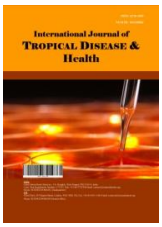

International Journal of TROPICAL DISEASE & Health

41(7): 34-44, 2020; Article no.IJTDH.58309
ISSN: 2278–1005, NLM ID: 101632866

Some Haematological Parameters among Urinary Schistosomiasis-Malaria Coinfected Children in Suburb of Malentouen Health District, West Region Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. As part of PhD thesis, Author KTDL wrote the protocol, wrote the first draft of the manuscript, managed the literature searches and collected the data. Authors PVK and LLG designed the study, participated in the writing of the protocol and wrote the first draft of the manuscript. Author GT help in collecting data and performed the statistical analysis. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2020/v41i730295
Editor(s):
(1) Dr. Arthur V. M. Kwena, Moi University, Kenya.
Reviewers:
(1) Soheil Ebrahimpour, Babol University of Medical Sciences, Iran.
(2) Jesús G. Rodríguez Diego, Universidad Autonoma Metropolitana (UAM), Mexico.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58309

Original Research Article

Received 14 April 2020
Accepted 21 June 2020
Published 01 July 2020

ABSTRACT

Background: Schistosomiasis and Malaria are among the most prevalent afflictions of humans who live in areas of poverty in the developing world. The present study was aimed at determining the socio demographic characteristics and prevalence of schistosomiasis and malaria in children living in Suburb of Malentouen Health District and analyzing the effect of co-infection on haemoglobin level, mean corpuscular volume and platelet count.

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Methods: Questionnaires were distributed to parents or guardians of children attending public primary school in the area. A total of 429 pupils aged 6-15 years old were screened for urinary schistosomiasis and 228 out of the 429 were tested for. Prevalences of the two parasites were calculated; Haemoglobin level, Mean Corpuscular Volume and platelets count of the 228 participants were recorded.
Results: The prevalence of malaria was 26.75%, where as that of schistosomiasis was 43.82%. 31(13.60%) of the participants were co-infected with the two parasites. Mean haemoglobin level obtained was 11.01± 1.19 G/dL, that of MCV was 84.50±5.31/fl and the mean platelet count was 255.13±96.99/µl. In malaria single infected and co-infected participants, low haemoglobin level (χ^2 = 50.315, p = .000), low MCV (χ^2 = 27.448, p = .000) and low platelets count (χ^2 = 37.253, p = .000) were observed with significant variations.
Conclusions: The three haematological parameters analysed in this study (Hb, MCV, Platelets count), showed low level or amount in malaria and malaria-schistosomiasis infected participants. Moreover, thrombocytopenia in children in this endemic area may be useful as supportive diagnostic criteria for malaria in case with low level of parasite number.

Keywords: Full blood count; haemoglobin; mean corpuscular volume; platelets count; malaria; schistosomiasis.

1. INTRODUCTION

Schistosomiasis and malaria are among the most prevalent afflictions of humans who live in areas of poverty in the developing world. The morbidity caused by these is most commonly associated with infections of heavy intensity [1]. In addition to their health effects, the two infections also impair physical and mental growth in childhood, thwart educational advancement, and hinder economic development. Because of the geographic overlap of these afflictions and their impact on children and adolescents, the World Health Organization (WHO), the World Bank, and other United Nations Agencies, bilateral and civil societies worked to integrate schistosomiasis and malaria control through a program of periodic school-based, targeted anthelminthics and antimalarial drug treatments [2].

Each environmental change, whether occurring as a natural phenomenon or through human intervention, may alter the ecological balance within which disease hosts, vectors, and parasites develop [3]. The construction of dams results in physical, chemical, and biological changes in natural ecosystems, changes that may lead to the proliferation of vectors [4], increase the transmission of vector-borne and water-related diseases [5]. Among vector-borne diseases afflicting populations surrounding dams are malaria and schistosomiasis [6].

In inter-tropical areas, multiple parasitic infections are common. Epidemiologic, clinical, or biologic outcomes are more often studied considering each parasite separately [7]. Co-infection with multiple parasites is common in malaria endemic areas. Although much is known about the epidemiology and immunology of specific parasitic illnesses, little is known about the interaction of concurrent infections. Mounting evidence suggests an interaction occurs between helminthic and plasmodial infections, although it is unclear as to whether this effect harms or protects the host [8].

Dams allow irrigation systems and throughout the tropics, water-related, water-based parasitic infections notably schistosomiasis and malaria are reportedly common and affect communities living along these water courses [9].

Schistosomiasis causes anaemia as a result of blood loss when eggs are embedded into the veins of the intestine and bladder; while malaria causes anaemia as a result of destruction of red cells containing haemoglobin by the *Plasmodium*. The contribution of malaria and schistosomiasis infections in the development of anaemia in individuals considering their socio-demographic characteristics, their behavioural patterns in a malaria-schistosomiasis co-endemic area is largely unreported.

The present study was aimed at determining the socio demographic characteristics, the prevalence and co-infection of schistosomiasis and malaria in children living in Suburb of Malentouen Health District and analyzing the effect of co-infection on haemoglobin level, mean corpuscular volume and platelet count.

2. MATERIALS AND METHODS

2.1 Study Area

The study area was located around the Mapé dam, built in July 1987, with a maximum water level of 715 m. It covers an area of about 550 km^2 from Adamaoua, Magba-West and North-West area in Malantouen Health District. Magba is one of the Sub-divisions in the Noun Division in the West Region of Cameroon located between Latitude 5°N and 6°N and Longitude 11°E to 12°E. More than twenty ethnic groups are found including Bamoun, Kotoko, Tikar, Guiziga, Toupouri, Mudang, Junkums, Musgoum, Arabs, etc, with an estimated population of 40000 and a density of 30 inhabitants/km^2. The equatorial climate is made up of two seasons: a short dry season (November to March), with temperature ranging from 30–35°C and a longer raining season (April to October), with temperatures ranged of 24–28°C. The vegetation is dense savannah, often mouldy. Agriculture and fishing are very common activities of the population and account for 60–70% of their economy and source of wealth [10, 11].

2.2 Study Subject

Four hundred and twenty nine pupils (aged 6 to 15) in three villages (Matta Barrage, Matta Village and Cité) around the Mapé Dam participated in the study between September 2017 and March 2018; period whereby consented children were screened for malaria infection using three different techniques. Out of the 429 pupils, 228 provided urine and blood samples, the rest of 201 provided only urine sample.

2.3 Specimen Collection and Processing

Socio-demographic and clinical data of the pupils were collected using structured questionnaire. Three millilitres of venous blood were collected into EDTA tubes from each of the 228 study subject for smear preparation of light microscopy and full blood count [12] while urine samples were collected between 11 AM -1PM. Analysis were carried out in the Laboratory at the Bafoussam Regional Hospital, West Region Capital, Cameroon.

2.3.1 Prevalence of urinary schistosomiasis

Urine analysis was carried out using Centrifugation/Sedimentation Technique. 10 mL of well mixed urine were transferred to a conical centrifuge tube and centrifuged for three minutes at 2000 rpm in order to sediment schistosome eggs (Centrifuging at greater force was avoided because this can cause eggs to hatch); then the supernatant fluid was discarded and all the sediment transferred to a slide with a dropper, covered with a cover glass and the entire sediment examined microscopically using the 10 X objective with the condenser iris close sufficiently to give good contrast. The number of eggs in the preparation was counted and the number/10 mL of urine was reported [13].

NB: If more than 50 eggs were present in the sediment, the counting was stopped and result addressed as «More than 50 eggs/ 10 mL" which indicates heavy infection [13].

2.3.2 Giemsa stained light microscopy (thick and thin blood film)

After collecting blood samples, thick and thin blood smears were prepared on the same slide. The thin blood film was fixed with methanol and stained with 10% Giemsa working solution for 10 min [12]. Blood films were observed under 100X objectives for detection of malaria parasites, counted against 200 leucocytes and converted (using the following formula) to number of parasites per volume having obtained the total white cells with semi-automated blood counting machine in order to calculate parasite densities; the result was reported as positive if malaria parasites were seen or negative if malaria parasites were not seen after observing 100 fields of the thick smear.

$$\text{Nb. of parasites per}\mu\text{L} = \frac{\text{Nb.of Parasites counted}}{\text{No.of WBCs counted}} \times (\text{Total WBCs counted})$$

Where, nb= number

2.3.3 Haemoglobin level, mean corpuscular volume and platelet counts analysis

Haemoglobin level, Mean Corpuscular Volume and Platelet counts were obtained by analysing anticoagulated blood using automated Blood Analyser from Mindray company (Zhenzhen, China).

Procedure of the assay: Blood counting machines (Automated Analyzer from Mindray Company, Zhenzhen, China) work by sampling blood, and sucking a standard amount through narrow tubing. In this tubing, there are sensors

that count the number of cells going through it and can identify the type of cell. The two main sensors used are light detectors and electrical impedance.

Blood for a FBC was collected into an EDTA tube to prevent it from clotting. The blood was then well mixed using a blood mixer and put through a machine which counted the number and type of different cells in the blood, prints out, and/or sends the results to a computer [14].

NB: Control cells were analysed to calibrate the machine.

2.4 Statistical Analysis

Data were treated and analysed statistically using SPSS 17 and Statgraphic 15.1.02. The Chi-square (χ^2) test was used to separate categorical values. Means were separated by Tukey studentized test. Pearson correlation test was used to determine relation between parameters. All these analyses were performed at the significance level of .05.

3. RESULTS

3.1 Socio-demographic Characteristics of Participants

3.1.1 Age and sex distribution

The distribution of population by age ranges (years) and sex are shown in Table 1. There was a significant difference of the population distribution by age (χ^2 = 289.331, p = .000) and by sex (χ^2 = 11.558, p = .01) (Table 1).

3.1.2 Religion, occupation of parents and time of residence in the study area

The population studied varied with religion (χ^2 = 128.7, p = .000), parent occupation (χ^2 = 340.916, p = .000) and time of residence (χ^2 = 257.655, p = .000) as shown in Table 2. The

Table 1. Distribution of population by age ranges (years) and sex

		Age (Year)				Total (%)	χ^2 (p)	Mean
		6-8	9-11	12-13	14-15			
Sex	Male	15	123	89	23	250(58.28)	11.558	11.06±1.79
	Female	2	109	59	9	179(41.72)	(.01)	11.13±1.34
Total (%)		17(4.00)	232(54.10)	148(34.50)	32(7.50)	429 (100)		11.09±1.62
χ^2 (p)		289.331 (.000)						

The χ2 analysis was made at a significance level of 5%

Table 2. Distribution of studied population in relation to religion, occupation of parent and time of residence in the area

Parameters	N° studied	Valid percent	χ2 (p)
Religion			
Muslim	332	77.39	128.7 (.000)
Christian	97	22.61	
Occupation of parents			
Civil servant	46	10.72	340.916 (.000)
Farming	16	3.73	
Fishing	65	15.15	
Trading	100	23.31	
Fishing / Farming	6	1.40	
Farming / Trading	196	45.69	
Time of residence (Years)			
3-4	35	8.16	257.655 (.000)
5-6	197	45.92	
7-8	124	28.90	
9-10	57	13.29	
>10	16	3.73	

The χ2 analysis was made at a significance level of 5%

majority of respondents 332 (77.39%) were Muslims; trading (23.31%) was the most prevalent occupation and the majority of respondents (197 or 45.92%) resided in the area for at least 5 to 6 years (Table 2).

3.2 Parasitological Results

3.2.1 Malaria status of studied participants

Sixty-one pupils were found to be positive for malaria, giving a prevalence of 26.75%. Malaria prevalence did not varied significantly neither with sex (χ^2 = 0.050, p = .88), with age (χ^2 = 4.398, p = .21) nor with parents occupation (χ^2 = 3.051, p = .55) (Table 3).

3.2.2 Status of schistosomiasis in studied participants

The overall prevalence of urinary schistosomiasis (43.82%) was determined and expressed in relation to socio-demographic parameters. The results obtained showed that 46.80% of males and 39.66% of females were infected. However the difference was not statistically significant (χ^2 = 2.157, p = .17) just as the difference in schistosomiasis prevalence by age range (χ^2 = 2.388, p = .50) and with religion (χ^2 = 0.013, p = .91) (Table 4). Also, children of farmer, trader and fisher were the most infected while those whose parents were Civil servants had low level of infection (χ^2 = 19.695, p = .001) (Table 4).

3.2.3 Haematological status of the studied population

The Hb concentration (χ^2 = 45.372; p = .000), MCV (χ^2 = 25.879; p = .000) and platelet concentration (χ^2 = 32.800; p = .000) varied with malaria (Table 5). But no significant variation was observe with schistosomiasis status (Table 6). Those having low haemoglobin level, were those infected with *plasmodium*.

Hb level (χ^2 =50.315; p=.000), MCV (χ^2 =27.448; p=.000) and platelet concentration (χ^2 =37.253; p=.000) varied with coinfection status (Table 7). The correlation between the parasites characteristics and the three haematological parameters was analysed (Table 8).

Table 3. Prevalence of malaria in relation to sex, age, occupation of parents and religion

	N° examined	Malaria		$\chi 2$ (p)
		N° Positive	% Infected	
Sex				
Male	132	35	26.52	0.050 (.88)
Female	96	26	27.10	
Total	228	61	26.75	
Age group (Years)				4.398 (.21)
6-8	2	0	0.00	
9-11	81	26	32.10	
12-13	118	26	22.03	
14-15	27	9	33.33	
Total	228	61	26.75	
Occupation of parents				
Civil servant	25	5	20.00	3.051 (.55)
Farming/trading	85	22	25.88	
Farming	13	3	23.08	
Fishing	36	12	33.33	
Fishing/Farming	6	0	0.00	
Trading	63	19	30.16	
Total	228	61	26.75	
Religion				
Muslim	177	50	28.25	1.524 (.22)
Christian	51	11	21.57	
Total	228	61	26.75	

The $\chi 2$ analysis was made at a significance level of 5%

Table 4. Prevalence of Urinary schistosomiasis in relation to sex, age, occupation of parents and Religion

	Schistosoma haematobium			
	N° examined	**Negative (%)**	**Positive (%)**	***χ2 (p)***
Sex				
Male	250	133 (53.20)	117 (46.80)	2.157 (.17)
Female	179	108 (60.34)	71 (39.66)	
Total (%)	429	241 (56.18)	188 (43.82)	
Age range (Years)				
6-8	17	7 (41.18)	10 (58.82)	2.388 (.50)
9-11	232	136 (58.62)	96 (41.38)	
12-13	148	80 (54.05)	68 (45.95)	
14-15	32	18 (56.25)	14 (43.75)	
Total (%)	429	241 (56.18)	188 (43.82)	
Occupation of parents				
Civil servant	46	33 (71.74)	13 (28.26)	19.695 (.001)
Farming / trading	196	116 (59.19)	80 (40.81)	
Farming	16	6 (37.50)	10 (62.50)	
Fishing	65	23 (35.39)	42 (34.61)	
Fishing/Farming	6	0 (0.00)	0 (0.00)	
Trading	100	57 (57.00)	43 (43.00)	
Total (%)	429	241 (56.18)	188 (43.82)	
Religion				
Muslim	332	187 (56.32)	145 (43.68)	0.013 (.91)
Christian	97	54 (55.67)	43 (44.33)	
Total (%)	429	241 (56.18)	188 (43.82)	

The χ2 analysis was made at a significance level of 5%

Table 5. Haematological status variation with *Plasmodium* status

Parameters	**Ranges**	***Plasmodium***		**Total (%)**
		Negative	**Positive**	
Hb range (g/dL)	8-10	12	27	39 (17.1)
	11-13	143	32	175 (77.2)
	14-15	12	2	14 (5.7)
	Total	167	61	228 (100)
	χ^2 *(p)*	45.372 (.000)		
MCV range (/fl)	60-80	16	23	39(17.1)
	81-98	151	38	189(82.9)
	Total	167	61	228(100)
	χ^2 *(p)*	25.879 (.000)		
Plt range (/µL)	60-149	6	18	24(10.5)
	150-450	154	40	194(85.5)
	451-560	7	3	10(3.9)
	Total	167	61	228(100)
	χ^2 *(p)*	32.800 (.000)		

The χ2 analysis was made at a significance level of 5%

4. DISCUSSION

4.1 Malaria Status of Studied Participants

In this study, the overall malaria prevalence was 26.75% (Table 5). No other data was recorded in the area because of insufficient consistent data for malaria in Cameroon [15]. This prevalence was close to the 27.7% obtained on population in the Mount Cameroon area with CareStart™ Malaria HRP2, RDT and microscopic methods [16] and not far from the 29.6% reported in the

South West Region of Cameroon while analysing the effect of insecticide treated nets (ITNs) on *P. falciparum* infection in rural and semi urban communities [17].

With 27.10%, female were more infected for malaria-this probably because as observed females spend more time outdoors at dusk and dawn than males performing household chores and as such are more permanently exposed to mosquito bites [18], whereas the age range 14-15 was the most infected with 33.33%. More children with low temperature were infected with *P. falciparum* (32.10%) whereas just 16.67% of those with high temperature had *P. falciparum* (χ^2 = 4.029; p = .03). In the same way, more of those who claimed they used to have headache were infected with *Plasmodium* spp. (28.57%) whereas those who claimed not to have it were less infected (12.00%) (χ^2 = 3.119; p = .08), because headache is among the clinical symptoms during malaria [2].

Table 6. Haematological status variation with *Schistosoma haematobium* status

Parameters	Ranges	*Schistosoma haematobium*		
		Negative	**Positive**	**Total**
Hb range (g/dL)	8-10	18	21	39
	11-13	97	79	176
	14-15	5	8	13
	Total	120	108	228
	χ^2 *(p)*	2.138 (.35)		
MCV range (fl)	60-80	18	21	39
	81-98	102	87	189
	Total	120	108	228
	χ^2 *(p)*	0.792 (.39)		
Plt range (/µL)	60-149	11	13	24
	150-450	106	89	195
	451-560	3	6	9
	Total	120	108	228
	χ^2 *(p)*	2.023 (.37)		

The χ2 analysis was made at a significance level of 5%

Table 7. Relation between coinfection and some haematological parameters

Parameters		*Schistosoma* and *Plasmodium*				Total
		No Parasites	***Schistosoma***	***Plasmodium***	***Plasmodium* and *Schistosoma***	
Hb range (g/dL)	8-10	7	5	11	16	39
	11-13	80	64	17	15	176
	14-15	4	8	1	0	13
	Total	91	77	29	31	228
	χ^2 *(p)*	50.315 (.000)				
MCV range (fl)	60-80	6	10	12	11	39
	81-98	85	67	17	20	189
	Total	91	77	29	31	228
	χ^2 *(p)*	27.448 (.000)				
Plt range (/µL)	60-149	1	5	10	8	24
	150-450	87	68	19	21	195
	451-560	3	4	0	2	9
	Total	91	77	29	31	228
	χ^2 *(p)*	37.253 (.000)				

The χ2 analysis was made at a significance level of 5%

Table 8. Correlation between parasites and haematological parameters

	Hb	MCV	Platelets count
Plasmodium	-0.4 (.000)	-0.3 (.000)	-0. 3 (.000)
S. heamatobium	-0.00 (.85)	-0.1 (.38)	0.0 (.97)
Plasmodium/ *Schistosoma* coinfection	-0.4 (.000)	-0.32 (.000)	-0.3 (.000)

The Pearson Correlation analysis was made at 2-tailed.significance level of 0.01

4.2 Schistosomiasis Status of Studied Participants

The overall *schistosoma* infection level (43.82%) reported in this study showed hyperendemicity of urinary schistosomiasis in the area and corroborates the WHO classification of schistosomiasis endemicity [2]. Matta Barrage school site, which is located by the lakeside, recorded the highest prevalence of infection. The result obtained in the study was close to the 41.1% obtained among primary school children in Magba sub-division of Cameroon [19] but higher than the 16.6% obtained in a similar study in the dam's suburbs in Malantouen Health District, Cameroon [20]. This result is probably high because all factors that favour transmission of schistosomiasis are present in the area; some of such factors include the presence of a dam to generate electricity with a lake, irrigation scheme, absence of potable water and the presence of snail intermediate hosts.

Male were the most infected with 46.80% and age range 12-13 was the most infected. Children of fishers were the most infected (64.32%) followed by those of parents occupying in fishing and trading (39.60%) (χ^2 = 19.695; p = .001). More of the children who recognised they used to have haematuria were infected with *S. haematobium* (61.54%) even though 36.24% of those who said no were still infected (χ^2 = 23.516; p = .001). Thirty-one (13.60%) coinfected people were recorded during the study.

4.3 Haematological Status of the Studied Population

Parasitic infections are leading causes of anaemia in the tropics and subtropics, worsened by malnutrition, inflammatory, and genetic diseases; and is one of the most common complications in malaria infection especially in younger children and pregnant women in high transmission areas [21]. Of the haematological parameters produced by the eighteen parameters Semiautomatic Analyser (Mindray), three were used in the study namely: Haemoglobin, Mean Corpuscular Volume and Platelets count.

Mean haemoglobin level obtained was 11.01±1.19 G/dL. Studied population infected with *plasmodium* alone and those coinfected saw their parameters affected compare to those infected by *schistosoma* alone. This study revealed that, there was a moderate negative correlation (r =-0.4, p =.000) between *plasmodium* infection and haemoglobin concentration. This anaemia resulted probably because red blood cells being the primary target of the parasites, their destruction results in the acceleration of removal of both parasitized and non-parasitized red cells, bone marrow dysfunction and yield a high level of parasitemia [22]. Also, as stated by Ihekwereme and collaborators (2014), some cytokines like interleukins (IL)-12 and 18 have also been implicated in dyserythropoiesis; hemozoin, which is a malarial pigment resulting from incomplete haemoglobin digestion by the parasite, has also been incriminated in the impaired erythroid development through its direct effects on human erythroid precursors [23].

On the contrary, the association between *S. haematobium* and haemoglobin concentration revealed no significative correlation since from the results obtained, the mean value of haemoglobin was not significantly different between *schistosoma* infected and *schistosoma* not infected children. These results seem interestingly because, normally, it is possible for *S. haematobium* in the bladder wall to reduce the uptake of iron during its pathogenesis through consumption of blood by the schistosomes or extrusion of *schistosoma*l ova which causes urethra and bladder irritation that yield blood in urine or have haematuria as major symptoms in infected children. This mechanism results normally to low haemoglobin level/anaemia; but in this study the mechanism yielded not low haemoglobin level during our. This result was close to the reported normal ranges of haemoglobin levels among school aged children infected with *S. haematobium* in Ibadan City (Nigeria) [24]. This might probably be explained by the fact that most of the infected children with the reinfection have developed immunity and live without problem in the area. However, bleeding

due to *S. haematobium* is not reducing just haematocytes but the whole blood components; and the haemoglobin level is expressed per blood µL.

Also, higher haemoglobin concentration observed in *S. haematobium* infected respondents was explained by the fact that not many children with heavy infection were found since heavy infection is linked with haematuria and low haemoglobin level [25]. Again, observation of normal haemoglobin level in this present study could be as a result of control efforts among children in the endemic area through administration of Praziquantel which would result in reduced pathological conditions. This corroborates previous observation made while monitoring Nigerien children infected by *S. Haematobium* [26]. Other results were found to be different from our results where low level of haemoglobin in children infected with *S. haematobium* was observed in Ghana [25,27].

All co-infected children had anaemia. This remark was observed in most of similar studies earlier reported [27,28,29]. These findings were probably as a result of *plasmodium* infection where most of the *plasmodium* infected respondents had low haemoglobin level. We also observed during our study that malaria was more strongly associated with anaemia than concurrent infections or schistosomiasis alone. This finding is in agreement with the findings of Tohon, et al. [26] who observed in a sub-sample of 636 children tested for *P. falciparum* infection, during a monitoring and evaluation study for the Nigerian schistosomiasis control programme that anaemia was significantly more frequent in malaria-infected children.

The mean of the Mean Corpuscular Volume (MCV) obtained during the study was 84.50±5.31. A weak negative correlation (r = -0.3, p = .000) between *Plasmodium* infection and MCV measurement was revealed, showing that MCV might have been affected by the severity of parasitemia and the fact that haemoglobin levels were highly affected due to heavy destruction of red cells by *plasmodium* parasites. Also, in uncomplicated malaria, no significant changes could occur in the red cells indices; that is why a weak correlation might have been observed during the study.

Afrifa et al., (2018) in similar studies, found that MCV was slightly affected in *schistosoma* infected children. It was not the case during our study where no statistical significance was observed in the effect of *S. haematobium* infection on MCV. As in the case of haemoglobin, probably light infection cases were more than heavy infection and the infection more tolerated by the pupils.

As in the case of haemoglobin again, all the coinfected respondents had their MCV affected with the results being statistically significant (p = .000). This result was obtained probably because of the destruction of RBC by the malaria parasites mostly and the loss of iron during *schistosoma*l infection.

The mean platelet count was 255.13±96.99/µl. The study also revealed again, as in the mean cell volume, a weak negative correlation (r = -0.3, p = .000) between the presence of malaria parasite and platelet count. The infection by *S. haematobium* has no effect on platelets count. This finding corroborates the observation of Afrifa et al. (2018) who had analysed the haematological profile and intensity of urogenital schistosomiasis in Ghanaian children. Platelet count of coinfected pupils were affected by infection with the two parasites (r = -0.3**,** p = .000), showing that co-morbidity might be associated with haematological parameters.

5. CONCLUSION

The present study showed that the three haematological parameters analysed during the study (Hb, MCV, Platelets count), showed great changes in malaria and malaria-schistosomiasis infected participants. Moreover, thrombocytopenia in children in this endemic area may be useful as supportive diagnostic criteria for malaria in case with low level of parasite number.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical clearance was obtained from the National Ethical Committee (N° 2018/05/1006/ CE/CNERSH/SP) and permission was obtained from the Malentouen District Health Officer to conduct the study. After informing about the objective of the study, written consent was taken from all study participants or parents/guardians. Participants, who were positive to malaria parasite and urinary schistosomiasis, were taken

to the nearest Health Centre for appropriate treatment and follow-up.

ACKNOWLEDGEMENTS

The authors are grateful to the parents of children, and to the children who responded positively to our demand; the Chief Service of Malentouen Health District who facilitated sample collections in villages; the directors of the three public primary schools in the three villages who gave us space and time for sample collection; and the Director the Bafoussam Regional Hospital where tests were made.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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