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THE EPIDEMIOLOGY OF SCHISTOSOMIASIS IN EGYPT: FAYOUM GOVERNORATE

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Abstract. Health questionnaires and parasitologic examinations of urine and stool were performed upon a stratified random sample of 7,710 individuals from 1,109 households in 21 rural communities in Fayoum Governorate, Egypt in 1992 to investigate the prevalence of, risk factors for, and changing pattern of, infection with *Schistosoma* sp. in the governorate. A subset, every fifth household, or 1,038 subjects, had physical and ultrasound examinations to investigate prevalence of, and risk factors for, morbidity. The prevalence of *S. haematobium* ranged from 0% to 27.1% and averaged 13.7%. The geometric mean egg count (GMEC) was 10.0 eggs/10 ml of urine. Age-stratified prevalence and intensity of infection were 18–25% and 10–15 eggs/10 ml of urine in those 5–25 years of age. *Schistosoma mansoni* were detected in inhabitants of 13 communities, but 78.5% of the infections were focally present in a group of 4 satellite hamlets around a single village. The overall prevalence of *S. mansoni* in the governorate was 4.3% and the GMEC was 44.0 ova/g of stool. Risk factors for infection with either species were male gender, an age <20 years, living in smaller communities, and exposures to canal water by males. Histories of burning micturation, blood in the urine, or prior schistosomiasis and reagent strip-detected hematuria and proteinuria were risks for *S. haematobium*, but not for *S. mansoni*. Both urinary tract and higher grades of hepatic morbidity were rare. Obstructive uropathy was present in 6.3% of the subjects and was more common in males and older people. Ultrasonography-detected bladder lesions were present in 5.2% and correlated with *S. haematobium* only in younger subjects and in those with hematuria and proteinuria. The prevalences of hepatomegaly, splenomegaly, and periportal fibrosis (PPF) were associated with each other and increased with age and in males. Ultrasonography-detected hepatomegaly and splenomegaly were weakly associated with *S. mansoni* infections only in children. The prevalence of PPF was greater in the 4 communities with >25% *S. mansoni* infection rates in comparison with the 17 other villages and ezbas. Transmission of *S. mansoni* is focally well established in Fayoum, which also has the highest prevalence of *S. haematobium* in the governorates surveyed by the Epidemiology 1, 2, 3 Project. However, both urinary tract and hepatic morbidity are relatively rare in the governorate. This probably results from the long-standing schistosomiasis control program in Fayoum, which suppressed intensity more than prevalence of infection, leading to less community morbidity.

El Fayoum, a large oasis in the Egyptian Western Desert 90–130 km southwest of Cairo, is supplied by water through a single canal (Bahr Youssef) from the Nile River (Figure 1 in Husein and others).[1] The governorate is inhabited by 1.2 million people who mainly work in agricultural and related industries. Irrigation is achieved through a system of open canals, with an estimated total length of 39,000 km, draining into Lake Quaroun, a salt lake, at the northwestern end of the governorate. Fayoum was included as 1 of the 9 governorates in the Schistosomiasis Research Project Epidemiology 1, 2, 3 component because of its location in Middle Egypt where *Schistosoma mansoni* is replacing *S. haematobium* and because of the Egyptian Ministry of Health (MOH)/German Federal Republic Fayoum Control Project started in 1969, resulting in extensive epidemiologic data on schistosomiasis in the province.

Under sponsorship of the Egyptian MOH/United States Agency for International Development (USAID)-sponsored Schistosomiasis Research Project, in 1992 we investigated the prevalence and intensity of infection with *Schistosoma* sp., the prevalence and magnitude of morbidity caused by schistosomiasis, the changing pattern of distribution of *S. mansoni* and *S. haematobium*, and the determinants of infection and morbidity in a random sample of rural inhabitants of the governorate.[1] Herein, we report the results of this survey.

SUBJECTS AND METHODS

The sample size, selected by multistage stratified random sampling, was calculated to detect a prevalence of *Schistosoma* sp. as low as 5% in villages or ezbas (satellite group of dwellings) with an 80% precision and 90% confidence level. The findings are considered representative of the rural areas of the entire governorate.[1] The total sample population was 7,710 individuals from 1,109 households in 5 villages and 16 ezbas (group of satellite dwellings). Randomization took place at the village/ezba and household levels, but the total household was included in the study sample.

The interview technique for collecting vital, environmental, sociodemographic, and medical data has been described in detail.[1] Quantitative microscopic counting of *Schistosoma* ova in a single stool specimen from 5,131 subjects using a modified Kato technique (2 slides) and in urine from 5,214 subjects using the Nucleopore (Pleasanton, CA) filter technique were performed as described.[2]

Physical examination and abdominal ultrasonography were performed by trained physicians upon 1,038 inhabitants from a randomly selected subset of 207 households as described.[3] Children less than 5 years of age were excluded from physical and ultrasonographic examinations by protocol but some were examined and these results are included.

Not all data from the 1,038 subjects having physical and ultrasonographic examinations were available for complete analysis for the following reasons: 1) 201 (19.4%) did not provide urine specimens for parasitology, hematuria, and proteinuria examinations; 2) 213 (20.9%) did not provide stool specimens for parasitology examinations; 3) 82 (7.9%) did not have height and weight recorded; 4) 32 (3.1%) did not respond to the questions regarding a history of, or treatment for, schistosomiasis; and 5) 21 (2.0%) failed to respond

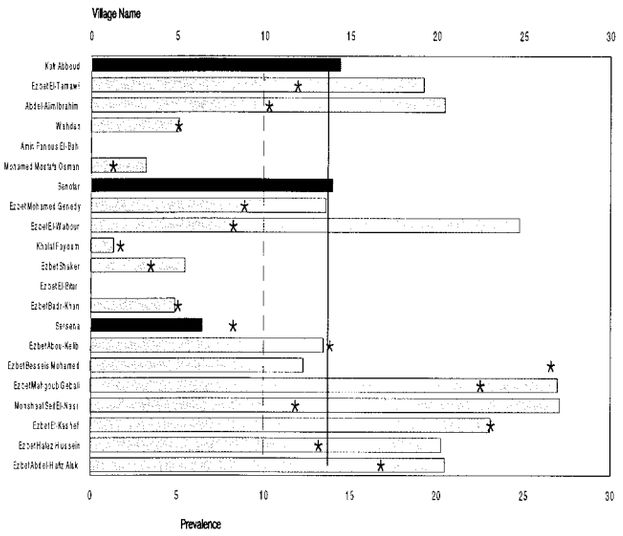

FIGURE 1. Prevalence (%) (**bars**) and intensity (**stars**) of *Schistosoma haematobium* infection in 21 rural communities in El-Fayoum Governorate. Solid horizontal bars show prevalences in villages, shaded horizontal bars show prevalences in ezbas, the solid vertical line is the mean prevalence for all communities, the broken vertical line is the mean intensity of infection, and the stars are the geometric mean egg counts/10 ml of urine for each community.

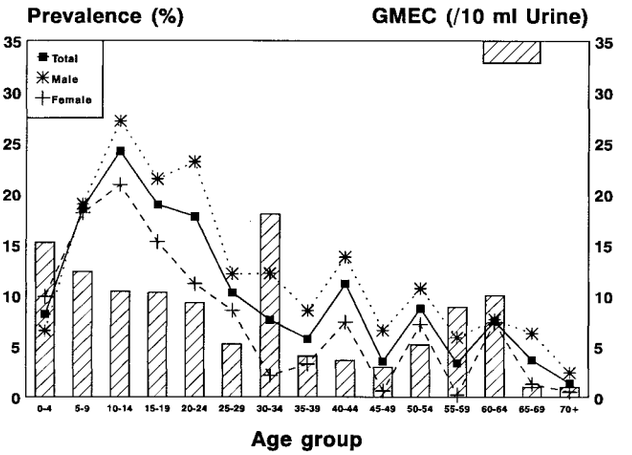

FIGURE 2. Age- and gender-adjusted prevalence and intensity of *Schistosoma haematobium* infection in El-Fayoum Governorate. GMEC = geometric mean egg count.

to the questions regarding burning micturation and blood in the urine. The most important among these omissions are 1) the absence of urine specimens from 20% of the subjects that excludes them from any analyses based upon *S. haematobium* infection, and 2) the absence of height measurements in 8%, which excludes them from any analyses of hepatic enlargement since height was used to adjust for differences in body size.

All data were transferred from the data collection forms to standard precoded sheets for computer entry using Epi-Info 5.01b.[1] Data was verified by the Statistical Core Team prior to analysis. Survey Data Analysis (SUDAAN) software[1] was used to calculate *Schistosoma* prevalence and geometric mean egg count (GMEC) for each governorate in entirety and distributed by community, gender, and age. Further analysis was performed after transformation to SPSS/PC + 4.01 (SPSS, Inc., Chicago, IL). This software was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs). Graphic presentations were prepared using Harvard Graphics 3.0 (Software Publishing Corp., Mountain View, CA). Because of the large volume of data only bivariate analyses was performed. It is possible that multivariate analyses of the data will be conducted at a later time as was done with the data from Minya governorate.[4]

RESULTS

Schistosoma haematobium. The prevalence of *S. haematobium* in the 21 surveyed communities ranged from 0% to 27.1% and averaged 13.7 ± 1.4% (±SEM) (Figure 1). The average intensity of infection in the surveyed villages was 10.0 GMEC/10 ml of urine and ranged from 0 to 26.6. Prevalence followed the classical community pattern for *S. haematobium*, being maximum (18–25%) in those 5–25 years of age and approximately 10% or less in those less than 5 years of age and those more than 25 years of age (Figure 2). Intensity of infection followed no particular age pattern, being higher, i.e., 10–15 ova/10 ml of urine, in all groups less than 25 year of age. Prevalence and intensity of infection was higher in males than in females in most age groups.

Weak, but statistically significant, risk factors in Fayoum for *S. haematobium* infection were age <20 years, male gender, living in ezbas (satellite group of dwellings) rather than mother villages, males bathing in canals, children swimming or playing in canals, and a history of, or treatment for, schistosomiasis (Table 1). Recent history of burning micturation or blood in the urine was more associated with infection in children than in adults. Females washing clothes or utensils in canal water were not at increased risk for infection. Hematuria and proteinuria were highly associated, particularly in children, with *S. haematobium* infection.

Neither hepatomegaly or splenomegaly measured by either physical or ultrasonographic examinations, or ultrasonography-detected periportal fibrosis (PPF) were more likely to be present in subjects with *S. haematobium* ova in their urine than in uninfected subjects. Bladder wall lesions were rare, being present in only 44 (5.2%) subjects. However, they were more frequently present (OR = 3.18, 95% CI = 1.65–6.12) in infected than in uninfected subjects. Obstructive uropathy was detected in 54 (6.3%) subjects; 78% of those with these lesions were adults. However, urinary tract obstruction was associated with *S. haematobium* ova in the urine only in children (OR = 4.74).

Morbidity defined as ultrasonography-detected bladder wall lesions or obstructive uropathy was age dependent, being more prevalent in adults than children (Table 2). It also was more common in males than in females. There was no association between urinary tract morbidity and residence in ezba or village or any of the 3 types of exposures to canal water. Urinary tract morbidity was more than twice as likely to be present in those with *S. haematobium* infections than in those who were uninfected, but the chance of having bladder wall and/or obstructive lesions was not increased in those

with more than 20 ova/10 ml of urine compared with those with lighter infections. A recent history of, or treatment for, schistosomiasis was not significantly associated with urinary tract morbidity. Both a recent history of burning micturation or blood in the urine doubled the odds of morbidity in comparison with those not having these complaints. Detection of hematuria (OR = 1.93) or proteinuria (OR = 2.57) by dipstick testing were both weakly associated with urinary tract morbidity (Table 2).

Hepatomegaly or splenomegaly detected by physical examination were not statistically significant risk factors for urinary tract lesions. Ultrasonography-detected urinary tract lesions were not present more frequently in those having hepatomegaly detected by ultrasonography. However, splenomegaly occurred twice as frequently (OR = 2.03) in children with urinary tract morbidity than in those without bladder or renal lesions. Periportal fibrosis was slightly more common (OR = 1.75) in adults with urinary tract morbidity.

Schistosoma mansoni. A total of 293 (5.7%) inhabitants of 3 villages and 10 ezbas among those surveyed in El Fayoum had *S. mansoni* infections. Most (78.5%) of these were in 4 ezbas belonging to a single village having infection rates ranging from 26% to 35%. Following correction for the stratified sampling, the overall prevalence of *S. mansoni* in the governorate was calculated to be 4.3% with a GMEC of 44.0 ova/g of stool. *Schistosoma mansoni* infection was very age dependent: 231 (78.8%) of those infected were 20 years old or younger. Males were much more likely (OR = 3.31) to be infected than females and all but 7 of those infected lived in ezbas (OR = 8.59). A history of bathing in canal water nearly doubled (OR = 1.83) the odds of males having ova in the stool, but a history among females of washing clothes or utensils or among children of playing or swimming in canals had no impact upon the *S. mansoni* infection rate. Recent history of, or treatment for, schistosomiasis were not risks for schistosomiasis mansoni. *Schistosoma mansoni* infections were not more frequently present in those giving a history of blood in the stools or abdominal pain.

Hepatomegaly and splenomegaly detected by physical examination both occurred with greater frequency in children with *S. mansoni* infection, but only the former was statistically significant (OR = 2.66). A total of 129 (16.3%) of 790 had hepatomegaly detected by physical examination and 86 (10.1%) of 852 had splenomegaly detected by physical examination. The frequency of ultrasonography-detected hepatomegaly measured in the midclavicular line (MCL) was similar (106 of 778; 13.6%), but splenomegaly was detected more than 3 times as frequently by ultrasonography (267 of 826; 32.3%) as by physical examination. Hepatomegaly of the left lobe of the liver measured in the midsternal line (MSL) was detected by ultrasonography in 70 (9.0%) of 777 subjects. Ultrasonography-detected hepatomegaly in the MCL (OR = 3.68) and splenomegaly (OR = 2.16) were associated with *S. mansoni* infection only in children. Periportal fibrosis (OR = 1.68) was not more likely to be present in *S. mansoni*-infected children. Among the 5 subjects having grade II or III lesions, 2 had active *S. haematobium* infections while another had an *S. mansoni* infection. The other 293 with PPF had grade I changes, giving a prevalence of 35.5%.

Periportal fibrosis was age-related, occurring with greater frequency in all older groups in comparison with those less than 10 years old (ORs = 2.10–3.55). Independent variables associated with PPF were male gender (OR = 1.89), living in smaller communities (OR = 1.53), males bathing in canals (OR = 1.83), and females washing clothes and utensils in canals (OR = 1.74). Although 65% of those with *S. mansoni* infections were <15 years old, a history of playing and swimming in canals was not associated with PPF (OR = 0.69). The presence of *S. mansoni* ova in the stools was not related to PPF (OR = 1.29). In addition, the following independent variables did not correlate with PPF: recent history of (OR = 1.19) or treatment for (OR = 1.28), schistosomiasis, blood in stools (OR = 1.33), or abdominal pain (OR = 1.20). However, subjects with PPF had twice the prevalence of hepatomegaly (OR = 2.06) and splenomegaly (OR = 1.99) detected by physical examination as subjects not having PPF. Subjects with PPF did not have a higher prevalence of ultrasonography-detected hepatomegaly in both the MCL (OR = 1.36) and MSL (OR = 1.26) than those without PPF. However, ultrasonography-detected splenomegaly had a positive relationship (OR = 2.52, 95% CI = 1.91–3.32) with PPF.

Community morbidity relationships. Hepatomegaly and splenomegaly detected by physical examination increased in the entire study population with age. The physical examination-detected splenomegaly rate was greatest in the community with the highest GMEC for *S. haematobium*. Ultrasonography-detected splenomegaly and PPF were age dependent, both increasing from a prevalence of about 10% in the youngest age group to approximately 50% in adults more than 35 years of age (Figure 3). Hepatic enlargement was slightly more prevalent in adults more than 35 years old, i.e., approximately 20% hepatomegaly measured at the MCL and approximately 10% hepatomegaly measured at the MSL in comparison with children. Ultrasonography-detected enlargement of the right lobe of the liver had the highest prevalence in the village with the highest GMEC for *S. haematobium*, which also was the community having the highest rate of bladder wall lesions. Bladder wall lesions were more common in the younger age groups, while obstructive uropathy was more prevalent in older adults (Figure 4).

Although the 4 communities with prevalences of *S. mansoni* greater than 25% had a higher ratio of inhabitants having physical examination- and ultrasonography-detected hepatomegaly and splenomegaly and PPF than the 17 communities having no or low infection rates with *S. mansoni*, only the difference in PPF prevalence rates was statistically significant (Table 3).

DISCUSSION

Despite the fact that El Fayoum has had the longest ongoing schistosomiasis control program in Egypt, primarily based upon applying molluscicides directly in the Bahr Youssef (which feeds all water to the province) and the other major irrigation canals, it had the highest *S. haematobium* infection rate and was the only governorate among those studied by the Epidemiology 1, 2, 3 Project that had a substantial prevalence of both *Schistosoma* sp.[5] Transmission of *S. mansoni* is well established focally in El Fayoum. Among the 5 villages and 16 ezbas surveyed in this project, 4 ezbas

TABLE 1
Odds ratio and 95% confidence limits for risk factors for infection with *Schistosoma haematobium* in Fayoum Governorate*

Risk factor	Total in group	Infected No. (%)	Odds ratio	Confidence limits
Demographics				
Age groups (years)				
0–10	1,950	314 (16.1)		
11–20	1,263	264 (20.9)	1.38	1.15–1.65
21–35	985	74 (7.5)	0.42	0.32–0.55
36–55	701	49 (7.0)	0.39	0.29–0.54
>55	315	14 (4.4)	0.24	0.14–0.42
Gender				
Female	2,658	306 (11.5)		
Male	2,556	409 (16.0)	1.46	1.25–1.72
Domicile				
Village (≥500 houses)	1,546	189 (12.2)		
Ezba (<500 houses)	3,668	526 (14.3)	1.20	1.01–1.44
Exposure to canal water				
Bathing (males)				
No	1,218	167 (13.7)		
Yes	1,261	233 (18.5)	1.43	1.15–1.77
Washing (females)				
No	1,164	129 (11.1)		
Yes	1,477	176 (11.9)	1.09	0.85–1.38
Playing (children <15 years old)				
No	1,447	233 (16.1)		
Yes	1,066	208 (19.5)	1.26	1.03–1.55
Clinical findings				
History of schistosomiasis				
No	2,476	339 (13.7)		
Yes	994	164 (16.5)	1.25	1.02–1.53
Prior treatment of schistosomiasis				
No	4,058	536 (13.2)		
Yes	973	164 (16.9)	1.33	1.10–1.61
History of burning micturition				
No	540	72 (13.3)		
Yes (total)	316	60 (19.9)	1.52	1.01–2.22
<15 years	124	36 (29.0)	2.05	1.25–3.35
≥15 years	192	24 (12.5)	1.39	0.76–2.54
History of blood in urine				
No	654	68 (10.4)		
Yes	203	65 (32.0)	4.06	2.76–5.98
<15 years	115	50 (43.5)	5.73	3.45–9.51
≥15 years	88	15 (17.0)	2.04	1.05–3.97
Hepatomegaly in MCL (by PE)				
No	661	104 (15.7)		
Yes	129	17 (13.2)	0.81	0.47–1.41
<15 years	49	10 (20.4)	1.02	0.48–2.14
≥15 years	80	7 (8.8)	0.78	0.33–1.82
Splenomegaly (by PE)				
No	766	123 (16.1)		
Yes	86	10 (11.6)	0.69	0.35–0.37
<15 years	24	7 (29.2)	1.63	0.65–4.06
≥15 years	62	3 (4.8)	0.38	0.11–1.27
Laboratory findings				
Hematuria				
No	3,584	196 (5.5)		
Yes	1,534	502 (32.8)	8.43	7.05–10.09
<15 years	719	329 (45.8)	13.17	10.32–16.82
≥15 years	815	174 (21.3)	5.24	3.99–6.87

TABLE 1
Continued

Risk factor	Total in group	Infected No. (%)	Odds ratio	Confidence limits
Proteinuria				
No	4,940	602 (12.2)		
Yes	178	97 (54.5)	8.63	6.35–11.73
<15 years	108	76 (70.4)	13.39	8.73–20.54
≥15 years	70	21 (30.0)	4.09	2.41–6.93
Ultrasonography				
Hepatomegaly in MCL				
No	672	102 (15.2)		
Yes	106	16 (15.1)	0.99	0.56–1.76
<15 years	55	12 (21.8)	1.15	0.57–2.31
≥15 years	51	4 (7.8)	0.69	0.23–2.01
Hepatomegaly in MSL				
No	707	107 (15.1)		
Yes	70	11 (15.7)	1.05	0.53–2.05
<15 years	37	8 (21.6)	1.13	0.49–2.58
≥15 years	33	3 (9.1)	0.83	0.24–2.83
Splenomegaly				
No	559	79 (14.1)		
Yes	267	43 (16.1)	1.17	0.78–1.75
<15 years	89	19 (21.3)	1.18	0.66–2.11
≥15 years	178	24 (13.5)	1.74	0.93–3.26
Periportal fibrosis				
No	542	89 (16.4)		
Yes (≥3 mm)	298	36 (12.1)	0.70	0.46–1.06
<15 years	103	15 (14.6)	0.64	0.35–1.19
≥15 years	195	21 (10.8)	1.02	0.55–1.88
Grade I (3–<5 mm)	293	34 (11.6)	0.67	0.44–1.02
Grade II (5–<7 mm)	4	1 (25.0)	1.70	0.17–16.50
Grade III (≥7 mm)	1	1 (100.0)		
Bladder wall lesions				
No	793	111 (14.0)		
Yes	44	15 (34.1)	3.18	1.65–6.12
<15 years	25	10 (40.0)	2.90	1.25–6.71
≥15 years	19	5 (26.3)	3.38	1.16–9.88
Obstructive uropathy				
No	796	117 (14.7)		
Yes	54	12 (22.2)	1.66	0.85–3.24
<15 years	12	6 (50.0)	4.74	1.52–14.78
≥15 years	42	6 (14.3)	1.50	0.63–3.60

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

geographically close to each other had *S. mansoni* infection rates between 25% and 35% with GMECs between 46 and 72 ova/g stool. Another nearby ezba had an *S. mansoni* prevalence of 10% with a GMEC of 40 ova/g of stool. A sixth ezba had a prevalence and intensity of about half of that, while the other 15 villages and ezbas had very few, or no, infections with this species. This confirms another study reporting that *S. mansoni* transmission is occurring focally in Fayoum.[6] *Biomphalaria alexandrina*, the snail reservoir for *S. mansoni*, was also reported in that publication to be replacing *Bulinus truncatus*, the reservoir for *S. haematobium*, focally in the local waterways. Although there is no snail data in the present report to substantiate this, the fact that all but 1 ezba with high *S. mansoni* infection rates had low, i.e., 0–6%, *S. haematobium* infection rates supports the conclusion that *S. mansoni* is replacing *S. haematobium* transmission in the Fayoum. Although we are unaware of reports of *S. mansoni* transmission in Fayoum prior to 1990, it was focally well established at that time (Table 4). Three of 103 villages surveyed had high prevalences of *S. mansoni* and the snail reservoir was abundant in the local water channels.

The first survey of El Fayoum by Scott reported the highest countrywide prevalence of *S. haematobium* in the country;[7] 89% of 1,510 subjects his team studied in the governorate were infected. The infection rates decreased to the 38–55% range in the 1950s and 1960s (Table 4). In 1969, the Egyptian MOH/German Federal Republic Fayoum Control Project based upon the application of niclosamide to Bahr Youssef in the spring and autumn was started. The survey performed prior to the start of the project, which showed an infection rate of 46% in the governorate, is considered complete and accurate. About the same time, the MOH replaced tartar emetic with the easier to administer oral niridazole for treating children. Snail surveys in the

TABLE 2

Odds ratio and 95% confidence limits for risk factors for urinary tract morbidity (obstructive uropathy and/or bladder wall lesion) with *Schistosoma haematobium* in Fayoum Governorate*

Risk factor	Total in group	Morbidity No. (%)	Odds ratio	Confidence limits
Demographics				
Age groups (years)				
0–10	375	33 (8.8)		
11–20	267	27 (10.1)	1.17	0.68–1.99
21–35	207	24 (11.6)	1.36	0.78–2.37
36–55	134	17 (12.7)	1.51	0.81–2.80
>55	55	12 (21.8)	2.89	1.39–6.02
Gender				
Female	497	34 (6.8)		
Male	541	79 (14.6)	2.33	1.53–3.55
Domicile				
Village (≥500 houses)	274	28 (10.2)		
Ezba (<500 houses)	764	85 (11.1)	1.10	0.70–1.73
Exposure to canal water				
Bathing (males)				
No	235	33 (14.0)		
Yes	282	44 (15.6)	1.13	0.69–1.84
Washing (females)				
No	181	15 (8.3)		
Yes	309	19 (6.1)	0.73	0.36–1.46
Playing (children <15 years old)				
No	259	24 (9.3)		
Yes	234	22 (9.4)	1.02	0.55–1.87
Parasitologic findings				
S. haematobium infection				
No	626	57 (8.7)		
Yes	125	23 (18.4)	2.37	1.40–4.02
<20 ova/10 ml of urine	87	16 (18.4)	2.37	1.29–4.34
≥20 ova/10 ml of urine	38	7 (18.4)	2.37	1.00–5.63
Clinical findings				
History of schistosomiasis				
No	445	52 (11.7)		
Yes	204	28 (13.7)	1.20	0.73–1.97
Prior treatment of schistosomiasis				
No	795	82 (10.3)		
Yes	202	28 (13.9)	1.40	0.88–2.22
History of burning micturition				
No	660	56 (8.5)		
Yes (total)	357	54 (15.1)	1.92	1.29–2.86
<15 years	138	16 (11.6)	1.46	0.76–2.78
≥15 years	219	38 (17.4)	2.19	1.29–3.72
Present and/or past history of blood in urine				
No	784	70 (8.9)		
Yes	233	39 (16.7)	2.05	1.34–3.13
<15 years	126	24 (19.0)	3.84	2.06–7.19
≥15 years	107	15 (14.0)	1.23	0.66–2.30
Hepatomegaly in MCL (by PE)				
No	793	80 (10.1)		
Yes	155	22 (14.2)	1.47	0.88–2.44
<15 years	56	6 (10.7)	1.20	0.48–2.99
≥15 years	99	16 (16.2)	1.54	0.83–2.86
Splenomegaly (by PE)				
No	927	96 (10.4)		
Yes	88	14 (15.9)	1.63	0.89–3.01
<15 years	23	4 (17.4)	2.18	0.71–6.72
≥15 years	65	10 (15.4)	1.34	0.65–2.79

TABLE 2
Continued

Risk factor	Total in group	Morbidity No. (%)	Odds ratio	Confidence limits
Laboratory findings				
Hematuria				
No	590	52 (8.8)		
Yes	248	39 (15.7)	1.93	1.24–3.01
<15 years	120	15 (12.5)	1.91	0.94–3.88
≥15 years	128	24 (16.6)	1.95	1.10–3.46
Proteinuria				
No	812	85 (10.5)		
Yes	26	6 (23.1)	2.57	1.00–6.57
<15 years	17	3 (17.6)	2.40	0.66–8.81
≥15 years	9	3 (33.3)	3.47	0.84–14.30
Ultrasonography				
Hepatomegaly in MCL				
No	824	93 (11.3)		
Yes	132	9 (6.8)	0.58	0.28–1.17
<15 years	70	6 (6.8)	0.91	0.37–2.24
≥15 years	62	3 (4.8)	0.34	0.10–1.12
Hepatomegaly in MSL				
No	874	93 (10.6)		
Yes	81	9 (11.1)	1.05	0.51–2.17
<15 years	44	6 (13.6)	1.64	0.65–4.12
≥15 years	37	3 (8.1)	0.63	0.19–2.10
Splenomegaly				
No	705	65 (9.2)		
Yes	306	44 (14.4)	1.65	1.10–2.49
<15 years	104	15 (14.4)	2.05	1.05–3.99
≥15 years	202	29 (14.4)	1.34	0.79–2.26
Periportal fibrosis				
No	667	61 (9.1)		
Yes (≥3 mm)	360	50 (13.9)	1.60	1.08–2.39
<15 years	125	13 (10.4)	1.22	0.62–2.40
≥15 years	235	37 (15.7)	1.75	1.04–2.94
Grade I (3–<5 mm)	354	50 (14.1)	1.63	1.10–2.43
Grade II (5–<7 mm)	4	0 (0.0)		
Grade III (≥7 mm)	2	0 (0.0)		

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

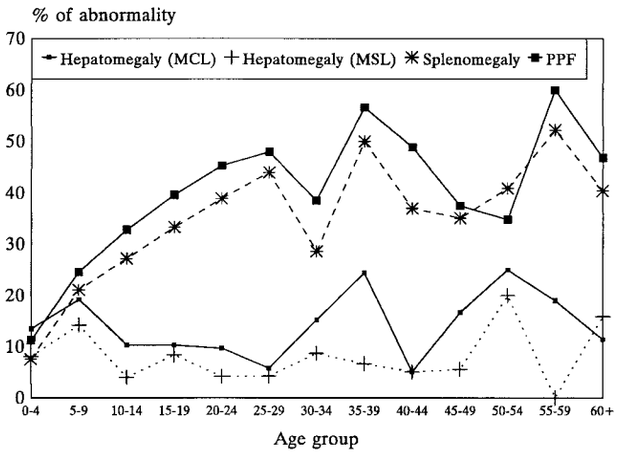

FIGURE 3. Age-adjusted prevalence of ultrasound-detected hepatomegaly, splenomegaly, and periportal fibrosis (PPF) in El-Fayoum Governorate. MCL = midclavicular line; MSL = midsternal line.

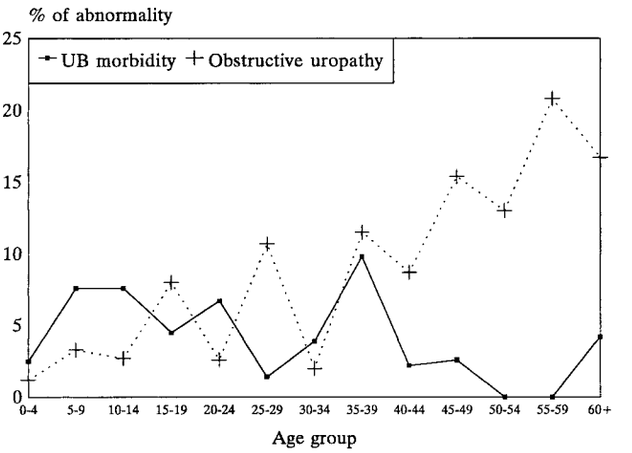

FIGURE 4. Age-adjusted prevalence of ultrasound-detected urinary tract obstruction and bladder wall lesions in El-Fayoum Governorate. UB = urinary bladder wall.

TABLE 3

Prevalence of morbidity variables in the 4 communities with *Schistosoma mansoni* infection rates of >25% compared with the 17 communities with *S. mansoni* infection rates between 0% and 8.9%

Variables*	Villages with *S. mansoni*	Villages with *S. haematobium* only	Difference (*P*)
PPF	41.8%	30.8%	0.005
Hepatomegaly (PE)	21.0%	16.1%	0.119
Hepatomegaly (MCL)	17.1%	12.8%	0.134
Hepatomegaly (MSL)	8.6%	8.3%	0.890
Splenomegaly (PE)	9.4%	9.0%	0.839
Splenomegaly (US)	35.6%	29.0%	0.088

* PPF = periportal fibrosis; PE = physical examination; MCL = midclavicular line; MSL = midsternal line; US = ultrasonography.

governorate described many *B. truncatus* present in the water channels with 18.3% of them infected with *S. haematobium*.[8] Over the next 6 years the prevalence of *S. haematobium* decreased to less than 10% and remained at that level until 1981 when molluscicide was discontinued.[8,9] Also, by 1972, the infection rate in young children had decreased to 2.6%, suggesting transmission was being interrupted. Thereafter, the *S. haematobium* infection rate has remained consistently between 13.7% and 17.7%, despite focal molluscicide in the governorate after 1984 (Table 4). The introduction of treatment with the modern antischistosomal drugs, metrifonate in 1977 and praziquantel in 1985, has markedly improved the ease of using chemotherapy for control. More recent prevalences reported by the MOH are surprisingly close to the infection rate of 13.7% found in the present study (Table 4).[10] An interesting survey published by Abdel-Salem and others in 1986 documented that molluscicide had little impact on snail control in communities further away from the main canals.[11] Her team investigated children from 3 communities; only the one located near the main canal had a low (2.2%) prevalence of *S. haematobium*; children from the other 2 communities, both more to the periphery, had infection rates of 61.3% and 76.3%. This clearly documents that applying molluscicides to Bahr Youssef did not, by itself, control the transmission of *S. haematobium* in the Fayoum. However, the 3-year interruption in treating water channels with niclosamide after 1980 led to doubling the prevalence of *S. haematobium* in the governorate and this level of transmission has persisted (Table 4). This lack of response to the reinstitution of snail control may be the result of a change in the application of niclosamide. From 1968 until 1980 area-wide treatment was used at a dose of 1–2 ppm twice a year. However, focal application of less niclosamide has been the strategy after 1984.

Risk factors for *S. haematobium* infection in El Fayoum were an age less than 20 years, male gender, a domicile in smaller communities, and males bathing or children playing or swimming in canal water. All of these risks were weak, with the exception of age: the odds of infection in children and adolescents was double or triple that of adults. The strongest risks for *S. mansoni* were younger age, male gender, males bathing in canal water, and living in ezbas. The latter increased the odds of infection almost 20-fold since almost all of those found infected with this species lived in satellite communities. A recent history of, or treatment for, schistosomiasis was a weak risk for *S. haematobium*, but not for *S. mansoni*. This finding can be explained by the fact that *S. mansoni* has been newly introduced into the governorate and two-thirds of those infected with this parasite

TABLE 4

Reported prevalence of *Schistosoma haematobium* and *S. mansoni* in El Fayoum Governorate and its relationship to schistosomiasis control programs

Year	Prevalence (%)		Control methods		Reference
	S. haematobium	*S. mansoni*	Molluscides	Chemotherapy	
1935	89.0	0	None	None	Scott (1937)[7]
1952	55.0	0	None	Tartar emetic	MOH*
1955	38.0	0	None	Tartar emetic	MOH
1968	45.7	0	2 times/year†	TE/niridazole‡	Abdullah (1976)[8]
1969	43.9	0	2 times/year	TE/niridazole	Abdullah (1976)[8]
1970	36.9	0	2 times/year	TE/niridazole	Abdullah (1976)[8]
1971	23.2	0	2 times/year	TE/niridazole	Abdullah (1976)[8]
1972	18.8	0	2 times/year	TE/niridazole	Abdullah (1976)[8]
1974	9.1	0	2 times/year	TE/niridazole	Abdullah (1976)[8]
1975	8.1	0	2 times/year	TE/niridazole	Mobarek (1982)[9]
1980	7.0	0	2 times/year	Metrifonate§	Mobarek (1982)[9]
1981	17.7	0	None	Metrifonate	MOH¶
1983	17.2	0	None	Metrifonate	MOH¶
1984	15.2	0	Focal#	Metrifonate	MOH¶
1985	14.6	0	Focal	Praziquantel**	MOH¶
1986	15.6	0	Focal	Praziquantel	MOH¶
1987	16.1	0	Focal	Praziquantel	MOH¶
1990	Not available	+	None	Praziquantel	MOH¶
1992	13.7	4.7	None	Praziquantel	Present study

* Unpublished Egyptian Ministry of Health (MOH) data.
† Bahr Youssef was treated with niclosamide twice annually in the spring and autumn.
‡ Tartar emetic (TE) given intravenously twice a week in up to 12 doses for up to 6 weeks was used to treat adults infected with schistosomiasis. Children were treated orally with niridazole, 25 mg/kg of body weight once a day for 5–7 days.
§ Metrifonate was administered at a dose of 10 mg/kg of body weight orally every 2 weeks up to 3 doses to infected adults and children.
¶ Data from Fayoum Governorate Endemic Diseases Units reported 3 of 103 villages and ezbas from which information was available had transmission of *S. mansoni* with prevalence averaging 25% and abundant *Biomphalaria alexandrina* in the local channels.
# Niclosamide was applied focally to known sites of transmission in the spring and autumn.
** Praziquantel was administered orally in a single dose of 40 mg/kg of body weight to infected patients.

were ≥20 years old. Therefore, many of this group had not had detected schistosomal infections in the past. Another hypothesis is that almost all of those having schistosomiasis mansoni lived in smaller communities where access to medical care is less readily available, and, therefore, they were less likely to have been diagnosed and treated in the past. Several other investigators, starting with Scott, have documented that peak prevalence of *S. haematobium* in perennially irrigated areas in Egypt occurs between the ages of 8 and 15 years in both sexes.[7,12,13] Infection occurs while males are bathing in canals, when children swim and play in canals, and often when the fields are being irrigated. School children from a village in Fayoum who gave histories of exposure to canal water had twice (36% versus 18%) the prevalence of *S. haematobium* as children from the same school denying these risks.[14] Adult females seldom have these same types of exposures, and since their exposures while washing clothing and utensils in the canals are much less intense, they are less frequently infected.

The association of a history of recent burning micturation and hematuria with *S. haematobium* ova in the urine was much weaker in adults than in children since the former had a much lower infection rate (which would reduce the positive correlation) and had other causes of these symptoms (which would increase the negative correlation). A history of blood in the stool or of abdominal pain was not associated with *S. mansoni* infection. We are unaware of recent studies correlating abdominal pain with *S. mansoni* infection and have noted earlier that a history of blood in stools was a correlate only in children.[15] The sample in the present study was too small to demonstrate this latter association.

Just as was found in the other governorates endemic for schistosomiasis haematobia, dipstick detected hematuria and proteinuria were twice as common in children as in adults and strongly correlated with active *S. haematobium* infections, particularly in children. This has been more extensively evaluated using the data from Minya.[16]

Since the prevalence of urinary tract morbidity increased with age, but not to exposure to canal water or prior schistosomiasis, many subjects probably had other causes for urinary bladder lesions and obstructive uropathy; or the urinary tract morbidity result from earlier *S. haematobium* infections. However, these abnormalities were also more common in males, in those who said they had a recent history of burning micturation or blood in the urine, and in those whose urine was dipstick positive for blood and protein. In addition, both bladder wall lesions and obstructive uropathy occurred more frequently in children with active *S. haematobium* infections. These points support the role of schistosomiasis haematobia in urinary tract morbidity in Fayoum since ultrasonography-detected bladder and renal lesions are frequently detected in active infections,[17,18] and they are much more specific for schistosomiasis haematobia in children than in adults.[19] With the exception of very weak relationships between splenomegaly and urinary tract morbidity in children and between PPF and urinary tract morbidity in adults, there was no correlation between liver and spleen lesions and urinary tract lesions. Any positive associations may be due to the hepatic and urinary tract lesions being independently present in the same subjects (confounding). Another possibility for the association in children is that *S. haematobium* infections may also cause mild liver involvement and portal hypertension with resulting hepatomegaly and splenomegaly.[14,20] This would not be detected in adults since they have more frequent confounding from nonschistosomal causes of hepatic abnormalities and splenomegaly.

There was no relationship between PPF and the presence of *S. mansoni* ova in the stool or between PPF and a history of schistosomiasis. The prevalence of PPF was primarily influenced by the subject's age, gender and social status, and not by schistosomiasis. Adults with hepatomegaly and splenomegaly were more likely to have PPF than those having normal size livers and spleens. These findings suggest we may have detected hepatic abnormalities, manifested as an increased prevalence of PPF, hepatomegaly, and splenomegaly, in a large proportion of the adult subjects we screened in Fayoum. This could not be associated with either schistosomiasis haematobia or schistosomiasis mansoni and we speculate it may also be a result of high prevalence of liver involvement from chronic viral hepatitis. Our earlier studies standardizing the detection and grading of PPF using ultrasonography were performed in hospitalized patients with moderate-to-severe schistosomal hepatic fibrosis.[21] Although we have found ultrasonography to be useful in detecting minimal lesions,[14] the sensitivity and specificity of ultrasonographic screening for PPF in communities is unknown and cannot be ethically established by using liver biopsy results as the gold standard. There is a report that grade I PPF changes may be visualized by ultrasonography in subjects with chronic hepatitis.[22]

Because *S. mansoni* and *S. haematobium* had a tendency not be present in the same communities, we were able to compare morbidity in the 4 ezbas having *S. mansoni* infection rates >25% with the 17 communities having *S. mansoni* infection rates <9.0% with or without *S. haematobium.* Only PPF was significantly more common in those communities having high prevalences of schistosomiasis mansoni. This, contrary to the above findings, suggest that schistosomiasis mansoni is a cause of PPF in El Fayoum.

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