Short Communication

Prevalence of *Schistosoma haematobium* Infection among Schoolchildren in Remote Areas Devoid of Sanitation in Northwestern Swaziland, Southern Africa

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SUMMARY: A parasitological survey of *Schistosoma haematobium* infection among primary schoolchildren in the remote areas of Hhohho and Manzini Provinces in northwestern Swaziland was undertaken. Presence of infection in subjects was confirmed on detection of *S. haematobium* ova in urine or the presence of hematuria. The intensity of the infection was estimated by calculating the total number of *S. haematobium* ova present in a 10-ml urine specimen and was expressed in terms of geometric mean intensity (GMI). The prevalence of *S. haematobium* infection in these populations was 5.3% (21/395) with a GMI of 46.5. Boys had higher prevalence (7.1%, 13/182) and GMI (50.4) than girls (3.8%, 8/213; 40.0) did (P > 0.05). Geographically, the prevalence in Manzini schoolchildren (14.6%, 12/82) was significantly higher than that in Hhohho schoolchildren (2.9%, 9/313; P < 0.001); however, Hhohho schoolchildren had a higher GMI (70.2) than that observed in Manzini schoolchildren (21.9). Children from schools located in Lowveld had a significantly higher prevalence (11.4%, 19/166) than that in children from schools located in Highveld (0.6%, 1/162) (P < 0.0001).

Schistosomiasis transmitted by snails is a major health problem in tropical and subtropical countries, and the World Health Organization (WHO) estimates that there are more than 200 million cases of this disease, 93% of which occur in sub-Saharan Africa (SSA) (1). There are 2 major forms of schistosomiasis found in SSA. Approximately two-thirds of the schistosomiasis cases are a result of *Schistosoma haematobium* infection. Possible consequences of *S. haematobium* infection include hematuria, dysuria, nutritional deficiencies, lesions of the bladder, kidney failure, and an elevated risk of bladder cancer (1).

Primary schoolchildren are particularly vulnerable to schistosomiasis because of their habit of playing in water, where they may contract the infection. As such, they are the ideal target group to investigate the prevalence of schistosomiasis, and the data collected from this age group can be used to assess not only whether schistosomiasis threatens the health of schoolchildren, but can also be used as a reference for evaluating the need for community intervention (2–4).

*S. haematobium* has been endemic in the Kingdom of Swaziland (KS) for several decades, particularly in areas situated in the eastern Lowveld districts of the country (5). In previous surveys of *S. haematobium* infection among schoolchildren, Logan showed that the average infection rate was 61.2% between 1958 and 1964 (5). In KS, there are 3 main sources of information on schistosomiasis: records obtained from patients’ self-referral to the National Bilharzia Control Programme (NBCP), the school reporting system, and the routine health information system. Data from only the NBCP and primary schools in endemic areas are systematically collected and reported on a regular basis. However, the magnitude and impact of *S. haematobium* infection have not been well documented to date. Recently, we carried out a parasitological survey of *S. haematobium* infection among the inhabitants of remote districts devoid of sanitation in Lowveld Swaziland, and the overall prevalence of *S. haematobium* infection was 6.1% (18/295), with a prevalence of 6.4% (5/78) found in schoolchildren between the ages of 6 and 12 years (6). Nevertheless, the prevalence of *S. haematobium* infection among inhabitants in some of the remote districts located of northwestern KS, which are not covered by NBCP, remains unclear.

The present study aimed to investigate the prevalence...
of *S. haematobium* infection among primary schoolchildren in remote districts in northwestern KS, which are not covered by NBCP, to help the KS in evaluating whether a deworming program should be introduced in those districts.

Geographically, the KS is a highland country that can be divided from west to east into the following 3 regions on the basis of altitude: Highveld (−1,200 m), Middleveld (−600 m), and Lowveld (−250 m). According to recommendations of the NBCP, 4 primary schools situated in remote districts in northwestern KS were selected in the present study, including 3 schools located in the High- (school A), Middle- (school B), and Lowveld areas (school C), of the Hhohho Province as well as 1 school (school D) located in the Lowveld area of the Manzini Province (Fig. 1). These schools were selected on the basis that the areas in which they were located had poor sanitation, an unsafe water supply, and the absence of a deworming program. Primary schoolchildren (mean age ± standard deviation: 11.0 ± 0.5 years)
residing in the Hhohho and Manzini Provinces in northwestern KS were selected to participate in the study after informed consent was obtained from their parents/guardians. This study was carried out from July to August 2010, and ethical approval (Ref. No. MH 599B) for the study was obtained from the Ministry of Health and Social Welfare, KS.

In total, 395 urine samples were obtained from apparently healthy schoolchildren, including 182 boys and 213 girls. The mean ages were similar across genders (boys: 11.3 ± 0.4 years versus girls: 10.7 ± 0.4 years). A single terminal urine sample was collected from each participant between 1,000 and 1,400 h, when the maximum ova excretion reportedly occurs (7). Ten milliliters of each of the well-mixed urine samples was poured into a quantitative centrifuge tube used specifically for counting cells or parasites in urine (cat. no. ParaQ 6b; High Skill), and the number of urinary solution was placed into a counting chamber (cat. no. ParaQ 5b; High Skill Co., Chupei, Taiwan), and the samples were then centrifuged at 2,000 rpm for 3 min. The supernatant was discarded, but about 0.6 ml of residual urine was retained in the bottom of tube. Then, 50 μl of the urinary solution was placed into a counting chamber (cat. no. ParaQ 5b; High Skill), and the number of S. haematobium ova present in the chamber was counted under the microscope at 100 × magnification. Finally, the number obtained was multiplied by 12 to determine the total number of ova present in a 10-ml urine sample (6). The mean number of ova per 10 ml of urine present in all the positive samples was defined as geometric mean intensity (GMI), and any sample that contained less than 50 ova/10 ml was considered an indication of a mild infection; however, if the figure was equal to or less than 50 ova/10 ml was considered an indication of a significant infection among primary schoolchildren in northwestern KS. These numbers were much lower than those reported in studies conducted in schoolchildren in other African countries, including Nigeria (15.1% (9) and Mali (38.3%) (7) in West Africa; Tanzania (13.2%) in East Africa (3); Sudan (80.6%) in Northeastern Africa (10), and Zimbabwean (60.0%) (11) and South Africa (68%) (12) in Southern Africa. Moreover, the prevalence was also lower than that previously reported in schoolchildren in the northern or southeastern Lowveld of Swaziland conducted in 1983 (5) or 2009 (6) (19.5% or 10.2%, respectively).

Although positive cases in the present study were identified confirmed by the presence of ova in urine or gross hematuria, the actual overall prevalence may be underestimated because of the possibility that some infected individuals may not have been shedding eggs during the limited period when their urine samples were obtained, or they may present with microhematuria, which may not have been detected in the present study. Furthermore, early infection was predominantly observed in schoolchildren living in these areas due to the higher percentile of schoolchildren with S. haematobium infection presenting with gross hematuria opposed to ova in

Table 1. Prevalence with a GMI and crude ORs with 95% CI for Schistosoma haematobium infection among primary schoolchildren in Northwestern Kingdom of Swaziland, southern Africa

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean age (y) (S.D.)</th>
<th>No. (% of subjects)</th>
<th>GMI (95% CI)</th>
<th>ORs (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Examined</td>
<td>Ova</td>
<td>GH</td>
<td>Subtotal</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>10.7 (0.4)</td>
<td>213</td>
<td>3 (1.4)</td>
<td>5 (2.4)</td>
<td>8 (3.8)</td>
</tr>
<tr>
<td>Boys</td>
<td>11.3 (0.4)</td>
<td>182</td>
<td>5 (2.8)</td>
<td>8 (4.4)</td>
<td>13 (7.1)</td>
</tr>
<tr>
<td>Province</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Hhohho</td>
<td>11.0 (0.6)</td>
<td>313</td>
<td>3 (1.0)</td>
<td>6 (1.9)</td>
<td>9 (2.9)</td>
</tr>
<tr>
<td>Manzini</td>
<td>10.9 (2.4)</td>
<td>82</td>
<td>5 (6.1)</td>
<td>7 (8.5)</td>
<td>12 (14.6)</td>
</tr>
<tr>
<td>Altitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highveld</td>
<td>11.3 (0.6)</td>
<td>162</td>
<td>0 (0.0)</td>
<td>1 (0.6)</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Middleveld</td>
<td>10.9 (2.8)</td>
<td>67</td>
<td>1 (1.5)</td>
<td>0 (0.0)</td>
<td>1 (1.5)</td>
</tr>
<tr>
<td>Lowveld</td>
<td>10.9 (0.1)</td>
<td>166</td>
<td>7 (4.2)</td>
<td>12 (7.2)</td>
<td>19 (11.4)</td>
</tr>
<tr>
<td>All subjects</td>
<td>11.0 (0.5)</td>
<td>395</td>
<td>8 (2.0)</td>
<td>13 (3.3)</td>
<td>21 (5.3)</td>
</tr>
</tbody>
</table>

(1): Compared with the prevalence among the girls.
(2): Compared with the prevalence in Hhohho Province.
(3): Compared with the prevalence in Highveld.
GH, gross hematuria; ND, not determined.
urine. It has been indicated that in endemic areas, hematuria is a common early sign of *S. haematobium* infection in non-treated populations exposed to *S. haematobium*; microhaematuria has been found in 41-100% of the infected children, whereas gross hematuria was observed in 0-97% (1).

Interestingly, boys had higher infection rate than girls did as detected by both a greater number of ova excreted in urine and gross hematuria. This finding may be explained by an increased predisposition in boys to behaviors that expose them to the risk of infection, e.g. swimming or bathing (1). In addition, boys were found to have heavier infection loads (GMI 50.4). As a result, investigation into whether boys in these regions are more susceptible to impaired mental performance than girls are is urgently needed since substantial amounts of evidence have indicated that severe *S. haematobium* infection may lead to impaired growth and cognitive performance (13).

Unfortunately, we did not examine clinical syndromes of the genital-urinary system among the girls infected with *S. haematobium*. A possible association between schistosomiasis and HIV/AIDS is currently receiving increased attention, and substantial evidence has indicated that female genital schistosomiasis (FGS) caused by *S. haematobium* infection could be an important risk factor for the bidirectional transmission of HIV, on the basis of the unique clinical and immunological features that characterize the egg granuloma: frequent microscopic lesions in the vulva, vagina, and cervix of afflicted women (14). Furthermore, in a study undertaken in a rural Zimbabwean community, Kjetland et al. found that women with FGS had an almost 3-fold increased risk of having HIV infection (15). Since like many SSA countries, KS is severely affected by the HIV and AIDS pandemic (16), thorough systematic epidemiological studies are urgently required to detect and treat early FGS among Swazi girls with *S. haematobium* infection, with the hope that it might help to decrease the transmission of HIV due to FGS in KS.

We also found that a geographical difference in *S. haematobium* infection in schoolchildren exists between Lowveld and Highveld regions in northwestern KS. This discrepancy may be explained by the timing of the study: urine samples were collected during early winter in northwestern KS, which may have led to a decrease in the shedding efficiency of cercaria from the snail host or possibly the temperature was too low for the parasite to fully develop into snails in Highveld districts. Pitchford has already indicated that although Bulinus globosus, the snail host for *S. haematobium*, can be found in slow-moving or still water in Middlíveld and Lowveld regions of the KS, this snail host was barely detectable in Highveld, and in addition, *S. haematobium* was not transmitted in the Highveld, particularly in winter when the average temperature (~8.2°C) markedly reduced the development rate of the sporocysts in the snail. On the other hand, the Kamati and Mzimphdu Rivers, which flow through Middlíveld and Lowveld, have temperatures that are much more suitable for parasite development (20.4°C) (17). Thus, the geographical discrepancies may be explained by the possibility that children in Lowveld Hhohho and Manzini are particularly highly susceptible to *S. haematobium* infection through contact with water contaminated by cercaria, thus leading to increased prevalence of newly or repeatedly acquired *S. haematobium* infection.

Individuals with urinary schistosomiasis may develop severe pathological defects, including carcinoma of the bladder, periportal thickening, portal enlargement, glomerulonephritis, pulmonary hypertension (18), and transmission of HIV (15). We found that most of the schoolchildren had only a mild infection of *S. haematobium* with the GMI being less than 50; however, if left untreated, such mild infections can lead to severe consequences. However, despite the fact that the early treatment of these infected schoolchildren may prevent advanced pathological consequences, regrettably, the medical resources in Hhohho Province are quite limited. The nearest large hospital is located in the city of Pigg's Peak, a 2-h drive from a remote village in Hhohho Province. Add to this the poor economic status of these families and it becomes very difficult for the families of this village to get the required medical assistance. However, in the Manzini Province, the conditions seem better than that in Hhohho Province. There are some large public hospitals and private clinics in Manzini City, and it is easier for people living in the Manzini Province to avail of these facilities, which at a driving distance of 0.5-1 h. Nevertheless, undertaking a routine deworming program for schoolchildren living in remote districts is urgently needed.

In summary, the present report provides useful information for planning an integrated schistosomiasis control program in neglected remote districts that are not covered by NBCP in northwestern KS. It is also recommended that even in districts with low transmission in northwestern KS, each person should be administered praziquantel, irrespective of age. Furthermore, water control and sanitation as well the elimination of the snail hosts by using molluscicides are urgently needed in Middlíveld and Lowveld regions in northwestern KS.

Acknowledgments The authors are grateful to the Ministry of Health and Social Welfare of the Kingdom of Swaziland. The authors also thank the Embassy of the Republic of China (Taiwan) in Swaziland, the International Cooperation and Development Fund, Taiwan, and Taiwanese Ministry of Foreign Affairs, and Taipei Medical University (TMU98-AE1-B19) for their support of this investigation. Also, we are grateful to Dr. Chamberlin for intensive revision of our manuscript.

Conflict of interest None to declare.

REFERENCES