MORTALITY DUE TO SCHISTOSOMIASIS MANSONI: A FIELD STUDY IN SUDAN

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Abstract. Although schistosomiasis affects 200 million persons, 20 million of whom have advanced disease, little is known about the mortality pattern in areas of endemic schistosomiasis mansoni. In an attempt to assess the mortality rates in an endemic area in Sudan, we conducted two demographic surveys in a village in the Gezira area. Clinical, sonographic, and parasitologic examinations were performed in a randomly selected sample of 25% of the population in 1987 and 1994. One of us asked each head of household about the names, sex, and age of family members. Particularly, we asked about death in the family if any, history of schistosomiasis, abdominal swelling, and hematemesis. Possible causes of death were ascertained by reviewing medical records in the village dispensary and the district hospital. There were 42 deaths in the village. Four males died of hematemesis secondary to portal fibrosis. The crude mortality rate of schistosomiasis was 51/100,000/year. The overall schistosomiasis fatality rate per year was 1/1,000 infected persons, but was as high as 11/100/infected patients with bleeding varices. These findings showed the impact of schistosomiasis on public health in this economically important region of Sudan.

Half of the annual 40 million deaths in developing countries are due to infection and parasitic diseases. Although schistosomiasis affects 200 million persons, 20 million of whom have advanced disease, little is known about the pattern of mortality in areas of endemic schistosomiasis mansoni. This is a manifestation of the general deficiency in recording the rates, causes, and distribution of mortality in endemic countries. The World Health Organization (WHO) has recently called for improvement in data collection and in mortality data related to schistosomiasis. In the last decade, we have been actively studying schistosomiasis in an area of high endemicity in Sudan. Here, we attempted to determine indices of mortality due to schistosomiasis.

STUDY PLAN, SUBJECTS, AND METHODS

Study area. This study was conducted during the period from 1987 to 1994 in the Gezira area of Sudan. The Gezira Irrigation Scheme, the largest irrigation scheme in Africa, lies in the central part of the Sudan, between the Blue and the White Nile Rivers. There are approximately 100,000 families with a total population of two million living in about 1,500 villages. Cotton, groundnuts, and wheat are the major cash crops produced in this economically important region of the country. The prevalence of Schistosoma mansoni reaches up to 70% and that of S. haematobium reaches 15%. Malaria is also endemic, with occasional epidemics in this locality. With the application of mass chemotherapy, health education, and monthly molluscaridying in coverage zones, the Blue Nile Health Project (BNBP), which recently has been dismantled, succeeded in maintaining a prevalence of schistosomiasis less than 10%.

The study was approved by the Medical Research Review Board, Faculty of Medicine, University of Khartoum. The study plan and objectives were explained to the village chief and to each subject enrolled in the study. Informed consent of the study participants obtained from each subject.

Survey. The village of Abu-Jin, 150 km south of Khartoum, was selected for the study because it was not covered by the BNHP at the time of our first survey in 1987. Since then, we have frequently visited this village and are familiar with its inhabitants and their morbidity pattern. We performed two house-to-house surveys in 1987 and 1994.

To assess the rates, causes and distribution of mortality, one of us (MMK) asked the heads of households about the names, sex, and age of family members and whether anyone died during the survey period. If a death was reported, MMK asked the family of the deceased about terminal symptoms and the possible diagnosis if rendered by a medical staff. A history of schistosomiasis, abdominal swelling and hematemesis, and coma were particularly sought. The possible cause of death was also ascertained by reviewing the records in the village dispensary and a nearby district hospital. For quality assurance, the interviews were performed twice.

To determine the case fatality rate, we performed clinical, monographic, and parasitologic examinations in a randomly selected sample of 25% of the population, as previously described. The presence and grade of esophageal varices was recorded in all subjects found to have schistosomal periporal fibrosis, as previously reported. Because the level of infection was very high, we treated all inhabitants present at the first survey with praziquantel (Biltricide®; Bayer AG, Leverkusen, Germany) in a single oral dose of 40 mg /kg. Following mass chemotherapy, only 28 subjects were treated between the surveys.

Statistical analysis. Mortality indices in the village, including schistosomiasis specific mortality rate, case fatality rate and proportionate mortality, were calculated as previously described. Projected demographic data of Sudan were kindly provided by the Population International Program Center, Bureau of the Census (Washington, DC). To compare the age distribution, mean age, and sex ratio of the village to the whole population of Sudan, the Kolmogorov-Smirnov, Student’s t-, and chi-square tests were used as appropriate. The chi-square test was used to compare morbidity data between the two surveys. Because the entries for mortality were small, we calculated and compared confidence intervals for mortality indices as described by the National Center for Health Statistics (Hyattsville, MD).
RESULTS

Demographic findings. In 1987, the total population in Abu-Jin was 1,080, whereas in 1994, the total population was 1,190. The estimated mid-term population was 1,135. There was no significant population movement apart from 5–10 Bedouin families who were not included in either survey. The mid-term distribution of the village population was not significantly different from that of the population of Sudan (Figure 1). There were comparatively fewer children less than nine years old than expected. The mean age and sex ratio were not significantly different than those of Sudan. During the period of study, 165 children were born in the area. Thus, the birth rate was 29/1,000/year and the fertility rate was 123/1,000/year.

Morbidity indices. Seven years after mass chemotherapy, the overall prevalence of infection and fibrosis decreased significantly from 53% to 34% (Figure 2). Prevalence in the 10–19-year-old age group was 73% in 1987, and it decreased to 51% in 1994. Eighteen percent of this group were still excreting more than 400 eggs per gram of feces, compared with 31% before treatment. The overall prevalence of fibrosis decreased from 14% to 10%. The reduction was observed mostly in those less than 20 years of age (Figure 2). The prevalence of esophageal varices and hematemesis in those with Simmer's fibrosis was 54% and 4%, respectively. At mid-term, there were approximately 485 subjects with infection, 133 with fibrosis, and 66 with esophageal varices of whom five were bleeding.

Mortality indices. During the study period, there were 42 deaths among those more than one year of age. Thus, the crude mortality rate per year, excluding those less than one year of age, was 5.3/1,000, which was significantly lower than that of Sudan (9/1,000). When stratified by age, this difference was most marked for those less than 1–4 years old and for those more than 59 years old (Figure 3). The causes of death were febrile illnesses (10), schistosomiasis (4) gastroenteritis (3), respiratory illness (3), heart failure (2), tuberculosis (1), severe anemia (1), keto-acidosis (1), trauma (1), and old age (17). The last group complained of

![Figure 1](image1.png) Estimated percentage age distribution of the population of a village in an area of endemic schistosomiasis in Sudan and of the projected population of Sudan in 1991.

![Figure 2](image2.png) Estimated mortality rates per year of a village in an area of endemic schistosomiasis in Sudan and the projected mortality rates for Sudan in 1991.
MORTALITY DUE TO SCHISTOSOMIASIS

FIGURE 3. Prevalence of infection with *Schistosoma mansoni* and periportal fibrosis seven years after a single mass chemotherapy in a village in an area of endemic schistosomiasis in Sudan.

Vague, nonspecific symptoms. None of them had the classic features of advanced schistosomiasis.

Those who died of schistosomiasis were all males (age range = 14–59 years) with advanced hepatosplenic schistosomiasis. Hematemesis with subsequent exsanguination was the direct cause of death in all four. Two of them were adequately examined in the first survey because they were included within the randomly selected sample. Both had high-grade fibrosis and high-grade esophageal varices. The other two died of bleeding varices and coma in a nearby hospital. No records of the grade of varices or fibrosis were available. Thus, the specific mortality rate for schistosomiasis in this village was 51/100,000/year, with a case fatality rate of 1/1,000/year in subjects with stools positive for schistosome eggs to 11/100/year in those with bleeding esophageal varices.

The village of Abu-Jin is unique in that the pattern of morbidity due to schistosomiasis has been well characterized. We collected detailed demographic, clinical, sonographic, parasitologic, and endoscopic data that are rarely available in areas endemic for schistosomiasis. However, the validity of mortality data is greatly influenced by the fact that retrospective assessment of causes of death from relatives is subject to bias. The villagers were often inaccurate in stating their age and those of their family members, and the cause of death, if any occurred. This was particularly obvious in those less than five years of age. To ensure the quality of our data, we interviewed each family twice. The validity of our sampling method and survey technique is supported by the fact that the age, sex, and mortality distributions in this village are similar to the figures expected for Sudan.

We found the villagers to be well informed about the distinct terminal symptoms and signs of advanced schistosomiasis. To supplement information given by the villagers, we reviewed medical records in a nearby hospital. Two of

**Table 1**
Indices related to mortality in endemic area of *Schistosoma mansoni* in Sudan

<table>
<thead>
<tr>
<th>Schistosomiasis specific mortality per year</th>
<th></th>
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<tbody>
<tr>
<td>Total population</td>
<td>51/100,000</td>
</tr>
<tr>
<td>Adults &gt;15 years old</td>
<td>66/100,000</td>
</tr>
<tr>
<td>Adult males</td>
<td>132/100,000</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Schistosomiasis fatality rates per year</th>
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</thead>
<tbody>
<tr>
<td>Positive for infection</td>
</tr>
<tr>
<td>Positive for fibrosis</td>
</tr>
<tr>
<td>Positive for varices</td>
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<tr>
<td>Positive fibrosis and bleeding</td>
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DISCUSSION

In this study, we found mortality due schistosomiasis mansoni to be 51/100,000/year, which is higher than that reported by recent WHO estimates. Ten percent of the deaths in this endemic area are due to schistosomiasis, a proportionate mortality similar to that of cerebrovascular disease in the United States. All who died were male in the most productive years of their life. The case fatality rate of schistosomiasis increased as the disease progressed from 1/1,000/year in subjects with stools positive for schistosome eggs to 11/100/year in those with bleeding esophageal varices.

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We found the villagers to be well informed about the distinct terminal symptoms and signs of advanced schistosomiasis. To supplement information given by the villagers, we reviewed medical records in a nearby hospital. Two of
the four subjects who died of severe hematemesis and coma had been examined during our first survey; both had high-grade fibrosis and high-grade varices. It is difficult to rule out cirrhosis as the cause of death in the other cases. Viral hepatitis is common in this endemic area. 10 All the villagers are Muslims and alcohol consumption is unusual. The descriptions given by their family and the absence of jaundice, severe epigastric pain, chronic ascites, and a history of alcohol abuse suggest that advanced schistosomiasis was the most probable cause of death in these subjects.

Schistosomiasis causes death through variceal bleeding and/or hepatic coma in the majority of cases.11,12 It rarely causes death due cardiopulmonary failure secondary to cor-pulmonale.12 It was difficult for us to diagnose cor-pulmonale in the field. However, two persons died of heart ailments; both were middle age women with known histories of rheumatic heart disease. It was difficult to assess the contributory role of schistosomiasis in these and other deaths in the village.

Variceal bleeding secondary to schistosomal fibrosis ranked second after febrile illnesses as a cause of premature death in this village. In the largest study of mortality in Sudan, Malik found that schistosomiasis ranked fourth, after malaria, tuberculosis, and hypertension, as a cause of hospital deaths in 1970.13 The estimated case fatality rate was 7/100/year. In a similar hospital-based study in Brazil, Kloetzel found a case fatality rate of 5/100/year.14 El Tourabi and others recently followed 42 hospitalized patients with variceal bleeding and found a case fatality rate of 9/100/year.15 These studies corroborate the present field finding of a fatality rate of bleeding varices of 11/100/year. In the Gezira area, we estimated that 12,000–15,000 persons have bleeding esophageal varices secondary to schistosomal fibrosis, some of which required immediate medical attention.6 Adding to this, a mortality rate of 51/100,000/year in the general population and 1/1,000/year in adult males shows the impact of schistosomiasis on public health in this economically important region of Sudan.

What is to be done for such a serious health problem? Mass chemotherapy has been reported to reduce mortality in Brazil from 0.67 to 0.44 per 100,000 in some areas.2 It is estimated that eliminating mortality due to schistosomiasis would extend the average life expectancy of males in areas of endemic schistosomiasis by 2.3 years.16 There is little information available on the mortality level in this village before mass chemotherapy. However, morbidity levels and active transmission among those less than five years of age remained high in spite of a statistically significant reduction in infection following a single mass chemotherapy. Repeated mass chemotherapy is effective in preventing and perhaps reversing fibrosis in the early stage.5,5 Antagonists of B-adrenoceptor have shown promising results in reducing mortality in advanced cases of portal fibrosis.15 Making these drugs available at an affordable price, together with other public health measures, remains a high priority in areas of endemic schistosomiasis.

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REFERENCES