EDITORIAL

TRANSMISSION OF SCHISTSOMIASIS IN THE BLUE NILE STATE, SUDAN, (An investigated study in May 2009 – April 2010)

Dr. Mohamed Khalid Taha Ahmed

Chemistry and Biology, Faculty of Education Hantoub, University of Gezira
Tel: 0122010112 – E-mail: Taha.M.K.2002@gmail.com

Abstract:

The present study was carried out at randomly selected villages in the Blue Nile State to assess the transmission of schistosomiasis, the distribution of snails in freshwater canals especially the intermediate host of *Schistosoma haematobium*, identification of different types of schistosomes and their epidemic.

A random sample which represented 25% of the residents in each village in addition to all pupils was enrolled in the study. From each individual a stool sample and a urine sample were subjected to microscopic examination to determine the prevalence and intensity of infection. The examination was repeated one year latter in each enrolled individual. Snails were collected by the standard scooping method small water bodies and canals. The snail's habitats were critically studied. The collected snails were reared in the laboratory to determine the Schistosoma parasites they harbour. The relation between people water contact behaviour and prevalence and intensity of infection was assessed. The data was subjected to epidemiology statistical package.

The study revealed the absence of intestinal schistosomiasis in the studied villages. The prevalence of infection among the pupils was 13.8% and the intensity was 21.6 egg/10 ml, and among the resident was 12.3% and the intensity was 21.9 egg/10 ml. The levels of urinary schistosomiasis differed significantly ($p < 0.05$) between the residents and the pupils. The highest infection rate was recorded in the age group 15-19 years (15.0% and 23.7egg/10ml). The study recorded the presence of the Prosobrancha (*Melanoides tuberculata*, *L. carinatus* and *C. bulimoides*) which are of no medical importance and the Pulmonate (*Bulinus truncatus*, *Bulinus forskalii* and *Biomphalaria pfeifferi*) of which *B. forskalii* of no medical importance. The dominated snail was *M. tuberculata*. The density of all snails dropped during the flood season, except for *M. tuberculata* which to protect its soft tissues inside the snails by the operculum. A significant relation ($p<0.05$) was found between the physical (turbidity and temperature), chemical and biological (decaying matter) characteristics of the water bodies and reproduction of snails. The density of the snails was negatively affected by distance of the site from the point of water entrance into the canal, season, abundance and density of vegetation.

The results showed infectivity of *B. truncatus* in water sites recurrently visited by the people indicating that schistosomiasis is endemic in the area. The infectivity among the studies population varied from light to average but few showed acute infection. Treatment with Praziquantel (under medical supervision) resulted in a significant reduction in the prevalence of *S. haematobium* infection among school children (50.7%) and villagers (50.4%).

The results revealed that the high improper diagnosis associated with the modified KATO diagnostic technique yielded low infection rate especially if only one sample was investigated. Any delay in repeated sampling might decrease or increase infection rate.

The results showed that B. truncatus is highly susceptible to S. haematobium infection. The infection rates increased with increasing number of miracidia to which the snail was

EDITORIAL

exposed. Cercariae emergence (began after the 5th week from infection) starts at 6.00 a. m. reaching a peak at 12.00-2.00 and decreases gradually till it stops at sun set. The maximum cercariae output was attained at the 9th week. There was a positive relationship between the number of miracidia the snail is exposed to and the number of cercariae liberated from it and the death among infected snails.

The study of human water contact pattern showed a positive correlation between infection indices and swimming, bathing, padding that exposes most of the body parts to cercariae for a long time.

It is suggested that the results of this study to be considered when implementing a strategic schistosomiasis combating action in the Blue Nile State.

The present study was an attempt to investigate transmission of schistosomiasis in Blue Nile State from May 2009 to April 2010. The influence of some critical micro-epidemiological factors on transmission of schistosomiasis in the State was assessed.

The Overall Objective of the present study: Fluctuations in snail population densities have been observed in many parts of the world. These fluctuations have been shown to be associated with variations in temperature and rainfall (Coulibaly and Madsen, 1990).

مستخلص:

اجريت هذه الدراسة في قرى اختيرت عشوائيا فى ولاية النيل الأزرق لدراسة إنتقال مرض البلهارسيا، وتوزيع القواقع في قنوات المياه العذبة، خاصة العائل الوسيط لطفيلي المنشقة والتعرف على أنواع البلهارسيا ووبائية مرض المنشقات المعوية والبولية.

اختيرت عينة شوائية تمثل 25% من سكان كل قرية بالإضافة إلى كل التلاميذ وأُجريت لهم الفحوصات الطفيلية المجهرية لتحديد نسبة المرض وشدته. كما أُجرى مسح وبائي آخر بعد عام في ذات العينة المختارة. جمعت القواقع بالمغرفة القياسية من الميعات والمجاري المائية ودرست بيئة تواجدها كما تم تربيتها فى المعمل للتحقق من انواع طفيليات المنشقة. كما درست العلاقة بين عادات وسلوكيات اتصال السكان بالماء ومؤشرات ومعدل الإصابة. تم تحليل النتائج بواسطة حزمة المعلومات الوبائية الإحصائية.

بينت النتائج توطن المنشقة البولية وعدم وجود المنشقة المعوية في مناطق الدراسة. نسبة الإصابة بين التلاميذ كانت 13.8% وشدة الإصابة 21.6 بيضة/10مل وبين المواطنين كانت 12.3% وشدتها 21.9 بيضة/10مل. اختلفت مناسيب الإصابة بالمنشقة البولية اختلافاً معنوياً ($p < 0.05$) بين السكان والتلاميذ، وبين المجموعات العمرية. أعلى مناسيب الإصابة سجلت في المجموعة العمرية 15-19 سنة (15.0%و 23.7 .بيضة/ 10مل، على التوالى).

أثبتت الدراسة وجود ستة أنواع من القواقع هى: الكليوباترا، الميلانويدس واللانستس من رتبة الخيشوميات وليس لها أهمية طبية. مجموعة رتبة الرئويات شملت البولاينس ترنكاتس والبايومفلاريا و لها أهمية طبية، والبولاينس فورسكالي وليس له أهمية طبية. الميلانويدس كان هو القوقع السائد. انخفضت كثافة أجناس القواقع فى فترة الخريف عدا جنس الميلانويدس الذى لا يتأثر كثيراً بعكورة بسبب وجود غطاء فتحة الصدفة الذي يحمي الأجهزة الداخلية للحلزون. وجدت علاقة معنوية ($p < 0.05$) بين الصفات الفيزيائية (العكورة و الحرارة) والكيميائية والإحيائية (المواد المتحللة) للمجاري والبرك المائية و تكاثر القواقع. اثر بعد الموقع عن مدخل الماء في القناة، الموسم وتوفر وكثافة الأعشاب المائية على كثافة مجموعات القواقع.

وضحت البيانات أن البولاينس ترنكاتس مصاب بالطفيل في مواقع الماء التى يتردد عليها السكان مما يؤشر لوبائية وتوطن المرض في المنطقة. تراوحت حدة الإصابة بين السكان بين الخفيفة والمتوسطة بينما عانت قلة من الإصابة الحادة. علاج المصابين بعقار البرازيكوانتيل (تحت اشراف طبى) خفض الإصابة بنسبة 50.7% بين التلاميذ المصابين و50.4% بين سكان القرى.

أبرزت نتائج الدراسة أن نسبة الخطأ العالية في تشخيص الطفيل عبر تقتية كاتو المعدلة تؤدى لخفض مؤشرات الإصابة إذا ما فحصت عينة واحدة، كما أن التأخير في جمع العينات المطلوبة للفحص ولو لأسبوع قد يزيد أو يخفض مؤشرات المرض.

أثبتت التجارب المختبرية أن البولاينس ترنكاتس شديدة القابلية للإصابة بالطفيل وأن نسبة الإصابة تزداد طردياً بزيادة اعداد الطور المعدي (الميرسيديم) الذي يتعرض له القوقع، وأن الطور المعدي للإنسان (السركاريا) يبدأ خروجه من القوقع (بعد الأسبوع الخامس) عند السادسة صباحاً لتصل اعداده للذروة بين 12 - 2 ظهراً، ثم ينخفض

EDITORIAL

قبل التلاشي التام عند السادسة مساء. ويمثل الأسبوع التاسع قمة إنتاجية السركاريا. ثبت أن العلاقة طردية بين اعداد الميرسيديم التى يتعرض لها القوقع وبين السركاريا التي تخرج منه وكذلك نسبة الموت وسط القواقع المصابة

دراسة نشاطات الأهالي واتصالهم بماء القنوات والميعات وضحت أن هنالك ارتباطاً وثيقاً بين مؤشرات الإصابة و ممارسة السباحة، الاستحمام، الخوض في الماء التى تعرض أكبر جزء من الجسم للماء لمدة طويلة.

توصى الدراسة بأخذ هذه النتائج في الاعتبار عند تطبيق أي إستراتيجية لمكافحة داء المنشقات بولاية النيل الأزرق.

الأهداف الرئيسية لهذه الدراسة هي التحقيق والتعرف على العوامل والأسباب التي كانت من وراء إنتقال مرض البلهارسيا بالولاية ، ولدراسة توزيع حلزونات المياه العذبة في قنوات المياه ، خاصة العائل الوسيط لطفيلي المنشقة. كذلك التعرف على أنواع البلهارسيا في المنطقة. أيضاً من أهداف هذه الدراسة هو إعطاء صورة متكاملة عن وبائية مرض المنشقات المعوية والبولية بولاية النيل الأزرق من مايو2009 حتى أبريل 2010

Introduction:

Schistosomiasis, also known as Bilharzia, is a disease caused by a parasitic worm that infects more than 200 million people worldwide. The disease is second only to malaria as the most devastating parasitic disease and considered as one of the neglected tropical diseases (Centers for Disease Control, 2010). Schistosomiasis affects at least 240 million people worldwide, and more than 700 million people live in endemic areas. The infection is prevalent in at least 76 tropical and sub-tropical countries, in poor communities without potable water and adequate sanitation. Schistosomiasis transmission is associated with poor socio-economic conditions, particularly in developing countries, where poverty, poor nutrition, inadequate sanitation, lack of clean drinking-water and minimal health care prevail (WHO, 2004).

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. 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). It remained the largest single contributor to gross domestic product (GDP), 31.6% of national output and the source of virtually 50.23% of the country's labour force (AFED, Arab Forum for Environment and Development, 2012).

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 (Omer et al., 1976; Kardaman et al., 1982; Hilali, 1992; Taha, 1998 and 2002; Ahmed, 1998; 2003, 2004, 2005, 2006, 2010, 2011, 2012). 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.

EDITORIAL

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.

In conjunction with the above, the alphabetic information on the elements of schistosomiasis epidemiology is not available from the study area. The present investigation was the first deep trial for determining the transmission pressure and epidemiology of Bilharzia in the Blue Nile State. Transmission of human schistosomiasis takes place in different forms of freshwater bodies whenever embryonated eggs contaminated water-body harbouring the suitable molluscan intermediate-host (Ahmed, 1998; Olivier et al., 1999).

Blue Nile State:

Ayad (1956) reported urinary schistosomiasis infection of 8.9% along the Blue Nile. Urine examination of the residents of Kurmuk town showed the declination of S. haematobium infection from 30.2% to 5.7%, in 1981. However, the findings of infected Bul. truncatus snails indicated resurgence of urinary schistosomiasis in the town, (Birrie et al., 1994).

Epidemiological Parameters:

Schistosomiasis, transmission and epidemiology are related to environmental and human infection-parameters. The environmental one is associated with human water-contact behaviour, snail population characteristic and snail infection-rate. The human infection parameters usually include prevalence, intensity and incidence of infection (Rollinson and Johanson, 1996). These factors are always calculated for small subgroup of people, such as age-class, occupation and recreational habit or any other socioeconomic factor (Ahmed, 1998). Epidemiological parameters provide basic information about the place and time of infection, prevalence and intensity of the disease (Rollinson and Johanson, 1996).

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 (Malek, 1959; Babiker et al., 1985a; El Hussein, 1989; Madsen et al., 1988; Hilali, 1992; Meyer-Lassen, 1992; Abdel-Latif, 1994; Ahmed, 1994; Taha, 1998 and 2002). 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).

EDITORIAL

Morbidity:

Chronic schistosomiasis reduces the capacity of those infected to work and in some cases can result in death and in children anemia, stunting and a reduced ability to learn. A review of disease burden estimated that more than 200,000 deaths/year are due to schistosomiasis in sub-Saharan Africa (WHO, 2010). The classical sign of urogenital schistosomiasis is haematuria, blood in urine. In women, urogenital schistosomiasis may present with a range of signs and symptoms included nodules in the vulva, lesions of the vagina and cervix uterus, vaginal bleeding and pain during sexual intercourse. In areas endemic for urogenital schistosomiasis a large proportion of women may have female genital schistosomiasis (FGS). The WHO (2010) linked FGS to HIV acquisition in women. Genital schistosomiasis also affects men, inducing pathology of the seminal vesicles, prostate and other organs, and may lead to infertility. Bladder and urethral fibrosis and hydronephrosis are common in advanced cases, and bladder cancer is also a possible late-stage complication (WHO, 2010).

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.

Epidemiological Parameters:

Schistosomiasis, transmission and epidemiology are related to environmental and human infection-parameters. The environmental one is associated with human water-contact behaviour, snail population characteristic and snail infection-rate. The human infection parameters usually include prevalence, intensity and incidence of infection (Rollinson and Johanson, 1996). These factors are always calculated for small subgroup of people, such as age-class, occupation and recreational habit or any other socioeconomic factor (Ahmed, 1998). Epidemiological parameters provide basic information about the place and time of infection, prevalence and intensity of the disease (Rollinson and Johanson, 1996).

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.

EDITORIAL

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).

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, 1998).

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 *et al*., 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.

EDITORIAL

Bilharzias Diagnosis:

There are three main methods for diagnosing the parasitic infections: First: the clinical diagnosis, based on examining the clinical manifestation caused by the parasites. Second: parasitological diagnosis, based on finding stages of the parasites microscopically. Third: immunological diagnosis, based on measuring the specific host reactions against the parasitic antigen. Parasitological diagnostic techniques are either qualitative (gives information about the species of the parasite(s) present which is useful for clinical practice or quantitative (number of eggs excreted by the patient and expression of the load of infection) useful in epidemiology, control and drug trails (Simonsen *et al*., 1986).

Diagnostic Parasitological Techniques:

Direct Smear Technique:

The fast qualitative and simple inexpensive method is based on examining a small portion of faeces directly under a microscope and is recommended for diagnosis of intestinal schistosomiasis (Simonsen *et al*., 1986). It is used for detection of moderate and heavy infections, but not for light infections (Salih, 1989).

Sedimentation/Concentration Methods:

The sedimentation method has been developed for detection of light infection by (Hoffman *et al*., 1934). The method requires minimum equipment and reagents and is suitable for field studies. It involves removal of faecal debris and then the concentration of the eggs in a container. Other concentration methods such as formal ether (Ritchie, 1948) and acid ether (Hunter *et al*., 1948) techniques involve removal of fat. These techniques have been modified to improve sensitivity but they are in generally not used in the health units as they are time consuming (Simonsen *et al*., 1986).

MATERIALS AND METHODS

Study Area:

The Blue Nile State is one of the 18 States of the Sudan, where Ad-Damazin is the capital of the State. The State is located in the south-eastern of the country and delimited by Sinnar State in the north-eastern, Ethiopia in the south-eastern and the Upper Nile State in the west. There are six Localities in the State: Ad-Damazin, Baw, Geissan, Kurmuk, Roseires, and Tadamon. El Roseires Dam is one of the main sources of hydroelectric power-generation capacity in the country, established in 1966 with a nominal volume of 36.3 km². Much of the water impounded at El Rosaries is used to expand and intensify agriculture on the Gezira Scheme, for a full-supply level of 480 m with intention that it could be raised later to a full supply level of 490 m. The existing embankment Dam was also designed to allow for the heightening to be realized without interruption in using the reservoir, which was recently realized.

The estimated area of the State is 45,844 km² and the approximate population was 850,000 individuals, with three-quarters of them resident in rural areas (Ministry of Irrigation and Water Resources, 1992). The same document stated that 40% of the population has access to safe drinking-water in the North of the State, and 10% in the South. The State lies in the

EDITORIAL

fertile woodland Savannah belt of eastern Sudan, and receives significant rainfall through much of the year. It is characterized by vast clay plains, the Ingassana Mountains and the Blue Nile River flowing north-west from the Ethiopian high lands. There is a huge land for cultivation in both mechanized and traditional rain fed sectors, a huge potential for fishing grounds, seasonal streams traversing the State fertile land along the banks of the Blue Nile River which are suitable for vegetables and fruits production and supporting considerable livestock. The most important cash crops are gum arabic, cotton, oil seeds, groundnuts and sorghums, while the animal resources were estimated to be of around 6,210,000 heads.

The State had a relatively long rainy season, May - October, where the precipitation averaged 1000 - 1200 mm annually, which might influencing the breeding of insects of medical importance (Blue Nile State, Ministry of Health, Development and Planning Management, 2011). Summer temperatures exceed (40˚ C) and are usually coupled with high humidity, winters are cooler (30˚ C) with lower humidity. Night time temperatures vary from 30˚ C in summer to as low as 10˚ C in winter. In the Blue Nile State there are 264 Basic Schools, 29 Secondary Schools, as well as 14 schools for nomads and one school for children of Especial Needs. In the State, there are 26,778 students, where 14,104 of them in Basic Schools and 12,674 in the Secondary Schools. All selected villages for the investigation are enjoying the aforementioned educational services. All seven selected villages were deprived from water-supply systems, excluding Ar Rugaybah, where the system is intermittently working; hence villagers have no alternative than the surrounding waterbodies. In the villages, the inevitable users of the surrounding waterbodies are children and adults, for recreational and occupational purposes. On the other hand, 80.5% of the villagers enjoying accessibility to latrines for their excreta disposal.

In the State, the health system includes hospitals (14) at the Localities, Health Centres (9), Insurance Foundations, special Therapy Foundations, Military Units (2) and health units in the villages (18). The considerable displacement from rural to urban settlements created demand pressure on available health services (Blue Nile State, Ministry of Health, Department of Statistics and Health Information, 2010). Regarding Preventive Medicine, the National Control Program of Bilharzia, Federal Ministry of Health, established a specialized unit for combating Bilharzia at the State level. However, treatment is available in the hospitals for those identified as being infected with Bilharzia.

Methodology and Organization of the Study:

Preparatory Phase:

This study was conducted in collaboration between Bilharzia Research Laboratory (University of Khartoum) and National Control Program (Federal Ministry of Health). In addition, all ensured infected individuals of the surveyed communities were treated under medical supervision. Before commencement of the study, information concerning the population and the villages were collected from available sources, mainly the administration of the Blue Nile State and the Local Council. Special meetings were held with the Sheikhs, teachers, and the Villages' Councils as well as the Youth Organisations to explain the objectives of the study and to encourage their collaboration. In the meetings, the best times

EDITORIAL

for collection of urine and faecal samples as well as completing the socioeconomic questionnaire were determined, at the level of each village. All those identified as infected were given Praziquantel, single dose 40 mg/kg b.w, under medical supervision.

Villages Selection and Geographical Recognition

Based on the fact that El Rosaries Reservoir extended in three Localities, all of them were selected for the study: Damazein, Gaissan and Rosaries. About 90% of the total population almost concentrated on the banks of the Blue Nile in an area not exceeding 5% of the State total area. Thus, making the population density of around up to 140 persons per square kilometre compared to one person per square kilometre in the other 95% of the State total area. Based on the logistic facilities and available resources, seven villages were randomly selected for the integrated epidemiological surveys, namely: Auffud, Maganza, Ar Rugaybah, Aradaba, El Amara, Garash and Ganees Sharig villages. All selected seven residential sites for the survey are located at the very bank of El Roseires Dam.

Figure 1:The Seven Villages were selected for the Surveys in Roseires Dam, Blue Nile State

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. In addition, all school children in the seven villages, 3332 students, were included to the conducted two epidemiological surveys.

EDITORIAL

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.

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.

Diagnostic Techniques for Schistosomiasis:

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.

Screening of Intestinal Bilharzia:

The collected stool samples were examined by the locally modified Kato Katz technique, calibrated template, which was used by Ahmed (2003). About one gram of the sample was

EDITORIAL

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 's*andwich*', 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.

Results:

Epidemiological Parameters of Schistosomiasis

Epidemiological Surveys: Villagers and School Children:

In the pre-interventional survey, the response rate of the randomly selected villagers and all school children were 100%, where 693 inhabitants and 3332 school children were cooperated by providing the requested faecal and urine samples. In the post-interventional surveys, these response rates declined to 98%, mostly due to population displacement, outside the study area. During both pre-interventional and post-interventional surveys, not a single *S. mansoni* ovum was detected in all screened stool samples, thus, all verified results in this study referred only to *S. haematobium* infection.

Overall Prevalence and Intensity of S. haematobium Infection:

Table (1) verifies the overall prevalence and intensity of S. haematobium infection among the villagers and school children in Blue Nile State, in both pre- and post-interventional surveys. Although the overall magnitudes of the two parameters were skewed to relatively low rates, but the prevalence among school children significantly overrode those of the villagers, in the two surveys ($P > 0.05$). As for the worm burdens, expressed by number of excreted eggs, the villagers slightly overnumbered the school children, in both pre- and post-interventional surveys. In fact, the individual geometric mean egg-counts of urine among villagers ranged between 3 and 999 eggs per 10 millilitres.

EDITORIAL

Table (1): Overall Infection Parameters of S. haematobium infection among the villagers and school children in Blue Nile State

Survey	Number Examined	Prevalence (%)	Intensity of eggs (Per 10 ml)	
			Log of egg load (X ± SD)	GEMC (X ± SD)
Pre-interventional Survey:				
School Children	3332	13.8	0.855 ± 0.395	21.6 ± 7.5
Villagers	4025	12.3	0.864 ± 0.397	21.9 ± 7.5
Statistical Significance		P > 0.05	P > 0.05	
Post-interventional Survey:				
School Children	3332	6.8	0.732 ± 0.485	16.2 ± 9.3
Villagers	4025	6.1	0.733 ± 0.475	16.2 ± 8.7
Statistical Significance		P > 0.05	P > 0.05	

Villagers:

Infection Parameters by Residential Sites:

Table (2) illustrate the pre-and post-interventional parameters of S. haematobium among villagers of the Blue Nile State, by residential sites. In the pre-interventional survey, the relatively high prevalence rates of S. haematobium could be arranged in the flowing descending manner: Maganza (33.0%), Auffud (18.0%) followed by Regaba (16.6%). Likewise, the low prevalence rates of S. haematobium detected among villagers from Ganees (7.3%), Garash (4.1%), while less than 1% of the villagers were ensured infected from both Aradaba and Amara.

As for the intensity of infection, almost the same above aforementioned pattern was observed, with significant variation, due to worm burden in Maganza, as suggested by deep analysis via Scheffe test, ($P < 0.05$). Regarding the obtained infection parameters from the post-interventional survey, both prevalence rates and intensity of infection were in symphony to the aforementioned patterns, with significant reduction ($P < 0.05$).

EDITORIAL

Table (2): Pre-and post-interventional Parameters of S. haematobium among villagers of the Blue Nile State, by residential sites

Survey	Number Examined (%)	Prevalence (%)	Intensity of eggs (Per 10 ml)	
			Log of egg load (X ± SD)	GEMC (X ± SD)
Pre-interventional Survey:				
Auffud	992 (24.6)	18.0	0.882 ± 0.423	22.8 ± 7.8
Maganza	285 (7.1)	33.0	1.92 ± 0.372	249.6 ± 7.2
Regaba	725 (18.0)	16.6	0.709 ± 0.370	15.4 ± 6.9
Aradaba	246 (6.1)	0.8	0.650 ± 0.068	13.5 ± 3.6
Amara	273 (6.8)	0.7	0.739 ± 0.369	16.5 ± 6.9
Garash	316 (7.9)	4.1	0.702 ± 361	15.0 ± 6.9
Ganees	1188 (29.5)	7.3	0.828 ± 0.287	20.1 ± 5.7
Total	4025 (100)	12.3	0.865 ± 0.397	21.9 ± 7.5
Statistical significance		P < 0.05	P < 0.05	
Post-interventional Survey:				
Auffud	992 (24.6)	10.0	0.882 ± 0.486	22.8 ± 9.3
Maganza	285 (7.1)	20.7	0.521 ± 0.424	9.9 ± 8.1
Regaba	725 (18.0)	6.1	0.699 ± 0.523	15.0 ± 9.9
Aradaba	246 (6.1)	0.0	0.00 ± 0.00	0.0 ± 0.0
Amara	273 (6.8)	0.4	0.301 ± 0.0	6.0 ± 0.0
Garash	316 (7.9)	2.5	0.840 ± 0.302	20.7 ± 6.0
Ganees	1188 (29.5)	3.0	0.703 ± 0.347	15.3 ± 6.6
Total	4025 (100)	6.1	0.733 ± 0.475	16.2 ± 8.7
Statistical significance		P < 0.05	P < 0.05	

Infection Parameters by Gender:

Table (3) shows the overall prevalence and intensity of *S. haematobium* in the seven investigated residential sites, by Gender. Regardless of the residential site, in both pre- and post-interventional surveys, the prevalence rates among males overrode those of the females, but not to the significance level. Likewise, the worm burden in the post-interventional surveys, but surprisingly, the females overnumbered the males in the post-interventional survey.

EDITORIAL

Table (3): Pre-and post-interventional Parameters of *S. haematobium* among villagers of the Blue Nile State, by gender

Gender	Number Examined (%)	Prevalence (%)	Intensity of eggs (Per 10 ml)	
			Log of egg load (X ± SD)	GEMC (X ± SD)
• **Pre-interventional Survey (2009):**				
• **Males**	1959 (48.7)	14.6	0.829± 0.405	20.1 ± 7.5
• **Females**	2066 (51.3)	10.2	0.912 ± 0.383	24.2 ± 7.2
Total	**4025 (100)**	**12.3**	**0.865 ± 0.397**	**21.9 ± 7.5**
Statistical significance		**P > 0.05**	**P > 0.05**	
• **Post-interventional survey (2010):**				
• **Males**	1959 (48.7)	7.8	**0.825 ± 0.487**	20.1 ± 9.3
• **Females**	2066 (51.3)	4.5	**0.585 ± 0.417**	11.4 ± 2.6
Total	**4025 (100)**	**6.1**	**0.733 ± 0.475**	**16.2 ± 8.7**
Statistical significance		**P > 0.05**	**P > 0.05**	

Infection Parameters by Age-groups:

Table (4) illustrate the pre-interventional parameters of S. haematobium among villagers of the Blue Nile State, by age-groups.

The prevalence rates gradually increased to peak (15.0%) at the age-group (15 - 19) years, then gradually declined and remained almost low throughout the following age-classes, with a minor peak at age-classes of the villagers above 45 years. The statistical analysis of the infection rates suggested a significant variation among the categorized age-classes, (P < 0.05). As for the worm burden, expressed in excreted eggs, there was no consistent pattern in the categorized age-classes, with a crucial observation; one major peak among the very younger age-group and a minor peak among villagers of the age-class (45 – 49) years. The statistical analysis of the worm burden suggested, deep analysis via Scheffe test, a significant variation among the categorized age-classes, (P < 0.05).

EDITORIAL

Table (4): Pre-and post-interventional Parameters of *S. haematobium* among villagers of the Blue Nile State, by Age-groups

Age-groups (Years)	Number Examined (%)	Prevalence (%)	Intensity of eggs (Per 10 ml)	
			Log of egg load (X ± SD)	GEMC (X ± SD)
≤ 04	38 (0.9)	2.6	1.301 ± 0.00	59.9 ± 0.0
05 – 09	1160 (28.8)	12.2	0.846 ± 0.396	20.7 ± 7.5
10 – 14	1536 (38.2)	13.7	0.880 ± 0.398	22.8 ± 7.5
15 – 19	738 (18.3)	15.0	0.901 ± 0.420	23.7 ± 8.1
20 – 24	128 (3.2)	14.1	0.719 ± 0.278	15.6 ± 5.7
25 – 29	101 (2.5)	5.9	0.823 ± 0.146	19.8 ± 4.2
30 – 34	46 (1.1)	0.0	0.0 ± 0.0	0.0 ± 0.0
35 - 39	78 (1.9)	1.3	0.954 ± 0.0	21.7 ± 0.0
40 – 44	50 (1.2)	4.0	0.452 ± 0.213	8.5 ± 4.8
45 – 49	33 (0.8)	3.0	0.954 ± 0.0	26.7 ± 0.0
50 + years	23 (0.6)	5.2	0.571 ± 0.3	15.9 ± 5.4
Total	**4025(100)**	**12.3**	**0.865 ± 0.397**	**21.9 ± 7.5**
Statistical significance		**P < 0.05**	**P < 0.05**	

Infection Parameters by Occupation:

Table (6) verify the pre-interventional parameters of *S. haematobium* among villagers of the Blue Nile State, by occupation.

The high infected occupants could be arranged in the following descending order: school children (13.8%), pre-school children (13.0%) followed by government employees (10.2%). Although including water-contact occupations, like farmers and fishermen, but few were ensured infected, but surprisingly with relatively high worm burden. The statistical variations of the both infection rates and excreted eggs by different occupants were found to be of significant rates, (P < 0.05).

EDITORIAL

Table (6): Pre-interventional Parameters of *S. haematobium* among villagers of the Blue Nile State, by Occupation

Occupational Category	Number Examined (%)	Prevalence (%)	Intensity of eggs (Per 10 ml)	
			Log of egg load (X ± SD)	GEMC (X ± SD)
Pre-school Children	146 (3.6)	13.0	1.001 ± 0.490	30.0 ± 9.3
School children	3332 (82.7)	13.8	0.855 ± 0.395	21.6 ± 7.5
Workers	161 (4.0)	3.1	0.796 ± 0.388	18.9 ± 7.2
Farmers	195 (4.8)	3.6	0.995 ± 0.269	29.7 ± 5.7
Fishermen	21 (0.5)	4.8	1.176 ± 0.0	44.7 ± 0.0
House Women	126 (3.1)	2.4	1.006 ± 0.106	30.3 ± 3.9
Government Employee	44 (1.1)	10.2	1.462 ± 0.0	46.3 ± 0.0
Total	**4025 (100)**	**12.3**	**0.865 ± 0.397**	**21.9 ± 7.5**
Statistical significance		**P < 0.05**	**P < 0.05**	

Discussion:

The essential five factors influencing the transmission pressure and increase of the infection rates of parasitic diseases were highlighted by (Cheesbrough, 1999). They include first, the inadequate sanitation and unhygienic living conditions, which ultimately lead to intensive faecal contamination of the environment. Second, lack of effective health-education messages. Third, the constrain of water-supply exaggerated the problem of waterbodies' contamination. Fourth, absence of serious program for vector control due to the lack of resources as well as trained cadre. Last, the curative medicine including the expenses of the drugs is beyond the financial means of the concerned affected communities.

In countries which implement the canalization system in irrigation schemes particularly tropical and subtropical, schistosomiasis became a public health problem. This is mainly due to creation of suitable habitats for the spread and multiplication of intermediate-host snail of schistosomiasis. The increase in agricultural activity and the conversion of arid and semi-arid areas into irrigated schemes increased water-associated diseases mainly malaria and schistosomiasis (El Gaddal, 1985). This ranked schistosomiasis as the second most important public health problem of the tropical and sub-tropical regions and among the 10 tropical diseases of most concern to the World Health Organization (WHO, 2003).

EDITORIAL

In Sudan, many agricultural schemes had been constructed, with its canalization system providing suitable microhabitats for the snails' breeding, and hence dramatic propagation of schistosomiasis, due to unwise water-contact activities that pollute water with Bilharzia ova. Many sound epidemiological surveys had been conducted in these agricultural schemes to assess the epidemiological situations and the control trials of schistosomiasis (Ahmed, 2012). Bilharzia is both preventable and curable if appropriate measures are seriously considered such as availing tap water and latrines in each house in the endemic sites (El Tash, 2002). In addition, lack of (a) focal snail control programs, (b) adequate chemotherapy, (c) trained personnel and (d) poor resources, contributes to notorious transmission and loss of the productivity of laborers in poor countries (El Tash, 2002 and 2005).

The indices of infection varied significantly by age-groups, among the residents, reaching a peak in the age-group 15-19 years. The decrease in the indices of infection in the older age-groups in the Blue Nile villages could be due to a decline in the frequency of water-contact as reported from other endemic areas (Dalton and Pole, 1978; Costa *et al.*, 1987; Chandiwana, 1987 a and b). Or it could be due to development of resistance to the parasite after frequent exposure to re-infection (Butterworth *et al.*, 1985; Wilkins *et al.*, 1987). Or it could be due to the combined effect of a build-up of acquired immunity with increasing age and reduction of water contact activities (Abdel Wahab *et al.*, 1980; Gryseels and Nkulikyinka, 1988). Such findings are in synchrony to those obtained from previous studies carried out in Gezira scheme, as reported by (Babiker, 1987; Hilali *et al.* 1995; El-Motasim, 1998 and Ahmed, 1999) and Al Rahad (Elias, 1992); White Nile (Ahmed, *et al* 1996) and Gunaid schemes (Ahmed, 1998). The significant decline in the prevalence and intensity of infection with increasing age might be due to the combined effect of a build-up of the acquired immunity with age and the decline of important water-contacts activities. This is in accord with findings from Egypt (Abd el Wahab *et al.*, 1980); Tanzania (McCullough and Magendantz, 1974) and Burundi (Gryseels and Nkulikyinka, 1988).

The prevalence rates and worm burdens varied significantly among school children in the difference school classes. Interestingly, in both pre- and post-interventional surveys, the averages of the infection parameters of children in the 1st, 4th and 7th classes were very homogeneous to those of the averages of all classes. Surprisingly, in the two surveys, the prevalence rates among the younger classes of the school children outnumbered those of the elders. This finding supported the recommended strategic policy of the World Health Organization, by microscopic examination of such classes, instead of all children in the school, to explore the epidemiological situation of their village.

In the study area both prevalence and intensity were significantly ($P < 0.05$) higher in males than females. This might be mainly due to the fact that males are more exposed to transmission sites than females. Similar findings were reported in Sudan at Gezira (Fenwick *et al*. 1982; Babiker, 1987; Hilali, 1992; Hilali *et al.*, 1995; Ahmed, 1998, 2002, 2004; El-Motasim, 1998; El Tash, 2000 and 2005; Taha, 2002); and in other countries, *e.g.* in Ghana (Klumpp and Webbe, 1987); in Egypt (King *et al.*, 1982) in Nigeria (Pugh and Gilles, 1978). No significant differences in sex-specific prevalence and intensity of Bilharzias

EDITORIAL

infection were found in permanent villages in Gunaid, as reported by (Ahmed 1999), El Rahad Scheme (Hilali, 1992) and in Jebel Mara (Zakaria, 2002). The role of social factors affecting gender and age-related prevalence rates were suggested by (Pugh and Gilles, 1978; Tayler and Makura (1985).

Higher prevalence rates were detected among water-related jobs than among other occupations in Gunaid Sugar Cane Scheme, as reported by (Ahmed, 1998; Ahmed et al. 2002 and El Tash, 2000). The present study revealed significant variations of the two infection parameters, based on the occupational categories. The pre-school and the school children as well as the water-related occupants had the lion-share of the two infection parameters. Such findings might be viewed within the frame of water-contact activities and educational level reflected in the awareness of the villagers. This was supported by the fact that 98.5% of the surveyed communities do not have clean water-supply, and the low-educated villagers significantly suffering the infection. Sadly, the vast majority of the villagers know nothing about Bilharzia and its intermediate-hosts, 91.9% and 92.0%, respectively.

Standard measures cannot achieve a real and meaningful control of any disease. Experience has shown that no single control method is likely to break the transmission cycle, and so all available methods should be considered and used concurrently. Thus, sound epidemiological surveys should be conducted for obtaining tangible and realistic figures of the infection parameters of any parasitic disease. In consistent with the above and based on the survey findings, some interventional tools were adopted: these include the chemotherapy, health education and community participation.

Treatment of the infected candidates as well as the health education and community participation programs are very important in the implementation of Bilharzia control. Large-scale chemotherapy program usually would result in higher reductions in the levels of morbidity and transmission intensity. Health-education program is very necessitous for maintaining full utilization of the water provided and to motivate latrine construction and use. The lunch of such programs, especially among the children, is an important measure in the control of schistosomiasis considering the characteristics of the disease during childhood. The process of acquiring better habits can be speeded up by utilization of religious messages in mosque.

The study confirmed the endemicity of *S. haematobium* in the Blue Nile State reported earlier by (Ayad, 1956) and (Birrie *et al*. 1994). This endemicity is likely due to location of villages beside the lake banks near a water pool, lack of tap water and poor sanitary facilities. It seems that population movement for labor supply had considerable role in transmission, especially among the working age-groups (15 – 49) years, who used to camp in the fields during the agricultural season. The study suggested noticeable heterogeneity in the interval and duration of the water-contact activities performed by the villagers.

EDITORIAL

The present integrated investigation in the Blue Nile State concluded that:

1- *Bulinus truncatus* were infected with *S. haematobium* and all *Biom. pfeifferi* were ensured free from infection with *S. mansoni*.

2- The indices of infection are much higher in the school children than other sectors of the community.

3- The highest indices of infection, prevalence and worm burden, are monitored among the 10 - 19 years age-group.

4- Prevalence and intensity are higher in males than females indicating that gender heterogeneity in exposure to infested waterbodies. Lack of safe water-supply exaggerated the epidemiological situation.

5- The pool and stream, in the Blue Nile State, provided favorable habitat for breeding of freshwater snails, especially optimum temperature as well as the abundance of aquatic vegetation cover.

6- The residential sites are very located near pools that attracted all types of water-contact activities.

7- *Bul. truncatus* and *Biom.pfeifferi* snails are abundant in large numbers at the terminal sites of the pool and stream.

8- The dense vegetation provided food and substrata for snails to lay eggs as well as protection.

9- In addition to human cercariae, Echinostome, Amphistome and Xiphidio type of cercariae were recognized.

10- Eight cercarial types were collected and their fine identification needs some inaccessible reference collection.

Recommendations:

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 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.
7. Carry out classical and molecular analysis on the eight recognized cercarial types

EDITORIAL

for their confident identification.

References:

1. Abdel-Wahab, M. F.; Strickland, G. T.; El-Sahy, A.; Ahmed, L.; Zakaria, S.; El Kady, N. and Mahmoud, S. (1980). *Schistosoma .mansoni* in an Egyptian village in the Nile Delta. *Americn. J. of Trop. Med. and Hyg*, 29:868-874.
2. Abdel-Latif, H. M. (1994). A study on prevalence and transmission of *Schistosoma. haematobium* in AL-Obied and AL-Rahad, North Kordofan, Sudan. M. Sc. Thesis, Faculty of Veterinary Science, University of Khartoum.
3. AFED, Arab Forum for Environment and Development, 2012).
4. Ahmed, E. S. (1994). Infection, disease and transmission patterns in human schistosomiasis in the White Nile Province, Sudan. Ph. D. Thesis. University of Khartoum.
5. Ahmed, E. S.; Daffalla, A. A.; Christensen, N. O. and Madsen, H. (1996). Patterns of infection and transmission of human Schistosoma mansoni and Schistosoma haematobium in White Nile Province, Sudan. *Ann. of trop. Med. and Parasitol*, 90 (2):173-180.
6. Ahmed, A. A. (1998). Micro-epidemiology of intestinal schistosomiasis in the Gunaid, Sugar Cane Scheme, Sudan, Ph. D. Thesis, Department of Zoology, University of Khartoum.
7. Ahmed, R. F. M. (1999). Distribution of freshwater snails and transmission pattern of Schistosoma mansoni in a low endemic area, Gezira irrigated scheme, Sudan. M. Sc. thesis, Department of Zoology, Faculty of Science, University of Khartoum.
8. Ahmed, A. A; Babiker, A; El Tash, L.A. and Shiff, C.J. (2002). Development of a modified baited trap for detection of schistosome cercariae using natural oils rich in polyunsaturated fatty acids in Sudan. Acta Trop (82): 363 - 368.
9. Ahmed, A. A. (2002). Micro-epidemiological factors influencing transmission pressure of schistosomiasis in Gunaid Scheme, Sudan. *J. of Nat. Sc*. Vol 2(B):117–132.
10. Ahmed, A. A. (2003). Schistosomiasis in sugar cane schemes, Sudan. *J. of Nat. Science*s. Vol 3 (B).
11. Ahmed, A. A. (2004). Modification of oil traps for detection of swimming different schistosome cercariae in Sudan. 4th workshop of the African Freshwater snails, Kampala - Uganda, *Wld Hlth Organization*.
12. Ahmed, A. A. (2005). Schistosomiasis in sugar cane schemes, Sudan. *J. of Nat Sciences*. Vol 4 (B).
13. Ahmed, A. A. (2006). Schistosomiasis in sugar cane schemes, Sudan. *J. of Nat. Sciences*, 3 (B), 1 - 17.
14. Ahmed, A. A. (2010). National epidemiological situation of Bilharzia with especial emphasis on some innovated findings for control. International Medical and Health Conference, Postgraduate Studies, University of Khartoum, 25 – 27 February 2011, Friendship Hall, Khartoum.
15. Ahmed, A. A. (2011). Panorama of Gum Arabic Research, Gum Arabic
16. Forum, Gum Arabic Board, Presidential Republic, 18 – 20 September 2011, Friendship Hall, Khartoum.
17. Ahmed A. A.; El Tash L. A.; Mohamed E.Y. and Adam I. (2012). High levels of Schistosoma mansoni infections among schoolchildren in central Sudan one year

EDITORIAL

after treatment with Praziquantel. *J. Helminthol*. 86(2): 228-32.

18. Ayad, N. (1956). Bilharziasis survey in British Somali Land, Eritrea, Somalia, Sudan and Yemen. *Bull. of WHO*, 14: 1-17.
19. Babiker, S. M.; Blankespoor, H. D.; Wassila, M.; Fenwick, A. and Daffalla, A. A. (1985 a). Transmission of Schistosoma haematobium in North Gezira, Sudan. *J. of Trop. Med. and Hyg*, 88: 65- 73.
20. Babiker, A. (1987). Transmission and control of Schistosoma mansoni in the Gezira irrigated area of the Sudan. Ph. D. Thesis, Department of Zoology, Faculty of Science, University of Khartoum.
21. Birrie, H.; Woldemichae, l. T.; Redda, A. and Chane, T. (1994). The status of Schistosoma mansoni and snail hosts in Tigray and northern Wello regions, northern Ethiopia: baseline characteristics before endod based intervention. *Ethiop. Med*. J, 32 (4): 245-254.
22. Blue Nile State, Ministry of Health, Department of Statistics and Health Information, 2010).
23. Blue Nile State, Ministry of Health, Development and Planning Management, 2011).
24. Butterworth, A. E.; Dalton, P. R.; Dunne, D. W.; Mugambi, M.; Ouma, J. H.; Richardson, B. A.; Arap-Siongok, T. K. and Sturrock, R. F. (1984). Immunuty after treatment of human Schistosomiasis mansoni. II. Identification of resistant individuals, and analysis of their immune responses. *Trans. of the Royal Society of Trop. Med. and Hyg*, 79: 393-408.
25. Butterworth, A. E.; Capron, M. and Cordingley, J. S. (1985). Immunity after treatment of human Schistosomiasis mansoni: II. Identification of resistant individuals and analysis of their immune responses. *Trans. of the Associat.of the American Physicians*, 79: 393-408.
26. Centers for Disease Control, (2010). Possible causes for schistosomiasis- causes infectous disorders specific agent schistosomiasis schistosomiasis…haematobium synonyms bilharzia bilharziasis bilharziasis blood fluke…disease blood, en.diagnosis pro.com/ differential- diagnosis-for/schistosomiasis…(CDC schistosomiasis, 2008), htt://www-cdc/parasites/schistosomiasis/centers for disease control and prevention/600clifton Rd atlanta, GA. Cdc info @ cdc-gov.
27. Chandiwana, S. K. (1987). Community water contact patterns and the transmission of Schistosoma haematobium in the highveld region of Zembabwe. *J. of Social Science Med*, 25: 495- 505.
28. Chandiwana, S. K. (1987 a). Seasonal patterns in water contact and the influence of water availability on contact activities in two Schistosomiasis- Endemic areas in Zimbabwe. Central African *J. of Med*, 33: 8-15.
29. Chandiwana, S. K. (1987 b). Community water contact patterns and the transmission of Schistosoma haematobium in the highveld region of Zimbabwe. Social Science Med, 25: 495-505.
30. Chandiwana, S. K. (1988). Antischistosomal treatment and the measurement of incidence of schistosomiasis in a community of a high transmission. *Trop. and Geograph. Med*, 40: 314-317.
31. Cheesbrough, M. (1999). Techniques used to Identify Parasites, Medical Laboratory Manual for Tropical countries, Vol. 1. Butterworth-Heinemann Ltd, UK, pp 178-197.
32. Christensen, N.; Fronds, F. and Kristensen, T. K. (1986). African schistosoma

EDITORIAL

Weinland, 1858 (Digamma: Schistosomatidae) and the intermediate snail host genera Bulinus Mulller, 1781 and Biomphalaria Preston, 1910 (Pulmonata: Planorbidae). A review. Revue de Zool. Afri, 100: 137-152.

33. Christensen, N. O.; Four, P. and Simonsen, P. E. (1987). Aims and strategies in the control of human African schistosomiasis. Notes of Danish Bilharziasis Laboratory, Charlottenlund, Denmark.
34. Costa, M. F. F. L.; Magalhaes, M. H. A.; Antunes, C. M. F. and Katz, N. (1987). Water-contact patterns and socio-economic variables in the epidemiology of Schistosomiasis mansoni in an endemic area in Brazil. *Bull. of the Wld. Hlth. Organ*, 65 (1): 57-66.
35. Coulibaly, G. and Madsen, H. (1990). Seasonal density flucations of intermediate hosts of schistosomes in two streams in Bamako, Mali. Journal of African Zoology, 104, 201-212.
36. Dalton, P. R. and Pole, D. (1978). Water contact patterns in relation to Schistosoma haematobium infection. *Bull. of the Wld. Hlth. Organ*, 56: 417-426.
37. El Gaddal, A. A. (1985). The Blue Nile Health Project: a comprehensive approach to the prevention and control of water-associated diseases in irrigated scheme of the Sudan. *J. of Trop. Med. and Hyg*, 88: 47-56.
38. El Hussein, A. S. (1989). A study on prevalence and transmission of Schistosoma haematobium in Kosti area, White Nile Province, Sudan. M. Sc. Thesis, University of Khartoum.
39. El Tash, L. A. (2000). Inter-relationship of socio-economic status and Bilharziasis infection in the Gunaid Sugar Cane Scheme, Gezira State, Sudan. M. Sc. Thesis, Department of Economics, Faculty of Economic and Social Studies, University of Khartoum.
40. El Tash, L.A. (2005). Socioeconomic analysis of malaria burden in Gezira and Khartoum State, Ph.D. thesis in Economics, University of Khartoum, Sudan.
41. Elias, E. E. (1992).Transmission of urinary schistosomiasis in the Rahad irrigation scheme, Sudan, Ph. D. Thesis, Department of Zoology, Faculty of Science, University of Khartoum.
42. El-Motasim, N. H. (1998). Schistosoma mansoni in a high transmission area in Gezira scheme and efficacy of Praziquantel to control disease. Laboratory and field evaluation. M. Sc. Thesis, Department of Zoology, Faculty of Science, University of Khartoum.
43. Farooq, M. and Hairston, N. G. (1964). The epidemiology of Schistosoma mansoni and Schistosoma haematobium infections in Egypt-49 project area. 4. Measurement of incidence of Bilharziasis. *Bull. of the Wld Hlth Organ*, 35: 331-338.
44. Fenwick, A.; Cheesmond, A. K.; Kardaman, M. A.; Amin, M. A. and Manjing, B. K. (1982). Schistosomiasis among laboring communities in the Gezira irrigated area. Sudan. *J. of Trop. Med. and Hyg*, 85: 3-11.
45. Gilles, H. M. (1973). Results of a seven year snail control project on the endemicity of Schistosoma haematobium infection in Egypt. *Ann. of Trop. Med. and Parasitol*, 67: 45-65.
46. Gryseels, B. and Nkulikyinka, I. (1988). The distribution of Schistosoma mansoni in the Rusizi Plain (Burundi). Ann. of Trop. Med. and Parasitol, 6: 581-589.
47. Gryseels, B. and Polderman, A. M. (1991). Morbidity due to Schistosoma mansoni, and its control in sub-saharan Africa. *Parasitol Today*, 7: 244-248.
48. Guyatt, M. L.; Brooker, S. and Donnelly, C. A. (1999). Can prevalence of infection

in school-aged children be used as index for assessing community prevalence. *Parasitol*, 118(pts), 257-268.

49. Hilali, A.H. (1992). Transmission of Schistosoma mansoni in the Managil area, Sudan. Ph. D. Thesis, Department of Zoology, Faculty of Science, University of Khartoum.
50. Hilali A. M. H.; Madsen, H.; Daffalla, A. A.; Wasilla, M. and Christensen, N. O. (1995). Infection and transmission pattern of Schistosoma mansoni in the Managil irrigation scheme, Sudan. *Ann. of Trop. Med. and Parasitol*, 89 (3): 279-86.
51. Hoffman, W. A.; Pons, J. A. and Jancer, J. L. (1934). The sedimentation concentration method in Schistosoma mansoni. Puerti Rico *J. of Public Hlth and Trop. Med,* 9: 283-291.
52. Hunter, G. W. III; Hodge, E. P; Jahnes, W. G; Diamond, L. S. and Ingalls, J. W. (1948). Bull. of United States Army Med. Depart, 8: 128.
53. Jordan, P. and Webbe, G. (1982). Schistosomiasis Epidemiology, treatment and control, William Heineman Medical Books, London pp 16-23. *J. of Trop. Med. and Hyg*, 31: 490-498.
54. Jordan, P.; Bartholomew, R. K. and Peter, P. A. (1981). A community study of Schistosoma mansoni egg excretion assessed by the Bell and a modified kato technique. *Ann. of Trop. Med. and Parasitol*, 75: 35-40.
55. Kardaman, M. W.; Amin, M. A.; Fenwick, A.; Cheesmonde, A. K. and Dixon, H. G. (1982). A field trial using praziquantel to treat Schistosoma mansoni and Schistosoma haematobium infection in Gezira, Sudan. *Ann. of Trop. Med. and Parasitol*, 77 (3): 297-304.
56. King, C. L.; Miller, F. D.; Hussein, M.; Barakat, R. and Monto, A. S. (1982). Prevalence and intensity of Schistosoma haematobium infection in six villages of upper Egypt. *Ameri. J.of Trop. Med. and Hyg*, 31 (2): 320-327.
57. Klumpp, R. K. and Webbe, G. (1987). Focal, seasonal and behavioural patterns of infection and transmission of Schistosoma haematobium in farming village at the Volta Lake, Ghana. *J. of Trop. Med. and hyg*, 90: 265-281.
58. Madsen, H.; Daffalla, A. A.; Karoum, K. O. and Frandsen, F. (1988). Distribution of freshwater snails in irrigation schemes in the Sudan. *J.of Appli Ecology*, 25: 853-866.
59. Kvalsvig, J. D. and Becker, P. J. (1988). Selective exposure of active and social children to schistosomiasis. *Ann.of Trop. Med. and Parasitol*, 82: 471-474.
60. Malek, E. A. (1959). Trematode infections in some domesticated animals in the Sudan. J. Parasitol. 45(Suppl): 21.
61. McCullough, F. S. and Magendantz, K. (1974). An epidemiological investigation into Schistosoma mansoni transmission in Mwanza, Tanzania. *Ann.of Trop.Med. and Parasitol*, 68: 69-80.
62. Meyer-Lassen, J. (1992). Studies on snail populations in the Rahad Agricultural scheme, Sudan, with special emphasis on Bulinus truncatus (Audouin) and Biomphalaria pfeifferi (Krauss) (Gastropoda: Planorbidae), snail intermediate hosts for species of the genus Schistosoma. Ph. D. Thesis, Faculty of Natural Sciences, University of Copenhagen, Denmark.
63. Ministry of Irrigation and Water Resources (MIWR), 1992
64. Mott, K. E. and Cline, B. L. (1980). Advances in epidemiology survey methodology and techniques in schistosomiasis. *Bull.of the Wld Hlth Organ*, 58: 639-647.
65. Olivier, G., Brutus, L. and Cot, M. (1999). Intestinal Schistosomiasis from

EDITORIAL

Schistosoma mansoni in Madagascar: extent and center of the endemic. *Bull. Soc.Pathol. Exot.* 92(2): 99-103.

66. Omer, A. H. S.; Homilton, P. J. S.; Marshall, T. F. and Draper, C. C. (1976). Infection with Schistosoma mansoni in the Gezira area of the Sudan. *J. of Trop.Med and Hyg*, 79: 151-157.
67. Pugh, R.N.H. and Gilles, H.M. (1978). Malumfashi endemic disease research Project, III. Urinary schistosomiasis : a longitudinal study. *Ann. of Trop.Med.and Parasitol*, 72: 471-482.
68. Ritchie, L. S. (1948). An ether sedimentation technique for routine stool examination. *Bull. of United States Army Med. Depart*, 8: 326-331.
69. Rollinson, D. and Johanson, B. (1996). Schistosomiasis: a review of recent literature. *Trop. diseases Bull*., 92 (2): 23-35
70. Salih, A. A. (1989). Comparative diagnostic methods in the assessment of urine and faecal egg count. M.Sc. Thesis, Department of Zoology, Faculty of Science, University of Khartoum.
71. Scott, D.; Senker, K. and England, E. C. (1982). Epidemiology of human Schistosoma haematobium infection around Volta Lake, Ghana, 1973-75. *Bul. of the Wld. Hlth. Organ*, 60: 89-100.
72. Shiff, C.J. (1973). The value of incidence for the assessment of schistosomiasis control. A study in Southern Rhodesia. *Bull. of the Wld. Hlth. Organ*, 48: 409-414.
73. Simonsen, P. E., Christensen, N. O., and Gotche, G. (1986). Diagnosis of schistosomiasis. Notes of Danish Bilharziasis Laboratory, Charlottenlund, Denmark.
74. Sudan Ministry of Finance and Economic Planning. (2000). Ann. Reports.
75. Taha, M. K. (1998). Distribution of snails in El-seylate irrigated agricultural scheme, East Nile Province, Khartoum State, Sudan. M. Sc. (Qualifying), Department of Zoology, Faculty of Science, University of Khartoum.
76. Taha, M. K. (2002). Studies on the Ecology of snails and transmission of schistosomiasis in the Gezira scheme. Sudan. M. Sc. Thesis. Department of Zoology, Faculty of Science, University of Khartoum.
77. Tanaka, H.; Blas, B. L.; Nosenas, J. S., Matsuad, H.; Ishige, M.; Kamiya, H.; Murata, I.; Hayashi, Y. and Santos, T. A. Jr. (1983). Longitudinal study on Schistosoma japonicum infection in the Philippines. 3. Incidence and environmental modification at Dagami, Leyte, Japan's *J. of Experimental Med*, 53: 87-94.
78. Taylor, P. and Makura, O. (1985). Prevalence and distribution of schistosomiasis in Zimbabwe. *Ann of Trop. Med. and Prasitol*, 79 (3): 287-299.
79. World Health Organization. (1993). The control of schistosomiasis. Report of WHO Expert Committee. WHO Technical Report Series, 80.
80. World Health Organization. (2003). Action against worms, Report Series, 2003-Issue 1.
81. World Health Organization. (2004). Prevention and control of schistosomiasis and soil-transmitted helminthiasis. Geneva, WHO (WHO/ CDS/ CPE/ PVC/2004.9).
82. World Health Organization, (2010). The strategy for schistosomiasis control aims to reduce morbidity through, the past 20 years to control schistosomiasis in Brazil, Burkina Faso, Cambodia and China. www. Who. Int/schistosomiasis/ strategy/en.
83. World Health Organization, (2010). 04. Dec. 2010| Geneva Report of an informal working group meeting on urogenital schistosomiasis and HIV transmission
84. World Health Organization, (2010). 26. Jan. 2010 | Geneva Informal Consultation

on Expanding Schistosomiasis Control in Africa. Facilitating PZQ access to scale up schistosomiasis control

85. Wilkins, H. A.; Blumenthal, U. J.; Hagan, P.; Hayes, R. J. and Tulloch, S. (1987). Resistance to reinfection after treatment of urinary schistosomiasis. *Trans of the Royal Society of Trop. Med. and Hyg*, 81: 48-51.
86. Yang, H. M. and Yong, A. C. (1998). The stabilizing of the acquired immunity on schistosomiasis transmission modeling the sensitivity analysis. Medical Institute Oswado Cruz, 1: 37-50.
87. Zakaria, A. S. (2002). Epidemiological observations of intestinal schistosomiasis in Jebel Marra Area, Darfur State, Sudan. M. Sc. Thesis, Department of Zoology, Faculty of Science, University of Khartoum.