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Review

Challenges of schistosomiasis prevention and control in Ethiopia: Literature review and current status

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The effect of schistosomiasis on human health is high especially in resource poor countries like Ethiopia. Intestinal schistosomiasis is the major causes of morbidity in most parts of the country. School age children are the vulnerable segments of the population. Lack of sanitation, potable water, environmental modification, health education, mass treatment, awareness and manageable water harvesting programs like irrigation are the contributing factors for schistosomiasis. Proper health impact assessment for new irrigation schemes and other water resources projects will provide a solid basis for the incorporation of health safeguards at design and construction plans in Ethiopia.

Key words: Schistosomiasis, irrigation schemes, sanitation, migration.

INTRODUCTION

Intestinal parasites adversely affect the health of humans in many parts of the world. They continue to be global problem, particularly among children in developing nations (WHO, 1981). The most prevalent and important helminths in developing countries are the soil-transmitted group and schistosomes (WHO, 2004). Intestinal helminthiasis is intimately related to poverty and most infections are entrenched particularly in tropical regions where the biophysical environment and cultural practices favor transmission (Cheesbrough, 2000). For instance, of the global burden of schistosomiasis, an estimated 85% is found in sub-Saharan Africa (WHO, 2006). Schistosomiasis also known as bilharziasis is a parasitic disease caused by trematode fluke of the genus *Schistosoma*. Schistosomiasis is mainly found in Asia, Africa and South America in areas where fresh water snails serve as the intermediate hosts (Gryseels et al., 2006). Schistosomiasis is endemic in 74 tropical countries worldwide, affecting over 200 million people while 500 to 600 million people are at risk of becoming infected (Rozendaal, 1997; Steinmann et al., 2006; Siddiqui, 2011).

Schistosomiasis is a disease caused by one of six *Schistosoma* species, namely *Schistosoma haematobium*, *Schistosoma guineensis*, *Schistosoma intercalatum*, *Schistosoma mansoni*, *Schistosoma japonicum*, and *Schistosoma mekongi* (Davis, 2009). A number of animal species as *Schistosoma margrebowiei* or *Schistosoma bovis* may also occasionally infect humans (McManus and Loukas, 2008).

In Ethiopia, infection of intestinal parasites is the second most predominant cause of outpatient morbidity (Tesfa-Yohannes and Kloos, 1988). Of which, intestinal schistosomiasis is the major causes of morbidity in most

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parts of the country (Tedla, 1981; Tedla and Jemaneh, 1998) at an altitude of 1000 to 2000 m above sea level (Yomi et al., 2010).

Information on countrywide epidemiology of schistosomiasis in Ethiopia is limited. But numberous studies conducted in different localities showed that the prevalence of *S. mansoni* was high among school children. For instance, 73.7% in Bushulo village near Lake Hawassa (Terefe et al., 2011), 43.2% in Ziway town and 31.6% in Wodogenet (Legesse et al., 2009), 67.6% in Finchaa valley (Haile et al., 2012), 82.8% in Sanja town (Alebie et al., 2014) and 73.9% in Waja-Timuga (Abebe et al., 2014) are prevalence values in some of the areas with high prevalence of *S. mansoni* infection in Ethiopia.

Schistosomes need fresh and still water for their survival. They are therefore found in lake-side communities, around water development schemes like dams. People are in contact with infested fresh water during their normal daily activities of fishing, farming, swimming, washing, bathing, recreation, and irrigation (WHO, 1999; WHO, 2007; NIPD, 2013).

The first step in human infection involves penetration of the skin by cercariae which come out from a freshwater intermediate host. Inside the human host, cercariae develop into sexually mature egg-laying worms in the hepatic portal system. The eggs are passed out from the human body in feces or urine, depending on the species of the parasite. The eggs hatch on contact with water and release free swimming miracidia which infect the intermediate snail host. This chronic infection can persist for decades causing disease of intestinal or urinogenital system depending on species types (Hotez et al., 2007). Children are the most heavily infected, because they spend hours playing and swimming in water and lack partial immunity (WHO, 1999).

The pathological effects of schistosomes cause a range of morbidities which seems to be influenced to a large extent by the nature of the induced immune response and its effects on granuloma formation and associated pathologies in target organs (Dunne and Pearce, 1999).

Diagnosis is made by microscopic identification of *S. mansoni* or *S. japonicum* eggs in stool or *S. haematobium* eggs in urine (Katz et al., 1972). Serologic tests are useful to diagnose light infections (in travelers) and in non-endemic or low transmission areas. Antibody tests do not distinguish between past and current infection (WHO, 2007; CDC, 2007).

The drug of choice for the treatment of schistosomiasis is praziquantel. However, despite successful treatment will improve the health of the people, schistosomiasis treated persons can become re-infected. Prevention is still preferable to treatment since in the absence of obvious symptoms, irreversible damages may be done before the infection is detected (IAMAT, 2012). Improved sanitation and potable water, environmental modification, health education, mass treatment and limiting human-water contact offer long-term control of schistosomiasis. Proper health impact assessment of new irrigation schemes and other water resources projects will provide a solid basis for the incorporation of health safeguards at design and construction plans (WHO, 2001).

The present review presents current challenges in the prevention and control of schistosomiasis in Ethiopia. The derived models used in prevention approaches are not practically applicable in Ethiopia. There are several reasons why prevention methods are not applicable and become challenging in Ethiopia. For instance, inadequate budget and lack of awareness are the dominant factors.

WATER HARVESTING PROGRAMS

A major mean of rehabilitating and reconstructing the natural resource base is through comprehensive water harvesting development. The impact of prolonged available surface water in newly developed irrigation areas is a predisposing factor for water and vector-borne diseases. Areas that are periodically affected by schistosomiasis are exposed to continued year round attack due to suitable environment for snails' survival (Behailu and Haile, 2002).

A major factor associated with the rise of schistosomiasis is water development projects, particularly manmade lakes (hydroelectric power) and irrigation schemes (agriculture), which can lead to shifts in snail vector populations (Patz et al., 2000; WHO, 2002). On the other hand, water stagnation and weed growing due to inadequate water management sustain the life of the snails to complete the life cycle of schistosomes (Boeele and Madsen, 2006).

Many surface irrigation systems in Africa create favorable snail-breeding conditions that facilitate the transmission of schistosomiasis (WHO, 2004). For instance, there was an introduction of *S. mansoni* to Mauritania and Senegal after construction of huge Diama dam on the Senegal River (Gryseels et al., 2006), and Koka dam in Ethiopia (Kloos et al., 1988).

Irrigation schemes are dynamic agro-ecosystems that can transport snails a long way along the canals and where local events can either provide habitat-friendly conditions or inhibit snail populations (Dale and Polasky, 2007). Generally, the variability within irrigated areas, the canal type, the distance of sites from the canal, the composition and density of aquatic vegetation (Appleton, 1978; Khallaayoune, 1998a), the season (WHO, 2001), specific local conditions such as water stagnation, water depth and shading (Dale and Polasky, 2007) and water flow velocities and the location of breeding sites affect the presence and density of snails among sites. Low-flow velocities and locations found at the starting point of low-order canals are favorable to get aeration of the water and food availability for snails (Boelee and Madsen, 2006).

Environmental changes linked to water resource development like water harvesting for irrigation and population growth which lead to sanitation problem in Ethiopia have facilitated the recent spread of schistosomiasis to areas where it was not endemic before (Gryseels et al., 2006; Li, 2007). For instance, there is an introduction of *S. mansoni* into the upper and middle Awash valley in Ethiopia, following the establishment of large-scale irrigation schemes of Wonji sugar factory and the prevalence steadily increased up to 20% in 1980 (Kloos et al., 1988) and 81.9% in 1988 (Simonsen, 1990). Similarly, the prevalence of *S. mansoni* of 10.7% was recorded after the introduction of new irrigation schemes in South and Central Tigray (Dejenie and Petros, 2009).

Currently, agriculture development especially in water harvesting for irrigation in Ethiopia have increased from time to time. Similarly, Ethiopia is now constructing a huge hydroelectric power in East Africa in different rivers. The existence of surface water for irrigation and power will sustain the snails in endemic areas of the countries. Therefore, water harvesting program have a negative impact on the health of community by sustaining the life of the snails unless critical plans are taken by both Ministry of Health and Agriculture for snail control and preventions.

Vector control

The aquatic snails (*Biomphalaria* and *Bulinus* species) cannot usually survive without water serving as intermediate hosts of *S. mansoni* and *S. haematobium*, respectively. All species of *Biomphalaria* and *Bulinus* are hermaphrodite, possessing both male and female organs and being capable of self- or cross-fertilization. A single specimen can invade and populate a new habitat. A snail lays up to 1000 eggs during its life, which may last more than a year. All the characteristics mentioned earlier make it difficult to eliminate snails in schistosomiasis endemic areas (NIPD, 2013).

Recently, a standard cement tanker which completes the green-house effect heating system is developed to control snails. It constituted movable dark canvas covers, which allowed the temperature to be controlled between 20 to 24°C especially during the coldest months of the year. The tanker facilitates the mortality of *Biomphalaria tenagophila* (Rosa et al., 2013).

Due to the relative high cost of molluscicides, no public health intervention measure is taking place in Ethiopia. However, since 1991 interest has rekindled in the use of local molluscicidal plant called Endod (*Phylolacca dodecondra*) for community based intervention of snails (Lambert et al., 1991).

Sanitation

Sanitation is one basic problem in Sub-Saharan countries. The ova of the parasites can easily access to the water when infected people urinate or defecate close to a water source. The contaminated water will be used for different purpose for the community. Schistosomiasis is easily spread in communities that do not have access to toilets or sanitation facilities and awareness about the means of transmission (Assefa et al., 2013). Despite of higher coverage of latrine reports in some places of Ethiopia, prevalence of intestinal parasites is significantly higher due to poor water supply (Mengistu et al., 2007). In addition, open air defecation, washing and bathing also favor transmission of schistosomiasis in Tikur Wuha area of Ethiopia (Mitiku et al., 2010).

The awareness of the people regarding how schistosomiasis infection occurs is limited in Ethiopia. Majority of the people practice open field defecation and urination. Most of the people wash their body in the streams and cross the streams during their daily activities. As a result, the possibility of schistosomiasis infection is high. Unless community awareness is created on the transmission, prevention and control of the infection, the impacts of the disease will live for unlimited time in the community.

Mass deworming

Current population-based schistosomiasis treatment programs are a first step to reduce the global burden of Schistosoma-related disease; however, they might not dramatically reduce parasite transmission in highly endemic areas (King et al., 2006). Prazquantel is given based on the WHO recommendations in a community level; schools with schistosomiasis high prevalence were mass treated with praziquantel annually (Montresor et al., 2013).

Although 42 schistosomiasis endemic countries in Africa have been determined, factors such as absence of disease mapping in endemic areas, limited availability of praziquantel, and lack of health infrastructure hampered programme implementation and medication distribution (NIPD, 2013). The proportion of people treated for schistosomiasis in the African Region in 2011 was only 9.8% of the people requiring treatment (WHO, 2013). Data for 2012 also showed that only 14.4% of people requiring treatments were reached (WHO, 2014).

Periodic treatment of the risk population groups will cure mild symptoms and prevent infected people from developing severe, late-stage chronic disease. However, a major limitation to schistosomiasis control has been the limited availability of praziquantel. Treatment of the infection brings immediately benefit and has long-lasting effect on morbidity and prevent irreversible sequelae in adulthood (WHO, 2002). On the other hand, there are some disadvantages of praziquantel treatment, which include the appearance of drug resistance in the treatment of *S. mansoni* along with allergic or hypersensitivity reactions against praziquantel treatment (Chai, 2013).

Though, 50% of the people suffering from schistosomiasis are school-aged children, and chemotherapy is mostly targeted at school-aged children; the community-based approach has been well received and implemented in schistosomiasis control to address out-of-school children in Africa (NIPD, 2013).

In Ethiopia, countrywide epidemiology of schistosomes is limited but there were some prevalence reports which showed high infection rates in endemic areas of the country (Terefe et al., 2011; Haile et al., 2012; Legesse et al., 2010). *S. mansoni* has been recorded in all regions of Ethiopia and is rapidly spreading with water resource development and population movements (Erko et al., 2002). But limited availability of praziquantel and absence of community-based mass treatment approach of children based on the WHO guide line in endemic areas are the challenges to control schistosomiasis. Unless mass treatment strategy is not applicable in endemic areas of schistosomiasis, prevention and control of schistosomes may not be effective in Ethiopia.

Co-infection with HIV

Mass deworming could have beneficial effects on HIV-1 transmission dynamics. *S. mansoni* infections can increase HIV-1 replication, cell-to-cell transmission and HIV progression as measured by reduced CD4+ T lymphocytes counts in HIV infected individuals (Mazigo et al., 2013). On the other hand, HIV affects *S. mansoni* egg excretion which potentially affects parasitic diagnosis of schistosomiasis infection and releasing of circulating schistosome worm antigens which is important for detection of the worm (Mwanakasale et al., 2003).

Immunological studies have demonstrated that T-cells from HIV-1 positive individuals co-infected with *S. mansoni* responded to egg antigens by producing less interleukin (IL)-4 and IL-10 and a lower amount of interferon-gamma (IFN-γ) as compared to those from individuals infected with *S. mansoni* alone, indicating immune skewing from Th2 to Th1 (Mwinzi et al., 2001).

Prevalence of HIV and *S. mansoni* is high in sub-Saharan Africa like Ethiopia. The impact of *S. mansoni* may be high if HIV infected individuals are co-infected with *S. mansoni.* So, deworming of HIV positive individuals living in *S. mansoni* endemic areas may decrease HIV-1 viral loads and increases CD4+ T lymphocyte counts. Deworming of *S. mansoni* will prevent HIV cases to early developing of AIDS stage. Prevention of HIV cases from *S. mansoni* co-infection especially in endemic areas of Ethiopia is limited.

Vaccination

Vaccine represents an essential component for the future control of schistosomiasis as an adjunct to chemotherapy. The immune response to schistosome infection, both in animal models and in humans, suggests that development of a vaccine may be possible (McManus and Loukas, 2008). For instance, DNA-based vaccines protect against zoonotic schistosomiasis in water buffalo and schistosome vaccines capable of reducing water buffaloes' fecal egg output by 45% (Dadara et al., 2008). The vaccine against the schistosomes decreases the fecundity of the adult worm, the worm burden or egg production and viability. But difficulties in obtaining good expression levels and in scaling up production for the limited number of antigens selected have turned out to be another major obstacle (Bergquist et al., 2005). Therefore, absence of vaccine in the country is also another challenge in the prevention and control of schistosomiasis in Ethiopia.

CURRENT POLICY OF THE COUNTRY

The major challenges in schistosomiasis control remain the scale-up of treatment and to the need to advocate for increased resources for implementation of treatment programmes, provision of potable water, adequate sanitation, hygiene education and snail control. In some countries, schistosomiasis transmission may have been interrupted through active control programmes and/or changing the socio-economic conditions (WHO, 2013).

Still today, most sub-Saharan African countries endemic for schistosomiasis are in a position to establish a country-wide elimination program. While elimination should be considered at the national level, there may be low prevalence areas within each country where elimination could be achieved given adequate resources and political commitments (Rollinson et al., 2012). For instance, schistosomiasis was endemic in Egypt since the ancient times and the most important public health problem but the present findings revealed a decrease in the prevalence of schistosomiasis due to the current policy of schistosomiasis control in Egypt (Zaher et al., 2011).

In Ethiopia, schistosomiasis infection is recorded in all regions of the country and the prevalence is significantly high, but there is no specific policy launched to decrease the disease burden especially in endemic areas.

POPULATION MOVEMENT AND MIGRATION

Population movement, rural to urban migration, forced displacement migration of workers and the rise of ecotourism have all contributed to the increase in schistosomiasis (WHO, 2007). Environmental changes linked to water resource development and migrations have facilitated the recent spread of schistosomiasis to areas where it is not endemic before (Gryseels et al., 2006; Li et al., 2007).

Migration of workers from endemic areas to irrigation projects or major hydroelectric power plants, followed by contamination of reservoirs with human feces, and subsequent inevitable increasing contact of communities adjacent to the reservoir for the purpose of bathing, laundering in adults or swimming and playing in children will result in an expansion of infection in regions once free of infection (Steinmann et al., 2006).

The people of Africa move from one place to another for different reasons such as war, famine, food and water. Migration is commonly cited as a significant factor in the spread of other infectious diseases (Lurie et al., 2003). Immigrants and refugees originating from areas where infections persist can pose a significant challenge for national disease control and/or elimination strategies.

The prevalence levels of infectious diseases in a world of increasing travel and migration make national disease control or elimination almost impossible (Gushulak and MacPherson, 2004). For instance, high schistosomiasis seroprevalence was reported from Sudanese lost boys and girls (Posey et al., 2007) and a single *S. hematobium* positive case was also identified from Somalian immigrants in America (Neal, 2004). The transmission of schistosomiasis is also high around water bodies due to movement of people around the great lakes such as Lake Victoria in Uganda (Standle et al., 2009). There is also a report that confirmed displacement of population has introduced *S. mansoni* into Somalia and Djibouti (Gryseels et al., 2006). In addition, 80% of the tourists were positive for schistosomula tegument antigens (Sm-Teg) which helps in community-based schistosomiasis control programs from non-endemic areas (Grenfell et al., 2013).

Due to its geographical position, as well as environmental and geo-political developments in the region, Ethiopia is likely to continue to receive migrants from neighborhood countries including Eritrea, Somalia, South Sudan and Sudan in 2014 and 2015 (UNHCR, 2014). Control and prevention of *Schistosoma* may be very difficult in Ethiopia due to migrant people from endemic countries like Sudan (Ahmed et al., 2012), Somalia and Eritrea (IAMAT, 2014) and South Sudan (Deribe et al., 2011).

It is very difficult to totally avoid sanitation problems in refugee camps of Ethiopia. In addition, there is no screening policy of migrants' people in the refugee camps for schistosomiasis as soon as they arrive. This will have its own contribution on the prevalence of schistosomiasis infection in the country unless measure is taken.

RECOMMENDATION

Environmental modification preventing snail vectors and limiting human water contact offers long-term control of schistosomiasis. Health education is a fundamental component that ensures community participation in control interventions. In areas of high prevalence and intensity of infection, community-based mass treatment of high-risk groups with praziquantel offers the most efficient way to achieve the recommended strategy for morbidity control. Proper health impact assessment of new irrigation schemes and hydroelectric water resources projects will provide a solid basis for the incorporation of health safeguards at design and construction plans. Considering migration as a risk factor, screening of schitosomiasis should be adopted for migrants from endemic areas in East Africa to Ethiopia.

Conflict Interests

The authors declare that there is no conflict of interests regarding the publication of this article.

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Full Length Research Paper

A comparative study on the prevalence of intestinal helminthes among rural and sub-urban pupils in Gwagwada, Nigeria

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A comparative study on infection with intestinal helminths among pupils in rural and sub-urban primary schools was carried out in Gwagwada district, Chikun Local Government Area of Kaduna State, Nigeria. Faecal samples were collected from 244 pupils in eight rural and sub-urban public schools and examined for eggs of intestinal helminths using the filtration technique and microscopically examined for intestinal parasites. The overall prevalence in both rural and sub-urban pupils was 67.2%, with the sub-urban pupils having a prevalence of 70.8% and the rural pupils a 58.9% prevalence. The five intestinal helminths observed in the study were *Ascaris lumbricoides* (37.0 and 29.8%), *Trichuris trichiura* (4.1 and 4.7%), hookworms (9.6 and 5.3%), *Taenia* species (32.9 and 11.1%) and *Schistosoma mansoni* (21.9 and 1.8%) in rural and sub-urban pupils, respectively. There was no significant association of the prevalence with location. Mass deworming campaign should be embarked upon immediately and sanitation facilities should be provided to curtail these alarming infections.

Key words: Helminths, rural, sub-urban, pupils, Gwagwada, Nigeria.

INTRODUCTION

Soil-transmitted helminth infections are among the most common infections worldwide and affect the poorest and most deprived communities. Latest estimates indicate that more than 880 million children are in need of treatment for these parasites (WHO, 2014). In sub-Saharan Africa, intestinal helminths are the most common and diseases with a very higher negative public health and socio-economic impacts (Enimien et al., 2014; Ojurongbe et al., 2014).

Parasitic helminths are endemic in Nigeria, due to poor environmental sanitation, pollution, and contamination of water and soil. Children in Nigeria are highly exposed and very vulnerable to these infections (Damen et al., 2010). In rural and sub-urban settlements in Nigeria, intestinal helminthes have been a major problem. This is as a result of their poor socio-economic status and

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lack of basic amenities such as pipe borne water and other sanitary facilities (Okon and Oku, 2001) and it may also be due to their illiteracy and careless behaviour(s). Generally, parasitic infections abound in Nigeria not only because a large number of the population still live(s) in insanitary surroundings with constant faecal pollution of soil, food and drinking water, but also as a consequence of the tropical environment, suitable for easy parasitic growth and spread (Adeyeba and Essiet, 2001).

A typical intestinal helminth has an intestinal lifecycle stage. Intestinal helminths of health relevance are nematodes (roundworms), cestodes (tapeworms) and trematodes (flukes). The most common of these helminths in Nigeria are *Ascaris lumbricoides, Trichuris trichiura* hookworms (*Necator americanus* and *Ancylostoma duodonale*), *Strongyloides stercoralis* and Schistosomes (Odening, 1976; Brooker et al., 2006). Other helminths of human health relevance but not very common in the tropics include: *Taenia* species, *Hymenolepis nana, Dicrocoelium hospes* and *Enterobius vermicularis* (WHO, 1994). The lifecycle of most helminths may involve more than one host, interspersed with a free living phase. Intestinal worms lay eggs inside the host body before they are passed out with faeces onto the ground or water as the case may be. The deposited eggs remain in the water/soil until they are ingested by the host. As they are ingested, they hatch into larvae and moult into adults which then start laying new eggs (Parker et al., 2003).

Due to the public health implications of these intestinal parasites, this study was carried out with the aim of comparing the intestinal helminthes infestation among pupils in rural and sub-urban primary schools in Gwagwada district, Chikun Local Government Area of Kaduna State, Nigeria.

MATERIALS AND METHODS

Study area

The study was carried out in Gwagwada educational district from January and September, 2006. Four public primary schools, each were randomly selected, from both the rural and sub-urban communities of the educational district, making a total of eight schools. The schools selected were Gwagwada, Dutse, Gazamari and Bakin Kasuwa (sub-urban schools) and Bakin Liza, Bashishi, Gwazunu and Lukuru (rural schools). Fifteen percent of the pupils (both male and female) in each school and class were randomly selected for the study. Approval was obtained from the local government education secretary, and consent from the district education officer, the head teachers of each school and parents/guardian of the pupils was also obtained before sample collection.

Faecal sample collection

Clean, labelled wide-mouth sample plastic bottles with covers were given out to the selected pupils for the study and were properly instructed on how to collect their early morning faecal sample without contamination using the applicator stick attached to the sample bottle cover. The bottles were then collected from the pupils as they resume for morning classes and the faecal samples were immediately preserved with formalin and were finally taken to the laboratory for analysis. Sample collection was carried out in accordance to internationally best practices (Odoba et al., 2012; Pham-Duc et al., 2013).

Paper and pen questionnaires were administered to selected pupils through personal interview and information on sex, age, class and school name were collected.

Laboratory examination of faecal samples

The faecal samples were examined for parasites using the formaldehyde-ether concentration technique as described by Cheesbrough (1992). An aliquot of 1 g of faeces was suspended in 10 ml of 10% formaldehyde solution and mixed with a glass rod. The suspension was passed through a funnel covered with a gauze pad, to remove debris into a centrifuge tube. Three millilitres of ether was added and the suspension thoroughly mixed. The tubes were centrifuged for 3 min at 4000 rpm. Four layers were formed at the end of the centrifugation. The first layer was the ether with fats dissolved in it, the second was the debris, the third was the formaldehyde solution and the fourth was the sediment of eggs and/or larvae.

The centrifuge tubes were decanted, leaving only the sediment. The sediment was examined by sampling a drop with a pipette and depositing it on a glass slide. The slide was covered with a slide cover slip and examined microscopically using X10 and X40 objectives of the microscope as describe by Cheesbrough (1992). The eggs/larvae were identified using Atlas of Medical Helminthology and Protozoology as well as Medical Parasitology (Jeffrey and Leach, 1975; Arora and Arora, 2010).

Statistical analysis

The data obtained in the study are shown in Tables 1, 2, 3, 4 and 5, interpreted in percentages and analysed with respect to rural and sub-urban schools, age, sex, class and type of helminth infection. Chi square was used to test for association of prevalence with rural and sub-urban pupils across class of study, sex and age using Excel Microsoft (2010).

RESULTS

The prevalence of intestinal helminths among the rural and sub-urban pupils and their distribution with schools are presented in Table 1. Out of a total of 244 pupils, in both rural and sub-urban schools examined, 164 pupils were found to be positive with at least one of the helminth parasites, which gave a prevalence of 67.2%. Among the rural schools, 43 (58.9%) pupils were found to be positive out of the 73 pupils examined, while 121 (70.8%) pupils were recorded positive out of 171 pupils examined among the sub-urban schools. The highest prevalence (76.6%), among all the schools was recorded in Dutse, a sub-urban area, and was followed by Lukuru (73.3%), a rural area, while the lowest prevalence (41.6%) was obtained in Gwagwada, the district headquarters.

The results, as shown in Table 2, indicate the sub-

Table 1. Prevalence in rural and sub-urban schools.

Rural			Sub-urban		
School	**No. examined**	**No. positive (%)**	**School**	**No. examined**	**No. positive (%)**
Bakin Lizza	15	8 (53.3)	Gwagwada	77	53 (68.8)
Bashishi	18	9 (50.0)	Dutse	64	49 (76.6)
Gwazunu	25	15 (60.0)	Gazamari	11	7 (63.6)
Lukuru	15	11 (73.3)	Bakin Kasuwa	19	12 (63.2)
Total	73	43 (58.9)	Total	171	121 (70.8)

Table 2. Prevalence by sex in rural and suburban schools.

School	Male		Female	
	No. examined	No. positive (%)	No. examined	No. positive (%)
Rural	45	26 (57.7)	28	17 (60.71)
Suburban	99	73 (73.74)	72	48 (66.67)

Males χ^2= 3.7; df = 1; p = 0.05 and Females χ^2= 0.3; df = 1; p = 0.05

Table 3. Prevalence by age group in rural and sub-urban schools.

Age (Years)	Rural		Sub-urban	
	No. examined	No. positive (%)	No. examined	No. positive (%)
7-9	19	13 (68.4)	49	38 (77.6)
10-12	17	11 (64.7)	43	32 (74.4)
13-15	14	8 (57.1)	41	27 (65.9)
>16	23	11 (47.8)	38	24 (63.2)

χ^2= 2.1; df = 3; p = 0.05.

urban pupils had the higher prevalence in both males (73.7%) and females (66.7%) than the male and female pupils in rural areas. However, there was no significant association with sex between rural and sub-urban prevalence (P>0.05). When compared across age groups (Table 3), the group of 7 to 9 years in sub-urban schools had the highest prevalence (77.6%), while the group >16 years in rural schools had the lowest prevalence (47.8%). Though, there was no significant association of prevalence with age between the two areas, there was a decline in prevalence as the age increased, in both areas.

The highest prevalence (80.0%) was obtained in sub-urban schools among Primary 4 pupils while the lowest prevalence of 47.8% was among Primary 6 pupils of sub-urban schools. Though no significant association was found, there was slight decline in prevalence as one went higher the classes (among rural schools) from Primary 1 to 3, a slight increase in Primary 4 and a continuous decline in Primary 5 and 6. The prevalence among sub-urban pupils, across classes showed a staggered pattern (Table 4).

Ascaris lumbricoides was the most prevalent helminth, with 37.0 and 29.8% among both rural and sub-urban pupils, respectively (Table 5). *Schistosoma mansoni* had the lowest prevalence (1.8%) among sub-urban pupils, but slightly higher among the rural pupils (21.9%).

DISCUSSION

The overall high prevalence (67.2%) of intestinal helminth infections among both rural and sub-urban pupils is similar to the high prevalence (80.9%) by Damen et al. (2011) reported among almajiris, 59.1% among primary school pupils by Usip et al. (2013). This could be attributed to carelessness and unhygienic behaviour(s) among these pupils both at home and in school. Lack of sanitation facilities in these schools might have also contributed to the high prevalence. In all the selected schools and environs, it was observed that there were no toilet facilities or, where present, they were not functional or no adequate water supply. The pupils mostly defecate in open field both at home and in school.

Table 4. Prevalence with class between rural and sub-urban schools.

Class	Rural		Sub-urban	
	No. examined	No. positive (%)	No. examined	No. positive (%)
Primary 1	16	11 (68.8)	35	23 (65.7)
Primary 2	8	5 (62.5)	29	22 (75.9)
Primary 3	12	7 (58.3)	27	20 (74.1)
Primary 4	10	6 (60.0)	30	24 (80.0)
Primary 5	13	7 (53.8)	27	21 (77.8)
Primary 6	14	7 (50.0)	23	11 (47.8)

χ^2= 1.3; df = 5; p = 0.05.

Table 5. Prevalence with type of helminthes between rural and sub-urban schools.

Type of helminth	Rural		Sub-urban	
	No. examined	No. positive (%)	No. examined	No. positive (%)
Ascaris lumbricoides	73	27 (37.0)	171	51 (29.8)
Trichuris trichiura	73	3 (4.1)	171	8 (4.7)
Hookworm	73	7 (9.6)	171	9 (5.3)
Taenia spp.	73	24 (32.9)	171	19 (11.1)
Schistosoma mansoni	73	16 (21.9)	171	3 (1.8)

Consequently, the faeces could contaminate nearby household and school environments with eggs from geohelminths, and this might have resulted to the high counts from this study. The pupils could have picked up the eggs from the contaminated soils during extracurricular activities and through eating with dirty, contaminated hands, thus leading to infection which affects the health, well-being and the academic performance of the pupils.

The very high prevalence ratio of infection obtained in this study is similar to that reported by Leykun (2001) in a study in Ethiopia among school children and that of Sebastián and Santi (2001) among Naporuna school children in the Low-Napo region, North-Eastern Ecuador. A high prevalence (77%) of intestinal geohelminthiasis among school children in riverine communities of Nigeria was reported by Ariyo et al. (2007).

Majority of the parents/guardians of these school pupils are either farmers or nomadic cattle rearers, having little or no education on good hygienic behaviour and so, children are not under adequate adult supervision of their sanitation habits even at home.

The insignificant association in prevalence between sex and locality could be due to the common lack or poor sanitation facilities and portable drinking water. The higher prevalence recorded among males in both rural and sub-urban pupils matches with the reports of Ajibola (2013), Ajibola and Hassan (2013), Alemu et al. (2011), Leykun (2001) and Sehgal et al. (2010), but contrary to the findings of Amaechi and Okore (2013). This could be attributed to the activities the males get involved in, which predispose them to infection, such as swimming, fishing, farming, football and other sports which females are mostly not involved in. The slight decrease of infection with increase in age may be due to increase in hygiene and behavioural changes that mostly come with increases in age and this also applies to the prevalence across the classes. In both rural and sub-urban pupils, the highest prevalence of *A. lumbricoides* corresponded with the reports of Ajibola (2013), Ajibola and Hassan (2013), Ekpenyong et al. (2008), Emeka (2013), Usip et al. (2013), Damen et al. (2011) and Ojurongbe et al. (2014), but are contrary to that of Odoba et al. (2012) that reported hookworm to have the highest prevalence among childrenin Zaria.

Conclusion

In conclusion, there was a very high prevalence of intestinal helminths among pupils in these rural and sub-urban areas, which reveals that intestinal helminthes are endemic in these areas. *Ascaris lumbricoides* has a very high prevalence among pupils. The health status of rural and sub-urban pupils was not significantly different, because the available social, health and sanitary facilities in these areas are not different in any way. There is a need for the state/local government and Non-Governmental Organizations (NGOs) to embark on urgent mass deworming campaigns among all pupils, and potentially all people living in these areas. The need for health/hygiene education and awareness among pupils, parents/guardians, teachers and food vendors will contribute immensely for improving their behaviour. Government agencies, at state and local levels, should provide more facilities, such as boreholes, toilet facilities, good drainage system and other basic facilities that will promote more healthy living conditions.

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Conflict Interests

The authors declare that there is no conflict of interests regarding the publication of this article.

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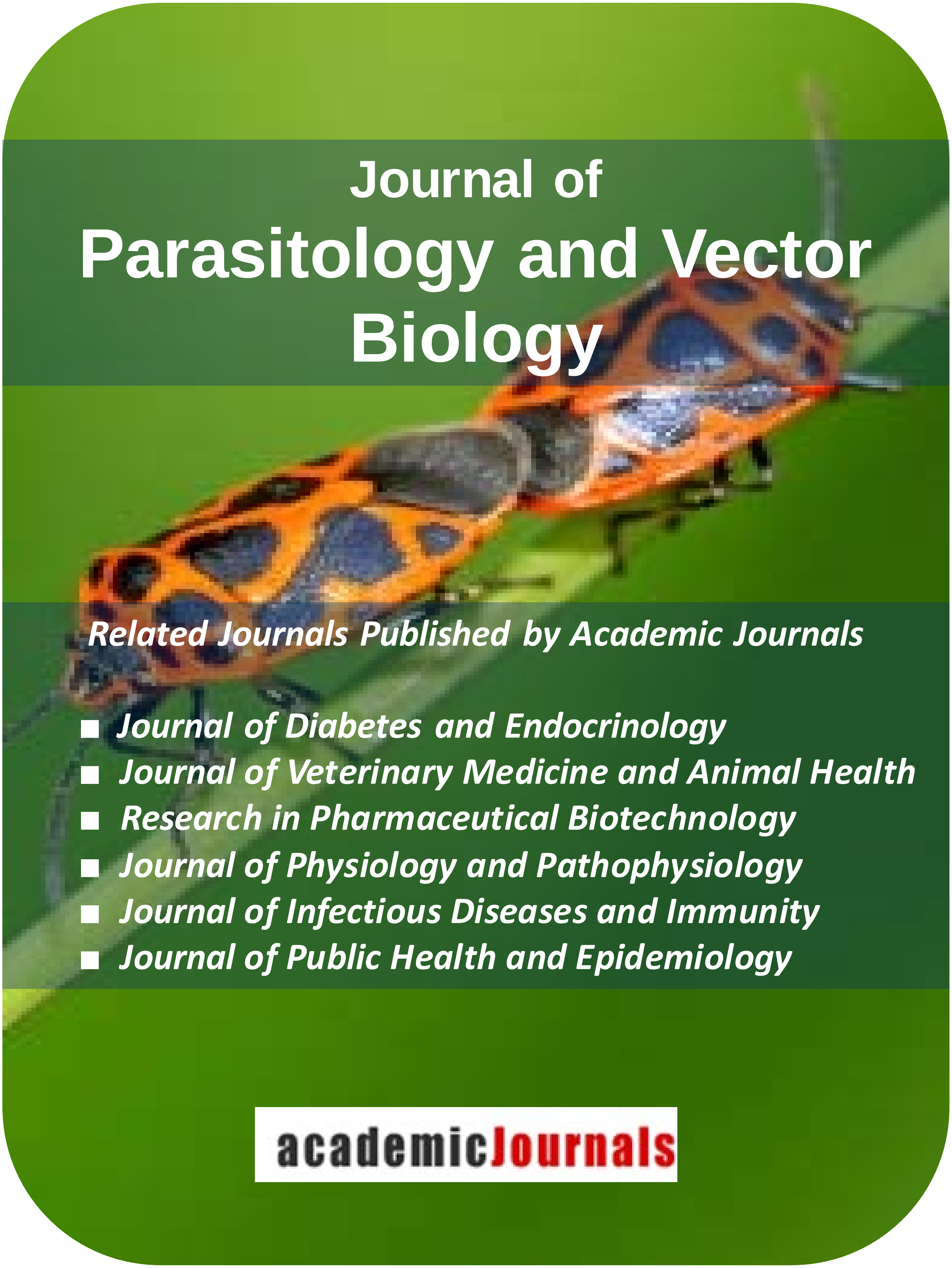

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