



## **Soil-Transmitted Helminths: Prevalence and Intensity of Some Soil Transmitted Nematodes among Pupils in Selected Primary Schools in Penka-Michel Sub-division, West-Cameroon**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors ATRJ and MM designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors ATRJ, YJ and NTA performed the statistical analysis and managed the analyses of the study. Authors ATRJ and NV managed the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Background:** Soil transmitted helminth infections are Neglected Tropical Diseases (NTD) affecting mostly pupils in developing countries. They seem to lose more and more interest due to the fact that resources and research are being justifiably diverted to more recent priorities such as HIV/AIDS, cancers, tuberculosis and malaria. As a result, specific data on STH infections is often lacking.

**Aims:** To evaluate the prevalence and intensities of STH parasites among pupils in Penka-Michel Sub-division, West-Cameroon in order to refresh information for a better management of these parasitic diseases.

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**Settings and Design:** A cross-sectional analytic study was conducted from October to December 2018 in Penka-Michel Sub-division.

**Methods and Materials:** To evaluate the prevalence and intensities of STH parasites among pupils, seven hundred and twenty nine (729) stool samples were collected from pupils aged 4 to 14 years old in 23 randomly selected primary schools. The samples were analysed using the concentration method of Willis and the Mc Master technic.

**Results:** Out of 729 pupils enrolled, 107 (14.7%) were infected with one or more STH parasite species. The nematodes species identified were *Ascaris lumbricoides* (9.9%), *Trichuris trichiura* (5.3%) and hookworms (2.2%). Pupils aged from 8 to 11 years were the most infected (17.3%). Statistically females were more infected with hookworms (2.2%). These parasites occurred as monospecific (84.11%), bi-specific (13.0%) and tri-specific (2.80%) infections. The mean fecal eggs count was  $3652.78 \pm 8715.93$ ,  $266.67 \pm 273.81$  and  $118.75 \pm 72.74$  for *A. lumbricoides*, *T. trichiura* and hookworm respectively. According to faecal concentration of eggs, 88.18% of infections were light.

**Conclusion:** These results show the necessity of sustainable application of regular deworming, health education and improvements in sanitation among pupils in Penka-Michel Sub-division.

*Keywords: Soil-transmitted helminths; prevalence; intensity; pupils; Penka-Michel; west-Cameroon.*

## 1. INTRODUCTION

Soil transmitted helminth (STH) infections are Neglected Tropical Diseases (NTD) caused by a cluster of four species of parasitic nematodes, including *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale* and *Necator americanus* (hookworms) [1]. They are among the most common chronic infections distributed throughout the world, disproportionately affecting poor populations living in tropical and subtropical parts of the world [2]. Worldwide, about 2 billion people are infected with STHs, in which 1,221 million are infected by *A. lumbricoides*, 795 million by *T. trichiura*, and 740 million by hookworms [3,4]. About 300 million people suffer from severe morbidity attributed to STH infections, resulting in 10,000–135,000 deaths annually [2,5].

They are most prevalent in regions exhibiting warm and moist climates coupled with poor sanitation and hygiene. Epidemiologically, there is no target age with STH infection, but the highest rates occur among children living in rural areas of the tropical and subtropical regions [6, 7,8]. Morbidity associated with STH infection are directly related to the intensity of infection, hence heavily infected children experience pathological sequels such as mal-absorption of nutrients, iron deficiency anemia, impairment of physical and mental development, which ultimately retards their educational advancement, expose them to other diseases and affect economic development of the nation [9,4,10].

Due to their frequent playing with soil, walking barefoot, poor health or nutritional status and

geophagic habits, coupled with a low level of awareness, more than 613 million school-aged children in the world are at higher risk of STH infections [11,2,12].

In Africa, géohelminthe infection is the second leading cause of mortality in children less than 6 years old [13]. It is estimated that over 30.7 million School-Aged Children are infected with *A. lumbricoides*, 36.5 million with *T. trichiura* and 50 million with hookworms [14,5].

In Cameroon, STHs are widely distributed. In January 2006, the Permanent Secretary of the National Programme of schistosomiasis and GI helminthiasis control reported that 2 million people were infected with schistosomes and more than 10 million by intestinal worms [15]. Due to unequal accessibility or lack of some facilities in the country like good source of drinking water, health care, public toilets, cleaning up services and overcrowding, the prevalence of STH infection varies from one region to another. According to Tchuem Tchuenté et al. [16], it was 32.5% in Littoral Region, 35.9% in North-West region, 46.2% in South-West region and 52.8% in South region. School children living in rural localities of the country are more exposed to STH infection than those living in urban areas [7,17]. Many studies have been carried out in some rural zones of West Region on STH infection among resident and school children who mostly faced the above mention problems [7,18-21]. But to the best of our knowledge, none or few epidemiological data are available on soil transmitted helminth infections among pupils in

Penka-Michel Subdivision. The present study was therefore designed to determine the prevalence and intensity of STH infections among pupils in selected primary schools in Penka-Michel Sub-division, West-Cameroon, for a better management of these parasitic diseases.

## 2. MATERIALS AND METHODS

### 2.1 Study Area and Population

This cross-sectional and analytic study was carried out from October to December 2018 in Penka-Michel Subdivision of the Menoua Division, West Region of Cameroon. Penka-Michel is located between latitude 21.52, 5° and 31.41, 5° north of the equator and longitude 7.39, 10° and 20, 10° east of the Greenwich Meridian. It has an altitude of about 1500 m above sea level. The locality experience two distinct seasons: a short dry (November to March) and a long rainy season (March to November). The highest rainfall registered in a year could reach 345.1 mm and the thermal amplitude between the hottest month of the year (March: 21.5°C) and the coldest (August: 18.9°C) is 2.6°C. Penka-Michel Subdivision is a rural area situated 35 km from the city of Dschang; it is made up of four villages (Balessing, Bamendou, Baloum and Bansa) with an estimated population of about 124 880 people with and a growth rate of 6.8% per year of which 'Bamilikés' constitute more than 90% of inhabitants [22 ,23].

Most of the inhabitants are peasant farmers. Penka-Michel has 64 Public (EP) and 23 private primary schools. Because of the low school fees, parent mostly preferred to send their children in public schools despite the low hygienic conditions prevailing in those schools. Some public schools lack functional toilet facilities and when they exist, they are mostly pit-hole toilets. Due to the high enrollment in these schools, coupled with lack or few toilet facilities available, some pupils defecate around classrooms, around toilets or in the bushes surrounding the schools. Most of the children go to school bare footed. Majority of the public schools lack drinking water. Such a poor hygienic environment favours proliferation of flies which feed on human faeces and by so doing help in the spread of many parasitic species on the dishes, on vegetable and water. Information obtained from many head teachers is that for one year, pupils have not received anti-helminthic drugs.

### 2.2 Sampling Method and Sample Size Estimation

Twenty three (23) government Primary Schools (EP) out of the sixty four (64) found in Penka-Michel subdivision were randomly selected for this study. This was done by writing the name of each school with respect to their group or village on a separate piece of paper, then placed in four boxes (representing the 4 villages) and thoroughly mixed before selection by blindly picking the pieces of paper. As result 23 schools were selected: 6 in Bamendou, 6 in Bansa, 6 in Balessing and 5 in Baloum villages.

The sample size for the study was calculated using prevalence 52.8% of STH reported by Tchuem Tchuenté et al. [16] in southern Cameroon, applying the following formula:

$$n = \frac{(Z_{1-\frac{\alpha}{2}})^2 \cdot P(1 - P)}{d^2}$$

Where; n = the expected sample size, p = prevalence of STH infection in school children from previous studies (P=0.528), d = 5% (margin of error) and  $Z_{1-\alpha/2}$  = 1.96 at 95% confidence interval (CI). This gave a sample size of 382.95 pupils. Thus minimum sample size of 383 was needed for the study. Finally 729 pupils were enrolled for this study.

### 2.3 Stool Sample Collection and Examination

A clean, well labeled plastic bottle was given to each participating pupil for the collection of early morning stool sample. By using national languages and dialect, appropriate instructions were given to pupils on how to hygienically collect the first morning stool. At 8 am on the following morning, stool samples were retrieved from the pupils and, immediately, 10% formalin was then added to each sample. Then, specimens were placed in an ice bag and transported to the Research Unit of Applied Biology and Ecology (RUABE) of the University of Dschang for parasitological analyses by the flotation technique using a saturated salt solution [24]. The intensity of the parasitic load was done using the Mc Master technique [25,24] and the identification of eggs was done using the morphological characteristic such as the size, shape, the shell and the egg contents [25,26]. Infection intensity was categorized as light,

moderate, or heavy as classified by World Health Organization standards (Table 1).

## 2.4 Data Analysis

Data was stored in a Microsoft Excel spread sheet and then exported to SPSS version 22 software for analysis. Descriptive statistics were used to summarize helminth eggs distribution according to schools, age groups, sex and village. Chi square ( $\chi^2$ ) test was used to assess differences in prevalence of STH infections. The Student t-test and one way analysis of variance (ANOVA) were used to compare mean egg intensity. Statistical significance was set at  $p < 0.05$ .

## 3. RESULTS

### 3.1 Socio-Demographic Characteristics of the Study Population

A total of 729 schoolchildren were enrolled for the study in the four villages of Penka-Michel subdivision, of whom 382 (52.4%) were boys. Pupils from 8-11 years of age were those most frequently recruited followed by those of 4-7 and 12-14, with participation rate of 499(68.4%), 175 (24.00%) and 55 (7.5%) respectively.

### 3.2 Prevalence of Soil Transmitted Helminths among Pupils

Overall, 107 of 729 (14.7%) stool samples examined were positive for soil transmitted helminth eggs. The eggs observed in the fecal

samples were identified to those of *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms (Table 2).

### 3.3 Soil Transmitted Helminths Profile among Different School Selected in the Four Villages of Penka Michel Subdivision

The STHs identified were unequally distributed among the 23 schools in the 4 villages involved in the study. Pupils from EP Bangouo and EP Balepipi in Balessing; EP Bilingue Toussan in Baloum; EP Bamendou 1 in Bamendou and EP Bilingue Penka-Michel in Bansoa were exempt of STH infection (Fig. 1). The same observations were done in EP Bambi in balessing; EP Milla II and EP N'Sanng in Baloum; EP Bamendou II and EP Melah in Bamendou; EP Balatsit and EP Bake in Bansoa where prevalence of hookworm infections were nul (Fig. 1). For the rest, regardless of the villages, *A. lumbricoides* infections were the most prevalent among pupils. This was following by *T. trichiura* infection.

### 3.4 Intensity of Soil Transmitted Helminth Infection (Mean EPG) among Pupils

The specific intensity of infection expressed in terms of mean concentration of eggs per gram (EPG $\pm$ SD) of faeces of identified parasite varies from one species to another. The difference between these parasitic intensity values was statistically significant ( $p < 0.05$ ) with the high mean concentration registered in pupils infected by *A. Lumbricoides* (Table 3).

**Table 1. Classification of geohelminth infections intensity by world health organization expert committee in 1987 [1]**

Helminth	Light	Moderate	Heavy
<i>Ascaris lumbricoides</i>	$\leq 5.000$	5.001–49,999	$\geq 50.000$
<i>Trichuris trichiura</i>	$\leq 1.000$	1.001–9,999	$\geq 10.000$
Hookworm	$\leq 2.000$	2.001–3,999	$\geq 4.000$

**Table 2. Type and frequency of STH parasites among the 729 pupils enrolled in 23 primary schools in Penka-Michel**

Parasites	N° of Positive stool samples	Frequency (%)
<i>Ascaris lumbricoides</i>	72	9.9
<i>Trichuris trichiura</i>	39	5.3
Hookworm	16	2.2

**Table 3. Specific mean concentration of eggs (EPG±SD) of STH in infected pupils from Penka-Michel during survey**

Parasites	No. Infected	Egg per gram (Mean ±SD)
<i>Ascaris lumbricoides</i>	72	3652.78 ± 8715.93
<i>Trichuris trichiura</i>	39	266.67 ± 273.81
Hookworm	16	118.75 ± 72.74

### 3.5 Pupil Age Groups - Related Prevalence of Soil Transmitted Helminth Infections

According to pupil age groups, the general prevalence of the observed STH parasites and specific prevalence of *A. lumbricoides* and *T. trichiura* were significantly higher with  $P= 0.010$ ,  $P= 0.017$  and  $P= 0.046$  respectively among pupils aged 8 to 11 years (Table 4). However the highest occurrence of hookworm infection (3.6%) was recorded in pupils aged 12 to 14 years. Considering fecal egg concentration, the mean EPG±SD of *A. lumbricoides* increases with age. While the mean EPG±SD of *T. trichiura* (342.42±281.49) was relatively high in pupils aged 8 to 11 years (Table 4). For hookworm concern, no significant difference ( $P=0.697$ ) was obtained in specific prevalence and in fecal egg concentration between age groups.

### 3.6 Sex - Related Prevalence of Soil Transmitted Helminth Infections

In relation to pupil sex, both sexes were infected by soil transmitted helminths. Independent of the parasite species, the prevalence of infection according to sex is 13.3% in females and 16.00% in males. Statistically females were more ( $p=0.026$ ) infected with hookworms (2.2%).

### 3.7 Village – Related Prevalence of Soil Transmitted Helminth Infections

The soil transmitted helminth infections among pupils in relation to their resident village shows that the general and specific prevalence of identified parasites did not varies from one village to another (Table 6).

### 3.8 Parasitic Associations among Infected Students

The overview of soil transmitted helminth associated infections among infected pupils shows that, three types of parasitic combinations

were found (mono-specific, bi and tri-specific). Mono-specific parasitism was the most frequent (Fig. 2). The associations involving two types of parasite species are *A. lumbricoides* – *T. trichiura*, *A. lumbricoides* – hookworms; hookworm – *T. trichiura*. For the tri-specific association, we registered *A. lumbricoides*, *T. trichiura* and hookworm in three cases (Fig. 2).

### 3.9 Faecal Concentration Density of Soil Transmitted Helminth Eggs

The Faecal concentration density of soil transmitted helminth eggs identified among infected pupils shows in general infection were light regardless of parasite species (>80%). Heavy intensity (2.8%) was only with *A. lumbricoides* infections (Table 7).

## 4. DISCUSSION

The occurrence of soil transmitted helminth infections due to *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms as observed in this study has been reported among pupils by various authors from different parts of Cameroon [7,16,19,20,17]. This seems to confirm the poor hygienic conditions prevailing in the area (as indiscriminate disposal of human and animal faeces in schools and in houses, lack of good source of drinking water). The study revealed that, 14.7% of pupils enrolled in this study were infected with at least one STH species. This prevalence is higher than the 1% obtained by Egbe et al. [5] in Tiko Health District, South West Region of Cameroon during post-intervention survey on prevalence and intensity of infection among primary school children. However it is not far from 24.5% obtained by Ngangnang and Khan Payne [20] among School Age Children in Nkondjock, Littoral-Cameroon and can be explain by the above mentioned situation and also, by the irregular deworming campaigns in schools of the study area.

Infection with *A. lumbricoides* and *T. Trichiura* was respectively the most prevalent among pupil.

This can be explained by the fact that: 1) *Ascaris* and *Trichuris* eggs are very adhesive and can easily stick to fruits, vegetables, flies and dust particles which could promote their transmission [27,21]; 2) These eggs can survive in adverse environmental conditions due to the presence of an inner shell layer of lipoprotein nature which makes them more resistant to harsh environmental conditions and air-borne [28]; 3) The relatively high prevalence of trichuriasis and ascariasis could be also due to the fact that people rear pigs (reservoir of *A. sum* and *T. suis* both known as responsible of zoonosis) nearer their houses [29,30,31]. However hookworm infections were less prevalence among pupils. This may surely be attributed to variations of climatic conditions of soil as far as the survival of infective hookworm larvae are much more dependent on soil moisture [32].

Intensity of infection is the main epidemiological index used to describe STH infection. The mean parasitic intensity for each STH species obtained in this work was higher than that obtained by Ngangnan and Khan Payne [20] in Nkondjock, Cameroon. It can be explained by the multiple infections due to frequent exposure of pupils to a particular risk factor such as frequently being in contact with contaminated soil, water or with domestic animals faeces (cat, dog, pigs). It can also be due to lack of awareness in school coupled to the irregular deworming campaign among these pupils.

With respect to age, pupils aged from 8 to 11 years old were the most infected (17.2%); especially with *A. lumbricoides* (12.0%) and *T. trichiura* (6.6%). The trend in the prevalence of these parasites in this group can be explained by the fact that children at this age are more exposed to contaminated soil during their playing time. More so, they tend to eat indiscriminately unwashed fruits or vegetables sometimes with unwashed hands [32]. While the low prevalence (8.0%) recorded among children aged from 4 to 7 is probably due to parental care on their personal hygiene, nutrition and healthcare. However, prevalence of hookworm infection in this study rose with age. This corroborates the finding of Tilahun et al. [33]. This reflects age related change in exposure to hookworm infection and can be explained by their behavioral pattern. As they grow, they tend to be more active barefooted when playing, going

to school, fishing or helping their parents with agricultural activities in the field.

According to gender, results showed that although males (16.2%) seemed more infected than females (13.0%), the difference was not statistically significant. This agrees with the findings of Nmor et al. [32]. Specifically, female (5.5%) were more infected by hookworm than male (1.0%). This is due to the fact that females are more helpful to their parent in farm work than male in the study area.

Location did not seem to be a significant factor in geohelminthic infection among pupils in this study as far as there was a little variation in prevalence among pupils in the four villages. This could be attributed to some socio-ecological factors that they share together such as poor sources of drinking water, low hygienic conditions, temperature, relative humidity and rainfall.

In developing countries, polyparasitism is the rule rather than exception [34]. In the present study, 15.88% of infected children harboured multiple parasites (two or three helminths). Three types of double parasitisms were identified with association involving *A. lumbricoides* and *T. trichiura* being the most prevalent (1.1%). This agrees with the works of Ngangnan and Khan Payne [20] and might be due to the fact that these two parasites have a common transmission pattern (faeco-oral).

The distribution of these eggs showed that majority of the pupils (88.18%) had light infection. This might be attributed to the method used for egg count per gram of faeces as the Mc master technique used in the present study is less sensitive as compared to the Kato Katz technique. Heavy infection (1.57%) was observed only in case of *A. lumbricoides* infection. It could be explained by the cosmopolitan pattern of *Ascaris* eggs and to the fact they can remain viable in the environment for long periods than the eggs of other parasites. Also it is related to the number of adult worms harboured in the host and on the egg output capacity of adult females of these parasites. As far as it is known that, *Ascaris* has a higher egg output (200,000 egg/day), hookworm less (6000 egg/day) and *Trichuris* lesser (2000 egg/day) [35, 36].

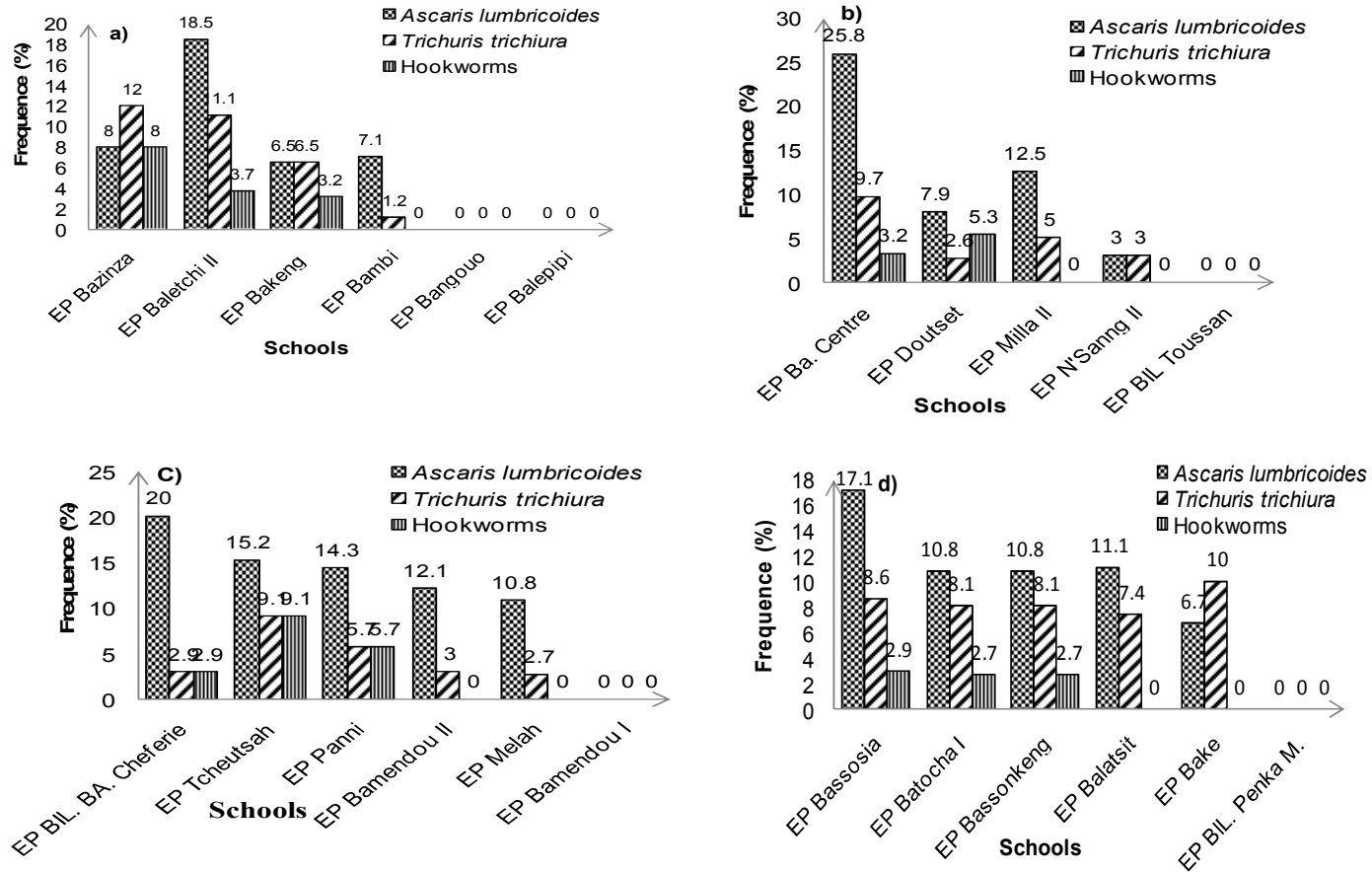


Fig. 1. Soil transmitted helminth infections profile among selected school in the four villages: a) Balessing, b) Baloum, c) Bamendou and d) Bansa of Penka-Michel sub-division

Table 4. Variation of soil transmitted helminth infections according to pupil age groups from selected schools in Penka-Michel

Age group (year)	N° stool examined	No positive stool (%)	Parasites					
			<i>Ascaris lumbricoides</i>		<i>Trichuris trichiura</i>		Hookworms	
			No infected (%)	EPG±SD	No infected (%)	EPG±SD	No infected (%)	EPG±SD
4-7	175	14(8.00)	9(5.1)	283.33± 237.17 <sup>a</sup>	3(1.7)	83.33± 28.86 <sup>a</sup>	3(1.7)	66.67 ± 28.86 <sup>a</sup>
8-11	499	86(17.2)	60(12.0)	3462.50± 7095.78 <sup>ab</sup>	33(6.6)	342.42± 281.49 <sup>b</sup>	11(2.2)	136.36± 80.90 <sup>a</sup>
12-14	55	7(12.7)	3(5.5)	17566.67± 29474.11 <sup>b</sup>	3(5.5)	116.67± 76.37 <sup>ab</sup>	2(3.6)	100.00±0.00 <sup>a</sup>
<b>Total</b>	729	107(14.7)	72(9.9)	3652.78± 8715.93	39(5.3)	305.13± 273.81	16(2.2)	118.75 ± 72.74
<b>p-value</b>		<b>0.010</b>	<b>0.017</b>		<b>0.046</b>		<b>0.697</b>	

a and b on the same column=significant at  $P<0.05$ - a, a on the same column=non-significant at  $P>0.05$

Table 5. Sex-related prevalence and intensity of STH infections among pupils enrolled during survey in Penka-Michel

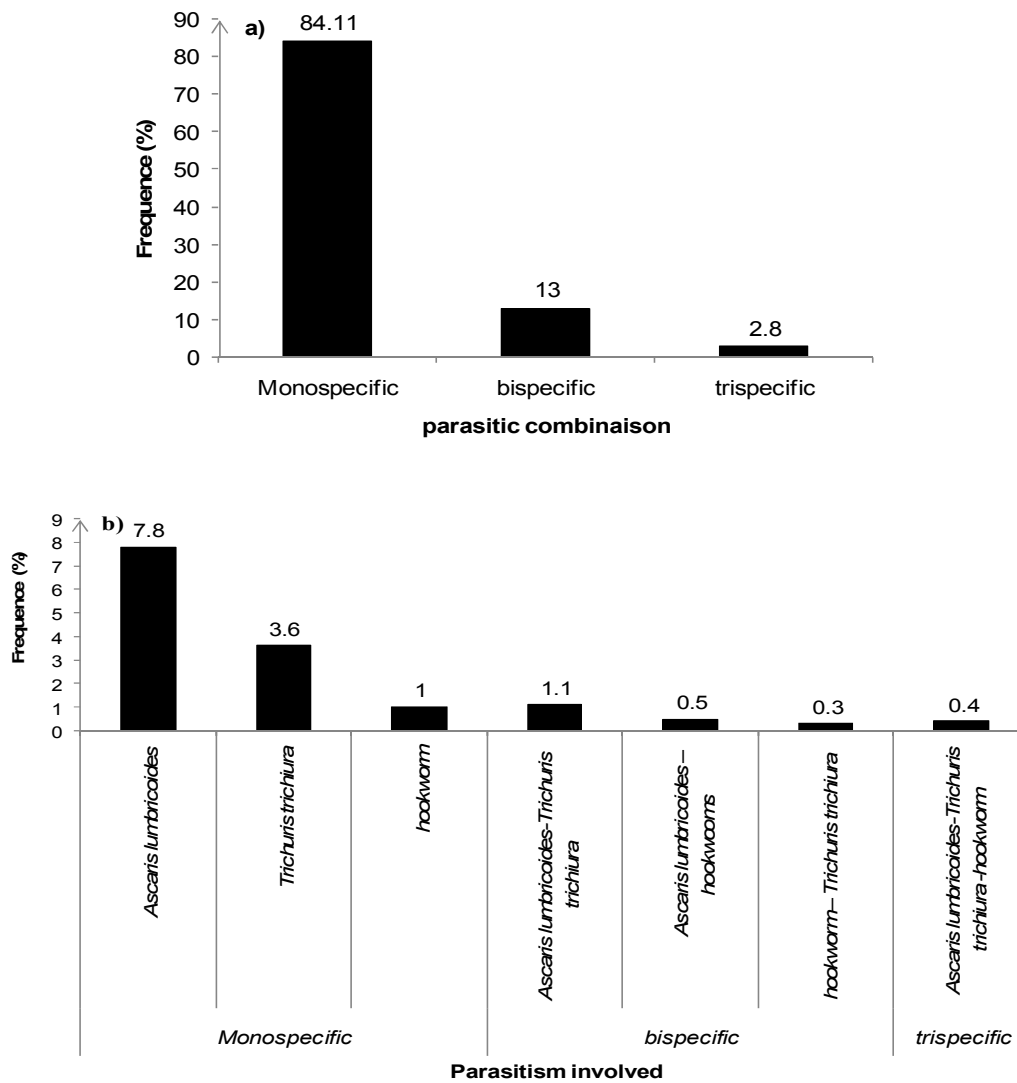
Gender	No of stool examined	No positive stool (%)	Parasites					
			<i>Ascaris lumbricoides</i>		<i>Trichuris trichiura</i>		Hookworms	
			No infected (%)	EPG±SD	No infected (%)	EPG±SD	No infected (%)	EPG±SD
Male	382	61(16.00)	42(11.0)	3286.67 ± 9399.02 <sup>a</sup>	26(6.8)	342.31 ± 267.04 <sup>a</sup>	4(1.0)	100.00 ± 00 <sup>a</sup>
Female	347	46(13.3)	30 (8.6)	3914.29 ± 8300.59 <sup>a</sup>	13(3.7)	286.54 ± 294.28 <sup>a</sup>	12(3.5)	125.00 ± 83.93 <sup>a</sup>
<b>Total</b>	729	107(14.7)	72(9.9)	3652.78 ± 8715.93	39(5.3)	305.13 ± 273.81	16(2.2)	118.75 ± 72.74
<b>P-value</b>		<b>0.225</b>	<b>0.288</b>	<b>0.766</b>	<b>0.067</b>	<b>0.556</b>	<b>0.026</b>	<b>0.570</b>

a and b on the same column=significant at  $P<0.05$  - a,a on the same column=non-significant at  $P>0.05$



**Table 6. Variation of STH infections in pupils according to the four villages of Penka-Michel Sub- division**

Villages	N° of stool examined	N° of positive stool N (%)	Parasites		
			<i>Ascaris lumbricoides</i> N (%)	<i>Trichuris trichiura</i> N (%)	Hookworms N (%)
Baloum	163	21(12.9)	11(6.7)	10(6.1)	4(2.5)
Bamendou	170	23(13.5)	17(10.0)	7(4.1)	3(1.8)
Bansoa	203	34(16.7)	25(12.3)	8(3.9)	6(3.0)
Baloum	193	29(15.0)	19(9.8)	14(7.3)	3(1.6)
<b>Total</b>	<b>729</b>	<b>107(14.7)</b>	<b>72(9.9)</b>	<b>39(5.3)</b>	<b>16(2.2)</b>
<b>P-value</b>		<b>0.726</b>	<b>0.369</b>	<b>0.410</b>	<b>0.774</b>



**Fig. 2. Variation of the types of parasitism recorded among infected pupil during survey: a) Parasitic combination; b) parasitism involved**

**Table 7. Distribution of parasite density according to faecal concentration of eggs among infected pupils**

Parasites	Class of Intensity			Total
	Light N (%)	Moderate N (%)	Heavy N (%)	
<i>Ascaris lumbricoides</i>	58(80.6)	12(16.6)	2(2.7)	<b>72</b>
<i>Trichuris trichiura</i>	38(97.4)	1 (2.6)		<b>39</b>
Hookworm	16(100)			<b>16</b>
<b>Total</b>	<b>112(88.18)</b>	<b>13(10.24)</b>	<b>2(1.57)</b>	<b>127</b>

## 5. CONCLUSION

This study ascertains that soil-transmitted helminth is an unresolved public health problem among pupils in Penka-Michel subdivision with the most common species being *Ascaris lumbricoides* follows by *Trichuris trichiura*, and Hookworm. In addition, this study demonstrated that moderate to heavy infections as well as polyparasitism are common in children. Therefore, improved sanitation, health education and school based health program as well as very deworming of the pupils will go a long way in reducing infection and consequently the associated morbidity. It is therefore suggested to investigate on Knowledge, attitude and practice with respect to soil contamination by Soil-Transmitted Helminths in public schools in such area.

## ETHICAL APPROVAL AND CONSENT

Permission to carry out the investigation was granted by West Health regional delegate, health officers of Penka-Michel district and basic educational authorities of Penka-Michel subdivision while informed consent of head school teachers, parents or guardians and teachers of the participating pupils was obtained after explaining the objectives of the study at a parent teacher association executive meeting. Only pupils who were willing to participate and whose parents or guardians signed the written informed consent form were included in the study.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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