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INDEX OF POTENTIAL CONTAMINATION: *SCHISTOSOMA HAEMATOBIUM* INFECTIONS IN SCHOOL CHILDREN IN THE ASHANTI REGION OF GHANA
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ABSTRACT

Background: **Children are acknowledged as the most vulnerable group to urinary schistosomiasis.**
Objective: **To determine the age group(s) of school children considered as the major contributor(s) to the spread of the disease.**
Design: **Observational/Prospective (concurrent) studies.**
Setting: **Barekuma, Aninkroma and Hiawo Besease, riparian communities in the Ashanti Region of Ghana.**
Subjects: **Hundred children each were randomly selected from Barekuma and Hiawo Besease basic schools with population age profiles between 4 and 18 years. They were then categorised into 4-6, 7-9, 10-12, 13-15 and 16-18 years, respectively. However, at Aninkroma, the entire school population of 119 pupils, aged between 4 and 15 years were used. They were similarly grouped into 4-6, 7-9, 10-12 and 13-15 years, respectively. Urine filtration method was used for isolation and enumeration of *S. haematobium* eggs from the subjects. The subjects were monitored through repetition of the experiment at fortnightly intervals over four weeks.**
Main outcome measures: **Corrected relative Index of Potential Contamination (IPC) expressed as percentage after calculating the crude IPC.**
Results: **The age groups with the highest relative IPCs at Barekuma, Aninkroma and Hiawo Besease were 7-9, 10-12 and 13-15 years, registering 35.6%, 53.9% and 57.7%, respectively. The age group 4-6 years consistently had the lowest IPC in all the communities.**
Conclusion: **The age groups 7-9,10-12 and 13-15 years were considered to be the major transmitters of the disease in the communities.**

INTRODUCTION

Various studies conducted on schistosomiasis indicate that all age groups are susceptible to this infection. However, the greatest infection occurs in children, but this tends to decline with age. The WHO(1) reported that 66 million children between the ages of 10-14 years in 54 countries are infected with this disease. A study in Torgome, an area in the Volta Region of Ghana similarly showed that children aged 10-14 years had the highest prevalence of 70% *S. haematobium* infections(2). On the other hand, Arinola(3) reported that the disease was most prevalent in school children aged 6-15 years with a prevalence rate of 21.1% in Ibadan, Nigeria.

Index of Potential Contamination (IPC)(4), a more powerful predictive methodology than the use of prevalence and/or intensity in identifying the relative potential of different age groups in the spread of the disease, is rarely utilised. For instance most epidemiological findings of the disease in Ghana have been reported using disease prevalence and/or intensity of infection(2, 5-6). Very little has been done with the application of IPC in schistosomiasis epidemiology, especially in Ghanaian school children. This led to an investigation to ascertain the contributions of the various age groups of school children to the spread of the infection in three typical, rural and riparian settings in the Ashanti Region of Ghana.

MATERIALS AND METHODS

The study was conducted at Barekuma, Aninkroma and Hiawo Besease (Figure 1). which are riparian communities found in the forest region in the Atwima District of the Ashanti Region of Ghana. School children in these communities were used for the study. The locations of the communities, their relative distances away from the dam(s) and their water source, the number and types of educational institutions and their respective populations are presented in Table 1.

The school populations and their age profiles were obtained from school records (Table 1). The age profile at Barekuma and Hiawo Besease ranged between 4 and 18 years and that at Aninkroma, between 4 and 15 years. They were then categorised into age groups 4-6, 7-9, 10-12, 13-15 and 16-18 years in the former, and 4-6, 7-9, 10-12, and 13-15 years in the latter. The sample size required for the study at Barekuma and Hiawo Besease was calculated using a formula for sample size determination in Sanders(7) and this yielded 80 and 70, respectively. However, the sample size was increased to 100 each in these communities in order to increase the accuracy of the work. Twenty subjects were then randomly selected from each age group for the study. At Aninkroma however, the entire school population of 119 pupils were used for the study.

Figure 1

Map of Ghana showing the study areas in the Atwima District of the Ashanti region

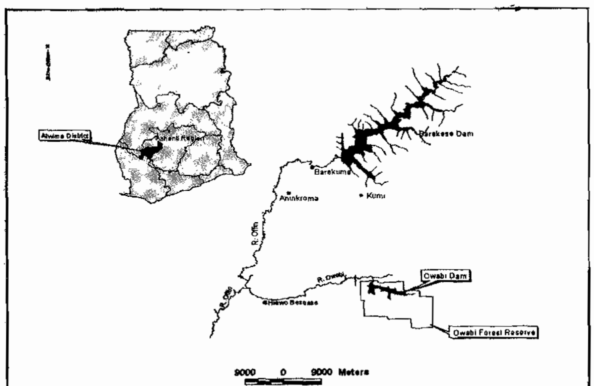

Fig 1 Map of Ghana showing the study areas in the Atwima District of the Ashanti Region

Urine samples were then collected from the subjects around mid-day since peak of egg excretion is around this time(8). The samples collected from each individual into 30 ml plastic containers, were corked tightly and labelled with the name, age and sex of each individual for follow-ups. The samples were then transported to the laboratory, preserved with 0.3 ml of 35% formaldehyde solution and kept refrigerated between 5-10°C.

Urine filtration technique was used for isolation and enumeration of the eggs(9-10) and this was based on their characteristic terminal spines(9-12). The subjects were monitored through repetition of the experiment(11) at fortnightly intervals over four weeks using the same laboratory procedure(9-10). From the data obtained for intensity, prevalence and population profiles of all the age groups, both crude and relative IPCs were then calculated using the method by Jordan *et al*(12).

RESULTS

The Index of Potential Contaminations (IPCs) for the various age groups in the communities are presented in Tables 2 to 4. Their relative IPCs ranged between 1.5 and 57.7%. At Barekuma the respective relative IPCs for the age groups 4-6, 7-9, 10-12, 13-15 and 16-18 years were 1.6%, 35.6%, 5.6%, 31.9% and 25.2% (Table 2). At Aninkroma, the age groups 4-6, 7-9, 10-12 and 13-15 years registered relative IPCs of 1.5%, 37.3%, 53.9% and 7.3%, respectively (Table 3).

Table 1

Locations of the study areas, the water source(s) and the educational institutions of the communities

Study areas	Locations	Bearings and distance from the dam(s)/km	Main water source(s)	Distance from water Source (s)/km	Educational institutions				
					No. of Nursery schools	No. of Primary schools	No. of Junior sec. schools	School Population	Age Profile (years)
Barekese Dam	6° 50', 1 ° 44' W								
Owabi Dam	6° 44', 1° 42' W								
Berekuma	6° 49', 1° 46' W	082°14'; 1.3 km,	R. Offin	0.3	1	1	1	415	4-18
Aninkroma	6° 48', 1° 46' W	072°21'; 1.5 km	R. Offin	0.4	1	1	0	119	4-15
Hiawo Besease	6° 44' 1° 47' W	031°03'; 4.1 km*/ 3.0 km**	*R.* Offin	0.9					
			R. Owabi	0.3	1	1	1	402	4-18

*=Distance from the Barekese dam, **= Distance from the Owabi dam

Table 2

Calculation of Index of Potential Contamination - crude and corrected at Barekuma

Age group (years)	Prevalence (%) +ve (1)	Intensity GM (2)	Crude IPC (3)=1x2	Relative IPC (%) (4)	Population Profile (%) (5)	Corrected IPC (6)=3x5/100	Relative IPC (%) (7)
4 - 6	55	2	110	2.0[a]	17.1	19	1.6[b]
7 - 9	90	17	1530	28.2	27.0	413	35.6
10-12	75	5	375	6.9	17.3	65	5.6
13-15	95	19	1805	33.2	20.5	370	31.9
16-18	95	17	1615	29.7	18.1	292	25.2
Total			5435	100	100	1159	100

a=Relative IPC % = 110/5435 x 100 = 2%, b= Corrected relative IPC= 19/1159x 100=1.6%, GM= Geometric Mean

Table 3

Calculation of Index of Potential Contamination-crude and corrected at Aninkroma

Age group (years)	Prevalence (%) +ve (1)	Intensity GM (2)	Crude IPC (3)=1x2	Relative IPC (%) (4)	Population profile (%) (5)	Corrected IPC (6) = 3x5/100	Relative IPC (%) (7)
4-6	33	5	165	4.4[a]	11.0	18	1.5[b]
7-9	67	17	1139	30.7	38.9	443	37.3
10-12	80	21	1680	45.3	38.1	640	53.9
13 -15	66	11	726	19.6	11.9	86	7.3
Total			3710	100	100	1187	100

a= Relative IPC %=165/3710x100=4.4%, b= Corrected relative IPC= 18/1187x100=1.5%, GM= Geometric Mean

Table 4

Calculation of Index of Potential Contamination - crude and corrected at Hiawo Besease

Age group (years)	Prevalence (%) +ve (1)	Intensity GM (2)	Crude IPC (3)=1x2	Relative IPC (%) (4)	Population Profile (%) (5)	Corrected IPC (6)=3x5/100	Relative IPC(%) (7)
4 - 6	40	4	160	13.1[a]	8.3	13	4.6[b]
7 - 9	45	4	180	14.7	20.2	36	12.7
10-12	40	5	200	16.3	13.4	27	9.5
13-15	65	8	520	42.4	31.6	164	57.7
16-18	55	3	165	13.5	26.5	44	15.5
Total			1225	100	100	284	100

a= Relative IPC % = 160/1225x100 = 13.1%, 1225, b= Corrected relative IPC = 13/284x100= 4.6%, GM= Geometric Mean

On the hand Hiawo Besease recorded relative IPCs of 4.6%, 12.7%, 9.5%, 57.7% and 15.5% for the age groups 4-6, 7-9, 10-12, 13-15 and 16-18 years, respectively (Table 4). It was observed from the results in Tables 2-4 that the age group 4-6 years in all the communities consistently recorded the lowest relative IPCs. However, the highest relative IPCs were registered by the age groups 7-9, 10-12 and 13-15 years, for Barekuma Aninkroma and Hiawo Besease, respectively, forming a well-fitted chronological age structure with distance downstream.

DISCUSSION

The results of the study indicate that all the children between age 4 and 18 years are all susceptible to the disease. This observation confirms previous studies in the same district conducted by Tetteh(5). The study further revealed that all the age groups have the potential of spreading the disease at different proportions.

In the communities, the age groups 7-9, 10-12 and 13-15 years which registered the highest relative IPCs, were potentially responsible for 35.6%, 53.9% and 57.7% contamination of their water with *S. haematobium* eggs. A similar observation in an area in St. Lucia showed that the age group 15-19 years was potentially responsible for 29.0% of contamination of their water(13). On the other hand Akogun and Akogun(14) reported that the greatest contribution to the spread of the disease in school children in Yule, Nigeria, occurred in the age group 5-10 years. The peculiar observation in the current study with respect to the age groups 7-9, 10-12 and 13-15 years having the highest relative IPCs and forming a well-fitted chronological age structure with distance downstream suggests a higher worm burden(15) manifested in copious egg excretion in their urine. This further suggests that the ability to cope with more riverine conditions with distance away from the dam(s) downstream (Figure 1) and the ability to contract and transmit the infections are age-dependent. This observation, probably was in response to their physiological needs such as avoidance of hot weather, thus ensuring longer periods of recreational contact with the contaminated water and/or in response to fulfilling their domestic/occupational duties(12,14,16-17).

The other age groups in the all the communities (Tables 2-4) posed less threat in the spread of the disease. This could be due to a much less water contact, thereby minimising their risk of acquiring heavy infections(16, 17) and spreading them. However, the most probable reason for the age group 4-6 years consistently recording the lowest relative IPCs throughout the study could be due to a much restriction imposed by their parents for fear of drowning, thereby minimising their- contacts with water and hence the risk of acquiring heavy infentions. On the other hand, restriction of Muslim girls from an early age for religious reasons in Nigeria was found to be the major reason accounting for their less contact with water leading to a lower prevalence of the disease than their male counter parts(18).

In conclusion, with the revelation of the age groups 7-9, 10-12 and 13-15 years as the major transmitters of the infection in the communities, any intervention in the control of the disease should prioritise on these age groups.

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