Update on the Status of urogenital schistosomiasis in Some Communities of Ebonyi State, Nigeria

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ABSTRACT

Background: Schistosomiasis is one of the most common parasitic infections in the world, particularly in sub-Saharan Africa, ranking second only to malaria in terms of its socio-economic and public health importance in tropical and subtropical areas. There is an urgent need for updated information on the intensity of the disease at the community level to ensure effective disease monitoring.

Materials and methods: The study was carried out in sixteen communities in the four local government areas of Ebonyi State. A total of 1,800 urine samples were collected from people of all ages randomly selected for this study. Urine samples were examined for Schistosoma haematobium egg using the standard parasitological method of diagnosis. Haematuria was evaluated using reagent test strips.

Results: In this study, 342 (19.0%) persons were infected with S. haematobium. The infection was recorded in all the Communities in the study area, with Enyibichiri having the highest prevalence, n=39 (32.2%), followed by Umuoghara, n = 26 (25.5), while Oshugbu Community had the least prevalence, 5 (6.6%). More males, 225 (20.3%) than females, 117 (16.9%) were significantly infected. Infection prevalence was higher significantly (27.3%) among the age group 11-20 years. Those with light infection intensity 207 (60.5%) were excreting below 50 eggs/10ml urine, 110 (32.2%) had moderate infection intensity excreting between 50-100 eggs/10ml urine while 25 (7.3%) had heavy infection intensity excreting above 100egg/10ml urine. Peak intensity 14 (10.2%) was recorded among 11-20 egg groups. Prevalence of light and moderate intensities varied significantly (P<0.05) when compared with the prevalence of heavy infection in different age groups, which was not significantly different (P> 0.05). The prevalence of haematuria was 188 (55.0%). The highest prevalence of haematuria (86; 62.3%) was recorded in the age group 11-20 years, while the least was recorded in age 31-40.

Conclusion: Based on the findings of this study, the prevalence of urinary schistosomiasis infection in the Central Ebonyi State falls within the WHO classification of endemicity. Urgent need for decisive interventions through mass chemotherapy, focal application of molluscsides in the water bodies during the dry season and sanitation facilities are recommended. Health education is highly advocated.

Keywords: Schistosoma haematobium, Prevalence, Infection intensity, Haematuria, Nigeria.
1. INTRODUCTION

Schistosomiasis, also known as Bilharziasis, is a parasitic disease caused by infection from one of the parasitic trematodes (Flukes) of the genus Schistosoma (Abebe et al., 2014). The worm was discovered by Theodore Bilharz (a German pathologist) while performing an autopsy in Cairo-Egypt (WHO, 2012). Weinland coined the name Schistosoma to reflect its shape, which is a cleft (Shisto) and body (Soma). The disease is now commonly known as Schistosomiasis or Bilharziasis, as suggested by [3]. It is one of the most common parasitic infections in the world [4], particularly in sub-Saharan Africa, ranking second only to malaria in terms of its socio-economic and public health importance in tropical and sub-tropical areas [5]. It has been estimated that Schistosomiasis occurs in 77 countries of Africa, the Middle East, India, and South and Central America and that more than 237 million people in tropical and sub-tropical regions are infected by the disease [2,6].

Schistosoma belongs to the class Trematoda, phylum Platyhelminthes, order Strigeatoidea and family Schistosomatidae [2]. These flukes have certain features in common; they are dioecious, their sexes are separate, and they exhibit sexual dimorphism [7]. The thicker male carries the slender female in a groove called the gynaecephoric canal [8]. They have aquatic snails of various genera as their intermediate hosts. The distribution of the snails coincides with the geographical distribution of the diseases [9]. Man serves as the definitive host of S. haematobium. Among the species of Schistosoma, S. haematobium is the most widely spread [10]. S. haematobium, which causes urinary Schistosomiasis, is more prevalent in Nigeria than intestinal Schistosomiasis due to the broader distribution of its snail host, Bulinus species [11]. This is in addition to the indiscriminate passing of urine containing S. haematobium eggs into water supplies containing the snail intermediate host [12]. Knowledge of exposure to infection patterns is essential in understanding the epidemiology of Schistosoma haematobium infection [7]. Transmission of S. haematobium is focal and usually depends on the presence of a compatible snail intermediate host of the parasite and human contact with the infected water [13]. The purpose of human water contact studies is to observe who in a study population visits natural water bodies, the purpose of visits, the site of contact, when and duration of contact, and finally, the type of exposure [14].

Urinary Schistosomiasis occurs in all the States of Nige-
the country, primarily because the disease is mainly a rural occupation disease that affects people engaging in agriculture activities and other people residing in rural and semi-rural areas area [24]. There is a high risk of people becoming infected due to low literacy levels, poverty, sub-standard hygiene and inadequate public infrastructures [9]. The principal objective is to ascertain the epidemiology of *S. haematobium* infection and its transmission patterns in Central Ebonyi State, Nigeria. This study was also designed to provide updated information on the extent of the disease burden among people of all ages in the rural communities at risk in the Central Senatorial Zone of Ebonyi state. It is hoped that the result from this study will add to the existing baseline data on the endemcity of this disease in the country.

2.0 METHODS

2.1 Study Area

The study was conducted in four local government areas (LGAs) (Ishielu, Ezza South, Ezza North and Ikwo) of Ebonyi State. The study area covers a total land area of 3,364 km² (Uneke, 2011) with a population of 578,604 people. The study area lies between latitudes 6°00'N - 6°45’N and longitudes 7°45’E - 8°15’E. The area's climate is tropical and the vegetation characteristics are predominantly the Guinea savannah with an average annual rainfall of about 1,300 mm and average atmospheric temperature of 30°C between June and December but rises from 31 – 35°C between January and April (Uneke, 2011).

2.2 Selection of Communities

Sixteen Communities were selected out of the forty-seven Communities in the four LGAs. Four Communities were selected randomly from the list of communities in each LGA. These communities are: Ikwo LGA (Alike-Ikwo, Enyibichiri, Nchionu and Echara), Ezza South LGA (Amagu, Amuzu, Ohaigbo, and Oshugbu), Ezza North LGA (Igweledeoha, Ogboji, Umughara and Umuome) and Ishielu LGA (Agba, Ntezi, Ohoffia and Okpoto).

2.3 Ethical clearance

Before the commencement of the study, permission to sample the communities was obtained from the Ebonyi State Ministry of Health, Abakaliki. Informed consent was obtained from the traditional rulers of the studied communities and village heads of the sixteen communities sampled.

2.4 Study Population

Individuals of all age groups living in the sixteen randomly selected communities within the study area that consented were included in this study.

2.5 Study design

A total of four (4) communities each were randomly selected from the list of communities in four (4) LGAs in Ebonyi state, totalling sixteen communities.

2.6 Sample Size Determination

The required sample size was determined using single population proportion formula and assuming a 58.1% proportion of urinary schistosomiasis from previous study by [4].

\[
\begin{align*}
n &= \frac{Z^2 \times p(1\mathchar`-p)}{e^2} \quad [26].
\end{align*}
\]

\[
\begin{align*}
e^2 n &= \frac{Z^2 \times p(1\mathchar`-p)}{e^2} \quad [26].
\end{align*}
\]

\[
\begin{align*}
n &= \text{minimum sample size}
\end{align*}
\]

\[
\begin{align*}
Z &\quad \text{is the confidence level (} Z = 1.96 \text{ for 95%)}
\end{align*}
\]

\[
\begin{align*}
E &\quad \text{is the desired margin of error (0.05)}
\end{align*}
\]

\[
\begin{align*}
P &= \text{proportion of schistosomiasis in the population from previous study} = 58.1\% = 0.581
\end{align*}
\]

\[
\begin{align*}
n &= \frac{1.96^2 \times 0.581(1 \mathchar`- 0.581)}{0.052}
\end{align*}
\]

\[
\begin{align*}
&= \frac{3.8416 \times 0.581 \times 0.419}{0.0025}
\end{align*}
\]

\[
\begin{align*}
&= \frac{0.9351952624}{0.0025}
\end{align*}
\]

\[
\begin{align*}
&= 374.08
\end{align*}
\]

\[
\begin{align*}
n &\sim = 374
\end{align*}
\]

A total of 1800 individuals, comprising of 1108 males and 692 females were selected randomly from the study communities. A higher sample size of 1800 was collected to reduce error.

2.7 Sample collection

Preliminary visits were made to the studied communities to brief the traditional rulers and village heads on the study's purpose, methods, and possible outcome Participants were randomly selected from the communities. Samples were obtained only from participants that consented to the study. All participants were given identification numbers. Each respondent was given a 25 ml wide-mouth, clean, dry, and screw-capped plastic container (bottles) for urine collection. The participants were advised to collect only terminal urine samples as these are
known to contain the highest number of eggs [27]. These 10 ml urine samples were collected daily between 9:00 am and 2:00 pm after physical exercise and fluid intake. This corresponded to the period of peak urinary schistosome egg secretion [14]. The samples collected were numbered serially by their name, age and sex. The urine samples collected were preserved in 1% formalin, transported to the laboratory, and analysed within two hours to avoid hatching of ova of Schistosoma haematobium.

2.8 Questionnaire administration

A pre-tested and structured questionnaire was designed to obtain demographic information of the study participants, such as; community name, age, sex, occupation, haematuria (visible) and water contact activities of the respondents. The participants were also asked about their previous knowledge of the infection.

2.9 Laboratory analysis

Sample bottles were retrieved and transported to the Post-graduate Laboratory, Department of Zoology and Environmental Biology, University of Nigeria, Nsukka. Five drops of 1% formalin were added to each urine sample to preserve the eggs, thus, preventing the eggs of the parasite from hatching.

The prevalence of haematuria was determined using commercial reagent strips (Medi-test combur-9; Analyticon Biotechnologies, Lichtenfels, Germany). Following the manufacturer’s instructions, each strip was briefly dipped into each fresh, stirred 10 ml urine sample, waited for about 60 seconds and then colour changes observed on the strip were read by comparing with a colour scale on the container [28].

The intensity of the infection was determined by examining for ova in 10 ml urine using the centrifugation method [29]. 10ml of urine samples was poured each into the test tubes, the tubes were placed in the centrifuge buckets, and the centrifuge lid was firmly closed. Centrifugation was set at one thousand revolutions per minute (1,000 rpm) for 5 minutes. After centrifugation, the supernatants were discarded. A drop of the deposits at the bottom of the tubes was placed on a clean grease-free slide using a wire loop and gently covered with a slip to avoid air bubbles. The slide was examined for egg count using x10 and x40 objectives to determine the intensity of the infection [30].

2.10 Malacological survey

The intermediate host was sampled at selected water contact sites for 10 months (July 2019 through April 2020) to estimate Schistosoma haematobium. At each site, sampling was carried out using a standard long-handled rectangular scoop net designed to WHO [2] specification. The net was lowered into the water, and then scoops were taken, dragging along the on-shore direction towards the bank, collecting even emergent vegetation for snail search. The snail identified as an intermediate host of Schistosoma haematobium was checked for cercariae shedding. Snails which do not shed any human type Schistosome bifid cercariae within the interval of exposure were labelled as not being infected. Availability of cercariae was used to identify the periods of the year when human populations are at the most significant risk of acquiring urinary Schistosomiasis.

2.11 Data analysis

All the data obtained were analysed using Statistical Package for Social Sciences (SPSS) software version 21.0. The relationship between the prevalence and intensity of the infection and various parameters obtained from the questionnaires, such as village name, age, sex, occupation, and water contact activities, were analysed. Chi-square test ($\chi^2$-test) and correlation analysis were used to compare the parameters. P-value less than 0.05 (P<0.05) was considered significant.

3. RESULTS AND DISCUSSION

3.1 Prevalence of Schistosoma haematobium Infection

The overall prevalence of Schistosoma haematobium infection in this study was 342(19.0%). Prevalence ranges from 5(6.6%) at Oshugbu to 39(32.2%) at Enyibichiri (Table 1). A comparison of the prevalence of S. haematobium among the communities revealed a statistically significant difference ($\chi^2$ =47.659, p <0.001) (Table 1).

3.2 Sex-specific prevalence of S. haematobium Infection in Ebonyi Communities

In this study, a total of 1108 males and 692 females were examined for the presence of S. haematobium eggs. In males, an overall prevalence of 225(20.3%) was observed, with prevalence ranging from 4(6.5%) at Nchionu to 28(32.6%) at Enyibichiri. A comparison of the prevalence of this parasite among males revealed a statistically significant difference ($\chi^2$ =37.638, p=0.001). For females, an overall prevalence of 117(16.9%) was recorded, with the lowest and highest prevalence of 2(4.9%) and 11(31.4%) observed at Oshugbu and Enyibichiri.
respectively (Table 1). No statistically significant difference in the prevalence of *S. haematobium* was recorded amongst female subjects across the communities ($\chi^2 = 19.433, p=0.195$).

### 3.3 Age-Specific Prevalence of *S. haematobium* Infection in Ebonyi Communities

According to the age groups, the highest prevalence of 138(27.3%) was recorded in the age group of 11-20 years, followed by the age group of 0-10 years with a prevalence of 93(21.0%). The prevalence among the age groups ranges from 24(8.6%) to 138(27.3%) in the age groups of 31-40 years and 11-20 years, respectively. A comparison of prevalence among the age groups revealed a statistically significant difference ($\chi^2 = 49.568, p<0.001$) (Table 2).

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>NE</th>
<th>NI (%)</th>
<th>$\chi^2$</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>444</td>
<td>93 (21.0)</td>
<td></td>
<td>15</td>
<td>0.001*</td>
</tr>
<tr>
<td>11-20</td>
<td>505</td>
<td>138 (27.3)</td>
<td></td>
<td>15</td>
<td>0.195</td>
</tr>
<tr>
<td>21-30</td>
<td>389</td>
<td>63 (16.2)</td>
<td></td>
<td>15</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>31-40</td>
<td>279</td>
<td>24 (8.6)</td>
<td></td>
<td>15</td>
<td>0.958</td>
</tr>
<tr>
<td>41-50</td>
<td>147</td>
<td>19 (12.9)</td>
<td></td>
<td>15</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>51+</td>
<td>36</td>
<td>5 (13.9)</td>
<td></td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1800</td>
<td>342 (19.0)</td>
<td></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

**NE**– Number examined, **NI**– Number infected, $\chi^2$ = Chi-square, * = significant difference at $p <0.05$.

### 3.5 Intensity of Infection in relation to age

Table 4 describes the intensity of urinary schistosomiasis among the infected individuals of Central Ebonyi State, Nigeria. The light intensity of infection (60.5) was observed to be higher than moderate intensity (32.2) and...
Table 3: Sex-Age Related Prevalence of *S. haematobium* Infection in Ebonyi Communities

<table>
<thead>
<tr>
<th>Age Groups (Years)</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NE</td>
<td>NI (%)</td>
<td>NE</td>
</tr>
<tr>
<td>0–10</td>
<td>270</td>
<td>58 (21.5)</td>
<td>174</td>
</tr>
<tr>
<td>11–20</td>
<td>317</td>
<td>97 (30.6)</td>
<td>188</td>
</tr>
<tr>
<td>21–30</td>
<td>241</td>
<td>42 (17.4)</td>
<td>148</td>
</tr>
<tr>
<td>31–40</td>
<td>160</td>
<td>12 (7.5)</td>
<td>119</td>
</tr>
<tr>
<td>41–50</td>
<td>94</td>
<td>14 (14.9)</td>
<td>53</td>
</tr>
<tr>
<td>51+</td>
<td>26</td>
<td>2 (7.7)</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1108</strong></td>
<td><strong>225 (20.3)</strong></td>
<td><strong>692</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>χ²</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>42.690</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>12.538</td>
<td>0.028*</td>
</tr>
<tr>
<td>49.568</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

NE – Number examined, NI – Number infected, χ² = Chi-square, * = significant difference at p <0.05.

Table 4: Age-related Intensity (No. of eggs/10 ml urine) of *Schistosoma haematobium* Infection in the Study Area

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>NE</th>
<th>NI (%) with <em>S. haematobium</em></th>
<th>Light Infection n(%) &lt;50 eggs</th>
<th>Moderate Infection n(%) 50–100 eggs</th>
<th>Heavy Infection n(%) &gt;100 eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10</td>
<td>444</td>
<td>93 (83.9)</td>
<td>78 (10.8)</td>
<td>5 (5.4)</td>
<td></td>
</tr>
<tr>
<td>11–20</td>
<td>505</td>
<td>138 (57.3)</td>
<td>48 (10.2)</td>
<td>14 (9.5)</td>
<td></td>
</tr>
<tr>
<td>21–30</td>
<td>389</td>
<td>63 (85.9)</td>
<td>41 (16.2)</td>
<td>6 (19.0)</td>
<td></td>
</tr>
<tr>
<td>31–40</td>
<td>279</td>
<td>24 (14.9)</td>
<td>19 (7.3)</td>
<td>4 (8.0)</td>
<td></td>
</tr>
<tr>
<td>41–50</td>
<td>147</td>
<td>19 (25.4)</td>
<td>17 (20.0)</td>
<td>2 (10.5)</td>
<td></td>
</tr>
<tr>
<td>51+</td>
<td>36</td>
<td>5 (9.5)</td>
<td>4 (5.4)</td>
<td>1 (20.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1800</strong></td>
<td><strong>342 (60.8)</strong></td>
<td><strong>207 (110.5)</strong></td>
<td><strong>110 (25.3)</strong></td>
<td><strong>25 (7.3)</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>χ²</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.852</td>
<td>5</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>119.931</td>
<td>5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>14.952</td>
<td>5</td>
<td>0.011*</td>
</tr>
</tbody>
</table>

NE – Number examined, χ² = Chi-square, * = significant difference at p <0.05.

3.6 Haematuria in relation to age

The haematuria distribution in different age groups in the communities surveyed is shown in table 5. Of the 342 persons infected, 188 (55.0%) were positive for haematuria. The highest prevalence of haematuria was observed in the age group of 11–20 years (86(17.0%)), followed by the age group of 0–10 years (54(12.2%)), while the least prevalence was in the age group of 31–40 years (6 (2.2%)). A highly significant difference was observed among the age groups (χ² = 54.919, p<0.001).

3.7 Variation of contact behaviour by age and sex

The water contact behaviour in the sampling sites by age and set is shown in table 6. It was observed that the number of males who made contact with the water was significantly more than the number of females (p<0.001), and the duration of contact was also significantly higher in males than in females. The contact rate was observed to increase from age group 0–10 years and peaked in the age group 11–20 years, after which it declined to five in the age group older than 50 years. A total of 17 persons in the age group 0 to 10 years had to contact with the water, with a peak increase to 100 persons for the age group 11–20 years. However, only five persons within the age group older than 50 years had contact with water. Chi-square analysis showed a significant difference in the transmission of the infection in both males and females (p<0.001).

3.8 Water contact activities in relation to sex

The distribution of the infection between males and females with water contact activities is shown in table 7. It was observed that the prevalence of the infection was higher (28.2%; n=88) among people who engage in recreational activities, followed by those who go to the water for economic purposes (16.6%; n=89), then by those who go to the water sites for personal activities (17.4%; n=77) while the least prevalence was observed among those who visit the water sites for domestic purposes (17.3%; n=88). However, personal and economic activities were the prin-
A total of 309 species of fresh water snails (excluding S. haematobium) were collected from water bodies in the study area. 

**Table 6:** Age- and sex-related pattern of human water contact at Central Ebonyi State between July 2018 and April 2019.

<table>
<thead>
<tr>
<th>Age Group (Years)</th>
<th>Total contacts</th>
<th>Total duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>0-10</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>11-20</td>
<td>61</td>
<td>39</td>
</tr>
<tr>
<td>21-30</td>
<td>37</td>
<td>23</td>
</tr>
<tr>
<td>31-40</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>41-50</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>51+</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>154</td>
<td>78</td>
</tr>
</tbody>
</table>

**Table 7:** Sex- related prevalence of Schistosoma haematobium infection due to water contact activities in Central Ebonyi State (July 2018 - April 2019)

<table>
<thead>
<tr>
<th>Water contact activities</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Examined</td>
<td>Number Positive (%)</td>
<td>Number Examined</td>
<td>Number Positive (%)</td>
</tr>
<tr>
<td>Irrigation</td>
<td>303</td>
<td>46(15.2)</td>
<td>232</td>
</tr>
<tr>
<td>Fishing</td>
<td>183</td>
<td>55 (30.1)</td>
<td>129</td>
</tr>
<tr>
<td>Washing</td>
<td>229</td>
<td>43 (18.8)</td>
<td>214</td>
</tr>
<tr>
<td>Swimming</td>
<td>261</td>
<td>52 (14.5)</td>
<td>249</td>
</tr>
<tr>
<td>Total</td>
<td>964</td>
<td>196 (20.3)</td>
<td>836</td>
</tr>
</tbody>
</table>

**Table 8:** Schistosome infection rates of fresh water snails collected from water bodies in the study area.

<table>
<thead>
<tr>
<th>Snail species</th>
<th>No. of snails collected</th>
<th>No. Of snails infected (% of the total count)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulinus globosus</td>
<td>48</td>
<td>11 (22.9)</td>
</tr>
<tr>
<td>Bulinus truncatus</td>
<td>61</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Lymnaea natalensis</td>
<td>73</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Bulinus forskali</td>
<td>59</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Lanistis varicus</td>
<td>64</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Total</td>
<td>309</td>
<td>11 (3.6)</td>
</tr>
</tbody>
</table>

3.9 Snail vector investigation

The distribution of aquatic snails in the central Ebony state according to water bodies and months of collection is summarized in table 8. During the snail collection, various types of snails were collected from water bodies in the study area. The species collected include Bulinus globosus, Bulinus truncatus, Bulinus forskali, Lanistis varius, and Lymnaea natalensis. A total of 309 species of different snails were collected at the river, streams and pond contact sites during the study period from 9 out of 10 water sites sampled. Of these, 48 snails were infected or found to be shedding human schistosome cercariae that cause urinary schistosomiasis.

3.10 Monthly and seasonal transmission potentials of Schistosoma haematobium in central Ebonyi State, Nigeria, water contact sites.

Table 9 shows monthly and seasonal transmission potentials of Schistosoma haematobium based on the number of infected Bulinus globosus and cercariae output in central Ebonyi State, Nigeria, water contact sites. From July through December (2019), 7 (21.9%) of the 32 Bulinus
Bulinus globosus discovered at the same water sites shed human infective cercariae for *Schistosoma haematobium* infection. From January to April (2020), 16 *Bulinus globosus* were collected, out of which 4 (25.0 %) were infected. The monthly and seasonal infection rates of *Schistosoma haematobium* in Bulinus were combined with the transmission potentials. There were variations in the monthly total of infected snails; the highest number of infected snails (3) was obtained in December (60.0%) in the dry season, followed by March (50.0%), while no infection was seen in the snail for September, October, November, and February. Generally, there was a low level of snail infection in July (12.5%) and August (20.0%). Infection of snails differed significantly in different water sites (\(P<0.05\)).

In conclusion, this study has reconfirmed the endemicity of urinary schistosomiasis in Central Ebonyi state, Nigeria. Also, the study revealed decreased prevalence from 33.81% previously in Ebonyi Central, as observed by Ogochukwu [31], to 19.0%, which falls within the WHO endemicity classification [2]. This study provides updated information on the decreased burden of urinary schistosomiasis in Central Ebonyi State, Nigeria.

The present study supports several previous reports in this geographical region where the prevalence of 15.3%, 15.3% and 11.0% were observed by Ezeagwuna [32], Ivokeetal. [19] and Unekeetal. [30], respectively, which have consistently shown that *Schistosoma haematobium* infection endemicity in Central Ebonyi state, Nigeria is on the decrease. The prevalence observed in this study was lower than the prevalence of 24.2%, 25.5%, 33.8% and 22.1% observed in different studies across the Eastern part of Nigeria by Mbata [17], Oyibo etal. [33], Ogochukwu etal. [31] and Anosike etal. [27] respectively. The decrease in the prevalence of the disease (as observed in the present study) may be attributed to the reduction in water contact activities due to health education and personal hygiene promotion across the communities.

Variations in prevalence might be due to poverty, ignorance, inadequate sanitation and water supplies, and deplorable personal and environmental hygiene characteristics of many rural communities in Nigeria and other developing tropical countries, identified as important factors contributing to the increase in transmission of schistosomiasis [2].

Although there were variations in prevalence across the region, all the prevalence was within the WHO recommendation for annual deworming. A higher Prevalence of infection was observed among males (20.3%) than females (16.9) with a significant difference of \(\chi^2 = 42.690; P< 0.001\) and \(\chi^2 =12.538; P< 0.028\) respectively. A similar prevalence was observed by Babatunde et al. (2013) in Southwest Nigeria, where males had a significantly higher prevalence of 20.7% than females (7.6%).

### Table 9: Monthly and seasonal transmission potentials of *Schistosoma haematobium* based on number of infected *Bulinus globosus* and cercariae output in water contact sites of central Ebonyi State, Nigeria.

<table>
<thead>
<tr>
<th>Years Months</th>
<th>No. of <em>B. globosus</em> collected</th>
<th>No. infected (a)</th>
<th>Infected Rate (%)</th>
<th>Mean No of cercaria shed/snail/day (b)</th>
<th>Total cercaria output (a×b)</th>
<th>Monthly transmission Potential</th>
<th>Seasonal transmission potential (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly 2019</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
<td>14 ± 5</td>
<td>14</td>
<td>7.5</td>
<td>Rainy season</td>
</tr>
<tr>
<td>August</td>
<td>10</td>
<td>2</td>
<td>20.0</td>
<td>18 ± 2</td>
<td>36</td>
<td>19.5</td>
<td>26.8</td>
</tr>
<tr>
<td>September</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>October</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>November</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>December</td>
<td>5</td>
<td>3</td>
<td>60.0</td>
<td>22 ± 5</td>
<td>66</td>
<td>35.3</td>
<td>Dry season</td>
</tr>
<tr>
<td>January 2020</td>
<td>3</td>
<td>1</td>
<td>33.3</td>
<td>16 ± 3</td>
<td>16</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>6</td>
<td>3</td>
<td>50.0</td>
<td>14 ± 2</td>
<td>42</td>
<td>22.5</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>4</td>
<td>1</td>
<td>25.0</td>
<td>19 ± 1</td>
<td>19</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>11</td>
<td>22.9</td>
<td>187</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\chi^2\) 14.647  
\(p\)-value 0.002

\(|n|\) represents number of Bulinus globosus collected; \(|a|\) represents number positive; \(|b|\) represents mean number of cercaria shed; \(|\chi^2|\) represents chi-square; significant difference (\(p<0.05\)).
Findings of this study revealed that *Schistosoma haematobium* infection was strongly correlated with gender, with boys being more heavily infected than girls. This conforms with other findings by Kenneth et al. [3] in Obudu local Government, Cross River State and Abebe et al. [1] in Northern Ethiopia. This could be due to socio-cultural and religious factors that expose males to more chore activities at the infested water bodies, such as fishing, swimming, washing and bathing, thereby increasing their rate of exposure to infection. Further, the study observed that females were restricted socially from water contact activities such as swimming and bathing in water bodies. This contrasts with Ekwunife et al. [22] in Ndokwa East Local Government, Delta State, which observed that sex played no significant role in *Schistosoma haematobium* distribution because of similar water contact activities by both sexes. Therefore, persons who have more significant contact with the breeding foci have a higher prevalence of the disease, irrespective of the sex of the individual [25,34].

The age-related prevalence may be attributed to the frequency and duration of contact with the water and the nature of the water-contact activities at the index site [3]. In this study, the high prevalence observed among the 11-20 years age group (27.3%) could be attributed to the fact that young people are more engaged in unrestrained water contact activities such as swimming, fishing and bathing that expose them to cercariae contaminated water bodies [35] which is similar to a report by Ozowara et al. [24] in Ezza South Local Government, Ebonyi State, who reported a higher prevalence among the age group 10 – 14 years. Okon et al. [36] and Ogochukwu et al. [31] also observed similar reports among 12 – 18 years and 10 – 20 years of age groups, respectively. This contrasts with Ekwunife et. al. [22] and Mbah and Useh [37], who reported a higher rate among the age groups 5 – 9 and 21 – 30 years, respectively.

The findings of this study showed higher light intensity (60.5%) of infection among the age group 41 – 50 years who excreted below 50 eggs/10ml urine when compared with moderate intensity (32.2%) of infection among the age group 11 – 20 years who excreted between 50 – 100 eggs/10ml urine while heavy intensity (7.0%) of infection was observed among 11 – 20 years age group who excreted above 100 eggs/10ml urine. This conforms with the report by Amuta and Houmsou [38] in the Guma Local Government Area of Benue State, Nigeria. The World Health Organization [2] set a threshold egg intensity of >50 eggs/10ml urine to indicate the risk of *Schistosoma haematobium* morbidity at the level of the individual.

Haematuria, often associated with schistosomiasis, has often been regarded as an important marker for diagnosing the disease [35]. The high prevalence of haematuria (55.0%) observed among the infected persons in this study was quite significant; this rate may change over time with its attendant pathological damages if not treated early. This finding is in line with Clement et al. [39] and Ozowara et al. [24], who reported a significant relationship between haematuria and the presence of urinary Schistosomiasis. Haematuria in this study showed a similar age prevalence pattern as individuals in age group 11-20 years presented higher (62.3%) haematuria, which decreased with an increase in age, a phenomenon attributed to the waning of egg hypersensitivity with age [9].

Personal and economic activities were the principal activities of both males and females and are therefore considered risk factors [17]. This study observed that the recreational contacts were mostly recorded during the dry season when the water level was low. This is attributed to the high risk of water levels during the rainy season, which scares people from going to water sites for their water-related activities for fear of being drowned. So, people perform their central water related activities at home during the rainy season with harvested rainwater leaving them with little or no reason to go to the stream. The report from this study is an indication that school children, teenagers and young adults are the populations at risk of schistosomiasis in the study area. This study's pattern of seasonal variation suggests that transmission occurs more in the dry season. Considering the prevalence observed in the study area, it showed that urinary schistosomiasis is still a disease of public health importance in Central Ebonyi State. Therefore, more research focusing on vector control should be carried out in this area. Similarly, the presence of haematuria among the infected individuals calls for mass chemotherapy in the communities. Health education should be encouraged within communities and schools to discourage people from bathing, swimming and washing in contaminated water. To achieve this, the government should provide potable water such as bore-holes and pipe-borne water in the communities to reduce contact with the contaminated water.

**Conflicts of Interest**

The authors declare no competing interests.
Authors’ Contributions

NCJ conceived and designed the study, contributed to laboratory analysis, data analysis tools, and statistical analysis and drafted the manuscript. Nl conceptualised the work. KNO contributed review of the manuscript. NDE contributed to the review of the manuscript and statistical analysis. All authors approved the final copy of the manuscript.

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