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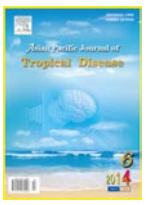

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Schistosoma mansoni infection in a fishermen community, the Lake Manzala region-Egypt

Amira Taman[1*], Nora El-Tantawy[1], Tarek Besheer[2], Saher Taman[3], Randa Helal[4]

[1]*Department of Medical Parasitology, Faculty of Medicine, Mansoura University, Mansoura 35516, Egypt*

[2]*Department of Tropical Medicine, Faculty of Medicine, Mansoura University, Mansoura 35516, Egypt*

[3]*Department of Radiology, Faculty of Medicine, Mansoura University, Mansoura 35516, Egypt*

[4]*Department of public Health and Community Medicine, Faculty of Medicine, Mansoura University, Mansoura 35516, Egypt*

PEER REVIEW

Peer reviewer

Mohamed EL-Malky, MD, PhD, Associate Professor, Department of Medical Parasitology, Faculty of Medicine, Umm AL-Qura University, Makkah, Kingdom of Saudia Arabia
Tel: +966-0537121416
E-mail: mmelmalky@uqu.edu.sa
malky197@mans.edu.eg

Comments

The data presented in this study is an alarm for the increased prevalence of schistosomiasis in this region and it reported the potential contamination of the lake water with cercaria, so Lake Manzala acts as a continuous source of schistosoma infection. The study also recommended control measures for the availability of antischistosomal drugs for the public.
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ABSTRACT

Objective: To determine the prevalence of schistosomiasis in the fishermen community in Egypt.
Methods: A cross-sectional survey for schistosomiasis mansoni was conducted among 150 fishermen and their families from January to November 2013. Faecal samples were examined by Kato Katz method and formalin-ether concentration technique. Malacological survey was conducted to identify infection of the snail intermediate host by larval stage of *Schistosoma mansoni*. Snails were collected and checked for shedding of cercariae after light exposure.
Results: Overall prevalence of infection was 26.6% with an intensity of (42.7±7.2) ova/g of stool. Infection was common in male and significantly increased in the age of 20-40 years. Praziquantel-treated individuals had a high significant decrease in intensity (27.2±2.4) ova/g of stool than those with no treatment history. *Biomphalaria alexandrina* snail was infected with *Schistosoma mansoni* particularly in warm seasons and mice infection was established successfully from the shed cercariae, moreover adult worms were obtained via portal perfusion of the infected mice.
Conclusions: Findings indicated the endemicity of schistosomiasis mansoni in Lake Manzala region, therefore, appropriate integrated control measures are needed among fishermen including health education, environmental sanitation, periodic screening and mass treatment with praziquantel.

KEYWORDS

Schistosoma mansoni, Prevalence, Lake Manzala, Praziquantel, Endemicity

1. Introduction

Schistosomiasis is a chronic parasitic disease caused by the blood flukes of the genus *Schistosoma*. It is estimated that schistosomiasis afflicts more than 240 million people in 78 countries mostly in sub-Saharan Africa[1,2]. *Schistosoma* infection comes next to malaria in terms of morbidity and mortality and is considered the third more frequent parasitic disease of public health importance[3].

Schistosomiasis is a multifactorial disease including parasitic, environmental, behavioral, vector and host factors[4]. The disease is prevalent in tropical and sub-tropical areas, particularly in poor countries with bad hygienic conditions and unsafe drinking water and mostly

*Corresponding author: Amira Taman, PhD, Department of Medical Parasitology, Faculty of Medicine, Mansoura University, 2 El-Gomhouria Street, Mansoura 35516-Egypt.
Tel: +2-050-2244873
Fax: +2-050-2263717
E-mail: amirataman@mans.edu.eg

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affects farmers, car washers and fishermen populations[5]. Schistosomiasis was endemic in Egypt for several decades. National control programs have been carried out based on the morbidity control strategy recommended by WHO in 1984. This included giving praziquantel (PZQ) to all school children and infected individuals only. With program progression, the prevalence of schistosomiasis decreased to 3% in 2003 according to the reports from the Egyptian Ministry of Health and by the end of 2010, only 20 villages in the country had prevalence more than 3.5% and none was more than 10%[6].

Lake Manzala is a shallow brackish lake and it is one of the largest lakes in Egypt. Untreated sewage and irrigation return from five major governorates located in the Nile Delta and nearby regions bring high inputs of pollutants from industrial, domestic, and agricultural sources from urban centers such as Cairo and other rural areas along the lengths of its drains. These pollutants contain a large number of pathogens, including bacterial, viral and parasitic, which affect health and productivity of population there[7,8]. Many fishermen and their families live around Lake Manzala with frequent water contact, in addition, boats have no sanitary facilities so that all excreta is usually passed into the lake. Moreover, water from Lake Manzala is the only available water for drinking and all daily life uses[9].

Although there are several encouraging attempts for vaccine development to control schistosomiasis, yet to date, no vaccine is available and control of morbidity relies on PZQ, the only drug approved by WHO in treatment and control programs. In 2001, a new antischistosomal drug, Mirazid of plant origin was introduced in the Egyptian market. With massive advertising efforts, physicians are motivated to use it for treatment of schistosomiasis, although its antischistosomal effect in experimental animal model and human is controversial[10,11] and not used by the Egyptian Ministry of Health in the national control programs.

This study was conducted to determine the prevalence of schistosomiasis among fishermen and their families living around Lake Manzala, and to demonstrate that the water of this lake is a potential source of *Schistosoma mansoni (S. mansoni)* infection. In addition, possible control strategies for infection reduction and proper elimination of schistosomiasis are discussed.

2. Materials and methods

2.1. Study area

Lake Manzala is a shallow brackish lake of approximately 1 000 km^2 situated in the northeastern edge of the Nile Delta (Figure 1), between the Damietta branch of the River Nile and the Suez Canal. Its coordinates are 30°30′ to 31°30′ N latitude and 31°15′ to 32°15′ E longitude[12]. The estimated number of population living around the lake is 75 034 and most of them are fishermen. To our knowledge, there have been no periodic anthelmintic treatment programs in this area prior to our study.

2.2. Study design and data collection

A total of 150 randomly selected fishermen and their families (a total of 700 persons) were included in this cross sectional study during the period from January to November 2013. Demographic data (age, sex) were collected. History

Figure 1. A map of the Nile Delta, arrow pointed to the location of Lake Manzala in the north east.

was taken about symptoms related to schistosomiasis in the last month and treatment of *Schistosoma* infection in the last two months. Children and their mothers were asked about *S. mansoni* infection risk factors such as swimming habit, washing clothes in the lake and any form of contact with water from the lake.

2.3. Clinical examination

2.3.1. Physical

Abdominal examination and ultrasonographic examination were performed for all participants, to detect splenic and/or hepatic enlargement.

2.3.2. Laboratory

Two faecal samples were collected from each participant on consecutive days. Faecal samples were collected from each subject, between 10:00 a.m. and 2:00 p.m. when maximum eggs excretion occurs[13], into 100 mL clean containers with wide mouth and screw cap cover. For each faecal sample, the consistency was recorded and three Kato-Katz thick smears using standard 41.7 mg plastic templates were prepared (total amount was 125 mg per examination), then the slides were examined under a microscope and the number of *S. mansoni* eggs was counted[14].

Negative faecal samples were re-examined by formalin ether sedimentation technique as described by Cheesbrough before the negative results were confirmed[15]. The number of eggs detected per gram of faeces was recorded and the geometric mean was calculated as an indicator for infection intensity. For quality control, faecal samples examination was performed in duplicate for about 15% of the samples selected randomly.

2.4. Malacological survey

Lake Manzala was surveyed for *S. mansoni* snail intermediate host. Snails were collected using a scoop and *Biomphalaria alexandrina (B. alexandrina)*, intermediate host for *S. mansoni* was identified based on the shell morphology[15]. Snails were transferred to the Parasitology Department, Mansoura University in a plastic bucket containing water and vegetation (lettuce) to be tested for natural *S. mansoni* infection using hatching test. Each snail was placed individually in a 5 mL plate with dechlorinated water and exposed to electric light for one hour, water is examined every 20 min for the presence of the characteristic cercaria of *S. mansoni* (furcocercous cercaria). Female BALB/c mice obtained from the Medical Experimental Research Center (MERC), Faculty of Medicine, Mansoura University, Mansoura, Egypt, were infected with the obtained cercaria through subcutaneous injection. Six weeks later, mice were sacrificed and adult worms were obtained by portal perfusion. Male and female schistosomes were identified according to morphology after microscopic examination[15].

2.5. Ethical consideration and treatment

This study was approved by the medical ethics committee of Faculty of Medicine, Mansoura University, Egypt. Informed and written consents were obtained from participants older than 18 years and parental consent was obtained from younger ones. All positive case detected in the study were treated with PZQ (40 mg/kg body weight).

2.6. Statistical analysis

Data were analyzed by using SPSS software version 16.0. Infection intensity (ova/g of stool) was calculated by geometric mean among the infected persons. Kolmogorov-Smirnov test was used to test the normality of egg intensity. A descriptive analysis of the collected data was done in the form of frequencies and percent. *Chi*-square was used to compare prevalence of infection according to sex and age group. Student's *t*-test and One-way ANOVA were used to compare the means between different groups as appropriate. $P<0.05$ was chosen as the level of statistical significance.

3. Results

3.1. Parasitological results

A total of 700 people were enrolled in the study (150 fishermen and their families), 65.9% males and 34.1% females. A total of 186 individuals were positive for *S. mansoni* infestation, the overall prevalence was 26.6% (Table 1). Males were significantly more affected (27.9%) than females (23.8%) with $P<0.05$. Infection was significantly higher (31.6%) in the age group of 20-40 years, followed by age from 5-20 years with prevalence of 24.7%. The lowest prevalence (16%) was detected in cases more than 41 years old (Table 2). The intensity of infection expressed as geometric mean egg count for positive cases is shown by age group, the geometric mean intensity was (42.7±7.2) ova/g of stool. Intensity of infection varied across age classes, it was significantly higher (44.40 ±6.15) ova/g in the age of 20-40 years, but there is non-significant increase (43.2±7.8) ova/g in age >40 years, while a significant intensity of (37.8±8.2) ova/g was at age of 5-20 years (Table 2). In schistosomiasis-positive cases, history of previous anti-schistosomal treatment in the last two months was given by 106 out of 186 positive cases. About 9.7% (18/186) received PZQ and most of them were at the age group 5-20 years, while Mirazid was taken by 47.3%, the majority from 20-40 years and the rest 43% did not receive any schistosomicidal treatment (Table 3). Cases had history of PZQ or Mirazid treatment were still passing eggs with the intensity of (27.2±2.4) and (42.3±4.2) ova/g respectively compared with (48.1±4.1) ova/g in the untreated group. The reduction in egg count with PZQ was highly significant ($P<0.01$) but not significant with Mirazid ($P>0.05$).

Table 1

Prevalence and intensity of infection of *S. mansoni* in the Lake Manzala region, Egypt, according to sex.

Sex	Number of cases (%)	Positive cases	Prevalence	Intensity[a]
Males	461 (65.9)	129	27.9%**	45.1±6.3
females	239 (34.1)	57	23.8%	39.6±7.1
Total	700	186	26.6%	42.7±7.2

[a]Infection intensity (ova/g of stool) was calculated by geometric mean among the infected persons±SD.

Numbers between parentheses indicate the percentage of examined cases.

**: $P<0.01$.

Table 2

S. mansoni prevalence and infection intensity of fishermen in the Lake Manzala region, Egypt, according to age.

Age (years)	Examined cases	Positive cases	Prevalence	Intensity[a]
5-20	170	42	24.7%	37.80±8.20**
20-40	380	120	31.6%**	44.40±6.15*
>40	150	24	16.0%	43.20±7.80

[a]Infection intensity (ova/g of stool) was calculated by geometric mean among the infected persons±SD.

*: $P<0.05$, **: $P<0.01$.

Table 3

Anti-schistosomal treatment taken by schistosomiasis mansoni positive cases.

Treatment	Number of cases	Prevalence (%)	Intensity[a]
No treatment	80	43.0	48.1±4.1
Praziquantel	18	9.7	27.2±2.4**
Mirazid	88	47.3	42.3±4.2

[a]Infection intensity (ova/g of stool) was calculated by geometric mean among the infected persons±SD.

**: Significant difference from untreated cases at $P<0.01$.

3.2. Symptom profile

Abdominal pain was the most frequently reported symptom (34.9%) in our study. Diarrhea was the common complaint of 19.9% of the cases, followed by blood in stool in 16.1%. Other common complaints were distension and blotting (13.4%) and heart burn (6.9%), while no symptoms were reported by 13.4% of the infected cases (Table 4). Physical examination revealed splenomegaly in infected cases only. Splenomegaly was detected in 18 cases (9.7%) of 186 by physical examination (Figure 2), but ultrasonographic examination recorded additional 48 cases (66 cases, 35.5%). Splenic enlargement was common in older age patients. Abdominal examination revealed liver enlargement in 55 (7.9%) of 700 (whole participants). Hepatomegaly in the midclavicular line or in the midsternal line was detected by ultrasonography in 120 (17.1%) and 67 (9.6%) respectively (Figure 2). Hepatic enlargement was more (35%) in age groups of 20-40 years and more than 40 years but decreased in the age group of 5-20 years to 5%-10% (data not shown).

Table 4

Major symptoms recorded in patients during acute schistosomiasis.

Symptoms	Number of cases	Percentage %
Abdominal pain	65	34.9
Diarrhea	37	19.9
Blood in stool	30	16.1
Distension and blotting	25	13.4
Heart burn	13	6.9
No symptoms	25	13.4

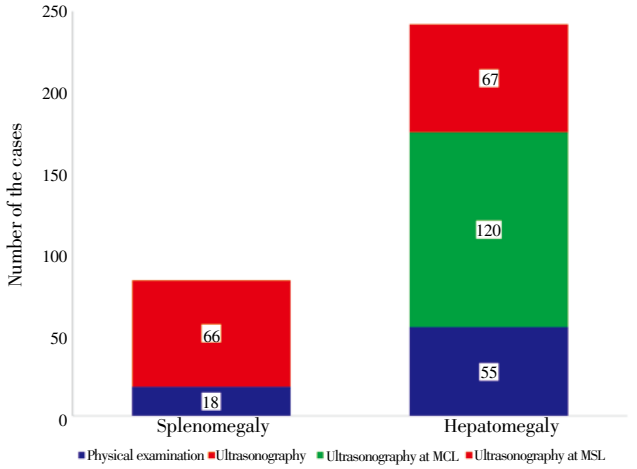

Figure 2. Cases of splenic and hepatic enlargement detected by physical and ultrasonographic examination.

MCL: Midclavicular line. MSL: Midsternal line.

3.3. Malacological survey

B. alexandrina snails were collected from the surrounding grass, stones, fallen leaves, decaying wood, and surrounding trees. From snails obtained during winter months, many died during transportation and very few cercariae were obtained with shedding the survived snails, while for those collected at April, few died during transportation, snails were larger in size and shed many cercariae after light exposure. Obtained cercariae were used successfully in mice infection and adult worms were harvested six weeks post infection using portal perfusion technique.

4. Discussion

The prevalence of *S. mansoni* infection intensity and/or morbidity is essential for selecting an appropriate control strategy. Fishermen are not only affected by schistosomiasis but also represent a potential source of spreading this disease in the north-east region of Egypt. No new medical records are available for prevalence of schistosomiasis in this region and the Egyptian Ministry of Health records estimated that the highest prevalence in the country was less than 10%. The present study updated the prevalence and intensity of *S. mansoni* infection and recorded the associated signs and symptoms profiles in fishermen and their families living around Lake Manzala.

In our study, the prevalence of *S. mansoni* in Lake Manzala region is relatively higher than the recorded prevalence of farming communities in Egypt, 4.3% in Fayoum governorate[16] and 17.47% in Qalubia governorate[17]. Other governorates have a higher prevalence than our findings as 37.7% in Gharbia[18], 28.5% in Menofia[19], and 42.9% in Ismailia[20]. This could be due to difference in the ecology of the areas, frequency of water exposure and occupations of the populations surveyed.

Although the prevalence of *S. mansoni* is relatively high, *i.e.*, 26.6%, the intensity of infection is relatively low, *i.e.*,

geometric mean egg count (42.7±7.2) ova/g of stool. This could be a result of repeated courses of chemotherapy. Symptomatic patients always seek medical care from rural health centers, which provide PZQ for positive cases but other medical centers and private clinics mostly provide Mirazid. For school children, they are always having periodic parasitologic examinations at school clinics and infected cases are treated with PZQ. In this fishing community, schistosomiasis diagnosis and treatment is followed by repeated exposures and reinfection. This suppresses the egg count and thus morbidity is less than the prevalence of infection. The prevalence of schistosomiasis is strongly affected by gender[21], females in these communities are less prone to catch infection since they do not have the same types of exposures as men, and their exposures while washing clothes and utensils in the lake water are much less intense, they are less frequently infected and they also have time to seek medical care on appearance of any symptoms, unlike males, who can spend days fishing in the lake and usually show less compliance with medical treatment.

In our work, the age-related pattern of *S. mansoni* infection did not follow the characteristic convex-shaped curve for schistosomiasis[22,23]. Infection was more in age group 20-40 years, who are working mainly as fishermen with frequent occupational exposure to infested water. The prevalence started to decline a little in younger age from 5-20 years; this age group includes children and young adults who have the habit of swimming at the lake but also have periodic medical examination at educational institutions, but bad hygienic conditions, inappropriate sanitation and disease endemicity keep transmission at a high level in these communities.

Despite the high prevalence of *S. mansoni* infection, we found relatively little *S. mansoni*-associated morbidity and even non-symptomatic infected cases, this is due to widespread presence of antischistosomal agents in Egypt, which make symptoms related to schistosomiasis to be difficult to be detected and help in the development of resistant strains to the available antischistosomal agents[24]. In fact, praziquantel-resistance has been recorded previously in Egypt[25], which is an alarm to re-think about the availability and distribution of PZQ at pharmacies without prescription. In this study, some positive cases reported treatment with antischistosomal agents in the last 6-8 weeks, although those having PZQ and Mirazid were still passing eggs, but PZQ administration leaded to significant reduction in egg count compared to untreated group. Group having Mirazid had little or even no reduction in egg count although they stated that they had repeated courses in the last 8 weeks. Recently, there was a great debate about the efficacy and effectiveness of Mirazid in the treatment of *S. mansoni*, both in laboratory and clinical. A number of previous studies showed a clear discrepancy in the effect of Mirazid on *S. mansoni*[10,11,26-30].

Clinical findings associated with *S. mansoni* infection in this study such as abdominal pain and history of blood in the stool were of diagnostic importance, while association of hepatomegaly and schistosomiasis is not firm since we found more cases of hepatic enlargement in uninfected cases. Viral hepatitis, which is frequent in the Nile Delta and chronic liver diseases can change the size of the liver causing enlargement especially in adults[31].

Herein, the observation that people around Lake Manzala are excreting *S. mansoni* ova, the shedding of *S. mansoni* cercaria by *B. alexandrina* collected from the Lake and the establishment of *S. mansoni* life cycle in laboratory bred mice are confirmation of the endemicity of *S. mansoni* in Lake Manzala region, although over the past few decades, significant progress has been made in the control of schistosomiasis in Egypt; however comprehensive control measures including chemotherapy accompanied with snail control are needed. Periodic mass chemotherapy using PZQ should be given to the entire population, especially those working or have frequent contact with lake water, monitoring after treatment, and treatment should be repeated if needed. Snail control with the available molluscicides is an important measure to reduce the transmission of the disease and supply safe water; moreover health education is effective in decreasing exposure frequency and subsequently will reduce reinfection in both children and adult females. For adult males, since their water exposure is inevitable, health education could improve their compliance with chemotherapy, encouraging them to use stored or boiled water and reduce fecal contamination to an acceptable level.

In conclusion, the results reported herein were the first to describe the higher *S. mansoni* infection rate in the fishermen community at Lake Manzala region, Egypt, in the last few years. These data highlight the need of implementing PZQ administration in this region and call for immediate intervention of regional control programs.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

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Comments

Background

S. mansoni the aetiological agent of intestinal schistosomiasis is prevalent across many African countries including Egypt. It is associated with high morbidity and the symptoms are progressively worsened with repeated infection. Occupational exposure in agricultural workers and fishermen is commonly reported which has significant economic impact on these poor communities.

Research frontiers

The present study provides new data about the prevalence and intensity of *S. mansoni* infection in Lake Manzala region and discusses some possible control strategies for schistosomiasis elimination.

Related reports

High prevalence of schistosomiasis in fishermen was reported before in China (Li *et al.*, 2003) and Lake Albert in Uganda (Kabatereine *et al.*, 2004). The presence of snails *B. alexandrina* and even *Bulinus truncates* was reported before in Lake Manzala (Khalil, 1990).

Innovations & breakthroughs

The malacological survey was conducted to identify infection of the snail intermediate host by larval stage of *S. mansoni*, which is an important point to be considered in control programs.

Applications

Schistosomiasis is a multifactorial disease and controlling the parasite and snail intermediate host are an effective measures in addition to modification of fishermen behavior, as they are considered as a potential source of spreading the disease.

Peer review

The data presented in this study is an alarm for the increased prevalence of schistosomiasis in this region and it reported the potential contamination of the lake water with cercaria, so Lake Manzala acts as a continuous source of *Schistosoma* infection. The study also recommended control measures for the availability of antischistosomal drugs for the public.

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