensities. These trends are consistent with the findings of other researchers [10,15].

Despite initiation and completion of the annual deworming campaign shortly after the start of these studies, the prevalence of infection in the targeted age group remained high. This is roughly comparable to the findings of Ndamukong et al [25]. Prevalence of infection was significantly higher in Mbefe than in Lebok and Njungo in these age groups. This is probably because the samples of Mbefe were collected before the anthelmintic campaign began and so these children had not received any anthelminthics. Such a high prevalence of infection is consistent with the results of other researchers [26]. The most affected age group was the 21-50 years age group consistent with the findings of Pinheiro et al. [27] and Ntonifor et al. [8]. These findings are probable indicators that adults in the community are more important epidemiologically than school-aged children. This can be because this is the most active age group, daily involved in agriculture and outdoor activities that put them at greater risk of infection with STHs. Unfortunately, this group is largely ignored by the deworming exercise which is targeted at children through schools. Thus infection with STHs would tend to amplify in this age group. Such tendencies would account at least in part for the differences in infection prevalence observed between age groups. Such heavily infected age groups would equally impact environmental contamination with ova considerably. In addition, the deworming programmes target only children therefore leaving the adults as the main sources of contamination.

The overall rate of soil contamination (26.79%) was similar to the findings of Cassenote, et al. [28] but much less than that reported by Horiuchi et al. [29]. Soil analysis revealed that the soils were seeded with the various ova of these worms. This moderate rate of Soil contamination is probably due to the use of the jetty toilet. Roundworms were more prevalent in soil samples than hookworm and whipworm, even though soil contamination with hookworm had the highest mean intensities. This is probably because hookworm development peaks during the rainy season [30]. This seasonal surge might not necessarily affect the distribution of soil-transmitted helminth infections in the long run. Although prevalence of STHs was higher in faecal samples than in the soil, the pattern of distribution of soil-transmitted helminth infections in the soil was identical to the pattern of infection in study subjects. This suggests that the soil plays a major role in the epidemiology of soil-transmitted helminth infections in the Upper Nkongho-Mbo area. However, the generally low intensities might point to the cultural use of some plants in foods and drinks in the study area. It is possible that the consumption of menag (a bitter-sweet liquor) garnished with Anona senegalensis (locally called ‘bitter’), and the use of Piper guineense (bush pepper) as a spice in most of their foods helps to reduce worm burdens. These plants have been shown to have anthelminthic activities [31,32]. This might affect worm fecundity and survival in the human host and thus reduce faecal egg counts. However, the possible anthelminthic activity of menag garnished with “bitter” needs to be investigated further.

Age and toilet type were identified as important predictors of infection. Older people tended to be more at risk of becoming infected with STHs. The use of the jetty increased the risk of becoming infected probably because this helped to seed the surroundings with infective helminth eggs. Contamination of the environment with infective stages of STHs is considerable in the absence of adequate sanitation [5,33].

5. CONCLUSION

These findings provide evidence for the high risk of acquiring STH infections from the middle age group in the Upper Nkongho-Mbo region of Cameroon. Effective measures are therefore necessary to reduce contamination of the region. Therefore, intervention including improving sanitation, providing better toilets and extending the deworming program to adults should be considered by the government.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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