Prevalence and factors associated with transmission of schistosomiasis in school-aged children in South Sudan: a cross-sectional study

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Abstract

Introduction: South Sudan is affected by a high burden of Neglected Tropical Diseases (NTDs). The country is very vulnerable to NTDs due to its favourable tropical climate and multiple risk factors. However, the distribution of the diseases and the populations at risk for the various NTDs is unknown. This paper described the distribution of schistosomiasis in 58 counties and 261 schools in South Sudan.

Methods: a descriptive quantitative cross-sectional study of schistosomiasis in 58 counties in 8 states of South Sudan recruited school-aged children. Using different laboratory techniques, the children were tested for Schistosoma mansoni (S. mansoni) and Schistosoma haematobium (S. haematobium). A quantitative descriptive statistical was performed to determine the prevalence rates and the endemicity of schistosomiasis among 13,286 school-aged children.

Results: the overall prevalence of S. mansoni and S. haematobium were 6.1% and 3.7% using Kato Katz and urine filtration concentration testing techniques. The highest state prevalence was reported in Western Equatoria for both S. mansoni (14.7%) and S. haematobium (7.3%). The age of the participants varied from 4 to 18 years; of these, children 10 to 12 years old had the highest prevalence of S. mansoni (6.8%) and S. haematobium (3.7%). The prevalence of S. mansoni (7% male vs 5% female) and S. haematobium (3.6% male vs 3.1% female) were higher in males than females. The likelihood of the prevalence of S. mansoni in males was 1.42 (95% CI:1.23, 1.64) higher than in females, while for S. haematobium, 1.36 (95% CI: 1.12, 1.65) higher than in females. The prevalence of S. mansoni and S. haematobium showed a statistically significant gender difference (P<0.05).

Conclusion: the study had provided evidence of the distribution of schistosomiasis in South Sudan for policy direction and recommended annual preventive chemotherapy with praziquantel in all endemic areas.
Introduction

Schistosomiasis, bilharzia, or snail fever is a common neglected tropical disease (NTD), highly endemic in the tropics and subtropical areas [1]. It is caused by trematode parasites of the genus Schistosoma which has five species known to infect and cause morbidity in humans, namely *S. haematobium*, *S. intercalatum*, *S. japonicum*, *S. mekongi*, and *S. mansoni* [2]. Sexual reproduction occurs in the human host, where fertilized eggs are produced and released through urine and stool. The eggs trapped in tissues induce inflammation and die [3]. In freshwater, free-living miracidia released by the eggs infect the snail and undergo asexual replication to release the cercariae, which penetrates the skin of humans who come into contact with the infected water [2]. The African region is endemic mainly by *S. haematobium* and *S. mansoni* due to the availability of freshwater where the intermediate hosts thrive well. *S. japonicum* and *S. mekongi* are confined to Asia, while the Caribbean and Latin America are affected mainly by *S. mansoni* [4]. Schistosomiasis is the commonest NTD affecting at least 230 million people globally. Sub-Saharan Africa contributes 90% of the disease burden [1-3].

Acute schistosomiasis, or "Katayama Syndrome" is a short-lived hypersensitivity reaction related to tissue migration of the larva. Acute infection presents as fever, myalgia, headache, cough, and rash. The symptoms appear 14–84 days after infection and may last for several weeks [5]. At the same time, chronic diseases include bladder cancer, blood in the stool, constipation, diarrhea, bowel wall ulceration, fibrosis, hyperplasia, polyposis, and portal hypertension [5,6].

In South Sudan, hospital records have indicated ongoing schistosomiasis transmission in Upper Nile, Jonglei, Eastern and Central Equatoria states with two species, *S. mansoni* and *S. haematobium*. The eastern and central parts of South Sudan including Jonglei, Unity, Upper Nile state, and Greater Pibor Administrative Area (GPAA) is prone to frequent flooding. Abnormally heavy rainfall causes the overflow of Lol, Nile, Pibor, Sobat and other rivers that lead to inland flooding where people reside and causes displacement. In addition, the flooding increases the chance of contact between people and the parasite carrying an intermediate and causes displacement. In addition, the flooding increases the chance of contact between people and the parasite carrying an intermediate and causes displacement. Before the section of the schools, all schools in the county were listed down for random sections. Fifty children aged between 10 and 14 years, balanced by gender, from each school were randomly enrolled on the study. WHO NTD transmission assessment survey guideline recommends 50 children per cluster [12]. When the target was not reached, children from an expanded age range were selected. Otherwise, the target area from the surrounding villages or the nearest school was sampled to complete the required samples. Each child submitted a stool and urine sample to test the presence of intestinal Schistosoma (*S. mansoni*) eggs and urinary Schistosoma (*S. haematobium*), respectively.

Data collection: the data collection was conducted by nine teams, each comprising a supervisor (i.e. laboratory technologist or an experienced laboratory technician), two laboratory technicians, a data clerk and a social mobilizer. A data manager coordinated the work of all data clerks and had access to the Open Data Kit (ODK) web-based cloud to monitor data as entries were made and uploaded using smartphones. A detailed field plan was developed based on the districts created and the counties included in the study. The local health personnel led the study teams to the selected schools. Geographical coordinates (i.e. longitude, latitude, and altitude) were taken at the survey sites using smartphones. Children aged between 10 to 14 years were randomly selected, and both urine and stool samples were collected from the selected children. The survey determined the prevalence of *S. haematobium* based on micro-hematuria or parasite eggs in urine using reagent dipstick and urine filtration procedures, respectively. A reagent dipstick for hematuria is a qualitative rapid diagnostic tool used to screen school-aged children for urinary schistosomiasis. The interpretation of the result was based on the presence or absence of a test strip line. Samples with red test lines were labelled as positive; however, further quantification of the test line was not performed. The urine filtration procedures determine the concentration of the egg per 10 millilitres (ml) of the urine sample. The testing result was reported as light: <50 ova per 10ml; heavy: ≥50 ova per 10ml.

The prevalence of *S. mansoni* was determined parasite eggs in stool using Kato Katz or circulating cathodic antigen (CCA) in urine. The Kato Katz technique is used for semi-quantitative and quantitative diagnosis of Schistosoma species (*S. mansoni*), soil-transmitted helminthiasis caused by Trichuris trichiura, hookworm, and ascaris lumbricoides. WHO had recommended the use of the technique in areas with moderate to high transmission of intestinal schistosomiasis (10-49.9% and ≥50%) [14]. A gram of faeces was collected and tested for the presence of an egg (egg per gram of faeces) using a microscope. The testing result was reported as light infection (0-99 e.p.g.), medium (100-399 e.p.g.), and heavy: (≥400 e.p.g.). A point-of-care Circulating Cathodic Antigen (POC-CCA) urine test is a simplified rapid diagnostic test (RDT) used for the qualitative detection of an active *S. mansoni* infection. The test detects Schistosoma specific antigen excreted in urine [15]. The result was labelled positive based on the appearance of a visible test line seen within 20 minutes of application of the urine. The prevalence estimate for each survey site was classified into non-endemic (0%), low (<10%), moderate (10-49.9%), or high-risk (≥50%). The prevalence estimate for each survey site was classified into non-endemic (0%), low (<10%), moderate (10-49.9%), or high-risk (≥50%) areas.

Data analyses: in 2016, data were captured on to a server hosted at the national level using Bold Like Us (BLU) Studio 5.5 smartphones running Android 4.2 (Jelly Bean) through a modified version of Open Data Kit (ODK), the LINKS application. Raw data on schistosomiasis infection were downloaded into Microsoft Excel, cleaned, and summarized from the server. In subsequent years, the Expanded Special Project for Elimination of Neglected Tropical Diseases (ESPEN) Collect application was used to capture, facilitate cleaning, and aggregation collected individual data into site data. The data entered was synchronized and hosted at the Standard Code Server. Only authorized officers had access to download individual data from the dashboard on the server. We conducted descriptive analyses on socio-demographic characteristics and epidemiological distribution of schistosomiasis. We have used International Business Machine (IBM) Statistical Package for Social Science Window Version 26.0 (SPSS V26) to conduct descriptive epidemiology. A prevalence map was produced...
using ArcGIS (ESRI, California, and the USA). A two-by-two table was used to determine the relationship between test types (urine filtration versus dipstick and CCA versus Kato Katz) and test result (positive versus negative). A two-by-two table was performed to compare whether the observed prevalence of *S. haematobium* and *S. mansoni* results for the two test types for each species were statistically different enough to reject the null hypothesis (there is no significant difference between the two test types) at a 95% confidence interval (CI) and a significant level of 0.05. The prevalence of schistosoma infection by location was found in all the eight states of South Sudan, with an overall prevalence rate of *S. mansoni* and *S. haematobium* was calculated using the stool Kato-Katz testing and urine filtration concentration respectively. The two tests were conducted in 2016, 2018 and 2019; however, circulating cathodic antigen (CCA)-(S. mansoni) and urine dipstick was only available in 2016.

| Variables     | Category               | Number tested (N) | *S. mansoni* Tested positive (%) | *S. haematobium* Tested positive (%) | Co-infection Tested positive (%) | Prevalence (%) |
|---------------|------------------------|-------------------|---------------------------------|-------------------------------------|---------------------------------|----------------|
| State         | Eastern Equatoria      | 1130              | 23                              | 2                                   | 3                               | 0.3            | 0              |
|               | Jonglei                | 2833              | 331                             | 11.7                                | 172                             | 6.1            | 102            | 3.6           |
|               | Lakes                  | 1822              | 94                              | 5.2                                 | 3                               | 0.2            | 0              |
|               | Unity                  | 99                | 2                               | 2                                   | 17                              | 17.2           | 0              |
|               | Upper Nile             | 2764              | 11                              | 0.4                                 | 92                              | 3.3            | 7              |
|               | Warrap                 | 1606              | 4                               | 0.2                                 | 31                              | 1.9            | 0              |
|               | Western Bar el Ghazal  | 745               | 2                               | 0.3                                 | 2                               | 0.3            | 2              |
|               | Western Equatoria      | 2287              | 337                             | 14.7                                | 167                             | 7.3            | 114            |
| Gender        | Male                   | 6982              | 488                             | 7.0                                 | 248                             | 3.6            | 125            |
|               | Female                 | 6304              | 316                             | 5.0                                 | 193                             | 3.1            | 110            |
| Age group     | 0-4                    | 6                 | 0                               | 0.0                                 | 0                               | 0.0            | 0              |
|               | 5-9                    | 1085              | 72                              | 6.6                                 | 19                              | 1.8            | 16             |
|               | 10-12                  | 7232              | 494                             | 6.8                                 | 267                             | 3.7            | 210            |
|               | 13-15                  | 4958              | 238                             | 4.8                                 | 155                             | 3.1            | 9              |
|               | >15                    | 5                 | 0                               | 0.0                                 | 0                               | 0.0            | 0              |

Note: the prevalence of *S. mansoni* and *S. haematobium* was calculated using the stool Kato-Katz testing and urine filtration concentration respectively. The two tests were conducted in 2016, 2018 and 2019; however, circulating cathodic antigen (CCA)-(S. mansoni) and urine dipstick was only available in 2016.

**Results**

Study population and schistosoma infection prevalence: the screening of the 13,286 samples collected from the children revealed the presence of both *S. haematobium* (*n*=441) and *S. mansoni* (*n*=804) Table 1. The age of the children tested varied from 4 to 18 years old. The age group 10 to 12 years had the highest prevalence rate for *S. mansoni*, *S. haematobium*, and Co-infection of the two species. Of the 6,982 males tested for *S. mansoni*, 7% tested positive. The prevalence of *S. mansoni* in males was 1.42 (95% CI: 1.23,1.64) times higher than in females. Regarding *S. haematobium*, 3.8% of males were tested positive compared to 2.8% positive females. The prevalence of *S. haematobium* in males was 1.36 (95% CI:1.12,1.65) times greater than in females.

Prevalence of schistosoma infection by location: *S. mansoni* infection was found in all the eight states of South Sudan, with an overall prevalence rate of 6.1% as shown in Table 2. Western Equatoria had the highest prevalence rate of *S. mansoni* (14.7%). The prevalence rate varied from 0 to 65.9% at the county level, with the highest in Bor South (65.9%). At the school level, 86% out of 261 schools were endemic to *S. mansoni*. The school prevalence rate of *S. mansoni* varied from 0 to 93.3%; the highest was recorded at Bandala primary school in Nagero county (93.3%) of Western Equatoria state. *S. haematobium* infection was found in all eight states with an overall prevalence rate of 3.7%. Unity state had the highest prevalence rate (17.2%) Table 2. At the primary school level, 72 (%) out of 261 schools were endemic to *S. haematobium*. The school prevalence rate varied from 0% to 84.4%, with the highest at Toch primary school in Old Fangak (84.4%) in Jonglei state. Overall, high endemicity for schistosomiasis combined is in Bor South, Old Fangak, Ezo and Ibba counties as indicated in Figure 1. Bor South county has highest the endemicity for *S. mansoni* species.

Prevalence of parasitic intensity: light intensity infection (1-99 egg per gram of faeces (e.p.g.) for *S. mansoni* by Kato Katz technique was observed in all the states that varied from 0.2 and 13.6% as indicated in Table 3. Western Equatoria recording the highest. Medium intensity infections (100-399 e.p.g. of faeces) were observed in five out of the eight states at 1.3% in Jonglei, 1.1% in Western Equatoria and 0.1% each in Eastern Equatoria, Lakes and Warrap states and heavy intensity infection (>400 e.p.g. of faeces) was observed in three states of Jonglei at 0.9%, Western Equatoria 0.3% and Lakes 0.1%. For *S. haematobium* using urine filtration, light intensity infection (<50 eggs/10mls of urine) and heavy intensity infection (≥500 eggs/10mls of urine) was observed at 0.3% in Jonglei, 0.5% in Western Equatoria and 0.0% in Lakes.
Table 2: summary of Schistosoma mansoni laboratory test, South Sudan (2016 to 2019)

| State              | Stool: Kato-Katz (S. mansoni) | Urine: circulating cathodic antigen (CCA)- (S. mansoni) |
|--------------------|-------------------------------|----------------------------------------------------------|
|                    | Number of stools tested | Prevalence rate (%) | Infection intensity (eggs per gram of faeces) [% of positive] | Number of samples tested | Prevalence rate (%) |
|                    | Light | Medium | Heavy | Light | Medium | Heavy | Light | Medium | Heavy |
| Eastern Equatoria  | 1130  | 2.0    | 1.9   | 0.1   | 0.0    | 1130  | 15.6  |
| Jonglei            | 2833  | 11.7   | 9.5   | 1.3   | 0.9    | 840   | 34.0  |
| Lakes              | 1822  | 5.2    | 4.9   | 0.1   | 0.1    | 1822  | 12.8  |
| Unity              | 99    | 2.0    | 2.0   | 0.0   | 0.0    | -     | -     |
| Upper Nile         | 2764  | 0.4    | 0.4   | 0.0   | 0.0    | -     | -     |
| Warrap             | 1606  | 0.2    | 0.2   | 0.1   | 0.0    | 1406  | 18.1  |
| Western Bar el Ghazal | 745 | 0.3    | 0.3   | 0.0   | 0.0    | -     | -     |
| Western Equatoria  | 2287  | 14.7   | 13.6  | 1.1   | 0.3    | 649   | 30.8  |
| Total              | 13286 | 6.1    | 5.3   | 0.5   | 0.3    | 5847  | 19.7  |

Intensity by Kato-Katz: light: 0-99 egg per gram of faeces (e.p.g.); medium: 100-399 e.p.g.; heavy: ≥ 400 e.p.g; intensity by urine filtration: light: < 50 ova per 10 ml; heavy: ≥ 50 ova per 10 ml; point of care-Schistosoma circulating cathodic antigen (POC-CCA) was used in 2016 in five states.

Table 3: summary of Schistosoma haematobium laboratory test, South Sudan (2016 to 2019)

| State              | Urine: filtration concentration | Urine dipstick |
|--------------------|---------------------------------|----------------|
|                    | Number of samples tested | Prevalence (%) | Infection intensity (eggs per 10 ml) [% of positives] | Number of samples collected | Prevalence (%) |
|                    | Light | Heavy | Light | Heavy | Light | Heavy | Light | Heavy |
| Eastern Equatoria  | 1130  | 0.3   | 0.1   | 0.2   | -     | -     |
| Jonglei            | 2833  | 6.1   | 3.8   | 2.3   | 1993  | 3.2   |
| Lakes              | 1822  | 0.2   | 0.1   | 0.1   | -     | -     |
| Unity              | 99    | 17.2  | 16.2  | 1.0   | 99    | 26.3  |
| Upper Nile         | 2764  | 3.3   | 2.3   | 1.0   | 2764  | 3.6   |
| Warrap             | 1606  | 1.9   | 0.7   | 1.2   | 200   | 0.0   |
| Western Bar el Ghazal | 745 | 0.3   | 0.3   | 0.0   | 745   | 0.3   |
| Western Equatoria  | 2287  | 7.3   | 4.4   | 2.9   | 1638  | 3.9   |
| Total              | 13286 | 3.7   | 2.3   | 1.4   | 7439  | 3.4   |

Note: Intensity by urine filtration: light: < 50 ova per 10 ml; heavy: ≥ 50 ova per 10 ml
was observed in the eight states with the highest in Unity (16.2%),
Western Equatoria (4.4%) and Jonglei (3.8%), while heavy intensity
infections (>50 eggs/10mls of urine) were observed in all except Western
Bahr el Ghazal.

Overall, the S. mansoni prevalence rate for 2016 surveys using Circulating
Cathodic Antigen (CCA) was 19.7%, while for the Kato Katz technique
was 7.8%. The likelihood of the test being positive was 2.87 (95% CI:
2.54, 3.24) higher for CCA than Kato Katz. There was a statistically
significant difference between the two tests (P<.001) (Table 4). As for S.
haematobium, the overall prevalence rate using urine filtration was 5.0%,
while for dipstick was 3.4%. The likelihood of the test being positive
was 1.49 (95% CI: 1.27, 1.75) higher in urine filtration compared to the
dipstick. There was a statistically significant difference between the two
tests (P<.001) (Table 4).
**Table 4: comparison of the performance of different tests used for S. mansoni and S. haematobium testing, South Sudan (2016 to 2019)**

| Test type               | Positive | Negative | Total | Odds ratio | P-value | 95% confidence interval |
|-------------------------|----------|----------|-------|------------|---------|-------------------------|
| circulating cathodic antigen | 1149(19.7%) | 4698(80.3%) | 5847(100%) | $<0.001$ | (2.54, 3.24) |
| Kato-Katz                | 400(7.8%) | 4698(92.8%) | 5098(100%) | $<0.001$ | (2.54, 3.24) |
| Total                   | 1549(14.2%) | 9396(85.8%) | 10945(100%) | $<0.001$ | (2.54, 3.24) |
| Urine filtration         | 375(5.0%) | 7064(95.0%) | 7439(100%) | $<0.001$ | (1.27, 1.75) |
| Urine dipstick           | 255(3.4%) | 7184(96.6%) | 7339(100%) | $<0.001$ | (1.27, 1.75) |
| Total                   | 630(4.2%) | 14248(95.8%) | 14878(100%) | $<0.001$ | (1.27, 1.75) |

**Discussion**

The cross-sectional study provides the baseline data on schistosomiasis prevalence as the first sizeable school-based survey in the 58 unmapped counties of South Sudan. Our study revealed the presence of schistosomiasis infections in all the states and almost in every county with a heterogeneous prevalence rate of $S. haematobium$ and $S. mansoni$ across the country, indicating the latter to be highly endemic [16]. There is a high prevalence of $S. mansoni$ in Jonglei, Western Equatoria and the Lakes States and $S. haematobium$ in Jonglei, Unity and Western Equatoria States. Higher co-infection has been observed in Jonglei State. The parasitic intensity was light across the eight states, with heavy intensities observed more for $S. haematobium$ than $S. mansoni$. Jonglei and the Western Equatoria States had co-infection of the two Schistosoma parasites [16]. Our findings showed the schistosomiasis burden in the central and southwestern regions of the country is high. The persistence of schistosomiasis’s high prevalence rate over the years indicates that no control or elimination measures are being implemented [16]. In Africa, the prevalence of human schistosomiasis is dependent on the level of environmental sanitation, the suitability of the area for the intermediate snail hosts, and the type of the snails. In South Sudan, this has been exacerbated by political conflict negatively impacting the country’s socio-economic status and funding for preventing and controlling infectious diseases such as schistosomiasis [17]. Previous surveys of 2010 showed a constantly lower prevalence of $S. haematobium$ compared to previous surveys [18, 19, 20]. Nonetheless, the rapid decline in prevalence rate requires further research to verify these findings and assess the contributing factors at length.

Previous schistosomiasis predictive maps for South Sudan suggested a high prevalence rate of $S. haematobium$ in Greater Bahr El Ghazal between 10-25% and the Equatoria States at ≤5%, and findings of a non-endemic Western Bahr El Ghazal and low prevalence rate of 0.5% in Western Equatoria [21]. While the surveys of 2009 found a prevalence rate of 3% in Northern Bahr El Ghazal [9]. Deganello in 2007 reported the presence of $S. mansoni$ mainly in Central Equatoria, with a national prevalence of both species between 10-25% again. This is inconsistent with our observed findings which are relatively lower with an overall prevalence rate of 7.9% (7.3-8.3% at 95% confidence interval) [22]. However, the conclusions of Jonglei were consistent with the predicted low prevalence of <5%. Overall, the current state-level data indicates an uneven distribution throughout the country, with a few previously thought-to-be highly endemic places found to be lowly or non-endemic.

The prevalence of schistosomiasis from the initial prevalence rate surveys and our study is not surprising as no sustainable control measures were instituted. An alarmingly (very high) prevalence rate of schistosomiasis was observed in Bor South, where schools recorded over 90% site prevalence rates. This high prevalence could be attributed to the long-running civil war that has devastated social and health services in the area and the presence of the schistosoma, intermediate host, and freshwater bodies. The high prevalence was seen in Bor South, Ibba, Ezno, Awerial, Nagero, and Old Fangak were comparable to other focal prevalence rate surveys in East African countries, Madagascar, Egypt, and the Democratic Republic of Congo, an indication of the high burden of schistosomiasis in South Sudan and many parts of the Africa Region [21, 22]. Also, the observed high prevalence in rural areas compared to urban areas such as Wau may be attributed to inadequate sanitary facilities, contaminated water sources for domestic chores, bathing, and insufficient health education on the affected communities’ preventive measures. In some countries, urban infection is found in individuals due to urbanisation. This could be the assumption for the situation seen in Juba, the capital city of South Sudan in the state of Central Equatoria, where the prevalence is high [10]. Typically, if the intermediate host is not present in an area with schistosomiasis cases, it is easier to control through better chemotherapy, sanitation, and water access facilities [23].

Presently, chemotherapy is the most cost-effective approach to controlling schistosomiasis in the short term, but complimenting it with access to clean water and sanitation would help address the risk factors, reduce transmission, and have a broader impact on health. While the provision of water, adequate sanitation, and snail control are essential for schistosomiasis elimination, directing these interventions to selected high transmission areas would ensure a higher impact [4]. The study’s five sites per county is an innovative way to improve resource allocation for interventions to focal transmission. However, this is also a study limitation as some counties are enormous, and the five sites may not be represented precisely. The utilisation of WASH facilities through behavioural modification has been challenging in some countries despite being the best approach to managing health problems [3]. The communities require sufficient knowledge and attitude about schistosomiasis through health education in the endemic areas.

Preventive chemotherapy either school or community-based approaches have not shown significant differences in some countries following treatment [24]. Most children are exposed to similar conditions when they get home with inadequate WASH facilities. Therefore, most schistosomiasis treatment should be both community and school-based, with many children in communities. Treatment immediately after 12 months is vital because delayed repeat therapy may not suppress transmission due to persistent reinfections leading to reduced drug efficacy observed after one to three years [24]. Therefore, the state government should emphasise the need for additional non-drug control measures in highly endemic areas.

**Conclusion**

This study shows that schistosomiasis is endemic in South Sudan, with a moderate to high prevalence rate in most parts of the country. In these endemic communities we advise the national schistosomiasis control programme to implement the WHO recommendation of annual preventive chemotherapy with a single dose of praziquantel at 75% treatment coverage in all the age groups from 2 years. The treatment should include pregnant women in the second and third trimester, lactating women and adults. In the low endemic communities, the test and treat approach is recommended. The low parasitic intensity for both species in South Sudan is an indication that with suitable interventions, the prevalence of infection in the affected population can reduce to elimination levels. The study has generated crucial epidemiological baseline information and indicators which could guide policy formulation, monitoring, and evaluation of interventions. Heightened health education to reduce contact with contaminated water and access to safe water, sanitation, and hygiene plus environmental interventions including snail control with molluscicides should be complementary measures to reduce the prevalence and burden of schistosomiasis. The effective implementation and monitoring of these strategies will interrupt transmission and eliminate schistosomiasis in South Sudan. The verification for the interruption of transmission should use diagnostics with high sensitivity and specificity.

**What is known about this topic**

- Although schistosomiasis is endemic in South Sudan, the geographic distribution of the disease is unclear;

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• The superior sensitivity of circulating cathodic antigen over KK in the detection of the S. mansoni circulating cathodic antigen.

**What this study adds**

- This study provides information on the prevalence and distribution of schistosoma infection in South Sudan;
- The younger children are at higher risk of S. mansoni infection;
- Key recommendations for scaling up effective and integrated public health measures for prevention and control of schistosomiasis including treatment of the pre-school age children;
- Malaria prevention practices are sub-optimal compared to the national targets.

**Competing interests**

The authors declare no competing interests.

**Authors’ contributions**

MNS and KKB conceived and wrote the first draft of the manuscript. KKB and MNS conducted the data analyses. OOO, MNS and KKB provided insights into the study's conceptualisation and conducted an extensive review of all manuscript drafts. All authors read and provided significant inputs into all drafts of the manuscript, agreed to be accountable for all aspects of the work and approved the final draft of the manuscript for publication.

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