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Research article

Point-of-care circulating cathodic antigen positivity and associated factors in school children one year after mass praziquantel administration in an endemic district in Ghana

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ABSTRACT

Background: Mass drug administration of praziquantel is expected to reduce *Schistosome* carriage in treated children in endemic communities. However, the effectiveness of this annual exercise has not been assessed in Ghana. Therefore, this study aimed to detect viable *Schistosoma mansoni* infection using point-of-care circulating cathodic antigen (POC-CCA) positivity as proxy and associated factors in children previously treated with praziquantel in an endemic municipality in Ghana.

Materials and methods: This cross-sectional study was done in the Assin Central municipality in the Central Region of Ghana. School children, less than 16 years of age, treated with 40 mg/kg of praziquantel (treatment period: February–March 2019), provided early morning urine (~40 mL) and stool (~4 g) samples. Immediately, POC-CCA (ICT International, South Africa) was done, while *S. mansoni* ova were detected in formalin fixed samples using microscopy later. Additionally, participant's socio-demographic information and factors associated with *S, mansoni* infection transmission were collected from each child.

Results: A total of 520 children participated in the study (males-51.9%, majority age range [9–11 years, 34.4%]). Overall, 244 (46.9%) were positive for urinary CCA with no *S. mansoni* detected by microscopy. POC-CCA positivity was higher in females (48.4%), children with 2–3 siblings (49.3%), children aged 6–8-year range (55.4%) and residents of Brofoyedur (52%). However, age ($x^2 = 16.1$, $p = 0.0003$) and town of residence ($x^2 = 11.7$, $p = 0.019$) associated with CCA positivity. Further, location of water body ($x^2 = 16.4$, $p = 0.008$), frequency of water contact ($x^2 = 12.3$, $p = 0.015$) and handling of the *Biomphalaria* intermediate host ($x^2 = 5.1$, $p = 0.024$) associated with POC-CCA outcome.

Conclusion: About 47% of the school children were positive for CCA, one year after mass praziquantel administration in the Assin Central municipality. Varied factors associated with the post-

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praziquantel administration POC-CCA positivity. This study should be replicated in other endemic areas to identify groups at risk of parasite persistence or reinfection to inform modification of control and preventive measures.

1. Introduction

Schistosomiasis is still endemic in Ghana and cited to be present throughout the whole country including urban areas according to the 2015 World Schistosomiasis Risk Chart [1]. *Schistosoma mansoni* infection in the country varies by location and depends on many factors including geographic location, gender, age, occupation, contact with water, distance to water resources and socioeconomic status [2]. People sometimes are infected during routine agricultural, domestic, occupational and recreational activities, which expose them to contaminated water. School-age children and preschool children, relative to other age classes, are the most vulnerable group [3].

Among school children, in Ghana, prevalence has been reported to be 76% at Weija community [4], 10.3% at Akyemanso District in the Eastern region [5], 10.4% in three districts in the Volta region [6], 10.4% in Asuogyaman District of the Eastern Region [7], and 4.7% at Ga East and South Districts [8]. Whereas in a community surveillance study in the Ga West municipality in Ghana, 1.7% prevalence was reported [9].

Mass drug administration has been cited as an important tool for the control of neglected tropical diseases (NTDs) including schistosomiasis [10–13]. Therefore, countries continue to adopt the use of praziquantel for the control of schistosomiasis. However, several cases of therapeutic failure of praziquantel used for the treatment of schistosomiasis have been reported [14]. Praziquantel treatment failure in both urinary and intestinal schistosomiasis have been reported in Spain [15], Italian returnees from Uganda [14], Senegal [16], Egypt [17,18], Malawi [19] and Ghana [20]. These studies underscore the importance of assessments of the efficacy of praziquantel administration after treatment.

Urinary detection of circulating cathodic antigens (CCA) could connote with presence of viable *Schistosome*. This is because *Schistosome*, especially the mansoni spp, regurgitate the CCA during feeding [21], which are excreted through urine of infected hosts. Therefore, presence of CCA in host urine could serve as a good determinant of host *S. mansoni* viability. POC-CCA technique has been reported as a valid substitute for microscopy for diagnosis mostly of intestinal schistosomiasis [22].

In Ghana, mass drug administration (MDA) of praziquantel started in 1999 [7]. However, this annual public health intervention has not yielded the desired results since there are focal endemicity of the disease in Ghana. In most sites where children were administered with praziquantel, the factors that influence the persistence or reinfections of the parasites have not been investigated. Therefore, there is the need to investigate the factors that perpetuate the disease in children after treatment in order to design control measures towards

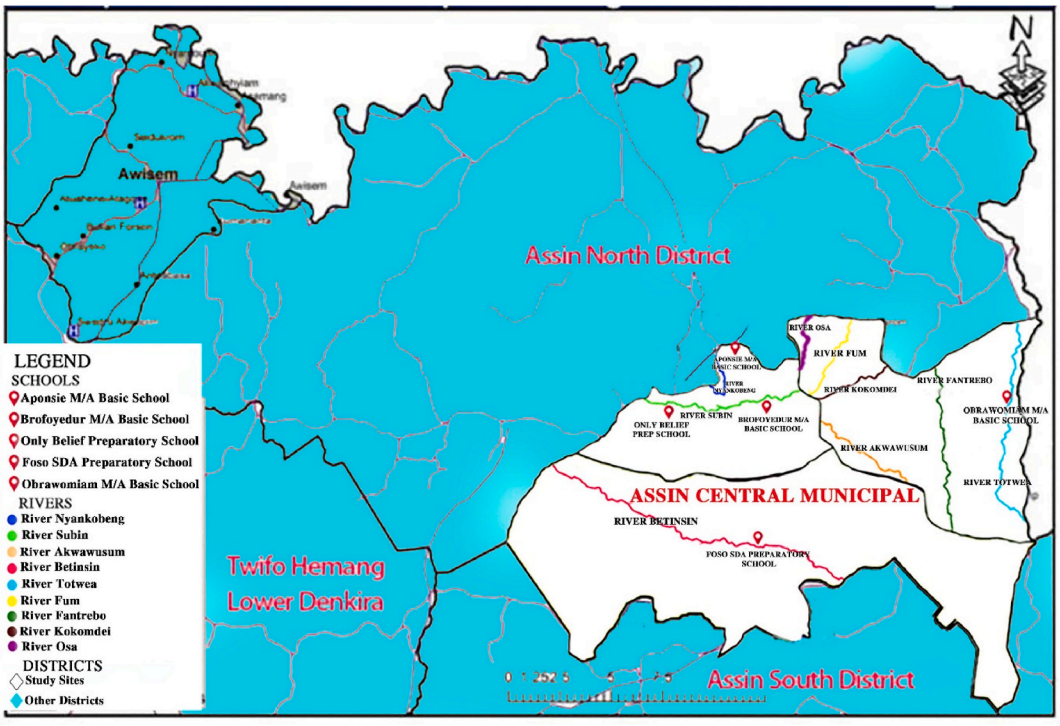

Fig. 1. The map of Assin Central Municipal showing the location of the schools and the water bodies.

elimination of the disease in endemic countries.

The latest MDA of praziquantel in the Assin Central Municipality in the Central Region of Ghana was in 2019. During the exercise, all school going children between the ages of 6 and 15 years were treated with praziquantel. Subsequently, the children were taken through preventive measures to prevent reinfection of the parasites. Therefore, this study sought to determine the effectiveness of praziquantel MDA in the Assin Central Municipality and the factors associated with POC-CCA positivity in previously treated children.

2. Materials and methods

2.1. Description of study municipality and study sites

Participants for the study were randomly selected from the Assin Central municipality located in North West part in the Central region of Ghana. The municipality is endowed with several water bodies such as river Subin, Nyankobeng, Totwea, Nkrabia, Kwabena Betansin, Atonsu, Kokwondo, Abotsi wura, Jetua, Sabramine and many others (Fig. 1). The municipality has an estimated population of 90,637 [23]. The main economic activities of the people in the municipal are farming, trading and agro-processing. There are one hundred and four (104) schools in the municipality of which 75 are public schools and 29 are private schools. Five schools were selected in the municipality for this study based on their history of recent mass praziquantel drug administration. Participating schools were Assin Aponsie M/A Basic School, Assin Brofoyedur M/A Basic School, Only Believe Preparatory School (located at Assin Brofoyedur), Fosu SDA Preparatory School and Obrawomiam M/A Basic School (Fig. 1).

2.2. Research design

Cross-sectional study design was employed in this study. School going children previously infected, with detectable S. mansoni ova, and treated with praziquantel were identified with the help of the Disease Control Officers from the Assin Central Municipal Health Administration in Assin Fosu together with the teachers of the various schools. The enrolees were systematically selected by recruiting those that selected YES from a blinded pool of Yes and No. Subsequent to that, consent to recruit was sought from their head teachers and a written consent from their parents.

2.3. Praziquantel administration and purposive selection of the school children

The last mass praziquantel administration (MPA) in the district was done in February–March 2019. The Assin South District Health Administration did the MPA. Praziquantel was administered at a dosage of 40 mg/kg (body weight measured to the nearest kilogram). The community health nurses administered the drug, directly observed, which was supervised by the team lead (either a disease control officer or a clinician). The school and the Health Directorate kept records of the pupils that were given the praziquantel. From that list, the school children were purposively selected, with prior parental consent, to participate in the study.

2.4. Sample size determination

The sample size was determined using the formula; $n = Nz^2\rho q/[E^2(N-1) + z^2\rho q]$ [2]. Where: n = required sample size; N = population size (90,637 people); z = 1.96 (confidence level of 95%); p = estimated prevalence of schistosomiasis (21.1%); q = 1-p; E = accuracy of estimation (0.05). A sample size of 255 was determined based on an estimate of *S. mansoni* prevalence in selected communities in the Central Region of 21.1% [24]. The sample size was determined using the StatCalc function of Epi Info software, Version 7.2.4.0 (Center for Diseases Control, Atlanta, Georgia, USA, and World Health Organization, Geneva, Switzerland). This sample size was multiplied by the maximum design effect of 1.96 (for a two tailed design) to give a sample of 500.

2.5. Inclusion and exclusion criteria

From the schools, pupils aged 6–15 years, attending the selected schools, with parent/guardian consent to participate were included in the study. Previous praziquantel administration was a key inclusion factor. Any female participant in her menstrual cycle as well as a male participant with obvious haematuria was excluded from the study.

2.6. Eliciting study information using structured questionnaires

A questionnaire (Supplementary file 1) was used to obtain relevant socio-demographic data of the participants. The questionnaire was also used to obtain information on the key risk factors and symptoms associated with schistosomiasis. To assess the risk factors for infection, the following indicators were employed; age, gender, school attended by pupil, residential town as well as whether they have had contact with water bodies. Additionally, the location of the water bodies they came into contact with was noted. Participants were also asked whether they have experienced any of these symptoms; abdominal pain, blood in stool, blood in urine, coughing within the past 3–6 months.

2.7. Assessment of knowledge of and contact with the intermediate snails

Samples of the intermediate hosts for the Schistosomes, *Biomphalaria* spp, *Bulinus* spp and *Oncomelania* spp were collected from the Department of Biomedical Sciences, University of Cape Coast. The school children were shown these snails to confirm if they had seen, touched or eaten any of them before.

2.8. Collection of urine and stool samples

Enrolees were supplied with sterile airtight urine and stool containers properly labelled with unique identification numbers based on registration numbers assigned to them. Each child was trained to collect about 4 g (four spoon full) of the stool sample using the collection spatula that accompanied the sample collection container. Additionally, about 40 mL of urine sample was collected. The Research Team collected samples for each participant on scheduled days as follows, Assin Aponsie M/A Basic School (11th to February 12, 2021), Assin Brofoyedur M/A Basic School (15th to February 17, 2021), Only Believe Preparatory School (22nd to February 23, 2021), Fosu SDA Preparatory School (1st and March 2, 2021) and Obrawomiam M/A Basic School (15th to March 16, 2021). The major limitation during sample collection was the inability of the Research Team to collect the samples close to midday and also our inability to allow the pupils to perform some physical activity prior to using collection, as recommended for *Schistosome* studies [25]. This was because, this study was done in the peak of the third wave of COVID-19 in Ghana, and for that matter, there were very strict restrictions for human contacts especially involving school children. On the day of sample collection, urine samples were tested for cathodic circulating antigens (POC-CCA) while the remaining urine and stool samples were fixed with 10% buffered formalin and stored at room temperature.

3. Laboratory analyses

3.1. Circulating cathodic antigen test method

A commercial point of care cathodic circulating antigens (POC-CCA) procured from ICT International, Noordhoek, Cape Town, South Africa was used for this study following the manufacturer's protocol (batch number: 200326039, date of manufacture: March 2020, expiry: March 2022). Briefly, two drops of the fresh urine were transferred to the circular well of POC-CCA test cassette using the pipette provided. Results were read within 20–25 min, as recommended by the manufacturer. Results were recorded as negative (if only one red band is seen at the control column) and positive when an additional band is seen at the test column, irrespective of the intensity of the band, as recommended by the manufacturer. However, irregular band, where the red color formed did not traverse the width of the kit, was considered a negative outcome.

3.2. Centrifugation method for S. haematobium ova identification

Ten millilitres (10 mL) of well-mixed fixed urine sample were poured into a clean centrifuge tube, spun at 2000 rpm for 5 min. The supernatant was discarded whereas the deposits were observed microscopically using iodine solution for contrast.

3.3. Stool examination for S. mansoni using formol ether-concentration method

The stool-10% buffered formalin suspension (1 mL) was emulsified completely in 4 mL of formol saline, sieved (double layer) into a clean centrifuge tube using a non-absorbent cotton gauze. Subsequently, 3 mL of diethyl ether (Honeywell, USA) was added and vortexed vigorously. The mixture (~8 mL) was centrifuged for 5 min at 2000 rpm. The debris plug was removed in a single movement with the assistance of the applicator stick by spiral movement and the supernatant decanted, and carefully leaving a few drops of residual fluid to flow back into the sediment. One drop of iodine solution was added to the sediment and all the deposits examined microscopically as previously described [26]. The Biomedical Scientist that performed the coproscopy was oblivious of the outcome of the POC-CCA test.

3.4. Statistical analysis

Data was analysed using IBM SPSS version 26 (Statistical Package for the Social Sciences, Chicago, IL USA). Descriptive statistics were used to analyse socio-demographic characteristics whereas categorical variables were described as numbers and percentages (%). Overall age of the participants was described as the mean and standard deviation (SD). Chi-square or Fisher exact test was used to test the differences between POC-CCA outcome and independent variables. All tests were 2-tailed and $p < 0.05$ was considered statistically significant in all the analyses.

3.5. Ethical considerations

Written parental consent was sought for each pupil as well as permission from the Municipal Directorate of the Ghana Educational Service. Prior to that, ethical approval was sought from Institutional Review Board of the University of Cape Coast (UCC-IRB) (reference number: UCCIRB/CHAS/2021/293).

4. Results

4.1. Demographic characteristics of the study participants

In all, 520 school children participated in the study. The mean age of the children was 11.44 ± 2.40 years. Majority of the children were males (51.9%). Most of them had more than four siblings (69.2%). Brofoyedur M/A Basic School provided majority of the study participants (35.6%) with most of them being in the 9–11-year age range (34.4%). More than half of the participants resided in Brofoyedur (52.1%). Majority of the parents of the participants were self-employed (father = 75.4%; mother = 96.9%) (Table 1).

4.2. Prevalence of POC-CCA positivity in children previously treated with praziquantel

Altogether, 244 (46.9%) children out of the 520 children tested positive for point-of-care cathodic circulating antigens (POC-CCA). Prevalence of POC-CCA positivity was marginally higher in males compared to females (48.4% vs. 45.6%, p = 0.516). Further, prevalence of POC-CCA positivity was higher in children with either no sibling or only one (64.7%). However, the number of children in a household did not significantly influence frequencies of POC-CCA positivity (p = 0.521). Additionally, parents' occupation did not significantly influence the frequencies of POC-CCA positivity (p > 0.05), although prevalence was higher in children whose fathers were public servants (70.3%) and whose mothers were unemployed (100%). That notwithstanding, prevalence was significantly higher in children with age range 12–15 years (65.1%) and lower among 6–8-year range (44.6%) ($x^2 = 16.1$, p = 0.0003). Additionally, prevalence of POC-CCA positivity was significantly higher among pupils in Assin Fosu S.D.A Basic (71.0%) while lower among pupils of Obrawomiam A.M.E. Zion (34.0%) ($x^2 = 24.7$, p < 0.001). Finally, infection was significantly higher among residents in Assin Fosu (67.9%) and lower in other residents (35.3%) ($x^2 = 11.7$, p = 0.019) (Table 2).

4.3. Factors associated with POC-CCA positivity

Risk factors associated with POC-CCA positivity is presented in Table 3. It was observed that previous contact with water body did not associate with POC-CCA positivity irrespective of the last time a child had contact with the water body (p > 0.05). However, contact with a particular water body associated with POC-CCA positivity. It was also observed that more than half of the children that

Table 1
Demographic characteristics of the study participants.

	Number of participants	Percentage (%)
Mean age	11.44 ± 2.40	
Gender		
Male	270	51.9
Female	250	48.1
Mean number of siblings		
0–1	17	4.3
2–3	138	26.5
≥4	360	69.2
Name of School		
Aponsie M/A Basic School	112	21.5
Assin Fosu S.D.A Basic	100	19.2
Brofoyedur M/A Basic School	185	35.6
Obrawomiam A.M.E. Zion	47	9.0
Only Believe Prep School	76	14.6
Age range in years		
6–8 (n = 166)	166	31.9
9–11 (n = 179)	179	34.4
12–15 (n = 175)	175	33.7
Town/Village of residence		
Aponsie	100	19.2
Brofoyedur	271	52.1
Assin Fosu	78	15.0
Habitat	37	7.1
Other[a]	34	6.5
Occupation of father		
Self-employed	392	75.4
Private employment	91	17.5
Public service	37	7.1
Occupation of mother		
Unemployed	5	1.0
Self-employed	504	96.9
Private	2	0.4
Public service	9	1.7

[a] The other residential villages were Adabo, Osa Nkwanta, Abodomfomu, Egya Botwe and Yawborg.

Table 2
Prevalence and demographic association of POC-CCA positivity **among previously treated children.**

	Point-of-care cathodic circulating antigen (CCA)		
	Negative (N = 276) N (%)	Positive (N = 244) N (%)	x^2 (p-value)
Gender			0.42 (0.516)
Male (n = 270)	147 (54.4)	123 (45.6)	
Female (n = 250)	129 (51.6)	121 (48.4)	
Mean number of siblings			1.3 (0.521)
0–1 (n = 17)	11 (64.7)	6 (35.3)	
2–3 (n = 138)	70 (50.7)	68 (49.3)	
≥4 (n = 360)	194 (53.8)	166 (46.2)	
Name of School			24.7 (<0.001)
Aponsie M/A Basic School (n = 112)	64 (57.1)	48 (42.9)	
Assin Fosu S.D.A Basic (n = 100)	71 (71.0)	29 (29.0)	
Brofoyedur M/A Basic School (n = 185)	93 (50.3)	92 (49.7)	
Obrawomiam A.M.E. Zion (n = 47)	16 (34.0)	31 (66.0)	
Only Believe Prep School (n = 76)	32 (42.1)	44 (57.9)	
Age range in years			16.1 (0.0003)
6–8 (n = 166)	74 (44.6)	92 (55.4)	
9–11 (n = 179)	88 (49.2)	91 (50.8)	
12–15 (n = 175)	114 (65.1)	61 (34.9)	
Town/Village of residence			11.7 (0.019)
Aponsie (n = 100)	58 (58.0)	42 (42.0)	
Brofoyedur (n = 271)	130 (48.0)	141 (52.0)	
Assin Fosu (n = 78)	53 (67.9)	25 (32.1)	
Habitat (n = 37)	23 (62.1)	14 (37.9)	
Other[a] (n = 34)	12 (35.3)	22 (64.7)	
Occupation of fathe			5.6 (0.06)
Self-employed (n = 392)	207 (52.8)	185 (47.2)	
Private sector (n = 91)	43 (47.3)	48 (52.7)	
Public service (n = 37)	26 (70.3)	11 (29.7)	
Occupation of mother			0.72 (0.69)
Unemployed (n = 5)	5 (100)	0 (0.0)	
Self-employed (n = 504)	264 (52.4)	240 (47.6)	
Private sector (n = 2)	1 (50.0)	1 (50.0)	
Public service (n = 9)	6 (66.7)	3 (33.3)	

[a] The other residential villages were Adabo, Osa Nkwanta, Abodomfomu, Egya Botwe and Yawborg.

contacted these water bodies carried the parasite; rivers Totwea (56.0%), Nyankobeng (56.7%), Kokomdei (58.3%), Akwawusum (61.1%) and Osa (62.5%). Additionally, the frequency of contact with the water body within a week associated with the POC-CCA positivity (x^2 = 12.3, p = 0.015). Finally, haematuria at the time of sample collection associated with POC-CCA positivity (x^2 = 4.89, p = 0.027). Surprisingly, contact with water body after praziquantel treatment did not associate with POC-CCA positivity (x^2 = 0.290, p = 0.590).

4.4. Association of knowledge of and contact with the intermediate snails and POC-CCA positivity

From Table 4, it was observed that majority of the children had seen the *Biomphalaria* spp (71.3%), *Bulinus* spp (63.5%) and *Oncomelania* spp (63.6%) intermediate hosts. Additionally, majority of them also confirmed previously handling of the snails (50.1–52.3%). Interestingly, 23.1–36% of the children indicated ever eaten the intermediate hosts. However, only handling of the *Biomphalaria* spp (x^2 = 5.1; p = 0.024) associated with POC-CCA outcome but eating and sight of them did not.

5. Discussion

Mass drug administration (MDA) has been cited as an important tool for the control of neglected tropical diseases (NTDs) such as schistosomiasis [10,13]. Consequently, praziquantel has been used as the chemotherapy for controlling schistosomiasis in MDA exercises in Ghana [7]. In view of that, MDA was implemented in the Assin Central municipality in the Central region of Ghana in 2019 where over 28,000 school going children below 16 years were treated, free of charge, per information obtained from the Municipal Health Directorate. In this study, we assessed the proportion of the children previously treated that harbour the *S. mansoni* parasites and factors that associated with post-treatment *S. mansoni* infection.

The CCA was detected in close to half (~47%) of the study population implying that the parasites are alive since it is only the live parasites that are able to regurgitate the CCA during feeding [27], considering the fact that all the female children that were menstruating were excluded from the study. Therefore, cross-reactivity of blood was avoided. That notwithstanding, the specificity of the CCA assay could be reduced due to false positive outcomes, which have been reported in some studies [28,29].

The observed prevalence of CCA positivity which could correlate with viable *S. mansoni* infection in the children post-praziquantel

Table 3
Risk factors associated with POC-CCA positivity.

Risk factor	Negative (N = 276) N (%)	Positive (N = 244) N (%)	Chi statistic	p-value
Previous contact with water body			0.141	0.707
No	24 (8.7)	19 (7.8)		
Yes	252 (91.3)	225 (92.2)		
Last time you enter water body (in months)			7.563	0.109
<3months	207 (75.0)	178 (73.0)		
3–6 months	22 (8.0)	26 (10.7)		
6–9 months	0 (0.0)	4 (1.6)		
9–12 months	2 (0.7)	4 (1.6)		
>12 months	21 (7.6)	13 (5.3)		
Name of water body			16.458	0.0087
Akwawusum	7 (2.5)	11 (4.5)		
Betinsin	35 (12.7)	19 (7.8)		
Fantrebo	7 (2.5)	5 (2.0)		
Fum	5 (1.8)	2 (0.8)		
Kokomdei	5 (1.8)	7 (2.9)		
Nyankobeng	13 (4.7)	17 (7.0)		
Osa	3 (1.1)	5 (2.0)		
River Pra	14 (5.1)	3 (1.2)		
Subin	152 (55.1)	142 (58.2)		
Totwea	11 (4.0)	14 (5.7)		
Reason for entering water body			4.039	0.544
Fishing	16 (5.8)	22 (9.0)		
Swimming	132 (47.8)	111 (45.5)		
Washing	19 (6.9)	14 (5.7)		
Playing	18 (6.5)	20 (8.8)		
Fetching	12 (4.3)	15 (6.1)		
Other	56 (20.3)	43 (17.6)		
Proximity of place of residence to water body			2.160	0.540
Very close (<1 km)	49 (17.8)	51 (20.9)		
Close (1–2 km)	98 (35.5)	93 (38.1)		
Far (2–3 km)	62 (22.4)	50 (20.5)		
Very far (>3 km)	67 (24.3)	49 (20.1)		
Number of times in a week pupil enters water body			12.340	0.015
None	46 (17.8)	31 (12.7)		
Once	126 (45.6)	110 (45.1)		
Twice	38 (13.8)	59 (24.1)		
Thrice	36 (13.0)	19 (7.8)		
4 or more times	30 (10.8)	25 (10.2)		
History of haematuria			0.402	0.526
No	219 (79.3)	188 (77.0)		
Yes	57 (20.6)	56 (23.0)		
Previous praziquantel treatment			0.989	0.320
Yes	276 (100)	244 (100)		
Contact into water body after the praziquantel Treatment			0.290	0.590
No	84 (30.4)	69 (28.3)		
Yes	192 (69.6)	175 (71.7)		
Current experience of haematuria			4.895	0.027
No	246 (89.1)	201 (82.4)		
Yes	30 (10.8)	43 (17.6)		

treatment underscores the fact that transmission intensity of schistosomiasis in Assin Central municipality is very high. Frequency of POC-CCA positivity was similar in both males and females, even though prevalence in females were slightly higher. In communities without potable water supply, young females are mostly relied on to do chores that required fetching of water from streams [30]. Additionally, it was observed that children with any number of siblings were also equally affected, however, viable parasite carrier rate could be higher in children with either no or only one sibling. The most plausible explanation to this observation is that children with no or few siblings had the unassisted responsibilities to carry out chores that involved visiting water bodies to fetch water for domestic activities, unlike children with several siblings, where domestic duties may be shared responsibility. Furthermore, children schooling at Obrawomiam were disproportionately affected. This observation was not surprising because Obrawomiam township is surrounded by three water bodies namely Totwea, Kokomdie and Osa. These river bodies had a number of intermediate hosts, predominantly *Biomphalaria* spp.

We also observed that frequencies of POC-CCA positivity was higher in younger children with children between 6 and 8 years recording higher rates. It would be recalled that on March 15, 2020, all primary and junior high schools were closed down due to the COVID-19 pandemic [31] and reopened on January 15, 2021 [32]. During this period, the children were at home, more especially, the younger ones that were not involved in any commercial activities being undertaken by their parents could enter the water bodies for

Table 4
Knowledge of the intermediate host and POC-CCA outcome.

	POC-CCA negative	POC-CCA positive	Chi statistic	p-value
Seen Biomphalaria* spp *in water bodies before			2.469	0.116
No	71 (47.7)	78 (52.3)		
Yes	205 (55.3)	166 (44.7)		
Seen Bulinus* spp *in water bodies before			2.050	0.152
No	93 (48.9)	97,951.1)		
Yes	183 (55.5)	147 (44.5)		
Seen Oncomelanea* spp *in water bodies before			0.241	0.624
No	103 (54.5)	86 (45.5)		
Yes	173 (52.3)	158 (47.7)		
Handled Biomphalaria* spp *before			5.123	0.024
No	123 (48.0)	133 (52.0)		
Yes	153 (58.00	111 (42.0)		
Handled Bulinus* spp *before			1.802	0.179
No	124 (50.0)	124 (50.0)		
Yes	152 (55.90	120 (44.1)		
Handled Oncomelanea* spp *before			0.536	0.464
No	128 (51.4)	121 (48.6)		
Yes	148 (54.6)	123 (45.4)		
Eaten Biomphalaria* spp *before			0.476	0.490
No	209 (52.3)	191 (47.8)		
Yes	67 (55.8)	53 (44.2)		
Eaten Bulinus* spp *before			0.035	0.852
No	191 (53.4)	167 (46.6)		
Yes	85 (52.5)	77 (47.5)		
Eaten Oncomelanea* spp *before			0.355	0.551
No	180 (54.1)	153 (45.9)		
Yes	96 (51.3)	91 (48.7)		

various reasons. It was also revealed that POC-CCA positivity was higher in children that had contact with the water bodies twice weekly (60.8%). Though relatively low, those that contacted the water bodies more than thrice weekly, had up to 45.5% CCA positivity. This confirms that multiple entry into water bodies could increase the risk of being infected with the *Schistosome* parasite.

Almost half of the previously treated children had CCA detected in their urine samples. Even though praziquantel insensitivity has previously been reported against the juvenile stages of the *Schistosome* parasite [33], it is difficult to conclude that the prevailing high CCA positivity were as a result of the inability of the praziquantel to kill the initial infection. However, microscopy failed to detect any *Schistosome* ova in the stool samples. Irregular laying of ova could reduce the sensitivity of the microscopy [34,35]. But in the face of high CCA detection rate amidst no detection of parasite ova could imply that some of the parasites survived the praziquantel treatment. This is because several studies have demonstrated that praziquantel reduced fertility in the *Schistosome* [36–39]. Aside the reduced fecundity imposed on the *Schistosome* possibly by praziquantel, treatment failure has also been widely reported [14,19,20]. Again, egg negative *Schistosome* could be due to the presence of immature or menopausal worms, presence of all male or all female parasites in the study participants and excretion of eggs on a different day [40]. Based on the data reported herein, it is unclear if we were dealing with persistent parasites or reinfections. Therefore, in future studies, CCA assay should be done immediately and regularly after praziquantel therapy. This approach could help distinguish reinfection from persistent infection.

Although a relatively high POC-CCA positivity was observed, stool microscopy was negative for *S. mansoni* in all samples examined. This observation is similar to that of other studies in Rwanda [41], Burundi [42], Egypt [43], and Switzerland [44], where CCA was detected with undetectable ova in stool by microscopy technique. It is important to note that POC-CCA and microscopy detect different stages of the *S. mansoni* life cycle and that is why it is possible to have worms without eggs. It is however not possible to have egg excretion without worms [40]. In explaining why it is possible to find people (sometimes many people) with low (or no) eggs by stool microscopy examination that have *S. mansoni* detected by CCA, Colley et al. (2017) cited the following as possible reasons. Microscopy might be insensitive and missed eggs as eggs may be on another part of the stool or excreted on a different day, temporary suppression of egg-production by worms damaged but not killed by praziquantel treatment, presence of single sex *Schistosome*, or presence of infertile, immature or menopausal *Schistosome*. One or multiples of these factors could have contributed to the observation made in the current study. Therefore, it is recommended that in similar observations, further studies should be carried out to unravel this dilemma to empirically ascertain the reasons underpinning the high number of egg-negative *S. mansoni* in endemic areas.

6. Limitations

The timing of the sample collection may affect the microscopy outcome of the study. Due to the COVID-19 restrictions, early morning sample was collected with no agitations prior to urine sample collection. Additionally, our inability to include PCR results, due to resource constraints, made it impossible to assess the true proportion of the CCA positive outcome attributable to *S. mansoni*. Finally, the pre-MPA rate of schistosomiasis endemicity in the study site was unknown.

7. Conclusion

The study reports that considerable number of school children harboured active *S. mansoni*, one year after mass drug administration with praziquantel. This is linked to geographic and socio-economic activities at the communities in the municipality. Data reported herein indicated high transmission intensity of schistosomiasis in the Assin Central municipality, since several children had active schistosomiasis. However, we are unable to tell if the *S. mansoni* survived praziquantel treatment or the children were re-infected. It is therefore recommended that future studies should include the immediate and regular detection of CCA after praziquantel therapy. This approach could help distinguish re-infection from persistent infection. Finally, several factors associated with the post-praziquantel administration POC-CCA positivity have been identified. This study should be replicated in this and other endemic areas with sensitive techniques to unearth the actual state of post-MPA schistosomiasis. Additionally, in similar studies in future, the immediate and regular detection of CCA after praziquantel therapy should be done. This approach could help distinguish reinfection from persistent infection.

Data availability statement

The dataset supporting the findings of this study is available from the corresponding author upon reasonable and justified request.

CRediT authorship contribution statement

Isaac Tukwarlba: Writing – original draft, Project administration, Methodology. **Enoch Aninagyei:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization. **Mavis Dakorah Puopelle:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Juliana Attoh:** Writing – review & editing, Methodology, Investigation, Data curation. **Kwabena Obeng Duedu:** Writing – review & editing, Resources, Project administration, Formal analysis. **Justice Kumi:** Writing – review & editing, Supervision. **Eunice Ampem-Danso:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Desmond Omane Acheampong:** Writing – review & editing, Resources, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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List of abbreviations

CCA	cathodic circulating antigens
MDA	Mass drug administration
NTD	Neglected tropical diseases
PCR	Polymerase chain reaction
POC-CCA	Point-of-care CCA

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e28529.

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