Original Research Article

Seasonal pattern and occurrence of *Schistosoma haematobium* egg excretion among pregnant women in Munyenge, South West Region, Cameroon

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ABSTRACT

Aim: This study aimed at describing temperature and precipitation pattern and the occurrence of maternal urogenital schistosomiasis (UGS) in 2017 in Munyenge.

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Study design: It was a twelve-month cross-sectional study.

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Study site and duration: The study was carried out in Munyenge from January to December 2017.

Materials and methods: Volunteer pregnant women attending antenatal care clinic were enrolled consecutively on a monthly basis from January to December 2017. A semi-structured questionnaire was used to obtain information on socio-demographic data and water contact behaviour. Urine samples were analysed for presence of microhaematuria and/or *Schistosoma haematobium* ova using filtration method. Monthly land surface temperature (LST) and precipitation were sourced from MODIS and CHIRPS satellite data respectively. Statistical analyses performed were analysis of variance, student t- test and correlation analysis.

Results:

The mean annual temperature was 27.18 ± 0.74°C. Monthly temperatures were fairly constant (range: 26.12 to 28.82°C). Precipitation varied greatly (range: 0.26 - 12.75mm) with a mean of

6.58 ± 4.5mm. A marginal negative correlation (r = -0.586; *P* = .04) was observed between stream usage and precipitation where stream usage reduced with increase precipitation. Generally, there was high dependence on the stream as source of water (60.9 - 90.6%) in the study area Dependency on the stream was associated (r = 0.603; *P* = .03) with domestic and bathing activities. The annual prevalence of maternal UGS was 24.1% (77/320) with a high occurrence during the rainy season (16.6%; 53/320) than the dry season (7.5%; 24/320) but the difference was not significant (χ^2 = 2.26; *P* = .13). There was no significant difference between months.

Conclusion: Our findings show no seasonal variation in the occurrence of maternal UGS in Munyenge. Transmission of infection may be perennial.

Keywords: *Schistosoma haematobium*, pregnancy, LST, precipitation, stream contact behaviour, Munyenge

Abbreviations

ANC: Antenatal clinic care

UGS: Urogenital schistosomiasis

LST: Land surface temperature

MODIS: Moderate Resolution Imaging Spectroradiometer

CHIRPS: Climate Hazards Infrared Precipitation with Station

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1. INTRODUCTION

Schistosomiasis is considered as one of the Neglected Tropical Diseases (NTDs) and its burden is disproportionately concentrated in Africa [1 – 3] where people living in areas with limited access to safe water, sufficient sanitation and hygiene [4, 5] and adequate levels of appropriate health education [6] are highly at risk to the disease. Human infection tends to vary with host immunity, water contact patterns, and geographical location defined by the specific range of snail intermediate host habitat [5, 7]. Urogenital schistosomiasis is transmitted by *Schistosoma haematobium* that develops into the human-infective stage within *Bulinus* snails that act as the intermediate host [8].

The infectious form of the parasite, the cercariae infect humans penetrating their skin when they come into contact with contaminated freshwater [1]. The microscopic worms migrate through the body until they develop into sexually mature adults, and lay eggs in about 25–30 days of infection [9]. Some of the eggs are passed out of the body in urine to continue the parasite life cycle and the rest remain in the body causing pathology associated to infection.

Climatic factors are considered important in the spatial and temporal distribution of vector borne diseases as they determine vector distribution and influence annual occurrence of the disease and long-term trends [10]. The climatic factors frequently considered are temperature and precipitation which are fundamental drivers of schistosomiasis transmission. Both factors show a positive correlation with prevalence of infection [11]. Rainfall is largely responsible for creating the conditions that allow sufficient surface water accumulating in freshwater bodies and providing abundant snail breeding sites. The temperature of water bodies governs the development rate of the parasite within snails and the infectivity of cercaria [12 – 14]. Satellite

temperature and precipitation products are suitable in providing useful information to understand and model the relationship between meteorological conditions and *Schistosoma* prevalence [9]. In recent years, a number of studies have indicated that *S. haematobium* infection exhibits seasonal variation [15 – 17] and that infection may vary between countries and even between regions in the same country. In some areas, the prevalence of *S. haematobium* is higher in the dry season [17 – 19], while in other areas, it is higher during the rainy season [20 – 21]. Also, perennial transmission has been reported in some areas [21, 22]. Schistosomiasis is not only influenced by climatic factors but human behaviour and socio-economic factors play a key role in the schistosomiasis transmission process [23, 24]. Through various water contacts, the human being ensures the successful transmission of the parasite [6, 25 – 28]. Climatic factors as well influence water contact patterns [29, 30]. Extensive epidemiological studies on UGS have been carried out in Munyenge but none assessed the occurrence of this infection across the different seasons. Ebai *et al.* [31] and Ndassi *et al*., [32] have carried out two independent studies, one in the rainy and dry seasons respectively. Thus, this study described the seasonal (land surface temperature and precipitation) and annual maternal UGS pattern in Munyenge, South West Region, Cameroon.

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2. MATERIAL AND METHODS

2.1. Study area

The study was conducted in Munyenge, a rural locality located in the Mount Cameroon area, South West Region, Cameroon. The characteristics of the study area have been described elsewhere [33]. The study sites included the three health facilities (Government Integrated Health Centre, Trans African Health services and Banga Annex Health Centre) that provide

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healthcare, antenatal care and delivery services for the local population of Munyenge. The Mount Cameroon area has an equatorial climate with two distinct seasons: a rainy season which lasts from March to October followed by a short dry season of four months (November to February) [34]. This locality is known for its higher rate of UGS prevalence when compared with Ikata and Bafia neighbouring communities [31, 35]. Transmission of *S. haematobium* in the locality is favoured by the presence of the snail intermediate host, frequent water contact with cercaria-infested streams and inadequate supply of piped water [33, 36, 37]. Nonetheless, recent reports show scale-up of communal piped-water sources between 2014 and 2017 [33] and these may account for the reduction of UGS in this endemic focus [31, 33].

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2.2. Field survey and laboratory analyses

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A twelve-month cross-sectional survey of UGS prevalence was carried out between January to December 2017 during which pregnant women reporting for antenatal care clinic at any of the three-primary healthcare centres (Government Integrated Health Centre, Banga-Annex Health Centre and Trans African Health Services) were enrolled consecutively. Written informed consent was obtained from the participants before enrolment. A structured questionnaire was administered to consented expectant women to obtain socio-demographic data (age, marital status, educational level and occupation), gravidity status and potential factors related to schistosomiasis (stream usage, activities carried out in the stream and stream frequency).

Collection and analysis of urine samples were performed following standard procedures [38]. Briefly, all participants received pre-labeled transparent bottles for urine collection between 10am and 2pm. The urine was screened for visible haematuria and microhaematuria using urine reagent strip (Mission®, ACON Laboratories, Inc, USA). The filtration technique was used to

113 determine urinary schistosome egg excretion as described elsewhere [37]. Briefly, 10 ml of urine
114 was filtered using membrane filters (Sterlitech Polycarbonate (PCTE) membrane filters, USA)
115 which retained the schistosome eggs. The membrane filter was then placed on a microscope slide
116 and examined under light microscopy (Olympus NYUSA). The number of eggs counted was
117 reported per 10 ml of urine. A pregnant woman was diagnosed for *S. haematobium* infection
118 when she was positive by microscopic examination and/or urine reagent strip.

119 **2.3. Data source for precipitation and land surface temperature**

120 Land surface temperature and precipitation estimates were obtained from standard satellite
121 products. The land surface temperature (LST) estimates were obtained from the MOD11 product
122 [39], derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on
123 board the polar-orbiting satellites Terra and Aqua which pass over a given region once a day.
124 Precipitation estimates were obtained from the satellite rainfall product Climate Hazards Infrared
125 Precipitation with Station Data (CHIRPS) [40].

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127 **2.4. Data management and analysis**

128 Data were analysed using SPSS version 22.0 (SPSS, Inc., Chicago, IL, USA) and Microsoft
129 Excel 2010 (Microsoft Corp., USA). The monthly prevalence of infection, LST, precipitation,
130 stream usage, frequency of contact with stream as well as type of stream activity were calculated
131 and used to establish monthly and seasonal variations. Statistical analysis performed were
132 analysis of variance, student t- test and correlation analysis. Graphs were used to show trend of
133 infection with the factors stated above. P value < .05 was considered significant.

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2.5. Ethics approval and consent to participate

The study protocol was approved by the Ethical and Scientific Committee of the Institutional Review Board, Faculty of Health Sciences, University of Buea (No2017/0481/UB/FHS/IRB). Approvals were also obtained from the South West Regional Delegation of Public Health, Buea and the District Medical Officer for Muyuka Subdivision. Written informed consent was obtained from the women. Participation was voluntary, and participants were permitted to opt out at any time.

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3. RESULTS

3.1. Temperature and precipitation pattern in the study area

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The mean annual land surface temperature for 2017 was 27.18 ± 0.74°C and varied between 26.12 to 28.82°C. Monthly mean temperatures showed a fairly constant trend (Figure 1). There was no statistically significant difference (t = -0.87; *P* = .40) in mean temperatures between the rainy (27.05 ± 05) and dry (27.45 ± 1.2) seasons. There was a high degree of intra-annual variability (range: 0.26 - 12.75mm) in precipitation with a mean of 6.58 ± 4.5mm. A significantly higher (t = 4.47; *P* < .001) precipitation was recorded during the rainy (9.04 ± 2.8) than the dry (1.6 ± 2.5) season. The intensity of rains was classified as follows; early rains (March –May), heavy rains (June – August), late rains (September – November) and little or no rains (December to February) with mean precipitation levels of 6.17 ± 0.42mm, 11.9 ± 0.77mm, 7.9 ± 2.7mm and 0.34 ± 0.68mm respectively. The difference was statistically significant (F = 36.34; P <.001).

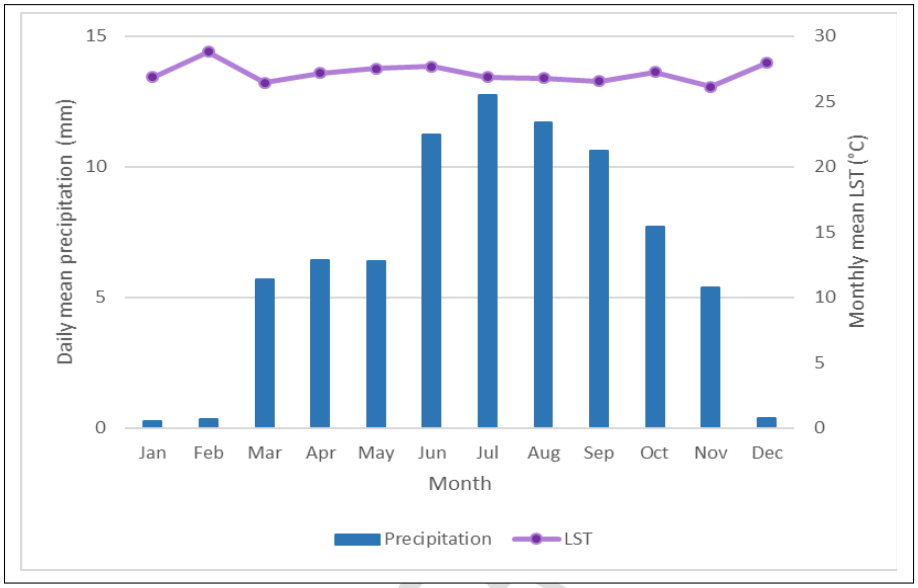

Figure 1: Annual precipitation and LST distribution in Munyenge in 2017.

3.2. Characteristics of study participants

A total of 320 women were enrolled within a one-year study period. The mean age of the women was 25.6 ± 5.6 (range: 15–42) with more women in the older age group (>25 years) (47.2%; n= 151) and multigravidae (45%; n = 144). The proportion of married women were about twice higher (73.9%; n = 232) than that of singles. With regards to occupation, a greater number of women were housewives (32.8%; n = 105) while 21.9% (70), 20.6% (66) and 24.7% (79) being student, farmer and doing business respectively. A majority of the women (57.5%; n = 184) had obtained at least a secondary level of education.

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3.3. Occurrence of *S. haematobium* infection

The overall prevalence of maternal UGS was 24.1% (77/320). Figure 2 presents the occurrence of *S. haematobium* egg excretion among pregnant women on a monthly scale from January to December 2017. Infection level varied between 8.3% (July 2017) and 38.1% (December 2017). It is worth noting that no month over the one-year period passed without an *S. haematobium*-infected case. *S. haematobium* infection exhibits varying peaks with higher prevalence within particular months. Peak egg excretion occurred in May (37.5%; 9/24), August (34.8%; 8/23) and December (38.1%; 8/21). However, there was no significant difference in prevalence between months (χ^2= 15.69; P = .15). A higher prevalence of egg excretion was recorded in the rainy season (16.6 %; 53/320) than in the dry season (7.5%; 24/330), although the difference was not statistically significant (χ^2 = 2.26; P = .13).

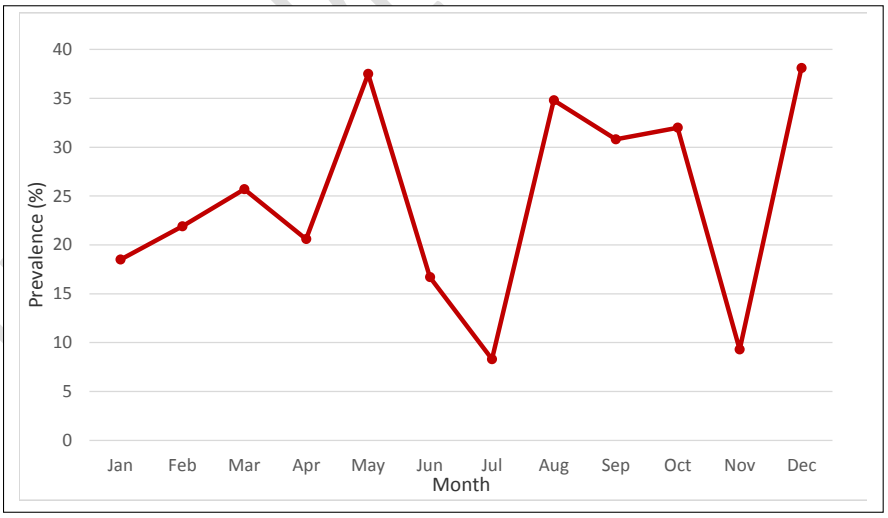

Figure 2: Annual occurrence of UGS among pregnant women in Munyenge in 2017.

3.4. Stream contact behaviour in the study area

Generally, there was high dependence on the stream as source of water (60.9 - 90.6%) in the study area (Figure 3a). Visit to the stream was significantly (r = 0.603; *P*= .03) associated with stream activities such as domestic chores and bathing (Figure 3b). A marginal significant negative correlation (r = -0.586; *P*= .04) was observed between stream usage and precipitation where stream usage reduced with increase precipitation. It is worth noting that, women who used piped water equally used the stream (r = 0.613; *P* = .03).

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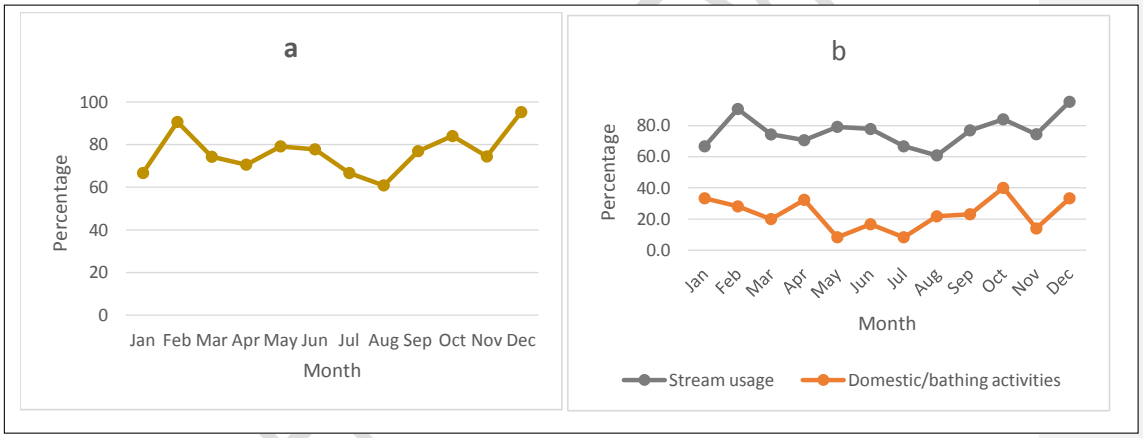

Figure 3: **a:** monthly stream usage **b:** monthly stream usage and stream activity.

4. DISCUSSION

Basic information regarding annual variation of maternal urogenital schistosomiasis can greatly enhance control efforts in endemic communities. This baseline study describes annual seasonal

pattern of Munyenge as well as reports on the occurrence of *S. haematobium* egg excretion in the study area during the period from January to December 2017.

Temperature and precipitation are fundamental drivers of schistosomiasis transmission as they determine snail distribution and influence annual occurrence of the disease [10, 11].Experimental studies have shown that the suitable temperature range for cercaria development in the laboratory is between 15°C to 35°C, with an optimum temperature of 25°C for development within the mollusc [13, 41]. The temperature pattern observed in the present study was within range of that which enhances cercarial incubation, shedding and infectivity. Similar to findings of Stirewalt and Fregeau [42], the monthly mean temperatures (Range: 26.12 to 28.82°C) is optimum for cercarial infectivity. Tay *et al*. [43] suggested t that temperature enhanced cercaria shedding to maintain infection within the study community. Longer rainfall period in the study largely sustains conditions that allow sufficient surface water accumulating in freshwater bodies and providing abundant snail breeding sites [44]. However, variations in rainfall tend to induce cyclic fluctuations in the infection rate and intensity of infection in the intermediate host. Rainfall may affect the level, rate of flow and the chemistry of a given body of water. Snails will turn to flourish at the start of the rainy season and may reduce as a result in the flooding of the snail habitat thereby dislodging them and leading to a fall in number [44].

In Munyenge stream water sources are often associated with high occurrence of snail intermediate host species (*Bulinus* sp) for urinary schistosome parasite [33]. About one in four women was positive for worm during pregnancy suggesting that the disease is an important public health concern in Munyenge. It is well-known that the transmission of schistosomiasis is common among rural African women who obtain water for domestic and other uses from springs and streams [45 – 48]. The high dependency on stream as water source in this setting is partly

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252 influenced by inadequate access to pipe-borne water despite scale up of communal piped water
253 sources [33, 37]. Climate exerts indirect effect on the appearance and spread of infectious
254 diseases by altering human behaviour and hence exposure to infection and disease [49]. With
255 regards to the present study, an inverse relationship was observed between stream usage and
256 precipitation where stream usage reduces with increase rainfall. This finding corroborates those
257 of Codjoe and Larbi [29] in Ghana and Ugbomoiko [50] in Nigeria which showed reduced water
258 contact behaviour (bathing, swimming and fishing activities) with increase rainfall. In
259 Munyenge, women use the stream purposely for domestic and bathing activities. Both activities
260 cause the most exposure to cercaria-infested water since it involves the immersion of large body
261 parts for long periods [37, 51, 52]

262 Our findings demonstrate high occurrence of *S. haematobium* egg excretion in the rainy season
263 than the dry season. This corroborates findings of Houmsou [21] in Nigeria, who reported no
264 monthly or seasonal difference in the prevalence of infection. On the contrary, well- marked
265 seasonal variation in *Schistosoma* infection has been reported by several authors [16, 17, 53 –
266 55]. The absence of seasonal difference in the occurrence in infection may suggest perennial
267 transmission of infection noting high dependency of the population on stream water source.
268 Also, the short-term (one-year lag time) investigation period may have allowed some infected
269 cases go undetected. The incubation period of schistosomiasis is at least six weeks [56]. This
270 may result in egg excretion after a considerable period of time had elapsed from the time of
271 infection. There are reports of live ova excretion many years after exposure, indicating worm
272 longevity and persistent ability to lay eggs [3].
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5. CONCLUSION

The seasonal pattern observed in Munyenge will enhance cercarial incubation, shedding and infectivity. There was high dependency on stream for bathing and domestic activities that will increase infectivity of human population. No seasonal difference in the occurrence of *S. haematobium* egg excretion suggesting perennial transmission.

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Competing interest

Authors have declared that no competing interests exist.

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