TECHNICAL REPORT

Joint EMRO/TDR Small Grants Scheme for Implementation Research in Infectious Diseases of Poverty

(SGS 18-95)

December 2019

Determinants of Schsistosoma mansoni Transmission in Hotspots at Late Stage of Elimination in Kafr El Sheikh Governorate

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ACKNOWLEDGEMENT

This study on **"Determinants of *Schsistosoma mansoni* Transmission in Hotspots at Late Stage of Elimination in Kafr El Sheikh Governorate"** was funded by the ***Joint EMRO/TDR Small Grants Scheme for Implementation Research in Infectious Diseases of Poverty***, implemented by a research team from the High Institute of Public Health, Alexandria University, in collaboration with the Ministry of Health and Population, Central Directorate of Endemic Diseases, and the Directorate of Health Affairs in Kafr El Sheikh Governorate.

Thanks is due to the village leaders in Kafr El Sheikh, who showed great cooperation and facilitated the field work during different stages of the research study. Without their support and cooperation, this work would have not been accomplished.

Thanks is due as well to our colleagues in the Kafr El Sheikh University, who showed great enthusiasm and unlimited support during the specimen collection and examination.

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ABBREVIATION LIST

B.Alexandrina	:	Biomphalaria alexandrina
EC	:	Escherichia coli
EMRO	:	Eastern Mediterranean Regional Office
HCU	:	Health care unit
KK	:	Kato-Kaztz
KSH	:	Kafr El Sheikh
MDA	:	Mass Drug Administration
MDA	:	Mass drug administration
MOHP	:	Ministry of Health and Population
NTDs	:	Neglected tropical diseases
PZQ	:	Praziquantel
S.mansoni	:	Schistosoma mansoni
TC	:	Total coliform
TDR	:	Tropical Disease Research
TDS	:	Total dissolved solids

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EXECUTIVE SUMMARY

Based on the results obtained from a previous research project entitled "Evaluation of PCR Assay for Detection of *S.mansoni* DNA in Human Stool Samples" funded by the Joint EMRO/TDR Small Grants Scheme for Implementation Research in Infectious Diseases of Poverty (2016), the prevalence of infection among children aged 5-15 years was more than 30%, despite the effective strategy of MDA adopted by the Ministry of Health and population (MOHP).

Based on this finding, our proposed study some environmental, biosocial, and economic factors in Kafr El Sheikh, which may have play an essential role in sustaining the transmission cycle. The prevalence of infection was significantly different within each village in the dry season and not significantly different between villages in the wet season.

Human survey: The study was conducted in 3 villages Kafr El Sheikh Governorate, El-Roos, El-Zawarat and El-Salahba. The total number of sampled children was 892; (31 were excluded during analysis for incompleteness of data) and the remaining 861 were distributed as follows: 432 children during the dry season and 428 during the wet one. A total of 2379 fecal samples were collected from 892 children (1213 samples in dry season and 1166 samples in wet season). One fecal sample was collected from each child for three consecutive days.

Children, community leaders, stakeholders, teachers, in the selected villages were approached though the schools and invited to participate in health education session and group discussion about schistosomiasis, its modes of transmission and how to break the cycle of infection.

Malacological survey: Some water streams surrounding selected villages were investigated for infected vector of *S.mansoni*. From each watercourse, five samples of snails (living, dead and empty shells) were gathered from beginning, middle (three samples at equal distances) and end. Snail sampling was undertaken by experienced field collector using a long-handed scoops and forceps for the duration of 15 min for each gathered sample following standard procedures.

Environmental survey: According to standard methods, three environmental samples were collected from the selected canals and banks along their length. The

samples were collected from three stations approximately each 150-200m according to their lengths: the first was from the beginning, the second was from the center and the third was from the end of each canal and bank. The following indices were measured: temperature, pH, salinity and total dissolved solids (TDS), velocity, turbidity, total coliform (TC) and E.Coli (EC), depth of water and vegetation distribution.

The following results were obtained:

- The mean age of the children observed in the dry season was 9.61±3.01, while it was 12.61±1.11 in the wet season.
- More than 99% of the screened children were of low or moderate socioeconomic class.
- Of the screened children, 91.29% were students, and 95.29 %stated that there is a nearby water canal.
- Child labor was reported in 17. 30%, 45% of them were exposed to water canal or sanitary disposal.
- Children walking barefoot represented 46.57% of all studied children, 95.35 % of children were washing vegetables and fruits before eating, a total 21.02% of them were toileting in the canal. About 70.85 % the children had history of parasitic infestation and 62.14% of them had family history of parasitic infection.
- There is no sanitary disposal system; Well as a site where waste was disposed was reported in 72%, of this number 88.87% were external (outside house). About 19.98% of the children were living in clay floor.
- About 9.41% of the studied children were dumping the trash into water canals, 97.56% of the studied were using safe water supply for drinking, however, 87.57% were complaining of water break with difference degrees. Water canals were located within 15 minutes of the studied children houses in 81.78% of the studied cases.
- A total 68.41% of children received praziquantel, either at home (36.84%), school (69.44%) or at health care unit (HCU) (9.17%). The number of doses ranged from one dose (36.84%) to three doses (21.9%). Side effect was reported in 29.2% while 83.19% were trusting in the PZQ effectiveness.

- Among the screened children 12% were visiting the local HCU if they had any health related conditions. Parasitic infestation (33.98%) followed by diarrheal diseases (30.10%) and schistosomal infection (23.30) were the most frequent reported diseases incurring visiting local HCU.

- The prevalence of *S. mansoni* infection was 7.18% in the dry season and 19.16% in the wet season.
- The prevalence of infection was significantly higher in the wet season in comparison to the dry one.
- About 87.61% of the infected children were of light infection and 10.62% of children were of moderate infection.

- Snail density, total number of collected *B. alexandrina* snails and water streams infection with cercaria showed remarkable difference in different villages under investigation.

- There is significance difference between snail intensity and different environmental parameters salinity, turbidity, TC, EC and vegetation percentage at different months.

- There is significance difference between infected and non-infected water streams regarding the five parameters (snail intensity, salinity, total coliform, fecal coliform and vegetation percentage).

- There is no significance difference between means of snail density, total number of *B. Alexandrina* snail and snail infection percentage at dry and wet seasons.
- Presence of vegetation is observed as an effective factor in infection as both grasses and duckweeds had a significance association with infection.

- Increasing age was a highly statistical significant factor affecting prevalence of *S. mansoni* infection.

- Sex of children and mother education level were significantly associated with higher prevalence of infection.

- Contact with water canal for the following reasons (washing clothes, water collection, irrigation, water unavailability and washing) was associated with acquiring infection.

- There was significant association between infection and the way they get rid of their rubbish, water break, and close proximity of houses to water canal

Introduction

Schistosomiasis is a parasitic tropical disease caused by the blood fluke, a group of flat worms that reside in the blood vessels in the human hosts. Due to its geographic and demographic distribution, the disease is listed as one of the neglected tropical diseases (NTDs).[1] Human schistosomiasis is one of the most important parasitic diseases. In 2017, it was estimated that about 220 million people required preventive treatment as transmission was still reported in 78countries.[2]

The regions of the Middle East and North Africa represent high endemic spots for schistosomiasis, especially Egypt, where about 7.2 million people were infected in 2010.[3] In Egypt, the spectrum of the disease has changed due to the control measures, which have succeeded in reducing the prevalence of infection all over Egypt, from 3% in 2003 to 0.3% in 2012.[4] Mass drug administration (MDA) is considered the chief component of the control programs for schistosomiasis due to high sustainability of this approach.[5] However, Schistosomiasis transmission is still maintained by the release of eggs through either urination *(schistosoma haematobium*) or defecation *(schistosoma mansoni*) into freshwater inhabited by snails which act as intermediate host, then humans get infection via contact with these water sources harboring cercariae. While, praziquantel (PZQ) does not address the underlying determinants of disease and is not a preventive drug, re-infection can occur rapidly if individuals are re-exposed to infested water sources.[6]

Sustainable control of the disease requires an integrated strategy including PZQ chemotherapy, snail control, health education, improved water supply and sanitation, and management of the sources of infection. Therefore, the implementation of the disease control programs necessitates addressing the epidemiological aspects of the transmission and control of *Schistosomiasis*, information about the distribution and population dynamics of the intermediate hosts.[7] One of the major disease control factors is stopping the human activities that allow the persistence of transmission cycle. The identification of the underlying factors that cause persistent transmission despite repeated MDA of communities, will be crucial to ensure effectiveness of supplemented control program to disrupt the continued pathogen transmission in endemic communities.[8, 9] This has led to calls for the integration of strategies, such as water, sanitation, and human hygiene (WASH)-related efforts, with drug treatment as more effective socio-ecological informed measures for achieving the sustainable control of *Schistosomiasis*, snail control, and indeed water-related infectious diseases in general.[10-12]

The snail population growth as another ecological factors, augments transmission of infection. It can be affected by either direct factors such as pH, salinity, temperature, rainfall, light, water current speed, vegetation, turbidity, and fluctuations in desiccation, or indirect factors which include abundance, feeding pattern and migratory and swimming behaviors.[13]

Behavioral aspects play an essential role in maintaining the transmission cycle, the health belief model (HBM) has been used to predict health-promoting behaviors also, used in patients with wide variety of disease to improve their disease condition through promoting their health behaviors.[14]

Despite the potential of such integrated approaches, there is a need for the effective configuration and implementation of these measures in the field through enhanced understanding of the environmental, behavioral, and social risk factors that jointly contribute to transmission of infection among different focal groups in endemic communities.[15]

Based on the results obtained from a previous research project entitled "Evaluation of PCR Assay for Detection of *Schistosoma mansoni* DNA in Human Stool Samples" funded by the Joint EMRO/TDR Small Grants Scheme for Implementation Research in Infectious Diseases of Poverty (2016), the prevalence of infection among children aged 5-15 years was more than 30%, despite the effective strategy of MDA adopted by the Ministry of Health and population (MOHP). Based on this finding, our proposed study some environmental, biosocial, and economic factors in Kafr El Sheikh, which may have play an essential role in sustaining the transmission cycle.

Aim of the work

Objectives:

General objective:

- To study the determinants of *Schistosoma mansoni* transmission in hotspots at late stage of elimination, Kafr El Sheikh governorate

Specific Objectives:

1- To estimate the prevalence of human *S.mansoni* infection in correlation to environmental factors seasonally.

2- To assess the prevalence of snail infection in correlation to environmental factors.

3- To carry out a malacological survey of the intermediate host seasonally.

4- To evaluate the role of socio-economic and behavioral factors affecting the prevalence of *S.mansoni* infection

Methodology

Study design

A cross-sectional design

Study Setting

The study was conducted in 3 villages Kafr El Sheikh Governorate, El-Roos, El-Zawarat and El-Salahba (El-Salhba and El-Islah villages were combined together)

Study Population

School aged children residents in the target villages (El-Roos, El-Zawarat and El-Salahba) and registered in the school (primary and preparatory grades).

Exclusion criteria:

- Children already diagnosed with schistosomiasis and were enrolled on treatment.
- Children with chronic diseases.
- Children with disabilities.

Sample size

Based on the reported prevalence of 30% in our previous survey, 5% precision, and confidence interval of 95%, the minimal required sample was 323 children. The total number of sampled children was 892; 31 were excluded during analysis for incompleteness of data and the remaining 861 were distributed as follows: 432 children during the dry season and 428 during the wet one.

Sampling method

1.During the dry season, and due to security issues and time constraints, a convenient sampling approach was adopted. Stool cups were distributed randomly to families with children in the target age groups with the support of the village leaders. The children's guardians were informed about the study, its benefits, consequences of their participation or non-participation, and instructed about the time and location of specimen delivery. On the specimen collection day, the guardians were consented, interviewed and specimens were collected. They were instructed about the steps for specimen's delivery on days 2,3.

2. During the wet season, and since the school season has already begun, a multistage stratified random sampling technique was adopted. Three schools were in the three villages were included. Each level was divided into grades (6 primary grades and 3 preparatory grades). Each grade was

divided into classes. Half of the classes were randomly selected and children were proportionately allocated according to the number of children in each grade. Children within the class based on simple random sampling approach.

Data collection tools and laboratory methods

1) A pre-designed structured interviewing questionnaire: (Appendix 5)

A pre-designed structured interviewing questionnaire was used to collect data from the children regarding the following items:

a) Socio-demographic data.
b) Medical history: previous S.mansoni infection or treatment.
c) Risk factors for S.mansoni.
d) Utilization of the health services in the village.
e) History of PZQ administration, number of doses, location and trust in its efficacy.
f) The socio-economic status was calculated based on the scoring system described by Fahmy et al.[(16)]

The questionnaire was uploaded on SurveyMonkey to save the time needed for the data entry and take the advantage of uploading the questionnaires on a server that could be extracted on Excel files.

Two workshops were held at the High Institute of Public Health (HIPH) to train the data collectors on how to use the data collection tool using MonkeySurvey. They were trained as well on the field work and modify the questionnaire. The first workshop was conducted with the objective of identifying the most reported determinants of schistosomiasis infection, and finalization of the variables to be included in the data collection tool. In the 2nd workshop, the MonkeySurvey link was generated and the data collectors became familiar to using it and were asked to test it and the generated Excel files were checked for completeness and accuracy of the data. Role play was adopted at the end of the 2nd workshop to ensure that the agreed data collection tool would be utilized efficiently.

A pilot study was conducted prior to starting the field work in order to:

- Estimate the duration of the field work that yielded the pre-defined sample size.
- Test the data collection tools using the MonkeySurvey.

- Estimate the average time needed to complete an interview and obtain the samples from the target population.
- Test the efficiency of the data collectors in using the tool.
- Identify the cultural context related to the village of the study.
- Test the accuracy and completeness of the Excel files extracted from the Monkeysurvey server.
- Identify any challenges that may occur during the interview using the MonkeySurvey.

The feedback was the following:

- The average time needed to fill in the data collection tool ranged from 10-15 minutes;
- Using more simple language to be easily understood by the target population;
- Difficulties were encountered during the utilization of the MonkeySurvey due to the mobile internet, and it was agreed to have a portable Wi-Fi device to facilitate this process.
- Skip logic functions of the SurveyMonkey were used to save more time and facilitate the interview process.

2) Laboratory methods:

a) Kato Katz (KK) cellophane fecal thick smear technique:

This procedure was carried out in the Lab of Tropical Health Department, High Institute of Public Health, Alexandria University.

A total of 2379 fecal samples were collected from 892 children (1213 samples in dry season and 1166 samples in wet season). One fecal sample was collected from each child for three consecutive days. Two slides were prepared for each sample with a total number of six slides per child. The number of eggs per gram stool was calculated by multiplying the number of counted eggs by 24. Intensity of infection was categorized according to WHO criteria as: 1–99 epg, 100–399 epg, ≥400 epg defined as low, moderate and heavy intensities of infection, respectively.[(17)] **Table (I)** shows the compliance of the children over the three days period of sampling collection during different seasons.

Table (I): Summary of the specimens collected from the study children according to the season of collection and the village (KSH, 2019)

<table>
<tr><th rowspan="2">Village</th><th colspan="3">Dry season</th><th colspan="3">Wet season</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>El-Roos</td><td>174</td><td>132</td><td>122</td><td rowspan="2">362</td><td rowspan="2">328</td><td rowspan="2">284</td></tr>
<tr><td>El-Zowarat</td><td>191</td><td>166</td><td>166</td></tr>
<tr><td>El-Salahba</td><td>100</td><td>84</td><td>78</td><td>65</td><td>64</td><td>63</td></tr>
<tr><td>Total</td><td>465</td><td>382</td><td>366</td><td>427</td><td>392</td><td>347</td></tr>
<tr><td></td><td colspan="3">1213</td><td colspan="3">1166</td></tr>
</table>

b) Environmental sampling methods: (Appendix 4)

This procedure was carried out in the Lab of Environmental Health Department, High Institute of Public Health, Alexandria University.

The samples were collected from the watercourses surrounding the three villages during summer (July, August and September) and during autumn (November). Four watercourses (2 canals – 2 banks) were studied in El-Salahba, while three watercourses (2 canals – one bank) were studied in El-Roos and El-Zawarat. In addition, samples were collected from joint points of canals and banks (when applicable). According to standard methods,[(18)] three environmental samples were collected from the selected canals and banks along their length. The samples were collected from three stations approximately each 150-200m according to their lengths: the first was from the beginning, the second was from the center and the third was from the end of each canal and bank.

The following indices were measured: temperature, pH, salinity and total dissolved solids (TDS), velocity, turbidity, total coliform and *E.Coli,* depth of water and vegetation distribution.

c) Malacological study:

This procedure was carried out in the Lab of Tropical Health Department, High Institute of Public Health, Alexandria University.

From each watercourse, five samples of snails (living, dead and empty shells) were collected from beginning, middle (three samples at equal distances) and end. Snail sampling was undertaken by experienced field collector using a long-handed scoops and forceps for the duration of 15 min for each gathered sample following standard procedures.[19] The collected snail specimens were transferred in perforated plastic boxes to the laboratory. Snails were identified according to shell morphology and structure using standard identification keys.[20] After identification, potential intermediate host snails (*Biomphalaria alexandrina*) were tested for shedding *Schistosoma* cercaria in their living water after 2-3 hours of exposure to sunlight. Subsequently, cercariae shedded were morphologically identified through identification keys. [20-22]

3) Health Education: (Appendix 2)

Health education sessions were held in the three villages that targeted the school-aged children, their parents, teachers, community leaders and religious leaders. They were approached through the school administration and invited to participate in sessions about schistosomiasis, its modes of transmission and how to break the cycle of infection. Posters explaining the modes of transmission, prevention and control were presented and gifted to the schools. Booklets showing the previous data as well were distributed to the children.

Data management and analysis

- Data processing: The data were extracted to Excel worksheets from the SurveyMonkey server. To ensure that all questions had valid codes, range checking was done by using frequency distributions and cross tabulation. Data processing also included recoding of variables and computation of new variables.
- Data analysis: SPSS version 25 was used for data analysis.
- Descriptive statistics were used for summarization of data utilizing frequency distribution tables and graphs.
- For quantitative variables, means, standard deviations and ranges were calculated.
- For qualitative variables: Pearson's chi – square test and Fisher's exact test as well were calculated.
- Repeated ANOVA test was done to test the difference between infection states on monthly basis.

Monitoring and quality control

- For data collection: field supervisors were assigned to regularly check the server for the completeness and accuracy of the uploaded questionnaires.
- Some questionnaires were identified with some missing data, and the team moved two times to fill in the missing data, and finally 31 cases were excluded from analysis due to incomplete data.

- For stool sample collection and analysis: checklist was used during sample collection for stool samples, and filling the questionnaire. The quality of the used reagents and instruments were checked by the parasitology consultant, specialists and laboratory technicians. The specimens were also checked by serial number, quantity, precaution of specimen collection, examination and transportation to the assigned laboratory.
- For the Kato-Katz technique: Two parasitology specialists double-checked the results of the positive results and randomly double-checked the negative ones.
- For the environmental samples and the malacological studies: before starting the analysis, the reagents were checked for their expiry dates, tested over controls and the equipment were calibrated.

Ethical considerations

- The approvals of the Ethics Committee of the High Institute of Public Health and Central Administration for Communicable and Endemic diseases were sought for conducting the research.
- The research team complied with the International Guidelines for Research Ethics.
- A written informed consent was taken from all the guardians of the study participants after explanation of the purpose.
- Confidentiality and anonymity were assured.

Results

1- Descriptive statistics

Table 1 shows the number of children screened during the dry and wet season, respectively, (432 and 429). In the dry season, women accounted for 50.23 % and in the wet season for 55.94 %.

Table 1: Distribution of the study participants according to the season of screening, their place of residency and sex (KSH, 2019)

Season	Village	Number of children	(%)	Sex	n	%
Dry	El-Ross	137	31.71	Female	217	50.23
	Zwarat	199	46.06			
	El-Salhba	96	22.23	Male	215	49.77
	Total	432	50.17			
Wet	El-Ross	315	73.42	Female	240	55.94
	Zwarat	42	9.79			
	El-Salhba	72	16.78	Male	189	44.06
	Total	429	49.83			

The mean age of the children observed in the dry season was 9.61±3.01, while it was 12.61±1.11 in the dry season. The mean child order of the studied children in the dry season was 2.75± 1.61 and in the wet season was 2.91±1.68. The child's crowding index in the dry season was 2.43±1.16 and in the wet season was 2.21±0.94 as shown in Table 2.

Table 2: Sociodemographic features of the screened children (KSH 2019)

Item	Dry					Wet				
	Mean	SD	Range	Minimum	Maximum	Mean	SD	Range	Minimum	Maximum
Age	9.61	3.01	10.50	5.00	15.50	12.61	1.11	10.00	6.00	16.00
Child order	2.75	1.61	8.00	1.00	9.00	2.91	1.68	0.68	1.00	10.00
No of family members	6.15	1.89	22.00	3.00	25.00	6.30	1.42	0.58	2.00	12.00
No of rooms	2.85	1.01	9.00	1.00	10.00	3.19	1.11	0.11	1.00	9.00
HCI	2.43	1.16	7.5	0.50	8.00	2.21	0.94	0.54	0.40	9.00

HCI: House hold crowding index

The results presented is Table 3 shows that two-thirds (66.66%) of women were illiterate, but still high percentage of fathers were illiterate (51.57%). Four women were working in farming while 272 men were contacting water canals as farmers or fishermen.

Table 3: Parents education and occupations (KSH 2019)

Item		Mothers		Fathers	
		no	%	No	%
Education	Illiterate	574	66.67	444	51.57
	Read write	90	10.45	148	17.20
	Primary	11	1.28	54	6.32
	Preparatory	34	3.95	44	5.11
	Secondary	123	14.29	108	12.50
	University degree	29	3.37	50	5.78
	Dead	0	00.0	13	1.48
Occupation	Working*	51	5.92	657	76.31
	House wife	810	94.08	191	22.18
	Dead	0	0.00	13	1.51

*Four of them were farmers, #272 were either farmers or fishermen

A total of 84% of the children surveyed did not have radios, 54.59% and 44.02% did not have televisions or telephones. Approximately 12.20% have computers at home, while 18.12% were using computers at home or at school, either always or sometimes (Table 4).

Table 4: Ownership of communication devices and computer utilization rate (KSH 2019)

Item (n=861)		No	%
Radio		140	16.26
Television		391	45.41
Telephone		482	55.98
Computer		105	12.20
Computer utilization rate	Never	705	81.88
	Sometimes	113	13.12
	Always	43	4.99

About 51.45% of the screened children stated that their income is not enough and they borrow from other to fulfil their living needs even they may not be able to repay what they had borrowed as showed in Table 5.

Table 5: Income of the screened children (KSH 2019)

Item (n=861)		No	%
Income	Not enough-borrow-can repay	108	12.08
	Not enough-borrow- cannot repay	354	39.37
	Enough	382	42.51
	Enough save	17	1.86
Socioeconomic class	Low	607	70.50
	Moderate	253	29.33
	High	1	0.12

Table 6 presents school environment of the screened children and showed that 91.29 % of the screened children were students, most of them (92.37%) had class density over 40 pupils/class. All schools had toilets, 95.29 % of children stated that a nearby water canal exists.

Table 6: School environment of the screened children (KHS 2019)

Item		**No**	**%**
Going to school	yes	786	91.29
Class density	<20	7	0.89
	>40	726	92.37
	20-40	53	6.74
Nearby water canal	Yes	749	95.29

From studied children 17. 30% were working, 45% of them were exposed to water canal or sanitary disposal (Table 7).

Table 7: Child labor and risk of exposure at the working environment (KHS 2019)

Item		**No**	**%**
Number of working		149	17.30
Are you exposed to any of the following during your work	Water canal	34	22.82
	Sewage system	5	3.36
	Both	28	18.79
	No	82	55.03

The housing environment of the studied children is presented in Table 8, it shows that 99.42% of children under this study were living for more than 1 year in the selected villages. About four fifths of the studied children stated that the streets where they are living are not asphalted. There was no a sanitary disposal system in the studied villages. A total 27.99% were disposing their wastes in the water canals. Well as a site where waste was disposed was reported in 72%, of this number 88.87% were external (outside house). About 19.98% of the children were living in clay floor. Water accumulation nearby houses was reported in 18.58%, and 27.76% were having domestic animals at their homes. About 9.41% of the studied children were dumping the trash into water canals. About 97.56% of the studied were using safe water supply for drinking. About 87.57% were complaining of water break with difference degrees. Water canals were located within 15 minutes of the studied children houses in 81.78%.

Table 8: Housing environment of the studied children (KHF 2019)

Item		No	%
How long have you been here?	< 1year	5	0.58
	>1year	856	99.42
Asphalted street	No	705	81.88
Waste disposal	Well	620	72.00
	Water canal	241	27.99
Site of the well (n=620)	External	551	88.87
	Internal	67	10.81
	Don't know	2	0.32
Floor	Ceramic	689	80.02
	Soil	172	19.98
Toilet	Setting	199	23.11
	Pour flush toilet	662	76.89
Water accumulation nearby houses	No	160	18.58
Domestic animals	No	239	27.76
Rubbish	Cars collecting	477	55.40
	Burn	6	0.70
	Through in street	3	0.35
	Collection areas	291	33.80
	Water canal	81	9.41
	Other	3	0.35
Drinking water	Tap	817	94.89
	Water pump	22	2.56
	Both	1	0.12
	Other	21	2.44
Water break	No	107	12.43
Frequency of water unavailability (754)	Rare	23	3.05
	Daily	421	55.84
	Monthly	35	4.64
	Weekly	275	36.47
Distance from nearest water canal	<15 minutes	704	81.78
	>30 minutes	78	9.05
	15-30 minutes	79	9.17

Of the studied children, (421) were contacting with water canals either with their friends 48.89% or alone (33.72%) as shown in Table 9. There was statistically significant difference between males and females regarding water contact.

Table 9: Behavior of water contact (KHF 2019)

Item			**No**	**%**
Contact with water canal		Yes	421	48.89
Contact with canal		Male	226	53.68
		Females	195	46.32
		$X^{2=}12.31$ $p<0.01$		
With whom you get into canal (n=421)		Friends	189	44.89
		Alone	142	33.72
		Brother	126	29.92
		Father	88	20.95
Site of contact (n=421)	Shore		257	61.19
	Middle		55	13.10
	Both		109	25.95

The main causes of water contact were swimming (38.48%), bathing (34.68%), washing cloths and plates (31.35%), irrigation of fields (26.15%) and for frequent water break (16.15%) (Table 10).

Table 10: Causes of water contact (KHF 2019)

Item (421)	**No**	**%**
Swimming	162	38.48
Bathing	146	34.68
Washing cloths/plates	132	31.35
Irrigation	113	26.84
Frequent water break	68	16.15
Cutting grass	67	15.91
Water collection	54	12.83
Fishing	50	11.88
Washing Vegetables	43	10.21
Playing	37	8.79
Dumping the trash	25	5.94
Drinking animals	12	2.85

Children walking barefoot represented 46.57% of all studied children, 95.35 % of children were washing vegetables and fruits before eating, a total 21.02% of them were toileting in the canal. About 70.85 % the children had history of parasitic infestation and 62.14% of them had family history of parasitic infection (Table 11).

Table 11: Unhealthy behaviors and history associated with parasitic transmission (KHF 2019)

Item		**No**	**%**
Walking barefoot	Often	404	46.92
	No	56	6.51
	Yes	401	46.57
Washing vegetables and fruits before eating	Often	294	34.15
	No	40	4.65
	Yes	527	61.20
Toileting in canals	Often	145	16.84
	No	680	78.98
	Yes	36	4.18
History of parasitic infection	Yes	610	70.85
Family history of parasitic infestation	Yes	535	62.14

Table 12 shows that 68.41% of children received praziquantel, either at home (36.84%), school (69.44%) or at health care unit (HCU) (9.17%). The number of doses ranged from one dose (36.84%) to three doses (21.9%). Side effect was reported in 29.2% while 83.19% were trusting in the PZQ effectiveness.

Table 12: Praziquantel treatment seeking behavior (KHF 2019)

Item		No	**%**
Received D PZQ		589	68.41
Where	Home	217	36.84
	School	409	69.44
	HCU	54	9.17
No of doses	One	217	36.84
	Two	243	41.26
	Three	129	21.90
Side effect to PZQ		172	29.20
Trust in effectiveness of PZQ		490	83.19

Among the screened children 12% were visiting the local HCU if they had any health related conditions. Parasitic infestation (33.98%) followed by diarrheal diseases (30.10%) and schistosomal infection (23.30) were the most frequent reported diseases incurring visiting local HCU (Table 13).

Table 13: Health setting to seek medical services and cause of visit (KHF 2019)

Item		**No**	**(%)**
Seeking health service	Health care unit	103	11.96
	Private clinic	461	53.55
	Governmental hospital	297	34.49
Disease that incur visiting HCU (n=103)	Parasitic infestation	35	33.98
	Diarrhea	31	30.10
	Schistsoma	24	23.30
	Typhoid	9	8.74
	Dysentery	7	6.80
	Hematuria	4	3.88

A total 70 children (67.96%) who were visiting the local HCU reported that the time to reach the HCU was less than 30 minutes. The waiting time for physician was accepted in 64.08%. Physician was present at HCU regularly in 18.45%. Physician was providing adequate time to explain treatment plan in 47.57%. About 57.28 were satisfied with physician communication, 66.02 were complaint to the study plan, and 44.66% were having regular follow up. Pharmacist and drug availability was reported in 68.93% and 37.86%, respectively. About 54.37% were trusting in medication effectiveness. About 39.80% reported that the lab technician is always present at HCU and 36.89% were always satisfied with the lab results. A total 73.79% stated that not all specialties were available at the HCU, and improvement of symptoms was reported in 83.52% of them (Table 14).

Table 142: Attitude and behavior toward local health care unit (KHF 2019)

Item (n=103)		Frequency	%
Time to reach nearest HCU	<30 Minutes	70	67.96
	>60 minutes	7	6.80
	30-60 minutes	26	25.24
Waiting time for physician or Lab technician	Not-accepted	37	35.92
	Accepted	66	64.08
Presence of physician	Never	10	9.71
	Sometimes	74	71.84
	Always	19	18.45
Physician take enough time to examine you	Sometimes	36	34.95
	Never	18	17.48
	Always	49	47.57
Physician explain treatment plan	Sometimes	22	21.36
	Never	22	21.36
	Always	59	57.28
Satisfied with physician communication	Sometimes	30	29.13
	Never	14	13.59
	Always	59	57.28
Do you complaint to the study plan	Sometimes	28	27.18
	Never	7	6.80
	Always	68	66.02
Is there a regular follow up	Sometimes	34	33.01
	Never	23	22.33
	Always	46	44.66
Pharmacist availability	Sometimes	26	25.24
	Never	6	5.83
	Always	71	68.93
Drug availability	Sometimes	59	57.28
	Never	5	4.85
	Always	39	37.87
Do you trust in effectiveness of medication received	Sometimes	41	39.80
	Never	6	5.83
	Always	56	54.37
Lab technician availability	Sometimes	43	41.75
	Never	19	18.45
	Always	41	39.80
Satisfaction with lab results?	Sometimes	45	43.69
	Never	20	19.42
	Always	38	36.89
Different specialties availability	No	76	73.79
Cost of health service	Expensive	4	3.88

	Free	38	36.89
	Accepted	61	59.22
Out come	Improvement	86	83.52
	No improvement	17	16.48

2. inferential statistics

The prevalence of infection was significantly different within each village in the dry season and not significantly different between villages in the wet season. The prevalence of *S. mansoni* infection was 7.18% in the dry season and 19.16% in the wet season. The prevalence of infection was significantly higher in the wet season in comparison to the dry one (x^2=27.18, p<0.001) (Table 15).

Table 15: The prevalence of infection among screened children in each village and within each season (KHF 2019)

Season			BETWEEN VILLAGES				BETWEEN SEASONS	
			Positive	**Negative**	**X^2**	**P**	**X^2**	**P**
Dry (n=432)	El-Ross	Count	1	136	72.28	0.001	27.18	0.001
		%	3.23	33.83				
	El-Salhba	Count	26	70				
		%	83.87	17.66				
	Zwarat	Count	4	195				
		%	12.90	48.51				
Wet (n=429)	El-Ross	Count	57	257	3.52	0.172		
		%	69.51	74.28				
	El-Salhba	Count	19	53				
		%	23.17	15.32				
	Zwarat	Count	6	36				
		%	7.32	10.40				

In all villages under investigation, there is harmony between the results of the infection of water streams with cercaria and human *infected* with *schistosomiasis* in both seasons whereas there is no cercaria infection in wet season in El-Ross. In dry season, *S. manosni* infection has its highest percentage in izbate El-Salahba (around 26%) followed by izbat EL-Zawarat and then izbat El-Ros (about 2.04% and 0.73% respectively). On the other hand, in wet season, the highest percentage of *S.manosni* infection is in izbate El-Salahba (around 26%) followed by izbat El-Ross and then izbat EL-Zawarat (nearly 18% and 14.6% respectively) (Table 16).

Table 163: The prevalence of snail infection of each village at different seasons (KHF 2019)

Village	Season	Time	Water stream	Water infection	Human Schisto-infection
Izbat El-Salahba	Dry	July	Main water canal	Positive	27.08%
			1st branch	Negative	
			2nd branch	Negative	
			Bank	Positive	
		August	Main water canal	Positive	
			1st branch	Positive	
			2nd branch	Positive	
			Bank	Positive	
		September	Main water canal	Negative	
			1st branch	Positive	
			2nd branch	Positive	
			Bank	Positive	
	Wet	November	Main water canal	Negative	26.3%
			1st branch	Positive	
			2nd branch	Positive	
			Bank	Negative	
Izbat El-Ros	Dry	July	1st canal	Negative	0.73%
			2nd canal	Negative	
		August	1st canal	Negative	
			2nd canal	Positive	
		September	1st canal	Negative	
			2nd canal	Positive	
	Wet	November	1st canal	Negative	18.15%
			2nd canal	Negative	
Izbat Zawarat	Dry	July	1st canal	Negative	2.01%
			2nd canal	Positive	
			Bank	Negative	
		August	1st canal	Negative	
			2nd canal	Negative	
			Bank	Negative	
		September	1st canal	Positive	
			2nd canal	Negative	
			Bank	Negative	
	Wet	November	1st canal	Positive	14.29%
			2nd canal	Positive	
			Bank	Negative	

Snail density, total number of collected (*B. alexandrina) snails* and infection percentage showed remarkable difference in means in different Izbats (El Salahba, El

Ross and El Zowarat) is consistent with p-value equals 0.002, 0.008, 0.043 respectively. At the same time as there is no significance difference between means of snail density, total number of *B. alexandrina* snail and infection percentage at both seasons which is compatible with P-value equals 0.489, 0.676, 0.239 respectively (Table 17).

Table 17: Snail density, total number of *Biomphalaria alexandrina* snail and infection percentage within each village at different seasons

Village	Snails Density					*Biomphalaria Alexandrina*					Infection (%)				
	N	**Mean**	**SD**	**Min.**	**Max**	**N**	**Mean**	**SD**	**Min.**	**Max**	**N**	**Mean**	**SD**	**Min.**	**Max.**
El Salahba	80	19.35	35.93	0	208	80	15.48	34.26	0.00	207	80	16.84	34.99	0.00	100.00
El Ross	40	2.03	7.12	0	40	40	0.40	1.37	0.00	8	40	3.75	17.50	0.00	100.00
El Zowarat	60	9.03	18.49	0	92	60	8.12	17.96	0.00	90	60	7.84	26.32	0.00	100.00
p-value	**0.002**					**0.008**					**0.043**				
	Snails Density					***Biomphalaria Alexandrina***					**Infection (%)**				
	N	**Mean**	**SD**			**N**	**Mean**	**SD**			**N**	**Mean**	**SD**		
Dry	135	10.06	28.21			135	4.30	18.78			135	10.95	28.61		
Wet	45	13.57	32.99			45	3.42	10.50			00	00	00		
p-value	**0.489**					**0.676**					**0.249**				

The results showed in Table 18 proved that there is significance difference between snail intensity and different environmental parameters salinity, turbidity, total coliform (TC), *Escherichia coli* (EC) and vegetation percentage at different months (July, august, September and November) according to p-value <0.05. There is significance difference between infected and non-infected water streams regarding the five parameters (snail intensity, salinity, total coliform, fecal coliform and vegetation percentage) where p-value equal 0.035, 0.002, 0.004, 0.000 and 0.001, respectively.

Table 18: The differences between environmental factors in different seasons and in infected and not infected water streams (KHF 2019)

Parameter	**Mean± SD**				**P** bet/month	**p** infection/not
	July	**August**	**September**	**November**		
Snail Intensity	9.88± 26.41	21.48±40.08	6.70±16.79	6.37±15.96	0.02*	0.035
Salinity (mg/L)	338.48±183.41	447.95±222.60	442.32±218.52	487.54±280.08	0.01*	0.002
Turbidity (NTU)	20.28±22.69	27.65±49.36	17.56±23.38	135.95±379.04	0.04	
TC (MPN/100 mL)	$2.27x10^5$±7.42 $x10^5$	1.1 $x10^6$±2.4 $x10^6$	7.43 $x10^5$±1.9 $x10^6$	2.7 $x10^6$±5.4 $x10^6$	0.017*	0.004
EC (MPN/100 mL)	2.18 $x10^3$±2.03 $x10^3$	7.96 $x10^4$±1.7 $x10^5$	5.56 $x10^4$±1.02 $x10^5$	8.06 $x10^4$±8.8 $x10^4$	0.004*	0.00
Vegetation percentage (%)	69.53±27.81	51.33±38.04	58.93±39.69	66.03±34.49	0.024*	0.001

TC: total coliform, EC: *E.coli*

Presence of vegetation is observed as an effective factor in infection as both grasses and duckweeds has a significance association with infection (p-value= 0.009 and 0.006 respectively) (Table 19).

Table 19: Types of vegetation associated with infection (KHF 2019)

Type of vegetation		Infected	Not infected	X^2	P-value
Reeds	N	24	135	3.66	0.08
	%	100	86.50		
Grasses	N	24	124	5.99	0.009*
	%	100	79.50		
Water Hyacinths	N	21	109	3.22	0.09
	%	87.50	69.90		
Duckweeds	N	21	92	7.24	0.006*
	%	87.50	59.00		

Table 20 demonstrated the correlation between different types of vegetation (reeds, grasses, water hyacinths and duckweeds) and water velocity, substrate, animals and human activities (sewage, washing/bathing, washing dishes, washing clothes, fishing, rice cultivation, other farming and collecting water). Water hyacinths have positive correlations with water velocity, substrate and human activities. Both grasses and duck weeds have positive correlation with water velocity. Otherwise, duckweeds and reeds have negative correlation with human activities.

Table 20: Correlation between some environmental factors and different types of vegetation (KHF 2019)

Types of vegetation		Reeds	Grasses	Water Hyacinths	Duckweeds
Water Velocity	**r**	NS	0.28	0.29	0.34
	P		0.00	0.00	0.00
Substrate	**r**	NS	NS	0.15	NS
	P			0.04	
Human activities	**r**	-0.173	NS	0.17	-0.15
	P	0.021		0.02	0.05

NS: not significant

Table 21 displayed the intensity of infection within different season, where 87.61% of the infected children were of light infection and 12 of 113 children (10.62%) were of moderate infection, and only two cases were of heavy infection.

Table 21: The intensity of infection within different seasons (KHF 2019)

Item			Dry	Wet	X^2	p-value
Intensity of infection	Light	n	29	70	1.63	0.632
		%	25.66	61.95		
	Moderate	n	2	10		
		%	1.77	8.85		
	Heavy	n	0	2		
		%	0.0	1.77		

The results proved that increasing age was a highly statistical significant factor affecting prevalence of *S. mansoni* infection. The mean age of positive cases was 11.79 years, while of negative cases was 10.96 years. Neither child order, number of family members, nor house hold crowding index was associated with prevalence of infection. Sex of children and mother education level were significantly associated with higher prevalence of infection (p-value = 0.02 and 0.017, respectively). Parental job, and father level of education were not significantly associated with acquiring infection. Social class was not associated with acquiring infection, as 99.88% of screened children were low to medium social class (Table 22).

Table 22: Features associated with *Schistosmoma mansoni* infection (KHF 2019)

			positive	Negative	X^2	p
Gender	Male	N	65.00	339.00	5.46	0.02
		%	57.52	45.32		
	Female	N	48.00	409.00		
		%	42.48	54.68		
Age	5-10 years	N	17.00	257.00	17.01	0.001
		%	15.04	34.50		
	11-15 years	N	96.00	491.00		
		%	74.96	65.56		
Mother level of education	Illiterate	N	86	489	12.00	0.017
		%	76.1	56.7		
	Read and write	N	17	73		
		%	15.0	8.5		
	Primary school	N	0	11		
		%	0.0	1.3		
	Preparatory school	N	1	33		
		%	0.9	3.8		
	Secondary school	N	9	114		
		%	8.0%	13.2%		
Father level of education	Illiterate	N	62	383	8.17	0.15
		%	54.9	51.2		
	Read and write	N	25	123		
		%	21.1	16.6		
	Primary school	N	7	47		
		%	6.2	6.3		
	Preparatory school	N	6	38		
		%	5.3	5.1		
	Secondary school	N	7	101		
		%	6.2	13.3		
	Dead	N	6	54		
		%	5.3	5.8		

Frequent water contact with different reasons (washing clothes, water collection, irrigation, water unavailability and washing) was associated with acquiring infection with different p-values (0.022, 0.008, 0.001, 0.037 and 0.002, respectively) (Table 23).

Table 23: Risk behaviors associated with *Schistosoma mansoni* infection (KHF 2019)

Item				Positive	Negative		
Contact with water canal		Yes	n	67	354	X	p
			%	59.29	45.15	5.16	0.023
		No	n	46	394		
			%	40.71	50.26		
Reason for contact	**Site of contact**	Lake	n	46	211	26.895	0.0001
			%	40.71	26.91		
		Center	n	22	33		
			%	19.47	4.21		
		Both	n	45	64		
			%	39.82	8.16		
	Washing clothes	Yes	n	26	106	5.25	0.022
			%	23.01	13.52		
		No	n	87	642		
			%	76.99	81.89		
	Water collection	Yes	n	13	40	7.13	0.008
			%	11.50	4.41		
		No	n	90	715		
			%	85.50	95.59		
	Irrigation	Yes	n	30	82	19.72	0.001
			%	26.55	10.96		
		No	n	83	666		
			%	73.45	89.04		
	Water unavailability	Yes	n	15	53	4.35	0.037
			%	13.27	7.086		
		No	n	98	695		
			%	86.73	92.91		
	Washing	Yes	n	31	113	9.84	0.002
			%	27.43	15.11		
		No	n	82	635		
			%	72.57	84.89		

The following table shows that, there was significant difference between the infected and not infected children regarding the way they get rid of their rubbish p value<0.01. Water break was associated with being positive for *S. mansoni* (p = 0.027). Close proximity to water canal was another housing condition associated with acquiring infection (p=0.033) (Table 24).

Table 24: Housing environment associated with infection (KHF 2019)

Item			Positive	Negative	X	p
Rubbish	Dumped in water canal	N	20	62	16.73	0.0002
		%	17.70	8.29		
	Collected by cars	N	46	438		
		%	40.71	58.56		
	Put in areas of collection	N	47	248		
		%	41.59	33.16		
Water break		N	107	650	4.903	0.0268
		%	94.69	86.90		
Proximity to water canal	Less than 15 minutes	N	102	600	6.820	0.033
		%	90.27	80.21		
	15-30 minutes	N	5	75		
		%	4.42	10.03		
	More than 30 minutes	N	6	73		
		%	5.31	9.76		

Table 25 showed health facilities visited by infected and non-infected children. This results proved that 91.15% of infected children were not visiting the local HCU within the village, and 86.57% of the non-infected children were not visiting the local HCU, this difference was not statistically significant.

Table 254: Health facilities visited by infected and non-infected children (KHF 2019)

Item		Positive	Negative	X	P
HCU	**n**	10	93	3.566	0.1681
	%	8.85	12.43		
Governmental hospital	**n**	56	406		
	%	49.56	54.28		
Private clinic	**n**	47	249		
	%	41.59	33.29		

Discussion

Schistosomiasis affects almost 240 million people worldwide, and more than 700 million people live in endemic areas. About 120 million people infected with schistosomiasis are estimated to be symptomatic; 20 million develop severe disease. The infection is prevalent in tropical and sub-tropical areas in poor communities without potable water and adequate sanitation.(1) On a global scale, 1 in every 30 individuals has schistosomiasis.(2) Schistosomiasis is endemic in 76 countries and territories, 67 of them have active transmission of this disease. Of these countries, 46 countries are in Africa alone which is estimated to account for 85% of all schistosomiasis transmission globally. (3) The estimated disability-adjusted life years lost due to this disease was 1.9 million in 2016. (4)

Schistosomiasis is associated with significant morbidity including anemia, chronic pain, diarrhea, exercise intolerance, malnutrition, bladder cancer, and portal hypertension and central nervous system complications. Although most infections occur in residents of endemic areas, it has been clearly documented that brief freshwater exposure is sufficient to establish infection, thus travelers may also be infected. Most of the severe cases occur in Africa, due to lacking morbidity control.(5)

Transmission of schistosomiasis is the result not only of interplay between humans, snails and parasites, but also of complex demographic, environmental, biological, technological, political, socioeconomic and cultural processes. The WHO Expert Committee on Epidemiology and Control of Schistosomiasis in 1978 asserted that "comprehensive understanding of environmental, demographic, social, human behavioral and economic factors in schistosomiasis is essential for the design of control programs that are successful in the long run". In this study the main objective was to identify causes of persistent transmission of *S.Mansoni* at the late stage of elimination in Kafr El Sheikh governorate, Egypt.(6)

The current schistosomiasis control strategy is mainly based on preventive chemotherapy that is the periodic administration of the antischistosomal drug praziquantel to school-aged children and other high risk groups.(7) Praziquantel reduces morbidity and might impact on transmission, but rarely eliminates infection.(8)

Various factors are responsible for the persistent transmission of schistosomiasis in Kafr El Sheikh Governorate in four villages (El-Ross, El-Zowrate and El-Salhba).

This study aims to identify different ecological factors responsible for sustained transmission of disease.

These factors include seasonal variation and its reflection on the environmental factors affecting prevalence of human and snail infection. In addition housing conditions including living in close proximity to water bodies. Also, socioeconomic factors were studied such as age, sex, level of parent education, and occupational activities, mass drug administration and quality of care provided by the local health care unit within the selected village based on interviewed response.

In this study 861 children were screened (432 and 429 in the dry and wet season, respectively), male children presented 46.81%. Seven canals and two banks surrounding the selected villages were examined 3 times (in July, August and September) in the dry season and once (November) in the wet season. Health education sessions were given targeting community leaders, stakeholders, teachers, school principal, and outstanding students focusing on safe utilization of water in canals and banks, and identifying barriers against elimination of infection.

Seasonal variation and schistosomal prevalence in snail and human:

In the current research the prevalence of *S.mansoni* infection was (31/432) 7.18% in the dry season and (82/429) 19.16% in the wet season. The overall seasonal classification of the studied villages was a low endemic area in dry season and mild infection in the wet season.[9] This prevalence of disease is considered relatively lower than the result of our previous survey in the same governorate in Arab El-Mahder village that was above 30%. The prevalence of infection was nearly the same at both seasons in the El-Salhba village (26.30, 27.08%). While, the prevalence of infection increased in El-Ross village from one case (0.74%) in the dry season to 18.15% (57/314%) in the wet season. This low prevalence in the dry seasons coincide with chemotherapy campaigns conducted recently in village. Important issue is not to depend on point prevalence to assess the yearly prevalence of schistosoma infection especially with MDA and cleaning of canals and banks.

Another issue to be noticed is that, the number of collected *B. alexandrina* snail from Izbat El-Ross was 75, the prevalence of snail infection with cercaria was 21.3%, and this may also explain the low prevalence of human infection.

In the wet seasons the collected snail number (*B. alexandrina*) decreased to 6 and the number of infected snail dropped to zero, while human infection raised to 18.15%.

The contradiction between human infection and snail infection in different villages can be explained by:

- First, Human activity, as the resident of El-Ross village prefer to swim in other villages canals where their farms are and away from their homes.
- Second, the water canal of the El-Ross village (from which no *B. alexandrina* snails were collected), is severely polluted, pollution ca lead to the disappearance of snails.
- Third, the extremely high level of water in the canals and banks in concomitant with the end of rice cultivation season (in September), results in decrease in number of collected snails

Environmental factor

S. mansoni was highly adapted to high salinity across the different months (338.48±183.41, 447.95±222.60, 442.32±218.52, 487.54±280.08 respectively) this is way there was a significance correlation between salinity and infection. This is because it is favorable condition for snail abundance and survival.[10]

Turbidity could be because of high planktonic density, sediments from soil erosion or flooding. Although some researches correlated the abundance of live *B. alexandrina* was negatively correlated with turbidity ,[11] there was no correlation between turbidity and *B. alexandrina* existence. This is the reason why that of turbidity was not high along four months (20.28±22.69, 27.65±49.36, 17.56±23.38, 135.95±379.04 respectively) but there was a significance difference between them.

For indicating the correlation between fecal contamination and infection, this analysis confirmed that the presence of human waste in the water. Where there was a significance correlation between TC-EC and infection (p-value equals 0.017, 0.004 respectively). This finding is of interest because human infections are strongly linked to contamination of the aquatic environment by coliforms. Total and thermo-tolerant coliforms verified sewage discharge in that area and elevated the likelihood that the *S. mansoni* eggs came from infected individuals in the community [12] because this waste was major sources of organic material in water streams, contributing to making them favorite snail habitats. [13] Moreover the significance correlation between vegetation percentage and infection (p-value equals 0.001) as *B. alexandrina* snails may be attached to various parts of the plants to escape the direct effect of sunlight, feed, or get access to oxygen. [11] Where the most significance correlations of infection with types of vegetation were with grasses and duckweeds ($p = 0.009$ and 0.006 respectively) which may be due to their importance as food source. [14]

The notable relationship between water velocity and vegetation's' types (grasses and duckweeds with p value equals 0.00 for both of them) may be connected with their net photosynthesis. This result indicates that the physical stress imposed on the vegetation by agitation or stretching in the flowing water could be a key factor for the observed flourishing response. [14] In addition, vegetation could serve as substrates for feeding and ovi-position as well as providing protection from high water velocities and predators such as fish and birds. Furthermore, snails can live on water plants and mud that is rich in decaying organic matter.[15]

The correlation between two types of vegetation (grasses and duckweeds) and human activities is significance in accordance with p value equals 0.021 and 0.05 respectively. This could mean that transmission rates at locations depend on human activities at each location which can change over time. [16]

Intensity of infection

The effectiveness of MDA programs for *S. mansoni* is mainly monitored by measuring changes in the prevalence of infection, drug treatment coverage, and also based on the prevalence of heavy infection (≥ 400 eggs per gram [epg] of feces). [17] Regarding intensity of infection,(111/113) 98.23% were of either light or moderate infection, and the prevalence of infection was below 10% or below 50% in other villages. This finding is due to intensive MDA campaign adopted by the Ministry of Health and Population. The policy should be MDA biannually if infection exceeded 10% or twice during primary school study first on entry and second on exit.

Social factors

Age: In endemic areas, the infection is usually acquired in childhood.[18] The prevalence and intensity of infection rises with age and peaks at approximately 15 to 20 years. In older adults, the prevalence of infection does not change significantly, but the intensity (parasite burden) decreases dramatically.[19] In this research the mean age of infected children was significantly higher than not infected. Additionally, the age category of 11-15 years was harboring infection more than the age category of 5-10 years. Indeed, children aged 10–14 years can become more vulnerable for schistosomiasis during recreational activities, i.e., swimming and playing in water, or while fetching water for household use, or agriculture activities On the same line, the different age group had different susceptibility to infection was reported in different studies.[20, 21] However, no differences in the prevalence of Schistosoma infection were observed among the three investigated age groups in a study conducted in Côte d'Ivoire. [22]

Sex: There are no global figures on the distribution of schistosomiasis by sex. From the scattered surveys available, it seems that men and women are infected in equal numbers, but that women are generally more intensely affected by the disease than men.[23] Nonetheless, in the current study, males were more likely to be infected with *S. Mansoni* than females, as they are more often come in contact with water than females. This is explained by gender-specific water-contact activities. The prevalence of infection among girls was lower than boys. Indeed, during swimming (the predominant water contact by boys), boys exposed their whole bodies in the water, while girls usually only exposed their legs and hands into the water, mainly in relation to carrying out domestic activities (e.g. fetching water, washing clothes and dishes). In line with this finding, another study conducted in Senegal stated that higher prevalence was reported among males. [24] Interestingly, similar prevalence rates for boys and girls was reported in the Côte d'Ivoire study, however, it be due to considerably higher number of boys than girls (727 vs. 460). [22] Although some studies stated that there was sometimes considerable local differences in prevalence and intensity observed between men and women, in this study, there was no difference in-between boys and girls regarding intensity of infection.

Education: In this research maternal illiteracy was strongly associated with higher prevalence of infection, 74.7% of infected cases had illiterate mothers. A study from Santo Antonio de Jesus, Bahia State, Brazil, indicates that an increase in the education level of the head of household was strongly associated with a decrease in the prevalence and intensity of infection in the household. [25] Nonetheless, father level of education did not significantly affect the prevalence of infection. Another study conducted in Côte d'Ivoire mother and father level of education was significantly associated with acquiring infection, but the mother odds ratio was more than three times the odds of father education. [22] The higher risk due to mother illiteracy may be explained by the longer time spent by mothers with their children and the great impact of them on their children.

Social class or status: Some researchers argue that it is more accurate to understand the social production of schistosomiasis in relation to social class or status rather than to urbanization. They often share conditions such as lower levels of education and unemployment as well as lack of sanitation, housing, transport and access to health facilities. Their point is not that lack of education or poor housing will automatically lead to infection, but that if infective snails are present in local waterways, it will most likely be members of the poorer households who are infected. [6] In this study, there was no significant effect of the social class level as nearly all the children were of low or intermediate class. A study from Côte d'Ivoire shows that while the general population in areas with piped water, less crowding and better housing was less infected than the population in crowded areas without piped water and good housing.[26]

Location of households in relation to water sources may play a role: In this research, close proximity of the houses to water canal was significantly associated with *S. manosi* infection. 91.15% of infected children were living nearby water (less than 15 minutes). A detailed epidemiological study was carried out in São Lourenço da Mata, Brazil, it showed that leisure water contact, particularly swimming, was the only type of water contact significantly associated with schistosomiasis among people between 10 and 25 years of age, and that a decrease in water contact was associated with better socioeconomic conditions.[27]

Human water-contact activities

Water contact is mandatory to acquire infection, however, 40.71% of infected children denied any contact with water canal. This issue needs to be discussed, as if there did not come in contact with water stream what is the supposed route of infection. Direct observations were made with an emphasis on the behavior of community members in order to understand how they might become infected with schistosomiasis. Two explanation for this issue; the first these children may not recognize the risk of some adopted behaviors as getting rid of their rubbish by dumping their trash it into the water canal. This may expose their legs or body to the stream as the and usually use basket to collect rubbish and they empty these baskets on the lack of the canal. Another issue is the stigma associated with using water canal and having schistoama infection, could be a possible cause that made the child deny contacting water canal. Site of contact is supposed to be associated with acquiring infection, 19.47% of the infected children were contacting the center of the canal, while, 0.71% were contacting the lack.

Health facilities within the village

The limited accessibility of diagnostic, chemotherapeutic and preventive services significantly constrains the health-seeking behavior of people infected with schistosomiasis and other infectious diseases, especially in developing countries. In addition, a lack of information, the costs of travel and health-services fees, geographic distance, social factors and frequently unavailable services are also major barriers people face in accessing health services.[27]

The major finding of this study is the small proportion 12% of the population that reported to visit the local health care unit within the village although it was accessible for the population living within its catchment area. This issue was asked while we providing health education sessions. The stakeholders and fathers of screened children stated that the doctors are available all times and there is sever lack of facilities within the unit. Others stated that, drugs are given to relatives and acquaintances. These issues make the local residence seek medical advice out of the local health care unit.

Health education program

Health education session is a cornerstone in elimination of any infectious disease, especially schistosomiasis. Community engagement is mandatory not only to ensure representation of all society components and their participation but also, it provides a comprehensive insight into the context of the community. Health education sessions were planned on the risky factors identified through questionnaire, however, more important issues detected during the group discussion.

As water canals are the main source of water supply for the local resident, it is exceedingly difficult to prevent the community from contacting this essential source of water on a daily basis for various uses (swimming, washing, washing cloths and plates, irrigation of lands or frequent water break). The health education program was held at school teacher, pupil representative, community leader and stakeholders were invited to attend the session. The program focused on safe contacting water canal, like rubbing skin immediately after getting out of water canal, avoid contact with areas of high snail intensity, avoid defection in water canal, importance of MDA, and avoiding long time exposure with the canal (not more than 10 minutes).

One of the attendance mentioned that “they have no pure water supply even also the water canal is contaminated with sanitation". This contamination is either caused by the population living in the village or by drainage canal that ends in water canal. If they report this offence, the guilty persons pay money to stop the continuation of legal issues”. Another citizen reported that “there is a great gap in providing health service in the local health-care unit due to either leakage of facilities or human resources”. Another issue raised also was discrimination of water share, on the tongue of a citizen “clean water goes to someone important (former minister) living in the village, even if he use insecticides he bring purer water from nearby village, this makes us use contaminated water”. The last was little bit frustrating to us; “ you asked us not to contact water canal more than 10 minutes which is impossible” this comment was one of the benefit of community engagement as it approve that any solution should be based on the community requirement not only on the established guidelines.

Limitation:

- Short duration of the grant and small amount of fund, we could not cover all seasons, and month.
- In the hot season; due to school holiday, we could not access schools.
- Some screened children didn’t bring 3 consecutive daily samples, but we have already collected more than the minimal required sample size with 3 stool samples.
- We cannot provide PZQ to the infected children based on the treatment policy of MOHP; treatment should be given by the ministry of health. Actually we have deliverd a detailed a report containing names of all affected children to the health authority to treat them with PZQ.

Conclusion

S.mansoni is still a circulating disease in endemic areas even after decades of MDA, the prevalence of infection is mainly of a low to mild endemic level, however, the intensity of infection is light to moderate this may be due to MDA. Effective elimination of infection should start with community engagement to highlight social determinant of persistent transmission and to gain their cooperation. Usual cycle of infection is largely changed, defecation in water canal is not the usual source of infection as in the past, while sanitary disposal in water canal is the main source of water contamination. Improving infrastructure, and housing conditions through providing safe water supply and sanitary disposal is a cornerstone in elimination of infection. Health education programs should be maintained and stressed on unrecognized risk factors like dumping the trash into water canal. Seasonal variation of infection should be kept in mind; point prevalence may not provide accurate estimation of the current situation.

The services provided by the local health care unit should be developed to cope with the rural village inhabitant’s requirements and increase their satisfaction on the service provided. Environmental factors, and water vegetation can effectively affect snail population and infection, consequently human infection. Effective elimination program should include malacological control and environmental study, considering the monthly variation in the snail population.

Recommendation

- Roadmap towards elimination of schistosmiasis from Egypt requires multi-sector collaboration, involving the Ministries of Health and Population, Environment and Education.
- MDA effectiveness is a matter of debate in the coming few years, another alternative should be available to face the possibility of development of PZQ resistance.
- Estimation of the cost-effectiveness of an elimination program based on four pillars; health education and behavior modification, environmental sanitation, malcological control, MDA versus MDA alone.
- A pilot community trial should be carried out that adopts the integrated program that adopts the previously mentioned pillars.

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Appendices

1- Annex 1: Codes, GPS image of the studied canals and their descriptive statistics.
2- Annex 2: Health education booklet
3- Annex 3: Photos recording the human survey, and Health education session.
4- Annex 4: Photos recording the environmental sampling and snail collection
5- Annex 5: Human Data collection tool