

# Some aspects in the control of schistosomiasis and soil-transmitted helminthiasis in Yemeni children

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## ABSTRACT

**Objective:** Prevalence, intensity and incidence of schistosomiasis and soil-transmitted helminthiasis among school children in an ignored area in Yemen were determined. The study aimed to investigate the impact of single doses of Praziquantel or Albendazole or both, relating to sanitary, socioeconomic and behavioral practices on the prevalence and intensity of infections.

**Methods:** Out of a total number of 897 pupils, 453 were randomly selected from AlMahweet town and 444 from rural surrounding areas. Millipore filtration, modified Kato and precipitation techniques were applied for urine and stool analysis.

**Results:** Prevalence rates were 27% for schistosomiasis, 61% for ascariasis, 21% for trichuriasis, 2% for fasciolosis, 0.3% for entrobiosis, 0.7% for hook worm infection and 0.2% for strongyloidosis. Factors found confounding the relationship between schistosomiasis and residence, under logistic regression analysis, were sex and frequency of water contact. Probability of infection by Bilharzia for boys who reside in rural AlMahweet and visit the water source is 0.52, compared to 0.30 for their mates who reside in AlMahweet town. Odds ratio estimates accounted for

via residence was 2.5, via water contact 1.7 and via boys 3.2. With regards to other helminthic infections, availability of latrines remained the only significant factor under ANOVA.

**Conclusion:** In conclusion, annual campaigns for treatment as a single control measure can reduce the infection rate of *S. mansoni* by 62.5%, *T. trichura* by 48% and *A. lumbricoides* by 24%. Whereas for *S. hematobium* the appropriate time interval for intervention should be shortened according to the findings of a properly designed intervention study before used as a single control measure. Since 77% of the children were infected by other helminthes, therefore mass treatment should be extended to cover all children. For those boys in rural AlMahweet who visited the water source during the week before the interview, mass treatment for schistosomiasis is recommended since the prediction of infection rate reached 52%.

**Keywords:** Albendazole, control, praziquantel, schistosomiasis, soil-transmitted helminthiasis, school children.

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**H**uman schistosomiasis and other soil-transmitted helminthiasis are globally distributed. These infections are also endemic in Yemen.<sup>1</sup> It affects populations where substandard conditions of living are predominant ie. poor sanitation, insufficient safe water supply and low standard hygiene is practiced. These infections were reported from areas such as

Sana'a and Saada,<sup>2</sup> Marib,<sup>3</sup> Taiz,<sup>4</sup> Ibb,<sup>5,6</sup> Hajja town,<sup>7</sup> central highlands,<sup>8</sup> Aden and Yahr.<sup>9</sup> Ministry of Public Health (MoPH) ranks schistosomiasis second to malaria from a socioeconomic point of view and is the sixth major health problem in the country.<sup>10</sup> Despite that safe and effective antischistosomal treatment is at hand and

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**Table 1** - Parasites detected in schoolchildren before and 12 months after intervention, AlMahweet, 1996-1997.

Parasite	n (%)	n (%)
1. <i>Schistosoma mansoni</i>	188 (22)	51 (8)
2. <i>S. hematobium</i>	60 (7)	38 (6)
3. <i>Ascaris spp.</i>	528 (61)	290 (47)
4. <i>Trichuris trichura</i>	179 (21)	67 (11)
5. <i>Hymenolepes nana</i>	65 (8)	38 (6)
6. Hook worm	6 (1)	0 (0)
7. <i>Strongyloides stercoralis</i>	1 (0.1)	3 (0.48)
Total urine samples examined at the start=897 samples. At follow up=638. Total stools samples examined=861 samples. At follow up=622.		

considerable households are covered with safe water supply (51%), the rate of schistosomal infection is expected to increase. This is due to the suitable environment created by expansions in agricultural activities linked with the noticeable increments in dam constructions as a result of The Water Policy applied during the last decade of the millennium. There is insufficiency in public health services, high rates of illiteracy (50%), inadequate household coverage with safe water supply and lack of latrines within houses in a considerable proportion (37%).<sup>11</sup> Officials of MoPH claim to have a comprehensive control policy. It is not effectively implemented due to costly needs. Searching for an affordable control measure, combined with the control of other helminthic infections would be persuasive.

**Methods.** A comparative study was implemented to estimate the rate and intensity of Schistosomes and soil-transmitted infections and to explore associations with social and environmental factors. Quasi-experiment was also designed to study the impact of chemotherapy in the control of infections. Single doses of Albendazole were given to 406 patients with soil-transmitted infection. Praziquantel alone was dispensed to 58 of the children infected with Schistosomes only. Combined therapies were given to 166 patients with combined infections and 202 were free of helminthes and were not given any medication. One year later the incidences of the infections were assessed again. The Al Mahweet town lies to the north west of Yemen. It is about 2000m above sea level, with extensive agriculture, depending on rain and ground water, and enjoys a temperate climate. There is a hospital serving a population of 371,595 individuals of the town and the surrounding area.<sup>12</sup> Out of a total of 897 children (5-

18 years old) included in the study, 453 were selected from the AlMahweet town and 444 from rural Al Mahweet. Urban residents were randomly selected from the 5 schools of the town, after stratification with grades and sex. Rural residents were chosen from 58 schools of the Al Mahweet directorate. Adopting the Education Office classification of the directorate into 5 areas (central, north, south, west and east), 2 schools were selected randomly from each direction and one class out of the 6 grades from each school were picked randomly. The examination team visited each school and collected detailed personal and behavioral information from each child in the questionnaire forms. Midday urine and stool samples were obtained from each individual in containers (labeled with name and number) and taken back to the laboratory for examination. Ten mls of each urine sample were examined for urinary schistosomosis within 5 hours of collection, applying the Millipore filtration technique.<sup>13</sup> The volumes were adjusted to 10 ml and counts were recorded as (n) eggs/10 ml urine. The modified Kato technique was applied for the stools examination and results were reported as (n) eggs/g of feces.<sup>14</sup> Other ova or larvae were recorded whenever encountered in the stool. Single doses of Praziquantel (40mg/kg) or Albendazole or both (400 mg) were dispensed to the infected children under the supervision of a collaborating physician. All compiled data was entered in the standard questionnaire forms and processed on computer. Logarithmic transformations were adopted to Schistosomes egg count in order to normalize data. Paired t-test, McNemar paired tests, bivariate, multivariate and odds ratios were calculated by SPSS version 9 computer program.

**Table 2** - Prevalence of infection with helminthes at start of study vs follow-up, Al Mahweet, 1997.

Parasite	-ve 1st* -ve 2nd	-ve 1st +ve 2nd	+ve 1st -ve 2nd	+ve 1st +ve 2nd	Sig.
<i>S.mansoni</i>	460	37	111	14	<0.00001
<i>T. trichura</i>	448	44	107	23	<0.00001
<i>A. lumbricoides</i>	153	91	179	199	<0.00001
<i>S. hematobium</i>	563	31	37	7	NS
<i>E. vermicularis</i>	615	5	2	0	ND
<i>H. nana</i>	552	25	32	13	NS
<i>S. stercoralis</i>	618	3	1	0	NS
<i>Taenia spp.</i>	621	1	1	0	NS
Total number of pairs examined for stools=622. Total number of pairs examined for urine=638. ND=not done, NS=not significant, Sig=McNemar Chi square significance, *1st=at start of study, 2nd=at follow up, Sig:significance					

**Table 3** - Schistosomes rate of infection versus socioeconomic factors, AlMahweet, 1996.

Factor		Infected N (%)	Not Infected N (%)	Significance
Sex	Boys	218 (33)	443 (67)	<0.00001
	Girls	17 (9)	165 (91)	
Age	5-8 years	42 (19)	182 (81)	0.00041
	9-13 years	144 (30)	341 (70)	
	14-18 years	49 (37)	85 (63)	
Residence	Urban	66 (16)	346 (84)	<0.000001
	Rural	169 (39)	262 (61)	
Latrine	Used not used	133 (23) 101 (39)	448 (77) 157 (61)	<0.000001
Water contact	No Yes	123 (24) 112 (34)	319 (76) 218 (66)	0.00164
Fathers job	Farmer	84 (32)	182 (68)	0.029
	Daily pay	95 (31)	214 (69)	
	Orphan	11 (27.5)	29 (72.5)	
	Monthly pay	43 (20)	169 (80)	
	Unemployed	2 (13)	13 (87)	
Literate father	Yes No	142 (26) 92 (32)	408 (74) 194 (68)	NS
Calculated from the total number of each sex in the study. Significance calculated by Chi square. NS=not significant.				

Sample size was calculated by Epi 6 program. As there is no official body in the country responsible for issuing ethical clearances, consents were taken from the General Directorate of Education and Director General of Health and Deputy Governor. At follow-up examination, children that were found to be re-infected or newly infected with Schistosomes were retreated, while other parasitized with geohelminthes were referred to the hospital. World Health Organization guidelines were used to recommend control for schistosomiasis and soil-transmitted helminthiasis at community level.<sup>15</sup>

**Results.** Of a total number of 897 pupils who participated in the study, boys constituted 78% and the girls were 22%. Mean±SD of age was 10.71±2.85 years. Information from student's interviews showed that latrines are at hand for (49%), not available to (30%) while (22%) had latrines but did not use them all the time. The availability of latrines relative to residence showed a statistically significant difference with Chi square equals 384.8 and P less than 0.00001 between the town residents and the rural residents. Illiterate custodian were (34%) while (8%) could read only and (58%) could read and write. A percentage of (61.5%) answered that they did not contact the water source the previous week, (31%) confessed visiting at least once, and (8%)

**Table 4** - Schistosomes intensity of infection versus socioeconomic factors, AlMahweet, 1996.

Factor		*SHEG/10ml urine			*SMEG/g feces		
		Mean	*test	P	Mean	Test	P
Sex	Boys	1.34	5.042	<0.0001	3.32	6.954	<0.0001
	Girls	1.04			1.41		
Age	5-8 years	1.10	11.05	<0.0001	1.85	6.476	<0.0001
	9-13 years	1.23			3.13		
	14-18 years	1.77			3.24		
Residence	Urban	1.04	6.214	<0.0001	1.79	4.681	<0.0001
	Rural	1.56			9.40		
Latrine availability	Yes	1.12	4.640	<0.0001	2.47	2.243	0.025
	No	1.70			3.48		
Water contact	No	1.09	4.874	0.0001	2.62	0.708	0.479
	Yes	1.60			2.90		
Fathers job	Farmer	1.44	1.741	0.1390	3.16	3.95	0.003
	Daily pay	1.20			3.30		
	Orphan	1.11			2.88		
	Monthly pay	1.21			1.82		
	Unemployed	1.42			1.40		
Literate father	Yes	1.24	0.721	0.4710	2.54	0.317	0.7510
	No	1.31			2.35		
*Test: t-test for bivariate analysis or f-test of one-way simple ANOVA. SHEG: s.haematobium antilogarithm mean egg count per child. SMEG: S. mansoni antilogarithm mean egg count per child.							

confessed a daily visit. Of those who visited the water source a week before the interview, 55% had gone for swimming, 50% for bathing, 31% for the purpose of water fetching, 5% for washing clothes, 2% defecating and other water contact activities constituted 8%. The activity of swimming and bathing were more practiced by boys 24%, 23%, than girls 11%, 6% ( $P < 0.0001$ ). Whereas the girls (6%) who washed clothes were more than boys (1%) with  $P$  value  $< 0.00001$ . Other activities such as water fetching and defecating were comparable among boys and girls. Prevalence and incidence rates were calculated at the start of the study and 12 months after intervention as seen in Table 1. Neither adverse effect was noticed during the first hour of ingestion of the concurrent doses. Of the children and their guardians around the team's residence, no complaints were reported in the hospital. Paired McNemar analysis of the infection rates revealed that intestinal Schistosomosis, ascariasis and trichuriasis were significantly reduced (Table 2). Paired t-value equal to 5.86 for 622 pairs of measurements of *S.mansoni* egg counts revealed significant ( $p < 0.0001$ ) reduction from 2.49 geometric mean to 1.47 pre and post intervention. Unlike *S.mansoni*, differences in *S.hematobium* eggs per child before (1.27) and after intervention (1.35) were not significant. Bivariate statistical analysis of the association between rate and intensity of infection with both Schistosomes versus socioeconomic, demographic and behavioral factors revealed that use of latrines, sex of the child, water-

contact, age and father's job were significant (Table 3 and 4). Logistic regression model was designed to assess the effect of the exposure variable the residence (RES) on the disease. RES was treated as the exposure variable rather than the water contact since polluted water is the only source for drinking and washing in rural areas. Those factors found significant under bivariate analysis i.e. age (continuous in years), sex (Female is coded 0, male is coded 1), water contact (1 for those who visited water source and 0 for not visited) and latrine availability (0 for available and 1 for not available) were considered for possible control. Father's job was excluded because it did not show a significant difference when regrouped into farmer or other job. The modifiers variables RES sex, RES latrine, RES age and RES water contact were added to the model to assess the interaction. When applying logistic regression backwards elimination, it was found that all modifiers are non significant and removed from the model. Comparing the odds ratio estimate for gold standard model (2.7) and the crude model (3.4) assessed are confounding. That is the variables age, sex and water contact are confounding the relationship between RES and schistosome infection. To achieve precision and validity, all the obtained reduced models that have approximately similar odds ratio estimate of the gold standard were explored. The RES, sex and water contact model was preferred because of its narrowest confidence interval (1.79-3.56) for odds ratio estimate (2.53) and it is controlling for all the relevant variables. Therefore the final model for Bilharzia infection becomes:  $\text{Logit (Bil)} = -2.5623 + 0.9263(\text{RES}) + (\text{sex}) + 0.54(\text{water contact})$ . The model indicated that the probability of infection by Bilharzia for boys who reside in rural areas and visited the water source the week before is 0.52, compared to 0.30 for their mates residing in AlMahweet town. The odds ratio estimate accounted for by residence is 2.5 i.e. children from rural AlMahweet have about 2.5 times the risk of infection with Schistosomes as compared to those of AlMahweet town after controls for sex and visiting water source. Of the children who visited the water source the week before interviewing had 1.7 times the risk of infection with Schistosomes compared to those who didn't. Boys had 3.2 times the risk of acquiring infection as compared to girls after controls for residence and contacting water source.

#### ***Infection with parasites other than schistosomes.***

Univariate analysis of parasites other than Schistosomes and soil-transmitted helminthes found infecting children were *Taenia spp.* 0.1%, *Fasciola hepatica* 2% (seen at the follow up examination of stool when precipitation technique was adopted), *Entamoeba histolytica* 36% and *Giardia lamblia* 20.5%. Bivariate analysis of the factors affecting rate of infection with soil-transmitted diseases showed

**Table 5** - Helminthes infection versus socioeconomic, AlMahweet, 1996.

Factor		Infected N (%)	Not Infected N (%)	Significance
Sex	Boys	473 (71.5)	189 (28.5)	0.014
	Girls	124 (62)	75 (38)	
Age	5-8 years	155 (66)	81 (28.5)	0.047
	9-13 years	338 (69)	153 (31)	
	14-18 years	104 (78)	30 (22)	
Residence	Urban	281 (66)	145 (34)	0.033
	Rural	316 (73)	119 (27)	
Latrine	Used	266 (65)	142 (35)	0.0127
	Not used	328 (73)	121 (27)	
Fathers job	Farmer	208 (78.5)	57 (21.5)	NS
	Daily pay	209 (65)	111 (35)	
	Orphan	31 (79.5)	8 (20.5)	
	Monthly pay	143 (65)	77 (35)	
	Unemployed	6 (37.5)	10 (62)	
Literate father	Yes	202 (70.4)	85 (30)	NS
	No	388 (68)	179 (32)	

Calculated from the total number of each sex in the study. Significance calculated by Chi square. NS=not significant.

that latrine use, residence, sex and age are associated significantly. Simple ANOVA model was designed hierarchically according to latrine use, sexes and age groups with father's job as covariant. The only significant factor was latrine use ( $F = 6.101$ ,  $P = 0.014$ ).

**Discussion.** The study unveiled that Schistosomes, geohelminthes and protozoan infections are prevalent in the area where no previous information is within reach. The obtained results are not apart from those reported from other areas such as Taiz,<sup>4</sup> Ibb,<sup>5,6</sup> etc. Dispensing of antischistosomal and antigeohelminthic treatments concurrently, when appropriate, seems to be safe. Annual intervention with drug only, neglecting the other components of the comprehensive control program is found satisfactorily decreasing the infection rate of *S.mansoni* 62.5%, *T.trichura* 48% and of *A.lumbricoides* 24%. Despite the fact that transmission of *S.hematobium* and *S.mansoni* look alike, re-infection rate, within a year, with *S.hematobium* returned back to about the same prevalence and intensity before intervention (Table 1, 2). This important finding means that a combined chemotherapy control program designed for *S.mansoni*, *T.trichura* and *A.lumbricoides* is not suitable for *S.hematobium* along with. The time interval for re-treatment of cases with *S.hematobium* should be shortened according to properly designed intervention study or combined with the other control details. Neither univariate nor bivariate analysis of Schistosomes rate of infection showed levels high enough to be mass treated. Therefore, mass chemotherapy is recommended only after multivariate analysis for boys of rural Al Mahweet who visit the water source at least once per week. This is based on the 52% prediction rate of infection with schistosomes for this slide of children (see the model equation). Availability and use of latrines were two factors, which had a major effect in the transmission of geohelminthes. Health education of the community to encourage the construction and use of latrine would have a major effect in the control of the geohelminthes. Univariate and between group's differences of the bivariate analysis showed infection rates far beyond the cutoff point suggested by WHO<sup>15</sup> for mass chemotherapy. Thus annual mass chemotherapy is recommended (Table 5).

In conclusion, annual campaigns for treatment as a single control measure can reduce the infection of *S.mansoni* by 63%, *T.trichura* 49% and *A.lumbricoides* by 23%. Whereas for *S.hematobium* the appropriate time interval for intervention should be shortened according to the findings of a properly designed intervention study before used as a single control measure. Since 69% of the children were infected by other helminthes, therefore mass

treatment should be extended to cover all children. For those boys in rural Al Mahweet who visit the water source during the week before interview, mass treatment for schistosomosis is recommended since the prediction of infection rate reached 52%.

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