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Assessment of Severity of Disease Caused by *Schistosoma haematobium* and *S. mansoni* in the Egypt-49 Project Area

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The impact of bilharziasis on a community has been evaluated in terms of the stages and grades of severity of the disease; egg counts in faeces and urine were correlated with the clinical severity. At the time this study was carried out, the over-all prevalence of S. haematobium *infection was 37.6%, that of* S. mansoni *infection 29.8% and that of mixed infections 17.1%.*

Of 579 people examined, 292 (58.2%) were excreting schistosome eggs. All except one person were classified as Stage III—asymptomatic, 122 (41.8% of those infected); mild, 74 (25.3%); moderate, 89 (30.5%); severe, 6 (2.1%). The remaining person was classified as Stage IV (moderate). Mixed infections produced a higher proportion of symptomatic cases (74.8%) than either infection alone (58.2%), and S. haematobium *(57.1%) a higher proportion than* S. mansoni *(37.8%). The percentage of symptomatic cases was highest in those aged 10-14 years, who also had the highest prevalence of infection.*

On average, the egg output per infection was in the range 32-63 eggs for S. haematobium *infections and 4-7 for* S. mansoni *in unit measure of urine and faeces, respectively. For* S. haematobium *infections, alone and in mixed infections, mean egg output increased with the severity of clinical symptoms. For* S. mansoni *infections, no such relation was established.*

It is concluded that the criteria of severity should be made more objective and that more satisfactory methods of determining egg counts should be adopted in an attempt to obtain more direct evidence of the validity of regarding egg count as a measure of worm load.

A survey to assess the impact of bilharziasis on a community was undertaken within the limits of the project resources and without any elaborate machinery. The disease load was evaluated by means of the criteria for stages and grades of severity given in Annex 3. Egg counts were made to assess the feasibility of correlating egg output with the clinical severity of the disease.

A partial analysis of the data obtained during the first six months of the study, July to December 1963, which covered the examination of a sample of 579 individuals, has provided quantitative information on the severity of bilharziasis within a community and has established a positive correlation between egg output and severity of disease.

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MATERIALS AND METHODS

Study area

The study area, the Akrisha section of the project area,[4] covers about 26 km² and has a population of 18 000 distributed in 41 villages. It represents an old-established agricultural area typical of the rural conditions in the Nile Delta. The population is homogeneous with regard to socio-economic conditions, religion and habits, consisting mostly of farmers with smallholdings, farm labourers and manual labourers, some of whom are employed in a textile factory in the neighbouring town of Kafr el Dawar. The villages consist mainly of compact groups of mud or mudbrick houses close to irrigation canals or drains. The sanitation and environmental conditions favour the maintenance of the

[4] See the papers on pages 281 and 293 of this issue for a discussion of the project area.

TABLE 1
PREVALENCE OF HELMINTHIC INFECTIONS BY AGE IN AKRISHA SECTION: JUNE TO OCTOBER 1962

Age-group (years)	No. examined	Percentage infected with				
		Ascaris	*Ancylostoma*	*Enterobius*	*Hymenolepis*	Other helminths
0-4	164	47.6	1.2	0.6	3.7	
5-9	154	76.6	2.6		3.9	
10-14	122	73.8	4.9		1.6	
15-19	87	59.8	6.9			
20-24	61	68.9	3.3			
25-29	85	65.9	3.5			
30-34	60	71.7	6.7	1.7		
35-39	56	67.9	7.1		1.8	
40-44	46	78.3	6.5			
45-49	38	76.3	5.3	2.6		
50-54	43	72.1	4.7	2.3		
55-59	10	50.0	10.0			
60+	47	63.8	6.4	2.1	4.3	4.3
Total	973	66.6	4.3	0.5	1.7	0.2

transmission of bilharziasis at a fairly high level. In recent years, 12 of the larger villages in the section (representing a population of 11 360) have been provided with one or two public water standpipes, which are popular sources of drinking-water.

As in the rest of the project area, no organized bilharziasis control has been undertaken in Akrisha. No molluscicides have been applied and no significant amount of chemotherapy has been administered, less than 3% of the population having received a full course of treatment during the three years preceding the investigation. No control measures are envisaged in the immediate future.

There is very little malaria. Cases of pellagra are occasionally encountered; otherwise the general nutritional status of the population is fairly good. Trachoma is a common infection among children and so are gastroenteritis and acute pulmonary infections. *Ascaris* is the most prevalent soil-transmitted helminth, with a prevalence rate of 66.6%. The prevalence of *Ancylostoma* is 4.3%, and other helminthic infections are relatively unimportant. Age-specific rates obtained in a recent survey in the area are given in Table 1.

Medical aid is available to the villagers at a 132-bed general hospital in Kafr el Dawar town, 5 km from the centre of Akrisha section. There is also a rural health centre situated at the northern outskirts of the area. Good road communications exist between the area and the city of Alexandria, 30 km away.

Sample examined

The prevalence of bilharziasis in Akrisha section was studied from June to October 1962, as part of the general survey undertaken to obtain base-line data for the project area. Sampling procedures and techniques employed during the survey have been described by Farooq & Nielsen.[1]

The same sample of individuals covered by the above survey was chosen for the clinical study. It includes 973 people, from 215 households in five villages, representing a 5% stratified random sample of the population of Akrisha section.

Prevalence rates of *Schistosoma haematobium*, *S. mansoni* and mixed infections, by age-group and by occupation, are shown in Tables 2 and 3, respec-

[1] See the paper on page 281 of this issue.

TABLE 2

PREVALENCE OF *S. HAEMATOBIUM* AND *S. MANSONI* INFECTIONS BY AGE IN AKRISHA SECTION: JUNE TO OCTOBER 1962

Age-group (years)	No. examined	Number with				Percentage with			
		S. haematobium infection	*S. mansoni* infection	Mixed infection	"Bilharziasis"	*S. haematobium* infection	*S. mansoni* infection	Mixed infection	"Bilharziasis"
0-4	164	20	16	7	29	12.2	9.8	4.3	17.7
5-9	154	67	50	33	84	43.5	32.5	21.4	54.0
10-14	122	75	65	50	90	61.5	53.3	41.0	73.8
15-19	87	35	33	18	50	40.2	37.9	20.7	57.5
20-24	61	24	25	12	37	39.3	41.0	19.7	60.7
25-29	85	24	38	10	52	28.2	44.7	11.8	61.2
30-34	60	14	28	10	32	23.3	46.7	16.7	53.3
35-39	56	17	21	12	26	30.4	37.5	21.4	46.4
40-44	46	9	15	6	18	19.6	32.6	13.0	39.1
45-49	38	10	10	4	16	26.3	26.3	10.5	42.1
50-54	43	12	14	6	20	27.9	32.6	14.0	46.5
55-59	10	1	3	1	3	10.0	30.0	10.0	30.0
60+	47	9	13	6	16	19.1	27.7	12.8	34.0
Total	973	317	331	175	473	32.6	34.0	18.0	48.6

TABLE 3

PREVALENCE OF *S. HAEMATOBIUM* AND *S. MANSONI* INFECTIONS BY OCCUPATION IN AKRISHA SECTION: JUNE TO OCTOBER 1962

Occupation	No. examined	Number with				Percentage with			
		S. haematobium infection	*S. mansoni* infection	Mixed infection	"Bilharziasis"	*S. haematobium* infection	*S. mansoni* infection	Mixed infection	"Bilharziasis"
Farmer	253	94	105	56	143	37.2	41.5	22.1	56.5
Farm labourer	200	67	76	40	103	33.5	38.0	20.0	51.5
Landowner	4	1	1	1	1	25.0	25.0	25.0	25.0
Fisherman	9	2	3	1	4	22.2	33.3	11.1	44.4
Boatman	12	6	3	3	6	50.0	25.0	25.0	50.0
Skilled labourer	203[a]	59	51	28	82	29.1	25.1	13.8	40.4
Manual labourer	68	27	22	14	35	39.7	32.4	20.6	51.5
Clerical	28	7	7	4	10	25.0	25.0	14.3	35.7
Professional	47	14	19	11	22	29.8	40.4	23.4	46.8
None or other	149	40	44	17	67	26.8	29.5	11.4	45.0
Total	973	317	331	175	473	32.6	34.0	18.0	48.6

[a] Most work in a textile factory in Kafr el Dawar town.

tively. The over-all prevalence of *S. haematobium* is 32.6% and that of *S. mansoni* 34.0%. Both infections attain maximum rates, 61.5% and 53.3%, respectively, in the age-group 10-14 years. In this age-group, 73.8% have one or both of these infections. Among the occupational groups, farmers, farm labourers, boatmen and other manual labourers have the higher rates of infection, as in the rest of the project area.[1]

It should be noted that the prevalence rates for *S. haematobium*, *S. mansoni* and mixed infections computed from the results of the clinical survey of July to December 1963 were 37.6%, 29.8% and 17.1% respectively, in comparison with the figures of 32.6%, 34.0% and 18.0% obtained in the 1962 survey. Although these differences are significant at the 5% level in respect of *S. haematobium* infections ($\chi^2=3.93$) and mixed infections ($\chi^2=24.70$), the difference in respect of *S. mansoni* infection is not ($\chi^2=2.81$). There may be several reasons for these differences, e.g., the time of collection of urine samples, which was early afternoon in the present survey and morning in the earlier one, or the different techniques employed in urine examination. Other workers (Bennie, 1949; Stimmel & Scott, 1956; Onori, 1962; Jordan, 1963) have shown that egg output is highest in afternoon urine samples and also (Bradley, 1963) least variable. The number of mixed infections observed during both surveys in Akrisha, as in the rest of the project area, was greater than would be expected to occur by chance: the observed rates were 18.1% and 17.1%, in comparison with the expected 11.2%. This is in agreement with the findings of Scott (1937) during an earlier survey in Egypt.

Methods

The study was preceded by an exploratory test, carried out in one village, of the examination procedures and record form.

A team of three people—a physician, a technician and a female attendant—visited each of the selected households; in addition, a second medical opinion was frequently obtained. The team operated from the project field unit based in Kafr el Dawar town. All individuals in the sampled households were examined and up to 10 individuals were seen each day between 9 a.m. and 1 p.m. Examination record forms were filled in on the spot. Specimens of urine and faeces were brought to the laboratory at the field centre for examination and examined the same afternoon.

The techniques employed in the examination of urine and faeces for egg counts are given in Annex 1 and the form on which the survey data were recorded is included as Annex 2.

The criteria followed in establishing the severity of the disease are based on the clinical manifestations of the stages in the pathogenesis of bilharziasis and their grades of severity; they are summarized in Annex 3.

The signs and symptoms determining the stages and degrees of severity of the disease are included in sections III and V of the survey form. On the basis of these, on the day of examination, the clinical stages in section VI were recorded.

The results reported in this paper are based on the examination of 579 individuals up to December 1963.

ANALYSIS OF RESULTS

Clinical gradient

Of the 579 individuals examined, 292 were found to be excreting schistosome ova and 170 (58.2%) of these showed overt disease. In Table 4, these cases are classified in each of the stages and grades of severity of the disease, for infection with either species of parasite and for mixed infections. No individual could be classified in stage I or II on the basis of symptoms alone, and only a single individual with a mixed infection could be placed in the moderate grade of stage IV.

It will be noted from Table 4 that there is a greater proportion of symptomatic cases (74.8%) among individuals with a mixed infection than among those with *S. haematobium* or *S. mansoni* infection alone. This could reasonably be expected when two species of parasite are present in an individual. The higher proportion of symptomatic cases among *S. haematobium* (57.1%) than among *S. mansoni* (37.8%) infections appears to be due to the ease with which the former infection manifests itself in the form of visible haematuria, nocturia or dysuria.

A breakdown of the data by age-group is presented in Table 5. Unfortunately, the data for each category are too few to enable firm conclusions to be drawn in respect of the relation between age and type of infection, but the totals for the three types of infection do indicate general trends. The percentage of symptomatic cases is higher in those aged 10-14 years than in any other age-group. Only 23.4% of all cases in this age-group are asymptomatic, compared with 34.2% in those aged 0-9 years, 50.6% in

[1] See the paper on page 293 of this issue.

TABLE 4

CLINICAL GRADIENT AMONG 292 INFECTED INDIVIDUALS IN A SAMPLE OF 579 EXAMINED IN AKRISHA SECTION: JULY TO DECEMBER 1963

Stage of disease [a]	*S. haematobium* infection		*S. mansoni* infection		Mixed infection		"Bilharziasis"	
	No.	% distribution	No.	% distribution	No.	% distribution	No.	% distribution
Stage III (established infection)								
Asymptomatic	51	42.8	46	62.2	25	25.2	122	41.8
Mild	23	19.3	17	22.9	34	34.4	74	25.3
Moderate	42	35.3	10	13.5	37	37.4	89	30.5
Severe	3	2.5	1	1.4	2	2.0	6	2.1
Stage IV (irreversible effects)								
Moderate					1	1.0	1	0.3
Total infections	119	20.6 [b]	74	12.8 [b]	99	17.1 [b]	292	50.4 [b]

[a] No cases were classified as Stage I (invasion) or Stage II (maturation).

[b] These figures are quoted as a percentage of the number of people examined; the other percentages are expressed as a proportion of the total number with the particular infection.

those aged 15-29 years and 56.0% in those aged 30 years and above.

The above relationships are brought out clearly in the case of *S. haematobium* infection only. For *S. mansoni* very few cases were found at ages under 15 years. Of all cases of *S. mansoni* infection, 62.2% were asymptomatic, compared with 42.8% for *S. haematobium* and 25.5% for mixed infection. Reference to Table 2 shows that the prevalence of infections with either species also attains its peak in the age-group 10-14 years. This then would appear to be the population sector in which both the prevalence of infection and the clinical manifestation of disease reach their highest levels in the area. It is interesting to note that a peak manifestation of overt disease due to *S. japonicum* infection was also found in the same age-group (10-14 years) in the Philippines, although the peak prevalence of infection occurred in an older age-group (20-24 years) (Pesigan et al., 1958).

Egg counts in relation to clinical gradient

The distribution of all positive persons by egg output and by clinical grade and age-group is shown in Tables 6 and 7. In Table 6 particulars are given of the 119 persons infected by *S. haematobium* only and the 74 persons infected by *S. mansoni* only; in Table 7 information on the 99 persons with both these infections is tabulated.

Because of the great variability in egg counts, with some very large values, the arithmetic mean counts for these various groups are not readily comparable. The distribution of persons by egg count is very skew, when classification is done by equal arithmetic intervals, with high frequencies for the lower classes and a long tail of low frequencies for the higher classes. For these reasons the grouping by number of ova has been done by using geometrically equal class intervals, each class representing twice as big an egg count as the preceding class and half as many as the following. It can be shown that, by this procedure, the distribution approaches the shape of the normal curve.

The mean value of egg output and the standard deviation of the distribution have been computed for each of the total groups by clinical grade and by age. For easy computation, these values are expressed in terms of the class interval. The class intervals have been given the following values:

	Number of ova	
Class	*S. haematobium*	*S. mansoni*
1	4-7	2-3
2	8-15	4-7
3	16-31	8-15
4	32-63	16-31
5	64-127	32-63
6	128-255	
7	256-511	

The results of the computations of the means from Tables 6 and 7 are shown in Table 8 for *S. haematobium* and in Table 9 for *S. mansoni*. For *S. haematobium* these means centre around the value that corresponds to the group 32-63 ova; for *S. mansoni* all the means are between 2 and 3, corresponding to between 4 and 7 ova. The standard deviations of the distribution and the standard errors of the means are also shown in Tables 8 and 9. Only mean egg output has been computed for groups consisting of less than 15 observations.

The coefficients of variation—namely, the standard deviations expressed as a percentage of the mean—are of about the same size in all the distributions, i.e., 25% to 35%.

The standard errors of the means have been used to decide whether differences between means should be regarded as significant or not. If a difference

TABLE 5

AGE DISTRIBUTION OF CLINICAL GRADIENT IN STAGE III INFECTIONS IN AKRISHA SECTION: JULY TO DECEMBER 1963

Grade of Stage III infection	*S. haematobium* infection		*S. mansoni* infection		Mixed infection		"Bilharziasis"	
	No.	%	No.	%	No.	%	No.	%
Age-group 0-9 years								
Asymptomatic	22	41.5	3	42.8	1	6.2	26	34.2
Mild	13	24.5	4	57.2	7	43.8	24	31.5
Moderate	17	32.1	0	0	8	50.0	25	32.9
Severe	1	1.9	0	0	0	0	1	1.3
Total	53		7		16		76	
Age-group 10-14 years								
Asymptomatic	5	21.7	5	83.3	5	14.3	15	23.4
Mild	5	21.7	0	0	15	42.8	20	31.8
Moderate	11	47.9	1	16.7	14	40.0	26	40.6
Severe	2	8.7	0	0	1	2.9	3	4.7
Total	23		6		35		64	
Age-group 15-29 years								
Asymptomatic	15	60.0	20	62.5	8	28.6	43	50.6
Mild	4	16.0	9	28.1	7	25.0	20	23.5
Moderate	6	24.0	3	9.4	12	42.8	21	24.7
Severe	0	0	0	0	1	3.6	1	1.2
Total	25		32		28		85	
Age-group 30 years and above								
Asymptomatic	9	50.0	18	62.1	10	52.6	37	56.0]
Mild	1	5.6	4	13.8	5	26.3	10	15.3
Moderate	8	44.4	6	20.7	4	21.1	18	27.2
Severe	0	0	1	3.4	0	0	1	1.5
Total	18		29		19		66	

TABLE 6

DISTRIBUTION OF PERSONS WITH *S. HAEMATOBIUM* OR *S. MANSONI* INFECTION BY AGE, CLINICAL GRADIENT AND EGG OUTPUT

Grade of Stage III infection	Egg output (class) [a]													
	S. haematobium infection								*S. mansoni* infection					
	1	2	3	4	5	6	7	Total	1	2	3	4	5	Total
Age-group 0-9 years														
Asymptomatic		8	3	5	5	1		22		2	1			3
Mild		1	3	1	6	1	1	13		4				4
Moderate		1		7	2	6	1	17						
Severe			1					1						
Total		10	7	13	13	8	2	53		6	1			7
Age-group 10-14 years														
Asymptomatic	2	1	2					5			5			5
Mild			2	1	2			5						
Moderate			1	2	5	3		11		1				1
Severe				1	1			2						
Total	2	1	5	4	8	3		23		1	5			6
Age-group 15-29 years														
Asymptomatic			3	8	3	1		15		12	7	1		20
Mild			1	3				4	2	4	1	2		9
Moderate			2	2		2		6	1		1	1		3
Severe														
Total			6	13	3	3		25	3	16	9	4		32
Age-group 30 years and above														
Asymptomatic		1	2	5	1			9	1	8	8	1		18
Mild			1					1		2	1	1		4
Moderate		1	4	2	1			8	1	5				6
Severe											1			1
		2	7	7	2			18	2	15	10	2		29
All age-groups														
Asymptomatic	2	10	10	18	9	2		51	1	22	21	2		46
Mild		1	7	5	8	1	1	23	2	10	2	3		17
Moderate		2	7	13	8	11	1	42	2	6	1	1		10
Severe			1	1	1			3			1			1
Total	2	13	25	37	26	14	2	119	5	38	25	6		74

[a] The range in egg output corresponding to each class is given in the text.

TABLE 7

DISTRIBUTION OF PERSONS WITH MIXED *S. HAEMATOBIUM* AND *S. MANSONI* INFECTION BY AGE, CLINICAL GRADIENT AND EGG OUTPUT

Grade of Stage III infection	Egg output (class) [a]													
	S. haematobium infection								*S. mansoni* infection					
	1	2	3	4	5	6	7	Total	1	2	3	4	5	Total
Age-group 0-9 years														
Asymptomatic			1		1			2			1	1		2
Mild			1	2	2	1		6		3	1	1	1	6
Moderate				2	4	2		8		6	2			8
Severe														
Total			2	4	7	3		16		9	4	2	1	16
Age-group 10-14 years														
Asymptomatic				2	2	1		5		2	3			5
Mild		1	3	3	7	2		16	2	9	5			16
Moderate			1	3	2	5	2	13	1	7	3	2		13
Severe					1			1			1			1
Total		1	4	8	12	8	2	35	3	18	12	2		35
Age-group 15-29 years														
Asymptomatic		2	3	1	2			8	1	5	2			8
Mild		2		2	3	1		8	3	5				8
Moderate		3	2	4	2	1		12	1	5	4	2		12
Severe				1				1		1				1
Total		7	5	8	7	2		29	5	16	6	2		29
Age-group 30 years and above														
Asymptomatic		1	3	3	3			10	1	2	4	3		10
Mild		2	1	1	1			5	1	4				5
Moderate			2		2			4		2	2			4
Severe														
Total		3	6	4	6			19	2	8	6	3		19
All age-groups														
Asymptomatic		3	7	6	8	1		25	2	9	10	4		25
Mild		5	5	8	13	4		35	6	21	6	1	1	35
Moderate		3	5	9	10	8	2	37	2	20	11	4		37
Severe				1	1			2		1	1			2
Total		11	17	24	32	13	2	99	10	51	28	9	1	99

[a] The range in egg output corresponding to each class is given in the text.

TABLE 8

MEAN OF CLASS INTERVALS FOR EGG OUTPUT, STANDARD DEVIATION AND STANDARD ERROR OF MEAN, BY CLINICAL GRADIENT AND AGE, FOR *S. HAEMATOBIUM* INFECTIONS

Clinical gradient and age-group	No. positive	Mean of class intervals for egg output	Standard deviation	Standard error of mean
S. haematobium infection only				
Asymptomatic	51	3.59	1.08	0.151
Mild	23	4.04	1.57	0.327
Moderate	42	4.52	1.25	0.193
Severe	3	4.00	—	—
0-9 years	53	4.15	1.44	0.119
10-14 years	23	4.04	1.44	0.300
15-29 years	25	4.12	0.91	0.192
30 + years	18	3.50	0.83	0.196
Total	119	4.03	1.26	0.116
S. haematobium in mixed infections				
Asymptomatic	25	3.88	1.11	0.222
Mild	35	4.17	1.23	0.208
Moderate	37	4.57	1.32	0.217
Severe	2	4.50	—	—
0-9 years	16	4.69	0.90	0.225
10-14 years	35	4.80	1.17	0.198
15-29 years	29	3.72	1.28	0.237
30 + years	19	3.68	1.10	0.252
Total	99 [a]	4.25	1.27	0.128
All *S. haematobium* infections				
Asymptomatic	76	3.66	1.18	0.135
Mild	58	4.17	1.21	0.159
Moderate	79	4.54	1.30	0.146
Severe	5	4.20	—	—
0-9 years	69	4.27	1.37	0.165
10-14 years	58	4.50	1.33	0.175
15-29 years	54	3.91	1.20	0.163
30 + years	37	3.60	0.95	0.156
Total	218	4.13	1.17	0.079

[a] Includes one individual with Stage IV infection.

TABLE 9

MEAN OF CLASS INTERVALS FOR EGG OUTPUT, STANDARD DEVIATION AND STANDARD ERROR OF MEAN, BY CLINICAL GRADIENT AND AGE, FOR *S. MANSONI* INFECTIONS

Clinical gradient and age-group	No. positive	Mean of class intervals for egg output	Standard deviation	Standard error of mean
S. mansoni infection only				
Asymptomatic	46	2.52	0.62	0.091
Mild	17	2.35	0.88	0.214
Moderate	10	2.10	—	—
Severe	1	3.00	—	—
0-9 years	7	2.14	—	—
10-14 years	6	2.83	—	—
15-29 years	32	2.44	0.99	0.175
30 + years	29	2.41	0.74	0.137
Total	74	2.43	0.75	0.087
S. mansoni in mixed infections				
Asymptomatic	25	2.64	0.84	0.168
Mild	35	2.14	0.84	0.142
Moderate	37	2.46	0.75	0.123
Severe	2	2.50	—	—
0-9 years	16	2.69	0.91	0.228
10-14 years	35	2.37	0.72	0.122
15-29 years	29	2.17	0.79	0.146
30 + years	19	2.53	0.87	0.200
Total	99 [a]	2.39	0.83	0.083
All *S. mansoni* infections				
Asymptomatic	71	2.56	0.72	0.085
Mild	52	2.21	0.87	0.121
Moderate	47	2.38	0.80	0.117
Severe	3	2.67	—	—
0-9 years	23	2.52	0.83	0.173
10-14 years	41	2.44	0.70	0.109
15-29 years	61	2.31	0.82	0.105
30 + years	48	2.46	0.79	0.114
Total	173	2.41	0.79	0.060

[a] Includes one individual with Stage IV infection.

TABLE 10
PERCENTAGE DISTRIBUTION OF CLINICAL GRADE IN RELATION TO EGG COUNT IN STAGE III *S. HAEMATOBIUM* INFECTION

Egg count (Class)	Asymptomatic		Mild		Moderate		Severe		Total no.
	No.	%	No.	%	No.	%	No.	%	
1	2	100							2
2	13	54	6	25	5	21			24
3	17	41	12	28	12	28	1	2	42
4	24	39	13	21	22	36	2	3	61
5	17	29	21	36	18	31	2	4	58
6	3	11	5	18	19	70			27
7			1	25	3	75			4
Total	76	35	58	27	79	36	5	2	218

between two means is at least 1.96 times larger than the standard deviation of the difference, it is regarded as significant at the 5% level. If the difference is at least 2.58 times larger than its standard deviation, it is regarded as significant at the 1% level.

Table 8 shows that, for *S. haematobium* infections alone, the mean egg output increases with the clinical grade; for asymptomatic cases the mean is 3.59, for mild 4.04 and for moderate 4.52. The difference between 4.52 and 3.59 is highly significant, being more than three times its standard deviation.

There are no significant differences in egg output between persons under 10 years, those aged 10-14 years and those aged 15-29 years, but persons aged 30 years and above have a significantly lower mean (3.50) than the three younger groups. From Table 6 it is evident that the increase in egg output with clinical grade refers specifically to the two age-groups under 15 years.

For persons with a mixed infection, the mean egg output in the *S. haematobium* infection also increases with clinical grade. There is a significant difference between asymptomatic persons (mean, 3.88) and persons with moderate symptoms (4.57). In terms of age, the two lower groups have means of 4.69 and 4.80, which are significantly higher than the means of the older age-groups (3.72 and 3.68).

The mean of the class intervals for egg output in *S. haematobium* infection is higher for persons who are also infected by *S. mansoni* (4.25) than for persons who are infected by *S. haematobium* only (4.03). This difference is not statistically significant, but this is possibly due to the size of the sample, since the higher egg count for mixed infections is seen in all four clinical grades and also for the age-groups under 10 years and 10-14 years.

For all 218 persons with *S. haematobium* infection, the increase in mean egg output from 3.66 for asymptomatic persons to 4.17 for mild cases and 4.54 for moderate cases is statistically significant. Persons above 14 years of age, who have a higher ratio of asymptomatic cases, have a significantly lower egg output than younger persons.

For *S. mansoni* infections (Table 9) no difference in egg output can be demonstrated between persons with *S. mansoni* infection alone (2.43) and persons with a mixed infection (2.39). It is not possible to show any significant differences in egg output by clinical grade, nor is there any clear association between egg output and age in this infection.

In Table 10 is presented the percentage distribution of clinical grades (Stage III) in relation to egg-count intervals for *S. haematobium* infection; there is a high degree of correlation. With increasing egg counts there is a diminishing ratio of asymptomatic cases (from 100% at the smallest egg counts to 0% at the largest), and a proportionate increase in the severer manifestations of disease.

This is a definite advance on what was demonstrated in *S. japonicum* infection in the Philippines; there, when the average egg count in each age-group was related to the percentage of persons in the group who showed symptoms, a high degree of correlation was found (Pesigan et al., 1958). A further necessary

step is to correlate the egg count in each individual with the degree of severity indicated by clinico-pathological examination.

DISCUSSION AND RECOMMENDATIONS

Modest beginnings in clinical field studies in bilharziasis can be made without elaborate machinery, by units engaged in studies on transmission and experimental control of bilharziasis. Such supplementary activities would assist in the development, testing and refinement of methods for the assessment of community effects of bilharziasis now in their infancy and should therefore be encouraged (Macdonald, unpublished, 1960; Farooq, 1964).

The use of working criteria of stages and grades of severity of bilharziasis [1] in field studies of the present nature, without the detailed pathological examination of individuals, was not found to be realistic. On the basis of a field clinical examination, a good number of cases in stage IV of irreversible effects (so often invisible) can be missed or classed under stage III.

The significance of splenomegaly in deciding whether *S. mansoni* infections should be classified as stage III or stage IV was not clear in the field. Although it is stated that "egg output not associated with splenic enlargement constitutes a specific criterion" of stage III, yet under the specifications for severe infections in this stage, presence or absence of hepatosplenomegaly, together with the manifestations of moderate severity and "with more frequent diarrhoea and dysentery" have been considered as diagnostic, with the result that, although there were 34 cases of splenic enlargement (24 of them associated with hepatomegaly) in the sample examined, they could only be classified under stage III. Among these, 12 were found to be entirely asymptomatic, which further increased the difficulty of their allocation. Only a single case of mixed infection with hepato-splenomegaly and concomitant "recurrent and marked dysuria" could be assigned under the prescribed basis in stage IV. The criterion of "marked disturbance of structure of an organ or loss of function" as indicative of a severe infection of stage IV, if unassociated with visible sequelae and complications, was not found to be objective. Detection of structural change or loss of function without access to a very detailed pathological investigation is impractical.

[1] See Annex 3.

It is true that objectivity in clinical field surveys is extraordinarily difficult to attain, but it must always be sought. From the study described, the need emerges for considerable revision, refinement and simplification of the working criteria adopted, ambiguous and vague symptoms being replaced by objective signs as far as possible. Terms like "more frequent" and "more marked" should be clearly defined, and statements like "presence or absence of" or "other disturbance" should be replaced by definite signs and symptoms requiring a "Yes" or "No" record, independent of the subjective judgement of the examiner. Such a classification should also include criteria relating to the measurement of episodes of incapacity or disability, suitably graded and fully defined and related to work loss, to provide information on the economic burden of bilharziasis.

In order not to appear completely negative, a simple basis of classification to measure ill health due to bilharziasis has been suggested tentatively in a study among very young children undertaken in a different context in the project area. This is being separately reported by Farooq & Samaan (in preparation). Some simple and practical schedule could be developed for field studies which could be undertaken without elaborate machinery, simultaneously in different areas.

Scott observed as far back as 1937 that the only satisfactory way to measure the extent of infection would be by demonstrating that a correlation existed between egg output and "either the degree of infestation or the severity of effects".

Inadequate as the classification given in Annex 3 may have been in more respects than the ones mentioned above, evidence has been obtained in the present study of a positive correlation between increasing egg load and progressive grades of severity in *S. haematobium* infection. *Prima facie* this would also indicate the validity of regarding egg counts as a measure of worm load, but more direct evidence has yet to be obtained. The data are, however, inadequate to demonstrate a similar relationship in respect of *S. mansoni* infection.

The techniques employed to determine egg counts in this study have not been altogether satisfactory, particularly in respect of *S. mansoni* infection. We believe that the recently developed Bell's technique (1963) for *S. mansoni* and Bradley's field filtration method (1965) for *S. haematobium* could be utilized with greater advantage in future studies.

In order to link clinical findings quantitatively with the prevalence of infection, it will be necessary

to select a suitable subsample of individuals classified as asymptomatic and in the three grades of severity in stage III, for intensive clinico-pathological examination. This would require accurate diagnosis of a wide range of pathological conditions and would involve X-raying of bladder, abdomen and lungs, cystoscopy, intravenous pyelography, liver biopsy, rectosigmoidoscopy and electrocardiography. For these examinations the patients would have to be hospitalized for about a week.

Neither the present terms of reference nor the limited personnel available at the Egypt-49 project would enable studies of this nature to be undertaken without revision of plans and considerable strengthening of staff and other facilities. It should, however, be stated that excellent possibilities for longitudinal or cohort surveys of bilharziasis for the study of the evolution of infection and of resulting complications exist in the project area, under ecological conditions very different from those obtaining in East Africa, where studies have been in progress under the auspices of the Ross Institute, supported by WHO, the Rockefeller Foundation and the Tropical Medical Research Board (East African Institute for Medical Research, 1963; Forsyth & Macdonald, 1965). The possibilities should be explored of similar collaboration being developed at the Egypt-49 project, in conjunction with the university medical centres in Alexandria.

Among the many attractions of such work being undertaken in the project area is the fact that considerable amounts of background information and basic epidemiological data have been gathered over the past three years with a carefully prepared sampling design, so that information obtained could be related to a defined population base. Classified prevalence data from the different strata—long-established rural communities, recently settled communities in newly reclaimed lands and people in semi-urban environments—are available.[1] In the reclaimed land settlements, the study of a population whose infection has been acquired within a determinable time period would provide information on the evolution of infection and its pathological processes.

The varying prevalence of *S. haematobium* and *S. mansoni* infections in the different geographical subgroups in the project area [2] indicates that these areas should prove suitable for comparative studies of disease patterns and egg output in relation to different levels of endemicity and other epidemiological factors, so that the existing variation of clinico-epidemiological patterns could be clarified. Such studies should throw light on the possibility of using egg counts as a quantitative tool for surveys of severity of infection in communities; this would prove much more meaningful than prevalence rates in indicating areas that deserve priority in the application of control measures. Studies in Brazil in recent years (Kloetzel, 1962, 1963) have indicated the feasibility of such methods for *S. mansoni* infection.

RÉSUMÉ

Les auteurs exposent les résultats d'une enquête sur les modalités de l'infection bilharzienne au sein d'une collectivité rurale dans le delta du Nil. Leur analyse porte sur un échantillon de 579 individus. Les infections ont été classées en quatre stades évolutifs: stade I, invasion; stade II, période d'état; stade III, infection cliniquement établie, bénigne, modérée ou grave; stade IV, manifestations irréversibles, avec les trois mêmes degrés de gravité. Les œufs ont été recherchés dans les selles et dans les urines après sédimentation et une corrélation a été recherchée entre le nombre d'œufs émis et la gravité clinique de l'infection. A l'époque où cette étude a été faite, la prévalence totale de l'infection était de 37,6% pour *Schistosoma haematobium*, 29,8% pour *S. mansoni* et 17,1% pour les infections mixtes.

Sur les 579 personnes examinées, 292 (58,2%) éliminaient des œufs de schistosome. Toutes sauf une ont été classées au stade III: sans symptômes, 122 (41,8%), bénin, 74 (25,3%), modéré, 89 (30,5%) ou grave, 6 (2,1%). Le sujet restant a été classé au stade IV modéré. Les symptômes s'observaient plus fréquemment dans les infections mixtes (74,8%) qu'au cours des infections simples (58,2%) et parmi ces dernières, les cas dus à *S. haematobium* étaient plus souvent symptomatiques (57,1%) que les cas dus à *S. mansoni* (37,8%). Chez les enfants âgés de 10 à 14 ans où la prévalence de l'infection était la plus forte, les cas symptomatiques étaient également les plus nombreux et on a constaté une élimination moyenne de 32-63 œufs pour les infections à *S. haematobium* et de 4-7 œufs pour celles à *S. mansoni*. Si l'élimination moyenne dans les infections à *S. haematobium*, qu'elles soient simples ou mixtes, augmente avec la gravité des symptômes cliniques, une telle relation

[1] See the papers on pages 293 and 319 of this issue.

[2] See Table 3 on page 296 of this issue.

n'a pas été mise en évidence dans les infections à *S. mansoni*.

Les auteurs analysent les critères de gravité de l'infection bilharzienne et les méthodes de numération qu'ils ont employés; ils estiment nécessaire d'adopter des normes cliniques plus objectives et des techniques de numération plus précises, permettant une meilleure estimation de la charge réelle en parasites.

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Annex 1

LABORATORY TECHNIQUES

EXAMINATION OF STOOLS FOR *Schistosoma mansoni* EGG COUNT

(1) Take 1 g of stool and sediment it, using 350 ml of a 0.5% aqueous solution of glycerol. Allow the sediment to settle for 30 min.

(2) Pour off supernatant liquid and sieve the sediment through a double layer of gauze. Repeat sedimentation as in (1) and allow 20 min for sediment to settle.

(3) Repeat step (2) three times, sedimenting for 10 min each time, to obtain a clear deposit of eggs.

(4) Decant the supernatant liquid and transfer the sediment to a watch-glass.

(5) Examine under a low-power microscope and count the number of ova (in 1 g stool sample).

EXAMINATION OF URINE FOR *Schistosoma haematobium* EGG COUNT

(1) Pour 50 ml of well-mixed urine into a separating funnel and allow the sediment to settle for 20 min.

(2) Draw 1 ml of urine sediment, transfer it to a watch-glass and examine under a low-power microscope (or a dissecting microscope).

(3) Express the egg count as the number present in the 50-ml sample.

Note. If there is a deposit of more than 1 ml, transfer all of it into a graduated cylinder to measure the volume, mix thoroughly and count the ova in 1 ml. Multiply the number of eggs by the total volume of deposit in ml in order to obtain the egg count in 50 ml of urine.

Annex 2

BILHARZIASIS CLINICAL SURVEY: DISEASE AND DISABILITY

I. General

Section ..... Name ..... Present ☐
Village ..... Occupation ..... Absent ☐
P. S. Household No. ..... Age ..... Left Village ☐
P. S. Individual No. ..... Sex [M] [F] Dead ☐

II. Helminthic Infections

Previous P. S. Record: ☐ Yes ☐ No Date of examination .....
Haem. ..... *Man.* ..... *Anky.* ..... *Asc.* ..... Other (specify) .....

Present examination date ..... If not exam, state reason .....

Haem. : No. ova[1] ..... Hatched ..... *Man.* : No. ova[2] ..... Hatched .....
Anky. ..... *Asc.* ..... Other (specify) .....
1. In 50 cc urine sedimented. Early afternoon specimen. 2. Per gram of faeces. Morning specimen.

III. Signs and Symptoms noted on the Day of Examination

Particulars	None	Mild	Moderate	Severe	V. Severe	Past history only
Cercarial dermatitis						
Febrile reaction						
Glandular enlargement						
Weakness						
Anorexia						
Hypogastric pain						
Haematuria						
Frequent micturition						
Dysuria						
Renal colic						
Abdominal pain						
Diarrhoea						
Dysentery						
Cough						
Haemoptysis						
Dyspnoea						
Cardiac enlargement						
Haematemesis						
Sup. abdominal veins						
Ascites						
Anasarca						
Others (specify)						

Mild : Subjective impairment of working capacity not exceeding 25%.
Moderate : Subjective impairment of working capacity not exceeding 50%.
Severe : Partial absence from work or school. Impairment of working capacity 75%.
Very severe: Total absence from work or school. Impairment of working capacity 100%.

IV. Nutritional Status, General Condition and other Clinical Information

(a) Particulars	None	Mild	Severe	Not examined
Oedema				
Poor turgor				
Bitot's spots				
Night blindness				
Angular stomatitis				
Gums swollen or bleeding				
Dental caries				
Others (specify)				

(b) General Condition

V. Good	Good	Fair	Poor	V. Poor

(c) Haemoglobin

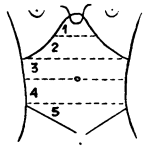
g/100 ml. .....

(d) Any other conditions (including pregnancy)

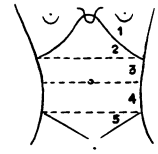
V. Degree of Enlargement of Liver and Spleen and Related Information

Hepatomegaly	0	1	2	3	4	5	Not examined
Splenomegaly	0	1	2	3	4	5	Not examined

LIVER



SPLEEN



History of Malaria				History of Jaundice			
None	During past 3 months	Earlier	No information	None	During past 3 months	Earlier	No information

VI. Stages of Infection and Estimated Degree of Severity (Clinical gradient) Based on Band III

	I Stage of Invasion	II Stage of Maturation	III Stage of Established Infection	IV Stage of Irreversible effects
Absent				
Past history only				
Present			—	—
mild	—	—		
moderate	—	—		
severe	—	—		

VII. Disability Relating to Conditions under III and VI during the past Three Months and Estimated Economic Loss

Number of days

1. Mild : Not well, but carrying out normal duties, not seeking medical care .....
2. Moderate : Not well, but carrying out normal duties, seeking medical care .....
3. Severe : Normal activity partially limited (partial absence from school or work) .....
4. Very severe: Normal activity severely limited, staying at home or at hospital .....

Estimated economic loss incurred from disability during past three months, based on information provided by head of household, including wages and other estimated loss: £E. .....

.....

VIII. Treatment Status during past Three Months

Treatment status	Bilharziasis			Any other conditions	
	Check if applicable	Period	Expenses incurred by patient £E.	Not specified	Specified
None					
Hospital					
Health centre					
Other institution					
Private practitioner					
Other (specify)					

Were any anti-bilharziasis drugs taken during last three months? Yes ☐ No ☐ If " yes " Complete ☐ incomplete ☐

State name of drug if known .....

Examined, date and signature

Checked, date and signature

Annex 3

SUMMARY OF WORKING CRITERIA FOR STAGES AND GRADES OF SEVERITY OF DISEASE CAUSED BY *S. MANSONI* AND *S. HAEMATOBIUM*

Stage I : Invasion

A slight inflammatory skin rash (cercarial dermatitis), itching and pricking sensation, in association with a history of recent exposure and later development of infection. Cough, accompanied by viscous mucus or blood, or occasional bronchial asthma may be present.

This stage cannot be readily divided into grades of severity.

Stage II : Maturation

Toxaemia, febrile reaction, weakness; glandular enlargement may be present, though it is not specific. Generalized pains, nausea, vomiting and diarrhoea, haemoptysis and enlargement of liver and spleen may be encountered. The nearest approach to exact recognition lies in the association of this state with the demonstration of a developing infection by egg output.

This stage, like stage I, cannot readily be divided into grades of severity.

Stage III : Established infection

In *S. mansoni* infection the occurrence of egg output not associated with splenic enlargement constitutes a specific criterion. The possibility of splenic enlargement due to malaria should, however, be borne in mind.

In *S. haematobium* infection the criterion of this stage is egg excretion without marked fibrotic changes, excluded on the basis of the absence of any history of repeated and marked dysuria or other localized symptoms, which are typical of stage IV.

Grades of severity in stage III:

Mild : Occasional abdominal pain, occasional diarrhoea or dysentery and other gastrointestinal complaints. Mild haematuria.

Moderate : Manifestations as above, together with other disturbances giving rise to weakness. With or without hepatomegaly. Marked haematuria. Some dysuria (due to ulceration of bladder mucosa, which may be present).

Severe : Manifestations of moderate severity, together with more frequent diarrhoea and dysentery; presence or absence of hepatosplenomegaly. No other evidence of portal hypertension, such as collateral circulation, haematemesis or ascites. (No comparable example for vesical infection is given because recurrent and marked dysuria is indicative of stage IV, fibrosis.)

Stage IV : Irreversible effects

In *S. mansoni* infections this stage is marked in intestinal infections by splenic enlargement, with or without hepatic enlargement, owing to portal hypertension, or by pulmonary, cardiopulmonary or panvisceral involvement; anaemia due to repeated haematemesis, impairment of growth and other disturbances, with either eggs in stools or a past history of intestinal bilharziasis obtained through a reliable clinical account or history of past examinaiton and treatment. A combination of these clinical effects will constitute a sufficiently specific syndrome.

In *S. haematobium* infection, presence of eggs in the urine or a reliable past history of the infection, with evidence of marked fibrotic changes, pulmonary or other extra-urogenital effects. Marked dysuria and frequency of micturition, together with attacks of renal colic, septic involvement of bladder, ureters and kidney, may be encountered.

Grades of severity of stage IV:

Mild : Apparent quiescent infection that has caused little fibrotic change and is not progressive.

Moderate : Any marked fibrotic changes accompanied by signs of continued active infection or progressive fibrosis.

Severe : Marked disturbance of structure of an organ or loss of function, shown in *S. mansoni* infection by episodes of haematemesis and the development of ascites, anaemia and anasarca.