# AN EDEMIOLOGICAL STUDY OF SCHISTOSOMIASIS AMONG PUPILS OF SELECTED LOCAL GOVERNMENT AREAS OF KATSINA STATE, NIGERIA

BY

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## DEDICATION

***TO MY PARENTS***

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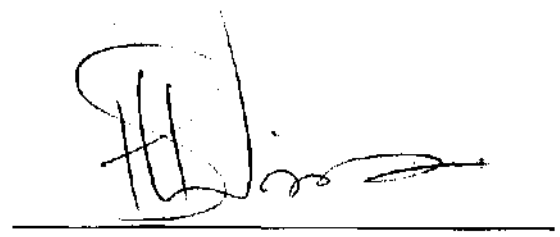
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## DECLARATION

I hereby declare that, I **Halimatu Sa'adiyya Idris** carried out the work reported in this Thesis in the Department of Veterinary Parasitology and Entomology, Ahmadu Bello University, Zaria. This project was supervised by Dr. V. C. Ogbogu (Late), Dr. O. J. Ajanusi both of Department of Vet. Parasitology and Entomology, Professor J. U. Umoh of Department of Vet. Public Health and Preventive Medicine and Dr. M. Galadima of Department of Microbiology.

The works of other investigators in related areas are duely acknowledged by means of references. No part of this thesis has been presented in any form else where for another qualification at any other University.



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CERTIFICATION

This Thesis entitled **An Epidemiological study of Schistosomiasis among pupils in selected Local Government Areas of Katsina State, Nigeria** meets the requirement governing the award of the degree of Doctor of Philosophy of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

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## ABSTRACT

A study on schistosomiasis among pupils of five local government areas in Katsina state was carried out between November 1994 and September 1996 while snail survey was conducted between March 1997 and February 1998. A total of 8000 samples consisting of 4000 urine and 4000 faecal samples were collected in 100 randomly selected primary schools from pupils between the ages 5 and 19 years. Parasitological analysis revealed that 522 (13.1%) pupils had S. *haematobium* while 161 (4.8%) had *S.mansoni.* The highest prevalence rate of 29.0% for S. *haematobium* was recorded in Dutsinma Local Government area and the least prevalence (13.0%) was recorded in Katsina Local Government area. On the other hand the highest prevalence rate of (26.7%) for S. *mansoni* was recorded in Rimi LGA while the least prevalence (10.6%) was in Jibia LGA. There was a significant relationship (P<0.05) between sex-specific rates of schistosomiasis in Katsina State. The highest prevalence rate of 16.1% and 56.5% for *S.haematobium* and S. *mansoni* respectively were recorded for the two seasons in the 10-14 years age group. There was a significant relationship (p<0,05) between frequency of water contact and infection rate of schistosomiasis. The presence of blood in both urine and faeces was found to be associated with infection. Majority of the pupils showed their ignorance of the disease and its etiologic agent. The relationship between other parameters such as types of toilet, sources of drinking water and types of treatment taken (if any) were also investigated. Other intestinal parasites encountered in the 4000 faecal samples examined included *Ancyclostoma duodenale (Hookworm) (15.6%), Hymenolepis nana (4.1%), Enterobius vermicularis (3.8%), Trichuris trichura (1.0%), Ascaris lumbricoides (0.7%) and Entamoeba histolytica (0.1%).*

*Snail of medical importance isolated were Bulinius globosus, B. forskalii, Biomphalaria pfeifferi and Lymnaea natalensis.* A total of 1107 snails were isolated, of which 364 were *B.globosus,* and 170 were *B. pfeifferi.* The distribution of infected *B. globosus* and *B. pfeifferi* was highest during the months of February and May when water temperature ranges between 26.0°C and 32.8°C. Lack of potable drinking water, ignorance of the disease and its etiologic agent contributed to the high prevalence rate of schistosomiasis in Katsina State. Enlightenment of the people, provision of potable drinking water, use of chemotherapy and application of mollucicide in water bodies during the dry season by the Government will be of paramount importance in controlling the disease.

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## CHAPTER ONE

## INTRODUCTION

Schistosomiasis refers to the pathological condition resulting from infection by a digenetic trematode of the genus *Schistosoma*. It is the second most prevalent tropical disease and a leading cause of severe morbidity (Schmidt and Roberts, 1985). It is often chronic and depilatory and manifestation vary with the infecting species but depends upon host tissue reaction (Edington and Gilles, 1969) in form of granulomas and scars, (Marquardt and Demaree, 1985) and the eggs deposited in venule, (Schmidt and Roberts, 1985). The disease has a worldwide distribution and it is estimated that around 200-300 millions people are infected by one or another species of *Schistosoma*, with 600 to 700 million at risk(W.H.O,1993). Extrapolation from detailed studies of WHO (1993) also indicates that there are tens of million of people with serious chronic schistosomal illness in the world. The disease may potentiate the development of other diseases such as hepatitis, hepatoma, cirrhosis and cancer of urinary bladder (Edington and Gilles, 1969).

Four species, *Schistosoma haematobium S mansoni, S. intercalatum* and *S.japonicum* are known to infect man. Other rare species that are parasitic in man include *S.bovis, S. matheei, S. currasoni* and *S. mekongi* (Cowper,1971). In Nigeria *S.mansoni* and *S. haematobium* are said to be the etiologic agent of human schistosomiasis (Blair, 1956; Pugh, 1979).

The adult worms of *S. haematobium* live in veins of urinary bladder plexus, *S.mansoni* prefers the portal veins draining the large intestine and *S. japonicum* concentrates in the veins of the small intestine (Woodruff, 1974; Marquardt and Demaree, 1985). Characteristic eggs layed are passed out of the body in faeces or urine depending on predilection sites.

Eggs of human schistosomes have epidemiological diagnostic and pathological significance as a major parasite component in the pathogenesis of human schistosomiasis and development of an overt disease (Edungbola *et al* 1996). Furthermore, all eggs deposited by female *Schistosoma*, are either sieve into and get trapped in the human host tissue or are eliminated into the external environment via stool or urine.

The development of schistosome of humans follow a similar pattern similar for all the three species. According to Jordan and Webbe (1969), it is necessary for the larval stage to develop in specific molluscan intermediate host. In Africa, *S.haematobuim* and *S. mansoni* have a wide distribution pattern, with *Bulinus* and *Biomphalaria Spp* identified as their intermediate host respectively ( Ukoli, 1990; Schmidt and Roberts, 1985).

Human waste in water containing the intermediate host of *Schistosoma* worm is the single most important epidemiologic factor in schistosomiasis while the availability of suitable species of snail host determines the endemicity of the particular species of *Schistosoma.*

Schistosomiasis is endemic in 76 countries where an estimated number of 500-600 million people are exposed to the infection and nearly 200 million of whom are actually infected (Doumenge and Mott 1984). In Egypt, the annual economic loss due to schistosomiasis is estimated at 560 million dollars, while in Iraq, Japan and Phillipines the annual losses have been estimated to be 10,18 and 13 million dollars respectively(Lemma *et al*, 1978). Infact this disease is one of the major occupational risks in rural areas of the developing communities and is second only to malaria in socio-economic and public health importance (Doumenge and Mott, 1984). More than 200,000 people die of the infection annually (Fabiyi, 1997).

Children were found to be frequently and severely infected (W.H.O., 1984). This made it possible to deduce overall prevalence rates and incidence of schistosomiasis in a given form data of appropriately designed studies on school children.

Schistosomiasis is endemic in Nigeria and it was estimated that 20 million Nigerians are infected (Fabiyi, 1997). Several records are available on intestinal and urinary schistosomiasis especially in the Western, Southern and Eastern parts of the country (Okuwosa, 1979; Gemade and Dipeolu, 1983; Edungbola *et al* , 1988; Ndifon,1979; Awogun, 1990 and Nduka *et al* 1995). In the Northern part of Nigeria the earlier reports was made by Ramsay (1932, 1934 and 1935). Later reports included those of Blair (1956); Cowper (1963 and 1971); Pugh *et al* , (1980); Audu (1988); Bassey, (1988) and Akufongwe *et al* (1995). These have not, however, covered enough area to give an accurate appraisal of the relative importance of schistosomiasis in Northern Nigeria. Previous work by Blair (1956) and Cowper (1971) in Katsina, Zaria and Ibadan reported a prevalence rate for *S. haematobium* to be between 65% and 95%. Also in Malumfashi Katsina State, Pugh (1979) reported a high prevalence rate (77%) for *S. haematobium* in males aged 15-20 years. Schistosomiasis is likely to be on the increase in Nigeria because of emphasis placed on Agriculture, which has led to the introduction of new irrigation schemes in form of canal, dams and drains all of which provide excellent habitats and breeding ground for the snail intermediate host. This lack of attention given to schistosomiasis may be due to lack of basic information on the particular areas.

Thus this investigation was embarked upon to:

(i) ascertain the levels of infection and the disease in some communities in Katsina State.

(ii) identify local epidemiological pattern which will aid in the selection of the most appropriate control methods for that area.

(iii) ascertain the seasonal prevalence of infection in the snail vector.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 The parasite species and life cycle

The family Schistosomidae include species that are among the most dreaded parasites of humans. To date, ten(10) species and two(2) varieties of schistosomes have been reported in Africa(Warren,1973;Cowper,1979).

Schistosomes are bisexual flukes inhabiting the blood stream of a vertebrate host. Their life cycle involves a fresh water or amphibious gastropod mollusc(Ukoli, 1990). *Schistosoma* is a member of the class Trematoda of the phylum Platyhelminth. Considerable sexual dimorphism exists in the genus *Schistosoma*, the males being stouter and shorter than the females(Schmidt and Roberts,1985). The males have a ventral longitudinal groove, the gynaecophoral canal, where the female is usually carried. The mouth is surrounded by a strong oral sucker. The acetabulum is near the anterior end. There is no pharynx. The paired intestinal ceca converge and fuse at mid point of the worm and continue as a single gut to the posterior end. There is a ventral sucker and the genital pore opens immediately behind it. The suckers of the females are smaller and not so muscular as those of the males and the integumental tubercles if any, are confined to the ends of the females. Comparative morphology of the four main species of *Schistosoma* are summarised in Table 1.

**Table 1:**

**Comparative morphology of the four primary species of schistosome that infect man**

| S/N | Characteristic | *S.haematobium* | *S.mansoni* | *S.intercalatum* | *S. Japonicum* |
|---|---|---|---|---|---|
| 1. | Tegumental Papilae | Small tubercles | Large papilae with spines | Short blunt spines | Smooth/minutes spines |
| 2. | Size<br>Length<br>Width<br>Female<br>Length<br>Width | <br>10 - 15mm<br>0.8 - 1mm<br><br>Ca 20mm<br>Ca 0.25mm | <br>10 - 15mm<br>0.8 - 1mm<br><br>Ca 20mm<br>Ca 0.25mm | <br>12 - 20mm<br>0.5 -0.5mm<br><br>Ca 26mm<br>Ca 0.3mm | <br>11 - 14mm<br><br><br>13 - 24mm |
| 3. | No of testes | 4 - 5 | 6 - 9 | 7 | 2 - 7 |
| 4 | *Position of Ovary* | *Near Mid body* | *Anterior half* | *Posterior to mid body* | *Mid body* |
| 5 | Uterus | 20 - 100 eggs at a time. Average 50 | Short, few eggs at one time | Long: may contain up to 300 eggs. Average 50 | 10 - 100+ |
| 6 | Vitellaria | Few Follicles Posterior to ovary | Few Follicles Posterior to ovary | Lateral field Posterior quarter of body. | - |
| 7 | Eggs | Elliptical, with sharp terminal spine; 112 - 170um by 40 70um | Elliptical, with sharp lateral; spine; 114 - 175um by 45 - 70um | Oval to almost spherical; rudimentary lateral spine; 70 - 100um by 50 - 70um | Terminal spine 140 - 240um by 50 - 85um |
| 8 | Passed in | Urine | Faeces | Faeces | Faeces |

Sources: Marquardt and Demaree, 1985 and Schmidt and Roberts, 1985.

## 2.2 Life cycle

The life cycles of the four major species of *Schistosoma* that infect man are similar, all being digenetic trematode alternating sexual phase of reproduction in man (definitive host) with an asexual reproductive phase in snail intermediate host. As summarised by Warren (1973),the fertilized eggs are produced by adult *Schistosoma* in the venule draining the pyloric viscera of man in the case of *S. haematobium* or the submucosa of the large intestine in the case of *S. mansoni*, they leave the host, man, through the urine and faeces respectively. The eggs remain viable for approximately twenty one (21) days after laying during which they must pass out of the body if their life cycle is to be completed. The eggs that pass out of the body and reach fresh water hatch rapidly into free swimming ciliated miracidia. Their average life span is about six (6) hours. The miracidium burrows into the soft tissues of the foot of the snail intermediate host, losses its outer cilia and enlarges into a sac-like mother sporocyst-near or close to the site of penetration. About ten days later daughter sporocyst begin to migrate into the digestive glands of the snail. Cercariae produced from daughter sporocyst are shed from snails at about five week after infection. Maximal stimulus for shedding cercariae of *S. mansoni* and *S. haematobium* cercariae is sunlight. Average daily output of cercaria for *S. mansoni* and *S. haematobium* is about seven hundred and for *S. japonicum* is two hundred. The cercariae may live up to 2-3 days under optimal conditions of temperature and pH, but their infectivity decrease after twenty four hours. When cercariae contact human skin they attach themselves on to the skin with their suckers. By mechanical means aided by enzymatic secretion (Warren,1973), the cercariae penetrate intact skin leaving the tail behind. Infection

occurs during immersion in fresh water containing cercariae or while skin remains moist and takes four to ten minutes for *S. mansoni* but only a few seconds to three minutes for *S. japonicum* (Ruppel *et al*, 1991). Each cercaria that penetrates the skin develops into a schistosomula, which then migrates to the lungs through either the blood stream or lymphatics. After a few days in the pulmonary vessels, they migrate to the liver either through the lungs and diaphragm or by the blood stream. This phase takes ten to twelve days for *S. mansoni* , shorter period of less than 10 days for *S.haematobium*. Once in the liver, the worms reach maturity rapidly, mate and move against the blood flow of the host (Schmidt and Roberts,1985) to their predilection site. The prelatent period is five to six weeks for *S. japonicum*, seven to six weeks for *S.mansoni* and ten to twelve weeks for *S. haematobium*.

The life cycle of other species of schistosomes were found to be basically the same as those that infect humans (Marquardt and Demaree, 1985)

## 2.3 Geographical distribution

Schistosomiasis is one of the most importance public health problems in the tropics and sub-tropics (WHO, 1993). Wright (1950) considered Central Africa as the origin of Schistosome worms. Egypt has been regarded as the birth place of schistosomiasis as a result of the discovery of *Schistosoma* eggs in the mesenteric veins of a patient at autopsy in Cairo in 1852 by Theodor Bilharz (Cowper, 1973). However Jordan and Webbe (1969) reported that calcified schistosome eggs existed in mummies dating back to 1250 BC.



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The four major species of *Schistosoma* which infect man are widely distributed in Tropical and subtropical regions(Cowper,1973). The World Health Organisation report (1974) stated that *S. haematonium* occurs in Africa, South West Asia and a small foci in Southern Portugal and India. *S. mansoni* distribution was reported in Africa and South West Asia while *S japonicum* was generally regarded as an oriental species occurring in Japan, China , the Philippines and parts of South East Asia (WHO,1987). Both *S. mansoni* and *S. haematobium* occur in Egypt and Madagascar and are distributed discontinuously over the greater part of Africa, south of the sahara (Brown 1980). The parasites were also found to be endemic in eastern South America, some Islands in that region and parts of Arabia (Laughlin, 1986; W.H.O. 1988). Hinz (1980) noted that *S. intercalatum* occur in Zaire, Rwanda, Burundi, Gabon , Cameroon and isolated cases indicating possible occurrences in Burkina Fasso, Chad, Nigeria and other parts of West Africa. A summary of the geographical distribution of schistosomiasis revealed that the disease was confined to an area between latitude 36 degrees north, and 34 degrees South where fresh water temperatures average 25°C to 30°C (Schmidt and Roberts, 1985).

## 2.4 Prevalence of Schistosomiasis

The human schistosomes occur mainly in some of the countries of the world that are at the lower end of the economic scale MacDonald and Farooq (1973), pointed out that in parts of South America, 12% of deaths in hospitals were due to the consequences of schistosomiasis. In the Philippines, the annual cost of medical care of schistosomiasis was estimated at two million dollars (Marquardt and

Demaree, 1985). Rodrigues *et al* (1995) recorded a high infection rate of 80.3% for *S. mansoni* during his survey in Brazil. Compilation of prevalence rates of schistosomiasis in West African countries was carried out by Odei (1961). His result showed that *S. mansoni* occurred more in countries north of the Sahara in Africa. The overall prevalence of infection in West Africa was estimated to be about 41% (Mcmullen, 1968). High morbidity and mortality for schistosomiasis have been reported in Egypt (Mousa, 1962). In Ghana, Wen and Chu (1984) recorded a prevalence rate as high as 96% for *S. haematobuim* infection .

A prevalence rate of 87.1% and 23.8% was observed during a survey of two communities in Zambia (De Jonge and van Vliet, 1991).

Other studies in Africa included those of Simarro *et al* ( 1991); Gryseels and Polderman (1987); Elias (1992); Brinkmann *et al* (1988); Chandiwana *et al* (1987) and Stelma *et al* (1993). These worked in Equatorial Guinea, Burundi, Sudan, Mali, Zambabwe and Northern Senegal respectively, and reported prevalence rates ranging from 25% and 91%. Nigeria has been reported as an endemic area of schistosomiasis (WHO, 1995). Though it is difficult to trace the first outbreak of the disease in Nigeria, its extent and clinical significance in the Northern region was reported as far back as 1932 by Ramsay. He reported the prevalence of *S. haematobuim* and *S. mansoni* through out this region. His work in 1934 described eggs suspected to be those of *S. matheei* in human faeces. In Nigeria today the species of *Schistosoma* known to exist include *S. haematobium*, *S. mansoni*, *S. bovis*, *S.matheei*, and *S. spindale* (Cowper,1973). The works of Cowper(1963) and Pugh (1979) identified hyperendemic foci of schistosomiasis in Northern Nigeria. Studies by Pugh *et al* (1980) revealed that *S.haematobium* predominate

the dry Northern regions where the infection is focal and acquired in seasonal pools A similar pattern was observed during a survey of irrigation schemes in Sokoto, Katsina and Kebbi state, where 22.3% prevalence was recorded for *S. haematobium* and 1.6% for *S. mansoni* (Ofoezie *et al,* 1996). Egwunyenga *et al* (1994) in Bauchi recorded a prevalence rate of 21.20% for *S. haematobium* and 11.45% for *S. mansoni.* Cases of schistosomiasis have also been reported in the Southern Nigeria by Lovett- Campbell (1948), Ikejiani (1959), Cowper and Woodward, (1960) and Okpala (1961). Nduka *et al* (1995) in a survey in South Eastern part of Nigeria reported a prevalence rate of 21.03% and a significant difference in infection rates in males than females. The report of Federal and Regional Medical Departments of 1929 referred to by Blair (1956) and Cowper (1973), described hyperendemic *S.haematobium* infection rates in children to be between 65% and 95% in Katsina, Zaria and Ibadan areas. The distribution of schistosomiasis and its vectors especially in the Western parts of the country had been described by Blair (1956) and Cowper, (1963). A recorded high infection rate of 78% in Bacita-Share-Petegi area and least infection rate of between 10% to 15% in the same area was observed. Recent surveys include those of Fajewonuomi and Afolabi (1994). They found a prevalence percentage of 20.5% for *S. haematobium* in Ile-Ife. Mafiana and Adesanya, (1994) had a general prevalence of 68.7% for *S. haematobium* infection in Akure where a prevalence rate of 67.9% was recorded for *S.haematobium* infection (Adeoye and Ipeayeda, 1994). Egwunyenga *et al* (1994) recorded 36.75% prevalence for schistosomiasis in Bauchi. Other surveys on schistosomiasis in Nigeria are vast and included those of Ofoezie *et al* (1991) Ofoezie *et al* (1996), Adeoye and Akabogu (1996) and Agbolade and Odaibo, (1996).

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Generally low infection rates for *S. mansoni* compared to *S. haematobium* have been recorded through out Nigeria. In Bauchi a prevalence rate of 21.20% and 11.45% was recorded for *S. haematobium* and *S. mansoni* respectively (Egwunyenga *et al*, 1994). Hospital laboratory records in Zaria revealed that *S.haematobium* eggs were detected in 7.6% of the 1305 urine samples examined (Ebele *et al*, 1981). Although, it was noted that the figures probably under estimated the prevalence of urinary schistosomiasis, as people suffering from the disease rarely attend hospitals and the cases earlier mentioned were those detected during the diagnosis of other diseases. Between 1976 and 1984 hospital records on schistosomiasis in North Eastern Nigeria showed that urinary schistosomiasis was the second most common communicable disease while intestinal schistosomiasis ranked sixth in the region (Chikwem and Alaku, 1987). Recent publications on schistosomiasis in Nigeria included those of Pugh *et al* (1980); Edungbola (1980a); Gemade and Dipeolu (1988); Chugh *et al* (1986); Audu (1988) Edungbola *et al* (1988); Betterton *et al* (1988) and Bassey (1988). These authors worked in Malumfashi, Ibadan, Benue, State, Maiduguri, Kaduna, Kwara state and Kano respectively.

Summary of incidence of schistosomiasis in Nigeria by Blair (1956) revealed that the prevalence rate varied from O% to 100%. Hyperendemic areas reported in the southern part included Ibadan, Ondo, Abeokuta, Epe and those in the northern part included areas such as Katsina, Sokoto, Zaria and Kano. Less heavily infect areas were found in the eastern part of Nigeria except in Owerri.However high infection rates were recorded in Plateau and North Eastern parts.

## 2.5 Intermediate hosts of *Schistosoma*

In Africa, *Schistosoma* is known to be transmitted by the planorbid snail *Bulinus* species of which include*B. globosus*, *B. africanus, B. nasatus, B. truncatus, B. forskali*, and *B. senegalensis*, and *Biomphalaria* species of snails are also involved in transmission (Betterton *et al*, 1983; Ukoli, 1990).

*Biomphalaria* and *Bulinus* species are aquatic and hermaphroditic snails which can be found in almost all types of water bodies, ranging from small temporary ponds or streams to large lakes and rivers (Brown, 1980). Manmade lakes or water bodies like irrigation canals and dams are, in particular, excellent habitats. Human water contact plays a very important role in transmission of schistosomiasis. Studies of man-water contact in parts of Nigeria showed males, especially young ones, to be the prime contaminators of the environment, thus playing an important role in the transmission of schistosomiasis (Tayo *et-al* , 1980; Pugh, 1979; Fajewonyomi and Afolabi, 1994; Egwunyenga *et al* 1994).

*Biomphalaria* and *Bulinus* species are implicated in the transmission of schistosomiasis in Nigeria ( Brown, 1980 ; Ofoezie *et al*, 1996). Eggs of *Bulinus* and *Biomphalaria* species are deposited in masses on plants or solid objects in water. Hatching takes place under optimal conditions after 7 to 10 days . Snails of the two genera may reach sexual maturity after 4 to 6 weeks. The average longevity of the snails varies between the species and depends on local conditions. The reproductive capacity is high and populations of these species may undergo marked seasonal fluctuation in density. For example, Hira (1969) found transmission rate of schistosomiasis to be intense during dry season. There may be a wide distribution of snails in areas but the tendency exists for those infected, to be focally distributed


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according to facility of human water contacts. Ofoezie *et al* (1996) reported patchy snail distribution which was associated with dense aquatic vegetation and intense human and cattle water contacts. In large irrigation schemes, most infected *Biomphalaria* and *Bulinus* snails are found close to human settlements (WHO, 1995). Humans were observed to pollute the water with excrement in those areas. The snails, however, live in unpolluted water as long as there are periphytons which happen to serve as food for the snails. Amankwa *et al* (1994) related intestinal helminthiasis to the irrigated agriculture which created breeding opportunities for vector snails and transmission.

In Nigeria, a lot of work has been done on ecology of fresh water snails that are important in the transmission of schistosomiasis. In the Northern parts of Nigeria, these include the works of Betterton *et al* (1988), Bassey (1989), Ofoezie *et al*, (1996), Agbolade and Odaibo, (1996), Egwunyenga *et al* (1994), while similar work in the Southern Nigeria include those of Cowper (1959), Okuwosa (1979) and Adeoye and Akabogu (1996) to mention a few. Adewunmi *et al* (1991) reported that *S.haematobium* infected *Bulinus globosus* were encountered in 7 sites and *S. mansoni* infected *Biomphalaria pfeifferi* in only 2 sites in South Western Nigeria. The bulinid and Planorbid snails prefer slightly shaded, slow flowing and shallow waters (Warren, 1973). They are found in a variety of habitats ranging from shallow pools, excavations, perennial and seasonal pools to swamps, irrigation channels, reservoirs and lakes (Bassey, 1988; Audibert *et al,* 1990; Ofoezie *et al,* 1991 and Betterton *et al*, 1988). Pulmonate snail populations undergo great seasonal variations in density and infection rates, rainfall and temperature being the main contributing factors. This results in a focal and seasonal pattern of transmission. Rainfall is presumed to facilitate transmission by washing eggs of *S. mansoni* in faeces passed near water bodies into the water bodies (Christie and Uphatham, 1977). Also, the work of Chandiwana (1986) recorded washing of faeces to be the

most important route by which eggs of *S. mansoni* reach water bodies and concluded that post rainy period was of great importance in the transmission of schistosomiasis.

Temperature has also been found to influence reproductive rate of snails. To maintain their numbers, these snails require a warm season of a few months (Warren, 1973). Abdulwahab (1979), stated that *Bulinus* and *Biomphalaria* are found to be tolerant to a seasonal variation from 26.6°C to 11.4°C.

The effect of sunlight on Pulmonate snails is indirect than a direct one. Abundance of sunlight means a flourishing of aquatic weeds and microflora which serve as food for the snails, as well as high dissolved oxygen content. Though the snails possess lungs, it seems that they depend more on oxygen dissolved in water than on atmospheric oxygen (Warren, 1973). It is, therefore, evident that the oxygen content of the water is very important in conditioning the habitat of these snails. Sunlight or light seems to have positive effect on the transmission pattern of schistosomiasis especially during cercarial shedding by the infected snails. Mouahid *et al*, (1991) recorded as high as 29.76% of the daily cercarial emission for *S. haematobium* when infected snails were exposed to light. Matsunaga *et al* (1987) also reported light as being an important factor influencing the hatching of *S. haematobium* eggs. He found out that the hatching was intensely suppressed in darkness. Similarly, Edungbola *et al* (1996) reported that three main conditions that favour hatching of human schistosome eggs are optimum temperature of about 28°C, powerful illumination, and hypotonic or fresh water (rain water). Under these conditions,this leads to completion of hatching which occurred within 5 minutes. Other ecological factors influencing transmission include turbidity and ion contents of water.

## 2.6 Pathogenesis, Pathology and Clinical aspects

The pathogenicity of schistosomiasis differs with the species involved, mainly because of the predilection sites of the parasites. According to Schmidt and Roberts (1985) progression of the disease caused by all three species is commonly divided into 3 phases, namely, the initial, intermediate and final phase.

The initial phase lasts between 4 to 10 weeks after infection. This stage is characterised by allergic phenomena such as cercarial skin reactions and cough which may result from migration of cercaria.

The intermediate stage is from two and a half months to several years after infection. In fact this stage could be further divided into maturation and establishment stages. During maturation, there is completion of maturation and early oviposition with migration to definitive sites. Clinical manifestation at this stage include febrile illness which may not be recognised or present. Pathologically, there are generalised and local hyperagic reaction as a result of presence of eggs and or the young schistosome. The stage of established infection begins with intensive oviposition accompanied by a corresponding egg excretion at the predilection site. It is also the stage of early chronic disease, characterised by haematuria or intestinal and other digestive manifestations. Fibrosis is not a common or predominant feature. Main symptom include local inflammatory reaction to ova resulting mainly in granuloma formation (Edington and Gilles, 1969).

The final phase or stage of late infection is marked by prolonged infection, often with reduced or discontinued egg extrusion. This results in complications involving the gastrointestinal, renal and other systems. The most serious damage is done by eggs of all the three species. With *S. mansoni*, the large intestine is most

notably affected, especially the sigmoid colon and rectum. The eggs lodged in the venule and submucosa, act as foreign bodies and cause inflammatory reactions with leucocytic and then fibroblastic infiltration which results in granuloma or pseudotubercles. The occlusion of small vessels lead to necrosis and ulceration with high eosinophilic count and is followed by leucopenia (Mahmoud, 1982). The clinical symptoms include abdominal pain and diarrhoea with blood, mucus and pus (Gryseels and Polderman, 1987). Many eggs are swept back into the liver where they are lodged in the hepatic capillary bed and cause similar foreign body reaction with granuloma formation. Enlargement of the spleen results from eggs lodged in it and also the chronic passive congestion of the liver. Ascites is common at this stage (Edington and Gilles, 1969). Some eggs pass the liver and lodge in the lungs, nervous system and other organs, and produce granulomas. Infection with *S. haematobium* is considered the least serious when compared with *S. mansoni* (Schmidt and Roberts, 1985). Symptoms usually include cystitis, haematuria, and pain on urination (Hunters, *et al*, 1976). The change in bladder wall are associated with foreign body reactions around the eggs, that is the formation of pseudotubercles, fibrous infiltration, thickening of muscularis layer and ulceration (Edington and Gilles, 1969). Chronic changes lead to ureta and kidney involvement (WHO, 1985) and to lesions in other parts of the body.

## 2.7 Schistosomiasis as a zoonosis

Not until recently, schistosomiasis was regarded exclusively as a human disease. In a review on schistosomiasis in Nigeria, Cowper (1963) on two occasions recorded ova that morphologically resembled those of *Schistosoma bovis* in human



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faeces in Ibadan. At Epe, Okpala (1956) described spindle shaped ova in urine samples of children and thought they may be that of either *S. bovis* or *S.matheei*. Mouchet *et al*, (1988) reported the presence of *S. bovis* ova in stool samples of 17 individuals in a village in the Republic of Niger. He, however, suggested that human infection with *S. bovis* is only slight and transient. Several species of the genus *Schistosoma* are known to cause schistosome cercarial dermatitis, when their cercariae penetrate the skin of an unsuitable host. For example the penetration of *S.spindale*, a parasite of ruminants and *S. bovis* a parasite of ruminants, equines and primates, into humans. On the other hand, animal reservoirs are undoubtedly of significance in maintaining the life cycle of *S. andersoni* infection. Nelson (1960) reported *S. haematobium* infection in baboons and vervets and sykes monkeys. Else, *et al* (1982) also recorded an infection rate of 20% in vervets in Kenya. *S.haematobium* was also reported to occur in domestic pigs in Ibadan by Hill and Onabamiron (1960).

Other areas with similar reports of *S. bovis* in stool samples of humans included those of Uganda, Kenya, Zimbabwe and South Africa (Else *et al*, 1982; Chunge *et al*, 1986). In Nigeria, Ofoezie *et al* (1996) isolated *Schistosoma* in *Bulinus globosus* which resembled *S. bovis*.

## 2.8 Immunology of schistosome infection

### 2.8.1 The host

The paired male and female worms of *S.mansoni* in the blood vessels of man, monkey and mice, induce a powerful immune response. Humoral antibodies are produced in a primary infection against surface antigens of the worms. To

demonstrate the importance of humoral antibodies, Sher *et al* (1975), transferred the serum of mice that had been infected for 12-15 weeks to a naive recipients, a partial resistance to schistosome challenge was observed. They further explained that it is likely that the worms were killed by a combined attack by IgG and eosinophils. In addition to these two substances, over enthusiastic cell-mediated immune response that produced granulomata around the schistosome eggs in the tissues were also recorded.

For serodiagnosis of schistosomiasis, a number of techniques and antigen preparations are available as reported by Mott *et al* (1985). The detection of serum antibodies in many of these tests is specific and sensitive whenever active infections (egg, excreting patients) are examined. When treated with praziquantel, he found that the chemotherapeutic treatment did not eliminate all schistosomes. Of the 15 *S.mansoni* infected mice 4(26.7%) harboured residual worms, while 11 out of 19 infected with *S.japonicum* had residual worms. The antibody response of mice infected with *S.mansoni* and *S.japonicum* showed high levels of antibodies against Sm 31/32 (Schistosome cathepsin BI and haemoglobinase) within a few weeks of infection, which later decreased during the post treatment year in some of the mice.

### 2.8.2 The parasite

Experimentally it has been demonstrated that during schistosome infection in rhesus monkeys, the parasite exhibited concomitant immunity (Whitfield, 1979). In human populations infected with schistosome, there is partial evidence that this type of immunity exists (McCullough and Bradley, 1973). The human blood flukes of the genus Schistosome have evolved antigenic mimicry. According to Damian (1964),

adult worm in host blood vessels coat themselves with host-produced molecules and thus appear to the host as self. In other words, the parasites possess host antigens associated with their outer surfaces and these appear to deflect the host's immunological attack in an, as yet, unexplained way (Whitfield, 1979). This antigenic disguise had been elegantly demonstrated in a series of experiments (Smithers and Terry, 1969), in which schistosome grown in the hepatic portal system of mice were transferred surgically to the same blood vessels in rhesus monkeys. If control monkeys were used, about 80% of the worms survived the hazards of transfer and re-establishment. Egg production halted for about 20 days but then resumed at the original level. So worms experiencing and overcoming an immune response in one species of host could, after some original difficulty, overcome a new response in a different host species (Whitfield, 1979). In another experiment by the same author, a different result were obtained when monkeys immunized against mouse red blood cells were infected with worms obtained from mice. In this transfer all the worms were normally destroyed by an intense immune response which produced catastrophic damage to the worm's surface teguments. This he explained as the disguise created by the schistosome be incorporation of the mouse antigen became a fatal characteristic and thus resulted in its subsequent destruction by the immunized rhesus monkey. Clegg (1972) immunized monkeys against human erythrocyte glycoproteins covalently linked to a protein carrier molecules. He then grew schistosomule in vitro for 15 days in incubation medium containing human red cells and serum. These schistosomule were then transferred surgically to the blood system of the anti-human glycolipid monkeys. The results of this experiment revealed the total destruction of all the schistosomule by an immune response while

in a control experiment they (Schistosomule) survived in normal non-immunized monkeys.

Apart from the schistosome ability to incorporate host-produced antigens into their surfaces, schistosome also seem to synthesis antigens themselves which show immunological similarities with host antigens. An example of this was seen when Damian (1964) demonstrated a substance produced by adults of *S. mansoni* which is anti genically very similar to mouse $\alpha_2$-macroglobulins.

Other findings on antibody courses observed which followed chemotherapy include those of Butterworth *et al* (1984), and Hagan *et al* (1987).

## 2.9 Control and Treatment

The knowledge of the life cycles of the blood flukes lead to its control. It became obvious that the two major steps to take would be sanitary disposal of human excreta and reducing the populations of snails. In addition treatment of infected persons, treatment or elimination of reservoir hosts, prevention of penetration of cercariae, immunization of persons at risk of infection and prevention of infections in snails also serve as methods in control of schistosomiasis. Each aim is to break the life cycle or interrupt the chain of infection. Marquardt and Demaree (1985) noted that if all definitive hosts were treated and maintained free of infection for a year, the cycle would be broken. If all snails could be removed from an endemic area, the probability of infection would approach zero.

Sanitary disposal of human faeces and urine could be achieved by public enlightenment. Not only are proper disposal of human waste done for aesthetic value or reasons but also should be for the avoidance of microbial and parasitic

diseases in the society. In areas where man alone serves as the definitive host and as the sole source of miracidia which infect the snails, the practical strict measure to prevent pollution of water bodies should terminate transmission. This method of control by sanitary disposal, however, is hampered because of some factors which includes, host range of the prevalent species, which are *Schistosoma mansoni* and *S.haematobium*. Schmidt and Roberts (1985) report that *S.mansoni* and *S.japonicum* have been found in hosts other than humans, including rodents, cattle and primates. This host range problem affects the spread of *S.mansoni* and *S.japonicum* more than *S.haematobium*. Thus sanitary disposal would have little effect on control in this case.

Treatment of schistosomiasis has been hindered by the fact that relatively few drugs are available, the toxic effects are sometimes severe and they are active only against matured worms. No drug developed to date has all of the characteristics of the ideal drug (Marquardt and Demaree, 1985). A number of workers have taken the view that three types of drugs are needed. These are, a prophylactic which will prevent infection, a curative, the ideal kills all adult worms and a suppressant, which will not have a reversible effects on flukes but will prevent the damaging effect of eggs being trapped in tissues. Thus preventing additional infections. Secondly, the suppressant drug will be able to maintain immunity and also serve as a public health measure by reducing the number of eggs shed into the environment. Davis, (1973) reviewed some chemical compound in use in the order in which they were developed.

These are:

**2.9.1. Trivalent antimonials:** These types of drugs were used for years but are now used infrequently. They were given as both intravenous and intramuscular injections on a daily or alternate day administration for two weeks or more.

Complete cure could be expected in 75% or more individuals who complete course of treatment. They are not suitable for mass treatment. Drugs of these nature include Tartar emetic (Potassium antimony tartrate), sodium antimonial glauconite and stibocaptate among others. Toxic side effects included nausea, vomiting, liver damage, muscular weakness, cardiovascular irregularities and skin rash.

**2.9.2 Thioxanthomes:** The drugs used here are lucanthone and hyacinthine. the latter gives a cure rate of 65.95% with greater success against *S.haematobium* than *S.mansoni*. Administration is by intramuscular injection and a single dose can be used. Side effects include gastrointestinal problems, though long term effect has been found to be mutagenic, carcinogenic and teratogenic. The drug however could be used for mass themotherrapy.

**2.9.3 Niridazol (Ambilhar):** The drug in use is (5-nitrothiazol-2y)-imidazolidin-2-one and has a cure rate of about 75%-95%. This drug is also used for mass chemotherapy. The general side effect of the drug are some gastrointestinal problems though a small percentage of patients exhibit neuropsychiatric changes which may last for weeks. The standard dose is five to ten days oral administration. It is less accepted and has a high cost. Lucas *et al* (1966) discovered, however, that patients with hydronephrosis and ureteric lesions showed striking improvement when treated with niridazol.

**2.9.4 Oxnamiquine:** This drug consists of 1, 2, 3, 4 - tetrahedra-2[<[1-methylethyl]amino>methyl]--7-nitro-6-quinoline methanol. This is tetrahydrozuinoline developed during the 1970s and is highly efficient against *S.mansoni*. A single oral dose gives a complete cure in 85%-95% of patients. In Africa, however, over 2 days treatment has been necessary (WHO, 1980). It has minor side effects such as dizziness or drowsiness in about one third of its users - and could be used in mass treatment programs against *S.mansoni*.

Chemotherapy in the control of schistosomiasis in definitive hosts suffers a lot of shortcomings, namely severe side effects, necessary multiple examinations is needed to be able to fish out cases, a relatively large number of cases do not complete course of treatment, and problems of reinfection as a result of continual contact with infested water bodies (Ebele, 1988).

## 2.10 Snail control

Snail control could be subdivided into chemical method, biological method and ecological methods.

*Chemical control is the use of chemicals such as tetra-oxo copper II sulphate,* sodium pentrachlorophenate and nidosamide (n-tritylmorpholine, 3,5-dibromo-4-hydroxy 4'-nitrazobenzene) in water. At present, snail control is best accomplished by chemical means. Despite the disadvantages of environment contamination, the effect on non-target species and the possibility of reducing organisms that serve in natural control of snails populations, chemicals are still most effective.

Biological control involves the utilization of diseases and predators of snails such as sciomyzid larvae (insect:diptera), which are predators of snails, or the use of

birds that may eat snails or even the use of pathogenic bacteria. Ebele (1981) observed that in Zaria city, Kaduna State of Nigeria, ponds in which ducks frequently swim are usually free of fresh water snails. In another research by Harry and Aldrich (1958) in Puerto Rico, identified the amphibian *Bufo marinus* and *Rana catesbians* as predators of the snail hosts of schistosomiasis. A unique biological control method on schistosomiasis has been the introduction of non vector snails that compete with the vectors. Jobin *et al* (1977) reported that *Marisa cornuarietis* (Ampullariidae) replaced *Biomphalaria glabarata* in 88% of reservoirs in Puerto Rico. Fish such as *Clarias aeriepinus* and *Tilapia* species are also potential agents for control in East Africa and Nigeria (Cowper, 1971).

Ecological control entails making the habitat unsuitable for reproduction or survival of the snails. The vectors of schistosomiasis are aquatic and prefer to attach to plants in water bodies where velocity is fairly slow. With this knowledge, periodic drainage of canals and ditches where irrigation is practised will reduce the population of snails. Removal of aquatic plants reduces a suitable habitats and altering stream beds or canal contours to increase water velocity will remove the preferred niche of the snail. As a rule continual effort and monitoring of ecological manipulations will bring a temporary reductions in snail population (Marquardt and Demaree, 1985). Associated problems of this method of control include the great reproductive capacity or potential of snails, their ability to disperse from one area to the other and their resistance to drying. Webbe (1962) noted that snails may become infected with miracidia even during dry seasons when their population have reached a low level. Public or Health education and community participation in combination with other control measures could be employed to combat the problems

caused by schistosomiasis. Positive efforts such as discovering children from initial polluted water sources including community participation could be recommended. For example, installation of good water supply system and improved living standards of the population by provision of basic amenities. These amenities could be availability of sanitary disposal facilities, use of protective clothings, satisfactory diagnostic and therapeutic facilities, etc (Laughlin, 1986).

Preventing infections in humans could be accomplished by immunization or prevention of cercariae penetration. Although the knowledge of immunity has progressed in recent years, there is still no vaccine marketed for developing artificial immunity.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Study area

The study areas involved 5 of the 34 Local Government Areas (LGA's) in Katsina State. These are Katsina, Dutsinma, Jibia, Rimi and Daura LGAs. The main criteria for selection were the presences of dams constructed for irrigation projects and the complete lack of information in the Local Government Areas.

Katsina state is situated on the extreme north of Nigeria. It is bordered to the south by Kaduna State, to the north by Niger Republic, to the east by Kano and Jigawa States and to the west by Sokoto State. It covers an areas of about 23,938 (twenty three thousand nine hundred and thirty eight) square kilometres with a total projected population of about 43.7 million people.

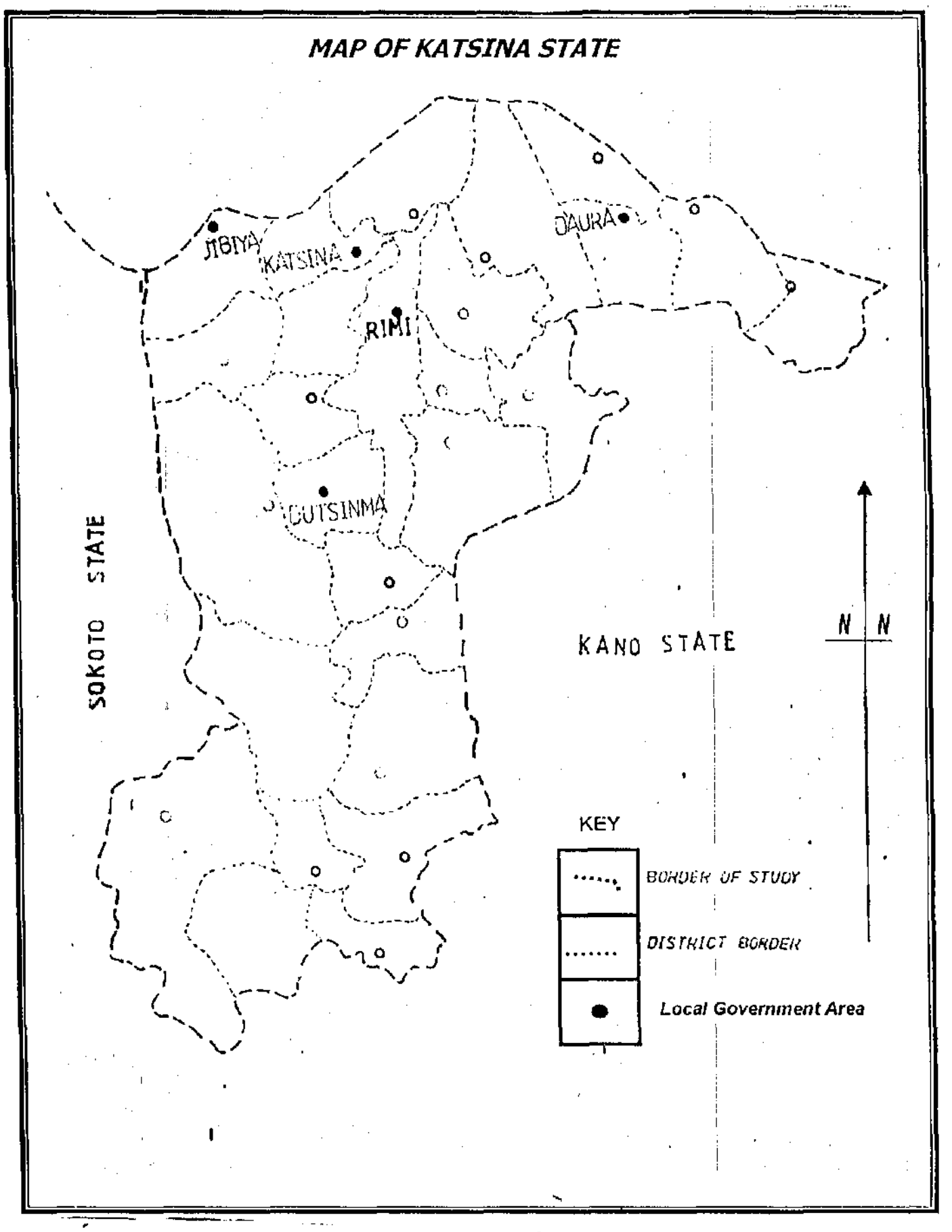
Katsina State lies in latitude 110 07' 49" N 130' 022" 57" N,Longitude 60 52' 03"E and 990 02 40"E.

The weather in Katsina State generally varies according to the season of the year. It is mostly cold in the morning, hot in the afternoon and cold again in the evening. Harmattan season (November to February) lowers the temperature. There is dry wind usually from January to April signalling the arrival of the rainy season, which lasts from April to September.

## 3.2 Study population.

The study population were pupils from primary schools between the ages of five and nineteen years distributed in the five selected local government areas of Katsina State.

A total of ten randomly selected schools from each local government area was identified. Forty pupils from each school were selected by random sampling (Appendix I).




*Source*: Map of Nigeria Destiny Publishers, Nigeria.

### 3.3 Prevalence study:

#### 3.3.1 Questionnaire

Questionnaire which sought to know the age, sex, source of drinking water, swimming habits, type of toilet facility, history of presence of blood in urine and/or stool, the treatment so far taken if any and awareness of the disease were numbered and distributed to the pupils. The number allocated to the questionnaire corresponded with that on the samples of urine and faeces for each candidate (Appendix II).

#### 3.3.2 Sample collection

Clean labelled sixty millilitres specimen bottles and cellophane bags were given to the selected pupils for collection of fresh urine and faecal samples respectively. These samples were usually collected between 0900 and 1400 hours, using 10% buffered formol - saline as preservative. Urine samples were observed for visible haematuria before addition of preservative.

### 3.4 Parasitological analysis;

#### 3.4.1 Urine:

The urine submitted from each pupil was shaken thoroughly to ensure even distribution of contents. Ten millilitres was then transferred into a graduated centrifuge tube. These tubes containing the urine were then centrifuged at 2000 revolution per minute for 5 minutes at room temperature, after which the supernatant was decanted. A drop of the sediment was placed on a slide and covered with a 22mm square coverslip. A drop of lugol's iodine was added to the side of the coverslip on the slide after which it was examined under a X10 objective of a light microscope for schistosome egg. The total number of egg was counted with the aid of a tally-hand counter.

### 3.4.2 Faeces:

The formol-ether concentration method of the WHO (1980) was used to process all stool samples. Seven millilitres of 10% formol -saline was added to a gram of faeces in a test tube. A thin suspension was made by stirring the faeces. The suspension was then sieved into a centrifuge tube through a double layer of surgical gauze placed in a funnel. 2ml of formol-saline was added to the filtrate which was shaken vigorously and then centrifuged at 2000rpm for 3 minutes at room temperature. The supernatant was again decanted. The above process was repeated until the filtrate assume a clearer appearance. 2ml of diethylether was then added to the filtrate and centrifuged at 1500rpm for 5 minutes. The supernatant was decanted. Pasteur pipette was use to transfer a drop of the sediment to a slide and a coverslip was placed on the specimen. A drop of lugol iodine solution was then added to the sediment on the slide. This was then examined under X10 objective of a light microscope. The results were expressed in eggs per gram of faeces. Photographs of eggs of schistosomes recovered from the samples were taken using X40/0.70 microscopic lens of a light microscopes (Plate 1-2). Identification of the parasitic was done using the criteria describe by Maurice (1973).

## 3.5 Snail survey

### 3.5.1 Prevalence study.

Snail sampling was conducted at monthly intervals from March 1997 to February, 1998 in ten major human water contact sites in five Local government areas of Katsina state (Plates 3 to 12). The dams, streams, canals and pond site included in this study represented different ecological settings. The scooping net

technique with a scooping time of 15 minutes as well as picking with a long pair of forceps was used. Picked and scooped snails were put in a plastic beaker and taken to the Laboratory for identification (Plates 13 to 16). Shedding and identification of both snail species and cercariae took place in the laboratory using the method of Brown, (1980).

### 3.5.2 Infectivity rate:

Monthly snail survey which was conducted for a year was carried out to determine the infectivity rate. Snail sampled were identified and sorted out into genera and observed for cercariae shedding in Petridishes under a dissecting microscope. Snails that did not shed cercariae were further crushed and examined for developing larval forms.

### 3.5.3 Laboratory infection of mice:

Six, 5 week old white albino mice each weighing about 21-30g were each exposed to about 3500 cercariae counted using Mcmaster slide and collected from *Bulinus sp* and suspended in 20 ml of distilled water. Infection of each mouse was carried out after shaving the abdomen with a new blade. The cercariae isolated were then transferred into a clean mice plastic cage (110 $cm^2$). 800ml of distilled water was added to the content of the cage. The mice were allowed to play in the water containing the cercariae for 30 minutes.

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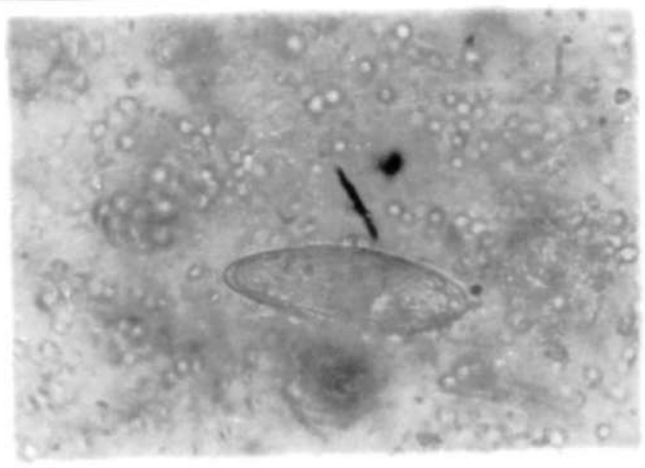


Plate 1 *Schistosoma haematobium* egg.

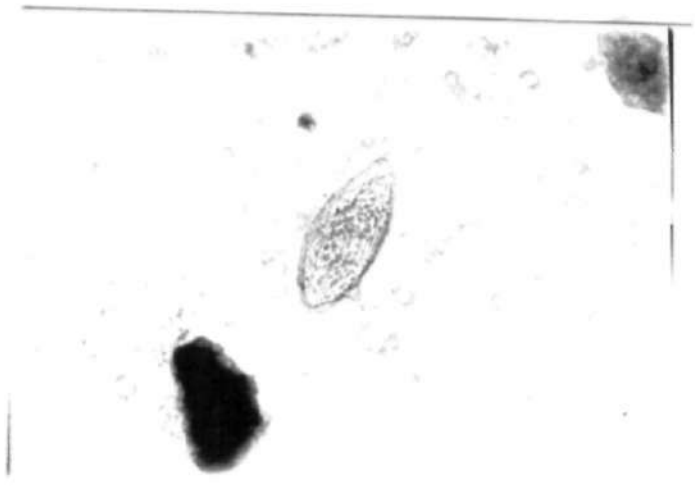


Plate 2 *Schistosoma mansoni* egg

### 3.6 **Data analysis**

A case was defined as an individual from whom the characteristic schistosome egg was found either in the urine or faeces. Controls consisted of individual pupils whose urine and faecal samples were examined and found to be negative. According to the results obtained, the age groups were classified as 5-9 years, 10-14 years and 15-19 years. The chi-squared test was carried out to determine the relationship between infection rates of *Schistosoma haematobium* and *S. mansoni* with some of the factors from the questionnaire data (Appendix III).

A 95% confidence interval was set for all variables in each factor and the level of significance determined to show whether a significant relationship exist between the variables and schistosomiasis. The odds ratios (OR) were also calculated where necessary to determine whether or not an association existed between a factor and schistosome infection.

### 3.7 **Ethical considerations**

The study was planned in collaboration with Ministry of Education, Katsina State who gave ethical clearance. All pupils that were infected with schistosome and/or any intestinal parasites were referred to Government General Hospital for treatment and further medical advice, through their Local Education Authority Offices.

# CHAPTER FOUR

# RESULTS

## 4.1 Wet season survey

### 4.1.1 General prevalence of infection

Out of a total of 2000 urine and faecal samples collected in the five Local Governments Areas (LGA), 241 (12.05%) of the urine and 66 (3.30%) of the faecal samples were found with *S. haematobium* and *S. mansoni* eggs respectively. In Dutsinma LGA, 101 (25.25%) samples were positive for *S. haematobium* while 16 (4.0%) were positive for *S. mansoni*. In Rimi LGA , 45 (11.25%) samples had *S. haematobium* while 23 (5.75%) had *S.mansoni*. The prevalence of *S. haematobium* in Daura LGA was found to be 9.00% (ie. 36 cases) while 5.25% (21 samples) was recorded for *S. mansoni*. In Jibia LGA, prevalence rates of 9.0% and 0.25% were recorded for *S. haematobium* and *S.mansoni* respectively out of the 400 pupils sampled, as compared to 5.75% and 1.25% in Katsina LGA.

### 4.1.2 Sex-related Prevalence.

Overall, the sex - specific rate for males infected by *S. haematobium* was 5.34% and 7.44% for females (Table 2). Thus the infection rates for males and females were significantly different ($\chi^2 = 28.59, df = 1, p<0.05$). Also the sex-specific rate for males infected with *S. mansoni* was 3.51% and that of females was 3.0%. These rates were not signficantly different ($\chi^2 = 0.40, df = 1, p>0.05$).

**Table 2.**

**Sex-related Prevalence of schistosomiasis in Katsina State school children.**

| Sex | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| Male | 1167 | 179 | 15.34 | 13.27-17.41 | 41 | 3.51 | 2.45-4.57 | 220 | 18.85 | 13.68-24.02 |
| Female | 833 | 62 | 7.44 | 5.66 - 9.22 | 25 | 3.00 | 1.84-4.15 | 87 | 10.44 | 4.02-16.87 |
| Total | 2000 | 241 | 12.05 | 10.62-13.48 | 66 | 3.30 | 2.52-4.08 | 307 | 15.35 | 13.77-16.93 |

$\chi^2$ = 28.59;df = 1; P<0.05 $\chi^2$ =0.40;df =1, P>0.05

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As shown in Table 3, the Sex-specific rates for males in Dutsinma LGA infected with *S. haematobium* was 29.52%, compared to 19.65% recorded for females. The infection rates in both males and females were not significantly different ($\chi^2$ = 5.06,df = 1, p>0.05). Similarly, the sex - specific rate for males infected with *S.mansoni* in this LGA was 4.41%, and 3.47% for females (Table 4). Both infection rates were not significantly different ($\chi^2$ = 0.22, df = 1, p>0.05).

In Rimi LGA the sex-specific rate for *S. haematobium* infection in males was 14.55% while that of females was 7.22% (Table 3). There was a significant relationship between the rates of *S. haematobium* infection and sex of pupils ($\chi^2$ = 5.32,df = 1, p<0.05). Also, the sex - specific rate for males infected with *S. mansoni* was 5.0% while that of females was 6.67% (Table 4). These sex - specific rates were not significantly related ($\chi^2$ = 0.51,df = 1, p>0.05) .

In Daura LGA, the sex-specific rate for males infected with *S. haematobium* was 12.73% while that for females was 4.44%. These rates were significantly different ($\chi^2$ = 8.3,df = 1, p<0.05). Similarly, the sex-specific rate for *S. mansoni* infection in males was 6.36% compared to 3.89% in females. There was significant relationship between the sex of pupils and *S. mansoni* infection ($\chi^2$ = 37.16,df = 1, p<0.05).

The sex-specific rates for males and females infected with *S. haematobium* in Jibia LGA were 12.21% and 2.9% respectively (Table 3). The infection rates for both sexes were significantly different ($\chi^2$ = 9.56,df = 1, p<0.05). The sex-specific rates for both males and females infected with *S. mansoni* were 0.38% and 0.0% respectively (Table 4). These infection rates were not significantly different ($\chi^2$ = 0.53,df = 1, p>0.05).

Table 3: **Prevalence of *S. haematobium* in both sexes of children in Katsina State, Nigeria.**

| LGA. | Sex | Number Examined | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| **Dutsinma** | Male | 227 | 67 | 29.52 | 23.58 - 35.45 | 1.70 | 5.06, |
| | Female | 173 | 34 | 19.65 | 13.72 - 25.57 | 0.0 | |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | | p>0.05 |
| **Rimi** | Male | 220 | 32 | 14.55 | 9.89 - 19.21 | 2.2 | 5.32, |
| | Female | 180 | 13 | 7.22 | 3.44 - 11.00 | 0.0 | |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | | p<0.05 |
| **Daura** | Male | 220 | 28 | 12.73 | 8.33 - 17.14 | 3.1 | 8.30 |
| | Female | 180 | 8 | 4.44 | 1.43 - 7.45 | 0.0 | |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | | p<0.05 |
| **Jibia** | Male | 262 | 32 | 12.21 | 8.25 - 16.18 | 4.7 | 9.58, |
| | Female | 138 | 4 | 2.90 | 0.10 - 5.70 | 0.0 | |
| | Sub Total | 400 | 36 | 9.00 | 6.20-4.81 | | p<0.05 |
| **Katsina** | Male | 238 | 20 | 8.40 | 4.88 -11.92 | 4.9 | 7.63, |
| | Female | 162 | 3 | 1.85 | 0.61 - 4.31 | 0.0 | |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | | p<0.05 |
| **Grand Total** | | 2000 | 241 | 12.05 | 10.62-13.48 | | 28.51 P<0.05 |

**Table 4: Prevalence of *S. mansoni* in both sexes of children in Katsina State, Nigeria**

| LGA. | Sex | Number Examined | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| **Dutsinma** | Male | 227 | 10 | 4.41 | 1.74 - 7.10 | 1.3 | 0.22 |
| | Female | 173 | 6 | 3.47 | 0.74 - 6.20 | 0.0 | |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | | p>0.05 |
| **Rimi** | Male | 220 | 11 | 5.00 | 2.12 - 7.88 | 0.8 | 0.51 |
| | Female | 180 | 12 | 6.67 | 3.03 - 0.32 | 0.0 | |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | | p>0.05 |
| **Daura** | Male | 220 | 14 | 6.36 | 3.14 - 9.59 | 1.7 | 37.16 |
| | Female | 180 | 7 | 3.89 | 1.07 - 6.72 | 0.0 | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | | p<0.05 |
| **Jibia** | Male | 262 | 1 | 0.38 | 0.37 - 1.13 | - | 0.53 |
| | Female | 138 | 0 | 0.00 | 0.00 | - | |
| | Sub Total | 400 | 1 | 0.25 | 0.24-0.74 | | p>0.05 |
| **Katsina** | Male | 238 | 5 | 2.10 | 0.28 - 3.92 | - | 3.345 |
| | Female | 162 | 0 | 0.00 | 0.00 | - | |
| | Sub Total | 400 | 5 | 1.25 | 0.16-2.34 | | p>0.05 |
| **Grand Total** | | 2000 | 66 | 3.30 | 2.25-4.08 | - | 1.66 P>0.05 |

In Katsina LGA the Sex-specific rate for males infected with *S.haematobium* was 8.4% and 1.85% for females. The Sex-specific rates for both Sexes was significantly different ($\chi^2 = 7.63$,df = 1, $p<0.05$). On the other hand, the Sex-specific rate for males infected with *S. mansoni* was 2.1%, while no female was found with the infection (Table 4).

### 4.1.3 **Prevalence rate of infection according to age of pupils.**

Table 5 showed the specific rates of infection according to age. In general, the specific rates of *S. haematobium* infection for pupils within the 5-9, 10-14 and 15-19 years age groups were 8.63%, 15.01% and 17.86% respectively, and the rates were significantly different ($\chi^2 = 33.62$,df = 2, $p<0.05$). The specific rates of *S. mansoni* infection for the same age groups were 4.69%, 2.13% and 0.0% respectively. The specific rates were also significantly different ($\chi^2 = 11.04$,df = 2, $p<0.05$) .

In Dutsinma LGA, the infection rates of *S. haematobium* for pupils within the 5 - 9 and 10-14 year age groups were 17.99% and 29.12% respectively. There was a significant relationship between the infection rates and age of pupils ($\chi^2 = 18.48$,df= 1, $p<0.05$). The specific rates of *S. mansoni* infection for the same age groups were 4.32% and 3.82% respectively, and there was a significant relationship ($\chi^2 = 49.73$, $p<0.05$) .

**Table 5.**

***Prevalence of schistosomiasis in different age groups of school children in Katsina State, Nigeria.***

| Age in Years | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| 5-9 | 939 | 81 | 8.63 | 6.83-10.43 | 44 | 4.69 | 3.34 - 6.04 | 125 | 13.31 | 11.14-15.48 |
| 10-14 | 1033 | 155 | 15.01 | 12.83-17.19 | 22 | 2.13 | 1.25 -3.01 | 177 | 17.14 | 14.84-19.44 |
| 15-19 | 28 | 5 | 17.86 | 3.67-32.05 | 0 | 0.0 | 0.0 | 5 | 17.86 | 3.67-32.05 |
| Total | 2000 | 241 | 12.05 | 10.62-1348 | 66 | 3.30 | 2.52-4.08 | 307 | 15.35 | 13.77-16.93 |

$\chi^2 = 33.62$;df = 2; P<0.05 $\chi^2 = 11.04$;df=2; P<0.05

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In Rimi LGA the specific rates for *S. haematobium* in the 5-9 and 10-14 years age groups were 11.44 and 10.98% respectively and the rates were not significantly different ($\chi^2 = 0.02$, $p>0.05$). Similarly, the specific rates of *S. mansoni* infection for the same age groups were 7.20% and 3.66% respectively. The rates were also not significantly different ($\chi^2 = 2.24$, $p>0.05$). The age specific rates are shown in Table 6 and 7.

In Daura LGA, the specific infection rates of *S. haematobium* for 5-9 and 10-14 year age groups were 6.25% and 13.89% respectively. The rates were significantly different ($\chi^2 = 6.57$, $p<0.05$). The specific infection rate of *S. mansoni* for the same age groups were 8.2% and 0.0% respectively and the rates were significantly different ($\chi^2 = 12.47$, $p<0.05$).

The specific rates of *S. haematobium* infection for 5-9, 10-14 and 15-19 years age groups in Jibia LGA were 5.0%, 10.82%, and 33.33% respectively and the rates were significantly different ($\chi^2 = 10.57$, $p<0.05$). In this LGA, *S. mansoni* was observed only in the 10-14 year age group where 0.4% was recorded. There was no significant difference ($\chi^2 = 0.73$,df = 2, $p>0.05$) between the infection rate of *S.mansoni* and age of pupils (Table 6).

In Katsina LGA, the specific rates of *S. haematobium* infection for the 5-9, 10-14, 15-19 years age groups were 3.38%, 7.30% and 5.26% respectively. However, these were not significantly different ($\chi^2 = 2.57$, df=2, $p>0.05$). *S. mansoni* infection was only recorded in the 10-14 year age group, with a prevalence rate of 2.15%.

Table 6: Prevelance of *S. haematobium* in relation to age in five Local Government Areas of Katsina State, Nigeria

| LGA. | Age in Years | Number Examined | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| Dutsinma | 5 - 9 | 139 | 25 | 17.99 | 11.61 -24.38 | 0.7 | 18.48, |
| | 10 -4 | 261 | 76 | 29.12 | 23.61 -34.63 | 1.2 | |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | | p<0.05 |
| Rimi | 5 - 9 | 236 | 27 | 10.98 | 7.38 - 15.50 | 0.1 | 0.02, |
| | 10 - 14 | 164 | 18 | 11.25 | 6.20 - 15.77 | 1.0 | |
| | Sub Total | 400 | 45 | 6.25 | 8.15-14.35 | | p>0.05 |
| Daura | 5 - 9 | 256 | 16 | 6.25 | 3.29-9.22 | 0.7 | 6.57, |
| | 10 - 14 | 144 | 20 | 13.89 | 8.24 -19.54 | 1.6 | |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | | p<0.05 |
| Jibia | 5 - 9 | 160 | 8 | 5.00 | 1.62 -8.38 | 0.5 | 10.57, |
| | 10 - 14 | 231 | 25 | 10.82 | 6.81 -14.83 | 1.2 | |
| | 15 - 19 | 9 | 3 | 33.33 | 25.3 -64.13 | 5.1 | p<0.05 |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | | |
| Katsina | 5 - 9 | 148 | 5 | 3.38 | 0.47 -6.29 | 0.6 | 2.57, |
| | 10 - 14 | 233 | 17 | 7.30 | 3.96 -10.64 | 1.3 | |
| | 15 - 19 | 19 | 1 | 5.26 | 4.78 - 15.30 | 0.9 | p>0.05 |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | | |
| Grand Total | | 2000 | 241 | 12.05 | 10.25-13.48 | | 28.51 P<0.05 |

**Table 7: Prevalence of *S. mansoni* in relation to age in five Local Government Areas of Katsina State, Nigeria.**

| LGA. | Age in Years | Number Examined | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| **Dutsinma** | 5 - 9 | 139 | 6 | 4.32 | 0.94 - 7.70 | 1.1 | 49.73, |
| | 10 -4 | 261 | 10 | 3.83 | 1.50 - 6.16 | 1.0 | |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | | p<0.05 |
| **Rimi** | 5 - 9 | 236 | 17 | 7.20 | 3.90 - 10.50 | 1.3 | 2.24, |
| | 10 - 14 | 164 | 6 | 3.66 | 0.79 - 6.53 | 0.6 | |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | | p>0.05 |
| **Daura** | 5 - 9 | 256 | 21 | 8.20 | 4.8 4- 11.56 | - | 12..47, |
| | 10 - 14 | 144 | 0 | 0.00 | 0.00 | - | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | | p<0.05 |
| **Jibia** | 5 - 9 | 160 | 0 | 0.00 | 0.00 | - | 0.73, |
| | 10 - 14 | 231 | 1 | 0.43 | 0.41 - 1.27 | - | |
| | 15 - 19 | 9 | 0 | 0.00 | 0.00 | - | p>0.05 |
| | Sub Total | 400 | 1 | 0.25 | 0.24-0.74 | | |
| **Katsina** | 5 - 9 | 148 | 0 | 0.00 | 0.00 | - | 3.63, |
| | 10 - 14 | 233 | 5 | 2.15 | 0.29 - 4.01 | - | |
| | 15 - 19 | 19 | 0 | 0.00 | 0.00 | - | p>0.05 |
| | Sub Total | 400 | 5 | 1.25 | 0.16-2.34 | | |
| **Grand Total** | | 2000 | 66 | 3.30 | 2.52-4.08 | - | 1.66 P>0.05 |

### 4.1.4 **Prevalence rate of infection according to source of drinking water.**

Of the 345 pupils that used water from the wells, 42 (12.17%) were found to harbour *S. haematobium* while 13 (3.77%) had *S. mansoni*. Of the 995 Pupils using tap water, 136 (13.67%) were positive for *S. haematobium* and 28 (2.81%) for *S.mansoni*. Of the 161 pupils that used the stream, 22 (13.67%) were infected with *S.haematobium* and 3 (1.86%) with *S. mansoni*. Of the fourteen samples from pupils that use water from the borehole, 2 (14.29%) and (0.00%) were positive cases for *S. haematobium*, while none was positive for *S. mansoni*. Of the pupils using both stream and well 2 (40%) were positive for *S. haematobium* and 0 (0.00%) for *S.mansoni*. A total of 98 pupils responded that they used water from both stream and borehole, out of which 5(5.1%) and 21 (21.43%) were positive for *S.haematobium* and *S. mansoni* respectively. Out of 266 samples from pupils that use both stream and tap water, 21 (7.9%) were found with *S. haematobium* and 1(0.38%) with *S. mansoni*. Prevalence rates of 9.9 percent and 0.0 percent were observed for *S. haematobium* and *S. mansoni* respectively, among the 101 pupils that use both tap and well water as source of drinking water. Only 1 individual (6.67%) was found with *S. haematobium* out of 15 that used tap, well and stream water combined. Statistically, there was no significant relationship between the distribution of *S. haematobium* and the source of drinking water in northern Katsina State. ($\chi^2$ = 16.26, df=8, p>0.05). On the other hand, there was a significant ($\chi^2$ = 114.40, df = 8; p<0.05) relationship between the distribution of *S. mansoni* and the source of water of the pupils.

**Table 8.**

**Prevalence of schistosomiasis in relation to source of drinking water in Katsina State, Nigeria.**

| Source of Drinking Water | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| Well | 345 | 42 | 12.17 | 8.72-15.62 | 13 | 3.77 | 1.76-5.78 | 55 | 15.94 | 12.08-19.80 |
| Tap | 995 | 136 | 13.67 | 11.6 - 15.8 | 28 | 2.81 | 1.78-3.84 | 164 | 16.48 | 14.18-18.79 |
| Pond | 161 | 22 | 13.67 | 8.4-- 19.0 | 3 | 1.86 | 0.23-3.95 | 25 | 15.53 | 9.94-21.13 |
| Borehole | 14 | 2 | 14.29 | 4.04- 32.62 | 0 | 0.00 | 0.00 | 2 | 14.29 | 4.04-32.62 |
| Pond & Well | 5 | 2 | 40 | 2.94–82.94 | 0 | 0.00 | 0.00 | 2 | 40.00 | 2.94-82.94 |
| Pond & Borehole | 98 | 5 | 5.10 | 0.74-9.46 | 21 | 21.43 | 13.31 - 29.55 | 26 | 26.53 | 17.83-35.27 |
| Pond/tap | 266 | 21 | 7.90 | 4.7 - 11.1 | 1 | 0.38 | 0.3 - 1.12 | 22 | 8.27 | 4.96-11.58 |
| Tap/Well | 101 | 10 | 9.90 | 4.08 - 15.73 | 0 | 0.00 | 0.00 | 10 | 9.90 | 4.08-15.73 |
| Pond/Tap/Well | 15 | 1 | 6.67 | 5.96 - 19.30 | 0 | 0.00 | 0.00 | 1 | 6.67 | 5.96-19.30 |
| Total | 2000 | 241 | 12.05 | 10.62-13.48 | 66 | 3.30 | 2.52-4.08 | 307 | 15.35 | 13.77-16.93 |

$\chi^2 = 16.26$,df =8, P>0.05 $\chi^2 = 114.40$, df = 8 P<0.05

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Types of drinking water in Dutsinma LGA came from four sources and a combination of two or more of the sources. These four sources were pond, well, borehole, tap water and a combination of pond and borehole, and well plus tap water. Infection rate for *S. haematobium* was highest (66.67%) in children that use pond and borehole while for *S. mansoni* 5.16% was from children that use tap water (Table 9 and 10). No significant difference existed between the sources of drinking water and infection with *S.mansoni* ($\chi^2$ =4.84,df =5, P>0.05) while there was significant difference between *S. haematobium* infection and source of drinking water ($\chi^2$ =17.24, df = 5, P<0.05).

The sources of drinking water of the pupils in Rimi LGA included, pond, well, borehole, tap water, combination of pond and well, pond and borehole, pond and tap, and well and tap. The highest prevalence of 20.59% and 7.69% for *S.haematobium* and *S. mansoni* respectively, were recorded in pupils that used pond water and a combination of pond and well water respectively (Table 9 and 10). The least prevalence for both parasites were recorded in both pupils that used borehole, and a combination of pond and boreholes. There was no significant difference between the prevalence of schistosomiasis and the sources of drinking water, for *S. haematobium* ($\chi^2$ =7.91, df = 7, P>0.05). and *S. mansoni.* ($\chi^2$ =2.4, df = 7, P>0.05)

Table 9: **Prevalence rate of *S. haematobium* in relation to source of drinking water in Local Government Areas of Katsina State, Nigeria.**

| LGA | Source of d/ Water | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| Dutsinma | Pond | 27 | 2 | 7.41 | 2.97 - 17.29 | 17.24, |
| | Well | 44 | 16 | 36.37 | 22.16 - 50.58 | |
| | Borehole | 6 | 2 | 33.33 | 4.40 - 71.05 | |
| | Tap | 310 | 73 | 23.55 | 18.83 - 28.27 | |
| | Pond/B/hole | 3 | 2 | 66.67 | 13.32 - 120.01 | |
| | Well/Tap | 10 | 6 | 60.00 | 29.64 - 90.36 | |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | p<0.05 |
| Rimi | Pond | 34 | 7 | 20.59 | 7.00 - 34.18 | 7.91 |
| | Well | 127 | 12 | 9.45 | 4.36 - 14.54 | |
| | Borehole | 6 | 0 | 0.00 | 0.00 | |
| | Tap | 41 | 5 | 12.20 | 2.18 - 22.22 | |
| | Pond/B/hole | 4 | 0 | 0.00 | 0.00 | |
| | Well/Tap | 116 | 16 | 13.79 | 7.52 - 20.07 | |
| | Pond/Well | 13 | 2 | 15.39 | 4.23 - 35.01 | |
| | Tap/Pond | 59 | 3 | 5.09 | 0.52 - 10.70 | |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | p>0.05 |
| Daura | Well | 271 | 28 | 10.33 | 6.71 - 13.95 | 5.00 |
| | Tap | 38 | 5 | 13.16 | 2.41 - 23.91 | |
| | Well/Tap | 91 | 3 | 3.30 | 0.37 -7.00 | |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | p>0.05 |
| Jibia | Pond | 62 | 10 | 16.13 | 6.98 - 25.29 | 13.67 |
| | Well | 18 | 2 | 11.11 | 3.41 - 25.63 | |
| | Tap | 19 | 0 | 0.00 | 0.00 | |
| | Pond/B/hole | 4 | 0 | 0.00 | 0.00 | |
| | Well/Tap | 11 | 0 | 0.00 | 0.00 | |
| | Pond/Well | 5 | 2 | 40.00 | 2.94 - 82.94 | |
| | Tap/Pond | 266 | 21 | 7.90 | 4.66 - 11.14 | |
| | Pond/Tap/Well | 15 | 1 | 6.67 | 6.20 - 19.30 | |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | p>0.05 |
| Katsina | Well | 53 | 0 | 0.00 | 0.00 | 4.24 |
| | Tap | 267 | 19 | 7.10 | 4.0 - 10.2 | |
| | Well/Tap | 80 | 4 | 5.00 | 0.2 - 9.8 | |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | p>0.05 |
| **Grand Total** | | 2000 | 241 | 12.05 | 10.25-13.48 | 28.51 P<0.05 |

**Table 10: Prevalence rate of *S. mansoni* in relation to source of drinking water in Local Government Areas of Katsina State, Nigeria.**

| LGA | Source of d/ Water | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| Dutsinma | Pond | 27 | 0 | 0.00 | 0.00 | 4.84, |
| | Well | 44 | 0 | 0 .00 | 0 .00 | |
| | Borehole | 6 | 0 | 0 .00 | 0 .00 | |
| | Tap | 310 | 16 | 5.16 | 2.70 -7.62 | |
| | Pond/B/hole | 3 | 0 | 0 .00 | 0 .00 | |
| | Well/Tap | 10 | 0 | 0 .00 | 0 .00 | p>0.05 |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | |
| Rimi | Pond | 34 | 1 | 2.94 | -2.74 - 8.62 | 2.40 |
| | Well | 127 | 8 | 6.30 | 2.07 -10.53 | |
| | Borehole | 6 | 0 | 0.00 | 0.00 | |
| | Tap | 41 | 3 | 7.32 | 0.65 -15.29 | |
| | Pond/B/hole | 4 | 0 | 0.00 | 0.00 | |
| | Well/Tap | 116 | 8 | 6.90 | 2.29 -11.51 | |
| | Pond/Well | 13 | 1 | 7.69 | 6.79 -22.17 | |
| | Tap/Pond | 59 | 2 | 3.39 | 1.23 - 8.01 | p>0.05 |
| | Sub Total | 400 | 23 | 5.25 | 3.47-8.03 | |
| Daura | Well | 271 | 21 | 7.75 | 4.57 -10.93 | 10.55 |
| | Tap | 38 | 0 | 0 .00 | 0 .00 | |
| | Well/Tap | 91 | 0 | 0 .00 | 0 .00 | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | p<0.05 |
| Jibia | Pond | 62 | 0 | 0 .00 | 0 .00 | 0.50 |
| | Well | 18 | 0 | 0 .00 | 0 .00 | |
| | Tap | 19 | 0 | 0.00 | 0.00 | |
| | Pond/B/hole | 4 | 0 | 0.00 | 0.00 | |
| | Well/Tap | 11 | 0 | 0.00 | 0.00 | |
| | Pond/Well | 5 | 0 | 0 .00 | 0 .00 | |
| | Tap/Pond | 266 | 1 | 0.38 | 0.36 - 1.12 | |
| | Pond/Tap/Well | 15 | 0 | 0 .00 | 0 .00 | p>0.05 |
| | Sub Total | 400 | 1 | 0.25 | 0.24-0.74 | |
| Katsina | Well | 53 | 0 | 0.00 | 0.00 | 2.52 |
| | Tap | 267 | 5 | 2.00 | 0.25 - 3.50 | |
| | Well/Tap | 80 | 0 | 0 .00 | 0 .00 | p>0.05 |
| | Sub Total | 400 | 5 | 1.25 | 0.16-2.34 | |
| **Grand Total** | | 2000 | 66 | 3.30 | 2.52-4.08 | 1.66 P>0.05 |

Out of the 400 pupils examined in Daura Local Government, 271 (67.8%) used only water from the well, 38 (9.5%) used only tap water and 91 (22.8%) used both well and tap water. Of 217 pupils that use well water 28 (10.33%) were positive for *S.haematobium,* and 21 (7.75%) for *S. mansoni.* Out of the 38 pupils that solely use tap water, 5(13.16%) were infected with *S. haematobium*, and none with *S.mansoni.* Of the 91 pupils that use a combination of both well and tap water, 3(3.3%) were positive for *S. haematobium* and none for *S.mansoni* infection. Statitistically, however, there was no relationship between infection of pupils with *S haematobium* and the source of drinking water ($\chi^2$ =5.0, df = 2, P>0.05). On the other hand, there was a statistically significant relationship ($\chi^2$ =10.05 and P<0.05) between the infection with *S. mansoni* and the sources of water.

Out of the 36 pupils infected with *S. haematobium* in Jibia LGA, 10 (27.78%), 2 (5.56%), 2 (5.56%), 21 (58.33%) and 1(2.78%) were found to use pond, well, a combination of pond and well, tap, and pond, and pond, well and tap water for drinking respectively. There was a significant relationship between *S. haematobium* infection and source of drinking water of pupils ($\chi^2$ = 13.67, df =7, P<0.05). The only case of *S. mansoni* infection within this LGA was recorded in one of the 266 pupils using a combination of pond and tap water. There was no significant relationship between *S. mansoni* infection and the source of drinking water ($\chi^2$ = 0.50 df=7, P>0.05).

Out of the 23 urine samples that had *S. haematobium* in Katsina LGA, 19 (82.61%) were from pupils who drank tap water, while the remaining 4(17.39%) were from pupils using both tap and well water. *S. mansoni* infection was found exclusively in those pupils who used tap water. No statistically significant relationship existed between infection with *S.haematobium* and *S. mansoni*, and the source of drinking water (p > 0.05).

### 4.1.5 **Prevalence rate of infection according to water contact habit.**

Of the 241 pupils infected with *S. haematobium* in the 2000 samples examined, 145 (60.16%) were found not to be associated with water contact activities, 2 (0.83%) had occassional water contact (about once in a month), 71 (29.46%) engaged in water contact activities about once to three times weekly and 23 (9.54%) were engaged in water contact activities daily. There was a statistically significant ($\chi^2$=46.87; df = 3; P<0.05) relationship between the distribution of *S. haematobium* and water contact activities of the pupils. (Table 11). In the case of *S. mansoni*, 53 (80.30%) of those infected reported that they were not engaged in water contact activities. 3(4.55%) of the infected pupils engaged themselves in water contact activities 1-3 times a week, while 8(12.12%) engaged in water contact activities daily (Table 11). There was a significant association between infection with *S.mansoni* and engagement in water contact activities by the pupils ($\chi^2$ = 8.51;df = 3; P<0.05).

Study of relationship between water contact for domestic purposes, such as cooking, fishing and bathing, and infection with *S. haematobium* in pupils showed that the highest prevalence rate of (36.26%) was recorded in pupils that reported 1-3 times a week contact with water bodies in Dutsinma LGA, while the least prevalence (21.99%) was recorded in children that reported no contact with any water body. There was statistically significant relationship between the distribution of *S. haematobium* infection and the degree of water contact ($\chi^2$ = 8.8,df=3, p<0.05). There was, however, no significant relationship between the distribution of *S. mansoni* (Table 13) in relation to water contact habit of the children, ($\chi^2$ = 2.58, df = 3, P>0.05).

**Table 11.**

**The relationship between frequency of Water contact and prevalence rate of schistosomiasis in Katsina State, Nigeria.**

| Frequency of Water Contact | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| No. contact | 1526 | 145 | 9.50 | 5.0-11.00 | 53 | 3.47 | 2.55-4.40 | 198 | 12.98 | 11.29-14.67 |
| Once month | 31 | 2 | 6.45 | 2.29-15.10 | 0 | 0.00 | 0.00 | 2 | 6.45 | 2.20-15.40 |
| 1-3 *times a week.* | 317 | 71 | 22.40 | 17.81-27.00 | 5 | 1.58 | 0.21-2.95 | 76 | 23.98 | 19.28-28.68 |
| Daily | 126 | 23 | 18.25 | 11.51-25.00 | 8 | 6.35 | 2.09-10.61 | 31 | 24.60 | 17.08-32.12 |
| Total | 2000 | 241 | 12.05 | 10.62-13.48 | 66 | 3.30 | 2.52-4.08 | 307 | 15.35 | 13.77-16.93 |

$\chi^2 = 47.09$;df = 3; P<0.05 $\chi^2 = 15.17$;df=3; P<0.05

In the response from the questionnaires in Rimi LGA, 246 (61.5%), 4 (1%), 81 (20.3%) and 69 (17.3%) out of the 400 pupils examined respectively admitted, no contact, contact once a month, contact one to three times a week and daily contact with water bodies for farming, swimming and other domestic activities (Table 12). Surprisingly, the highest prevalence rate (12.2%) of *S. haematobium* was recorded in pupils that do not have water contact of any sort, even though contact with these water bodies happen to be important in the transmission of the diseases. There was no significant difference between the number of contact with water bodies of the pupils and the prevalence of *S. haematobium* ($\chi^2 = 0.96$, df = 3, P>0.05). The same applied to *S. mansoni* infection ($\chi^2 = 1.06$, df = 3, P>0.05, Table 13).

In Daura LGA, the highest prevalence rate of 25% each for *S. haematobium* and *S. mansoni* was recorded in pupils that had daily water contact and the least was observed for pupils that engage in water contact activities once a month. There was a significant difference between the prevalence rate of *S.haematobium* and *S.mansoni*, with frequency of water contact of the pupils ($\chi^2 = 30.76$and 16.56 respectively, df = 3, P<0.05).

As shown in Table12 the evidence of regular water contact was established among the pupils infected with *S. haematobium* in Jibia LGA. The highest prevalence rate of 50% was recorded for pupils that engaged in water contact activities daily and the least (5.4%) was recorded in pupils that had no contact with water bodies at all. There was a significant association ($\chi^2 = 35.25$, df = 3, P<0.05) between *S. haematobium* infection and water contact activities of pupils.

**Table 12: Relationship between water contact habit and prevalence of *S. haematobium* in Local Government Areas of Katsina State, Nigeria.**

| LGA | Frequency of water contact | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | No contact | 282 | 62 | 21.99 | 17.16 -26.82 | 8.80 |
| | Once Monthly | 4 | 0 | 0.00 | 0.00 | |
| | 1 - 3 times/week | 91 | 33 | 36.26 | 26.38 - | |
| | Daily | 23 | 6 | 26.09 | 46.14 | |
| | Sub Total | 400 | 101 | 25.25 | 8.14 - 44.04 | p<0.05 |
| | | | | | 20.99-29.51 | |
| **Rimi** | No Contact | 246 | 30 | 12.20 | 8.11 - 16.29 | 0.96 |
| | Once Monthly | 4 | 0 | 0.00 | 0.00 | |
| | 1 - 3 times/week | 81 | 8 | 9.88 | 3.38 - 16.38 | |
| | Daily | 69 | 7 | 10.15 | 3.02 - 17.28 | p>0,05 |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | |
| **Daura** | No Contact | 312 | 16 | 5.13 | 2.7 - 7.58 | 30.76 |
| | Once Monthly | 7 | 0 | 0.00 | 0.00 | |
| | 1-3 times/week | 65 | 16 | 24.62 | 14.15 - | |
| | Daily | 16 | 4 | 25.00 | 35.09 | p<0.05 |
| | Sub Total | 400 | 36 | 9.00 | 3.75 - 46.22 | |
| | | | | | 6.02-11.81 | |
| **Jibia** | No contact | 331 | 18 | 5.44 | 3.00 - 7.88 | 35.25 |
| | Once Monthly | 12 | 2 | 16.67 | 4.42 - 37.76 | |
| | 1-3 times/week | 51 | 13 | 25.49 | 13.53 - | |
| | Daily | 6 | 3 | 50.00 | 37.45 | p<0.05 |
| | Sub Total | 4.00 | 36 | 9.00 | 9.99 - 90.01 | |
| | | | | | 6.02-11.81 | |
| **Katsina** | No contact | 355 | 19 | 5.4 | 3.01 - 7.69 | 1.10 |
| | Once monthly | 4 | 0 | 0.0 | 0.00 | |
| | 1-3 times/week | 29 | 1 | 3.5 | 3.19 - 10.09 | |
| | Daily | 12 | 3 | 25.0 | 0.50 - 49.50 | p>0.05 |
| | Sub Total | 400 | 23 | 5.75 | 13.47-8.03 | |
| **Grand Total** | | 2000 | 241 | 12.05 | 10.25-13.48 | 28.51 P<0.05 |

**Table 13 Relationship between water contact habit and prevalence of *S. mansoni* in Local Government Areas of Katsina State, Nigeria.**

| LGA | Frequency of water contact | Number Examined | Number Infected | Infecti on rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | No contact | 282 | 14 | 4.97 | 2.43 -7.51 | 2.58 |
| | Once Monthly | 4 | 0 | 0.00 | 0.00 | |
| | 1-3 times/week | 91 | 2 | 2.20 | 0.81 -5.21 | |
| | Daily | 23 | 0 | 0.00 | 0.00 | |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.90 | p>0.05 |
| **Rimi** | No Contact | 246 | 16 | 6.50 | 3.42 - 9.58 | 1.13 |
| | Once Monthly | 4 | 0 | 0.00 | 0.00 | |
| | 1-3 times/week | 81 | 3 | 3.70 | 0.41 - 7.81 | |
| | Daily | 69 | 4 | 5.80 | 0.29 - 11.32 | p>0,05 |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | |
| **Daura** | No Contact | 312 | 17 | 5.45 | 2.93- 7.97 | 16.56 |
| | Once Monthly | 7 | 0 | 0.00 | 0.00 | |
| | 1-3 times/week | 65 | 0 | 0.00 | 0.00 | |
| | Daily | 16 | 4 | 25.00 | 6.78- 46.22 | p<0.05 |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | |
| **Jibia** | No contact | 331 | 1 | 0.30 | 0.29 -0.89 | 0.28 |
| | Once Monthly | 12 | 0 | 0.00 | 0.00 | |
| | 1-3 times/week | 51 | 0 | 0.00 | 0.00 | |
| | Daily | 6 | 0 | 0.00 | 0.00 | p>0.05 |
| | Sub Total | 400 | 1 | 0.25 | 0.24-0.74 | |
| **Katsina** | No contact | 355 | 5 | 1.41 | 0.18- 2.64 | 0.64 |
| | Once monthly | 4 | 0 | 0.00 | 0.00 | |
| | 1-3 times/week | 29 | 0 | 0.00 | 0.00 | |
| | Daily | 12 | 0 | 0.00 | 0.00 | |
| | Sub Total | 400 | 5 | 1.25 | 0.16-2.34 | p>0.05 |
| **Grand Total** | | 2000 | 66 | 3.30 | 2.52-4.08 | 1.66 P>0.05 |

On the other hand, the only infection with *S. mansoni* occurred in a pupil that did not engage in any water contact activity. No significant relationship existed between *S. mansoni* infection and water contact activities of pupils ($\chi^2 \approx 0.28$, df = 3, P>0.05).

Water contact habit and prevalence rate of schistosomiasis in Katsina LGA, are shown in Table 12 and 13. The highest prevalence rate (25%) for *S.haematobium* was observed in pupils who had contact with water bodies daily followed by 5.35% in pupils who reported not to have engaged in water activities at all and 3.45% was in pupils who visited the water bodies 1 to 3 times a week. The relationship between water contact habit of pupils and the distribution of *schistosomiasis* was found to be negatively significant (P > 0.05). *S. mansoni* was found exclusively in those pupils who do not engaged in swimming or playing in water.

### 4.1.6 **Prevalence rate of infection in according to type of toilet.**

Of the 2000 samples examined for *S. haematobium*, a prevalence of 31.82% was recorded in pupils that urinate indiscriminately in farms or bushes (Table 14). Similarly for *S. mansoni* the highest prevalence rate of 20% was recorded from pupils that pass faeces in pit toilets as well as in the surroundings. There was significant relationship between the type of toilet and infection with both *S.haematobium* and *S.mansoni* ($\chi^2$ =20.67,df = 5, P<0.05 and $\chi^2$ = 99.83, df =5, P<0.05) respectively.

In Dutsinma LGA, 98 (24.94%) of those that use pit toilet and 3(42.86%) that use water closet toilets had *S. haematobium* egg in their urine samples, while 16 (4.07%) of the pupils using Pit toilets had *S. mansoni* (Table 16). The prevalence of *S. haematobium* and *S.mansoni* were not found to be significantly

associated with the type of toilet, ($\chi^2$= 1.18 and 0.30 respectively, df = I and P > 0.05).

The relationship between toilet type and infection with schistosomiasis in Rimi LGA is on Tables 15 and 16. There was no significant relationship between *S. haematobium* and type of toilet, ($\chi^2$ = 1.53, df = 2, P>0.05). There was also no significant relationship, however, between the prevalence of *S.mansoni* and the type of toilet used by pupils ($\chi^2$ = 0.18 and P > 0.05). The recorded positive cases (5.80%) for *S. mansoni* infection were found in pupils that used pit toilet.

The relationship between toilet type and infection with *S. haematobium* and *S. mansoni* in Daura LGA, is shown in Table 15. For infection with *S. haematobium*, the highest prevalence of 50% was recorded in pupils that urinate indiscriminately in farms or bushes or by water bodies. In the case of *S. mansoni*, the highest prevalence rate of 7.81% was recorded from pupils that pass faeces in pit toilets. There was a significant relationship between the type of toilet and the distribution of *S. haematobium* and *S. mansoni* ($\chi^2$ =37.62,df =4, P<0.05 and $\chi^2$ = 10.80, df =4, P<0.05) respectively.

Out of the 36 infected with *S. haematobium* in Jibia LGA, 30 (83.33%) were found to use pit toilet, 2 (5.56%) used any place around and 4 (11.11%) use pit and surrounding bushes or farms. A statistically significant relationship ($\chi^2$ =10.6, P<0.05) occurred between type of toilet of pupils and *S. haematobium* infection. The only recorded case *S. mansoni* infection was observed in a pupil who use pit toilet.

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**TABLE 14.**

**Relationship between the types of toilet facility and prevalence of schistosomiasis in Katsina State, Nigeria.**

| Type of Toilet | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| Pit Laterine | 1805 | 215 | 11.91 | 10.42-13.40 | 44 | 2.44 | 1.73-3.15 | 259 | 14.35 | 12.73-15.97 |
| Water Closet | 39 | 3 | 7.69 | 0.67-16.05 | 0 | 0.00 | 0.00 | 3 | 7.69 | 0.67-16.05 |
| Pond | 3 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 |
| Surroundings | 44 | 14 | 31.82 | 18.06-45.58 | 1 | 2.27 | 2.13-6.67 | 15 | 34.09 | 20.08-48.10 |
| Pit & WC | 4 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 |
| Pit & Surroundings | 105 | 9 | 8.57 | 3.22-13.92 | 21 | 20.00 | 12.35-27.65 | 30 | 28.57 | 19.93-37.21 |
| Total | 2000 | 241 | 12.05 | 10.62-13.48 | 66 | 3.30 | 2.52-4.00 | 307 | 15.35 | 13.77-16.93 |

$\chi^2 = 20.67$,df =5, P<0.05 $\chi^2 = 99.83$, df = 5 P<0.05

**Table 15: Prevalence of *S. haematobium* in relation to the types of toilet in use in Local Government Areas of Katsina State, Nigeria.**

| LGA | Type of Toilet | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | Pit Latrine | 393 | 98 | 24.94 | 20.66 - 29.22 | 1.18 |
| | Water Closet | 7 | 3 | 42.86 | 6.20 - 79.52 | p>0.05 |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | |
| **Rimi** | Pit Latrine | 397 | 43 | 10.83 | 7.78 - 13.89 | 1.53 |
| | Surroundings | 2 | 1 | 50.00 | 19.30-110.29 | |
| | Pit/Surroundings | 1 | 1 | 100.00 | 0.00 | p<0.05 |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | |
| **Daura** | Pit Latrine | 269 | 24 | 8.92 | 5.51 - 12.33 | 37.62 |
| | Water Closet | 19 | 0 | 0.00 | 0.00 | |
| | Surroundings | 16 | 8 | 50.00 | 25.50 - 74.50 | |
| | Pit/Surroundings | 92 | 4 | 4.35 | 0.18 - 8.52 | |
| | Pit/Water Closet | 4 | 0 | 0.00 | 0.00 | P<0.05 |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | |
| **Jibia** | Pit Latrine | 366 | 30 | 8.20 | 5.39 - 11.01 | 10.6 |
| | Water Closet | 2 | 0 | 0.00 | 0.00 | |
| | Surroundings | 21 | 2 | 9.52 | 3.03 - 22.07 | |
| | Pit/Surroundings | 11 | 4 | 36.36 | 7.93 - 64.78 | P<0.05 |
| | Sub Total | 400 | 36 | 9.00 | 6.20-11.81 | |
| **Katsina** | Pit Latrine | 380 | 20 | 5.26 | 3.02 - 7.50 | 28.23 |
| | Water Closet | 11 | 0 | 0.00 | 0.00 | |
| | Pond | 3 | 0 | 0.00 | 0.00 | |
| | Surroundings | 5 | 3 | 60.00 | 17.06 -102.94 | |
| | Pit/Surroundings | 1 | 0 | 0.00 | 0.00 | p<0.05 |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | |
| **Grand Total** | | 2000 | 241 | 12.05 | 10.25-13.48 | 28.5 P<0.05 |

**Table 16: Prevalence of *S. mansoni* in relation to the type of toilet and in use in Local Government Areas, Katsina State, Nigeria.**

| LGA | Type of Toilet | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | Pit Latrine | 393 | 16 | 4.07 | 2.12 - 6.02 | 0.30 |
| | Water Closet | 7 | 0 | 0.00 | 0.00 | p>0.05 |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | |
| **Rimi** | Pit Latrine | 397 | 23 | 5.79 | 3.49 - 8.09 | 0.18 |
| | Surroundings | 2 | 0 | 0.00 | 0.00 | |
| | Pit/Surroundings | 1 | 0 | 0.00 | 0.00 | p>0.05 |
| | Sub Total | 400 | 23 | 5.75 | 3.47-8.03 | |
| **Daura** | Pit Latrine | 269 | 21 | 7.81 | 4.6 - 11.02 | 10.80 |
| | Water Closet | 19 | 0 | 0.00 | 0.00 | |
| | Surroundings | 16 | 0 | 0.00 | 0.00 | |
| | Pit/Surroundings | 92 | 0 | 0.00 | 0.00 | |
| | Pit/Water Closet | 4 | 0 | 0.00 | 0.00 | P<0.05 |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | |
| **Jibia** | Pit Latrine | 366 | 1 | 0.27 | 0.26 - 0.80 | 0.09 |
| | Water Closet | 2 | 0 | 0.00 | 0.00 | |
| | Surroundings | 21 | 0 | 0.00 | 0.00 | P>0.05 |
| | Pit/Surroundings | 11 | 0 | 0.00 | 0.00 | |
| | Sub Total | 400 | 1 | 0.25 | 0.24-0.74 | |
| **Katsina** | Pit Latrine | 380 | 5 | 1.32 | 0.17 - 2.47 | 0.27 |
| | Water Closet | 11 | 0 | 0.00 | 0.00 | |
| | Pond | 3 | 0 | 0.00 | 0.00 | |
| | Surroundings | 5 | 0 | 0.00 | 0.00 | |
| | Pit/Surroundings | 1 | 0 | 0.00 | 0.00 | p>0.05 |
| | Sub Total | 400 | 5 | 1.25 | 0.16-2.34 | |
| **Grand Total** | | 2000 | 66 | 3.30 | 2.52-4.08 | 1.66 P>0.05 |

The relationship between toilet facilities of pupils and infection with *S.haematobium* and *S. mansoni* in Katsina LGA is shown in Tables 15 and 16. For infection with *S. haematobium,* the highest prevalence rate of 60% was recorded in pupils who urinated indiscriminately, followed by 5.26% for those pupils who used pit latrine. In the case of *S. mansoni* infection, it was found exclusively in pupils who defecated in pit latrine for faeces. There was a significant relationship between the type of toilet of pupils and the prevalence rate of *S. haematobium* ($\chi^2$=28.23, df = 4, P < 0.05). However, no significant association existed between type of toilet and the prevalence rate of *S. mansoni* ($\chi^2$ = 0.27, df = 4, P > 0.05).

### 4.1.7 **Prevalence rate of infection according to level of awareness.**

An overall, 2916 pupils (72.9%) were ignorant of the disease out of the 4000 pupils observed . The prevalence rate of *S. haematobium* amongst pupils that were aware of the disease was 18.64% as against 10.97% in pupils that were not aware of the disease (Table 17). There was a statistical significant relationship between these two classes (i.e those aware and those not aware) and the disease prevalence with ($\chi^2$ = 40.9, df = 1 and P<0.05). In the case of infection with *S. mansoni,* a prevalence rate of 4.18%% was observed in pupils that were not aware of the disease, as opposed to 3.6% in the group that were aware of the disease. There was no significant difference between the two groups of pupils ($\chi^2$ = 0.7, df = 1, P>0.05).

**Table 17.**

**Level of awareness and prevalence rate of schistosomiasis in Katsina State, Nigeria.**

| Level of awareness | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| Aware | 1084 | 202 | 18.64 | 16.32-0.96 | 39 | 3.60 | -2.49-4.71 | 241 | 22.23 | 19.96-24.71 |
| Not aware | 2916 | 320 | 10.97 | 9.84-12.10 | 122 | 4.18 | -3.45-4.91 | 442 | 15.16 | 13.86-16.46 |
| Total | 4000 | 522 | 13.05 | 12.01-4.09 | 161 | 4.03 | 3.42-4.64 | 683 | 17.08 | 15.91-18.25 |

$\chi^2 = 40.90, df = 1, P<0.05$ $\chi^2 = 0.70, df = 1 P>0.05$

### 4.1.8 **Prevalence rate of infection according to type of treatment.**

Of the 4000 sampled population, 2916 (72.9%) were not aware of the disease let alone seek any form of treatment when they see the symptoms. Out of the 1084 that were aware of the infection only 908 responded to this section of the questionnaire. A total of 290 (21.94%) were actually infected with *S.haematobium* and 86(9.47%) with *S. mansoni* out of the total of 908 pupils (Table 18). Out of 290 infected with *S.haematobium,* 222 (76.55%) received no treatment at all, 42(14.48%) sought for traditional method of treatment and 26(8.97%) consulted the hospital for treatment.Of the 86 pupils infected with *S. mansoni*, 45(52.33%) sought no treatment whatsoever, 23 (26.74%) went for traditional medicine and 18(20.93%) sought western medicine. There was a significant relationship ($\chi^2$ = 13.69, df = 2, P<0.05) between *S. mansoni* distribution and type of treatment. Similarly, there was a significant relationship between *S. haematobium* and type of treatment ($\chi^2$ = 83.04, df =2,P<0.05).

**Table 18.**

**Relationship between the types of treatment undergone and prevalence rate of schistosomiasis in Katsina State, Nigeria.**

| Type of Treatment | Number Examined | *S. haematobium* | | | | *S. mansoni* | | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | OR | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | OR | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| None | 524 | 222 | 42.37 | 38.14-46.60 | 1.6 | 45 | 8.59 | 6.19-10.99 | 0.9 | 267 | 51.34 | 47.06-55.62 |
| Traditional | 126 | 42 | 33.33 | 25.10-41.56 | 1.1 | 23 | 18.25 | 11.51-24.99 | 2.1 | 65 | 51.59 | 42.86-60.32 |
| Western | 258 | 26 | 10.08 | 6.41-13.75 | 0.2 | 18 | 6.98 | 3.87-10.09 | 0.7 | 44 | 17.05 | 12.46-21.64 |
| Total | 908 | 290 | 31.94 | 28.91-34.97 | 0.0 | 86 | 9.47 | 7.57-11.38 | 0.0 | 376 | 41.41 | 38.21-44.61 |

$\chi^2 = 83.04$,df =2, P<0.05 $\chi^2 = 13.69$, df = 2 P<0.05

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### 4.1.9 Prevalence rate of infection according to visible haematuria and bloody stool.

Tables 19 show the relationship between the presence of visible blood and prevalence rate of schistosomiasis. Of the 496 that showed visible haematuria in the urine samples, 278 (56.5%) were positive for *S. haematobium*. Out of the remaining 3508 urine samples that were recorded without visible haematuria, 244 (6.96%) were found positive for *S. haematobium*. The faecal analysis, on the other hand, revealed that of the 492 samples recorded for bloody stool, 82(14.45%) positive cases of *S. mansoni* . Amongst the 3432 faecal samples observed to have no blood in the faeces, 79(2.3%) were positive for *S. mansoni*. In both *S.haematobium* and *S . mansoni* infection, there is a significant relationship between the appearance of the parasite egg in urine and stool respectively and the appearance of blood in both samples ($\chi^2$ = 933.58 and 18.5 respectively, df = 1 and $P<0.05$).

Table 19.

**Relationship between presence of blood in urine and faeces and the prevalence rate of schistosomiasis in Katsina State, Nigeria.**

| Visible blood | Number Examined | *S. haematobium* | | | | *S. mansoni* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate% | 95%.C.I on Prev. % | OR | Number Examined | Number Infected | Infection Rate % | 95% C.I On Prev. % | OR |
| Present | 492 | 278 | 56.50 | 52.12-60.88 | 17.4 | 568 | 82 | 14.45 | 11.56-17.34 | 4.6 |
| Absent | 3508 | 244 | 6.96 | 6.12-7.80 | 0.0 | 3432 | 79 | 2.30 | 1.00-2.80 | 0.0 |
| Total | 4000 | 522 | 13.05 | 12.01-14.09 | | 4000 | 161 | 4.03 | 3.42-4.64 | |

$\chi^2 = 933.58, df = 1, P<0.05$ $\chi^2 = 185.5, df = 1\ P<0.05$

## 4.2 DRY SEASON SURVEY

### 4.2.1 General Prevalence of Infection

Of a total of 2000 urine and stool samples surveyed in the five Local Government Areas, 281 (14.05%) of the urine and 95 (4.75%) of the faecal samples were found to contain *S.haematobium* and *S.mansoni* eggs respectively.

In Dutsinma LGA, 50 (12.5%) pupils had *S. haematobium* ova in their urine sample while 21 (5.25%) had *S.mansoni* in their faecal samples. The Prevalence of *S. haematobium* in Rimi LGA was 42 (10.5%) while that of *S.mansoni* was 5.0%. In Daura LGA, 43 (10.75%) urine sample, had eggs of *S.haematobium* while 21 (5.25%) faecal samples had *S.mansoni.* In Jibia LGA, 101 (25.25%) and 16 (4.0%) pupils had *S.haematobium* and *S.mansoni* eggs respectively. Of the 400 pupils sampled in Katsina LGA, 45 (11.25%) and 17 (4.25%) had *S. haematobium* and *S.mansoni* respectively.

### 4.2.2 Prevalence rate of infection according to sex.

Of the 281 urine samples with *S.haematobium* eggs, 201 (71.53%) were from males and 80 (28.47%) from females (Table 20) . There was a statistical significance difference between the sex-specific rates ($\chi^2$ =23.2,df=1, P<0.05). The sex-specific rate for males infected with *S.mansoni* was 71.58% compared with 28.42% recorded in their female counterparts. The difference in infection rates of *S.mansoni* according to sex was statistically significant ($\chi^2$ =7.13, df=1, P<0.05).

Table 20

**Sex -related prevalence of schistosomiasis in Katsina State school children.**

| Sex | Number Examined | *S. haematobium* | | | | *S. mansoni* | | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | OR | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | OR | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| Male | 1168 | 201 | 17.21 | 15.05-19.38 | 2 | 68 | 5.82 | 4.48-7.16 | 1.8 | 269 | 23.03 | 20.6-25.45 |
| Female | 832 | 80 | 9.62 | 7.62-11.62 | 0 | 27 | 3.25 | 2.05-4.46 | 0.0 | 107 | 12.86 | 10.59-15.14 |
| Total | 2000 | 281 | 14.05 | 12.53-15.57 | | 95 | 4.75 | 3.82-5.68 | | 376 | 18.80 | 17.09-20.51 |

$\chi^2 = 23.2, df = 1, P<0.05$ $\chi^2 = 7.13, df = 1 P<0.05$

The sex - specific rate in males infected with *S. haematobium* in Dutsinma LGA was 14.55% compared with 10.0% recorded for females (Table 21). Infection rate and sex of pupils were not significantly related ($\chi^2$ = 1.64, P>0.05). The sex-specific rate for males with *S.mansoni* in this LGA was 6.36% and 3.89% for females. Both infection rates were not significantly related ($\chi^2$ =1.16, P>0.05) to sex.

In Rimi LGA the sex-specific rate for males with *S.haematobium* was 13.36% compared to 5.07% for females. The relationship between the sex of pupils and *S. haematobium* infection was statistically significant ($\chi^2$ = 5.91, P<0.05). Similarly, the sex-specific rate for males with *S.mansoni* was 6.87% and 1.45% for females. A significant difference existed between the infection rate and sex of pupils ($\chi^2$ =5.31, P<0.05).

In Daura LGA, the sex-specific rate for males with *S. haematobium* was 14.71% while that of females was 4.94%. There was a significant difference between the rates and sex of pupils ($\chi^2$ = 8.56, P<0.05). In the case of *S.mansoni* infection, the sex-specific rate of males was 6.3% and for females, 3.7%. The infection rate for both sexes were not significantly different ($\chi^2$ = 1.24, P>0,05).

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Table 21:

**Prevalence of *S. haematobium* in both sexes of pupils in Katsina State, Nigeria.**

| LGA. | Sex | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| **Dutsinma** | Male | 220 | 32 | 14.55 | 9.89-19.21 | 1.5 | 1.64 |
| | Female | 180 | 18 | 10.00 | 5.62 -14.38 | | |
| | Sub Total | 400 | 50 | 12.50 | 9.26-15.74 | | p>0.05 |
| **Rimi** | Male | 262 | 35 | 12.50 | 9.24-17.48 | 2.9 | 5.91 |
| | Female | 138 | 7 | 5.07 | 1.41-8.73 | 0.0 | |
| | Sub Total | 400 | 42 | 10.50 | 7.50-13.50 | | p<0.05 |
| **Daura** | Male | 238 | 35 | 14.71 | 10.21 -19.21 | 3.3 | 8.56 |
| | Female | 162 | 8 | 4.94 | 1.60 - 8.28 | | |
| | Sub Total | 400 | 43 | 10.75 | 7.72-13.79 | | p<0.05 |
| **Jibia** | Male | 227 | 67 | 29.52 | 23.59-35.45 | 1.7 | 3.78 |
| | Female | 173 | 34 | 19.65 | 13.73-25.57 | | |
| | Sub Total | 400 | 101 | 25.25 | 20.99 - 29.51 | | p<0.05 |
| **Katsina** | Male | 221 | 32 | 14.48 | 9.84 -19.12 | 2.2 | 4.58 |
| | Female | 179 | 13 | 7.26 | 3.46 - 11.06 | | |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | | p>0.05 |
| **Grand Total** | | 2000 | 281 | 14.05 | 12.53-15.57 | | 23.2<br>P<0.05 |

**Table 22:**
**Prevalence rate of *S.mansoni* in relation to sex and Local Government Areas, Katsina State, Nigeria.**

| LGA. | Sex | Number Examined | Number Infected | Infection rate (%) | 95% C.I on Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| Dutsinma | Male | 220 | 14 | 6.36 | 3.14 -9.59 | 1.7 | 1.16 |
| | Female | 180 | 7 | 3.89 | 1.07 -6.72 | 0 | |
| | Sub Total | 400 | 21 | 5.25 | 3.05-7.44 | | p>0.05 |
| Rimi | Male | 262 | 18 | 6.87 | 3.81 -9.93 | 50 | 5.31 |
| | Female | 138 | 2 | 1.45 | -0.55 -3.45 | | |
| | Sub Total | 400 | 20 | 5.00 | 2.86-7.14 | | p<0.05 |
| Daura | Male | 238 | 15 | 6.30 | 3.21 -9.39 | 1.7 | 1.24 |
| | Female | 162 | 6 | 3.70 | 0.79 - 6.61 | | |
| | Sub Total | 400 | 21 | 5.25 | 2.06-7.65 | | p>0.05 |
| Jibia | Male | 227 | 11 | 4.85 | 2.06-7.65 | 1.7 | 6.44 |
| | Female | 173 | 5 | 2.89 | 0.39-5.39 | | |
| | Sub Total | 400 | 16 | 4.00 | 2.08 - 5.92 | | p<0.05 |
| Katsina | Male | 221 | 10 | 4.53 | 1.79 -7.27 | 1.2 | 0.09 |
| | Female | 179 | 7 | 3.91 | 1.07 - 6.75 | | |
| | Sub Total | 400 | 17 | 4.25 | 2.27-6.23 | | p>0.05 |
| Grand Total | | 2000 | 95 | 4.75 | 3.82-5.68 | - | 7.14<br>P<0.05 |

The sex-specific rate of males and females with *S.haematobium* in Jibia LGA were 29.52% and 19.65% respectively (Table 21 & 22). These rates were significantly related to the sexes of pupils ($\chi^2$ = 3.78, P<0.05). Similarly, the sex-specific rates for males and females infected with *S.mansoni* were 4.85% and2.8% respectively. There was a significant difference between the infection rates for both sexes ($\chi^2$ = 6.44,P<0,05)

In Katsina LGA the sex-specific rate for males infected with *S.haematobium* was 14.48%, as against 7.26% in females. The sex-specific rates for both sexes were significantly related ($\chi^2$ =46.58,P<0,05). On the other hand, the sex-specific rate for males infected with *S.mansoni* was 4.53% while that of females was 3.91%. There was no significant relationship between the infection rates and sex of pupils ($\chi^2$=0.09,P>0,05).

### 4.2.3 **Prevalence rate of infection according to age.**

Generally there was a significant relationship between the age of pupils and prevalence rates of *S.haematobium* and *S.mansoni* infection in Katsina State during the dry season survey ($\chi^2$ = 35.48 and $\chi^2$ = 13.88 respectively, P<0.05).The highest prevalence rates for both *S.haematobium* and *S.mansoni* (18.56% and 12.90% respectively) were recorded in pupils between the 10-15 years of age (Table 23).

**Table 23.**

**Prevalence of schistosomiasis in different age groups of school children in Katsina State, Nigeria.**

| Age in Years | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev.% | Number Infected | Infection Rate (%) | 95% C.I On Prev. % | Number Infected | Infection Rate (%) | 95% C.I On Prev. % |
| 5 - 9 | 945 | 89 | 9.42 | 7.56 - 11.28 | 22 | 2.33 | 1.37 - 3.29 | 111 | 11.75 | 9.70-13.80 |
| 10 - 14 | 1024 | 190 | 18.56 | 16.18 - 20.94 | 69 | 6.74 | 5.20 - 8.28 | 259 | 25.29 | 22.63-27.95 |
| 15 - 19 | 31 | 2 | 6.45 | 2.20 - 15.10 | 4 | 12.90 | 1.10 - 24.70 | 6 | 19.36 | 5.45-33.27 |
| Total | 2000 | 281 | 14.05 | 12.53-15.57 | 95 | 4.75 | 3.82-5.68 | 376 | 18.80 | 17.09-20.51 |

$\chi^2 = 35.48$, df = 2, P<0.05, $\chi^2 = 13.88$, df = 2, P<0.05

Table 24 and 25 showed the specific rates of *S.haematobium* and *S.mansoni* infection in relation to age in each Local Government Area.

In Dutsinma LGA a lower specific rate was observed in the 5 -9 years age group for both *S.haematobium* (6.8%) and *S.mansoni* (0.8%). There was a high specific rates for the same parasites where 23.57% and 13.57% were recorded respectively in the 10-14 year age group. There was a significant relationship ($P<0.05$) between the specific rates of both parasites and the age of pupils in the LGAs.

In Rimi LGA the specific rates for *S.haematobium* in the 5 - 9, 10-14 and 15-19 years age groups were 5.39%, 13.85% and 50.0% respectively. The rates were significantly associated ($\chi^2 = 9.6, P<0,05$). Similarly, the specific rates of *S.mansoni* infection for the same groups were 1.8%, 6.93% and 50.0% respectively. The rates and age groups were also significantly related ($\chi^2 = 13.25, P<0,05$).

In Daura LGA, the specific rate of *S.haematobium* infection for the 5-9,10-14 and 15-19 years age groups were 8.78%, 12.45% and 5.26% respectively. The Prevalence rates were however not significantly related ($\chi^2 = 1.69, P>0,05$). The specific rate of *S.mansoni* for the same age groups were 2.03%, 6.44% and 15.79% respectively. The age - specific rates for *S.mansoni* were significantly related ($\chi^2 = 7.57, P<0,05$).

The specific rates of *S.haematobium* infection in Jibia LGA for 5-9 and 10-14 years age groups, were 16.55% and 29.89% respectively. These age - specific rates were significantly related ($\chi^2 = 6.39, P<0,05$). Similarly the specific rates for *S.mansoni* infection in the same age group were 2.88% and 4.6% respectively. The rates were however, not significantly related ($\chi^2 = 0.67, P>0,05$).

**Table 24:**

**Prevalence of *S.haematobium* in relation to age in five Local Government Areas Katsina State, Nigeria.**

| LGA. | Age in Years | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| Dutsinma | 5 - 9 | 250 | 17 | 6.80 | 3.68 -9.92 | - | 21.48, |
| | 10 -14 | 140 | 33 | 23.57 | 16.54 -30.60 | - | |
| | 15 - 19 | 10 | 0 | 0.00 | 0.00 | - | p<0.05 |
| | Sub Total | 400 | 50 | 12.50 | 9.26-15.74 | | |
| Rimi | 5 - 9 | 167 | 9 | 5.39 | 1.97 - 8.82 | 0.5 | 9.60, |
| | 10 -14 | 231 | 32 | 13.85 | 9.40 -18.31 | 1.4 | |
| | 15 - 19 | 2 | 1 | 50.00 | 19.30 -119.30 | 8.5 | P<0.05 |
| | Sub Total | 400 | 42 | 10.50 | 7.50-13.50 | | |
| Daura | 5 - 9 | 148 | 13 | 8.78 | 4.22 -13.34 | 0.8 | 1.69, |
| | 10 - 14 | 233 | 29 | 12.45 | 8.21 -16.69 | 1.2 | |
| | 15 - 19 | 19 | 1 | 5.26 | 4.78-15.30 | 0.5 | p>0.05 |
| | Sub Total | 400 | 43 | 10.75 | 7.72-13.79 | | |
| Jibia | 5 - 9 | 139 | 23 | 16.55 | 10.37 -22.73 | 0.6 | 6.39, |
| | 10 - 14 | 261 | 78 | 29.89 | 24.34 -35.44 | 1.3 | |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | | p<0.05 |
| Katsina | 5 - 9 | 241 | 27 | 11.20 | 7.22 - 15.18 | 1 | 0.0012, |
| | 10 -14 | 159 | 18 | 11.32 | 6.40 - 16.25 | 1 | p>0.05 |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | | |
| **Grand Total** | | 2000 | 281 | 14.05 | 12.53-15.57 | | 35.48 P<0.005 |

**Table 25:**

**Prevalence of *S.mansoni* in relation to age of pupils in five Local Government Areas, Katsina State, Nigeria.**

| LGA. | Age in Years | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | OR | $\chi^2$ and P Values. |
|---|---|---|---|---|---|---|---|
| Dutsinma | 5 - 9 | 250 | 2 | 0.80 | 0.30 -1.90 | - | 28.42, |
| | 10 -14 | 140 | 19 | 13.57 | 7.90 -19.24 | - | p<0.05 |
| | 15 - 19 | 10 | 0 | 0.00 | 0.00 | - | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | | |
| Rimi | 5 - 9 | 167 | 3 | 1.80 | 0.22 - 3.82 | 0.4 | 13.25, |
| | 10 -14 | 231 | 16 | 6.93 | 3.66 -10.21 | 1.4 | P<0.05 |
| | 15 - 19 | 2 | 1 | 50.00 | 19.30 -119.30 | 19 | |
| | Sub Total | 400 | 20 | 2.03 | 2.66-7.44 | | |
| Daura | 5 - 9 | 148 | 3 | 2.03 | 0.24 -4.30 | 0.4 | 7.57, |
| | 10 - 14 | 233 | 15 | 6.44 | 3.39 -9.59 | 1.2 | p<0.05 |
| | 15 - 19 | 19 | 3 | 15.79 | 0.61 -32.19 | 3.4 | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | | |
| Jibia | 5 - 9 | 139 | 4 | 2.88 | 0.10 -5.66 | 0.7 | 0.67, |
| | 10 - 14 | 261 | 12 | 4.60 | 2.06 -7.14 | 1.2 | p>0.05 |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | | |
| Katsina | 5 - 9 | 241 | 10 | 4.15 | 1.63 - 6.67 | 1 | 0.014, |
| | 10 -14 | 159 | 7 | 4.40 | 1.21 - 7.59 | 1 | p>0.05 |
| | Sub Total | 400 | 17 | 4.25 | 2.27-6.23 | | |
| Grand Total | | 2000 | 95 | 4.75 | 3.82-5.68 | | 13.88 P<0.05 |

In Katsina LGA, the specific infection rates of *S.haematobium* for the 5-9 and 10-14 years age group were 11.2% and 11.32% respectively. The rates were also, not significantly different ($\chi^2$ = 0.0012,P>0,05). The specific rate of *S.mansoni* for the same age groups were 4.15% and 4.4% respectively. Similarly, the infection rates were not significantly different ($\chi^2$ = 0.014,P>0,05)

### 4.2.4 **Prevalence rate of infection according to source of drinking water.**

The sources of drinking water of pupils during this survey included, pond, well, tap water, combination of pond and well, pond and borehole, pond and tap, well and tap, as well as tap, well and pond (Table 26).

Generally, out of the 345 pupils that drank well water 69(20.0%) were found with urinary schistosomiasis while 15(4.35%) were found with *S.mansoni* eggs in their faecal samples. Out of the 995 that use tap water 112(11.26%) were found with *S.haematobium* and no case of *S.mansoni* infection was recorded. Of the 161 that use pond water for drinking, 34 (21.12%) were found with *S.haematobium* while 46(28.57%) were found with *S.mansoni.* 14 pupils reported the use of water from borehole, out of which 2(14.29%) had *S.haematobium* and none was having *S.mansoni.* Out of the 5 pupils that used a combination of well and pond, 2 (40%) had *S.haematobium* eggs and 1(20%) had *S.mansoni* eggs.

The sources of drinking water in Dutsinma LGA included well,(38 pupils) tap water (271 pupils) and a combination of pond and borehole (91 pupils). 17 (18.68%) pupils that were infected with *S.haematobium* used a combination of pond and borehole. 28(10.33%) of the 271 pupils that use tap water were positive for *S.haematobium* while 5(13.16%) of the 38 pupils that use well water for drinking were positive for *S.haematobium* (Table 21).

**Table 26**

**Prevalence rate of schistosomiasis in relation to source of drinking water in Katsina State, Nigeria.**

| Source of Drinking Water | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev. % | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | Number Infected | Infection Rate (%) | 95% C.I on Prev. % |
| Well | 345 | 69 | 20.00 | 15.78 - 24.22 | 15 | 4.35 | 2.20 - 6.50 | 84 | 24.35 | 19.82-28.88 |
| Tap | 995 | 112 | 11.26 | 9.30 - 13.22 | 0 | 0.00 | 0.00 | 112 | 11.26 | 9.30-13.22 |
| Pond | 161 | 34 | 21.12 | 14.82 - 27.43 | 46 | 28.57 | 21.59 - 35.55 | 80 | 49.69 | 41.97-57.41 |
| Borehole | 14 | 2 | 14.29 | 4.04 - 32.62 | 0 | 0.00 | 0.00 | 2 | 14.29 | 4.04-32.62 |
| Pond & Well | 5 | 2 | 40.00 | 2.94 - 82.94 | 1 | 20.00 | 15.06 - 55.06 | 3 | 60.00 | 17.06-102.94 |
| Pond & Borehole | 98 | 21 | 21.43 | 13.31 - 29.55 | 23 | 23.47 | 15.08 - 31.86 | 44 | 44.90 | 35.05-54.75 |
| Pond/tap | 266 | 21 | 7.90 | 4.66 - 11.13 | 3 | 1.13 | 0.14 - 2.40 | 24 | 9.02 | 5.58-12.46 |
| Tap/Well | 101 | 15 | 14.85 | 9.92-21.79 | 6 | 5.94 | 13.30-10.55 | 21 | 20.79 | 12.88-28.70 |
| Pond/Tap/Well | 15 | 5 | 33.33 | 9.47- 57.19 | 1 | 6.67 | 5.96-19.30 | 6 | 40.00 | 15.21-64.79 |
| **Total** | 2000 | 281 | 14.05 | 12.53-15.57 | 95 | 4.75 | 3.82-5.68 | 371 | 18.80 | 17.09-20.51 |

$\chi^2 = 43.43, df = 8, P>0.05$ $\chi^2 = 336.8, df = 8\ P<0.05$

There was no significant relationship, however, between the infection rate of *S. haematobium* and source of drinking water ($\chi^2$ =3.84, df=2, P>0.05). On the other hand, *S.mansoni* infection was found exclusively in pupils that use a combination of pond and Borehole water ($\chi^2$ =71.31, df=2,P<0.05)

In Rimi LGA, the highest prevalence of 50% and 25% for *S.haematobium* and *S.mansoni* respectively, were recorded in pupils that used a combination of Borehole and pond water (Table 27 and 28). The least prevalence rate for both parasites were recorded in pupils that used tap water solely and a combination of well and tap water. There was a significant relationship (P<0.05) between the prevalence of schistosomiasis and the sources of drinking water.

In Daura LGA, 53(13.25%) pupils depended on well water for drinking, while 267 (66.75%) and 80(20.0%) used tap water and a combination of well and tap water respectively. The prevalence rate of *S.haematobium* in pupils that used well, tap and both well and tap water were 28.3%, 7.12% and 11.25% respectively. The association between the prevalence rate of *S.haematobium* and source of drinking water was significant ($\chi^2$ =18.5, df=2, P<0.05). The highest prevalence for *S.mansoni* was found in those pupils that used well water where 18.87% was recorded. This was followed by 7.5% for pupils that use both well and tap water, while the least prevalence of 2.0% was observed in pupils that used only tap water. The infection rate of *S.mansoni* was significantly ($\chi^2$ =25, df=2, and P<0.05) associated to the source of drinking water.

Of the 101 pupils infected with *S.haematobium* in Jibia LGA, 12(11.88%), 26(25.74%), 2(1.98%),53(52.48%), 2(1.98%) and 6(5.94%) were found to use pond, well, Borehole, tap, and a combination of pond and Borehole and, well and tap water respectively. There was a significant relationship between *S.haematobium* infection and source of drinking water of the pupils in this LGA ($\chi^2$ =39.03, df=5,P<0.05).

**Table 27:**

**Prevalence of *S.haematobium* in relation to source of drinking water in Local Government Areas of Katsina State, Nigeria.**

| LGA | Source of d/ Water | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | Well | 38 | 5 | 13.16 | 2.41 - 23.91 | 3.81 |
| | Tap | 271 | 28 | 10.33 | 6.71 - 13.95 | |
| | Pond/B/hole | 91 | 17 | 18.68 | 10.67 - 26.69 | |
| | *Sub Total* | 400 | 50 | 12.50 | 9.26-15.74 | P > 0.05 |
| **Rimi** | Pond | 62 | 12 | 19.36 | 9.53 - 29.20 | 27.04 |
| | Well | 18 | 2 | 11.11 | 3.41 - 25.63 | |
| | Tap | 19 | 0 | 0.00 | 0.00 | |
| | Pond/Well | 5 | 2 | 40.00 | 2.94 - 82.94 | |
| | Pond/B/hole | 4 | 2 | 50.00 | 1.00 - 99.00 | |
| | Pond/Tap | 266 | 21 | 7.90 | 4.66 - 11.14 | |
| | Well/Tap | 11 | 0 | 0.00 | 0.00 | |
| | Pond/Well/Tap | 15 | 5 | 33.33 | 9.45 - 57.19 | |
| | Sub Total | 400 | 42 | 10.50 | 7.50-13.50 | P < 0.05 |
| **Daura** | Well | 53 | 15 | 28.30 | 16.27 - 40.43 | 18.5 |
| | Tap | 267 | 19 | 7.12 | 4.04 - 10.21 | |
| | Well/Tap | 80 | 9 | 11.25 | 4.33 - 18.17 | |
| | Sub Total | 400 | 43 | 10.75 | 7.72-13.79 | P < 0.05 |
| **Jibia** | Pond | 27 | 12 | 44.44 | 25.70 - 63.18 | 39.03 |
| | Well | 44 | 26 | 59.09 | 44.56 - 73.62 | |
| | Tap | 310 | 53 | 17.10 | 12.91-21.29 | |
| | Borehole | 6 | 2 | 33.33 | 4.39-71.05 | |
| | Pond/B/hole | 3 | 2 | 66.67 | 13.23- 120.01 | |
| | Well/Tap | 10 | 6 | 60.00 | 29.64 - 29.51 | P < 0.05 |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | |
| **Katsina** | Pond | 72 | 10 | 13.89 | 5.90 - 21.88 | 1.37 |
| | Well | 192 | 21 | 12.10 | 7.44 - 16.71 | |
| | Tap | 128 | 14 | 10.94 | 5.53 - 16.35 | |
| | Borehole | 8 | 0 | 0.00 | 0.00 | P > 0.05 |
| | Sub Total | 400 | 45 | 11.25 | 8.15 -14.35 | |
| **Grand Total** | | 2000 | 281 | 14.05 | 12.53 - 15.57 | 43.43 P>0.05 |

**Table 28:**

**Prevalence of *S.mansoni* in relation to source of drinking water in Local Government Areas of Katsina State, Nigeria.**

| LGA | Source of d/ Water | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| Dutsinma | Well | 38 | 0 | 0.00 | 0.00 | 71.31 |
| | Tap | 271 | 0 | 0.00 | 0.00 | |
| | Pond/B/hole | 91 | 21 | 23.08 | 14.42-31.74 | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | P < 0.05 |
| **Rimi** | Pond | 62 | 13 | 20.97 | 10.84 -31.10 | 46.64 |
| | Well | 18 | 1 | 5.56 | 2.03 - 16.15 | |
| | Tap | 19 | 0 | 0.00 | 0.00 | |
| | Pond/Well | 5 | 1 | 20.00 | 15.06 - 55.06 | |
| | Pond/B/hole | 4 | 1 | 25.00 | 17.44 - 67.44 | |
| | Pond/Tap | 266 | 3 | 1.13 | 0.14 - 2.40 | |
| | Well/Tap | 11 | 0 | 0.00 | 0.00 | |
| | Pond/Well/Tap | 15 | 1 | 6.67 | 5.96 - 19.30 | |
| | Sub Total | 400 | 20 | 5.00 | 2.86-7.14 | P < 0.05 |
| **Daura** | Well | 53 | 10 | 18.87 | 8.34 - 29.40 | 25.3 |
| | Tap | 267 | 5 | 1.87 | 0.25 - 3.50 | |
| | Well/Tap | 80 | 6 | 7.50 | 1.73 - 13.27 | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | P<0.05 |
| **Jibia** | Pond | 27 | 15 | 55.56 | 36.82 - 74.30 | 200.67 |
| | Well | 44 | 0 | 0.00 | 0.00 | |
| | Tap | 310 | 0 | 0.00 | 0.00 | |
| | Borehole | 6 | 0 | 0.00 | 0.00 | |
| | Pond/B/hole | 3 | 1 | 33.33 | 20.01 - 86.67 | |
| | Well/Tap | 10 | 0 | 0.00 | 0.00 | |
| | Sub Total | 400 | 16 | 4.00 | 2.08 - 5.92 | P <0.05 |
| **Katsina** | Pond | 72 | 13 | 18.06 | 9.17 - 26.95 | 40.19 |
| | Well | 192 | 4 | 2.08 | 0.06 - 4.10 | |
| | Tap | 128 | 0 | 0.00 | 0.00 | |
| | Borehole | 8 | 0 | 0.00 | 0.00 | |
| | Sub Total | 400 | 17 | 4.25 | 2.27-6.23 | P < 0.05 |
| **Grand Total** | | 2000 | 95 | 4.75 | 3.82-5.68 | 336.8 P<0.05 |

The infection with *S.mansoni* however, occurred in those pupils who used water from pond and a combination of pond and borehole, the respective prevalence rate being 88.24% and 5.88%. The relationship between *S. mansoni* and sources of drinking water was equally significant ($\chi^2$ =200.67, P<0.05).

Sources of drinking water of pupils in Katsina Local Government Areas were pond, tap water, well and water from boreholes. Pupils that used borehole did not have *S.haematobium* infection. Of the 45 urine samples positive for *S.haematobium*, 10 (22.22%) were from pupils that used pond water, 4(8.89%) from those that used tap water, and 21(46.67%) from those that used well water. There was no significant relationship between prevalence of *S.haematobium* and source of drinking water of pupils. ($\chi^2$ =1.37,df=3,P>0.05). *S.mansoni* was found in pupils that used pond and well water, with prevalence rate of 18.06% and 2.08% in these respective groups. The relationship between sources of drinking water and prevalence of *S.mansoni*, was significant ($\chi^2$ =40.19, df=3, P<0.05).

### 4.2.5 Prevalence rate of infection according to water contact habit.

In general, those pupils that frequent surrounding water bodies daily had the highest prevalence of 47.62% and 38.89% for *S.haematobium* and *S.mansoni* respectively( Table 29).

The least infection rate of both parasites ( 5.64% and 0.46%) was recorded for those that do not contact water bodies. There was a significant relationship (P<0.05) between the infection rate of both parasite and the frequency of water contact by the pupils.

Table 29

**The Relationship between frequency of water contact and prevalence rate of schistosomiasis in Katsina State, Nigeria.**

| Source of Drinking Water | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev. % | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | Number Infected | Infection Rate (%) | 95% C.I on Prev. % |
| No contact | 1526 | 86 | 5.64 | 4.48 - 6.80 | 7 | 0.46 | 0.12 - 0.80 | 93 | 6.09 | 4.89-7.29 |
| Once a month | 31 | 8 | 25.81 | 10.41 - 1.21 | 4 | 12.90 | 1.10 - 24.70 | 12 | 38.71 | 21.56-55.86 |
| 1-3 times a week | 317 | 127 | 40.06 | 34.67-45.54 | 35 | 11.04 | 7.59 - 14.49 | 16.2 | 51.10 | -45.60-56.60 |
| Daily | 126 | 60 | 47.62 | 38.90 - 6.34 | 49 | 38.89 | 30.38 - 47.40 | 109 | 86.51 | -80.54-92.48 |
| Total | 2000 | 281 | 14.05 | 12.53-15.57 | 95 | 4.75 | 3.82-5.68 | 376 | 18.80 | -17.09-20.51 |

$\chi^2 = 333.7$,df =3, P<0.05 $\chi^2 = 399.8$, df = 3 P<0.05

The highest prevalence rate of 100% for *S.haematobium* in Dutsinma LGA, was reported in pupils that contact water bodies daily (Table 30 and 31). The least prevalence (0%) was recorded in pupils that do not contact any water body, followed by 3(42.86%) for those pupils that visit water bodies once a month. There was a significant association between the prevalence rate and the water contact ($\chi^2$ =275, 18 df=3, P<0.05). The highest prevalence (31.25%) for *S.mansoni* was recorded for those who visit water bodies on daily basis followed by 28.57% for those that contact it once a month. There was also a significant relationship between the distribution of *S.mansoni* and the number of water of pupils ($\chi^2$ =77.08, df=3, P<0.05).

Of the 400 pupils examined in Rimi LGA, 331(82.75%) admitted non-engagement with any water body, 12(3%) admitted engagement with water bodies once a month, 51(12.75%) visited it 1-3 times a week and 6(1.50%) contacted it on daily basis for farming, swimming and other domestic activities. The highest prevalence rate for *S.haematobium* (66.67%) was observed in pupils that contact water bodies on daily basis and the least (5.44%) was seen in pupils that admitted negative water contact habit. There was significant association between *S.haematobium* prevalence and the number of contact with water bodies by the pupils ($\chi^2$ =38.08, df=3,P<0.05). In the case of *S.mansoni*, no infection was recorded for pupils that did not contact water bodies at all, while the highest prevalence rate (50%) was observed in those that engage in daily water contact habit. There was also a significant association between the number of contact with water bodies by the pupils and prevalence of *S.mansoni* ($\chi^2$ =98.85%, df=3,P<0.05).

Table 30:

**Prevalence of *S.haematobium* in relation to water contact habit in Local Government Areas of Katsina State, Nigeria.**

| LGA | Frequency of w/contact | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | None | 312 | 0 | 0.00 | 0.00 | 275.18 |
| | Once a month | 7 | 3 | 42.86 | 6.20 - 79.52 | |
| | 1-3 times/ week | 65 | 31 | 47.69 | 35.55 - 59.83 | |
| | Daily | 16 | 16 | 100.00 | 0.00 | P < 0.05 |
| | Sub Total | 400 | 50 | 12.50 | 9.26-15.74 | |
| **Rimi** | None | 331 | 18 | 5.44 | 3.00 -7.88 | 38.08 |
| | Once a month | 12 | 2 | 16.67 | 4.42 - 37.76 | |
| | 1 - 3 times/week | 51 | 18 | 35.29 | 22.18 - 48.41 | |
| | Daily | 6 | 4 | 66.67 | 29.00 - 104.39 | P < 0.05 |
| | Sub Total | 400 | 42 | 10.50 | 7.50 - 13.50 | |
| ***Daura*** | *None* | 355 | 19 | 5.35 | 3.01 - 7.69 | 97.20 |
| | Once a month | 4 | 0 | 0.00 | 0.00 | |
| | 1 - 3 times/week | 29 | 17 | 58.62 | 40.69 - 76.55 | |
| | Daily | 12 | 7 | 58.33 | 30.44 - 86.23 | |
| | Sub Total | 400 | 43 | 10.75 | 7.72-13.79 | P < 0.05 |
| **Jibia** | None | 282 | 41 | 14.54 | 10.43 - 18.65 | 48.15 |
| | Once a month | 4 | 1 | 25.00 | 17.44 - 67.44 | |
| | 1 - 3 times/week | 19 | 43 | 47.25 | 36.99 - 57.51 | |
| | Daily | 23 | 16 | 69.57 | 50.77 - 88.37 | |
| | Sub Total | 400 | 101 | 25.25 | 2.99-29.51 | P < 0.05 |
| **Katsina** | None | 264 | 8 | 3.25 | 1.03 - 5.47 | 38.99 |
| | *Once a month* | 4 | 2 | *50.00* | *1.00 - 99.00* | |
| | 1 - 3 times/week | 81 | 18 | 22.22 | 13.17- 31.27 | |
| | Daily | 69 | 17 | 24.64 | 14.47 - 34.81 | |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | P < 0.05 |
| **Grand Total** | | 2000 | 281 | 14.05 | 12.53-15.57 | 333.7 P<0.05 |

*Table 31:*

**Prevalence of *S.mansoni* in relation to water contact habit in Local Government Areas in Katsina State, Nigeria.**

| LGA | Frequency of w/contact | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | $\chi^2$ and P Values |
|---|---|---|---|---|---|---|
| **Dutsinma** | None | 312 | 0 | 0.00 | 0.00 | 97.08 |
| | Once a month | 7 | 2 | 28.57 | 4.90 - 62.04 | |
| | 1-3 times/ week | 65 | 14 | 21.54 | 11.55 - 31.53 | |
| | Daily | 16 | 5 | 31.25 | 8.54 - 53.96 | P < 0.05 |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | |
| **Rimi** | None | 331 | 0 | 0.00 | 0.00 | 98.85 |
| | Once a month | 12 | 1 | 8.33 | 7.31 - 23.97 | |
| | 1 - 3 times/week | 51 | 16 | 31.37 | 18.64 - 44.11 | |
| | Daily | 6 | 3 | 50.00 | 9.99 - 90.01 | P < 0.05 |
| | Sub Total | 400 | 20 | 5.00 | 2.86-7.14 | |
| **Daura** | None | 355 | 3 | 0.85 | 0.11 - 1.81 | 175.2 |
| | Once a month | 4 | 1 | 25.00 | 17.44 - 67.44 | |
| | 1 - 3 times/week | 29 | 7 | 24.14 | 8.57 - 39.72 | |
| | Daily | 12 | 10 | 83.33 | 62.24 - 104.42 | P < 0.05 |
| | Sub Total | 400 | 21 | 5.25 | 5.06-7.44 | |
| **Jibia** | None | 282 | 4 | 1.42 | 0.04 - 2.80 | 45.55 |
| | Once a month | 4 | 0 | 0.00 | 0.00 | |
| | 1 - 3 times/week | 19 | 5 | 5.50 | 0.82 - 10.18 | |
| | Daily | 23 | 7 | 30.44 | 11.63 - 49.25 | |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | P < 0.05 |
| **Katsina** | None | 264 | 0 | 0.00 | 0.00 | 52.45 |
| | Once a month | 4 | 0 | 0.00 | 0.00 | |
| | 1 - 3 times/week | 81 | 3 | 3.70 | 0.41 - 7.81 | |
| | Daily | 69 | 14 | 20.29 | 10.80 - 29.79 | P < 0.05 |
| | Sub Total | 400 | 17 | 4.25 | 2.27-6.23 | |
| **Grand Total** | | 2000 | 95 | 4.75 | 3.82-5.68 | 399.8 P<0.05 |

In Daura LGA, the highest prevalence rate of (59.62%) for *S.haematobium* was recorded in those pupils that frequent water bodies, 1-3 times a week and on daily basis. No infection was recorded for pupils that visit water bodies once a month. In the case of *S.mansoni*, the highest prevalence (83.33%) was recorded in pupils with daily water contact activities. This was followed by 25% for those who visit once a month and 24% for those who frequent it 1-3 times a week. There was a significant relationship between prevalence of *S.mansoni* and water contact activity ($\chi^2$ =175, P<0.05)

Out of the 101 infected with *S.haematobium* in Jibia LGA, 41 (40.59%) admitted no contact habit, 1(0.99%) contacted water body once a month, 43(42.57%) contacted it between 1-3 times a week and 16 (15.84%) visit it daily. There was a significant relationship between water contact habit and *S.haematobium* infection ($\chi^2$ =48.15, df=3, P<0.05). On the other hand, of the 16 with *S.mansoni,* 4(25%) admitted no contact at all, 5(31.25%) contact it once to three times a week and 7(43.75%) visited it on daily basis. There was also a significant relationship between water contact habit and prevalence rate of *S.mansoni* ($\chi^2$ =45.6, df=3,P<0.05)

The relationship between pupils and prevalence rate of both *S.haematobium* and *S.mansoni* in Katsina LGA was found to be significant (P<0.05). The highest prevalence rate of *S.haematobium* was recorded in pupils that have contact with water bodies once to three time a week, followed by 17(37.78%) for pupils that contact it daily. The least prevalence (4.44%) was observed in pupils that contacted water bodies once a month. On the other hand, infection with *S.mansoni* was observed only in pupils that contacted water bodies 1 - 3 times a week and on daily basis, (17.65% and 82.35%) respectively.

### 4.2.6 **Prevalence rate of infection according to type of toilet.**

The highest prevalence rate (66.67%) for *S.haematobium* in Katsina state was observed in those pupils that urinated near or inside ponds followed by those who do it indiscriminately (56.52%). The least (5.41%) was recorded for those that use water closet system (WC). There was a statistical significant relationship between *S.haematobium* infection and the of type of toilet of pupils ($\chi^2$ =233.3, df=5, P<0.05). On the other hand, *S.mansoni* was absent in those that use both pit and WC. There was a high infection rate of 33.33% in pupils using pond and 43.48% in pupils that defecate anywhere in their surroundings. There was a significant relationship between *S.mansoni* prevalence and the type of toilet facility ($\chi^2$ =321.3, df=5, P<0.05).

Of the 400 pupils surveyed in Dutsinma LGA, 268(67%) were found to use pit toilet, 20 (5%) used WC, 18 (4.5%) were indiscriminate, 90 (22.5%) either used pit or were indiscriminate while 4(1%) use both pits and WC. Out of a total of 50 urine samples that had *S.haematobium*, 24(48%) were from pupils that used pit toilet followed by 15(30%) from those who either used pit or were indiscriminate, 10(20%) from those pupils that used exclusively the surrounding and 1(2%) was that of a pupil who used both WC and pit toilet. The result of the faecal examination showed that out of the 21 cases of infection recorded 7(33.33%) were for those pupils that used their surroundings to pass faeces while 14(66.67%) were for those that either used both pit or were indiscriminate (Table 33). There was a statistically significant relationship between infection with both species and the type of toilet the pupils used. ($\chi^2$ =38.7, and $\chi^2$ =77.91 respectively, df=4 ,P<0.05)

**Table 32**

**Relationship between the types of toilet facility and prevalence of schistosomiasis in Katsina State, Nigeria.**

| Type of Toilet | Number Examined | *S. haematobium* | | | *S. mansoni* | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Number Infected | Infection Rate (%) | 95% CI on Prev. % | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | Number Infected | Infection Rate (%) | 95% C.I on Prev. % |
| Pit Latrine | 1782 | 200 | 11.22 | 9.76 - 12.69 | 40 | 2.25 | 1.56 - 2.94 | 240 | 13.47 | 11.89-15.06 |
| Water Closet. | 37 | 2 | 5.41 | 1.88 - 12.70 | 1 | 2.70 | 2.52 - 7.92 | 3 | 8.11 | 0.69-16.91 |
| Pond | 3 | 2 | 66.67 | 13.33 - 120.01 | 1 | 33.33 | 20.01 - 86.67 | 3 | 100.00 | 0.00 |
| Surroundings | 69 | 39 | 56.52 | 44.83 - 68.25 | 30 | 43.48 | 32.90 - 56.70 | 69 | 100.00 | 0.00 |
| Pit & Water Closet | 5 | 1 | 20.00 | 15.06 - 55.06 | 0 | 0.00 | 0.00 | 1 | 20.00 | 15.06-55.06 |
| Pit & Surroundings | 104 | 37 | 35.38 | 26.38 - 44.78 | 23 | 22.12 | 14.14 - 30.10 | 60 | 57.69 | 48.20-67.19 |
| Total | 2000 | 281 | 14.05 | 12.53-15.57 | 95 | 4.75 | 3.82-5.68 | 376 | 18.80 | 17.09-20.51 |

$\chi^2 = 233.3, df = 5, P<0.05$ $\chi^2 = 321.3, df = 5\ P<0.05$

**Table 33:**

**Prevalence of *S.haematobium* in relation to types of toilet in use in Local Government Areas of Katsina State, Nigeria.**

| LGA. | Type of Toilet | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | $\chi^2$ and P values |
|---|---|---|---|---|---|---|
| **Dutsinma** | Pit Latrine | 268 | 24 | 8.96 | 5.54 - 12.38 | 38.70 |
| | W.ater Closet | 19 | 0 | 0.000 | 0.00 | |
| | Surroundings | 19 | 1 | 5.26 | 4.78 - 15.30 | |
| | Pit/Surroundings | 90 | 24 | 26.67 | 17.53-35.81 | P < 0.05 |
| | Pit/Water Closet | 4 | 1 | 25.00 | 17.44-67.44 | |
| | Sub Total | 400 | 50 | 12.50 | 9.26-15.44 | |
| **Rimi** | Pit Latrine | 366 | 16 | 4.37 | 2.28-6.46 | 177.23 |
| | W.ater Closet | 1 | 0 | 0.00 | 0.00 | |
| | Surroundings | 21 | 15 | 71.43 | 52.11-91.75 | p <0.05 |
| | Pit/Surroundings | 12 | 11 | 91.67 | 76.04-107.31 | |
| | Sub Total | 400 | 42 | 10.50 | 7.58-13.50 | |
| **Daura** | Pit Latrine | 380 | 36 | 9.47 | 6.23-12.41 | 40.2 |
| | W.ater Closet | 11 | 0 | 0.00 | 0.00 | |
| | Pond | 3 | 2 | 66.67 | 13.33- 120.01 | |
| | Surroundings | 5 | 4 | 80.00 | 44.94 - 115.06 | |
| | Pit/Surroundings | 1 | 1 | 100.00 | 0.00 | P<0.05 |
| | Sub Total | 400 | 43 | 10.75 | 7.72-13.79 | |
| **Jibia** | Pit Latrine | 370 | 80 | 21.62 | 17.43-25.82 | 46.47 |
| | W.ater Closet | 7 | 2 | 28.57 | 4.90-62.04 | |
| | Surroundings | 23 | 19 | 82.61 | 67.12-98.10 | P<0.05 |
| | Sub Total | 400 | 101 | 25.25 | 20.99-29.51 | |
| **Katsina** | Pit Latrine | 397 | 44 | 11.08 | 8.00-14.17 | 2.8 |
| | Pit/surroundings | 2 | 1 | 50.00 | 19.30-119.30 | |
| | Pit/W.ater Closet | 1 | 0 | 0.00 | 0.00 | p>0.05 |
| | Sub Total | 400 | 45 | 11.25 | 8.15-14.35 | |
| **Grand Total** | | 2000 | 281 | 14.05 | 12.53-15.57 | 233.3 P>0.05 |

**Table 34:**

**Prevalence of *S.mansoni* in relation to types of toilet in use in Local Government Areas of Katsina State, Nigeria.**

| LGA. | Type of Toilet | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % | $\chi^2$ and P values |
|---|---|---|---|---|---|---|
| **Dutsinma** | Pit Latrine | 268 | 0 | 0.00 | 0.00 | 77.91 |
| | W.ater Closet | 19 | 0 | 0.00 | 0.00 | |
| | Surroundings | 19 | 7 | 36.84 | 15.15-58.33 | |
| | Pit/Surroundings | 90 | 14 | 15.56 | 8.01-23.05 | P < 0.05 |
| | Pit/Water Closet | 4 | 0 | 0.00 | 0.00 | |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | |
| **Rimi** | Pit Latrine | 366 | 1 | 0.27 | -0.26-0.80 | 201.66 |
| | W.ater Closet | 1 | 1 | 100.00 | 0.00 | |
| | Surroundings | 21 | 10 | 47.62 | 26.26-68.98 | p <0.05 |
| | Pit/Surroundings | 12 | 8 | 66.67 | 40.00- 93.34 | |
| | Sub Total | 400 | 20 | 5.00 | 2.86-7.40 | |
| **Daura** | Pit Latrine | 380 | 14 | 3.68 | 1.79-5.57 | 109.5 |
| | W.ater Closet | 11 | 0 | 0.00 | 0.00 | |
| | Pond | 3 | 1 | 33.33 | 20.01-86.67 | |
| | Surroundings | 5 | 5 | 100.00 | 0.00 | |
| | Pit/Surroundings | 1 | 1 | 100.00 | 0.00 | P<0.05 |
| | Sub Total | 400 | 21 | 5.25 | 3.06-7.44 | |
| **Jibia** | Pit Latrine | 370 | 9 | 2.43 | 0.86-4.00 | 54.43 |
| | W.ater Closet | 7 | 0 | 0.00 | 0.00 | |
| | Surroundings | 23 | 7 | 30.44 | 11.63-49.25 | P<0.05 |
| | Sub Total | 400 | 16 | 4.00 | 2.08-5.92 | |
| **Katsina** | Pit Latrine | 397 | 16 | 4.03 | 2.10-5.97 | 26.70 |
| | Pit/surroundings | 2 | 1 | 50.00 | 19.30- | |
| | Pit/W.ater Closet | 1 | 0 | 0.00 | 119.30 | p<0.05 |
| | Sub Total | 400 | 17 | 4.25 | 0.00 | |
| | | | | | 2.27-6.23 | |
| **Grand Total** | | 2000 | 95 | 4.75 | 3.82-5.68 | 321.3 P<0.05 |


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In Rimi LGA, the highest prevalence rate (91.67%) for *S.haematobium* was recorded in pupils that urinate indiscriminately. On the other hand, the highest prevalence (66.67%) for *S.mansoni* was observed in pupils that used a combination of pit toilet and indiscriminate defaecation. For both parasite species there was a significant relationship between infection and the type of toilet used by pupils ($\chi^2$ =177.23 and $\chi^2$ =201.66 for *S.haematobium* and *S.mansoni* respectively, df=3 and P<0.05).

The relationship between type of toilet used by pupils in Daura LGA and schistosomiasis is shown on Table 33 and 34. 36(83.72%) out of the 43 pupils infected with *S.haematobium* used pit latrine, 4(9.3%) urinate indiscriminately, 2(4.65%) used the pond sites and 1(2.33%) pupils used pit and indiscriminate urination. *S.mansoni* prevalence was found to have the same type of distribution pattern. The highest prevalence of 66.67% was from those pupils who used pit, followed by 23.81% for pupils who defecated in their surroundings. The relationship between the distributions of both *S.haematobium* and *S.mansoni* and types of toilet was statistically significant ($\chi^2$ =40.2 and $\chi^2$ =109.5 respectively, df=4 and P<0.05).

Three ways of faecal disposal were identified in Jibia LGA, namely pit, water closet system and the use of the surroundings. Out of the 101 pupils found with urinary schistosomiasis, 80 (79.21%) admitted using pit latrines, 2(1.98%) used water closet and 19(18.8%) urinate indiscriminately. A significant relationship existed between the type of toilet and prevalence of *S.haematobium* ($\chi^2$ =46.45, df=2, P<0.05). Of the 16 pupils that had *S.mansoni* eggs in their faeces, 9(56.25%) used pit toilet while 7(43.75%) used any available place to defaecate. The relationship between toilet of pupils and *S.mansoni* was also statistically significant ($\chi^2$ =54.43, df=2, P<0.05).

In Katsina LGA, three ways of urine and faecal disposal were identified in pupils, namely, pit, a combination of pit and water closet system and, pit and indiscriminate disposal around the compound (Tables 33 and 34). The highest prevalence rate (50.0%) of *S.haematobium* infection was observed in pupils using pit and the surroundings to defaecate while the least prevalence (0.0%) was in those pupils that use pit and WC. A similar pattern was observed for *S.mansoni*, with the highest prevalence of 50.00% in pupils who pass faeces in pit and/or indiscriminately and 4.03% for those who used pit toilet. While the relationship between *S.haematobium* and type of toilet was not significant ($\chi^2$ =2.8, P>0.05), that of *S.mansoni* and type of pupils toilet was significant ($\chi^2$ =26.7, df=3, P<0.05).

### 4.2.7 **Experimental Infection of Mice.**

Experimental infection of mice to confirm the species of human schistosome encountered during this survey, proved negative.

On dissection of mice after 8 weeks of infection no schistosome was recovered only cestodes namely *Hymenolepis nana*.

## 4.3 SNAIL SURVEY

### 4.3.1 General Distribution

A total of 1107 snails were collected over a period of 12 months in the study area. The study area were 10 randomly selected sites spread is five LGA namely, Dutsinma, Rimi, Daura, Jibia and Katsina. These sites are in Plates one to ten.

The snail fauna of the area surveyed are predominantly *Bulinus globosus* (Morelet) 364 (32.88%), *Bulinus forskalii* 93 (8.40%), *Biomphalaria pfeifferi* (krauss) 170 (15.36%) and *Lymnaea sp* 480 (43.36%). The distribution of *Biomphalaria pfeifferi* was restricted, occurring sparsely in 4 of the 10 sites namely, Dutsinma (Plate 8), Rimi (Plate 9 and 10) and Daura (Plate 11). *B.globosus,* however, occurred in the remaining 7sites. The snail population collected was found to be more in abundance between the months of February and July and less abundant between August and December (Table 38). Snails encountered in most habitat types were generally associated with dense aquatic vegetation or floating objects. This was observed particularly in sites 9 and 11 for *B. pfeifferi* and 12, 14 and 16 for *B. globosus* where less than 25 were collected in the 15 minutes scooping time. It was also observed that human and animal water contacts were very often in sites 7,8,9,11,and 16 (Table35).

Plates 3 to 6 show the pictures of the snails encountered during the study.

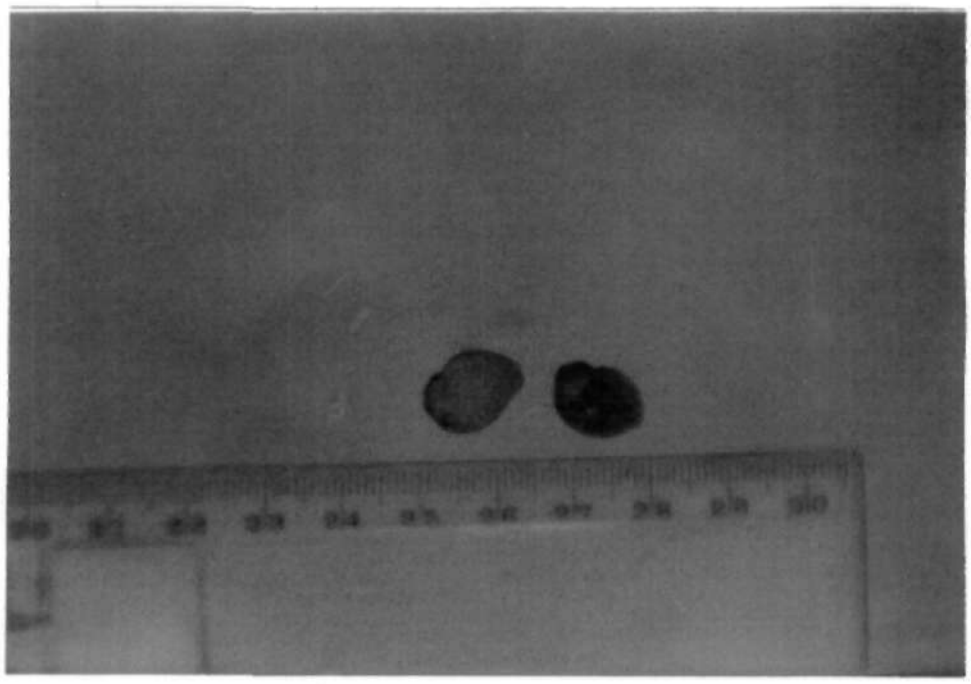


Plate 3 *Bulinus globosus*.

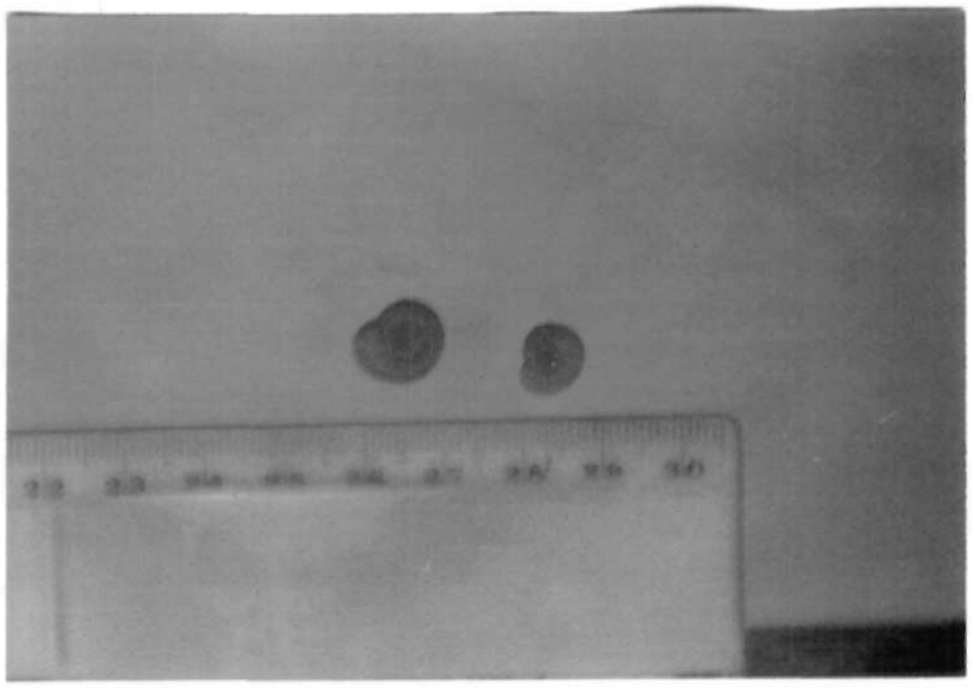


Plate 4 *Biomphalaria pfeifferi*

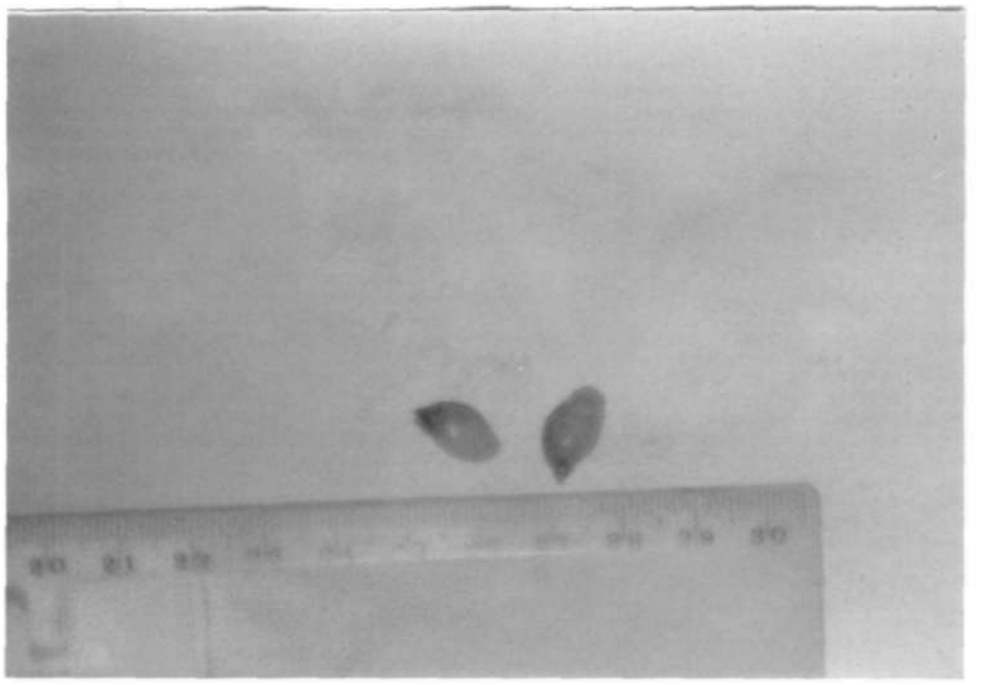


Plate 5 *Lymnaea natalensis*.

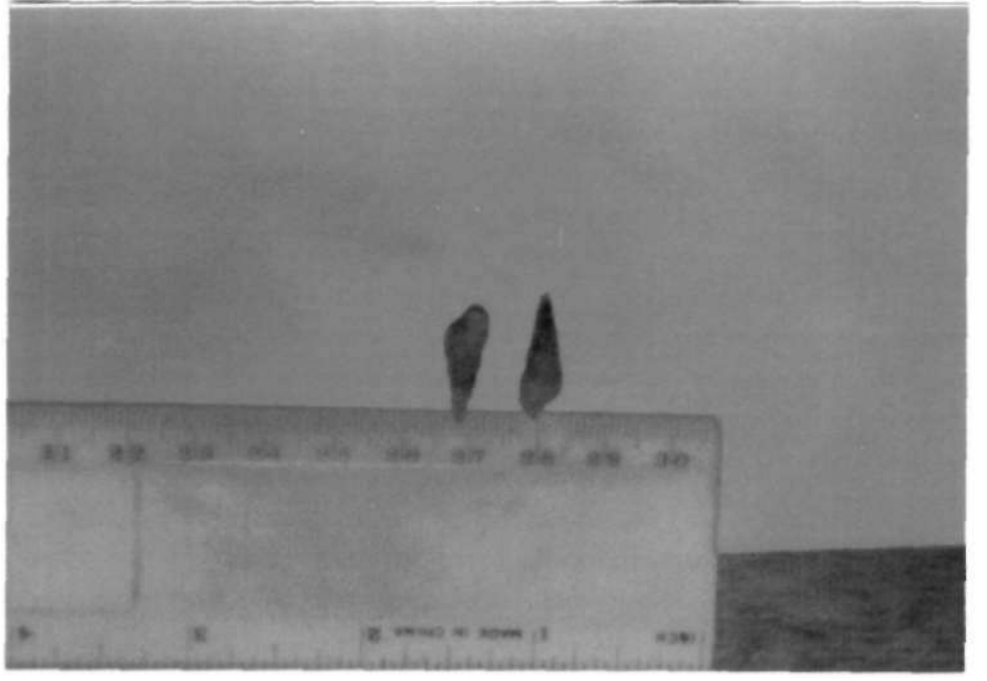


Plate 6 *Bulinus forskalii*

**Table 35:**

**Distribution of snail vector and characteristics of snail habitats**

| Site No. | Name of Site | Location | Use | Snail Species | Schistosome |
|---|---|---|---|---|---|
| 7 | Dutsinma Burrow - Pit pool | About 700 metres from nearest school along Dutsnma - Radda Road | Recreation, watering of livestock, laying mud bricks in drier season | *B. globosus* | + |
| 8 | Zobe Excavation Area | About 500 metres from nearest School along Dutsinma - Kankara Road. | Recreation watering livestock, Domestic water supply | *B. pfeifferi*<br>*B.. forskalii*<br>*Lymnaea*<br>Cyclops | +<br>-<br>0<br>0 |
| 9 | Makurda Pond | About 150 metres from School, along Katsina- Mashi Road | Domestic water, Irrigation watering of Livestock. | *B. pfeifferi*<br>*Lymnaea* | +<br>0 |
| 10 | Radda Burrow Pit pool | About 500 metres from school along Dutsinma - Kafin Soli Road | Domestic water supply Recreation, watering of livestock. | *B. globosus*<br>*B. forskalii*<br>*B. pfeifferi* | +<br>-<br>+ |
| 11 | Karkaru pond | About 200 metres from school, off Daura-Sandamu Road | Watering livestock, Irrigation and Domestic Users. | *B. pfeifferi*<br>*Lymnaea* | +<br>0 |
| 12 | Dannakola Dam/Pond | About 150 metres from school, along Katsina - Daura Road. | Domestic Water use, Irrigation, Recreation, watering livestock. | *B. globosus*<br>*Lymnaea* | +<br>0 |
| 13 | Jibia Central Pond | About 50 metres from school, off Jibia - Kauran Namoda Road | Recreation, watering livestock, Domestic use | *B. globosus*<br>*Lymnaea* | +<br>0 |
| 14 | Daddara Burrow Pit Pool | About 700 metres from school Daddara town along - Katsina - Jibia Road | Domestic Uses, Recreation and watering livestock | *B. globosus*<br>*Lymnaea* | +<br>0 |
| 15 | Dannabaso pond | 100 metres from school, off Katsina - Kaita Road. | Domestic water supply, Recreation and watering livestock | *Lymnaea*<br>*B. globosus* | 0<br>+ |
| 16 | Kofar Sauri Tafki | Off Katsina GRA Road | Recreation, Livestock and domestic | *B. globosus* | + |

KEY:

+ Presence of Schistosome Cercariae

- Absence of Schistosome Cercariae

0 Not Studied.



PLATE 7 Burrow - Pit Pool Dutsinma Town



PLATE 8 Zobe Excavated Area, Dutsinma LGA



PLATE 9 Makurda Burrow - Pit Pool, Rimi LGA



PLATE 10 Radda Burrow - Pit Pool., Rimi LGA

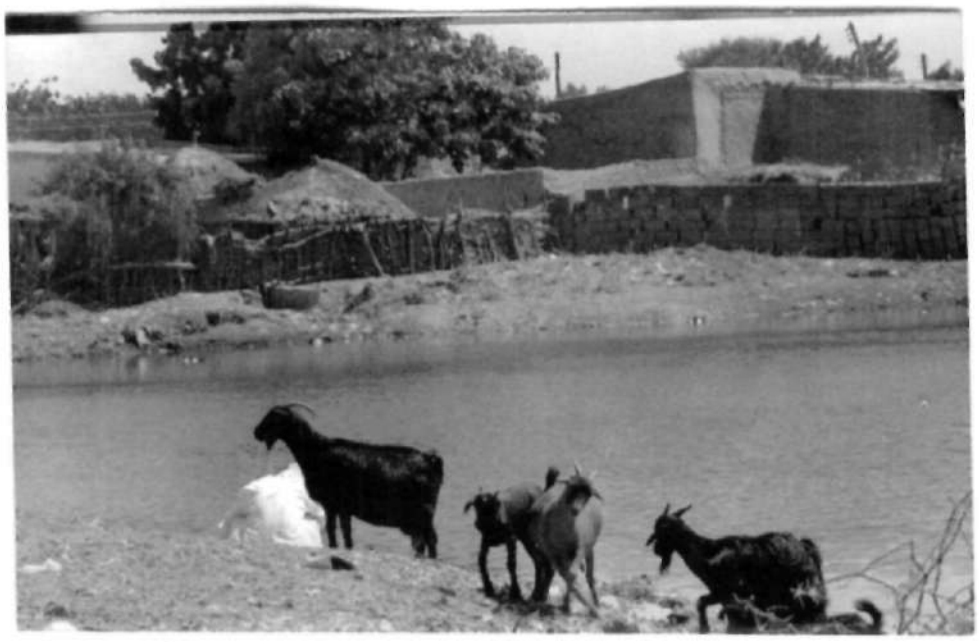


PLATE 11 Karkarku Pond, Daura LGA

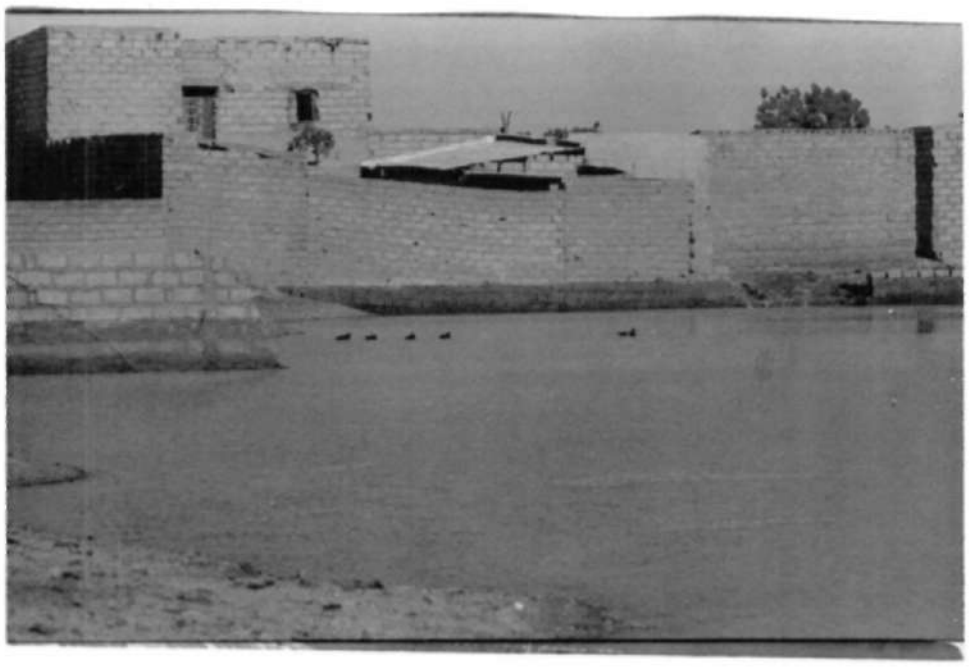


PLATE 12 Dannakola Pond, Daura LGA

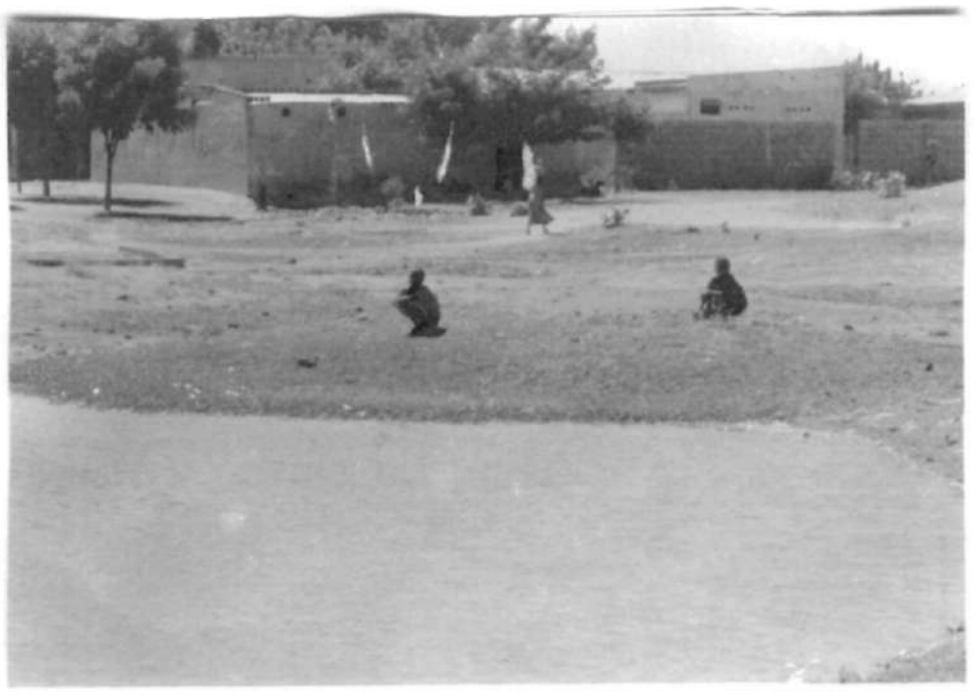


PLATE 13 Jibia Central Pond, Jibia LGA



PLATE 14 Daddara Burrow - Pit pool, Jibia LGA



PLATE 15 Dannabaso Pond, Katsina LGA



PLATE 16 K/Sauri Tafki, Katsina LGA



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### 4.3.2 **Infection rate of Schistosome Snail Vector**

Generally, a total of 534 Schistosome Snail Vectors were collected during the survey, of which 364 (68.16%) were *Bulinus globosus* and 170 (31.84%) were *Biomphalaria pfeifferi.* Of the 534 Schistosome snails vectors sampled 181(33.90%) were from Dutsinma LGA, 147 (27.53%) were from Rimi LGA, 96(17.42%) were from Daura, 48 (8.99%) were from Jibia and 62(11.61%) from Katsina LGA(Tables 36 and 37). 91(17.04%) out of 534 snails collected had schistosome cercariae. A total of 60(16.48%) of the 364 *Bulinus* snails shed Schistosome cercariae while 31(18.20%) of the 170 *Biomphalaria* snails were also infected (Table 36 & 37).

In Dutsinma LGA, 181 snails were collected, identified and observed for cercariae shedding. 155 (85.64%) snails were identified as *Bulinus globosus* and 26 (14.45) were *Biomphalaria pfeifferi*.. Out of the 155 *B. globosus* examined 31 (20.0%) were positive for *S.haematobium cercariae.* Similarly, *5(19.25%) of the 26 B. pfeifferi were found with S.mansoni cercariae.*

147 Schistosome snail vectors were collected in Rimi LGA (Tables 36 and 37) of which 53 (36.05%) and 94(63.95%) were identified as *Bulinus and Biomphalaria* respectively. About 17.0% each of 53 *Bulinus* and 94 *Biomphalaria* were observed to shed cercariae.

In Jibia LGA, 6(12.5%) of the 48 snail collected were found with cercariae of Schistosome. Only *Bulinus* snails were isolated (Table 36).

Also in Katsina LGA, 62 snails, all belonging to the genus *Bulinus* were collected and 7(11.29%) were found to shed Schistosome cercariae.

A total of 96 snails were collected in Daura LGA. Out of which 46 (47.92) were of the *Bulinus sp* and 50(52.08%) were of *Biomphalaria sp*. Of the 46 *Bulinus* snails, 7 (15.22%) were found positive for *S.haematobium* while 10 (20.0%) of the 50 *Biomphalaria sp* were infected with *S.mansoni* cercariae.

Table 36:

Cercarial Infection rate of *Bulinus sp* in each Local Government Areas of Katsina State, Nigeria.

| *LGA* | Site Number. | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % |
|---|---|---|---|---|---|
| Dutsinma | *7* | *123* | *27* | *21.95* | *14.64 - 29.27* |
| | *8* | *32* | *4* | *12.50* | *1.0 4- 23.96* |
| Rimi | *9* | *30* | *5* | *16.67* | *3.33 - 30.01* |
| | *10* | *23* | *4* | *17.39* | *1.90 - 32.88* |
| Daura | *11* | *35* | *6* | *17.14* | *4.66 - 29.63* |
| | *12* | *11* | *1* | *9.09* | *7.90 - 26.08* |
| Jibia | *13* | *30* | *4* | *13.33* | *1.17 - 25.49* |
| | *14* | *18* | *2* | *11.11* | *3.41 - 25.63* |
| Katsina | *15* | *42* | *5* | *11.91* | *2.11 - 21.71* |
| | *16* | *20* | *2* | *10.00* | *3.15 - 23.15* |
| Total | *10* | *364* | *60* | *16.48* | *12.67-20.29* |

Table 37:

Infection rate of *Biomphalaria sp* in each Local Government Area.

| *LGA* | Site Number. | Number Examined | Number Infected | Infection Rate (%) | 95% C.I on Prev. % |
|---|---|---|---|---|---|
| Dutsinma | *7* | *0* | *0* | *0.00* | *0.00* |
| | *8* | *26* | *5* | *19.23* | *4.08 - 34.38* |
| Rimi | *9* | *54* | *11* | *20.37* | *9.63 - 31.11* |
| | *10* | *40* | *5* | *12.50* | *2.25 - 22.75* |
| Daura | *11* | *50* | *10* | *20.00* | *8.91 - 31.09* |
| | *12* | *0* | *0* | *0.00* | *0 .00* |
| Total | *6* | *170* | *31* | *18.24* | *12.44 - 24.05* |

### 4.3.3 **Monthly cercarial infection rate of snail vectors.**

The abundance of Schistosome snail vectors, as shown in Table 37, varied by the month of the year. Generally the snail populations fluctuated, with a decrease at the peak of the rainy season and further reduced during the very dry months. Precisely, this were the months of August to December for *Bulinus* and July to January for *Biomphalaria*.

The proportion of infected *Bulinus species* was highest in the months of may and June which recorded 21.05% and 88.33% respectively. No infection rates were recorded in these snails between the months of July and December. In the case of *Biomphalaria sp*, the highest rate of infection was recorded in the month of February, March and April, with 25.0%, 55.56% and 61.11% respectively. The least infection rates was observed between July and January.

Table 38:

**Infection rate of snails vector by months of the year in Katsina State.**

| Months of the year | *Bulinus Sp* | | | *Biomphalaria Sp* | | | Mean water |
|---|---|---|---|---|---|---|---|
| | Number Examined | Number Infected | Infection Rate (%) | Number Examined | Number Infected | Infection Rate (%) | Temp. in $^0C$ |
| **1997 March** | 64 | 9 | 14.06 | 18 | 10 | 55.56 | 30.40 |
| **1997 April** | 70 | 13 | 18.57 | 18 | 11 | 61.11 | 32.80 |
| **1997 May** | 38 | 8 | 21.05 | 20 | 3 | 15.00 | 29.80 |
| **1997 June** | 36 | 21 | 58.33 | 22 | 1 | 4.55 | 30.10 |
| **1997 July** | 25 | 0 | 0.00 | 4 | 0 | 0.00 | 26.80 |
| **1997 August** | 9 | 0 | 0.00 | 9 | 0 | 0.00 | 26.20 |
| **1997 Sept.** | 11 | 0 | 0.00 | 9 | 0 | 0.00 | 26.90 |
| **1997 Oct.** | 10 | 0 | 0.00 | 12 | 2 | 16.67 | 27.40 |
| **1997 Nov.** | 8 | 0 | 0.00 | 13 | 0 | 0.00 | 27.30 |
| **1997 Dec.** | 3 | 0 | 0.00 | 14 | 0 | 0.00 | 25.10 |
| **1998 Jan.** | 39 | 3 | 7.69 | 15 | 0 | 0.00 | 24.50 |
| **1998 Feb.** | 51 | 6 | 11.77 | 16 | 4 | 25.00 | 26.00 |
| **Total** | 364 | 60 | 16.48 | 170 | 31 | 18.24 | 25.53 |

As far as this survey is concerned the water temperature did not have much effect on the snail distribution generally. However, the infection rate in *Bulinus* was observed to be highest when the temperature range was between 29.8$^0$C and 32.8$^0$C where 21.1% and 58.35% infection rate were respectively recorded. Similarly the highest infection rates (61.11% and 55.56%) were recorded when the water temperature was 32.8$^0$C and 30.4$^0$C respectively.

### 4.4 Prevalence of other Intestinal parasites.

Out of the 4000 faecal sample analysed during the dry and wet season, 1022 (25.55%) pupils were infected with one or more parasites other than *S.haematobium* and *S.mansoni.* The other intestinal parasites identified were *Ancylostoma duodenale* (15.55%), *Ascaris lumbricoides* (0.7%), *Hymenolepis nana* (4.13%), *Enterobius vermicularis* (3.83%), *Trichuris truchiura* (0.85%), *Strongyloides stercoalis* (0.4%) and *Entamoeba histolytica* (0.1%).

The spread of those infected in the Local Government Areas revealed that 259 (32.38%) were from Dutsinma LGA, 176 (12.00%) from Rimi, 185 (23.13%) from Daura, 194 (24.2%) were from Jibia and 208 (26.0%) were from Katsina (Table 39). The relationship between prevalence rate of all the intestinal parasites and the Local Government Areas were found to be statistically significant ($p<0.05$).

Table 39:

**Prevalence rate of intestinal parasites according to Local Government Areas.**

| Parasites | Number Examined | Number Positive (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Dutsinma n=800 | Rimi n=800 | Daura n=800 | Jibia n=800 | Katsina n=800 | Total |
| *Ancylostoma duodenale* | 4000 | 172 (4.3%) | 107 (2.68%) | 114 (2.85%) | 111 (2.78%) | 118 (2.95%) | 622(15.55%) |
| *Ascaris lumbriciodes* | 4000 | 6 (0.15%) | 3 (0.08%) | 9 (0.23%) | 3 (0.08%) | 7 (0.18%) | 28(0.70%) |
| *Hymenolepis nana* | 4000 | 27 (0.68%) | 31 (0.78%) | 30 (0.75%) | 37 (0.93%) | 40 (1.00%) | 165(4.13%) |
| *Enterobius verimcularis* | 4000 | 48 (1.2.%) | 26 (0.65%) | 20 (0.5%) | 33 (0.83%) | 26 (0.65%) | 153(3.83%) |
| *Trichuris trichuira* | 4000 | 6 (0.15%) | 3 (0.08%) | 8 (0.20%) | 7 (0.18%) | 10 (0.25%) | 34(0.85%) |
| *Strongyloides stercoralis* | 4000 | 0 (0.00%) | 6 (0.15%) | 2 (0.05%) | 3 (0.08%) | 5 (0.13%) | 16(0.40%) |
| *Entamoeba histolytica* | 4000 | 0 (0.00%) | 0 (0.00%) | 2 (0.05%) | 0 (0.00%) | 2 (0.05%) | 4(0.10%) |
| *Total* | 4000 | 259 (32.38%) | 176 (22.08%) | 185(23.13%) | 194(24.25%) | 208(26.00%) | 1022(25.25%) |

# CHAPTER FIVE

## DISCUSSION

The results of this study show that Schistosome infection has a relatively low prevalence in the northern part of the Katsina State of Nigeria. Traditionally, parasitological analysis is used to determine the presence of eggs in faecal and urine specimens for defining exposure to Schistosome infection.

A significantly higher prevalence rate (13.05%) found in pupils infected with *S.haematobium* compared with (4.03%) of those with *S.mansoni*. This disparity between urinary and faecal schistosomiasis was not unrelated to the low prevalence and the infection rate (5.9%) of *Biomphalaria pfeifferi* , the intermediate host of *S.mansoni* which was found in only three of the five Local Government areas, while *Bulinus globosus*, the intermediate host of *S.haematobium* was not only found in all the five Local Government areas but also had the higher prevalence rate (16.48%)of infection. Earlier researchers (Awogun, 1990 and Gemade and Dipeolu, 1983) also reported that intestinal schistosomiasis was less common than urinary form in Nigeria. In the southern part of Nigeria, it was also reported that *S.mansoni* was limited to certain foci (Cowper, 1963). Higher prevalence rate for *S.mansoni* was, however, observed in other parts of the world. Rodrigues *et al.* (1995) reported a prevalence rate of 87.65% in Poute Do Pasmado, Brazil. Stelma *et al.* (1993) also recorded a high prevalence rate of 22.3% in El-sheikh Fadi village, Egypt.

The data on the presence of both *Schistosoma haematobium* and *S.mansoni* infection were obtained for the first time in school children in Dutsinma, Daura, Rimi,

Jibia and Katsina Local Government Area of Katsina State. The overall prevalence rate of 12.05% and 3.33% for *S.haematobium* and *S.mansoni* respectively were recorded for the rainy season survey, while during the dry season survey, 14.05% and 4.75% was recorded for *S.haematobium* and *S.mansoni* respectively. There was no significant relationship ($P>0.05$) between the seasons and *S.haematobium* infection while there was a significant relationship ($P<0.05$) between the two seasons and *S.mansoni* infection.

It was quite common to find pupils spending much of their time playing in irrigation canals and ponds during the hot months. The canals and ponds may contain infected intermediate host of *Schistosoma*. This is the reason for the disparity. This was rightly stated by Akogun and Obadiah (1996), and may be the reason for the increase in prevalence rate during the dry survey. Though this finding was the representative of the status of Schistosomiasis in these sampled populations, it may reflect the minimum prevalence for the entire population of these five local government areas under study. This low prevalence rate is in contrast with the findings of Pugh *et al.* (1979), Akogun and Akogun (1996), Awogun (1990), Akogun and Obadiah (1996), Lengeler *et al.* (1991) and Istifanus *et al.* (1990) in other part of Nigeria. Edungbola *et al.* (1988) recorded a prevalence rate of 45.4% in Ilorin for *S.haemotobium*. A prevalence rate of 73.7% was recorded in Kano for *S.haematobium*. Akogun and Obadiah (1996) recorded a prevalence of 65.8%) in some Primary Schools, Numan, Adamawa State. In the case of *S.mansoni*, Bassey (1988) reported a prevalence rate of 61.3% in Kano.

On the other hand, a low prevalence rate of *S.haematobium* has also been observed in other parts of the Nigeria. Chugh *et al.* (1986) reported an overall

prevalence rate of 6.2% Maiduguri, Bornu State. Gemade and Dipeolu (1983) recorded 15% as prevalence rate in Benue state while Agbolade and Odaibo (1996) reported 6.5% as prevalence rate in Ago-Iwoye, Ogun State.

The difference in results recorded in the two seasons during this study coincided with the relative abundance of infected snail intermediate host *Bulinus globosus* and *Biomphalaria pfeifferi*, which was observed between May and June and between March and May. These months mark the onset of the rainy season and the water temperature range of $26^0$C and $32.8^0$C recorded lies within the optimum limits for the snail vectors. At the peak of the rainy season, a decline in the infection rate was observed which was probably the reason for the fewer number of snails that were scooped and the possibility of the snail and cercariae being washed away by rain water.

This observation was similar to the findings of Etim *et al* (1998) who recorded a high prevalence rate of 35.95% for *S.haematobium* and attributed it to the presence of snail intermediate host with infection rate of 35.9% and 39.9% in the rainy and dry season respectively. Ezeugwu and Mafe (1998) had a similar view.

The prevalence of infection varied among the local government areas. The highest prevalence rate (26.7%) for *S. mansoni* and 29.0% for *S. haematobium* were recorded in Rimi and Dutsinma Local Government areas respectively. This result was expected because *B. pfeifferi* was isolated in both sites surveyed in Rimi Local Government areas and also Rimi happened to be one of the 3 sites with the abundance of the snail vector. *B. globosus* was isolated in all the 5 local government areas (LGA) but Dutsinma LGA recorded the highest prevalence rate. The same factors would be used to explain the reason for the least prevalence rates of 10.6%

for *S.mansoni* and 13.0% for *S.haematobium* observed in Jibia and Katsina local government areas respectively. Ityondo (1991) also reported a disparity in prevalence rates between Igabi and Soba Local Government areas.

The differences in snail distribution could be related to the difference in physiochemical nature/properties of the water bodies in the two LGA, which may support the growth of one genus of snail and not the other. This parameter however, has not been studied during the current study.

There was also a marked difference in prevalence rate between males and females. For *S.haematobium* infection, males were significantly more infected than females during both wet and dry season surveys. This is similar to observation of Pugh and Gilles (1978), Awogun (1990), Istifanus *et al* (1990), Kaneko *et al* (1991) and Nduka *et al* (1995). This result, however, contrasted with that of Husting (1983). Similarly in *S.mansoni* infection, the males were found with higher prevalence rate for both seasons. The same pattern of infection was observed in all the local government areas. The difference may probably be due to greater water contact of males with contaminated water during swimming, fishing and playing in water (plate1). Studies carried out by Awogun (1990), Edungbola *et al* (1988), Ityondo (1991) and Anigbo and Nwaorgu (1990) confirmed the above statement. Tayo *et al*, (1980) observed that males were responsible for 98% of activities involving contamination and exposure.

In the culture of the people of the northern part of Nigeria, males enjoy more freedom of movement and have more time for themselves compared with their female counterpart. Thus they are more likely to spend such time and opportunity by frequenting water bodies which may contain infected intermediate snail host of

schistosomiasis. The males were more likely to follow their male parents to farm in one of the irrigation schemes in their locality and may run the risk of infection, while their female counterparts may remain at home most of the time helping their mothers in domestic activities.

In all Local Governments Areas studied, *S.haematobium* and *S.mansoni* were found in mostly children between the ages of 5 years to 16 years. This gave the same characteristic pattern as it has been previously reported in Nigeria (Pugh and Gilles, 1978; Istifanus *et al*, 1990 and Nduka *et al*, 1995). Husting (1983) found the parasite in every age group except in 0 - 3 years. Children of the age group 7 - 18 years have been described as "hydrophylic" and they frequent areas that contain *Schistosoma* cercariae and hence the high prevalence rate of Schistosoma sp infection. Warley (1976) also associated the higher prevalence in children to the *frequency of water contact.*

The higher prevalence rate of between 21% - 40% for *S.haematobium* and 20% - 29% for *S.mansoni* recorded during the dry season survey, and 14% - 40% for *S.haematobium* and 2% - 21% for *S.mansoni* during the wet season survey were all observed in those pupils who used pond water as source of drinking water. The lack of tap water in most of the pupil's respective dwellings may be a factor associated with the higher prevalence of schistosomiasis. Therefore these children run the risk of infection by going to fetch water from the ponds or streams for drinking and other domestic purposes.

In general the result analysis revealed that infection occur even among those pupils who reported no contact with water bodies. It was explained, however, that the answers given by the pupils to this particular question was unreliable because of the fear of being punished by the school authority if they responded in the

affirmative. Another explanation to this could be that they got the infection not while swimming or fishing but while fetching water for drinking and other domestic purposes or even while being involved in irrigation.

Exposure to transmission is obviously an important factor in the spread of disease. When the result of the survey were analysed under the respective local government areas, infection rates were found to be significantly associated ($P<0.05$) with human water contact habit of pupils particularly during the dry season. Rodrigue *et al* (1995) detected a statistical significant risk for pupils swimming, playing, fishing, working in fields, fetching water, and washing dishes.

*Human - water contact activities, however go side by side with the amount of* contamination and incidence of infection, more so when the right species of snail vector were in abundance. The observation in this study shows that the highest prevalence of between 30% and 80% *S. haematobium* and 20 and 45% for *S.mansoni* were found in pupils that urinate and defaecate indiscriminately. It is on record that even when small amount of human waste contaminate an area and that even when the number of snails is low, Schistosome life cycle can be completed. There is, therefore, a close association between the type of toilet of pupils and prevalence rate of Schistosomiasis. This study supports the works of Tayo *et al* (1980) who observed that males were responsible for 98% of activity involving contamination and exposure. Other researchers with similar views were Akogun and Obadiah (1996). The pupils became a source of contamination to the water bodies by defaecating indiscriminately especially when such was washed into close by ponds and streams by rain water.

Majority (73%) of the pupils in the study population showed their ignorance of the disease and its etiologic agent. The level of awareness to the diseases in Katsina has been reported for the first time in this survey. The prevalence rate of schistosomiasis was higher in those that were aware of the disease compared with those that were not aware. The result obtained in this study could be attributed to the fact that pupils in Katsina State became aware of the disease only after they must have contacted it and not before.

The relationship between the type of treatment taken by pupils (if any) and prevalence rate of schistosomiasis was significant ($P<0.05$). A low prevalence rate was recorded for both urinary and intestinal Schistosomiasis in those pupils that opted for western medicine. This supported the work of Ruppel *et al* (1991), who treated infected mice with praziquantel and studied the antibody response against schistosome worm proteins. He reasoned that Western chemotherapy is subjected to testing and improvement on target parasite, thus more effective in the treatment of Schistosomiasis compared to traditional medicine. Since the worms do not multiply in the human body, complete immunity apparently does not occur and in addition to this the worms may live for decades (Warren, 1973). This may be the reason for a high prevalence rate of infection in those pupils that were not treated at any time.

The presence of blood in urine and faecal sample was found to be significantly associated with infection rate of schistosomiasis during both seasons. Abdel-Salem and Eshan (1978) have associated hematuria with active schistosomiasis lesions in children. This reason could equally be used to explain the appearance of blood in the stool, even though we could not rule out the compound effect of other gastro intestinal parasites.

Adewunmi *et al* (1991) and Moth *et al* (1983) also reported that the presence of blood in faeces and urine could be caused by other factors such as menstruation, glomerulonephritis, pile and even sickle cell diseases. The high prevalence rate of schistosomiasis in pupils with bloody urine and faeces suggested that there was an association between the parasite and appearance of blood. This study agrees with that of De Jonge and Vliet (1991) who reported that 23 (92%) patients out of the 25 examined with dysuria and haematuria in Zambia, were excreting *S.haematobium* ova. Also Akogun and Obadiah (1996) revealed in their study, the haeraturia in pre-teenage children are usually due to schistosomiasis. The presence of blood in urine and faecal samples could be used as the easiest approach to investigate the prevalence of schistosomiasis in an area (Poggensee *et al.*, 2000).

Infection rate and the prevalence of both *Bulinus globosus* and *Biomphalaria pfeifferi* tend to fluctuate during the months under study. The highest infection rate were observed for *B. globosus* during the months of May and June where 21.05% and 58.33% were recorded respectively. *B. pfeifferi* had infection rates of 25.0%, 55.56%, 61.1% and 15.0% for the months of February, March, April and May respectively. All the months fall within the dry season but towards the onset of the rainy season when temperature range ($26.0^0$C and $32.8^0$C) lies within the optimum limits for snail growth and reproduction. This explains the reason for the low population and infection rate observed during the peak of the rainy season when a fall in water temperature was observed and the snails and cercariae get washed away. A similar observation was recorded in the Lake Chad basin by Ezeugwu and Mafe (1998) who attributed the increase in abundance of snail species during the hot season to the stability of the aquatic habitat in terms of water level and velocity.

Though these parameters were not studied during this survey, the same reason could be applied to explain the fluctuation in the distribution of both *B.globosus* and *B. pfeifferi*. In addition to this other physio-chemical parameters such as hardness of water and level of manganese concentration which could be of vital importance to the snail and which might have been diluted at the peak of the rainy season may equally have affected the snail population.

Other intestinal parasites encountered in the study areas could be as result of the insanitary habits of the pupils. It was common to find pupils defecating indiscriminately in open spaces as shown in Plate 13. Other factors responsible for high prevalence rate of intestinal parasites include poor personal hygiene and human habits which may lead to contamination of hands and subsequently food and water with ova of the parasite (Idris, 1988), lack of adequate health care and education and poor or inadequate refuse disposal methods. Food may also be exposed to flies as observed during sales of food to pupils by illiterate food sellers (Idris, 1988).

The presence of intestinal parasite in parts of Nigeria was reported by other works of Idris (1988), Ukoli (1990), Ityondo (1991) and Ofoezie *et al* (1996).

## 5.1 SUMMARY AND CONCLUSION.

Fresh urine (4000) and faecal (4000) samples were obtained during the dry and wet seasons from pupils between the ages of 5 and 19 years, from 100 randomly selected schools in Dutsinma, Daura, Rimi, Jibia and Katsina Local Government Areas of Katsina State. Analysis of both urine and faecal samples revealed that of the 4000 urine samples, 522(13.05%) had *S. haematobium* and also of the 4000 faecal samples, 161(4.03%)had *S. mansoni*.

Infection rate was found to vary not only between the local government areas but also between the two seasons of the year. The highest prevalence rate 151(28.93%) of 522 infected pupils for *S.haematobium* was observed in Dutsinma local government, while *S.mansoni* recorded the highest prevalence rate of 43 (26.71%) out of 161 infected pupils, in Rimi local government area.

Higher prevalence rates, 382(73.18%) and 109(67.7%) were obtained for both *S.haematobium* and *S.mansoni respectively* in the males than in the females . The age-specific rates for 10 - 14 year old were 66.1% and 56.5% for *S.haematobium* and *S.mansoni* respectively. The least prevalence rate was recorded for pupils between the 15 - 19 years of age.

Water contact habit of pupils investigated for the two season showed, surprisingly, the highest prevalence rate in pupils that do not frequent water bodies followed by those that contact water bodies on weekly to daily basis.

The level of *haematuria was also associated with the prevalence rate of* urinary schistosomiasis, since majority of pupils with visible haematuria were found with schistosome eggs while most pupils with negative haematuria had none.

Most of the pupils surveyed (73.0%) reported being neither aware of the disease nor its etiologic agent.

Other intestinal parasites encountered in this study included *Ancylostoma duodenale* (hookworm), *Ascaris lumbricoides* (Roundworm), *Hymenolepis nana* (dwarf tapeworm),*Enterobius vermicularis* (pinworm) *Trichuris trichiura* (whipworm), *Strongyloides stercoralis* and *Entamoeba histolytica*. Cases of multiple infection were not common. The highest number of infected pupils (32.38%) were recorded in Dutsinma local government area and the least (22.0%) was observed in Rimi local government area of Katsina State.

The survey on intermediate host of schistosomiasis was investigated in 10 randomly selected ponds in five local government areas of Katsina State, for 12 months (March 1997 - February 1998). A total of 1107 snails were collected. Predominantly, *Bulinus globosus*, *Bulinus forskalii*, and *Biomphalaria pfeifferi* and *Lymnaea natalensis* were identified during the survey. Infectivity rate with schistosome was determine in *Bulinus globosus* and *Biomphalaria pfeifferi* and found to vary with the months in the year. Of the 534 schistosome snail vectors, 91 (17.04%) were found to shed schistosome cercariae. Out of the 91 infected snails, 60(65.93%) were identified as *B. globosus* and 31(34.07%) as *B. pfeifferi.* The highest infection rate for *B. pfeifferi* was recorded between February and April while that of *B. globosus* was between May and June. It was observed that the distribution of infected *B.globosus* was highest when water temperatures ranged between 29.8$^{0}$C and 30.1$^{0}$C, while the number of infected *B. pfeifferi* was found more when temperature ranged between 27$^{0}$C and 32.8$^{0}$C.

This study has established that schistosomiasis is endemic in the five selected Local Government Areas of Katsina State.

It is worth noting that most of the primary schools were not located very close to the irrigation areas even though all the local government surveyed had an irrigation scheme in them, yet a high prevalence was observed. The distribution of snails vectors and the engagement of free swimming in the many ponds and streams in the villages where the schools were located in addition to lack of awareness of the dangers associated with such contaminated water bodies contributed to this high prevalence rate of infection. It is important, therefore, to enlighten the people in these local government areas on schistosomiasis through

mobilisation and education. Control measures using chemotherapy should be made available and subsidised for the local populace. Clearing of bushes and vegetations surrounding water bodies that are frequented for domestic purposes should be encouraged by the village headmasters, chiefs and the clinics. Also provision of potable drinking water by the Government will be paramount importance in controlling water borne diseases. The use of mollucicides in water bodies particularly between the months of February and June when the rains are about starting and when infection rate of snails in Katsina state is at its highest could go along way in reducing the vector population. Finally it will be a welcomed idea if the control of intestinal parasites is made an adjoin to the Expanded Programme on Immunization (E.P.I.).

Area of further study which could have yielded more information on infection rate and distribution of snail vectors, and which could not be investigated in this study are snail density, physio-chemical properties of water bodies, floral distribution and their association with snail species. This, when investigated, could further assist the Government of Katsina State in designing control programmes particularly now that *S.haematobium* is being associated with HIV infection (Poggensee *et al.*, 2000).

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## APPENDIX I

### SCHOOLS SURVEYED AND THEIR LOCAL GOVERNMENTS:

### JIBIA LOCAL GOVERNMENT:

Total No. of Schools = 57
Schools sampled = 10

1. Magama Primary School
2. Jibia Central Primary School
3. Daddara Primary School
4. Kusa Primary School
5. Dan masani primary school
6. Zandam Primary School
7. Faru Primary School
8. Gurbin magarya Primary School
9. Makada Primary School
10. Army Barracks Primary School.

### KATSINA LOCAL GOVERNMENT

Total number of Schools = 31
Schools sampled = 10

1 Kofar yandaka Primary School
2. Gafai Primary School
3. Ambutai Primary School
4. Farin yaro Primary School
5. Sabuwar Kofa Primary School
6. Danabaso Primary School
7. Shinkafi Primary School
8. Kofar Marusa Primary School
9. Ajiwa Primary School
10. Dandagoro Primary School.

### DAURA LOCAL GOVERNMENT

Total number of schools = 83
Schools sampled - 10

1. Ganga Primary School
2. Karkarku Primary School
3. Mazoji Primary School
4. Danakola Primary School
5. Madobi Primary School
6. Sandamu Primary School
7. Makairachi Primary School
8. Daura Primary School
9. Gurjiya Primary School
10. Baro Primary School.

**RIMI LOCAL GOVERNMENT**

Total number of schools = 102
Schools sampled = 10

1. Abukur Primary school
2. Tsegero Primary School
3. Rimi Primary School
4. Radda Primary School
5. Makurda Primary School
6. Rimin Guza Primary School
7. Are Primary School
8. Safana Primary School
9. Kuraye Primary School
10. K/Kudu Primary School.

**DUTSENMA LOCAL GOVERNMENT**

Total number of Schools = 58
Schools sampled = 10

1. Sabon garin zobe Primary School
2. Bagagadi Primary School
3. Na Alhaji Primary school
4. Yandaka Primary School
5. Karofi Primary School
6. Kuki Primary School
7. Shiek Abubakar Gumi Primary School
8. Makera Primary School
9. Garki Primary School
10. Taura Primary school.

## APPENDIX II

### QUESTIONNAIRE
### THE EPIDEMIOLOGY OF SCHISTOSOMIASIS IN PRIMARY SCHOOL PUPILS OF SOME SELECTED LOCAL GOVERNMENT AREAS OF KATSINA STATE, NIGERIA

**INSTRUCTION: Tick ( ) where appropriate**

1. Village/Town_____ 2 School_____
3. Name of Pupil _____ 4. Sex_____
5. Age/Date of Birth_____
6. Duration of stay in Village/Town:
   a) Since birth ( ) b) Less than 1 year ( )
   c) Up to 5 years ( ) d) Above 5 years ( )
7. How long where you cut off from this village/town before your return?.
   a) Never ( ) b) About a year ( ) c) Up to 5 years ( )
   d) Over 5 years ( ).
8. What are your sources of drinking water ?.
   a) Stream (pond) ( ) b) Wells ( ) c) Boreholes ( )
   d) Pipe - borne water ( )
9. How often do you visit stream/ponds for any of the followings: swimming, fetching water, laundry, fishing, etc ?.
   a) Daily ( ) b) 1 - 3 times a week ( ) c) Once a month ( )
   d) Not at all ( )
10. What type of toilet facilities do you use ?
   a) Pit toilet ( ) b) Modern Toilet (WC) ( ) c) Stream/river ( )
   d) Anywhere around ( )
11. Have you been passing out blood in your urine ? Yes ( ) No ( )
12. Have you been passing out blood in your stool ? Yes ( ) No ( )
13. If your answer is yes for questions 11 and 12, what do you do when you observe blood in your urine or stool ?_____
14. Are you aware of the disease bilharziasis ? Yes ( ) No ( )

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15. Nature of urine sample: Overt blood ( ) Occult blood ( )
16. Result of Dip stick:
   a) Level of protenaemia: High ( ) Moderate ( ) Low ( )
   b) Level of haematuria: High ( ) Moderate ( ) Low ( )
17. Result of urine sample:
   a) Type of egg seen *S.haematobium* ( ) *S.mansoni* ( )
   Any other type ( )
   b) Egg count per gramme (egg) _____
18. Result of feacal sampling:
   a) Nature of faecal sample: formed ( ) Diarrhoeic ( ) blood ( )
   Mucus ( )
   b) Type of egg seen: *S.haematobium* ( ) *S. mansoni* ( )
   Any other type ( )
   c) Egg count per gramme _____
19. Other parasites, Level of infection: _____
_____
_____

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## APPENDIX III

## CHI $_7$ SQUARE CALCULATIONS FOR THE GENERAL TABLES IN CHAPTER FOUR

Table 2
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 179 | 140.6235 | 10.4730 |
| 62 | 100.3765 | 14.6723 |
| 988 | 1026.3765 | 1.4349 |
| 771 | 732.6235 | 2.0103 |
| | | $\sum$=**28.5905** |

Table 2
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 41 | 38.511 | 0.1609 |
| 25 | 27.489 | 0.2254 |
| 1126 | 1128.489 | 0.0055 |
| 808 | 805.511 | 0.0077 |
| | | $\sum$=**0.3995** |

Table 5
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 81 | 113.1495 | 9.1347 |
| 155 | 124.4765 | 7.4848 |
| 5 | 3.374 | 0.7836 |
| 858 | 829.686 | 0.9663 |
| 878 | 998.911 | 14.6354 |
| 23 | 27.076 | 0.6160 |
| | | $\sum$=**33.6184** |

Table 5

| *S. mansoni* Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 44 | 30.987 | 5.4648 |
| 22 | 34.089 | 4.2871 |
| 0 | 0.924 | 0.9240 |
| 895 | 908.013 | 0.1865 |
| 1011 | 998.911 | 0.1463 |
| 28 | 27.076 | 0.0315 |
| | | $\sum$=**11.0402** |

Table 8

| *S. haematobium* Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 42 | 41.5725 | 0.0044 |
| 136 | 119.8975 | 2.1626 |
| 22 | 19.4005 | 0.3483 |
| 2 | 1.6870 | 0.0581 |
| 2 | 0.6025 | 3.2415 |
| 5 | 11.8090 | 3.9260 |
| 21 | 32.0530 | 3.8115 |
| 10 | 12.1705 | 0.3871 |
| 1 | 1.8075 | 0.3608 |
| 303 | 303.4275 | 0.0006 |
| 859 | 875.1025 | 0.2963 |
| 139 | 141.5995 | 0.0477 |
| 12 | 12.3130 | 0.0080 |
| 3 | 4.3975 | 0.4441 |
| 93 | 86.1910 | 0.5380 |
| 245 | 233.9470 | 0.5222 |
| 91 | 88.8295 | 0.0530 |
| 14 | 13.1925 | 0.0494 |
| | | $\sum$=**16.2596** |

Table 8
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 13 | 11.385 | 0.2291 |
| 28 | 32.835 | 0.7120 |
| 3 | 5.313 | 1.0070 |
| 0 | 0.462 | 0.462 |
| 0 | 0.165 | 0.165 |
| 21 | 3.254 | 96.7795 |
| 1 | 8.778 | 6.8919 |
| 0 | 3.333 | 3.333 |
| 0 | 0.495 | 0.0495 |
| 332 | 333.615 | 0.0078 |
| 967 | 962.165 | 0.0243 |
| 158 | 155.687 | 0.0344 |
| 14 | 13.538 | 0.1747 |
| 5 | 4.835 | 0.6964 |
| 77 | 94.766 | 3.3306 |
| 265 | 257.222 | 0.2352 |
| 101 | 97.667 | 0.1137 |
| 15 | 14.505 | 0.1562 |
| | | **∑=114.40** |

Table 11
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 145 | 183.8830 | 8.2220 |
| 2 | 3.7355 | 0.8060 |
| 71 | 38.1985 | 28.1670 |
| 23 | 15.183 | 4.0246 |
| 1381 | 1342.1170 | 1.1265 |
| 29 | 27.2645 | 0.1105 |
| 246 | 278.8015 | 3.8592 |
| 103 | 110.8170 | 0.5514 |
| | | **∑ = 46.87** |

Table 11
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 53 | 50.358 | 0.2239 |
| 0 | 1.023 | 1.0230 |
| 5 | 10.461 | 2.8508 |
| 8 | 4.158 | 4.1580 |
| 1473 | 1475.642 | 0.0047 |
| 31 | 29.977 | 0.0349 |
| 312 | 306.539 | 0.0979 |
| 118 | 121.842 | 0.1212 |
| | | $\sum = \mathbf{8.514}$ |

Table 14
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 215 | 217.5025 | 0.0288 |
| 3 | 4.6995 | 0.6146 |
| 0 | 0.3615 | 0.3615 |
| 14 | 5.3020 | 14.2692 |
| 0 | 0.4820 | 0.4820 |
| 9 | 12.6526 | 1.0544 |
| 1590 | 1587.4975 | 0.0040 |
| 36 | 34.3005 | 0.0842 |
| 3 | 2.6385 | 1.0175 |
| 30 | 38.6980 | 1.9550 |
| 4 | 3.5180 | 0.6550 |
| 96 | 92.3475 | 0.1445 |
| | | $\sum = \mathbf{20.67}$ |

Table 14
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 44 | 59.565 | 4.0673 |
| 0 | 1.287 | 1.287 |
| 0 | 0.099 | 0.099 |
| 1 | 1.452 | 0.1407 |
| 0 | 0.132 | 0.132 |
| 21 | 3.465 | 88.7377 |
| 1761 | 1745.435 | 0.1388 |
| 39 | 37.713 | 0.0439 |
| 3 | 2.901 | 1.2457 |
| 43 | 42.548 | 0.0048 |
| 4 | 3.868 | 0.9021 |
| 84 | 101.535 | 3.0283 |
| | | $\sum = \mathbf{99.83}$ |

Table 17
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 202 | 141.462 | 25.91 |
| 320 | 380.538 | 9.63 |
| 882 | 942.538 | 3.89 |
| 2596 | 2535.462 | 1.45 |
| | | $\sum$ = **40.90** |

Table 17
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 39 | 43.631 | 0.492 |
| 122 | 117.369 | 0.183 |
| 1045 | 1040.369 | 0.021 |
| 2794 | 2798.631 | 0.008 |
| | | $\sum$ = **0.704** |

Table 18
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 222 | 167.367 | 17.830 |
| 42 | 40.2423 | 0.077 |
| 26 | 82.401 | 38.610 |
| 302 | 356.6432 | 8.370 |
| 84 | 85.758 | 0.036 |
| 232 | 175.60 | 18.120 |
| | | $\sum$ = **83.04** |

Table 18
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 45 | 49.63 | 0.432 |
| 23 | 11.934 | 10.261 |
| 18 | 24.436 | 1.695 |
| 479 | 474.37 | 0.045 |
| 103 | 114.07 | 1.073 |
| 240 | 233.564 | 0.177 |
| | | $\sum$ = **13.685** |

Table 19
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 278 | 64.206 | 711.9 |
| 244 | 457.794 | 99.84 |
| 214 | 427.794 | 106.85 |
| 3264 | 3050.206 | 14.99 |
| | | $\sum$ = **933.58** |

Table 19
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 81 | 22.436 | 152.87 |
| 77 | 135.564 | 25.30 |
| 487 | 545.564 | 6.29 |
| 3355 | 3296.436 | 1.04 |
| | | $\sum$ = **185.5** |

Table 20
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 201 | 164.104 | 8.2954 |
| 80 | 116.896 | 11.6455 |
| 967 | 1003.896 | 1.3560 |
| 752 | 715.104 | 1.9037 |
| | | $\sum$ = **23.20** |

Table 20
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 68 | 55.48 | 2.8254 |
| 27 | 39.52 | 3.9664 |
| 1100 | 1112.52 | 0.1409 |
| 805 | 792.48 | 0.1978 |
| | | $\sum$ = **7.131** |

Table 23
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 89 | 132.7725 | 14.4310 |
| 190 | 143.8720 | 14.7895 |
| 2 | 4.3555 | 1.2740 |
| 856 | 812.2275 | 2.3590 |
| 834 | 880.1280 | 2.4170 |
| 29 | 26.6445 | 0.2082 |
| | | $\sum$ = **35.48** |

Table 23
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 22 | 44.8875 | 11.6700 |
| 69 | 48.6400 | 8.5224 |
| 4 | 1.4725 | 4.3384 |
| 923 | 900.1125 | 0.5820 |
| 955 | 975.3600 | 0.4250 |
| 27 | 29.5275 | 0.0090 |
| | | $\sum$ = **13.88** |

Table 26
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 69 | 48.4725 | 8.6910 |
| 112 | 139.7975 | 5.5273 |
| 34 | 22.6205 | 5.7246 |
| 2 | 1.9670 | 0.0006 |
| 2 | 0.7025 | 2.3970 |
| 21 | 13.7690 | 3.7980 |
| 21 | 37.3730 | 7.1730 |
| 15 | 14.1905 | 0.0462 |
| 5 | 2.1075 | 3.9699 |
| 276 | 296.5275 | 1.4210 |
| 883 | 855.2025 | 0.9040 |
| 127 | 138.3795 | 0.9360 |
| 12 | 12.0330 | 0.0001 |
| 3 | 4.2975 | 0.3920 |
| 77 | 84.2310 | 0.6210 |
| 245 | 228.6270 | 1.1730 |
| 86 | 86.8095 | 0.0075 |
| 10 | 12.8925 | 0.6490 |
| | | $\sum$= **43.43** |

Table 26
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 15 | 16.3875 | 0.1175 |
| 0 | 47.2625 | 47.2625 |
| 46 | 7.6475 | 192.3400 |
| 0 | 0.6650 | 0.6650 |
| 1 | 0.2375 | 0.2375 |
| 23 | 4.6550 | 72.300 |
| 3 | 12.6350 | 7.3500 |
| 6 | 4.7975 | 0.3000 |
| 1 | 0.7125 | 0.1200 |
| 330 | 328.6125 | 0.0060 |
| 995 | 947.7375 | 2.3570 |
| 115 | 153.3525 | 9.5920 |
| 14 | 13.3350 | 0.0332 |
| 4 | 4.7625 | 0.1221 |
| 75 | 93.3450 | 3.6100 |
| 263 | 253.3650 | 0.3660 |
| 95 | 96.2025 | 0.0150 |
| 14 | 14.2875 | 0.0058 |
| | | $\sum$ = **336.80** |

Table 29
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 86 | 214.403 | 76.8988 |
| 8 | 4.3555 | 4.3555 |
| 127 | 44.5385 | 152.6750 |
| 60 | 17.7030 | 101.0584 |
| 1440 | 1311.5970 | 12.5704 |
| 23 | 26.6445 | 0.4985 |
| 190 | 272.4615 | 24.9573 |
| 66 | 108.2970 | 16.5197 |
| | | $\sum$ = **389.534** |

ble 29
*mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 7 | 72.4850 | 59.1610 |
| 4 | 1.4725 | 4.3384 |
| 35 | 15.0575 | 26.4123 |
| 49 | 5.9850 | 309.1550 |
| 1519 | 1453.5150 | 2.9503 |
| 27 | 29.5275 | 0.2164 |
| 282 | 301.9425 | 1.3172 |
| 77 | 120.0150 | 15.4172 |
| | | $\sum$ = **418.97** |

Table 32
*S. haematobium*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 200 | 250.371 | 10.1339 |
| 2 | 5.1985 | 1.9680 |
| 2 | 0.4215 | 5.9114 |
| 39 | 9.6945 | 88.5876 |
| 1 | 0.7025 | 0.1260 |
| 37 | 14.6120 | 34.302 |
| 1582 | 1531.6290 | 1.6566 |
| 35 | 31.8015 | 0.3217 |
| 1 | 2.5785 | 0.9663 |
| 30 | 59.3055 | 14.4812 |
| 4 | 4.2975 | 0.0206 |
| 67 | 89.3880 | 5.6073 |
| | | $\sum$ = **23.054** |

Table 32
*S. mansoni*

| Observed (O) | Expected (E) | $\frac{(O-E)^2}{E}$ |
|---|---|---|
| 40 | 84.6450 | 23.5475 |
| 1 | 1.7575 | 0.3265 |
| 1 | 0.1425 | 5.1600 |
| 30 | 3.2775 | 217.8770 |
| 0 | 0.2375 | 0.2375 |
| 23 | 4.9400 | 66.0250 |
| 1742 | 1697.3550 | 1.1743 |
| 36 | 35.2425 | 0.0163 |
| 2 | 2.8575 | 0.2573 |
| 39 | 65.7225 | 10.8653 |
| 5 | 4.7625 | 0.6523 |
| 81 | 99.0600 | 3.2926 |
| | | $\sum$=**329.4316** |