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RESEARCH TITLE

TRANSMISSION OF SCHISTOSOMIASIS IN THE GEZIRA SCHEME, GEZIRA STATE, SUDAN.

(An investigated study in August 1999 – July 2000)

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Abstract

This study was carried out in part of a village area (Angadho village area) in the northern part of the Gezira Irrigation Scheme (GIS). The main objectives of the study were (1) to investigate the reasons behind the reduction in the snail populations reported by many researchers and (2) to determine the distribution of freshwater snails in the different types of canals, with special emphasis on schistosome intermediate hosts.

The study confirmed the endemicity of Schistosoma mansoni infection in the village and the field camp. Only three individuals were found infected with Schistosoma haematobium in the camp and no one was found infected with urinary schistosomiasis in the village. In the camp, the overall prevalence was 39.9% and the geometric mean egg count (GMEC) was 5.5 epg. Among the school children, in Angadho village, the overall prevalence 4.4% and the GMEC was 1.2 epg.

The prevalence and intensity of intestinal schistosomiasis varied significantly between the camp and schoolchildren of the village. In the camp, the indices of infection varied significantly by age reaching a peak in the age group 10 – 19 years (67.3%). The prevalence and intensity of infection in the age group below 10 years of age was 45.4% and the GMEC was 7.1 epg. Prevalence and intensity of infection with schistosomiasis were higher in males than females in the camp and among Angadho school children. Differences by six were only statistically significantly for Schistosoma mansoni in the camp. This may be due to differences in social attitudes of the two sexes.

Key Words: Schistosomiasis (Bilharziasis) - Schistosoma mansoni – Schistosoma haematobium. Freshwater snails - Biomphalaria pfeifferi – Bulinus truncatus - Bulinus forskalii - Lymnaea natalensis.

عنوان البحث

انتقال داء البلهارسيا في مخطط الجزيرة ، ولاية الجزيرة ، السودان.

(دراسة تحقيقية اجريت في الفترة أغسطس 1999 - يوليو 2000)

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المستخلص

أجريت هذه الدراسة في منطقة أنجضوا في الجزء الشمالي من مشروع الجزيرة المروي في الفترة من أغسطس 1999 الي يوليو 2000 . الأهداف الرئيسية لهذه الدراسة هي التحقيق والتعرف على العوامل والأسباب التي كانت وراء إنخفاض حلزونات المياه العذبة في قنوات الري الرئيسية في المشروع ، ولدراسة توزيع حلزونات المياه العذبة في قنوات الري خاصة العائل الوسيط لطفيلي المنشقة.

أثبتت الدراسة توطن داء المنشقات المعوية في أنجضوا ومعسكرات توبا ، في حين وجد ثلاثة أفراد فقط مصابين بالمنشقة الدموية في المعسكرات ، ولم يوجد أى تلميذ مصاب بهذا النوع في قرية أنجضوا . نسبة إنتشار الإصابة بالمرض في معسكرات توبا كانت 39.9% وشدة الإصابة 5.5 بيضة/الجرام . إختلفت مناسيب الإصابة بالمنشقة المعوية إختلافاً معنوياً بين سكان المعسكرات العمالية وتلاميذ المدرسة في أنجضوا ، وبين المجموعات العمرية في المعسكرات . أعلى مناسيب الإصابة سجلت في المجموعة العمرية 10 – 19 سنة ، وكانت هذه المناسيب عالية في المجموعات العمرية أقل من عشر سنوات (45.4% و 7.1 بيضة/الجرام) . أوضحت الدراسة بأن مناسيب الإصابة بداء المنشقات عالية في الذكور مقارنة بالإناث ، في المعسكرات وبين تلاميذ المدرسة في القرية .

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1. Introduction:

Schistosomiasis, also known as bilharzia, is a disease caused by parasitic worms. Although the worms that cause schistosomiasis are not found in the United States, more than 200 million people are infected worldwide. In terms of impact this disease is second only to malaria as the most devastating parasitic disease. Schistosomiasis is considered one of the neglected tropical diseases (NTDs), (CDC, 2010).

The parasites that cause schistosomiasis live in certain types of freshwater snails. The infectious form of the parasite known as cercariae, emerge from the snail, hence contaminating water. You can become infected when your skin comes in contact with contaminated freshwater. Most human infections are caused by *Schistosoma mansoni*, *Schistosoma. haematobium*, or *Schistosoma. japonicum* (CDC, 2010).

Sudan is an agricultural country. For development purposes in Sudan, irrigation schemes have been constructed *e.g*. Gezira, Managil and Rahad Agricultural Schemes as well as El Gunaid, El Girba Asalaya and Kinana Sugar Cane Schemes. The main crops cultivated in these schemes are cotton, wheat, sorghum, groundnuts and sugar cane. These irrigation schemes and others were constructed and established along the Nile, the Blue and White Nile Rivers and their tributaries. The agricultural sector plays a pivot role in the Sudanese economy, where its efficiency is central to any programmes of economic recovery (SMFEP, 2000).

The establishment of the irrigation schemes has created ideal habitats for the breeding of the snail intermediate-hosts of schistosomiasis. This led to a dramatic increase in both prevalence and intensity of schistosomiasis in these schemes (Kardaman *et al.*, 1982; Hilali, 1992; Taha, 1998; Ahmed, 1998). Man-made habitats, such as irrigation canals, pools behind small dams and ponds along roads and railway constructions, may become rapidly inhabited by intermediate-host snails, thus, contributing to disease transmission.

Biomedical sciences alone cannot eliminate ill-health and disease from any community, for although medical techniques may reduce the burden of disease, they are in most cases only palliative and must be continued indefinitely since they do not strike at the root of the evil. Thus, human water-contact activities with infested water are essential for the transmission of the disease. This should be strengthened by a well-designed knowledge, attitude and practice (KAP) survey with special emphasis on the socioeconomical aspects of the disease.

Schistosomiasis is an ancient parasitic disease of man (Ruffer, 1910 a & b) and few other mammals, caused by bisexual blood flukes of the genus *Schistosoma*. It's one of the most wide spread parasitic diseases and is second to malaria in terms of socio-economic and public health importance. It is estimated that 200-300 million persons are infected 74 countries in the tropical and sub-tropical zones of the world (WHO, 1993). The proportion of the population infected with schistosomiasis is increasing, in the endemic areas, due to displaced population and construction of irrigation schemes. The disease has serious social consequence such as decreasing work capacity, restricting marriage and occupational mobility (Sleigh et al, 1998). Irrigation modifies the transmission from seasonal and focal to constant and intensive (Ndamba et al, 1994; Birrire et al, 1994; Babiker et al, 1985 a & b).

1.1. Distribution of snails in the Sudan:

The varied climatic environment of the Sudan has considerable influence on the distribution of snails. Thus, the occurrence of snails in different parts of the Sudan was reported.

Archibald (1933), reported the presence of Bulinus forskalii in springs in the Nuba mountains in western Sudan. Doumenge et al, (1987) mentioned that Bulinus truncatus, the intermediate host of Schistosoma haematobium, seems to tolerate drought and as thus it is the most widespread in Darfur, Kordofan and the area around Kassala. It is also well established in the Nile below Khartoum. Doumenge et al, (1987) also reported the occurrence of Biomphalaria pfeifferi, the intermediate of Schistosoma mansoni, in Jebel Marra area, western Sudan and in the area around Juba in Southern Sudan. Recently, both Bulinus and Biomphalaria snails were found in Jonglei canal region, southern Sudan (Brown et al, 1984).

In the White Nile area, the occurrence of Bulinus truncatus, Bulinus ugandae, Bulinus forskalii, Biomphalaria sudanica and Biomphalaria alexandarina was reported (Malek, 1958; Williams and Hunter, 1968). In the same area, a recent survey conducted in Umm Hani irrigation scheme south of Kosti revealed the presence of Bulinus truncatus, Bulinus ugandae, Bulinus globosus, Bulinus forskalii, Biomphalaria sudanica and Biomphalaria pfeifferi (Saeed, 1992).

Malacological surveys conducted in old and new irrigation schemes showed the presence of Biomphalaria pfeifferi and Bulinus truncatus In the Gezira – Managil (Karoum, 1988; Hilali, 1992), Rahad (Elias, 1992; Meyer – Lassen, 1992) and New Halfa (Madsen et al, 1988) irrigation schemes. Madsen et al, (1988) found the following snail species in Gezira – Managil and Rahad schemes: Cleopatra bulimoides, Melanoides tuberculata, Gabiella senaariensis, Biomphalaria pfeifferi, Bulinus truncatus, Bulinus forskalii, Lymnaea natalensis, Ferrissia sp, Gyraulus costulatus and Ceratophallus natalensis.

In Khartoum state, both Bulinus truncatus and Biomphalaria pfeifferi were found in bump schemes in Khartoum north (East Nile Provence) by Malek, (1962) and William and Hunter (1968). In a recent survey, both Bulinus truncatus and Biomphalaria pfeifferi in addition to Bulinus forskalii, Physa acuta, Lymnaea natalensis, Melanoides tuberculata and Cleopatra bulimoides were found in irrigation canals in all of the three provinces of the state i.e. Khartoum, East Nile and Omdurman (Hilali et al, 1996; Taha, 1998).

1.2. Gezira and Sennar States:

In 1927, an epidemiological survey was conducted among children in twenty settlements, where not a single child was reported to be infected in the area, in spite of the presence of the intermediate hosts (Humphreys, 1932). Then the prevalence of *Schistosoma haematobium* in the Gezira area was found to be 15% among adults and 45% in Children Stephenson (1947). Malek (1962) reported the prevalence of 5% of *Schistosoma haematobium* at Wad Medani. Amin (1972) reported the intestinal schistosomiasis infection of more than 60% among Gezira villagers. Babiker (1985) showed that the prevalence of *Schistosoma haematobium* in four villages in Northern

Gezira was 20%. Higher prevalence rates of *Schistosoma mansoni* have been reported from Gezira region El-Tayeb et al., (1988). Babiker, 1987, reported a prevalence rate of 21% of *Schistosoma haematobium* among school children and adults in Gezira. While the prevalence of infection ranged between 33.3% and 45% in El-Managil extension Hilali (1992). Thompson (1911) found *Schistosoma haematobium* among boys aged (5-15) years in west Singa. In Sennar the prevalence of schistosomiasis was 10% among school children Hasseb and Khalil (1966). Survey findings revealed that 37% is rate of infection of disease in Sennar Scheme and 72% in Gunaid Sugar Cane Scheme, (Ahmed, 1998).

1.3. Intermediate-hosts of Schistosomiasis:

Each schistosome species has its own characteristic intermediate-host snails. African schistosome species and their intermediate-hosts have been reviewed by (Christensen et al., 1986). The intermediate-hosts of S. mansoni, S. haematobium and S. intercalatum belong to the Pulmonate family: Planorbidae; S. mansoni is transmitted by snail genus Biomphalaria, while S. haematobium and S. intercalatum are transmitted by genus Bulinus. Bulinus truncatus serves as the intermediate-host for S. haematobium in the Sudan (Hilali, 1992; Ahmed, 1994; Taha, 1998). The amphibious snail Oncomelania hupensis (Family Pomaiopsidae) also transmit S. japonicum.

According to WHO (1993) S. intercalatum transmitted by Bulinus forskalii and S. meckongi by Bobertsiella. kaporensis. Some human parasite species have no reservoir host at all, like S. haematobium, while others like S. mansoni and S. meckongi have some mammalian species acting as reservoirs (WHO, 1993).

The role of the definitive-host in the disease transmission is illustrated in the following:

1. Contamination of accessible water with human urine and faeces and sewage.
2. Washing the anal or urethral orifices after defecation or urination.
3. Poor and ignorant people are more susceptible to the infection.
4. School children and adults men are more infected than others groups according to water-contact activities.
5. Water-contact activities such as fishing, farming and canals cleaning are related to high incidence of expose to the disease.
6. Population movement from endemic areas spreads the disease into new areas.

Some of the none-human factors that might substantially help in the distribution and transmission of schistosomiasis are:

1. An aquatic environment with suitable condition of water flow, vegetation cover, water temperature and pH, which determines snails' density and distribution.

2. Availability of the suitable snail species as appropriate intermediate-hosts.

3. Establishment of irrigation system and creation of artificial water.

1.4. Prevalence of Infection:

The prevalence of infection at a particular point of time is expressed as percentage (Ahmed, 1998). It increases when the rate of infection becomes more than the rate of loss of infection. To properly detect the prevalence, it is important to differentiate between changes of prevalence among the same group examined in different times and changes in specific age-group at different times (Gilles, 1973) and adopt a sensitive diagnostic technique (Gryseels and Polderman, 1991). Sometimes the prevalence of infection data is used for guiding the community health policy. In such case, school-aged children prevalence of infection is used as an index, because community prevalence data is very expensive to collect. Thus, most surveys focus on and use school-aged children as sentinel population. School-aged children prevalence of infection could district national level to identify target areas for control and evaluate the numbers at risk of infection (Guyatt *et al.*, 1999).

1.5. Intensity of Infection:

The condition of intensity of infection frequently is measured or recognized by the number of parasites found in the organs of the patient. Jordan *et al.* (1981) stated that there is a correlation between the number of eggs excretion, size and the number of worm's burden, at least in the younger cases of infections. Intensity of infection is generally used to indicate the disease development, ova output figures, especially from younger group population give valuable data about the overall epidemiological situation and therefore, intensity of infection is used to determine the effectiveness of control measure on the level of transmission (Christensen *et al.*, 1987).

Schistosoma spp. infecting young patients produces more eggs than those infecting older ones. In the heavy infection the two groups show light variation in infection probably due to differences in water-contact behaviour and/or immunological response (Dalton and Pole, 1978; Costa *et al.*, 1987; Chandiwana, 1987), on transmission of schistosomiasis in the human host (Yang and Yong, 1998).

1.6. Incidence of Infection:

This incidence, defined as frequency of occurrence of new infections in a specific population normally during 1 year, provides information on transmission intensity in a particular area. The incidence is too complex for use in surveillance of control programs, but of value for research purposes (Christensen *et al.*, 1987). The most convenient study groups, for determination of incidence, are children cured from infection by drug treatment. Enrolment of uninfected or untreated children results in an under-estimation of incidence rates. Difficulties in obtaining precise incidences of infection have been attributed to population movements (Shiff, 1973; Scott *et al.*, 1982); complications of acquired immunity (Butterworth *et al.*, 1984; Gryseels and Polderman, 1991); lack of sensitive diagnostic techniques (Farooq and Hairston, 1964); difficulty to differentiate between an unsuccessful chemotherapy and a re-infection (Jordan and Webbe, 1982). All these led to few publications on incidence of schistosomiasis (Mott and Cline, 1980; Tanaka *et al.*, 1983). However, Chandiwana (1988) and Kvalsvig and Becker (1988) suggested that, incidence studies should include individuals from both treated and untreated groups to represent unbiased samples.

2. Material and Methods:

2.1. The study area:

The study area was in Gezira Irrigated Scheme. This is the largest and oldest irrigation scheme in the country, utilizing water from the Blue Nile River. The Gezira irrigation Scheme is situated to the south of Khartoum between the Blue Nile and White Nile Rivers. It was opened in 1924 and receives irrigating water from Sennar dam on the Blue Nile. It comprises an area of almost 2.25 million feddan (1 feddan = 1.04 acres). The area is divided into 14 administrative agricultural groups and these are further sub-divided into 107 agricultural blocks.

Before irrigation by canalization, the population was approximately 135,000. Following irrigation, there was an influx of people and by 1986 more than 2.5 million people were living there (Babiker, 1987). The total human population of Gezira irrigation Scheme now is about 4.5 million living in about 1500 villages and 500 camps (Sudan National Census, 1993). The human population consists of Arabs and immigrant tribes from western Sudan and Nigeria. The land is farmed by about 100,000 tenant farmers. Most of the tenants live in small villages 5,000 to 10,000 residents. The majority of the villages have either a dispensary or a dressing station, a primary school and a water supply system (El Gaddal, 1985). Immigrants live in camps (unregistered villages) that are not officially recognized, and therefore do not receive any services from the government. Children can attend the nearest school. During the annual cotton picking season, there is an influx of cotton pickers. They are totally dependent on canal water for all purposes (Fenwick et al, 1981).

The agricultural cycle in Gezira irrigation Scheme can be summarized as follows: the field designated for cotton are ploughed and irrigated in February and again in June to germinate and kill any weeds. Cotton is planted in early August and the fields are then irrigated regularly until December. Cotton picking starts in January and the plant dies after the third pick in March or April. In May all dead plants are uprooted and burned. Sorghum is seeded in July and harvested in October/November. Groundnut is seeded in July and harvested in December/January. Vegetables, which are planted at the same period as groundnut, are harvested in October/November. Wheat is seeded in mid November and harvested in March/April. The irrigation season, which begins in June, finishes in May. Thereafter, all canals except those required for village water supplies and gardens, are left to dry out, refilling of canals occurs during June.

2.2. The Experimental Area:

2.2.1. Angadho village area:

The village area chosen for the study was Angadho village area. In Dolga agricultural block in the northern part of Gezira irrigation Scheme. The village is a small with a population of approximately 2500 individuals. It is sited adjacent to the Sharafat Major Canal (on the east bank of the major) and north to Angadho Minor Canal. There are two abu-eshreens adjacent to the village on the eastern and southern sides. The village is supplied with electricity and is provided with a deep pore well for water supply. It has two primary schools, one for boys and the other for girls and a

dispensary. Latrines are found in the village. The residents lived in houses made from mud and red bricks. Adjacent to the village, on the northern side and almost part of the village, there is a permanent Fallata camp. The residents of the camp depend totally on Sharafat Major Canal for water. Some of the residents of the camp are field labourers and the others are shepherds.

2.2.2. Toba Camps:

$Toba_{16}$ and $Toba_{17}$ camps are permanent agricultural labourers camps near Angadho village. They are located near the tail end of Toba Minor Canal, less than fifty meters apart, and are adjacent to an abu eshreen. The two camps were selected because they were within Angadho village area and high prevalence and intensity of infection are known to exist in the agricultural labourers camps (Fenwick et al, 1982; Babiker, 1987).

The inhabitants of $Toba_{16}$ camps were from the Tama tribe. All residents were field labourers. They use the camp as a base camp. During the harvesting period (November-April) they and their families tend to move to temporary dwelling in the field. The majority of the houses were built with mud-bricks, without latrines.

The inhabitants of Toba17 camp were Fallata, originally from Nigeria, living in houses made from mud and red-bricks. Few houses were with latrines. In addition to working as hired labourers. The Fallata cultivate land behind their village and they manufacture Zihrs (large containers made of clay for water). Many of boys attend quranic schools in other parts of the Gezira. Not all the residents were field labourers.

The two camps were without schools, water supply or health units and illiteracy was high among the residents. Few children attend school in Gad El-Ain primary school, seven kilometers to the west of the camps. The residents depended on canal water collected from Toba Minor Canal for domestic use. In this study, the two camps were considered as one unit (Toba Camps).

2.3. Sample Size Determination:

To determine the prevalence and intensity of Bilharzia in the surveyed villages, a random sample size from the population of each village should be selected. Based on previous experience and the guidance of epi-info (epidemiological information) program, the sample size was determined to be of around 120 residents or around 25% of the households in each selected village. A meeting was, then, held with the randomly selected households to explain the purpose of the study and to obtain their consent and to ensure their participation.

2.4. Parasitological Surveys:

Two parasitological surveys were carried out, 12-months apart, to determine the prevalence and intensity of schistosomiasis among the selected villagers and all school children.

2.5. Collection of Urine and Stool Samples:

In each parasitological survey, for delivery of excreta containers, the selected households were visited in the afternoons, when most villagers had returned from work. To facilitate quality control and proper collection of excreta, the flowing measures were ensured:

(1) A serial number and the first name of each member in the selected families were written on the delivered two types of containers. The first one is a container with a lid and the second is a universal bottle with screw top, for collection of stool and urine samples, respectively.

(2) The aforementioned containers and bottles were not left for those absent from the village. When families were deemed to be illiterate, the containers and bottles were given to the individuals personally to reduce the risk that the samples would be collected in the wrong container and bottle.

(3) As agreed by the villagers, the distributed containers were collected the following morning, central nominated point.

On the other hand, excreta from school children were obtained, considering the following measures**:**

(1) Teachers prepared full-lists of students attending classes, where each student was given a serial number, for coding.

(2) In each school, the containers and bottles were distributed and collected after two-hours in the same day.

All obtained excreta samples, from villagers and school children, were then transported to a specially prepared laboratory for parasitological screening, in the University of Blue Nile. At the end of screening each collected excreta batch, the serial numbers of those who did not give enough samples were prepared and were revisited the next day to persuade them to give the samples.

2.6. Diagnostic Techniques for Schistosomiasis:

2.6.1. Screening of Urinary Bilharzia – Centrifugation Technique:

In this technique, 10-milliliters of the collected urine sample were placed into each of three centrifuge tubes. These tubes were centrifuged at 200 rpm for three minutes, where the supernatant was discarded and the deposit of each tube was placed onto a slide, which was covered with a cover-slip and examined under a binocular microscope. Eggs seen in each of the three slides were counted, of S. haematobium ova. The average of the egg-counts in the three slides was manipulated as eggs per 10 milliliters of urine.

2.6.2. Screening of Intestinal Bilharzia:

The collected stool samples were examined by the locally modified Kato Katz technique, calibrated template. About one gram of the sample was put on a piece of paper and pressed through a sieve. The sieved stool was scraped from the sieve surface with a slide and compacted *'ice cream cone*' fashion into the Kato Katz template, which was calibrated to hold 40 milligrams of sieved stool. The 40 mg was then pressed out onto a slide, and the process was repeated so that three slides from each sieved stool sample were prepared. Each slide was then covered with a clean slide to form a '*sandwich*', and pressure was applied with the finger until the faecal matter spread to cover an area of 20-25 mm, in diameter. The slides were then examined under the binocular microscope immediately. Where the S. mansoni and any other parasite(s)

were identified and counted. An average of the egg count on the three slides was taken and multiplied by 25, for calibration to the gram level. The results were expressed as eggs per gram (epg), for intensity of infection or worm burden.

3. Results:

3.1. Parasitological Surveys

3.1.1. Transmission of Schistosomiasis in Angadho Village Area

3.1.1.1. Human Infection in Toba Camps

The study area proved to be a *Schistosoma mansoni* area. From Toba Camps, 396 stool samples were examined for *Schistosoma mansoni* infection and 396 urine specimens were examined for *Schistosoma haematobium* infection. The ova of *Schistosoma haematobium* worms were found in only 3 individual (1.1%) specimen of urine, Table 1. Among the school children of Angadho not a single child was found infected with *Schistosoma haematobium*.

The overall prevalence of *Schistosoma mansoni* was 39.9% and the intensity of infection was 5.5 ± 9.2 epg (GMEC ± SD) and it was 53.1±126 epg (arithmetic ± SD) among the infected. The prevalence and intensity of infection were higher in males than females. However, the prevalence and intensity of infection were not significantly different ($P < 0.05$) between sexes.

The prevalence rates of *Schistosoma mansoni* infection among the different age groups were highly significantly different ($P < 0.001$). Although the intensity of infection was not ($P < 0.05$), Table 2. The prevalence and intensity of infection in the age group below 10 years of age prevalence was 45.4% and the intensity of infection was 52.4 ± 94.37 epg (arithmetic ± SD) and it was 7.1± 9.6 epg (GMEC ± SD). Both indices increased to reached a peak in the age group10 – 19 years old. Prevalence was 67.3% and intensity 114.1± 195 epg (arithmetic ± SD) and it was 20.8 ± 10.2 epg (GMEC ± SD), and then declined with increasing age.

Table 1: Prevalence and intensity of *Schistosoma mansoni* and *Schistosoma haematobium* Infections In Toba Camps, 2000

Sex	*Schistosoma mansoni*				
	No. Exam	No. Infected	Prevalence %	Intensity epg	
				arithmetic ± SD	GMEC ± SD
Males	220	96	43.6	66.3 ± 150.7	6.8 ± 10.1
Females	176	62	35.2	36.6 ± 82.9	4.3 ± 8.0
Total	396	158	39.9	53.1 ± 126	5.5 ± 9.2
			$P < 0.001$		$P < 0.05$

Sex	*Schistosoma haematobium*				
	No. Exam	No. Infected	Prevalence %	Intensity epg	
				arithmetic ± SD	GMEC ± SD
Males	220	1	0.5	0.10 ± 1.7	1.01 ± 8.9
Females	176	2	1.1	0.09 ± 0.8	1.02 ± 1.3
Total	396	3	0.8	0.10 ± 1.4	1.02 ± 1.2

Table 2: Prevalence and intensity of *Schistosoma mansoni* Infection In Toba Camps by age groups, 2000.

Age group	No. Exam	No. Positive	Prevalence %	Intensity epg	
				arithmetic ± SD	GMEC ± SD
10>	108	49	45.4	52.4 ± 94	7.1± 9
10 -19	110	74	67.3	114.1 ± 195	20.8 ± 10
20 – 29	70	16	22.9	20.7 ± 59	2.5 ± 5
30 – 39	47	12	25.5	15.8 ± 39	2.6 ± 5
40 – 49	22	3	13.6	20.7 ± 94	1.6 ± 4
50 +	39	4	10.3	5.8 ± 26	1.4 ± 3
Total	396	158	39.9	53.1 ± 126	5.5 ± 9
			P < 0.001		P < 0.05

3.1.1.2. Angadho School

The prevalence and intensity of *Schistosoma mansoni* Infection among the school children in Angadho village is shown in table 3. Out of the 275 child examined, only 12 (10 boys and 2 girls) were found infected. The overall prevalence was 4.4% (intensity 3.3 ± 21.3 by arithmetic ± SD and 1.2 ± 2.3 by GMEC ± SD eggs per gram). The number of individuals infected in the two sexes in the school of the village was very small to allow for any statistical analysis. However, the difference in the overall prevalence rates and the intensity of infection were highly significantly different (P < 0.001) from those found in the camps.

Table 3: Prevalence and intensity of *Schistosoma mansoni* Infection In Toba Camps among the school children in Angadho school, 2000

Sex	*Schistosoma mansoni*				
	No. Exam	No. Positive	Prevalence %	Intensity epg	
				arithmetic ± SD	GMEC ± SD
Males	137	10	7.3	5.8 ± 29.4	1.4 ± 3.0
Females	138	2	1.4	0.7 ± 6.1	11 ± 1.6
Total	275	12	4.4	3.3 ± 21.3	1.2 ± 2.3
			P < 0.001		P < 0.05

4. Discussion:

The increase in agricultural activity and conversion of arid and semi-arid areas into irrigated schemes have resulted in an increase in the water-associated diseases namely malaria and schistosomiasis (El Gaddal, 1985). Schistosomiasis is the second most important public health problem of tropical and sub-tropical regions, malaria being the first important disease (WHO, 1993). Large irrigation schemes are needed in developing countries to provide and to increase the national income. The construction of these schemes, however, creates different social, economical and environmental problems that affect health. The largest irrigation scheme in the Sudan is the Gezira Irrigated scheme (GIS**).** There are over 2000 registered villages and more than 500 unregistered permanent agricultural labourers' camps in Gezira Irrigation Scheme. This study confirms the endemicity of *Schistosoma mansoni* in the northern of the Gezira Irrigation Scheme reported by Babiker (1987), El-Motasim (1998) and Ahmed (1999). Whereas only three individuals were found infected with *Schistosoma haematobium* in Toba camps, only *Schistosoma mansoni* infection was found in Angadho school children in spite of the presence of snail intermediate hosts of both types of schistosome, i. e. *Biomphalaria pfeifferi* and *Bulinus truncatus* in the canalization system round the village.

The result confirms the early findings by Babiker (1987) that the camps in Gezira Irrigation Scheme are intense transmission areas for *Schistosoma mansoni.* The overall prevalence and intensity of *Schistosoma mansoni* infection were high (39.9%) among the population of the camps. The indices of infection varied significantly by age, among the camp's residents, reaching a peak in the age group 10 – 19 year before they decrease in the following age groups. These results are comparable to those reported from various studies carried out in Gezira Irrigation Scheme (Babiker, 1987; Hilali et al, 1995; El-Motasim, 1998; Ahmed, 1999) and from other irrigation schemes in the Sudan such as the Rahad (Elias et al, 1994) White Nile (Ahmed et al, 1996) and Guneid schemes (Mohamed, 1998).

Although both village and camps are within the study zone of the BNHP in which a comprehensive control strategy was implemented for 10 years, the indices of infection varied significantly between school age children in Toba camps and the school children in Angadho village. The overall prevalence among the school children of Angadho village was relatively low (4.4%). This could be due to a number of reasons. First, the village was the first village to be treated with Praziquantel by the Schistosomiasis Research Group in 1978 to determine the efficacy of the then new drug Praziquantel. The people were followed closely during the implementation of the control strategy by BNHP. All those found infected were treated immediately. This would result in a very low prevalence and intensity of infection. Second, there had been a health education program in the village for more than 10 years by the BNHP. Third, the awareness of the population about the disease is very high (Babiker, Per, Com). Fourth, Angadho village is characterized by an adequate piped water supply system, and the presence of electricity and health unit i. e. social services are adequate. Fifth, the school age children in the camps incomparitive with the village spend most of their time playing in the fields or in the canals and they are therefore repeatedly exposed to infection, in addition to they depend on canal water for the daily domestic use. Sixth, the high illiteracy and the unawareness about the disease among the adults in the camp is reflected in their behaviour towards the disease.

Fenwick et al, (1982) studied schistosomiasis among the laboring communities in Toba Camps. Similar to the present study, they reported a high prevalence and intensity of Schistosoma mansoni infection. The prevalence in Toba Camps could be due to two reasons. First, the camps are located inside the irrigated area, near a canal and an abu eshreens, without any water supply and the sanitary facilities are poor. Second, there is a continuous population movement, especially among the working age groups (15 to 49 years old), between camps at the end of the agricultural season looking for the better jobs. The population movement, to and from other camps, is suspected to play important part in the transmission of the disease in the Gezira irrigation Scheme (Fenwick et al, 1982; Babiker, 1987; Ebrahim et al, 1997) but this needs to be clarified. Camping in the fields during the agricultural season would result in an increase in the prevalence and intensity of infection among the population in the camps. This stay in the field coincides with the high transmission season in Gezira irrigation Scheme (Babiker et al, 1985a; Hilali et al, 1995). During the harvesting season (December, 1999- April, 2000), some of the families stayed in the field and depended totally on the canal water. The same behaviour, in the same camps, was reported by Fenwick et al, (1982), indicating that population behaviour has not changed for almost twenty years, at least in this camps. If any control measures are to be in the camps, it would be advisable to provide safe water, a health education program, supplementary tool but is unlikely to have a marked noticeable effect, because they do not have any other alternative to water.

Both indices of infection, prevalence and intensity, in Toba Camps, were high. It seems that the absence of safe water supply system in the camps is the, most important determining factor for the high prevalence rates and the high intensity of Schistosoma mansoni infection among the population. The high prevalence among the children and the working age groups confirm that the absence of safe water supply is a major factor

in the spread of the disease. Different studies showed that prevalence and intensity of schistosomiasis are closely related to the socio-economic conditions prevailing in any particular endemic area. The most important factors among these are availability of a adequate water supply and sanitary facilities (Arap-Siongok et al, 1976; Mohamed, 1998). It will be ideal to provide the camps, at least the permanent ones, with safe water supply to reduce the infection among the population to insignificant levels.

Schistosomiasis is caused by people. They contaminate the environment by their unsanitary habits. They acquire infection through repeated daily contact with fresh water during fishing, farming swimming, bathing washing and recreational activities. Generally, the prevalence of schistosomiasis is higher in males than in females (Klumpp & Webbe, 1987; Babiker, 1987; Hilali et al, 1995). Social factors may affect sex and age-related prevalence rates (Taylor & Makura, 1985).

This study showed that there were no significant differences in Schistosoma mansoni infection rates of the males and the females in the camps of the Gezira irrigation Scheme. This means that both males and females have the same pattern of the exposure to infection. This is unlike the situation in the permanent village in Gezira irrigation Scheme (1999) but similar to the situation in the permanent camps (Fenwick et al, 1982; Babiker, 1987; El-Motasim, 1998). In Toba Camps, reported higher prevalence rates among the adult males in comparison with adult females. This difference is most probably due to cultural and behavioural differences between the two sexes (Ebrahim et al, 1997**).**

The younger age groups, especially male children of the age 5-14 years, are more active and infrequent contact with water in the absence of schools in the camps. Thus, it was expected and has been found that boys are more heavily infected than girls. Children not attending school, spend their time swimming and playing in the canals near the camps, the decrease in the indices of infection in the older age groups, in Toba Camps, could be due to a decline in the frequency water contact as reported from other endemic areas (Costa et al, 1987; Chandiwana, 1987 a & b), or it could be due to development of resistance to the parasite after frequent exposure to re-infection (Wilkins et al,1987), or it could be due to the combined effect of a build-up of acquire immunity with increasing age and reduction of water contact activities (Abdel Wahab et al, 1980; Gryseels & Nkulikyinka, 1988). The recent studies carried out in the villages (Ahmed, 1999) and the camps (El-Motasim, 1998), did not provide a definite answer to this decline.

4.1. Conclusion:

The present study highlights the schistosomiasis transmission situation in the northern part of Gezira Irrigation Scheme. The following conclusion could be drawn from the results.

1- Since the inception of the Gezira Irrigation Scheme in 1926, schistosomiasis infection has progressively increased to reach high levels. *Schistosoma haematobium* which was the dominant species at the beginning has been replaced by *Schistosoma mansoni* except for very minor endemic pockets. Today, *Schistosoma mansoni* is the dominant species in the northern part of the Gezira Irrigation Scheme.

2- The indices of infection are much higher in the camps than in the registered villages. The determining factors are the presence of adequate water supply and high awareness about the disease. The camps are reservoirs of schistosomiasis infection in the Gezira Irrigation Scheme. Implementation of a health education programme in the camps is unlikely to change the human behavior quickly. On the other hand, provision of safe water supply to the camps will reduce the infection in these camps.

3- The highest indices of infection (prevalence and intensity) are found among the 10-19 years age group. Both parameters are higher in males than females and are directly related to each other and with water contact patterns. The two indices are also higher in males than females in the camps, but the difference is not statistically significant. This indicates that the exposure to infested water with cercariae is the same for the two sexes and that every one living in the camps is at risk of getting the infection.

4.2. Recommendation:

To knock-down the overall Bilharzias parameters and subsequently morbidity to levels where the disease is no longer considered to be of public health problem, the study recommended the followings:

1. Provision of tap water supply and latrines to reduce the contamination of water bodies with excreta infected with egg of schistosomiasis and to reduce human water-contacts.
2. Mass chemotherapy to ensure treatment of all inhabitants in villages especially school children to reduce, if not eliminate, prevalence rate.
3. Snail control or elimination by molluscicides and/or biocontrol agents or by accessible environmental approach.
4. Effective, sound and well-designed health education programs should be implemented to increase the awareness of the community.
5. Use of the modified KATO technique in public and private medical laboratories to improve the detectability of different parasitic infection.
6. Schistosomiasis prevention should be adopted by the Federal Ministry of Health instead of the curative approach.

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