Assessment of awareness and knowledge of schistosomiasis among school-aged children (6–13 years) in the Okavango Delta, Botswana

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Abstract

Background: Schistosomiasis is a global health problem affecting 250 million people, with 90% in Sub-Saharan Africa. In Botswana, the burden is high in the Okavango delta because of the water channels. WHO recommends integrated measures, including access to clean water, sanitation, health education, and drugs to control and eliminate schistosomiasis. Gauging knowledge and awareness of schistosomiasis for School-Aged Children (SAC) is crucial. Our study aimed at assessing knowledge and awareness of schistosomiasis among SAC in the Okavango Delta.

Methods: A cross-sectional survey assessing awareness and knowledge of schistosomiasis in schools was conducted. 480 questionnaires were administered to gather demographic profiles, awareness, and knowledge of risky behaviors. Chi-square and descriptive analysis determined the differences in SAC’s awareness and knowledge levels based on localities, gender, age, and health education.

Results: The results showed a low awareness level, with only (42%) of respondents having heard about the disease and (52%) knowing its local name. Younger children from Sekondomboro (83%) and Samochima lacked awareness, while children from Mohembo (77%) and those who had health education (70%) demonstrated significant awareness levels ($P \leq 0.001$). Seventy-two percent (72%) lacked knowledge of the cause and (95%) did not know the disease life-cycle. Children from Xakao (91%), (85%) Sepopa, and (75%) of younger children did not know haematuria is a symptom of the disease. Older and SAC with health education were more likely to know that swimming is a risk factor ($P \leq 0.001$) and ($P \leq 0.05$) respectively.

Conclusions: Although respondents from four schools demonstrated some level of awareness of the disease, and knowledge of risky behaviors, the study showed a lack of in-depth knowledge on the life-cycle and cause of the diseases. We, therefore, recommend the implementation of an integrated approach to health education and improvement in access to clean water and sanitation in all study areas.

Keywords: Awareness, Knowledge, Schistosomiasis

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Background

Schistosomiasis is a Neglected Tropical Disease (NTD) with negative effects on public health. Endemic in 78 tropical and sub-tropical countries, schistosomiasis afflicts approximately 250 million people worldwide, with more than 90% of cases occurring in Sub-Saharan Africa [1–3]. An estimated 20,000–200,000 people die of schistosomiasis each year [3]. The disease is ranked among the top ten causes of disability in six African countries.
Schistosomiasis is a parasitic disease caused by blood flukes of the genus schistosome [8, 9]. Humans are usually infected by five species of Schistosoma mansoni, Schistosoma japonicum, Schistosoma mekongi, and Schistosoma intercalatum causing intestinal infection and haematobium responsible for urinary infection [10]. The sub-Saharan African infection is caused by Schistosoma mansoni and Schistosoma haematobium. The disease is often acquired during domestic, occupational, and livelihood activities which involve contact with water infested with cercariae from the intermediate host-the snail [5]. Climate change, ecological changes such as dam construction, and socio-economic factors have been crucial factors in the continuous transmission of schistosomiasis in endemic areas [5, 10]. In Botswana, the Okavango region presents a major threat of schistosomiasis because of its potential for a resurgence due to flood recession farming and the predicted increase in the seasonal flow of the delta [11, 12]. In their research, Appleton, and Madsen [13] indicated that hydrological factors seem to play an important role in disease transmission than livelihood activities in Botswana. The authors [13] noted that the population living near the river and children attending schools near the river in Botswana are at an increased risk of repeated epidemics. Recognizing the intense studies on the contribution of the aforementioned risk factors on the rate of infection with schistosomiasis, it is assumed that the complexity of the socio-economic, behavioral, and knowledge factors vary considerably at global, regional, and local levels, hence the need for in-depth risk factor analysis for their contextual understanding.

The World Health Assembly (WHA) has made several resolutions [14] and specified control and elimination measures of schistosomiasis. These include snail control, mass treatment, improved sanitation, provision of potable water, and health education. Disease control programs recommended for School-Aged Children (SAC) include Mass Drug Administration (MDA), sanitary methods, and health education. The WHO guidelines recommend every-other-year praziquantel treatment of all SAC in communities having moderate risk (prevalence between 10 and 49%), and annual SAC treatment for communities having high risk (prevalence ≥ 50%) [15]. Re-infection with Schistosoma haematobium among SAC is of global concern, especially with low (34.6%) MDA program coverage and low implementation of preventive therapy (40.8%) in the African region [16]. Several studies [17, 18] indicated that often after treatment new infection cases resurface to the point where baseline prevalence is reached within a short period. The 65.21 World Health Assembly resolutions [9] therefore called for the inclusion of all high-risk groups, including SAC, to eliminate schistosomiasis.

The schistosomiasis control program for Botswana was integrated into the Primary Health care services in 1983, and by 1985, the program existed in four districts of the country and was sustained until 1991 when Botswana reached elimination status. Despite, the huge success of the control program back then, Botswana still battles with transmission interruption and complete elimination of the disease, especially in the Okavango region. With a high-level prevalence of 38% [7] and impairing morbidity and the resultant complications, especially among the SAC, the disease has been undervalued in the past three decades in Botswana, thus qualifying it as a neglected disease. Moreover, the scarcity of data showing risk factors and their associated behaviours and rates of re-infections in Botswana poses scientific and ethical challenges in addressing the burden of this disease. Primary school-aged children in endemic foci are considered a high-risk group but there is a scarcity of data in Botswana showing the dynamics of re-infections among school children to inform current and future control strategies. Also, the Botswana schistosomiasis control program has heavily relied on the test and treats strategy, where cases detected through the Kato-Katz method are treated with 40 mg/kg of praziquantel [12].

Communities in the Okavango have low levels of knowledge and awareness of the disease [19]. Adequate knowledge and adoption of correct and consistent preventive behavior in endemic areas are necessary for an effective and sustainable control program owing to the elimination of the disease. Although health promotion through community education is an important aspect of the elimination of any disease, a review of literature in this area for Botswana SAC revealed a paucity of empirical data owing to decadal neglect of the disease.

There is insufficient knowledge in Botswana which mapped the knowledge and awareness of schistosomiasis and its risk factors. This calls for assessment knowledge of key risk factors for infections within endemic communities. This study aimed at assessing awareness and knowledge of risk factors for schistosomiasis among SAC in the Okavango Delta. The specific objectives are to determine the SAC’s i) awareness of the disease, ii)
general knowledge, and iii) knowledge of risky behaviors of schistosomiasis among SAC in the Okavango Delta.

Methods

Study design This was a cross-sectional survey that assessed students’ knowledge and awareness of schistosomiasis haematobium and its associated risky behaviors.

Study setting The study was conducted in the Ngamiland district in the Northwestern part of Botswana which has a population of 175,631 [20]. The site is part of the Okavango Delta which is one of the world’s largest wetlands. The delta comprises permanent, seasonal, and swampy areas which originate from upstream of Angola and Namibia. The Cubango River from Namibia enters Botswana and travels along with the stream passing into upper villages of the panhandle. As it travels along these villages it gives way to seasonal swamps. The flood is often at its peak at Mohembo between mid-March and mid-May immediately after the summer rains. The delta is the residence of a multi-ethnic group of people who include: Bayei, Hambukushu, San/Khoikhoi, and Batawana. More than 8000 people live in six villages along the Okavango River where the study was conducted (Fig. 1) [20, 21]. Six schools in villages along the Okavango watercourse were purposively sampled as sites for the study. Each village has one primary school. The proximity of the villages to the wetland and water contact livelihoods which often involve schoolchildren provided a good opportunity for studying schistosomiasis. The selected villages are proximal to the seasonal flood plains/permanent water channels status. The upstream schools of Samochima, Mohembo, Skondomboro, Ngarrange, Xakao, and Sepopa were included in the study. Sepopa is one among the selected villages that are further at the mid-upper delta or where the Panhandle spread into the alluvial Delta.

Study population and sampling strategy

The sample for the study consisted of a population of 2417 children in standard 1 to 6, aged 6–13 years. Six Primary schools in the Okavango region were purposively selected to be included in the study due to their geographical location and being close to the river course. The sample size of 598 SAC was estimated using Yamane’s formula for the cross-sectional survey [22]. The eligible children were requested for assent and parental consent. One hundred and eighteen (118) of the 598 did not consent hence their exclusion from the study, (refer to Fig. 2). The response rate for the study was however notably high (80%).

A stratified random sample proportionate to size was drawn from each school as shown in Table 1. In each selected school, the total number of respondents per standard was obtained from the school head to determine
the number required from each standard. The selection of children at each school was done through systematic random sampling using class lists obtained from class teachers and only 480 respondents participated in the study.

Survey questionnaire development and validation

A structured questionnaire was developed using the Theoretical Rational Approach (TRA), where targeted constructs of knowledge and awareness of schistosomiasis were adopted and adapted from literature and previous related research work [23]. The literature that guided the questionnaire construction included Xiao and colleagues’ Protection Motivation Theory (PMT) [24] and the Knowledge Attitude and Practice (KAP) Theory [25–27].

Derived from previous similar studies [28–31], 13 subjective measures on knowledge of signs and symptoms, key risky behaviours, and the lifecycle of the disease were constructed. The items on knowledge did not comprise a score but assessed if the respondents possess the correct information and knowledge about the disease. The scales comprised “yes, no, or I don’t know” and probes with pre-coded responses. Awareness measures were also developed based on previous related studies [32–35] and comprised closed-end (yes and no) and open-ended items.

The questionnaire consisted of three main sections. The first section comprised 8 items on the respondents’ socio-demographic information. The second section comprised 10 questions, 8 of which were closed-ended (yes, no and I don’t know) and 2 open-ended measuring awareness. Questions measuring knowledge were also part of this section and comprised 2 open-ended and 6 close-ended items. The last section comprised 7 questions on the respondents’ knowledge of key risky behaviours. The Cronbach’s alpha coefficient for 8 close-ended questions on the domain of awareness was 0.81, indicating an adequate internal consistency. The Cronbach’s alpha score for the knowledge of risk factors items was almost 0.70 (0.69). While this is marginal, the mean intercorrelation for the items was 0.35, which according to

| Villages      | Total school enrolment | Required sample per school | Consented to the study |
|---------------|------------------------|---------------------------|------------------------|
| Sepopa        | 250                    | 62                        | 55                     |
| Samochima     | 394                    | 97                        | 93                     |
| Mohembo       | 494                    | 122                       | 101                    |
| Xakao         | 659                    | 163                       | 100                    |
| Skondomboro   | 268                    | 66                        | 63                     |
| Ngarange      | 352                    | 87                        | 68                     |
| Total         | 2417                   | 598                       | 480                    |

![Fig. 2 Study participant flow diagram](image-url)
Briggs and Cheeks is within the optimal ranges (0.2–0.4) that is recommended [36]. Pretesting in one non-selected school was done to assess content validity, appropriateness, and question comprehensiveness, and revisions were made based on the findings of the pre-test.

Data collection
Data was collected on January 18–28th, 2020 using the questionnaire directly administered by the researchers. Community research assistants received training to assist with the data collection. Mini-sized cellular tablets which had the Research Electronic Data Capture (REDCap) software installed in them were used for data collection. The researchers were onsite to ensure appropriate data capturing and to address any technical issues. Two data collectors and the principal investigator used 4 electronic tablets to collect data across the six study sites.

Data analysis
Data were exported from the REDCap and entered into Statistical Package for Social Scientist (SPSS) version 25.0 for management and analysis. Descriptive statistics (proportions and mean) were computed to summarise and describe the sample. Chi-squared tests of independence were used to determine the associations between demographic variables and variables of interest. Inferences using \( P \leq 0.05 \) to test for statistical significance were made on the relationship between variables. All quantitative analyses were done at the 5% level of significance.

Ethical consideration
The study design and protocol were reviewed and approved by the Human Research Development Committee at the Botswana Ministry of Health and Wellness (letter referenced HPDME: 13/18/1) and the University of Botswana Institutional Review Board (referenced UBR/RES/IRB/BIO/154). Parental consent was sought and children were asked for assent at the beginning of the interview.

Results
Socio-demographics profile of respondents
A total of 480 respondents (80% response rate) 6–13 years were enrolled in the study, of which 51% were females and 41% were males. The mean age for the respondents was 9.13 years with a standard deviation of 1.66. Respondents were further divided into two age groups: 6–9 who formed the majority 59% and 10–13 years who were 41%. Most (21%) of respondents were from Mohembo and Xakao villages. Twenty percent (20%) of the respondents were in the fifth standard and the lowest number (10%) of respondents were from standard one (Table 2). Almost one-fifth of the respondents (38%) reported having received health education about the disease from different sources, while the majority (62%) had not.

Awareness of schistosomiasis among respondents
Majority of older respondents (10–13 years) (51%) were aware of Bilharzia compared to younger ones (6–9 years) (35%), and an almost equal proportion of females (42%) and males (41%) have heard about the disease. Over two-thirds of SAC in Sekondomboro (79%) and Samochima (69%) villages had not heard about the disease. The majority, (93%), of respondents who had no health education about the disease, indicated that they had not heard about the disease. A chi-square test conducted to determine if there were any significant differences among age groups and between those who received health education and those who did not, showed that older respondents and those with health education were more likely to have heard about the disease \( (P \leq 0.001) \) and \( (P \leq 0.001) \) respectively. A relatively higher proportion of respondents in the age group 10–13, (57%), and males (57%) knew the local name of the disease to be “bilharzia:’ The majority of respondents who had health education (70%) knew the local name of the diseases than those with no health education (41%). Most respondents from

| Variable | Category       | Frequency (n) | Percentage (%) |
|----------|----------------|---------------|----------------|
| Gender   | Female         | 245           | 51             |
|          | Male           | 235           | 49             |
| Age Group| 6–9            | 282           | 59             |
|          | 10–13          | 198           | 41             |
| Standard | 1              | 48            | 10             |
|          | 2              | 83            | 17             |
|          | 3              | 85            | 18             |
|          | 4              | 92            | 19             |
|          | 5              | 97            | 20             |
|          | 6              | 75            | 16             |
| School   | Mohembo        | 101           | 21             |
|          | Ngarange       | 68            | 14             |
|          | Samochima      | 93            | 19             |
|          | Sekondomboro   | 63            | 13             |
|          | Sepopa         | 55            | 12             |
|          | Xakao          | 100           | 21             |
| Health education about disease | No health education | 297 | 62 |
|          | Had health education | 183 | 38 |

Table 2 Respondents’ socio-demographic characteristics
Mohembo village (77%) demonstrated more awareness of the local name of the disease than those from other villages. A chi-square test indicated no significant differences in awareness of the local name of bilharzia between males and females in the four villages, ($P=0.09$) and the age groups ($P=0.99$). Respondents who had health education ($P \leq 0.001$) were more likely to be aware of the local name of the disease. Similarly, respondents from Mohembo were more likely to be aware of the local name of the disease ($P \leq 0.001$) than those from other villages.

The majority of younger respondents (75%) from, Sekondomboro (83%), and Samochima (80%) villages indicated that children from their schools lacked awareness of the disease. Similarly, respondents who had no health education about the disease (88%) were more likely to mention that other children from their schools lacked awareness of the disease than those who had health education. An almost equal proportion of respondents in the gender category indicate that other children from their school lacked awareness of the disease. Younger children ($P \leq 0.001$), those who have no health education ($P \leq 0.001$), and those from Sekondomboro and Samochima ($P \leq 0.001$), were more likely to indicate that children from their schools lacked awareness of the disease. The results on the difference between males and females on this fact were not significant ($P=0.83$), (refer to Table 3).

**General knowledge of schistosomiasis among respondents**

The majority (72%) did not know that schistosomiasis was caused by parasites released during snail bites when one comes in contact with infested water. In terms of respondents’ knowledge of the effects of schistosomiasis on one’s health, a very small proportion (17%) and (23%) mentioned slow growth and poor concentration respectively. An overwhelming majority, (95%) of respondents did not know the life cycle of schistosomiasis in both humans and snails.

Concerning respondents’ knowledge of signs and symptoms of schistosomiasis, younger respondents (75%) did not know that blood in the urine (haematuria) is the main symptom of schistosomiasis compared with older children. The majority of respondents from Xakao (91%) and Sepopa (85%) and those with no health education (73%) did not know that haematuria is a symptom of schistosomiasis (see Table 4). The knowledge of fever as a symptom of schistosomiasis was very low (<20%) across all the socio-demographics of the respondents. The results on fever as a sign were not significant between the age groups (refer to Table 4), of children who had and had no health education ($P=0.94$). An overwhelming majority of older respondents (87%) than younger children (58%) did not know that lower abdominal pain is a symptom of schistosomiasis. Similarly, respondents from Xakao (99%), Sepopa (96%), and Mohembo (90%) didn’t

### Table 3  Awareness of Schistosomiasis by demographic characteristics

| Demographics         | Frequency (n) | Heard about Bilharzia (%) | P-value | Know the local name of the disease (%) | P-value | Think other children are aware of the disease (%) | P-value |
|----------------------|--------------|---------------------------|---------|---------------------------------------|---------|-------------------------------------------------|---------|
|                      |              |                           |         |                                        |         |                                                 |         |
|                      |              | No | Yes | 0.001 | No | Know | Bilharzia | 0.09 | No | Yes | 0.001 | 0.001 | 0.001 |
| Age                  |              | 282 | 65 | 35 | 0.001 | 51 | 49 | 0.09 | 75 | 25 | < 0.001 |
|                      | 198 | 49 | 51 |
| Total                | 480 | 57 | 43 |
| Gender               | Females | 245 | 58 | 42 | 0.001 | 48 | 49 | 0.99 | 69 | 31 | 0.83 |
|                      | Males | 235 | 59 | 41 |
| Total                | 480 | 59 | 48 |
| Village              | Mohembo | 101 | 49 | 51 | 0.001 | 23 | 77 | 0.001 | 66 | 34 | < 0.001 |
|                      | Ngarange | 68 | 47 | 53 |
|                      | Samochima | 93 | 69 | 31 |
|                      | Sekondomboro | 63 | 79 | 21 |
|                      | Sepopa | 55 | 47 | 53 |
|                      | Xakao | 99 | 59 | 41 |
| Total                | 480 | 58 | 42 |
| Health education status | No health education | 297 | 93 | 19 | 0.001 | 59 | 41 | 0.001 | 88 | 12 | < 0.001 |
|                      | Had health education | 183 | 11 | 89 |
| Total                | 480 | 54 | 52 |
know that abdominal pain was a symptom of the disease. A chi-square test for the difference in knowledge of abdominal pains showed that children from the three villages were more likely \((P \leq 0.001)\) to demonstrate a lack of knowledge of abdominal pain as a symptom than children from other villages. The results for the difference in knowledge of abdominal pain as a symptom between age groups \((P = 0.29)\), gender \((P = 0.75)\), and children with no or some health education \((P = 0.97)\) were not significant.

### Knowledge of risky behaviors for the disease among respondents
The majority (71%) of respondents aged 6–9 years knew that swimming was a risk factor for schistosomiasis, with (81%) of those who had health education possessing knowledge. An equal proportion of females (76%) and males (77%) knew that swimming poses a risk for the disease. One hundred and seventy of the respondents (85%) who had heard about schistosomiasis knew that swimming was a risk for the disease. The majority (81%) of respondents from Samochima and Xakao (79%) villages knew swimming was a risk factor for Bilharzia. A chi-square test showed that older respondents and those with health education were more likely to know that swimming as a risk factor \((P \leq 0.001)\) and \((P = 0.04)\) respectively. Similarly, children who have heard about

### Table 4 Knowledge of signs and symptoms of schistosomiasis by demographic characteristics

| Socio-demographics | Frequency (n) | Fever (%) | Blood in Urine (%) | Lower Abdominal Pain (%) | P-Value |
|---------------------|--------------|-----------|--------------------|--------------------------|---------|
|                     |               | No | Yes | P-value | No | Yes | P-value | No | Yes | P-Value |
| Age                 |               |    |     |         |    |     |         |    |     |         |
| 6–9                 | 282           | 88 | 12  | 0.08    | 75 | 25  | 0.11    | 58 | 17  | 0.29    |
| 10–13               | 198           | 82 | 18  |         | 54 | 46  |         | 87 | 13  |         |
| Total               | 480           | 85 | 15  |         | 65 | 36  |         | 73 | 15  |         |
| Gender              |               |    |     |         |    |     |         |    |     |         |
| Female              | 245           | 85 | 15  | 0.08    | 69 | 31  | 0.001   | 85 | 15  | 0.75    |
| Male                | 235           | 86 | 14  |         | 63 | 37  |         | 84 | 15  |         |
| Total               | 480           | 86 | 15  |         | 66 | 34  |         | 85 | 15  |         |
| Village             |               |    |     |         |    |     |         |    |     |         |
| Mohembo             | 101           | 81 | 13  | 0.02    | 75 | 25  | 0.001   | 90 | 10  | 0.001   |
| Ngarange            | 68            | 82 | 18  |         | 47 | 53  |         | 87 | 13  |         |
| Samochima           | 93            | 75 | 25  |         | 35 | 65  |         | 61 | 39  |         |
| Sekondombo          | 63            | 87 | 13  |         | 60 | 40  |         | 78 | 24  |         |
| Sepopa              | 55            | 93 | 13  |         | 85 | 15  |         | 96 | 4   |         |
| Xakao               | 99            | 91 | 9   |         | 91 | 9   |         | 99 | 1   |         |
| Total               | 480           | 85 | 15  |         | 60 | 35  |         | 85 | 15  |         |
| Health education status |           |    |     |         |    |     |         |    |     |         |
| No education        | 297           | 86 | 14  | 0.94    | 73 | 27  | 0.00    | 85 | 15  | 0.97    |
| Had education       | 183           | 86 | 14  |         | 55 | 46  |         | 85 | 15  |         |
| Total               | 480           | 86 | 14  |         | 64 | 37  |         | 85 | 15  |         |

### Table 5 Knowledge of swimming as a risk behaviour for Schistosomiasis by socio-demographics

| Factor | Variable | Frequency(n) | Swimming (%) | P-Value |
|--------|----------|--------------|--------------|---------|
|        | No | Yes | | | |
| Age    | 6–9 | 282 | 29 | 71 | <0.001 |
|        | 10–13 | 198 | 16 | 84 | |
| Total  | 480 | 23 | 78 | |
| Gender | Female | 245 | 24 | 76 | 0.86 |
|        | Males | 235 | 23 | 77 | |
| Total  | 480 | 24 | 77 | |
| Village | Mohembo | 101 | 31 | 69 | 0.12 |
|        | Ngarange | 68 | 15 | 85 | |
|        | Samochima | 93 | 19 | 81 | |
|        | Sekondombo | 63 | 29 | 71 | |
|        | Sepopa | 55 | 29 | 71 | |
|        | Xakao | 100 | 21 | 79 | |
| Total  | 480 | 24 | 76 | |
| Health education | No education | 297 | 27 | 73 | 0.04 |
|        | Had education | 183 | 19 | 81 | |
| Total  | 480 | 23 | 77 | |
| Heard about disease | Not heard | 280 | 30 | 70 | <0.001 |
|        | Heard | 200 | 15 | 85 | |
| Total  | 480 | 23 | 77 | |
schistosomiasis were more likely to know swimming was a risk factor for the disease (refer to Table 5). There were no significant differences within villages between those who know that swimming is a risk factor and those who did not know ($P=0.12$).

Children aged 10–13 years (71%) and those who received health education (74%) knew that walking barefooted in water poses a risk for schistosomiasis. Females (72%) were more knowledgeable about this fact than males (65%). The respondents who had received health education were more likely to know that walking in water barefooted was a risk factor for schistosomiasis ($P=0.03$). There was no significant difference in age and gender (refer to Table 6) between those who did not know and those who know that walking barefooted in water was a risk factor for schistosomiasis Most (77%) of children who had heard about schistosomiasis knew that walking bearefooted in water was a risk for contracting the disease compared to those who had not heard about it (63%). These results were significant ($P=0.001$). Three quarters of children from Ngarange and Xakao (75% and 74% respectively) knew that walking barefooted in water was a risk for schistosomiasis. The comparison across villages was insignificant ($P=0.47$) [see Table 6].

The majority of female respondents (76%) considered drinking contaminated water as a risk for schistosomiasis compared to males (72%). Of the 198 respondents aged 10–13, (78%) mentioned drinking contaminated water was a risk for the disease compared to (71%) of those aged 6–9 years. Respondents from Samochima (59%) and Sekondombo (60%) did not mention this factor as a risk for the disease. Respondents who had health education (83%) on the diseases mentioned drinking contaminated water as a risk factor to those who had no education (69%) of the disease. Health education ($P=0.01$), and village ($P=0.001$) were significantly associated with mentioning drinking contaminated water as a risk for the disease.

**Discussion**

Active participation of local populations in prevention and control programs of schistosomiasis in endemic areas, is highly dependent on adequate knowledge and awareness of the disease, especially among children who are often the target of control programs. Our study findings show low levels of awareness of the disease, where only a few of the respondents had heard about the disease and just above half knew the local name of schistosomiasis. These findings corroborate those of other studies [37]. Respondents who had health education at least knew that haematuria was a sign of the disease. However, having health education did not influence knowledge of the signs and symptoms of the disease because our study records low levels of knowledge of the

| Table 6  | Knowledge Walking in Water Barefooted by Socio-Demographics |
|----------|-------------------------------------------------------------|
| Factor   | Variable                 | Frequency (n) | Walking in water barefooted (%) | $P$-value |
|----------|--------------------------|---------------|---------------------------------|-----------|
|          |                          |               | No     | Yes     |          |
| Age      | 6–9                      | 282           | 33     | 67      | 0.39     |
|          | 10–13                    | 198           | 29     | 71      |          |
| Total    | 480                      | 31            | 69     |          |          |
| Gender   | Females                  | 245           | 35     | 72      | 0.11     |
|          | Males                    | 235           | 35     | 65      |          |
| Total    | 480                      | 35            | 69     |          |          |
| Health education | No education | 297           | 35     | 65      | 0.03     |
|          | Had education            | 183           | 26     | 74      |          |
| Total    | 480                      | 31            | 70     |          |          |
| Village  | Mohembo                  | 101           | 35     | 65      | 0.47     |
|          | Ngarange                 | 68            | 25     | 75      |          |
|          | Samocchima               | 93            | 32     | 68      |          |
|          | Sekondombo               | 63            | 37     | 64      |          |
|          | Sepopa                   | 55            | 36     | 64      |          |
|          | Xakao                    | 100           | 26     | 74      |          |
| Total    | 480                      | 32            | 68     |          |          |
| Heard about disease | Not heard   | 280           | 37     | 63      | 0.001    |
|          | Heard                    | 200           | 24     | 77      |          |
| Total    | 480                      | 31            | 70     |          |          |
signs and symptoms. It is also important to note that the few respondents who had heard about the disease got information from school, while the health sector’s role in educating children was very insignificant. This may be attributed to the decadal neglect of the disease since 1993 when the national control program was terminated. A high proportion of respondents had no health education on the disease. This shows that health education as a control strategy has not been implemented for over two decades. Our results are similar to a Yemen study [38], which reported a lower knowledge of signs and symptoms but a higher level of awareness. A systematic review of the knowledge, attitude, and practices on schistosomiasis found that knowledge of signs and symptoms is often low [39]. This poses challenges and threats to the uptake of most prevention and control strategies.

Our study found that males and those who had health education significantly knew haematuria as a symptom compared to females and those without health education. This could be explained by the fact that the universal local name for urinary schistosomiasis in Botswana is “thuti-sa-madi” which means blood in the urine. This finding is similar to that obtained in Swaziland [2] where 74% mentioned haematuria as a symptom. Again Folefac and colleagues [40] in their study, recorded that among respondents who had prior knowledge of the disease, 80% mentioned haematuria as a symptom. With regards to males possessing more knowledge than females, a systematic review in sub-Saharan Africa [39], found eight out of twelve studies that reported high levels of knowledge among males compared to females. The authors of a review [39] attributed better knowledge among males to health education provided to fishermen and farmers because of their exposure to risky water practices. The difference between the review and the Cameroon study [40] and our study is that our respondents were SAC while the two studies focused on adults.

Our study also revealed that respondents do not know the cause and the life cycle of schistosomiasis. This finding is similar to what Swaziland’s [2] study obtained. However, Kitalile [41] reported a higher proportion (77.6%) of respondents who knew the cause of schistosomiasis. The difference may be that we asked closed-ended questions which limited exploration of possible responses which could have unearthed the real causes of the disease. Part of these differences might have been related to the fact that these studies used a different study method (that is, non-probability purposive sampling technique) than ours [42].

Regarding the mode of transmission of the disease, which is indicated as a proxy from the question on drinking contaminated water, our study found some misconceptions from the respondents. A significant proportion of pupils across all villages mentioned that drinking contaminated water poses a risk of contracting schistosomiasis. This can be attributed to the fact that residents in the Okavango area often depend on contaminated river water for domestic purposes [43]. Consequently, outbreaks of water-borne disease (diarrhea) are common, especially during the dry season [44]. In addition to this, it is worth noting that the recurring unavailability and unreliability of water due to nonfunctioning taps and pumps and leaks experienced by villages in the Okavango delta, often prompt the utilization of river water for domestic use even in schools [45]. This may have prompted the respondents in our study to believe that schistosomiasis may be caused by drinking contaminated water. Moreover, this could suggest the lack of integrative approaches toward schistosomiasis and STH programming. Of greater concern is how these fears translate into preventive practices.

Regarding the knowledge of risk behaviours for schistosomiasis, our study found that younger pupils (aged 6–9 years) were more likely to know that swimming is a risk for the disease. This may be the influence of the teaching of content on schistosomiasis which is done at lower than upper school grades. Moreover, the health education in schools during MDA for STH in the past two years has contributed to this finding. Other studies [39] concurred that programs such as MDA improve awareness, knowledge, and uptake of preventive chemotherapy.

Notwithstanding the important findings from our study, we acknowledge the following limitations encountered during the implementation of the study; firstly, there was an issue with the subjectivity of responses. The self-reported data obtained from respondents lacked objectivity. Secondly, the study did not provide in-depth information about reasons for not having knowledge about schistosomiasis. It is important to note that being a cross-sectional survey, the study could not establish causal factors for the lack of knowledge and awareness which could be provided by analytic designs. There is a need, therefore, for a future qualitative and more analytic research design for this purpose.

The small sample size although adequate for statistical analysis used in the study, restricted the generalization of findings to the population, because the study was conducted in one sub-district, and hence may not be generalised to other sub-districts and districts elsewhere. Future studies must therefore target more districts using random sampling procedures for generalisation across the country. Notwithstanding these limitations, the study results provided insights in knowledge and awareness of schistosomiasis among schools within the Okavango sub-district, which in turn informs and guided the following conclusions and recommendations.
Conclusions
This study found that school children in the sampled schools of the Okavango delta lack awareness and knowledge of schistosomiasis with the majority not knowing the life cycle and most of the symptoms of the disease. This provides a window of opportunity to re-instating prevention and control measures of the disease within the area. SAC demonstrated a fairly average knowledge of water contact and risky behaviors of swimming and walking barefooted in infested water. Health education has impacted positively on the children’s awareness and knowledge, but other socio-demographics of age and gender did not. This is a signal of the importance of health education as a key component of the control program for schistosomiasis. There is thus the need for intense integration of school-based health education to improve the level of knowledge and awareness to reduce children’s water contact behaviors. Further research focused on unearthing reasons for low levels of awareness and knowledge is required to inform policy on elimination. More consideration and appreciation of the socio-cultural and cognitive behaviors of children than a focus on their age, gender, and place of residence which are found to have very little influence on their knowledge of risk behaviours for schistosomiasis prevention in the present study.

Consent for publication
The regional (Okavango) education office, parents, and children consented to participate in the study. Consent, assent forms, and letters are available from the corresponding author upon request.

Competing interests
DELP is the Deputy Editor-in-Chief for the Journal of Global Health Research and Policy. He is not involved in the review of decision related to the manuscript.

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