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THE EPIDEMIOLOGY OF SCHISTOSOMIASIS IN EGYPT: QALYUBIA GOVERNORATE

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Abstract. The primary objectives of this study, carried out in Qalyubia Governorate in Egypt (south-central Nile Delta), were to continue tracking historical trends of infection prevalence of *Schistosoma mansoni* and *S. haematobium*, determine whether satellites (ezbas) of mother villages differed significantly with respect to schistosomiasis transmission, and to asses schistosomiasis-induced morbidity on a population basis using ultrasonography. Our study revealed that *S. haematobium* has virtually disappeared from Qalyubia governorate, and that *S. mansoni* prevalence continues to decline slowly (17% in 1991 compared with 19% in 1990). The prevalence of intestinal schistosomiasis was actually higher in the mother villages than in the ezbas of the same villages, indicating that prevalence based on surveys of villages alone did not (at least for Qalyubia) cause underestimates of true prevalence. (A mother village is the large village in an area that includes hamlets or ezbas. In many areas, the infection rate in ezbas is significantly higher than in the larger central village.) Ultrasonographic studies revealed that less than 3% of the population had stage 2 or stage 3 periportal fibrosis, commonly associated with chronic schistosomiasis mansoni. This low level of morbidity was consistent with earlier data from Qalyubia, which also showed a low level of *S. mansoni*-induced morbidity in this governorate.

In part because of its proximity to Cairo, Egypt, and because of the degree to which it is representative of the Nile Delta region, Qalyubia Governorate has hosted a disproportionately large share of field-based research for control of endemic diseases in Egypt, including schistosomiasis. During the early 1950s, the Qalyub Center for Field and Applied Research was established by the Egyptian Ministry of Health as a population laboratory in which control strategies for endemic diseases were perfected and applied. During the decade of the 1950s, much schistosomiasis research was conducted, as well as pilot programs to control tuberculosis, hookworm, and other locally important endemic diseases. From the mid-1950s until the mid-1970s, virtually no field studies of schistosomiasis were undertaken. Work has resumed in 1975 with technical support from and collaboration with U.S. Government agencies such as the Centers for Disease Control, Tulane University, and international donors. It was soon recognized that in the interim, profound changes in patterns of schistosomiasis had occurred, most notably a remarkable decrease in the population levels of *Bulinus truncatus* and the transmission of urinary schistosomiasis. Because more studies were performed in Qalyubia than in most other areas, especially after the some 20 years without current data, this governorate offers special advantages for understanding temporal patterns of change.

Prevalence data on schistosomiasis in Qalyubia, collected with methodologies that permit reasonable comparison, come from surveys conducted in 1935 (Scott),[1] 1955 (Ministry of Health,[2] 1976 (El Alamy and Cline),[3] 1983 (Cline and others),[4] and 1990 (Michelson and others).[5] These data, summarized in Table 1, represent the key information available to investigators immediately prior to the Epidemiology 1, 2, 3 (EPI 1, 2, 3) project. It is the results from the EPI 1, 2, 3 project, part of the United States Agency for International Development (USAID)-funded *Schistosomiasis Research Project*), which are reported in this paper.

Clearly, the decreasing prevalence of *Schistosoma haematobium* infection was relatively rapid and real, and not confounded significantly by differences in parasitologic techniques nor sampling methods. The changes in *S. mansoni* prevalence are more difficult to interpret, but the evidence strongly suggests that this species has undergone a gradual decline in prevalence and intensity[3–7] that was accelerated in recent years by wide-scale treatment with praziquantel. Since 1988, praziquantel has been available free of charge at Ministry of Health clinics and hospitals, and regular TV campaigns have urged people to report for stool and urine examination, and treatment if infected. Apparent increases in prevalence shown in Table 1, for example, from 26% in 1935 to 40% in 1976, are largely explained by differences in the sensitivity of the parasitologic techniques used in the two surveys. In early surveys, a simple direct smear examination was used. In later surveys, concentration methods improved sensitivity, but stool examinations miss positive samples especially when overall intensity of infection is light. The very low prevalence reported from the Ministry of Health 1955 survey is not explained.

With respect to morbidity, very limited data are available because virtually all the reported studies were hospital rather than community-based, preventing extrapolation to the population at large. Estimates of morbidity in Qalyubia prior to EPI 1, 2, 3 can be derived from 2 sources: 1) morbidity inferred from infection intensities and 2) from 1 morbidity study conducted on a population basis.[7] The overall intensities of *S. mansoni* infection reported from Qalyubia have been low. In 1976–1977, the geometric mean intensity for the nearly 4,000 infected subjects in the 8 villages of the Qalyub Bilharziasis Project (QBP) was 12.8 eggs per gram of feces (epg).[3] In 1983, the geometric mean egg output was

TABLE 1

Prevalence of schistosomiasis in Qalyubia governorate, Egypt

Survey year	*Schistosoma haematobium*	*S. mansoni*	Reference
1935	61%	26%	1
1955	31%	3%	2
1976	27%	40%	3
1983	6%	29%	4
1990	7%	19%	4

TABLE 2

Odds ratio and 95% confidence limits for risk factors for infection with *Schistosoma mansoni* in Qalubyia Governorate*

Risk factor	Total in group	Infected No. (%)	Odds ratio	Confidence limits
Demographics				
Age groups (years)				
0–10	2,192	217 (9.9)		
11–20	1,875	484 (25.8)	3.17	2.66–3.77
21–35	1,471	426 (29.0)	3.71	3.10–4.44
36–55	1,133	284 (25.1)	3.04	2.51–3.70
>55	540	101 (18.7)	2.09	1.62–2.71
Gender				
Female	3,707	625 (16.9)		
Male	3,504	887 (25.3)	1.67	1.49–1.87
Domicile				
Village (≥500 houses)	5,297	1,058 (20.0)		
Ezba (<500 houses)	1,914	454 (23.7)	1.25	1.10–1.41
Exposure to canal water				
Bathing (males)				
No	2,368	517 (21.6)		
Yes	1,101	367 (33.3)	1.81	1.54–2.12
Washing (females)				
No	1,989	288 (14.5)		
Yes	1,700	337 (19.8)	1.46	1.23–1.74
Playing (children <15 years old)				
No	2,136	223 (10.4)		
Yes	882	177 (20.1)	2.15	1.74–2.67
Clinical findings				
History of schistosomiasis				
No	5,740	1,154 (20.1)		
Yes	1,345	329 (24.5)	1.29	1.12–1.48
Prior treatment of schistosomiasis				
No	5,791	1,167 (20.1)		
Yes	1,345	330 (24.5)	1.29	1.12–1.48
History of blood in stools				
No	1,007	187 (18.6)		
Yes (total)	52	14 (26.9)	1.62	0.86–3.04
<15 years	18	2 (11.1)	0.85	0.19–3.80
≥15 years	34	12 (35.3)	1.78	0.86–3.70
History of abdominal pain				
No	846	154 (18.2)		
Yes	210	45 (21.4)	1.23	0.84–1.78
<15 years	61	7 (11.5)	0.87	0.38–2.01
≥15 years	149	38 (25.5)	1.13	0.73–1.74
Hepatomegaly in MCL (by PE)				
No	992	190 (19.2)		
Yes	63	11 (17.5)	0.89	0.46–1.74
<15 years	24	1 (4.2)	0.28	0.04–2.12
≥15 years	39	10 (25.6)	1.09	0.52–2.30
Splenomegaly (by PE)				
No	1,040	196 (18.8)		
Yes	23	6 (26.1)	1.52	0.59–3.90
<15 years	2	0 (0.0)		
≥15 years	21	6 (28.6)	1.28	0.49–3.36
Ultrasonography				
Hepatomegaly in MCL				
No	956	180 (18.8)		
Yes	101	21 (20.8)	1.13	0.68–1.88
<15 years	26	2 (7.7)	0.55	0.13–2.37
≥15 years	75	12 (25.3)	1.08	0.62–1.89

TABLE 2
Continued

Risk factor	Total in group	Infected No. (%)	Odds ratio	Confidence limits
Hepatomegaly in MSL				
No	1,017	149 (17.3)		
Yes	40	8 (20.0)	1.07	0.48–2.35
<15 years	11	0 (0.0)		
≥15 years	29	8 (27.6)	1.21	0.52–2.80
Splenomegaly				
No	863	149 (17.3)		
Yes	204	53 (26.0)	1.68	1.17–2.41
<15 years	49	9 (18.4)	1.62	0.74–3.50
≥15 years	155	44 (28.4)	1.37	0.90–2.08
Periportal fibrosis				
No	393	61 (15.5)		
Yes (≥3 mm)	675	141 (20.9)	1.44	1.03–2.00
<15 years	228	35 (15.4)	1.54	0.90–2.63
≥15 years	447	106 (23.7)	0.94	0.60–1.47
Grade I (3–<5 mm)	671	138 (20.6)	1.41	1.01–1.96
Grade II (5–<7 mm)	4	3 (75.0)	16.33	1.67–159.57
Grade III (≥7 mm)	0			

* MCL = midclavicular line; PE = physical examination; MSL = midsternal line.

11.0 epg for the entire delta sample.[4] This level was comparable to Puerto Rico, where morbidity was quite low. In 1990 in Qalyubia, 9% of the infections were high-intensity (≥100 epg), a level not usually associated with severe morbidity.

Far more direct and objective information on schistosome-induced morbidity in Qalyubia comes from the in-depth clinical studies conducted at the Naval Medical Research Unit No. 3 by Pope and others.[7] Using a population-based approach, subjects were selected from the QBP study communities on the basis of their infection status (high intensity) and stratified by age (≤25 and ≥26 years old). Despite the high intensity infection (454–658 eggs/gram mean output for *S. mansoni*; 450 eggs/10 ml for *S. haematobium*), the degree of morbidity was not striking. Rectocolonic polyposis was found in 12%, and was the main pathology clearly related to *S. mansoni.* Hepatomegaly was observed in 26% of the subjects compared with 18% in unselected residents of the same QBP communities. There was a direct correlation between egg output and fecal occult blood (but not anemia). For *S. haematobium,* abnormal intravenous pyelograms were found in 72% of those with high-intensity infections. This study was done before ultrasonography became available to assess schistosomiasis morbidity. Physicians practicing in Qalyubia also report that the late-stage, severe manifestations of chronic intestinal schistosomiasis, such as hematemesis and other signs of portal hypertension, are rare (Habib M, unpublished data). In summary, morbidity induced by *S. mansoni* was not striking in this study population representative of Qalyubia.

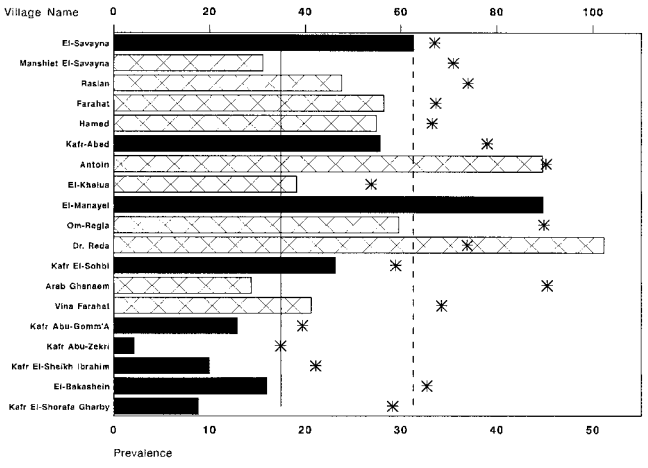

FIGURE 1. Prevalence (%) (**bars**) and intensity (**asterisks**) of *Schistosoma mansoni* infection in the surveyed communities in Qalyubia Governorate. Solid horizontal bars show prevalences in villages, hatched horizontal bars show prevalences in ezbas, the solid vertical line is the mean prevalence for all communities, the broken vertical line is the mean intensity of infection, and the asterisks are the geometric mean egg counts/gram of stool for each community.

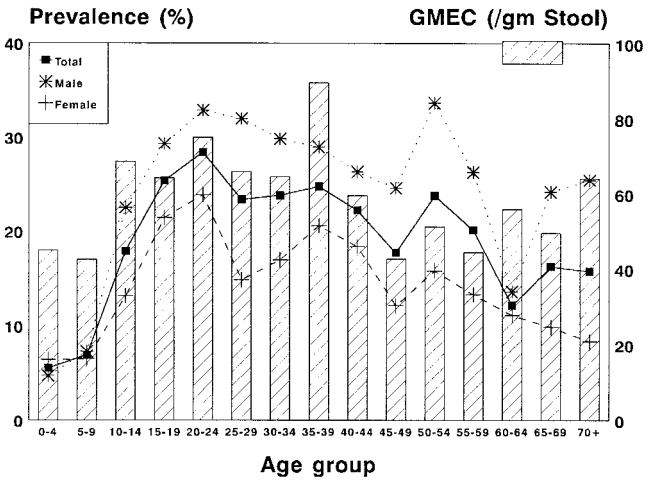

FIGURE 2. Age- and gender-adjusted prevalence and intensity of infection of *Schistosoma mansoni* in Qalyubia Governorate. GMEC = geometric mean egg count.

TABLE 3

Odds ratio and 95% confidence limits for risk factors for morbidity (periportal fibrosis) with *Schistosoma mansoni* in Qalubyia Governorate*

Risk factor	Total in group	Morbidity No. (%)	Odds ratio	Confidence limits
Demographics				
Age groups (years)				
0–10	360	131 (36.4)		
11–20	243	198 (81.5)	7.69	5.22–11.34
21–35	231	180 (77.9)	6.17	4.23–9.00
36–55	164	126 (76.8)	5.80	3.80–8.84
>55	86	53 (61.6)	2.81	1.73–4.56
Gender				
Female	574	326 (56.8)		
Male	510	362 (71.0)	1.86	1.45–2.40
Domicile				
Village (≥500 houses)	849	539 (63.5)		
Ezba (<500 houses)	235	149 (63.4)	0.99	0.74–1.35
Exposure to canal water				
Bathing (males)				
No	332	213 (64.2)		
Yes	174	146 (83.9)	2.91	1.83–4.63
Washing (females)				
No	289	116 (40.1)		
Yes	283	209 (73.9)	4.21	2.96–6.00
Playing (children <15 years old)				
No	341	129 (37.8)		
Yes	145	98 (67.6)	3.43	2.27–5.17
Parasitologic findings				
S. mansoni infection				
No	866	534 (61.7)		
Yes	202	141 (69.8)	1.44	1.03–2.00
<100 ova/gram of stool	138	87 (63.0)	1.06	0.73–1.54
≥100 ova/gram of stool	64	54 (84.4)	3.36	1.69–6.68
Clinical findings				
History of schistosomiasis				
No	829	489 (59.0)		
Yes	228	181 (79.4)	2.68	1.89–3.80
Prior treatment of schistosomiasis				
No	842	498 (59.1)		
Yes	226	179 (79.2)	2.63	1.86–3.73
History of blood in stools				
No	1,016	643 (63.3)		
Yes	51	34 (66.7)	1.16	0.64–2.11
<15 years	18	12 (66.7)	2.30	0.85–6.23
≥15 years	33	22 (66.7)	0.58	0.28–1.24
History of abdominal pain				
No	854	554 (64.9)		
Yes	210	121 (57.6)	0.74	0.54–1.00
<15 years	61	23 (37.7)	0.64	0.37–1.11
≥15 years	149	98 (65.8)	0.46	0.31–0.70
Hepatomegaly in MCL (by PE)				
No	1,006	648 (64.4)		
Yes	63	33 (52.4)	0.61	0.36–1.01
<15 years	24	11 (45.8)	0.93	0.41–2.12
≥15 years	39	22 (56.4)	0.35	0.18–0.69
Splenomegaly (by PE)				
No	1,047	664 (63.4)		
Yes	23	17 (73.9)	1.63	0.64–4.18
<15 years	2	2 (100.0)		
≥15 years	21	15 (71.4)	0.74	0.28–1.93

TABLE 3
Continued

Risk factor	Total in group	Morbidity No. (%)	Odds ratio	Confidence limits
Ultrasonography				
Hepatomegaly in MCL				
No	970	617 (63.6)		
Yes	101	64 (63.4)	0.99	0.65–1.51
<15 years	26	13 (50.0)	1.12	0.51–2.46
≥15 years	75	51 (68.0)	0.59	0.35–1.00
Hepatomegaly in MSL				
No	1,031	659 (63.9)		
Yes	40	22 (55.0)	0.69	0.37–1.30
<15 years	11	5 (45.5)	0.92	0.28–3.07
≥15 years	29	17 (58.6)	0.40	0.19–0.87
Splenomegaly				
No	876	515 (58.8)		
Yes	207	172 (83.1)	3.44	2.34–5.08
<15 years	49	40 (81.6)	5.86	2.78–12.38
≥15 years	158	132 (83.5)	1.74	1.09–2.80

* MCL = midclavicular line; PE = physical examination; MSL = midsternal line.

Because of our special interest in the changing patterns of schistosomiasis transmission in Qalyubia and related causes, we wanted to use the EPI 1, 2, 3 data to continue to track the trends for both parasites. We also were interested in possible differences between mother villages and their satellites (ezbas) with respect to transmission levels. This was important because the 1983 and 1990 delta-wide surveys did not include ezbas, and we wanted to assess the potential impact of this on estimates of prevalence and intensity. Finally, we wanted to further assess changes in morbidity patterns.

SUBJECTS AND METHODS

The sampled population, selected by multistage stratified random sampling, was calculated to detect a prevalence of *Schistosoma* sp. as low as 5% in each ezba or mother village with an 80% precision and 90% confidence level. The findings are considered representative of the rural areas of the entire governorate.[8] The total sample studied was 7,173 individuals from 1,431 households in 11 ezbas and 9 villages. Randomizing took place at the village/ezba and household levels but the total household was included in the study sample. Samples were collected during 1992. The non-compliance rates were as follows: 1) 8.4% of the households did not participate, 2) 9.8% of the individuals in the households that participated were not examined, and 3) 15.7% did not provide stool or urine.

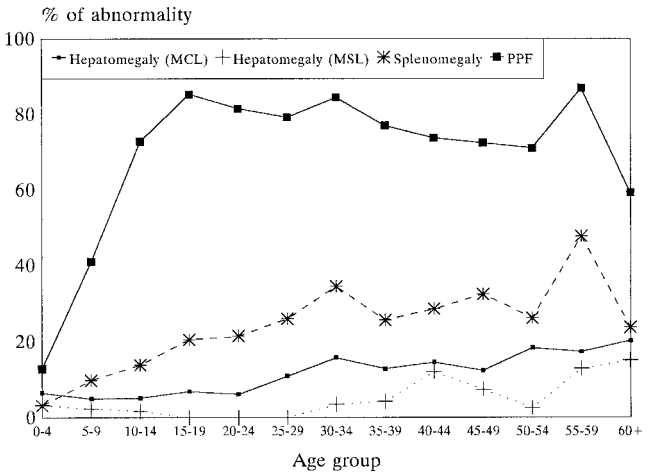

FIGURE 3. Age-adjusted prevalence of ultrasound-detected right and left lobe hepatomegaly, splenomegaly, and periportal fibrosis (PPF) in Qalyubia Governorate. MCL = midclavicular line; MSL = midsternal line.

The interview technique for collecting vital, environmental, sociodemographic, and medical data is described in detail.[8] Four data collection forms were used for recording village, household, family, and individual information. Quantitative microscopic counting of *Schistosoma* ova were performed on stool specimens using a thick smear technique, and from urine specimens using Nuclepore (Pleasanton, CA) filtration.[9–11]

Physical examination and abdominal ultrasonography were performed by trained physicians on most of the inhabitants of every fifth household, as described.[12] From an initial list of 1,823 selected for examination, 1,075 (59%) had clinical and ultrasonographic investigations. Children less than five years of age were excluded by protocol from the physical examinations and ultrasonography.

All data were transferred from the data collection forms to standard precoded sheets for computer entry using Epi-Info 5.01b (USD, Inc., Stone Mountain, GA). Data were verified prior to analysis. Survey Data Analysis (SUDAAN) software was used to calculate *Schistosoma* prevalence and geometric mean egg counts (GMECs) for each governorate, and by community, gender, and age. Further analysis was performed after transformation to SPSS/PC+ 4.01 (SPSS, Inc., Chicago, IL) as described.[8] This software was used to calculate odds ratios and 95% confidence intervals. The community burden of schistosomiasis was calculated using the GMEC (X + 1) of the predominant *Schistosoma* species. Product moment correlation coefficient (r) and its statistical

significance (p) was used for testing the association of the morbidity variables of interest, e.g., splenomegaly by ultrasonography, with the community burden of schistosomiasis. Graphic presentations were prepared using Harvard Graphics 3.0 (Software Publishing Corp., Mountain View, CA).

RESULTS

Qalyubia Governorate, which lies immediately north of Cairo, is shown on the map in Figure 1 of Hussein and others.[8] The prevalence of *S. mansoni* in the 20 study communities ranged from 2% to 45%, with a mean ± SEM of 17.5 ± 1.8 (Figure 1). The average intensity of infection was 62.6 GMEC per gram of stool (range = ~35–290). The prevalence of *S. mansoni* infection in mother villages which have ezbas (2,384 inhabitants) was 34% compared with 27.5% in the ezbas of the same mother villages (1,907 inhabitants).

Schistosoma haematobium prevalence in Qalyubia ranged from 0% to 0.5%, with a mean of 0.01% for the entire governorate. Only 7 positive individuals were found in the study population in 20 villages; only one village, with 3 positive individuals, had more than 1 positive subject.

The age and sex distribution of *S. mansoni* infection is shown in Figure 2. Infection rates in males were consistently higher than in female, for each age category. The age-specific prevalence curves are somewhat atypical in the rates increase in the 50–54-year-old age group for both sexes. Indeed, males of this age have the highest infection rate of any age group. The peak intensity of infection occurred in the 35–39-year-old age group.

The risk factors for *S. mansoni* infection and morbidity are summarized in Tables 2 and 3, respectively. With respect to morbidity (periportal liver fibrosis) determined by ultrasound, 675 (63%) of 1,068 exhibited some fibrosis, but none of the subjects had stage 3 and only 4 (0.375%) of 1,068 had stage 2 fibrosis. Thus, there was very little clinically significant fibrosis clearly associated with *S. mansoni*. No stage 2 or 3 fibrosis was seen in subjects less than 15 years of age.

No cases of hydronephrosis were detected ultrasonographically. The prevalence of hepatomegaly detected by ultrasound, by age, is shown in Figure 3.

DISCUSSION

With regard to trends in prevalence, our finding of *S. haematobium* infection rates of 0.01% indicated that transmission of this species has virtually ceased in the study villages. Because of the extreme focality of remaining transmission sites in the Nile Delta,[4–6] it is not possible to know whether this prevalence is representative of the entire governorate of Qalyubia, but it certainly is consistent with a continuing, dramatic decrease in the region.

Considering *S. mansoni*, the 17% prevalence found in our study is similar to the 19% reported in 1990,[5] and further substantiates a continuing reduction in prevalence in Qalyubia.

The atypical shape of the age-prevalence and age-intensity curves seen in Figure 1, with peak prevalence in the 50–54-year-old age group and peak intensity in the 35–39-year-old age group, may reflect the gradual decrease in transmission of *S. mansoni* during recent decades, and the tendency for chemotherapy to be targeted at younger age groups.

The finding that the prevalence of infection is higher in mother villages than in the ezbas of the same villages is of interest because it indicates, at least for Qalyubia, that earlier surveys[4,5] conducted in villages (but not ezbas) did not result in an underestimation of prevalence. Our data strongly suggest that future efforts to monitor delta-wide changes in prevalence can indeed use the same villages and techniques used in the 1983 and 1990 surveys, making it unnecessary to compound logistical and methodologic demands by including ezbas in the samples.

Finally, with respect to morbidity, our findings of very low levels of significant periportal fibrosis is consistent with the earlier data,[3–7] which showed relatively low intensity of infection and *S. mansoni*-induced morbidity in Qalyubia.

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