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# Prevalence of Malaria Parasitaemia and Intestinal Protozoan Infections among Schoolchildren in Ndop, Northwest Cameroon, A Conflict Hit Locality

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Authors CBE, FNN, ONN and CY designed the study. Authors CBE and JAM did the field work, laboratory analysis and wrote the manuscript. Author CBE analyzed the data. Authors FNN, ONN, CY and HKK edited the manuscript. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** The aim of this study was to investigate the prevalence and factors associated with malaria and intestinal protozoans among schoolchildren in Ndop a conflict hit locality in Northwest Cameroon.

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**Study Design:** This was a school-based cross-sectional study.
**Place and Duration of Study:** This study was carried out at the Cameroon Baptist Convention Nursery and Primary School Bamunka, Ndop during the months of April and May 2023.
**Methodology:** Sociodemographic and hygiene-related data was collected using a structured questionnaire. Capillary blood and stool samples were collected, giemsa-stained blood films were examined to detect malaria parasites, while normal saline and iodine wet preparations were used to detect intestinal parasites in stool. Data was analyzed using SPSS version 22.0. The Chi-square test was used to compare prevalence between groups, p values less than 0.05 were considered statistically significant.
**Results:** One hundred and eighty (180) children took part in the study. The prevalence of malaria, intestinal protozoans, and malaria and intestinal protozoan coinfection observed were 7.2%, 13.0%, and 1.5% respectively. *Plasmodium falciparum* was the only *Plasmodium* species identified while the intestinal protozoans observed were *Entamoeba histolytica* (9, 6.9%), *Entamoeba coli* (12, 9.1%) and *Giardia lamblia* (10, 7.6%). With respect to socio-demographic characteristics, father's profession (*p=0.04*) and, class of children (*p=.01*); whereas for methods related to prevention, taking anti-helminthics (p=.001), having a toilet at home (p=.001), toilet type (p=.000), washing of hands at school (p=.001), washing of hands at home (p=.001) and source of water were associated with intestinal parasite prevalence.
**Conclusion:** This study revealed that malaria parasite and intestinal protozoans still constitute public health problems in Ndop. Control measures implemented by government to curb the prevalence of helminthic infections are quite effective meanwhile there is need to maintain and re-enforce measures for the control of malaria and intestinal protozoans.

*Keywords: Prevalence; malaria; intestinal parasitic infections; coinfection; schoolchildren; Ndop; Cameroon.*

## 1. INTRODUCTION

Malaria and intestinal parasitic infections (IPIs) are among the most prevalent diseases in Sub-saharan Africa (SSA) including Cameroon with reported coinfections due to the overlapping of favourable human-related and environmental factors. Malaria is a potentially life-threatening mosquito-transmitted infectious disease that is of worldwide public health concern [1]. It is caused by a blood dwelling protozoan parasite of the genus *Plasmodium*. The most serious and sometimes fatal type of malaria is caused by *Plasmodium falciparum*. Other human malaria parasite species are *P. vivax, P. ovale, P. malariae,* and *P. knowlesi*. Malaria has persisted as the most important infectious disease in tropical and subtropical regions, and continues to be a major global health problem, with over 40% of the world's population exposed to varying degrees of risk in some 100 countries [1, 2]. Globally, there were an estimated 247 million malaria cases in 2021 in 84 malaria endemic countries an increase from 245 million in 2020. Most of this increase is said to come from countries in the WHO African Region, resulting in about 1-2 million deaths, among which 90% are children less than 5 years in sub-Saharan Africa [1]. Reports from sub-Saharan Africa show varied prevalence of *Plasmodium falciparum* infection among populations. Higher values have been reported in children less than five years in Mount Cameroon Region in Southwest Cameroon [3] and in Tubah Health District in Northwest Cameroon [4] meanwhile other reports in other parts of the Mount Cameroon Area have shown higher values in children above five [5,6].

About 200 million school-age children are at risk of malaria in Africa, with an overall prevalence of more than 50% in this age group although this may vary within the region [7] and within countries like Cameroon. The disease is associated with manifestations including anaemia, diminished cognitive function, and lower educational achievement [8]. Innovative interventions are urgently needed to protect children from the consequences of malaria and to reduce the reservoir of the parasite especially *P. falciparum* circulating in endemic communities like Ndop in Cameroon. However, current efforts by Governments and other bodies have yielded appreciable efforts [9]. These current interventions include; timely diagnosis using reliable tests, treatment with anti-malarial drugs; indoor residual spraying with safe insecticides; and the use of long-lasting insecticide-treated nets (LLINs) to protect people from mosquito bites at night [7]. The Cameroon Government in recent times has made the fight against malaria a

priority, with a highlight in the country's Health Sector Strategy. It has also adopted the High Burden High Impact stratification exercise in the National Malaria Strategic Plan, yet the country remains amongst the fifteen highest burdened malaria countries with 2.7% of all global cases and deaths [10]. Despite the scale up in measures to fight against malaria, less than 30% of children who reported with fever were tested for malaria in 2020 [10,11].

Intestinal parasitic infections are among the most common communicable diseases worldwide, especially in communities with low levels of personal hygiene and sanitation measures. Globally, about 3.5 billion people are affected, and 450 million are sick as a result of intestinal parasite infections with the majority being children [12]. Intestinal parasites are among the most widespread infections in the developing world. Common intestinal protozoa include *Entamoeba histolytica* and *Giardia lamblia* while common helminths include *Ascaris lumbricoides, Shistosoma mansoni*, *Trichuris trichiura*, and *Necator americanus* [1,13]. Although deaths associated with intestinal parasites do occur, the majority of their burden is related to their morbidity which is manifested by chronicity, anaemia, delayed growth and development in children among other manifestations [14]. Occurrence and endemicity of IPIs are associated with factors including but not limited to food, personal and environmental hygiene, educational level and health sector strategy put in place to fight the infections. Schoolchildren are particularly vulnerable to these infections because of their dependence on guardians and school authorities for hygiene measures, insufficient knowledge and play habits [15]. In 2012, the World Health Organization (WHO) estimated that 270 million preschool-aged children and more than 600 million school-aged children lived in areas where intestinal helminths and protozoans are intensively transmitted, and thus warrant interventions [16]. The necessity of these interventions is to curb morbidity and mortality, and also associated complications like stunting, underweight, physical weakness and low educational performance in schoolchildren. It is important to note that, IPIs gradually exacerbate the nutritional status of children and increase vulnerability to other infections especially concomitant cases [17]. To reduce the burden of IPIs, the WHO recommends sanitary education and mass drug administration of mebendazole or albendazole antihelminthics, but also praziquantel as a therapeutic and preventive strategy for pre-school and schoolchildren in endemic areas given that helminths are associated with the majority of the morbidity and mortality associated with intestinal parasitic infections. This is to enable the WHO 2030 strategy achieve and maintain elimination of STH morbidity in pre-school and school age children [16].

Although there has been a decline in the global prevalence of malaria [1], many especially children in sub-Saharan Africa still die of malaria related conditions [18]. Also, IPIs still constitute a major public health problem in the tropics, as these areas are often characterized by all the conditions favoring transmission of these infections, such as humid climate, unsanitary environment and poor socio-economic status [16]. Therefore, due to the overlapping distribution of malaria and IPIs, concomitant infections are common in developing countries such as Cameroon. Coinfection causes varying effects on the host, including poor development and learning capabilities as well as increased susceptibility to other infections [3,19]. However, in areas where preventive measures against both malaria and IPIs have been implemented, determining the prevalence of the infections will also be a contribution to the assessment of the efficacy of the measures. This is undoubtedly important in areas with conflicts given that the implementation of health strategies may have been impeded. This study was designed to determine the prevalence of malaria and IPIs among schoolchildren in Ndop, a conflict hit locality in Northwest Cameroon. The locality like the whole of the country has features that favour malaria and intestinal parasitic infections.

## 2. MATERIALS AND METHODS

### 2.1 Study Area and Participants

The study was carried out at the Cameroon Baptist Convention Nursery and Primary School Bamunka, Ndop. Ndop is situated at 06°00'N, and 10°42'E, 1220m above sea level. It is the administrative headquarters of the Ngo-ketunjia Division in the Northwest Region of Cameroon. There are public and private educational establishments although facing challenges in their functioning due to an ongoing conflict in the anglophone regions of the country. The area is characterized by a plain with low land vegetation and a mean annual temperature of 24°C. It has a high-water table with streams running down from nearby hills. Rice farming is a common practice

although done using rudimentary tools and near absent protective clothing. Pipe-borne water is in limited supply. There is a public district hospital and a few private health facilities.

Participants in this study were school children of both sexes from primary one to six who were present in school during data collection and whose parents/guardians had given their consent for participation. Only children who had spent at least a school term (three months) in the school were admitted into the study and participation was totally voluntary.

## 2.2 Study Design, Sample Size Estimation and Technique

This study was a school based cross-sectional study carried out between the months of April to of May 2023. A pretested questionnaire was used to collect sociodemographic data from the children. Blood samples were collected for malaria parasite diagnosis while stool samples were collected for the detection of intestinal parasites. It should be noted that the locality just like other parts of Cameroon had benefited from several rounds of deworming using mebendazole, albendazole and praziquantel for the control of intestinal parasites and schistosomiasis and the distribution of long-lasting insecticide treated bed nets from the Ministry of Health.

The sample size was calculated using the formula $n= Z^2pq/d^2$ [20], where n is the minimum sample size, Z is 1.96, the standard normal deviation for 95% confidence interval, p was 11.9%, the prevalence of malaria and intestinal parasite coinfection reported in Cameroon [21], q=1-p, while d is 0.05 which is the acceptable level of error set for the study. The calculated sample size was 162 participants, but 180 were admitted. Participants were enrolled using the convenient sampling method.

## 2.3 Preliminary Visit

Before the start of the study, visits were made to the locality in order to obtain authorization from school authorities, inform the children and their parents/guardians of the study procedure, the advantages and inconveniences as well as schedule appointments for the survey and specimen collection. Informed consent forms were distributed to the schoolchildren to take to their parents/guardians for authorization to take part in the study. Only children whose parents consented were admitted into the study.

## 2.4 Data Collection

### 2.4.1 Administration of questionnaire

A pre-tested structured questionnaire was used to collect data on socio-demographics, history of malaria and intestinal parasites as well as methods used for the prevention of malaria and intestinal parasites. The questions were read out to the children in English language by the team members and answers provided were ticked in the spaces provided in the questionnaire. Pupil registers were used to obtain the ages of the participants.

### 2.4.2. Laboratory procedures

#### *2.4.2.1 Blood sample collection and malaria parasite detection*

After filling the questionnaire, 70% alcohol was used to disinfect the site to be punctured on the finger, capillary blood was collected by finger prick. The blood was used to prepare thick and thin blood smears. The smears were allowed to air dry and transported to the Ndop District Hospital laboratory for microscopy. After drying, the thin smears were fixed with absolute methanol and allowed to air-dry for 2 minutes [22]. Both the thick and thin blood smears were stained with 10% Giemsa stain for 15 minutes, washed, air-dried and observed using the oil immersion objective of a light binocular microscope (Olympus, NY-USA). The thick smears were used to detect trophozoites, gametocytes or schizonts of malaria parasites while the thin smears were used to identify *Plasmodium* species. For quality check, each smear was read by two microscopists and in the case of discrepancy, the result of a third microscopist was adopted.

#### *2.4.2.2 Collection and analysis of stool specimens*

The participants were provided with wide mouthed, screw-capped stool containers with an attached scoop to facilitate collection. The procedure for stool sample collection was explained to them. The very young ones were assisted by members of the research team and their teachers. After collection, the stool specimens together with the blood smears were transported to the Ndop District Hospital

Laboratory for analysis. The macroscopic parameters of the stool specimen were recorded. For microscopy, one drop each of normal saline (0.85%) and iodine were placed on separate spots on a microscopic slide and a small amount of fresh stool sample (approximately 2 mg of stool or 1 ml of liquid stool) was emulsified on the saline and iodine solutions separately using an applicator stick, covered with a cover slide and examined microscopically using the 10× and 40× objectives [22]. Each specimen was smeared on two slides and each examined by two microscopists. In case of a discrepancy, the result of a third reader was adopted. All stool specimens were examined on the same day within an hour after collection.

### 2.5 Data Analysis

Data from questionnaires was keyed into a Microsoft excel sheet, cleaned and exported to Statistical Package for Social Sciences (SPSS) version 22.0 for analysis. The chi-square test was used to determine differences between proportions. Particularly, to compare the prevalence of different groups of participants. The chi-square was preferred because of its flexibility to compare both two groups and multiple group studies. The level of significance was set at $p<.05$.

## 3. RESULTS

### 3.1 Socio-demographic Characteristics of the Study Participants

A total of 180 schoolchildren, 98(54.4%) males and 82(45.6%) females were enrolled into this study. The age range was 5-18 years with a Mean$\pm$SD of 10$\pm$2.5 yeas. The most represented aged group was 9-11 years. The majority of parents (85, 47.2%) had attained secondary education while the most represented mother's profession was farming (97, 53.9%). One hundred and seventy-two (95.6%) of the participants were Christians while 8 (4.4%) were Muslims. Children from primary 1 to 6 were enrolled in the study with primary 5 having the highest number of participants (52, 28.9%). This can be seen in Table 1.

### 3.2 Prevalence of Malaria Parasitaemia with Respect to Socio-demographic Characteristics

The overall prevalence of malaria was 7.2% (13/180) with *Plasmodium falciparum* as the only species identified. Although there was no significant statistical difference in the prevalence of malaria with respect to sociodemographic characteristics, we however observed that the highest prevalence of malaria was observed in the 12-18years age groups (5, 9.5%), more females (7, 8.5%) were infected than males (6, 6.1%) as shown in Table 2.

### 3.3 Prevalence of Malaria Parasitaemia with Respect to Class of Schoolchildren

Although there was no statistically significant difference in prevalence with respect to class of schoolchildren, the highest prevalence of malaria was observed among class 5 children (5, 9.9%). This can be seen in Table 3.

### 3.4 Prevalence of Malaria Parasitaemia with Respect to Malaria Prevention Methods

There was no significant statistical association between malaria parasite prevalence and the use of malaria prevention methods by the schoolchildren. However, the prevalence was higher among participants who did not use the prevention measures than those who use, except for house type where the prevalence was higher among children living in cement-brick houses compared to those living in mud -brick and plank houses as can be seen in Table 4.

### 3.5 Prevalence of Intestinal Parasites

#### 3.5.1 Overall Prevalence of intestinal parasites and species identified

A total of 131 participants provided stool samples and 17 were positive for intestinal parasites giving an overall prevalence of 13.0%. Three parasite species were detected and identified. *Entamoeba histolytic* (9, 6.9%), *E coli* (12, 9.1%) and *Giardia lamblia* (10, 7.6%). This is presented in Table 5.

### 3.6 Prevalence of Intestinal Parasite with Respect to Sociodemographic Characteristics

It was observed that father's profession ($\chi2=12.84$, $p=.04$), and class of the children ($\chi2=182.44$, $p=.00$), showed significant statistical association with prevalence of intestinal parasite. This is shown in Table 6.

**Table 1. Sociodemographic characteristics of the study participants**

| Characteristic | Category | Frequency or value | Percentage (%) |
|---|---|---|---|
| | Mean (SD) | 10(2.5) | |
| Age (years) | 5-8 | 49 | 27.2 |
| | 9-11 | 77 | 42.8 |
| | 12-18 | 54 | 30.0 |
| Sex | Male | 98 | 54.4 |
| | Female | 82 | 45.6 |
| Religion | Christians | 172 | 95.6 |
| | Muslims | 8 | 4.4 |
| Parent's highest level of education | Primary | 78 | 43.3 |
| | Secondary | 85 | 47.2 |
| | Tertiary | 17 | 9.4 |
| Mother's profession* | Farmers | 97 | 53.9 |
| | Others | 20 | 11.1 |
| Father's profession* | Builder | 36 | 20.0 |
| | Civil servants | 21 | 11.7 |
| | Others | 25 | 13.9 |
| Class of schoolchildren | 1 | 18 | 10.0 |
| | 2 | 20 | 11.1 |
| | 3 | 33 | 18.3 |
| | 4 | 29 | 16.1 |
| | 5 | 52 | 28.9 |
| | 6 | 28 | 15.6 |

**: not all children provided information on the profession of parents*

**Table 2. Malaria parasite prevalence with respect to socio-demographic characteristics**

| Characteristics | Category | Frequency/ value (%) | Malaria status | | χ2 (level of significance) |
|---|---|---|---|---|---|
| | | | Negative (%) | Positive (%) | |
| Age (years) | 5-8 | 49 (27.7) | 46 (93.3) | 3 (6.1) | 0.48 (0.79) |
| | 9-11 | 77 (42.8) | 72 (93.5) | 5 (6.5) | |
| | 12-18 | 54 (30.0) | 49 (90.7) | 5 (9.5) | |
| Sex | Male | 98 (54.4) | 92 (93.3) | 6 (6.1) | 0.39 (0.57) |
| | Female | 82 (45.6) | 75 (91.5) | 7 (8.5) | |
| Parent's highest level of education | Primary | 78 (43.3) | 72(92.3) | 6(7.7) | 0.78(0.70) |
| | Secondary | 85 (47.2) | 80(94.1) | 5(5.9) | |
| | Tertiary | 17 (9.4) | 15(88.2) | 2(11.8) | |
| Mother's profession | Farmers | 97 (53.9) | 90(92.8) | 7(7.2) | 13.89(0.22) |
| | Others | 20 (11.1) | 18(90.0) | 2(10.0) | |
| Father's profession | Builder | 36 (20.0) | 35(97.2) | 1(2.8) | 14.32(0.23) |
| | Civil servants | 21 (11.7) | 20(95.2) | 1(4.8) | |
| | Others | 25 (13.9) | 20(80.0) | 5(20.0) | |
| Overall prevalence | Total | 180 | 167(92.8) | 13(7.2) | |

### 3.7 Prevalence of intestinal parasites with respect to preventive measures

The prevalence of intestinal parasites was surprisingly higher among those who took antihelmintics (5,13.9%), who had a toilet at home (17, 13.1%), used a water system toilet (2, 14.3%); and as expected among those who do not wash their hands in school (8, 20.0%), do not wash their hands at home (16, 13.9%) and those who use stream as source of water (1, 50%) than their counterparts. All these showed a significant statistical association (*P<.01*) with intestinal parasite prevalence as shown in Table 7.

**Table 3. Malaria parasite prevalence with respect to class of schoolchildren**

| Class | Frequency/ value (%) | Malaria status | | χ2 (level of significance) |
|---|---|---|---|---|
| | | Negative (%) | Positive (%) | |
| 1 | 18(10.0) | 16(88.9) | 2(11.1) | 3.67(0.62) |
| 2 | 20 (11.1) | 19(95.0) | 1(5.0) | |
| 3 | 33 (18.3) | 31(93.9) | 2(6.1) | |
| 4 | 29 (16.1) | 26(89.7) | 3(10.3) | |
| 5 | 52 (28.9) | 47(90.4) | 5(9.6) | |
| 6 | 28 (15.6) | 28(100.0) | 0(0.0) | |

**Table 4. Malaria parasite prevalence with respect to malaria prevention methods**

| Prevention method | Category | Frequency (%) | Malaria status | | χ2 (level of significance) |
|---|---|---|---|---|---|
| | | | Negative (%) | Positive (%) | |
| Have nets | No | 20(11.1) | 18(90.0) | 2(10.0) | 0.26(0.64) |
| | Yes | 160(88.9) | 149(93.1) | 11(6.9) | |
| Sleep under nets | No | 73(40.6) | 67(91.8) | 6(8.2) | 0.18(0.77) |
| | Yes | 107(59.4) | 100(93.5) | 7(6.5) | |
| Use coils | No | 129(71.7) | 118(91.5) | 11(8.5) | 1.16(0.36) |
| | Yes | 51(28.3) | 49(96.1) | 2(3.9) | |
| Indoor residual spraying | No | 155(86.1) | 142(91.6) | 13(8.4) | 2.26(0.22) |
| | Yes | 25(13.9) | 25(100.0) | 0(0.0) | |
| Treatment drugs | No | 124(68.9) | 113(91.1) | 11(8.9) | 1.62(0.24) |
| | Yes | 56(31.1) | 54(96.4) | 2(3.6) | |
| House type | Cement bricks | 92(51.1) | 83(90.2) | 9(9.8) | 2.23(0.40) |
| | Mud bricks | 77(42.8) | 73(94.8) | 4(5.2) | |
| | Plank | 11(6.1) | 11(100.0) | 0(0.0) | |
| Holes on walls | No | 132(73.3) | 121(91.7) | 11(8.3) | 0.91(0.52) |
| | Yes | 48(26.7) | 46(95.8) | 2(4.2) | |

**Table 5. Parasites identified in stool specimens of participants**

| Parasite specie | Frequency (n=131) | Percentage (%) |
|---|---|---|
| *Entamoeba histolytica* | 9 | 6.9 |
| *Entamoeba coli* | 12 | 9.1 |
| *Giardia lamblia* | 10 | 7.6 |
| Overall prevalence | 17 | 13.0 |

## 4. DISCUSSION

In this study, the prevalence of malaria among the study participants in the conflict-hit Ndop of the Northwest Reigon of Cameroon was 7.2 %, which is lower than the prevalence of 9.13% obtained in Bambili in 2013 [4], another locality not too far from the study site. This prevalence is lower compared to the prevalence reported in children in other areas of Cameroon [3,19,21]. These discrepancies could be explained by the fact that the present study was school based while the other studies were either hospital or community based, but also because of a scale up in malaria prevention measures put in place by the government. The prevalence of malaria observed was also lower compared to similar studies done in other countries [23,24]. Levels of endemicity vary with geographical areas. The health care system, strategies put in place for the fight against diseases and their uptake by populations vary and would possibly influence the prevalence of infections including malaria in the different countries. The fight against malaria has actually received a great attention in the Cameroon Health sector strategy.

**Table 6. Intestinal parasite prevalence with respect to sociodemographic characteristics**

| Characteristics | Category | Frequency (%) | Intestinal parasite status | | χ2 (*P-value*) |
|---|---|---|---|---|---|
| | | | Negative (%) | Positive (%) | |
| Age (years) | 5-8 | 33 (25.2) | 27(81.8) | 6(18.2) | 3.38 *(.50)* |
| | 9-11 | 55(42.0) | 48(87.3) | 7(12.7) | |
| | 12-18 | 43(32.8) | 39(90.9) | 4(9.3) | |
| Sex | Male | 60(45.8) | 51(85.0) | 9(15.0) | 0.41 *(.83)* |
| | Female | 71(54.2) | 63(88.7) | 8(11.3) | |
| Religion | Christians | 127(96.9) | 110(86.6) | 17(13.4) | 2.62 *(.27)* |
| | Muslims | 4(3.1) | 4(100.0) | 0(0.0) | |
| Parent's level of education | Primary | 59(45.0) | 52(88.1) | 7(11.9) | 3.07 *(.56)* |
| | Secondary | 61(46.6) | 51(83.6) | 10(16.4) | |
| | Tertiary | 11(8.4) | 11(100.0) | 0(0.0) | |
| Mother's profession (n=138) | Farmers | 73(55.7) | 65(89.0) | 8(11.0) | 2.87 *(.59)* |
| | Others | 16(12.2) | 13(81.3) | 3(18.7) | |
| Father's profession (n=105) | Builder | 19(14.5) | 14(73.7) | 5(26.3) | 12.84 *(.04)* |
| | Civil servants | 16(12.2) | 12(93.8) | 1(6.2) | |
| | Others | 21(16.0) | 19(90.5) | 2(9.5) | |
| Class | 1 | 11(8.4) | 11(100.0) | 0(0.0) | 13.23 *(.00)* |
| | 2 | 14(10.7) | 11(78.6) | 3(21.4) | |
| | 3 | 28(21.4) | 21(75.0) | 7(25.0) | |
| | 4 | 19(14.5) | 16(84.2) | 3(15.8) | |
| | 5 | 38(19.0) | 35(92.1) | 3(7.9) | |
| | 6 | 21(16.0) | 20(95.2) | 1(4.8) | |

**Table 7. Prevalence of intestinal parasites with respect to preventive methods**

| Prevention method | Category | Frequency (%) | Intestinal parasite status | | χ2 (*P-value*) |
|---|---|---|---|---|---|
| | | | Negative (%) | Positive (%) | |
| Took antihelminthic | Yes | 36(27.5) | 31(86.1) | 5(13.9) | 170 *(.001)* |
| | No | 93(71.0) | 81(87.1) | 12(12.9) | |
| Toilet at home | Yes | 130(99.2) | 113(86.9) | 17(13.1) | 175.06 *(.001)* |
| | No | 1(0.8) | 1(100.0) | 0(0.0) | |
| Toilet type | Open Air | 4(3.1) | 4(100.0) | 0(0.0) | 175.93 *(.000)* |
| | Pit | 112(85.5) | 97(86.6) | 15(13.4) | |
| | Water system | 14(10.7) | 12(85.7) | 2(14.3) | |
| | Others | 1(0.7) | 1(100.0) | 0(0.00) | |
| Wash hands at school | Yes | 91(69.5) | 82(90.1) | 9(9.9) | 178.43 *(.001)* |
| | No | 40(30.5) | 32(80.0) | 8(20.0) | |
| Wash hands at home | Yes | 16(12.2) | 15(93.80 | 1(6.2) | 175.9 *(.001)* |
| | No | 115(87.8) | 99(86.1) | 16(13.9) | |
| Water Source at home | Spring | 19(14.5) | 19(100.0) | 0(0.00) | 182.44 *(.00)* |
| | Stream | 2(1.5) | 1(50.0) | 1(50.0) | |
| | Tap | 81(61.8) | 69(85.2) | 12(14.8) | |
| | Well | 29(22.2) | 25(86.2) | 4(13.8) | |

### 4.1 Coinfection with Malaria Parasitaemia and Species of Intestinal Parasites

Two participants had coinfection of malaria and intestinal parasites giving an overall prevalence of 1.5% while 8(6.1%) participants had a coinfection of *E. histolytica* and *E. coli*. This is shown in Table 8.

**Table 8. Prevalence of malaria and intestinal parasites coinfection**

| Coinfection combination | Frequency | Percentage (%) |
|---|---|---|
| Mp and Intestinal parasite | 02 | 1.5 |
| *E. histolytica* and *E. coli* | 08 | 6.1 |

With respect to age, there was no statistically significant difference in prevalence, however the highest prevalence of malaria observed in the 12-18 years age group could be as a result of the several strategies that target malaria prevention in the younger age groups. These strategies include free diagnosis and treatment of malaria in children less than 5 years as well as the distribution of bed nets to homes with children less than 5 that was earlier practiced.

The prevalence of intestinal parasites obtained in this study was 13%. Although this prevalence is lower than that reported in studies in similar settings in the country [3,12], it is however higher than the prevalence in other reports from studies carried out earlier in other localities [22]. The reduced prevalence could be as a result of the implementation of prevention and control measures put in place by the government, although being higher than prevalence from other reports could be attributed to the negative impact of the current armed conflict on the implementation of prevention measures both at the individual and community level.

Only Protozoans were detected as intestinal parasites in this study. *G. lamblia* (7.6%), *E. histolytica* (6.9%) and *E. coli* (9.1%). This is similar to reports obtained from other studies. *Entamoeba histolytica* was the most prevalent as reported by other studies [25,26]. These protozoans are generally spread through the fecal-oral route which is directly linked with personal and food hygiene. Children generally exhibit a high dependence on adults for hygiene practices. This makes them vulnerable to infection with these pathogens. But also, this could be as a result of inadequate supply of pipe-borne water in the community. The prevalence recorded here is non-negligible as could rise to epidemic values in case of continuous breakdown in health strategies. No helminths were reported in this study, this could be explained by the routine deworming program organized by the Ministry of Public Health in an attempt to eradicate intestinal helminths among primary school children.

Children 9-11 years were strangely the most infected with IPIs compared to their counterparts. It is expected that at this level there is some awareness on the basic hygiene rules compared to younger counterparts. This however corroborates reports from other studies [22]. Children of primary 3 were most infected by IPIs, a possible indication that their level of knowledge on hygiene measures could be rudimentary. It was also observed that, the difference in prevalence with respect to some intestinal parasite preventive measures was statistically significant ($p$<.01). This means that the adherence to some preventive measures could reduce the prevalence of intestinal parasitic infections among school children. This is in agreement with a study carried out in Muyuka and Ekona of the South West Region [3].

The prevalence of coinfection in the study population was relatively low. Although these parasites are all of the fecal-oral route, it is possible that either they all have low endemicity in the study area or their spread is independent of each other. Similar findings were reported in other localities [3,22,25].

## 5. LIMITATIONS

There was no confirmation of *Plasmodium* species using PCR; stool specimens were not analyzed using concentration techniques. These might have reduced the sensitivity and specificity of the methods and possibly influence the results obtained in this study. However, measures were taken to reduce the influence of these shortcomings.

## 6. CONCLUSION

This study revealed that malaria and IPIs particularly protozoans still constitute public health problems in the Ndop. Control measures implemented by government to curb the prevalence of helminthic infections are quite effective meanwhile there is need to maintain

and re-enforce measures for the control of malaria and intestinal protozoans in the study area.

## CONSENT

Informed consent was obtained in writing from the children's parents/guardians after due explanation of the process. The authorization of the children to participate in the study was also obtained. The specimens were identified and processed using codes. Confidentiality of participants was respected. Participation was totally free and voluntary. Participants could opt out of the study at any time without any penalty. Results of the laboratory analysis were handed to parents or guardians and advised to see the clinician where necessary.

## ETHICAL APPROVAL

Ethical clearance for this study was obtained from the Institutional review Board of the Faculty of Health Sciences (FHS) of the University of Bamenda. Administrative authorizations were obtained from the North West Regional Delegation of Basic Education, the head-teacher of the school and the authorities of the Ndop District Hospital.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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