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# Community-Based Intervention and Its Effect on Decreasing the Prevalence of Urinary Schistosomiasis in an Al-Alaqa Male Primary school in Al-Alaqa Village White Nile State, Sudan

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ABSTRACT

*Aim of study:* This study assessed the effectiveness of community-based interventions, health awareness, and treatment in controlling schistosomiasis among schoolchildren to improve policies and strategies.
*Methods:* This pre- and post-intervention study was conducted in an Al-Alaqa male primary school, and systematic simple random sampling was used to investigate 237 participants, which resulted in 132 (55.7%) infected students. The infected and noninfected students (580 students) were treated by delivering the praziquantel doses immediately after the results; after 4 weeks, the infected students received the second dose. After 6 months, the rates were investigated again, and all procedures were performed after the height and weight of the students were recorded according to the protocol. Health education was provided for all participants using posters and leaflets. The data were collected via a questionnaire and urine test. The data were analyzed using SPSS (Statistical Package for the Social Sciences), and ANOVA and t-tests were used to determine the significant differences between the variables.
*Results:* A urine investigation was conducted on 237 students; 132 (55.7%) had positive results which showed marked improvement and the prevalence in the school decreased to 3.8% after the intervention. The researcher found strong evidence of a relationship between the prevalence of schistosomiasis before the intervention and availability of water in the home (chi-square = 18.331, df = 1, $p$ value = 000). ANOVA showed strong statistical significance (0.002 and F = 6.564) between the mean score of student age and reasons behind going to the pond.

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*Conclusion:* This study concluded that mass chemotherapy and treatment were highly effective when associated with a health program intervention. Mass chemotherapy alone may reduce the prevalence of disease for a short time.
*Recommendation:* Community-based interventions should be applied in schools with an emphasis on health education programs through the training of schoolteachers on investigations for schistosomiasis, treatment with praziquantel, and the provision of materials (microscopes, reagents, and drugs).

## 1. Introduction

Approximately 85 km south of Omdurman is a small village called Al-Alaqa, close to the White Nile River. Poor health care is provided in a neglected area. The White Nile State villages are well known for having high incidences of infectious disease and poverty. According to (Bergquist and Whittaker, 2012), schistosomiasis is a significant communicable disease with socioeconomic and public health implications in underdeveloped countries. Schistosomiasis, also known as bilharziasis or snail fever, is a long-lasting parasitic disease that can harm internal organs and inhibit growth and intellectual development in children (Alemu et al., 2011) . It is brought on by several species of trematodes (flukes), parasitic worms of the genus Schistosoma. It has been estimated that approximately 200 million individuals are infected worldwide. Schistosomiasis is primarily found in Africa (North, West, Central, and East Africa), some areas of the Middle East, China, the Philippines, and other foci in the Far East, Southeast Asia, and South America. When humans collect water, wash, bathe, play, fish, or cultivate crops in contaminated fresh water, they typically develop problems (Gabrielli, 2013). Both the intestinal and urogenital forms of schistosomiasis occur frequently in individuals living near the Nile River in Sudan, an endemic sub-Saharan country (Cavicchi et al., 2013). In different locations, the prevalence of S.haematobium infection ranges from 1.7% to 56.0%, but the prevalence of *S. mansoni* is quite low (Lee et al., 2015). The Nile River emerges in Sudan when the Blue and White Nile rivers converge. Sudan has the largest waterway basins of all the nations that cross the Nile, as well as one of the major irrigated agricultural zones along the banks of the Nile River. Such irrigation initiatives have created significant environmental hazards that have aided in the spread of vector-borne illnesses such as schistosomiasis (Conway, 2005).

## 2. Methods

The current study employed a quasi-interventional pre- and post-test design. The study was conducted in Al-Alaqa, a village in the White Nile State comprising male education institutions. It is situated on the west bank of the White Nile River and has numerous ponds scattered across the communities. Most of the population are members of the Hassania tribe, residing approximately 85 km from Omdurman's south and 90 km from Aldoueim in the south. Approximately 6000 people live there in total. For both genders, there are four public elementary schools. There are 1742 total pupils in public elementary schools: 580 students in the Al-Alaqa male school, 472 children in the two Al-Alaqa female schools, and 700 students in the coeducational school. A general hospital provides healthcare services for the people in the area, and before this study, preventive chemotherapy had not been employed in the study area. The research was performed between 2018 and 2020. A total of 580 students who attended the Al-Alaqa male School served as the sample. The inclusion criteria for those enrolled in the Al-Alaqa male school were those between 6 and 13 years of age and residence in the study region for more than 6 months during the study period. The female pupils were not allowed to participate for the following reasons. First, there are cultural barriers to girls' education in the region, such that the norms and community beliefs prevent girls from participating in community-based interventions according to their experience, which was not explained to the researchers. Second, local customs restrict how often they fish, wash, bathe, play, or grow crops in contaminated fresh water. As a result, there was little community involvement during the study. For the above reasons and limited resources, the researchers decided to limit the study to boys' schools. It is possible to conduct a comparative study in areas similar to the place of study or in the place of study itself if the obstacles are removed in the future.

Study factors: Dependent variables included the effectiveness of interventions in health education and praziquantel treatment, as well as changes in the prevalence of schistosomiasis and public knowledge of the disease. Poor awareness, untreated cases, lack of access to water and latrines, treatment accessibility, and schistosomiasis diagnosis were the independent variables. The age and gender of the student were background variables. Socioeconomic status, mother's level of education, father's level of education, father's line of work, bathroom fixtures, and water supply accessibility. Confounding factors include the frequency with which people visit the ponds, the White Nile River, water availability, and the presence of latrines.

### *2.1. Sample size and technique*

The following equation was used to calculate the sample size: $n = N/1 + N\ (d)^{2}$ (n = the sample size, N = total population, d = degree of error (0.05 was used). The total population in the Al-Alaqa male primary school was 580 students ($n = N/1 + N\ (d)^{2}$ $580/1 + 580\ (0.05)^{2} = 237$). A systematic simple random sampling technique was used, and the interval was approximately 580/237. The data were collected via a questionnaire and a laboratory test for urinary schistosomiasis. The following measurements were considered to reduce bias and error rates: participants were randomly allocated to the intervention group to prevent potential bias in the selection process. The researchers were blinded to the assignments of the participants to avoid any potential bias in the data collection and analysis process. The same chemotherapy regimen, dosage, and frequency were given to each individual. The data were analyzed using statistical techniques, including suitable tests for contrasting intervention phases for confounding variables. Transparent reporting of the findings included disclosing the study's limitations and other bias-causing factors.

### 2.2. Intervention

In phase 1, a questionnaire was distributed before urine samples were collected to determine the prevalence of schistosomiasis, transmission methods, severity of symptoms and signs, and prevention methods. (Baseline assessment) (Phase one). Second, the students were advised to collect terminal urine samples, specifically between 10 am and 2 pm; this period is crucial because the likelihood of egg passage in urine is greater (Lalaye et al., 2019). Students were also encouraged to engage in physical exercise before sample collection, which, although controversial, may enhance egg detection (Coulibaly et al., 2018).

During laboratory analysis, each urine sample underwent a physical and macroscopic examination for urine characteristics such as color and the presence of visible blood (macrohematuria), followed by microscopic examination using the centrifugation sedimentation technique to detect S. haematobium eggs (Lalaye et al., 2019). This comprehensive approach is vital for accurate diagnosis, and proper handling and timely analysis of samples are crucial for obtaining valid results (Katica et al., 2019). The results showed that 132 students were infected (55.7%), which is considered a very high percentage, so all participants were treated with praziquantel, which is the drug of choice in most cases. This treatment consisted of 600-mg tablets, and the dose is usually 40 mg/kg given as a single dose. Additionally, doses of praziquantel in numbers of 600-mg tablets by height in cm were given according to the WHO dose pole (World Health Organization. WHO, 2006). The study was conducted ethically by distributing pamphlets and posters explaining the disease's definitions, transmission mode, symptoms, control, and treatment. Even the height and weight of noninfected students were measured before receiving protective doses. **Phase 2:** The infected students were treated with praziquantel immediately after the results, followed by a second dose four weeks later. This treatment was completed after taking the students' height and weight in accordance with the protocol. The researcher emphasized the significance of the follow-up in his or her session. **Phase 3:** Following the advice of the importance of the follow-up, six months later, the infected participants were tested again, and 96.2% of the participants were negative for the remaining positive result; the third dose of praziquantel was given to them.

An endogenous population of 80 students, divided into 40 students in each coeducational school, pretested the instrument. Their feedback was amended and tested, and the final questions were approved. Training of the data collectors: Nine data collectors attended five days of training on the study tools. White Nile State obtained ethical approval, the Schistosomiasis Prevention and Control Unit obtained written consent and approval, the school directors obtained consent, the local administrative of the village committee obtained consent, the local hospital obtained a consent form for the use of their labs, and the participants were informed that the submission of their completed surveys implied consent and ethical approval obtained from the Institutional Review Board University. The study was limited to male school students (Osman et al., 2022), with no control group.

## 3. Results

More than half of the respondents (56%) went to the pond daily, which sometimes increased their susceptibility to infection with the disease; the remaining 44% never went, and some went rarely. More than half of the respondents (62%) went to the Nile daily, which sometimes increased their susceptibility to infection with the disease. The remaining 38% never went, and some rarely went. Most participants (44%) mentioned that the main reason for going to the pond was to prepare and bring water for building because it is one of the main occupations in the study area. Fifty-one percent of the participants mentioned that the main reasons for going to the Nile were swimming (29%) and fishing (21%), and only 10% mentioned drinking water from the Nile. Seventy-five percent of the participants had a pit latrine in the home.

The ANOVA tests used an alpha level of 0.05. A significant value of 0.05 or less calls for rejection of the null hypotheses. One-way analysis of variance and correlation tests were used to test this hypothesis. The mean square (MS) was obtained by dividing the sum of squares (SS) by the degree of freedom (DF) between groups and within groups. The F value is compounded by dividing the variance (mean square) between groups (items) by the variance within groups (items).

$$F = \frac{\text{variance between items}}{\text{variance within items}}$$

The ANOVA test indicated a significant difference in the mean age of the students and the results of the urine test before intervention [F (44.748), $p = 0{,}000$].

**Post Hoc Tests ($n = 237$)**

| Dependent Variable: Urine test for schistosomiasis before intervention – Bonferroni | | | | | | |
|---|---|---|---|---|---|---|
| (I) Student age group in the Al-Alaqa School | (J) Student age group in the Al-Alaqa School | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | Lower Bound | Upper Bound |
| 6–9 Years | 10–13 Years | −0.609-* | 0.064 | 0.000 | −0.76- | −0.45- |

(continued on next page)

(*continued*)

| Dependent Variable: Urine test for schistosomiasis before intervention – Bonferroni | | | | | | |
|---|---|---|---|---|---|---|
| (I) Student age group in the Al-Alaqa School | (J) Student age group in the Al-Alaqa School | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | Lower Bound | Upper Bound |
| | >13 Years | −0.314-* | 0.072 | 0.000 | −0.49- | −0.14- |
| 10–13 Years | 6–9 Years | 0.609* | 0.064 | 0.000 | 0.45 | 0.76 |
| | >13 Years | 0.296* | 0.070 | 0.000 | 0.13 | 0.46 |
| 13 Years and more | 6–9 Years | 0.314* | 0.072 | 0.000 | 0.14 | 0.49 |
| | 10–13 Years | −0.296-* | 0.070 | 0.000 | −0.46- | −0.13- |

* The mean difference is significant at the 0.05 level.

**Post Hoc Tests**

| Dependent Variable: Urine test for schistosomiasis after intervention – Bonferroni | | | | | | |
|---|---|---|---|---|---|---|
| (I) Student age group in the Al-Alaqa School | (J) Student age group in the Al-Alaqa School | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
| | | | | | Lower Bound | Upper Bound |
| 6–9 Years | 10–13 Years | 0.020 | 0.029 | 1.000 | −0.05- | 0.09 |
| | More than 13 Years | 0.068 | 0.032 | 0.101 | −0.01- | 0.15 |
| 10–13 Years | 6–9 Years | −0.020- | 0.029 | 1.000 | −0.09- | 0.05 |
| | More than 13 Years | 0.048 | 0.031 | 0.368 | −0.03- | 0.12 |
| 13 Years and more | 6–9 Years | −0.068- | 0.032 | 0.101 | −0.15- | 0.01 |
| | 10–13 Years | −0.048- | 0.031 | 0.368 | −0.12- | 0.03 |

A post hoc test with Bonferroni post hoc correction was used to determine which age level exactly showed significance; the post hoc test showed strong significance at all age levels.

Both tables show no significant differences between the urine results before and after intervention.

ANOVA showed a strong statistically significant difference of 0.000 between the mean score of student age and time of pond attended—i.e., student age increased with pond and other water supply attendance for many reasons mentioned in question six, leading to an increase in the percentage of schistosomiasis infections.

ANOVA showed a strongly statistically significant difference (0.002 and $F = 6.564$) between the mean score of student age and time spent at the Nile River—i.e., student age increased with Nile River and other water supply attendance for many reasons mentioned in question seven, leading to an increase in the percentage of schistosomiasis infections. Extensive annual education and advice are needed regarding these issues.

ANOVA showed a strongly statistically significant difference (0.002 and $F = 6.564$) between the mean score of student age and reasons for going to the pond—i.e., student age increased their Nile River and other water supply attendance for many reasons mentioned in question seven, leading to an increase in the percentage of schistosomiasis infections. Extensive annual education and advice are needed regarding these issues.

ANOVA results were not statistically significant (0.112 and $f = 2.211$), indicating that regardless of the reason for going to the Nile, the suspected illness did not arise.

Independent t-test was used to support the ANOVA results comparing the urine results after intervention with student age; the results were not statistically significant (0.900) when equal variances were assumed.

Independent t-test was used to support the ANOVA results comparing the urine results before intervention with student age; the results showed a statistically significant difference of 0.000 when equal variances were assumed.

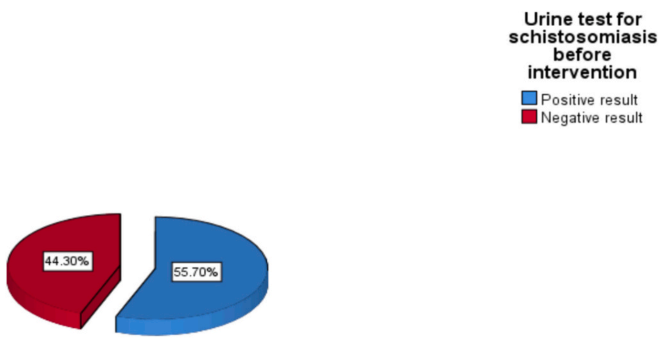


**Fig. 1.** Urine test for schistosomiasis in students before intervention in the Al-Alaqa male primary school.

## 4. Discussion

This study included only male students for many reasons discussed before and also many studies have shown that male students usually have a greater prevalence of schistosomiasis than female students, which was attributed to the observation that boys are more outgoing and adventurous and tend to play away from their homes more than their female counterparts (Rudge et al., 2008). These results showed that male students are more likely to be exposed to schistosomiasis, and this difference was significant (Fig. 1). Most of the students (39.2%) were 10–13 years of age, 26.2% were older than 13 years, and the remaining 34.6% were between 6 and 9 years of age. In this study, higher treatment coverage of praziquantel (98%) was demonstrated for children aged 6–13 years who received praziquantel after primary screening and assessment than for praziquantel and mebendazole in another study by Ndyomugyenyi and Kabatereine, in which treatment coverage was higher using CDI (85%) than a school-based treatment approach (79%) for children aged 5–14 years. The pretreatment prevalence of S. haematobium in the study area averaged 55.7% (Fig. 1). A significant percentage of the illness spread, and the researcher made an urgent decision to address this issue by investigating the school's students to optimally manage and treat these cases by delivering the praziquantel doses immediately after the results. In addition, leaflets, brochures and posters were distributed explaining the definitions, mode of transmission, signs, symptoms, and the control and treatment of schistosomiasis; even the noninfected students were given a protective dose of praziquantel. However, the dose of praziquantel was given according to the community category prevalence of WHO for the prevention and control of schistosomiasis: high prevalence: >30% visible hematuria (S. haematobium, using a questionnaire) or > 50% infected (*S. mansoni* and S. haematobium, using parasitological methods); moderate prevalence: <30% visible hematuria (S. haematobium, using a questionnaire) or > 10% but <50% infected (*S. mansoni* and S. haematobium, using parasitological methods); low prevalence: <10% infected (S. haematobium and *S. mansoni*, using parasitological methods) (Bundy et al., 2006), exactly was used as category number one >50% infected (*S. mansoni* and S. haematobium, using parasitological methods) for treatment. (Tables 1–16.)

To address this dilemma, the researcher sought help from the Schistosomiasis Control Program unit in Kosti city and, with special gratitude, provided us with praziquantel and covered all the students in the school. After four weeks, the dose of praziquantel was repeated for approximately 55.7% of the infected students (132). 6 months after one round of drug administration, their urine was tested again, and the percentage of negative results was 96.20% while the percentage of positive result was gust 3.8%, so the percentage of positive results after the third dose of praziquantel was given; the percentage of S. haematobium infections decreased from 55.7% to 3.80% (Fig. 3). This study was inspired by Pauline NM and his group (2012) (Pauline et al., 2012), who used CDI for schistosomiasis in western Kenya. Their findings align with those of this study. Their study revealed that the pretreatment prevalence of *S. mansoni* averaged 17.4% (range 5–43%) across the entire location. Treatment coverage in different villages ranged from 54.19% to 96.6%, according to community drug distributor (CDD) records. An assessment from a household survey showed coverage of 52.3%–91.9%, while the proportion of homesteads (home compounds) covered ranged from 54.9% to 98.5%. Six months after one round of drug treatment, the prevalence of *S. mansoni*, S. haematobium, hookworm, and Trichuris infections decreased by 33.2%, 69.4%, and 42.6%, respectively. In addition to the water supply of the study population, 68% of the respondents answered that they have a water supply for drinking water, and the other 32% did not Fig. 2. This affects schistosomiasis, as a study performed by Fourent, N, Guessan, and Catdo in 2004 in Cote D'Ivoire (N'Guessan, 2003), showed that the general population in areas with piped water is less infected with schistosomiasis than the population without piped water (Gabrielli, 2013; Graham et al., 2010) . In this study, more than half of the respondents (56%) went to the pond daily; sometimes, the remaining 44% never visited the pond daily, and some rarely visited the pond daily. More than half of the respondents (62%) went to the Nile daily and sometimes; the remaining 38% never visited the pond daily, and some rarely visited the pond daily. However, most of the participants (44%) mentioned that the main reason for going to the pond is to prepare and bring water for construction because it is one of the main occupations in the study area. The researchers observed that all ponds in the village and surrounding area are not well covered and are unclean, which increase the susceptibility to infection with the disease. Fifty-one percent of participants mentioned that the main reasons for going to the White Nile River were swimming (29%), fishing (21%), and drinking water (10%). The most serious finding of the study was that approximately 24.9% of the participants had a toilet purpose or used other methods; Mazigo HD and his Group 2012 mentioned in their study, Epidemiology and Control of Human Schistosomiasis in Tanzania, "this led to intermediate host snail distribution, environmental contamination with human excreta, human water-contact patterns and host-parasite relationships." These factors are the main cause of the disease's distribution (Mazigo et al., 2012), and 75% of patients have a pit latrine. Additionally, ANOVA was used to compare the mean scores between student age and urine test results before the intervention in the Al-Alaqa male primary school. The ANOVA tests used an alpha level of 0.05. A significant value of 0.05 or less calls for rejection of the null hypotheses. ANOVA uses the F test; a ratio of the two independent variance estimates of the same population variance. The researcher compared whether group means differed and which one group significantly differed from the other group. In this study, the obtained larger F statistic value called for the rejection of

**Table 1**
Student age group distribution in the Al-Alaqa male primary school ($N = 237$).

| Student age in the Al-Alaqa Male Primary School | | | |
|---|---|---|---|
| Age group | Frequency | Percent | Std. Dev |
| 6–9 Years | 82 | 34.6 | 0.777 |
| 10–13 Years | 93 | 39.2 | |
| >13 Years | 62 | 26.2 | |
| Total | 237 | 100.0 | |

**Table 2**
Students' daily activities that were associated with the infection ($n = 237$).

| A- Frequency of students going to the pond in the Al-Alaqa male primary school. | | |
|---|---|---|
| Description | Frequency | Percent |
| Daily | 70 | 29.5 |
| Sometimes | 62 | 26.2 |
| Rarely | 56 | 23.6 |
| Never | 49 | 20.7 |
| Total | 237 | 100.0 |

| B- Frequency of students going to the White Nile River in the Al-Alaqa male primary school. | | |
|---|---|---|
| Description | Frequency | Percent |
| Daily | 75 | 31.6 |
| Sometimes | 73 | 30.8 |
| Rarely | 61 | 25.7 |
| Never | 28 | 11.8 |
| Total | 237 | 100.0 |

| C- Reasons for students going to the pond in the Al-Alaqa male primary school. | | |
|---|---|---|
| Description | Frequency | Percent |
| For Swimming | 44 | 18.6 |
| For drinking | 40 | 16.9 |
| For building | 103 | 43.5 |
| Others | 50 | 21.1 |
| Total | 237 | 100.0 |

| D- Reasons for students going to White Nile River in the Al-Alaqa male primary school. | | |
|---|---|---|
| Description | Frequency | Percent |
| For Swimming | 69 | 29.1 |
| For recreation | 33 | 13.9 |
| For fishing | 49 | 20.7 |
| For drinking | 24 | 10.1 |
| For agriculture | 62 | 26.2 |
| Total | 237 | 100.0 |

| E- Availability of a pit latrine in the home? | | |
|---|---|---|
| Description | Frequency | Percent |
| Yes | 178 | 75.1 |
| No | 59 | 24.9 |
| Total | 237 | 100.0 |

**Table 3**
ANOVA statistics comparing the mean score between student age and urine test results before intervention in the Al-Alaqa male primary school ($n = 237$).

| Urine test for schistosomiasis before intervention | | | | | |
|---|---|---|---|---|---|
| Type | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 16.179 | 2 | 8.090 | 44.748 | 0.000 |
| Within Groups | 42.302 | 234 | 0.181 | | |
| Total | 58.481 | 236 | | | |

each of the null hypotheses. One-way analysis of variance and correlation tests were used to test this hypothesis. The mean square (MS) was obtained by dividing the sum of squares (SS) by the degree of freedom (df) between groups and within groups. The F value is compounded by dividing the variance (mean square) between groups (items) by the variance within groups (items).

$$F = \frac{\text{variance between items}}{\text{variance within items}}$$

**Table 4**
ANOVA statistics comparing the mean score between student age and urine test results after intervention in the Al-Alaqa male primary school ($n$ = 237).

| Urine test for schistosomiasis after intervention | | | | | |
|---|---|---|---|---|---|
| Type | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 0.170 | 2 | 0.085 | 2.349 | 0.098 |
| Within Groups | 8.488 | 234 | 0.036 | | |
| Total | 8.658 | 236 | | | |

**Table 5**
ANOVA and chi-square statistics comparing the mean scores between the urine test results before and after intervention in Al-Alaqa male primary school students ($n$ = 237).

| Urine test for schistosomiasis after intervention | | | | | |
|---|---|---|---|---|---|
| Type | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 0.000 | 1 | 0.000 | 0.000 | 0.993 |
| Within Groups | 8.658 | 235 | 0.037 | | |
| Total | 8.658 | 236 | | | |

**Table 6**
Crosstabs (n = 237).

| Urine test for schistosomiasis before intervention * Urine test for schistosomiasis after intervention cross-tabulation | | | | |
|---|---|---|---|---|
| Urine test for schistosomiasis before intervention | Result type | Urine test for schistosomiasis after intervention | | |
| | | Positive result | Negative result | Total |
| | Positive result | 5 | 127 | 132 |
| | Negative result | 4 | 101 | 105 |
| Total | | 9 | 228 | 237 |

P value = 1.000

**Table 7**
ANOVA statistics comparing the mean score between student age and time spent at the pond in the Al-Alaqa male primary school ($n$ = 237).

| **ANOVA** | | | | | |
|---|---|---|---|---|---|
| How many times do you go to the pond? | | | | | |
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 31.467 | 2 | 15.734 | 13.857 | 0.000 |
| Within Groups | 265.697 | 234 | 1.135 | | |
| Total | 297.165 | 236 | | | |

**Table 8**
ANOVA statistics comparing the mean score between student age and time spent visiting the Nile in the Al-Alaqa male primary school (n = 237).

| **ANOVA** | | | | | |
|---|---|---|---|---|---|
| How many times do you go to the White Nile? | | | | | |
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 12.779 | 2 | 6.390 | 6.564 | 0.002 |
| Within Groups | 227.778 | 234 | 0.973 | | |
| Total | 240.557 | 236 | | | |

The ANOVA test indicated a significant difference in the mean score of student age and the urine test results before the intervention [F (44.748), $p = 0.000$]. A post hoc test with Bonferroni post hoc correction was used to determine which age level exactly showed significance; the post hoc test showed strong significance at all age levels. Independent t-test was used to support the ANOVA results comparing the urine results before the intervention with student age; the results showed a statistically significant difference of 0.000 when equal variances were assumed. ANOVA and chi-square tests were used to compare the mean scores between the urine test results before and after the intervention in the Al-Alaqa male primary school group, and neither table showed significant differences between the urine results before and after the intervention in the program group. Additionally, ANOVA was performed to compare the mean score between student age and time spent visiting the pond in Al-Alaqa male primary school. ANOVA revealed a strongly statistically

**Table 9**
ANOVA statistics comparing the mean score between student age and reasons for going to the pond in the Al-Alaqa male primary school (n = 237).

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Why did you go to the pond? | | | | | |
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 20.323 | 2 | 10.161 | 10.808 | 0.000 |
| Within Groups | 220.006 | 234 | 0.940 | | |
| Total | 240.329 | 236 | | | |

**Table 10**
ANOVA statistics comparing the mean score between student age and reasons for going to the Nile in the Al-Alaqa male primary school (n = 237).

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Why did you go to the White Nile? | | | | | |
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 10.734 | 2 | 5.367 | 2.211 | 0.112 |
| Within Groups | 568.034 | 234 | 2.427 | | |
| Total | 578.768 | 236 | | | |

**Table 11**
ANOVA statistics comparing the mean score between student age and urine results after intervention in the Al-Alaqa male primary school (n = 237).

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Urine test for schistosomiasis after intervention | | | | | |
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 0.055 | 2 | 0.027 | 0.745 | 0.476 |
| Within Groups | 8.603 | 234 | 0.037 | | |
| Total | 8.658 | 236 | | | |

The results were not statistically significant (0.476), with a low F of 0.745.

**Table 12**
Independent sample t-test statistics comparing the mean score between student age and urine results after intervention in the Al-Alaqa male primary school (n = 237).

| Independent Samples Test | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Levine's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| Student age in the Al-Alaqa School | | F | Sig | t | df | Sig (2-tailed) | Mean deference | Std Error deference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| | Equal variances assumed | 0.016 | 0.900 | 2.098 | 235 | 0.037 | 0.550 | 0.262 | 0.033 | 1.066 |
| | Equal variances not assumed | | | 2.221 | 8.730 | 0.054 | 0.550 | 0.248 | −0.013- | 1.112 |

**Table 13**
ANOVA statistics comparing the mean score between student age and urine results before intervention in the Al-Alaqa male primary school (n = 237).

| ANOVA | | | | | |
|---|---|---|---|---|---|
| Urine test for schistosomiasis before intervention | | | | | |
| | Sum of Squares | Df | Mean Square | F | Sig. |
| Between Groups | 1.801 | 2 | 0.901 | 3.718 | 0.026 |
| Within Groups | 56.680 | 234 | 0.242 | | |
| Total | 58.481 | 236 | | | |

The results showed a statistically significant difference of 0.026 (F = 3.715).

**Table 14**
Independent sample t-test statistics comparing the mean score between student age and urine results before intervention in the Al-Alaqa male primary school (n = 237).

| Independent Samples Test | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Levine's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| Student age in the Al-Alaqa School | | F | Sig | t | df | Sig (2-tailed) | Mean Deference | Std Error deference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| | Equal variances assumed | 57.437 | 0.000 | −4.531- | 235 | 0.000 | −0.442- | 0.098 | −0.634- | −0.250- |
| | Equal variances not assumed | | | −4.734- | 228.605 | 0.000 | −0.442- | 0.093 | −0.626- | −0.258- |

**Table 15**
Relationship between the prevalence of schistosomiasis before intervention and water supply availability in the home.

| Urine test for schistosomiasis before intervention | | Availability of water supply in the home | | Total % |
|---|---|---|---|---|
| | | Available % | Not available % | |
| Positive result | Count | 75 | 57 | 132 |
| | Expected Count | 90.2 | 41.8 | 132.0 |
| | % with a urine test for schistosomiasis before intervention | 56.8 | 43.2 | 100.0 |
| | % with water supply availability in the home | 46.3 | 76.0 | 55.7 |
| | % of Total | 31.6 | 24.1 | 55.7 |
| Negative result | Count | 87 | 18 | 105 |
| | Expected Count | 71.8 | 33.2 | 105.0 |
| | % with a urine test for schistosomiasis before intervention | 82.9 | 17.1 | 100.0 |
| | % with water supply availability in the home | 53.7 | 24.0 | 44.3 |
| | % Of Total | 36.7 | 7.6 | 44.3 |
| Total | Count | 162 | 75 | 237 |
| | Expected Count | 162.0 | 75.0 | 237.0 |
| | % with a urine test for schistosomiasis before intervention | 68.4 | 31.6 | 100.0 |
| | % with water supply availability in the home | 100.0 | 100.0 | 100.0 |
| | % of Total | 68.4 | 31.6 | 100.0 |

There is strong evidence of a relationship between the prevalence of schistosomiasis before intervention and water supply availability in the home (chi-square = 18.331, df = 1, p value = 000)

**Table 16**
Chi-square tests.

| Chi-Square Test | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 18.331a | 1 | 0.000 | 0.000 | 0.000 |
| Continuity Correction | 17.147 | 1 | 0.000 | | |
| Likelihood Ratio | 19.117 | 1 | 0.000 | | |
| Fisher's Exact-Test | | | | | |
| Linear-by-Linear Association | 18.254 | 1 | 0.000 | | |
| N of Valid Cases | 237 | | | | |

significant difference (0.000) between the mean score of student age and duration at the pond—i.e., student age increased in response to time frequency at the pond and other water supply usage for many reasons mentioned in question 6; the percentage of schistosomiasis infections also increased. One-way ANOVA statistics compared the mean score between student age and their time-frequency at the pond. ANOVA revealed a strongly statistically significant difference (0.002 and F = 6.564) between the mean score of student age and duration at the Nile River—i.e., student age increased with Nile River attendance and other water supply usage, for many reasons mentioned in question seven; the percentage of schistosomiasis infections also increased. Extensive annual education and advice are needed regarding these issues. The ANOVA results showed a strongly statistically significant difference (0.000 and f = 10.808), such that suspected illness arose regardless of the reason behind going to the pond. Additionally, broad educational sessions are needed in all types of media and schools. However, the ANOVA results showed no statistically significant difference (0.112 and f = 2.211), indicating that regardless of the reasons for visiting the Nile River, the illness did not arise. One-way ANOVA was used to compare the mean score between student age and urine results after the intervention in the Al-Alaqa male primary school; the results showed no statistically significant difference (0.476, low F = 0.745). Independent *t*-test was used to support the ANOVA results

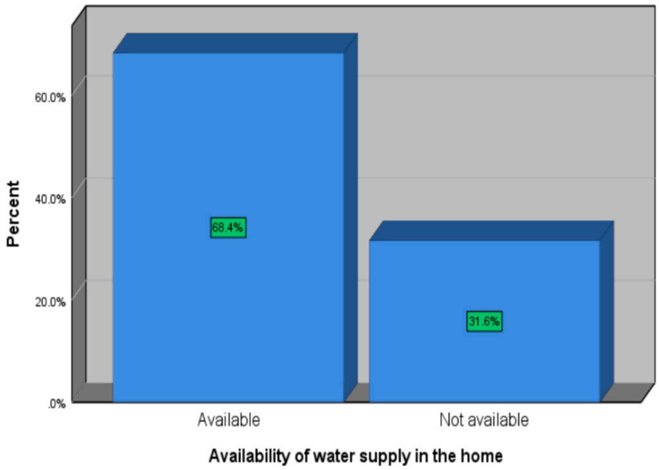


**Fig. 2.** Distribution of the availability of water supply in the Al-Alaqa male primary school.


**Fig. 3.** Urine test for schistosomiasis in students after intervention in the Al-Alaqa male primary school (n = 237).

comparing the urine results after the intervention with student age; no statistically significant difference (0.900) was detected when equal variances were assumed. The most significant difference was 0.026 (F = 3.715) between student age and the urine result before the intervention in the Al-Alaqa male primary school.

Finally, this study confirmed the effectiveness of health education in controlling schistosomiasis and treating schistosomiasis with praziquantel and estimated the prevalence of schistosomiasis among the study population. A similar study was performed in Kenya and may be useful elsewhere.

## 5. Conclusion

This study confirmed the effectiveness of community-based interventions, health awareness and treatment of cases to control schistosomiasis among schoolchildren. A significant reduction in the number of patients was observed after the intervention, even after 6 months. The study concluded that mass chemotherapy with praziquantel in combination with a health program is more effective and sustainable. The incidence of disease in school decreased to 3.8%, while it decreased to 55.7% before the intervention. The study concluded that mass chemotherapy and treatment were highly effective when associated with a health program intervention. Mass chemotherapy alone may reduce the prevalence of disease for a short time, as seen in the Blue Nile Project in Sudan and some studies in Kenya.

### *5.1. Recommendations*

Community-based interventions should be applied in schools with an emphasis on health education programs through training of schoolteachers on investigations for schistosomiasis and treatment with praziquantel, the provision of materials (microscopes, re-agents, and drugs), intensive training of teachers in health education programs using pamphlets and posters, and the Ministry of Health in Sudan; schoolteachers should take urgent action to handle this problem, and school health teams should be supplied with all the requirements needed for this issue. The enhancement and distribution of praziquantel should be encouraged in both private and public schools, a healthy water supply should be provided for all people in the village and other surrounding areas, and preventive strategies should be provided for all people in endemic areas with praziquantel to prevent disease progression and reduce transmission by reducing egg passage and encouraging household members to participate in schistosomiasis control programs.

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## CRediT authorship contribution statement

**Hamza Hussain Ahmed Balola:** Methodology. **Eltayeb Abdelazeem Idress:** Conceptualization, Supervision. **Mohammed Hassan Moreljwab:** Software. **Amani Mahmoud Fadul Mokhtar:** Validation. **Murtada Mustafa Gabir Tia:** Formal analysis. **Abdalla Mohamed Ahmed Osman:** Data curation. **D.S. Veerabhadra Swamy:** Writing – review & editing. **Abubakr Ali Elamin MohamedAhmed:** Writing – review & editing. **Mohamed E. Elnageeb:** Validation.

## Declaration of competing interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

## Data availability

The data used to support the findings of this study are available with the corresponding author upon request.

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