INFECTION RATES OF SCHISTOSOMA HAEMATOBIUM AMONG PRIMARY SCHOOL CHILDREN IN GAREN CONSTITUENCY, TANA RIVER COUNTY, KENYA AND THE TYPES OF SNAIL VECTORS

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Thesis submitted in partial fulfillment of the requirements for the award of the degree of Master of Science (Applied Parasitology) in the School of Pure and Applied Sciences of Kenyatta University.

January, 2017
DECLARATION

I declare that this thesis is my original work and has not been presented for degree or any other award in any other university.

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DEDICATION

I dedicate this work to,

Dad and Mum Mr and Mrs Morris Kuta, my brothers and sisters and my lovely husband Mr Muhiri for their inspiration and support that they have always given me. My two sons John and James who persevered to be without their mother many times during my study.

*God bless you all.*
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ACRONYMS AND ABBREVIATIONS

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<tr>
<td>ASALS</td>
<td>Arid and Semi-Arid Lands</td>
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<td>ANOVA</td>
<td>Analysis Of Variance</td>
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<tr>
<td>CAA</td>
<td>Circulating Anodic Antigens</td>
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<td>CCA</td>
<td>Circulating Cathodic Antigens</td>
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<td>DALYs</td>
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<td>HIV</td>
<td>Human Immuno-deficiency Virus</td>
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<tr>
<td>KEMRI</td>
<td>Kenya Medical Research Institute</td>
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<td>NGOs</td>
<td>Non-Governmental Organization</td>
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<td>Tana and Athi River Development Authority</td>
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<td>WHO</td>
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ABSTRACT

Schistosomiasis, also known as bilharziasis, is a parasitic disease caused by blood flukes (trematodes) of the genus Schistosoma. Both urinary schistosomiasis caused by Schistosoma haematobium and intestinal schistosomiasis caused by S. mansoni occur in various regions of Kenya, including the coastal region. River Tana which flows through Garsen, offers breeding sites for Bulinus snails which are the fresh water snail vectors for S. haematobium. Despite the WHO recommending the strategy for control of schistosomiasis by school based mass drug administration with praziquantel every three months in endemic areas, the program has not been rolled out in this area, hence the full extent of the infection in the area was unknown. There was therefore, need to institute studies to explore the extent and intensity of the infection in Garsen area of Tana River County. The objective of this study was to assess the infection rates and intensity of S. haematobium infections among the school going children. The study also determined the main water contact activities influencing infection and also the species of Bulinus snails involved in the transmission of the infection. The target population comprised of primary school going children, aged 8 to 16 years in class 3 to 7, from 5 selected schools in Garsen sub-county. The study was a cross sectional survey which involved collection and examination of urine samples using a microscope for diagnosis as well as quantification of eggs for determination of intensity. Gross examination of urine coloration and reagent strips was used to assess hematuria. Questionnaires were used to collect qualitative data which included occupation of the parents, age of the children and water contact activities. Sampling of snails was done to determine the snail species involved in transmission in the study area. Variations in prevalence of schistosomiasis among age group 8-10, 11-13 and 14-16 were analyzed by ANOVA. T test was used to compare the difference in infection rates and intensities between male and female pupils. Correlation coefficient (r) was used to relate the rate of infection in relation to the proximity to River Tana and irrigated farm. An overall prevalence of 21% was obtained with male pupils recording the highest prevalence of 28%. A total egg count of 3798 eggs per 10 ml of urine was recorded among 63 pupils who were positive. Majority of the pupils had heavy infection intensities. Swimming was the predominant activity among the pupils along the river, while Bulinus nasutus were the predominant intermediate host for S. haematobium in the study area. Data derived from the study will be availed to the Tana River County authority to be used in the implementation of control programs in the area. The study was also used for early diagnosis by determining the intensity of the infection through egg counts and treatment was offered to the patients to reduce the disease from spreading and becoming chronic. It is recommended that the County government of Tana River to come up with control programs for the snails and infected school going children. Also, it is recommended for large scale screening and treatment for the whole community covering all age groups be carried out to evaluate the risk of transmission from the adult population to children.
CHAPTER ONE: INTRODUCTION

1.1 Background information

Schistosomiasis or Bilharzia is a tropical water borne disease which is caused by blood flukes or trematodes of the genus *Schistosoma*. After malaria and intestinal helminthiasis, schistosomiasis is the third most prevalent tropical disease in the world (Hotez and Fenwick, 2009), thus remains an important public health problem globally especially in sub Saharan Africa (World Schistosomiasis Risk Chart, 2010). Schistosomiasis is a neglected parasitic disease. Although it has a low mortality rate, it can damage internal organs and in children impair growth and development (WHO, 2006).

Five species of schistosoma are known to infect humans; *S. haematobium*, *S. mansoni*, *S. japonicum*, *S. mekongi* and *S. intercalatum* (Despommier *et al.*, 2004; Hotez and Fenwick, 2009). Two species common in Africa of main concern to humans are; *S. haematobium* transmitted by *Bulinus* snails and causes urinary Schistosomiasis and *S. mansoni* transmitted by *Biomphalaria* snails and causing intestinal and hepatosplenic Schistosomiasis (Ross *et al.*, 2007; Sang *et al.*, 2014). Resent estimates suggest that 779 million people are at risk of contracting schistosomiasis infection worldwide, an estimated 200 million people are infected of which 20 million are assumed to suffer from more or less a severe form of the disease (Steinmann *et al.*, 2006; Deribe *et al.*, 2011).

The true burden of Schistosomiasis is however underestimated as it is chronic and many people may carry the infection for a long time without showing symptoms. Of the 200 million people with schistosomiasis worldwide 85 % live in Africa where the disease is endemic. Seventy millions of this population may have haematuria associated with *S. haematobium* infection, 18 million suffer major bladder wall pathology and 10 million
suffer from hydronephrosis (Gryseels et al., 2006; Deribe et al., 2011). It is estimated that kidney failure due to *S. haematobium* causes 150,000 deaths per year and the portal hypertension due to *S. mansoni* causes 130,000 fatalities annually. Up to one third of school age children may be actively infected although not always aware of their status (Chidozie and Daniyan, 2008). In Kenya *S. haematobium* is endemic in coastal plains from Lamu to the border of Tanzania, scattered foci in Eastern, Central and western Kenya around Lake Victoria (Muchiri et al., 2006). The risk of infection is also present in the Coastal River basins including lower valley of Tana River extending from the towns of Garissa to Galole through Garsen to the Indian Ocean Coastal line (Kihara, 2013).

In 1993, WHO noted that the prevalence and intensity of the disease have been increased in areas undergoing water resource development, especially irrigation (WHO, 2006). Modern agricultural technology and hydroelectric development has increased the potentials for transmitting *Schistosoma* infection. Fresh water snails which are the intermediate hosts for *S. haematobium* thrive well in such water masses. The Hola settlement schemes in Tana River district in Kenya where there is irrigation for agriculture which begun in 1956 had very few intermediate hosts of the Schistosomes at the beginning, a decade later, the prevalence rates of infection among school children was 70% rising to 90% by 1985 among the Pokomos and Orma (Hilali et al., 1985).

Research has linked urinary schistosomiasis in Kenyan children to anemia and retarded physical growth (Kihara et al., 2011). Such retardation of physical growth in children was reported to affect child’s intellectual capacity and to cause school absenteeism (Chidozie and Daniyan, 2008). Schistosomiasis is also associated with economic losses and
frequently interferes with development projects particularly water development projects such as dams, irrigation schemes, planned and unplanned forestry (Gryseels et al., 2006). In some societies where *S. haematobium* is common, chronic infections persist and are assumed to be normal to pass bloody urine for a while. Unfortunately, years of infection lead to a steady decline in the health of affected tissues and may lead to severe complications such as cancer of the bladder and liver and intestinal complications (Ross et al., 2007). Early diagnosis and treatment is therefore essential to prevent the disease from becoming chronic.

1.2 Statement of the problem

The residents of Garsen constituency are majorly pastoralists’ and farmers. Both groups depend on the waters of River Tana to sustain their livelihoods hence there is constant contact with the river water. Various fresh water snails including *Bulinus* species inhabit River Tana (Blank et al., 2006). Fresh water snails are known for transmission of *S. haematobium* infection thus contact with *Bulinus* infected water may lead to *Schistosoma* infections. River Tana is the main source of domestic water for the villagers’ thus high rate of exposure to infections. Children in this community are involved in various water contact activities in the river which include swimming, irrigating farms, grazing livestock, fetching water, bathing and crossing the river to school (Appendix v), which expose them to high risks of infections (Boelee and Madsoen, 2006; Chidozie and Daniyan, 2008). The government of Kenya established Tana and Athi River Development Authority (TARDA) to irrigate the land along Tana River for food security (Appendix iv). Irrigation canals in many irrigation schemes are known to be major sources of *Schistosoma* infections (Blank et al., 2006). Therefore,
this study was designed to determine the rates of *S. haematobium* infections in school children in the region, the associated vector snails and also the water activities that lead to infections.

1.3 Justification

World Health Organization (WHO) recommended mass drug chemotherapy with praziquantel as a major compound for control of schistosomiasis and there are successful programs in many endemic communities (WHO, 2006; Floy *et al*., 2012; Wanjala *et al*., 2013). Such program was not introduced among the communities in Tana Delta. According to World schistosomiasis risk Chart (2010) the risk of infection is present in the lower valley of Tana River extending from the town of Garissa to Galole and along the Indian Ocean coastal areas from Lamu to Tanzania. However, the full extent of the infection is unknown in the study area. Therefore, the current study aimed at establishing infection rates and intensity which will enable rolling out of *Schistosoma* treatment program in the region and initiation of parasite control programs. School children aged 8 – 16 years were chosen for the study because of the previous studies in Msambweni in the coast province of Kenya which indicated high prevalence’s ranging from 60% to 80% with overall area prevalence of 40% to 50%, among 10 – 17 years old and highest intensity among the 10 – 13 years old children (King, 2006; Muchiri *et al*., 2006; Matonge *et al*., 2013).
1.4 Research questions

a) What is the infection rate of *Schistosoma haematobium* infections among the school going children of age 8 - 16 years in Garsen constituency, Tana River county of Kenya?

b) What are the main water contact activities that influence the transmission of *Schistosoma haematobium* infection among the school children in Garsen area?

c) Which type of snails are associated with the transmission of *Schistosoma haematobium* in the study area?

1.5 Null Hypotheses

i. *Schistosoma haematobium* infections are not present among the School children in Garsen constituency, Tana River county of Kenya.

ii. There are no water contact activities associated with transmission of *S. haematobium* in school children in Garsen constituency.

iii. There are no fresh water snails, intermediate hosts for *S. haematobium* inhabiting River Tana in Garsen constituency.

1.6 Objectives of the study

1.6.1 General objective

To determine the infection rates and intensity by *S. haematobium* among primary school going children of Garsen constituency in Tana River County of Kenya and the type of intermediate hosts involved in the transmission.
1.6.2 Specific objectives

a) To determine the infection rates and intensity of *S. haematobium* among primary school children aged 8 –16 years in Garsen constituency, Tana River county of Kenya.

b) To determine the main water contact activities associated with transmission of *S. haematobium* in school children in the study area.

c) To determine the species of snails that transmits the *Schistosoma haematobium* in the study area.

1.7 Significance of the study

The study established that there were high infection rates among the school going children. This information is important for future targeted control programs of *Schistosoma haematobium* infections among the population. The data on the presence of the infected host snails will also provide a basis for the control programs of the intermediate host to be carried out. The children who were positive with the infection got a chance to be treated early enough to avoid the spread of the infection to other populations.
CHAPTER TWO: LITERATURE REVIEW

2.1 Extent of the effects of schistosomiasis

Schistosomiasis, which is also known as Bilharzia, is a tropical water-borne parasitic disease caused by Schistosoma flukes which affects millions of people (Brooker et al., 2009). Schistosomiasis is confined to fresh water lakes, slow running rivers and streams and stationery water. The infection is also a public health problem in areas set aside for wide scale irrigation such as rice growing schemes and dams because of the high level of water contamination (Boelee and Madsoen, 2006).

Several factors contribute to the high rate of S. haematobium infection in developing countries, these include extreme poverty, lack of knowledge of the risks, inadequate or total lack of health facilities and poor sanitary conditions (Hotez and Kamathi, 2009; King, 2010). The adult Schistosomes are about 7 – 20 mm in length and have a cylindrical body with an oral and ventral sucker (Gryseels et al., 2006). Although S. haematobium do not always result in clinical diseases, and many infections are asymptomatic, the infection produces bladder wall pathology in approximately 10 million people in sub-Saharan Africa and 10 million people suffer from hydronephrosis and renal failure (Maizels et al., 2009).

A significant percentage of women and men with urinary schistosomiasis acquire genital ulcers and other lesions which lead to poor reproductive health including sexual dysfunction and infertility (Kjetland et al., 2006). Apart from organ specific pathology for S. haematobium infections, there is also increasing evidence for more generalized morbidity resulting from chronic inflammation of the long standing infections. The most
important are anemia, stunted growth and malnutrition among children, fatigue, diminished physical fitness and impaired cognitive development among school going children (King et al., 2005; Kjetland et al., 2006).

2.2 Epidemiological factors and transmission risks
Schistosomiasis is prevalent in tropical and sub-tropical areas, especially in poor communities without access to safe drinking water and adequate sanitation. It is estimated that 90% of those requiring treatment for schistosomiasis live in Africa. Schistosomiasis transmission is highly dependent on environmental conditions, particularly those affecting the snail host (Despommier et al., 2004; Opisa et al., 2011). The life cycle of Schistosoma parasite requires a stage in fresh water molluscan snails as an intermediate host and a stage in humans as definitive host in which to undergo development (Gryseels et al., 2006). This ties transmission to landscapes where people and snails come together at the same water habitat.

Fresh water snails survive in slow running stream or river water or in stationary water like open dams (Boelee and Madsoen, 2006). The snails breed underneath the water vegetation or attached to the water plants. Such vegetation also provides shelter from high water flow velocities and is the main source of nutrition for the snails (Kabatereine et al., 2006). Both Biomphalaria and Bulinus species prefer water velocities below, gradual changes in water levels, a slope of less than 20 m/km, firm mud substrate, little turbidity, partial shade and optimal water temperature between 18°C and 28°C (Kabatereine and Stordhard, 2010).
Vegetation, Socio economic and behavioral characteristics of the human community such as water contact behavior and inadequacy of water and sanitation, affect the frequency and intensity of exposure to infected water (Brooker, 2009). People whose occupations are water related such as women during domestic work, fishermen and farmers practicing irrigated agriculture are also the highest risk groups (Kabatereine and Stordhard, 2010). Inadequate hygiene and play habits make children vulnerable to the infection. Migration to urban areas and refugee movements often introduce the disease to new areas. Increasing population size and corresponding needs for power and water usually result in development schemes and environmental modification such as building of dams that also lead to transmission of schistosomiasis such as Sudan Volta Lake, hydroelectric dams such as Kariba dam (Blank et al., 2006).

Urogenital schistosomiasis is also considered to be a risk factor for HIV infection in women (King and Dangerfield, 2008; Mbabazi et al., 2011). Transmission occurs when human beings contact fresh water sources that have been contaminated with human urine that contained *Schistosoma* eggs.

### 2.3 Life cycle of *Schistosoma haematobium*

Schistosomes have an indirect life cycle that requires fresh water pulmonate snails of the *Bulinus* species for *S. haematobium* and *Biomphalaria* species for *S. mansoni* as the intermediate host. The *Bulinus* species include members of the *Bulinus africanus* group which includes *Bulinus africana*, *B. globosus*, and *B. nasutus* (Opisa et al., 2011). Humans become infected after contact with surface water contaminated with the infective cercarie.
The release of cercarie is pronounced around noon and starts 3 to 5 hours after the snails are exposed to sunlight (Luka and Mbaya, 2015). Cercarie are positively phototropic thus congregate towards water surface where human activities are many such as swimming, washing clothes, fishing, farming, for maximum contact with humans. Once in contact with the human skin, they use their oral suckers to adhere to it. They respond to chemicals secreted by the sebaceous glands, particularly the short chain fatty acids, as a signal for skin invasion (Chand et al., 2010). Once they penetrate the skin by the help of the enzyme they secrete, they shed their tail and transform to schistosomuler. Lack of a tail makes the schistosomule use their oral and ventral suckers for attachment as they move. The schistosomule rapidly adapt to the isotonic medium within the human host and undergo morphological and physiological changes prior to migration into the blood stream on route to their final destination in perivascular plexus.

Schistosomuler are carried through the vena cava and access the systematic circulation (Despommier et al., 2004). Majority of the schistosomuler are shunted into the abdominal aorta and gain access to the mesenteric artery, pass through the capillary bed in the intestine and enter portal circulation where they reach the liver. The schistosomuler grow within the blood vessels and pairing of adults on sexual maturation occurs. They migrate against the blood current into the portal venules systems of the urinary bladder for S. haematobium or mesenteric vessels for S. mansoni. Female worm start laying eggs after approximately 30 days.

The life span of adult worms ranges from 3 to 38 years and thus a large number of eggs will be produced in a lifetime which are discharged in urine for S. haematobium or feces for S. mansoni and the cycles is repeated (Odegaard and Hsieh, 2014). When excreted
eggs come in contact with fresh water, they hatch into miracidia. The miracidia larvae have 8-12 hours to infect a suitable snail hosts after hatching from the embryonated eggs. In the snail, the miracidia develops into sporocysts that migrate to digestive gland of the host snail and start producing the cercarie stage. The snail shed an average of 2700 cercarie per day for 18 days (Gryseels et al., 2006). The free swimming cercarie released from the snails infect human and the cycle is repeated.

Figure 2.1 Life cycle of schistosomes, courtesy of CDC (Brooker et al., 2009)
2.4 Pathogenesis
The major cause of pathology is the host immune response to parasite eggs that become trapped in the hepatic sinusoids causing granulomas and subsequent fibrosis (King and Dangerfield, 2008). The adult worms do not replicate within the mammalian host and the extent of the disease depends on the number of adult worms present, their egg laying capacity and their longevity within the host (Odegaard et al., 2012).

2.4.1 Dermatitis
The skin penetration by cercarie may induce early signs and symptoms which include dermatitis with itching and pruritic papular lessons in skin which occur within 15 minutes to 2 – 3 hours after invasion in case of multiple exposures. In endemic areas, cercaricidal dermatitis may pass unnoticed or neglected by affected people (Clive, 2012). However, dermatitis can be more severe in travelers and tourists who have no previous contact with Schistosomes. Tissue oedema with mononuclear cells is observable on histological examination. People with experimental acute dermatological reactions often have high titers of IgE and IgG antibodies (Odegaard and Hsieh, 2014).

2.4.2 Migration
The migration of schistosomuler into the lungs provokes cough and mild fever due to immune response against larvae penetrating bronchial alveoli (Gryseels et al., 2006). Studies in primates and mice have indicated that schistosomes migrating through the lung are associated with accumulation of significant numbers of mononuclear cells such as macrophages that are involved in production of high levels of IFN-γ (Maizels et al., 2009).
2.4.3 Established infection

Acute schistosomiasis occurs about a month after exposure and symptoms are mediated by immune complexes. It begins with the female worm depositing eggs in the blood venules of the host, for *S. haematobium* around 160 eggs per day and 300 eggs per day for *S. mansoni* (King and Dangerfield, 2008). These eggs actively penetrate the tissue of the bladder or intestines to reach the lumen of the bladder or the bowels. However, 50% or more become trapped in the tissue and die within 20 days causing antigenic stimulation (Maizels *et al*., 2009). Soluble egg antigens which are actively excreted through the egg shell induce the CD4+ T cell response which is responsible for the development of granulomas. The granulomas are composed of collagen fibers and cells including macrophages, lymphocytes and the CD4+ T cells. As the egg dies, the granulomas rarely since the tissues are already fibrotic and egg antigen continuously stimulate the immune system. (King and Dangerfield, 2008).

In *S. haematobium*, there is recurrent painless haematuria resulting from ulcers of the bladder (King *et al*., 2005). Burning sensations on micturation, increased urination and discomfort or pain in the lower abdomen are common clinical symptoms of urinary schistosomiasis. It has been suggested that loss of blood causes anaemia (King *et al*., 2005). In *S. mansoni*, katayama fever is common among patients characterized by abdominal pain, diarrhea, cough, fever, fatigue and enlargement of the liver and spleen (Gryseels *et al*., 2006; Deganello *et al*., 2007).

*S. haematobium* infection may be complicated by urinary tract infection during its late manifestation leading to hydronephrosis and hydroureter due to obstruction of urinary tract (Elagba *et al*., 2006; Darren *et al*., 2011), which may lead to renal failure. This is
due to the gradual compression of the kidney parenchyma which leads to the glomerular and proximal convoluted tubes remaining intact for a long time, thus urine cannot pass through.

2.4.4 Female genital Schistosomiasis

Female genital schistosomiasis (FGS) is a common manifestation of *S. haematobium* infection. It occurs when *S. haematobium* eggs are deposited in the female genital tract organs including the bladder, uterus and cervix. The eggs are excreted in the urine and this allows propagation of the parasite life cycle (Brindley and Hotez, 2013). However, many schistosome eggs fail to exit the body and come to embolize within the capillary beds of the pelvic organs especially the tissues of the bladder, ureters, female and male genital organs. In these organs, they induce granulomas and small fibrotic nodules called sandy patches (Botelho *et al*., 2011; King and Dangerfield, 2008). Numerous granulomas and sandy patches cause bladder and urethral inflammation associated with haematuria in more than 50% of the cases (Kjetland *et al*., 2012). Apart from organ deformities in ureteric obstruction, renal infections, renal failure and hydronephrosis occur in millions of people (Botelho *et al*., 2011; Mbabazi *et al*., 2011). Several girls and women with chronic *S. haematobium* infection also experience deposition of eggs with granulomas and sandy patches on their uterus, cervix and lower genital tract (Karl and Savatovsk, 2006).

Clinical manifestations of the FGS include irregular menstruation, pelvic pain, vaginal discharge and post coital bleeding. Other severe consequences of FGS if not treated may be infertility, miscarriage, or ectopic pregnancy. It is estimated that 70 million children currently infected with *S. haematobium* approximately 19 million girls and women will
eventually develop Female genital schistosomiasis in the coming decade (Kjetland et al., 2012). It has also been suggested that FGS may enhance risk of contracting HIV (King and Dangerfield, 2008; Mbabazi et al., 2011). Schistosome eggs have also been located in ectopic locations such as the skin and the central nervous system. Lesions caused by the eggs in the brain result to epileptic signs while lesions in the spinal cord cause acute transverse myelitis (Clive, 2012).

**2.5 Diagnosis of Schistosoma haematobium**

Positive diagnosis of schistosomiasis include several methods such as; medical history of the patient, specific signs to look for on physical examination and relevant supportive laboratory and radiological investigations.

**2.5.1 Parasitological diagnosis**

The most conventional method of diagnosis that has been frequently used is microscopy. *S. haematobium* eggs are released in urine of infected persons and are detected by microscopy of urine samples concentrated by sedimentation, centrifugation or filtration and forced over a filter paper or nitrocellulose filter (Darren et al., 2011). The presence of micro or macro – haematuria in urine has enabled the development and validation of a range of indirect diagnostic tests useful for epidemiological mapping of prevalence, such as the reagent strips (Obeng et al., 2008; King, 2009). Simple interview methods to ascertain a history of haematuria have also been used in determining prevalence.

**2.5.2 Antibody – antigen tests**

Schistosoma infection is highly immunogenic and anti – schistosome antibodies can be detected using a wide range of immunodiagnostic techniques. The antigens are present in serum and urine of infected individuals (Chand et al., 2010). According to their migratory
behavior in immunoelectrophoresis, they are commonly referred to as Circulating Anodic Antigens (CAA) and Circulating Cathodic Antigens (CCA). The ELISA technique uses soluble egg antigens (SEA) as the target (De oliveira et al., 2008; Ibironke et al., 2011).

Measurement of CAA in blood, serum and urine ELISA based assays is sensitive, specific and much less variable than egg counts (Storthard et al., 2006; De oliveira et al., 2008). However, serodiagnosis of schistosomiasis has several drawbacks common to antibody detection techniques such as difficulty in distinguishing active from past infection, with parasite specific antibodies remaining for a long time after cure (Storthard et al., 2006). They also have the inability to measure the intensity of the infection. Despite all this, immunodiagnostic techniques remain the best method for diagnosis in areas of low intensity of infection where sensitivity and specificity of these methods are satisfactory.

### 2.5.3 Ultrasonography

Use of ultrasound method is a noninvasive, radiation free and inexpensive way to assess morbidity (Clive, 2012). Ultrasonography can detect hypertrophy of the bladder mucosa, thickening of the bladder wall and bladder calcification (Clive, 2012). In some patients, calcification of the ureters can be detected. Dilation of the renal collecting system can be detected very early and this represents significant uretic dysfunction. Ultrasonography should be repeated after treatment, about 70% of schistosomiasis bladder lesions regress in less than 12 months after treatment with praziquantel (Clive, 2012).

### 2.5.4 Treatment and control of schistosomiasis

Chemotherapy plays a major role in the control of schistosomiasis and represents the single most effective and practical strategy to control human schistosomiasis
Praziquantel is the drug of choice for treatment of schistosomiasis caused by any of the human Schistosome species (King, 2009; Hotez et al., 2010). It is a single dose drug prescribed to all age groups at a dose of 40 mg/kg body weight. In individuals not cured, the drug causes egg excretion to be reduced by 90%. Praziquantel affects the membrane permeability of the parasite which causes vacuolation of the tegument (Kabatereine et al., 2006). It paralyses the worm and exposes it to attack by the host immune system. Maturing Schistosomes are less susceptible to therapy than adult worms thus praziquantel cannot abort early infection. Praziquantel can be used in pregnant and lactating mothers. Its adverse effects include dizziness, headache, nausea, vomiting, diarrhoea, abdominal discomfort, bloody stool and fever following initiation of treatment (WHO, 2006). These are mostly reactions from dying worms. The reactions are mild and last for 24 hours.

Large scale drug administration through school or community based programs was thought to solve the problem of schistosomiasis transmission and in so doing eliminate the risk of parasite associated diseases (Kihara et al., 2011). Such mass treatment campaigns have been carried out in Kenya which substantially reduce the infections burden and parasite associated morbidity (Clennon et al., 2006; Muchiri et al., 2006). However, they often fail to curb parasite transmission in high risk communities hence fail to prevent re-infection especially where untreated children who do not attend school are many. Thus to break the cycle of transmission, chemotherapy has to be integrated with other control strategies.

WHO welcomes the international momentum in favor of provision of clean water and sanitation to all its member states (WHA, 2012), which will eventually lead to long term
transmission control, provided every household has safe water for daily activities other than their needs for drinking and cooking (Mayra, 2008). Other integrated approaches involve the application of several measures such as; to reduce water contact, snail control interventions such as mollusciding, and health education (Kabatereine et al., 2006; King, 2009). Canal cleaning should be done regularly to remove vegetation and silt in order to create a smoother canal bed and steeper banks allowing higher water flow velocities unsuitable for the snail habitat (King, 2009).
CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area

The study was conducted in Garsen sub County of Tana River County which falls in the Arid and semi-arid lands (ASALS) in the coastal region of Kenya. Its geographical coordinates lies between latitudes 0˚0’53” and 2˚16’11” South and longitudes 38˚25’43” and 40˚7’12” East (Appendix ii). The major physical feature is an undulating plain which is interrupted by low hills while River Tana runs across from the fur North to the South of Tana River County. Rainfall is low, and erratic with mean annual range between 300 mm to 500 mm per year. Rains occur in the months of April to May with seasonal flooding occurring during this period. Average annual temperature is between 25˚C to 30˚C which favors development of snails in the vegetation’s along the river (Schade, 2011).

3.2 Study design

The study was a cross sectional survey for diagnosis of the disease hence laboratory tests were carried out on the urine samples collected from school going children in five selected schools in Garsen constituency.

3.3 Study population

The study population comprised of primary school going children from five selected schools within Garsen Sub County namely, Gamba, Gadени, Reuben Mwewe, Kulesa and Garsen Primary Schools. The schools were selected in relation to distance from River Tana. Kulesa and Reuben Mwewe had close proximity estimated to be < 700 meters from River Tana. Gadени and Garsen primary schools were between 2 – 4 km from River Tana while Gamba Primary school was the furthest from the River more than 7km. Gadени
primary was also close to the Tana and Arthi River Development Authority (TARDA) irrigation scheme.

3.4 Target population
School going children aged between 8 to 16 years in class 3 to 7 were targeted for the study. This age group was chosen because according to (WHO, 2006), it is a high risk age group and it’s known to demonstrate highest prevalence and intensity of infection (WHA, 2012).

3.5 Inclusion and Exclusion criteria
3.5.1 Inclusion
All the school going children in Garsen constituency who had stayed in their respective schools for more than one year were legible to be included in the study.

3.5.2 Exclusion
Girls who were in their menstrual period were excluded from the study to avoid the menstrual blood from getting into the urine to avoid confusing it with microhaematuria due to schistosomiasis.

3.6 Sample size determination
The sampling frame comprised of primary school pupils within the age bracket 8 to 16 years who were in classes 3 – 7:

\[ n = \frac{t^2 x P (1-P)}{M^2} \] (UNICEF, 1995)

Where:

\[ n = \] the desired sample size
\[ t = \text{Confidence level at 95\% standard value of 1.96.} \]

\[ P = \text{Estimated prevalence of schistosomiasis in study area taken to be 25\%.} \]

\[ M = \text{Margin of error at 5\%, standard value of 0.05.} \]

The sample size therefore was calculated as follows:

\[ n = \frac{(1.96)^2 \times 0.25(1-0.25)}{0.05^2} = 288.12 \]

\[ n = \text{Rounded off to 300} \]

The sample size was shared among 5 schools hence for each school,

\[ \frac{300}{5} = 60 \text{ pupils per school were sampled.} \]

Estimated Population for the targeted age groups was calculated by:

\[ N = (n \times D) + 5\% \text{ (UNICEF, 1995)} \]

Where;

\[ n = \text{Sample size} \]

\[ D = \text{design effect assumed to be 2} \]

Thus;

\[ N = (300 \times 2) + 0.05 = 600.05 \]

\[ N = 600 \]

Sampling fraction per class was calculated by;

\[ \text{Sample size per school} = \frac{60}{5} = 12 \text{ students per class were sampled} \]

The desired sampling fraction was calculated by use of the sampling constant K.
Where:

Constant $K = \frac{\text{Class population}}{\text{Sample size per class}}$

Every $k^{th}$ student was selected throughout the register, starting from randomly chosen number e.g. in a class of 40 pupils;

$$K = \frac{40}{12} = 3.33$$

Thus, every third pupil in the class register was selected.

### 3.7 Sampling method

Sixty pupils of ages 8 - 16 years in class 3 – 7 were selected by systematic random sampling of every third pupil per class register from each of the five classes in each school. All the selected pupils were given each a consent form (appendix vii), which their parents or guardians signed to allow them to take part in the study. The pupils were involved in the answering of the questionnaires and also provided urine samples for laboratory examination.

### 3.8 Pre-testing of instruments

The research instruments were pre-tested through a pilot study at Garsen primary school. Ten students were picked at random from the targeted group to provide urine samples for diagnosis and were issued with questionnaires in order to test the clarity, validity, accuracy and reliability of the data collection tools (Appendix viii).

### 3.9 Collection of qualitative data

Administration of questionnaires to each of the pupils selected from the five schools was done in second term during the month of June to July 2013. The questionnaires contained
open ended questions to allow the respondent to answer in their own words and closed ended questions to give the respondent a set of choice or options in their response. They were used to collect demographic data and information on the main water contact activities influencing transmission and also the level of knowledge on schistosomiasis among the pupils. The class teachers in each school were taken through the questionnaires by trained field assistants to assist in the administration of the questionnaires in their classes. They interpreted the questions to pupils who did not understand English. A sample questionnaire is included as appendix I.

3.9.1 Collection of urine samples

Collection of urine was done between the months of September to December in 2013. Urine samples were obtained between 11:00 hours and 13:00 hours. This is the period when maximum numbers of eggs are found in urine (Odegaard et al., 2012). The pupils were given clean, labeled urine containers in school to collect single terminal urine of at least 10 ml and return the containers immediately (Appendix vi). The urine samples were examined immediately by gross observation and by use of reagent strips for presence of haematuria and macrohaematuria.

The samples that tested positive with the reagent strips were separated from those that were negative. All the urine samples were preserved at the collection site by adding two drops of approximately 0.1ml of 1% V/V sodium hypochlorite. Samples from each school were packed in cooler boxes and transported to Malindi at Pathcare laboratories, where they were stored refrigerated as they awaited samples from the other schools. Urine sample collection was conducted for one week, all the samples were then transported by Pathcare in their special vehicles that had coolants to KEMRI laboratories
in Kwale for microscopic examination to determine the presence of Schistosoma eggs (Darren et al., 2011).

3.9.2 Examination of urine for Haematuria

Urine reagent strips for urinalysis called Medi-test Comb 9 (Machery – Nagel, Germany) were used to test for presence of blood in urine (haematuria). Enough strips for immediate use were removed from the bottle and the cap replaced tightly. The plastic end of the strip was held and the reagent area completely immersed in the urine sample (Obeng et al., 2008; Ibironke et al., 2011). It was removed immediately to avoid dissolving out the reagent area. After 60 seconds, the colour of reagent area was compared to the colour chart on the bottle. The result was classified according to the corresponding colour shades (Darren et al., 2011) and values for haematuria. Recording was done as per the following values, 0 was negative, + for 5-10 erythrocyte / micro-liter (ery/μl) which was low, ++ for 50 ery/μl which was medium or moderate and +++ for ≥ 250 ery/μl which was high haematuria.
Figure 3.1 Infected urine-(Gross haematuria).

Container A, urine had very small micro - haematuria results indicated by +, B ++, while in C, the urine sample was bloody (gross haematuria), indicated by +++ (Kjetland et al., 2012).

3.9.3 Examination of urine for Schistosoma haematobium eggs

Nuclepore urine filtration method was used to determine prevalence and intensity of the Schistosoma infection (King, 2006; Clive, 2012; Richard et al., 2014). This method involved passing 10 ml of urine through the microfilm of pore size 15 µm. S. haematobium eggs which are 120 – 150 µm in diameter are bigger than the pore size of the microfilm hence get trapped on the surface of the film. The film was transferred on to
the microscope slide upside down. The film remained fixed to the slide as it was examined under a microscope at a low magnification objective of X10 and X40. A drop of lugol's iodine was added to stain the eggs during examination as described before (Obeng et al., 2008; Odegaard and Hsieh, 2014)

3.9.4 Observation and counting of the *Schistosoma haematobium* eggs

*Schistosoma* eggs were counted per filtrate from 10 ml of urine and recorded according to egg count categories which included; Eggs between 1 to 49 per 10 ml of urine indicated light infection; 50 - 100 eggs per 10 ml indicated heavy infection and above 100 eggs per 10 ml indicated very heavy infection (WHO, 2006; Ibironke et al., 2011; Matonge et al., 2013).

![Schistosoma haematobium egg](image)

**Figure 3.2 Schistosoma haematobium egg (Richard et al., 2014).**
The egg has a terminal spine, which is the distinguishing feature

3.10 Snail survey

Five main water contact sites especially those with children activities and also in relation to the schools and community domestic activities were identified along River Tana for snail survey (Appendix iii). Three sites were close to Kulesa Primary school, Reuben Mwewe and Garsen primary school. The other two sites were located along the canals in
the rice fields close to Gamba and Gadeni primary schools. Snail sampling was conducted at each site by the researcher and two trained field collectors and this was done after every two weeks at each site for a period of three months during the month of January to March 2014. This period was appropriate as rains were being anticipated after a long spell of drought from August to December.

3.10.1 Snails’ collection procedure

Snails were collected using the drag scooping method (El khayat et al., 2009; Opisa et al., 2011). A scoop was made of a dip net with a mesh of about 2 mm\(^2\) area supported by a metal frame and mounted on a wooden handle about 2 M long. The scoop was then pushed through the vegetation or the surface of the substratum and the material collected washed gently for the snails to be picked. Snails collected were placed in containers together with some vegetation and transported to science laboratory at Garsen High School the same day. They were placed in large beakers with some parts of vegetation to keep the water clean for a longer period.

3.10.2 Snail identification and examination for cercarie

The snails were placed individually in large beakers filled with clean fresh water and exposed to direct sunlight for 4 hours to induce shedding of cercarie (Clennon et al., 2007; El khayat et al., 2009). The beakers were then examined for presence of cercarie against the light with naked eyes or with a hand lens after every hour and the snails observed to shed cercarie were recorded and expressed as a percentage of the total snails collected for each site.

Species of the snails were then classified based on a key on the morphology of the shell (Hilali et al., 1985; Opisa et al., 2011). Bulinus species are medium ovoid snails that are
around 12mm long with 2 to 3 whorls (Luka and Mbaya, 2015). They are also sinistrial, meaning they have a left sided aperture. The mean aperture area of each species is significantly different. The aperture area was greater in *Bulinus globosus* than in *Bulinus nasutus*. *B. nasutus* were long spired with 3 whorls while *B. globosus* were short spired with 2 whorls (Appendix ix). The shells were sent to KEMRI laboratories in Kwale for further clarification of the species.

### 3.11 Data analysis

Variation in occurrence levels of urinary schistosomiasis between age sets 8-10, 10-13 and 13-16 years was done by analysis of variance (ANOVA), which was suitable for comparing two or more groups. F test was applied to test for significance. T test was used to compare the difference in infection intensities between female and male pupils. Chi square computation was used to analyze snails collected at different sites. One way ANOVA was used to analyze the water contact activities at the various sites. The results obtained from the analysis were presented in form of frequencies and percentages, in tables and graphs.

### 3.12 Ethical consideration

Permission to conduct research was obtained from Kenyatta University Graduate School. Authorization to conduct study in the five schools was granted by Garsen Sub-County Education office (Appendix x), and the head teachers of the schools. Participation was voluntary and pupils and their guardians were assured that they could withdraw it without any consequences. Written consent of the parents of the children involved was obtained before the start of the study (appendix vii).
CHAPTER FOUR: RESULTS

4.1 Infection rates of *Schistosoma haematobium* among the children sampled in the five primary schools

A total of 300 urine samples from children sampled in five primary schools in Tana River County namely; Kulesa, Garsen, Reuben Mwewe, Gamba and Gadeni primary schools were analyzed for *Schistosoma haematobium* eggs. An overall prevalence of 21% was obtained. Male pupils were 51% of those sampled and had the highest infection rates of 27.5%. Females had a point prevalence of 14.3% (Table 4.1). One tail t-test analysis indicated significantly higher *Schistosoma haematobium* egg count in the male than female participants evaluated (t =3.633; \( P = 0.005 \)). The prevalence on haematuria was 30% in males and 31% in females.

4.1.1 Infection rate by age categories and sex among the pupils sampled

It was evident that the children aged 11 – 13 years had the highest infection rate of 24.5% followed by 8 – 10 years, who had 17.1% while those in age group 14 – 16 years recorded the lowest infection rate of 16.4% (table 4.1). However, it was also noted that the highest number of the pupils sampled, 163/300 equivalent to 54% belonged to age group 11 – 13 years. Analysis of variance indicated that the 11 – 13 years age category had a significantly higher infection rates (\( F = 2.715; P = 0.007 \)), compared to age group 14-16 years.
Table 4.1 Infection rates of *Schistosoma haematobium* among the three age sets

<table>
<thead>
<tr>
<th>Age set (Years)</th>
<th>No. of pupils sampled</th>
<th>Positive with <em>S. haematobium</em> eggs</th>
<th>Positive with haematuria</th>
<th>Infection rate as a %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>8-10</td>
<td>36 34</td>
<td>9 3</td>
<td>10 5</td>
<td>17</td>
</tr>
<tr>
<td>11-13</td>
<td>87 76</td>
<td>28 12</td>
<td>30 17</td>
<td>25</td>
</tr>
<tr>
<td>14-16</td>
<td>30 37</td>
<td>5 6</td>
<td>6 23</td>
<td>16</td>
</tr>
<tr>
<td>TOTAL</td>
<td>153 (51%)</td>
<td>42 (27.5%)</td>
<td>46 (30%)</td>
<td>21 (31%)</td>
</tr>
</tbody>
</table>

Male pupils had a higher infection rate of 27.5%, slightly above the overall prevalence of 21%. Age set 11 – 13 years had the highest infection rate (F= 2.715; P= 0.007)

4.1.2 Infection rates of *Schistosoma haematobium* in schools

Table 4.2, shows the infection rates of pupils in the five schools sampled in relation to their proximity from River Tana. Kulesa Primary School which was the nearest to the River by less than five hundred meters had the highest infection rates of 38.2%, followed by Reuben Mwewe at 21.1%. Gamba Primary was the furthest from the River and had the lowest infection rates of 10.8%. Analysis of variance revealed no significant difference in the infection rates between Kulesa and Reuben Mwewe primary school (F= 2.364; P = 0.053).
Table 4.2: Infection rate of *Schistosoma haematobium* in the five schools sampled

<table>
<thead>
<tr>
<th>Distance to River Tana</th>
<th>School</th>
<th>No. of Pupils</th>
<th>Positive</th>
<th>Negative</th>
<th>Infection rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500M</td>
<td>Kulesa</td>
<td>68</td>
<td>26</td>
<td>42</td>
<td>38.2(^a)</td>
</tr>
<tr>
<td>500 – 700M</td>
<td>Ruben Mwewe</td>
<td>57</td>
<td>12</td>
<td>45</td>
<td>21.1(^a)</td>
</tr>
<tr>
<td>2 – 3km</td>
<td>Garsen</td>
<td>56</td>
<td>10</td>
<td>46</td>
<td>17.9(^b)</td>
</tr>
<tr>
<td>3 - 4km</td>
<td>Gadeni</td>
<td>54</td>
<td>8</td>
<td>46</td>
<td>14.8(^b)</td>
</tr>
<tr>
<td>&gt;7km</td>
<td>Gamba</td>
<td>65</td>
<td>7</td>
<td>58</td>
<td>10.8(^a,b)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>300</strong></td>
<td><strong>63</strong></td>
<td><strong>237</strong></td>
<td><strong>21</strong></td>
<td></td>
</tr>
</tbody>
</table>

Infection rate of *S. haematobium* in different schools. Values with different letters in superscript indicate significant differences of infection rates between different schools (F=2.364, P= 0.053).

**4.2 Intensity of *Schistosoma haematobium* in the children sampled**

This study demonstrated high total count of 3798 *Schistosoma haematobium* eggs per 10 ml of urine among the children sampled, which reflected mean of 60.3 eggs per 10 ml of urine per child. Majority of the eggs shed (66.8%) were from heavy infections. The male pupils recorded the highest total egg count of 2396 than their female counterparts who had a total egg count of 1402. One sample t-test analysis indicated significantly higher *Schistosoma haematobium* egg count in the male than female participants evaluated in different schools sampled (t =3.492; P = 0.003).

Children aged 11 to 13 years had the highest total count of *Schistosoma haematobium* eggs at 2314 eggs per 10 ml of urine whereby 60.1% of the eggs were from heavy infection of >100 eggs per 10 ml of urine. Children aged 8 to 10 years had a total count of
945 eggs whereby 90% of the eggs were from heavy infection of 850 eggs per 10 ml of urine and none had moderate infection of 50 to 100 eggs per 10 ml of urine.

The lowest egg count was recorded in children of age 14 to 16 years with a total of 539 eggs whereby 55.1% of the eggs shed were from heavy infection. Turkey Post-Hoc multiple comparisons test indicated that there was no statistically significant difference in intensity rates between the age group 11-13 years and the other age groups. (F = 1.121; df = 2, p = 0.329). Within the age of 8 – 10 years there was a gradual increase in total count of *Schistosoma haematobium* eggs with children of age 10 years having the highest number of eggs shed. However there was a decrease in the total number of eggs shed in children of ages 14 to 16 years (Table 4.3).

**Table 4.3: Intensities of *Schistosoma haematobium* according to the age categories**

<table>
<thead>
<tr>
<th>Egg counts per 10 ml Of urine</th>
<th>8-10 (n=70 (+ 12))</th>
<th>11-13 (n=163 (+40))</th>
<th>14-16 (n=67(+11))</th>
<th>Totals (n=300(+63))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light infection 0-49 eggs</td>
<td>95 (10.5%)</td>
<td>396 (17.1%)</td>
<td>70 (13%)</td>
<td>561(14.8%)</td>
</tr>
<tr>
<td>Moderate infection 50-100 eggs</td>
<td>0 (0%)</td>
<td>528 (23%)</td>
<td>172(31.9%)</td>
<td>700(18.4%)</td>
</tr>
<tr>
<td>Heavy infection &gt;100 eggs</td>
<td>850 (90%)</td>
<td>1390 (60.1%)</td>
<td>297 (55.1%)</td>
<td>2537(66.8%)</td>
</tr>
<tr>
<td>Total eggs</td>
<td><strong>945(24.9%)</strong></td>
<td><strong>2314(60.9%)</strong></td>
<td><strong>539(14.2%)</strong></td>
<td><strong>3798</strong></td>
</tr>
</tbody>
</table>

Letter n represents the total number of pupils in the age group, (+) indicates the positive individuals. The eggs are total counts per 10 ml of urine.
4.2.2 Intensity of *Schistosoma haematobium* infection in children enrolled in five primary schools sampled

Analysis of *S. haematobium* eggs shed in urine of the pupils sampled in the five schools revealed that Kulesa primary had the highest number of total *Schistosoma haematobium* egg count at 1374 eggs per 10 ml of urine, while Reuben Mwewe, Garsen, Gadeni and Gamba had 930, 645, 467 and 382 total *Schistosoma haematobium* eggs respectively. An overall total of 3798 eggs were recorded from the five schools (Figure 4.1).

![Graph showing egg count per school](image)

**Figure 4.1:** Total number of *Schistosoma haematobium* eggs according to the different primary schools sampled

Kulesa was significantly higher (*F*=0.002; *P*= 0.009) compared to Gamba in total egg count, but there was no significant (*P*= 0.998) when compared with Reuben Mwewe.
4.3: Water contact activities influencing transmission of *S. haematobium*

The results showed that swimming was significantly higher (F=3.5, P=0.032), compared to other water contact activities. Swimming had the highest total count of 115 while bathing, washing clothes, fetching water for domestic use, watering animals and irrigating farms activities counted 36, 42, 15, 29, 56 respectively. Crossing the river to school recorded the lowest count of 7 (Table 4.4).

Table 4.4: Water contact activities potentially influencing transmission of *S. haematobium* obtained from respondents in the 5 primary schools of Tana River County

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of participants n= 300</th>
<th>Number infected n= 63</th>
<th>% infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing the river</td>
<td>7</td>
<td>1</td>
<td>14.3</td>
</tr>
<tr>
<td>Swimming</td>
<td>115</td>
<td>31</td>
<td>27*</td>
</tr>
<tr>
<td>Bathing</td>
<td>36</td>
<td>7</td>
<td>19.4</td>
</tr>
<tr>
<td>Washing clothes</td>
<td>42</td>
<td>3</td>
<td>7.1</td>
</tr>
<tr>
<td>Fetching water</td>
<td>15</td>
<td>2</td>
<td>13.3</td>
</tr>
<tr>
<td>Watering animals</td>
<td>29</td>
<td>6</td>
<td>20.7</td>
</tr>
<tr>
<td>Irrigating</td>
<td>56</td>
<td>13</td>
<td>23.2</td>
</tr>
</tbody>
</table>

Percentage represent the infection rate of each activity. Swimming had the highest number of participants and was of great significance (F=3.5, P=0.032), compared to the other activities.
4.4 Other transmission factors

Demographic data collected from the questionnaires on other major transmission factors are shown in table 4.5 below. Children of farmers represented the largest population (45%) and had a high infection rate of 27%. The pastoralist community followed closely while only a few parents were in business or employed by the government and their children had the lowest infection rate. Majority of the households used water from river Tana for domestic purposes (40%), and this population consist of most pupils who were infected at a rate of 31% (table 4.5).

Table 4.5: Occupation of parents and source of water of the respondents

<table>
<thead>
<tr>
<th>Activity</th>
<th>Occupation of parents</th>
<th>Number of pupils involved n= 300</th>
<th>Number of pupils infected n= 63</th>
<th>% infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td></td>
<td>136</td>
<td>36</td>
<td>26.5</td>
</tr>
<tr>
<td>Pastoralists</td>
<td></td>
<td>74</td>
<td>14</td>
<td>18.9</td>
</tr>
<tr>
<td>Businessmen</td>
<td></td>
<td>38</td>
<td>5</td>
<td>13.2</td>
</tr>
<tr>
<td>Civil servants</td>
<td></td>
<td>52</td>
<td>8</td>
<td>15.4</td>
</tr>
<tr>
<td>Source of water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bore hole</td>
<td></td>
<td>95</td>
<td>15</td>
<td>15.8</td>
</tr>
<tr>
<td>Tap water</td>
<td></td>
<td>56</td>
<td>3</td>
<td>5.4</td>
</tr>
<tr>
<td>River Tana</td>
<td></td>
<td>121</td>
<td>38</td>
<td>31.4</td>
</tr>
<tr>
<td>Rain water</td>
<td></td>
<td>28</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

Letter (n) represents the total population. Percentage represents the infection rates. Pupils of farmers and those that use water from River Tana were highly infected at 26.5% and 31.4% respectively.
4.5 Types of snail intermediate hosts of *Schistosoma haematobium* in the study area

The study investigated the species of snails possibly transmitting *S. haematobium* in the study area by sampling five different locations selected in relation to their proximity to the five schools used in the study. A total of 41 snails were collected. The highest number of snails were found at Kulesa site, followed by Garsen 9, Reuben Mwewe 8, Gadeni 5, and lastly Gamba had 2. Two *Lymnaea natalensis* snails were identified at Kulesa and Reuben Mwewe sites (Table 4.5). Chi square computation indicated a significant difference in the number of snails collected at the site near Kulesa primary, compared to the other sites ($\chi^2 = 13.160$; df = 5; $P = 0.022$). However, there was no statistical difference in the number of infective *Bulinus nasutus* snails shedding cercarie at Kulesa, Garsen, Gadeni and Reuben Mwewe sites ($x^2=0.000$, df =5, P= 1.000).
The high number of *Bulinus nasutus* snails were found at kulesa site correlates. *Lymnaea natalensis* was the other species found at Kulesa and Reuben Mwewe site.

Figure 4.2 Number of snails obtained from different locations neighboring the 5 primary schools sampled

The high number of *Bulinus nasutus* snails were found at kulesa site correlates. *Lymnaea natalensis* was the other species found at Kulesa and Reuben Mwewe site.
CHAPTER FIVE: DISCUSSION

5.1 Infection rates of *Schistosoma haematobium* in primary school pupils in Garsen Area.

The results of microscopic examination of urine samples for *S. haematobium* eggs revealed the occurrence of urinary schistosomiasis among school pupils at a rate of 21% in the five primary schools selected for the study. This point prevalence is slightly below the national prevalence of approximately 24% and similarly, slightly close to the prevalence calculated in the study county at 24.5% by Kihara in 2013. In contrast, this prevalence is significantly lower to the prevalence of 40 – 60% reported in the Coastal area of Kenya (King *et al.*, 2005; Clennon *et al.*, 2006; King, 2006; Matonge *et al.*, 2013). This reduced prevalence can be linked to several factors; (i) Implementation of the awareness campaign and health education of the population, (ii) Efforts to clean up the canals in the irrigation schemes (King *et al.*, 2005), (iii) Free distribution of praziquantel in public hospitals to infected individuals (Kihara, 2013); (iv) Creation of modern water points such as tap water and bore holes that limits the frequency of human water contacts (Muchiri *et al.*, 2006; Clennon *et al.*, 2007).

5.2 Gender and age group difference in infection rates of schistosomiasis

The results of this study indicated that male pupils were more infected at the rate of 27.5% than females who had 14.3%. Similar results were obtained in Nigeria (Chidozie and Daniyan, 2008), and in Tanzania (Clements *et al.*, 2008), where the boys were found to be more highly infected than the female pupils. In Kenya, documented results indicate similarity to the results of this study on the gender difference (Matonge *et al.*, 2013; Muchiri *et al.*, 2006). The current study demonstrated a significant difference among the male and female pupils. Previous studies associate this difference to the boys being
sedentary, that is, they remain in one position for a longer period which gives them compensation to infestation with the schistosomes (Kihara et al., 2011; Hotez and Fenwick, 2009), however genetic link cannot be ruled out. Studies done in BALB/c mice suggest males are more susceptible than females. Activities that indulge males in one position include, frequent bathing in rivers than girls who are restricted by various cultural norms and this could result in the lower infection rates due to reduced contact with infected water. Male children frequently help their parents in farming, padding of canoes and fishing in areas considered infested environments of schistosomes such as flood plains along the river (Brooker, 2009). In this study, pupils in age group 11 to 13 years had the highest infection rate of 24.5%, while 8 to 10 years had 17.1% and pupils of age 14 to 16 had the lowest infection rate of 16.4%. The results are closer to the pattern commonly found where there is a peak in the age group 9 – 14 years and a gradual decrease of the infection gradually as the age increases (Kihara et al., 2011; Verana et al., 2011). The high infection rate of schistosomiasis among the children of 8 to 13 years observed could be attributed to high contacts with cercarie contaminated water through swimming, playing and home chaos as reported previously (Kihara et al., 2011; Chidozie and Daniyan, 2008). Infection rate was lowest in age group 14 to 16 years (16.4%), which corresponds with other studies done by Matonge et al., 2013 and King, 2006 at the coast, in which they attributed the lower infection rate to better hygiene practices in this age category and increase in use of shoes by the pupils.

5.3 Infection rates among the five schools investigated

Among the schools investigated, Kulesa primary school had the highest incidence levels at 38.2%, followed by Reuben Mwewe primary which had 21.1%, while Garsen followed
closely with 17.8% infection rate. This is an indicator that the area had high transmission rates where uncontrolled water contact activities took place and several open water bodies were widely available for domestic and recreational use as reported previously (Blank et al., 2006). Relatively low incidence levels were observed in Gamba and Gadani primary schools at 10.8% and 14.8% respectively. This could be due to reduced access to the cercarie contaminated water from River Tana which is approximately 3 - 7 km from the two schools (Boelee and Madsoen, 2006). In addition, from the interviews conducted it was observed that the children are forbidden to work in the rice farms within the area. The few affected pupils in these two schools were most likely of parents who were small scale farmers in their own farms along the river, and got access to the infected waters while assisting in farming activities.

5.4 Intensity of S. haematobium infections by age and sex

This study found children aged 11 to 13 years had the highest total count of Schistosoma haematobium eggs at 2314 eggs which accounted for 60.93% of the total eggs obtained. Similarly, a slow decline in intensity of the infection was observed in age 14 to 16 years who shed the lowest total eggs. Age specific intensity curves for communities in schistosomiasis endemic areas show a sharp rise in mean intensities of infection from time of first exposure during early childhood until early in the second decade of life (Clements et al., 2008; Deribe et al., 2011; Verana et al., 2011). The intensity of the infection then declines progressively with the increasing age. Individuals shedding 1 – 49 eggs per 10 ml of urine were considered as having light infection, those shedding 50 – 100 eggs per 10 ml of urine as moderately infected while those shading above 100 eggs per 10 ml as having heavy infection (WHO, 2006; Matonge et al., 2013). In this study,
majority of the pupils (62%), had heavy infections which accounted for 66.8% of the total eggs shed. A total of 700 eggs per 10 ml of urine were shed by the moderately infected pupils and this accounted for 18.4% of the total eggs. Pupils with light infection shed a total of 561 eggs per 10ml of urine.

Intensity of S. haematobium infection was sex related (F=5.23, P=0.013). The males had significantly higher intensities of urinary schistosomiasis at a mean of 57.05 eggs per 10ml of urine per individual which represented 63.09% of the total eggs shed. The females contributed 36.91% of the total eggs shed. Previous studies reported a similar pattern on intensity of Schistosoma infection in which the males shed more eggs than females (Muchiri et al., 2006; Matonge et al., 2013; Sang et al., 2014).

5.5 Transmission risk factors

Data collected using the questionnaires on water contact activities indicated that swimming in the river, was the most exercised activity among the pupils followed by irrigating farms and washing clothes in the river. These activities potentially provided a platform for the infective cercarie present in water to infect the children since they stay in the water for a longer period while performing the activities (Kabatereine et al., 2006).

Similarly, in the current study, children of farmers accounted for the highest rate of infection compared with children of other occupational groups. This could be attributed to the fact that they often assisted their parents in farm work in the flood plains of River Tana which could be the main source of infection (Blank et al., 2006). Children of families who used River Tana as their main source of water were also highly infected (32%), than those who used tap water and bore holes. Data on presence of haematuria in
urine samples collected by use of the reagent strips indicated that more girls had blood in urine than boys. However, this trend increased with increase in age among the girls. This could be attributed to the onset of menses among the older girls which also influences the presence of blood in urine (Kihara et al., 2011).

5.6 Snail species transmitting urinary schistosomiasis identified in the study area

In the present study, live *B. nasutus* and its shells were collected in the five strategic points sampled and therefore was the predominant species in the study area. There were fewer live snails than the shells collected in the sites probably because the region was experiencing a dry spell from August to January 2013. Shells were found along the dry sections of the river and dry water pools, an indication that snails existed in the area and could have died. The total number of snails collected were 41 snails from the five sites. The 41 snails were extremely low compared to other studies done along the coastal strip of Kenya in Kwale County where around 300 *Bulinus globus*us and *B. nasutus* were obtained (Kariuki et al., 2004). The reduced amount of water in River Tana due to the drought and drying of seasonal ponds could have led to many snails aestivating due to lack of moisture (El khayat et al., 2009; Opisa et al., 2011), and were thus not easily captured. The small number could also be attributed to the relatively small area of the constituency covered in the current study compared to the study done in Kwale that covered the whole county. Most of the *B. nasutus* snails collected did not shed cercarie when they were exposed to sunlight while placed in fresh water. This could be due to the fact that *B. globus*us are considered more efficient shedders of cercarie than *B. nasutus* (Kariuki et al., 2004; Clennon et al., 2007).
The highest number of snails were collected in the site close to Kulesa primary and this could be due to many water contact activities that were being conducted at the selected site which included small scale farming, swimming and fishing. Presence of vegetation in this site provided a conducive environment for the snails to thrive. The site close to Gadeni primary school located around the middle of the rice farms had relatively fewer snails and shells. This could be attributed to the clean drainage canals that allowed smooth movement of water which could therefore not harbor the snails (Opisa et al., 2011). The site along the river close to Gamba primary school had the least number of snails. This site had few human activities as it was the furthest from the river by more than 7km. The river water was flowing swiftly and fast which could have restricted snails from inhabiting the region. This distance may have restricted most pupils from accessing the river frequently, and thus were least infected.

Two other live snails collected and identified in the study area belonged to the species *Lymnea natalensis*. One was collected at the site near Kulesa primary while the other at the site near Reuben Mwewe primary school. Presence of these fresh water snails which are intermediate host for *Fasciola gigantica* and *F. hepatic*, could be an indication that fasciolosis could be present in the area. This is aggravated by the fact that transmission occurs where rural farming communities regularly share the same source of water with domestic animals (Dalton and Robinson, 2009).
CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

i. The study concludes that *S. haematobium* infection is still rampant in Garsen Sub County as indicated by the infection rates of 21%. Male pupils had a point prevalence of 27.5% while females had 14.3%. The age group 11 – 13 years had significantly high infection rates of 24.5% while the least infected age category was 14 – 16 years. Infection rate in schools decreased with increase in distance from River Tana as observed in Kulesa Primary School which was <500M from River Tana, had higher infection rate than Gamba which was >7KM from River Tana.

ii. Majority of the pupils (62%), had heavy infections shedding >100 eggs per 10ml of urine. The average eggs shed were 60.3 eggs per 10ml of urine per individual. With the egg counts being used as a reflection of the number of schistosomes present in an individual, then majority of these population with heavy infection are assumed to harbor a high number of *Schistosoma haematobium*.

iii. The common predisposing factor in the study area was found to be contact with the waters of River Tana through swimming and carrying out domestic and farm work.

iv. *Bulinus nasutus* species are the main intermediate host of *S. haematobium* in the study area. Two *Lymnae natalensis* snails were collected at Kulesa and Reuben Mwewe site did not shed cercarie. Out of the total, 23.1% of *Bulinus nasutus* snails were found to shed cercarie.
6.2 RECOMMENDATIONS

i. The high prevalence of *S. haematobium* infections in school children suggested that there is need for the public health sector of Tana River County to carry out large scale screening and treatment program for the whole community. Administration of praziquantel can be integrated into the ongoing programme of distribution of albendazole in primary schools in the county.

ii. The current study indicated that the highest percentage of the population, (66.8%) had heavy infections. Therefore urgent treatment should be given to individuals with heavy infection loads to reduce the worm burden within the population. This will help reduce the morbidity and disease complications such as bladder calcification, uterine obstruction, renal failure and renal colic.

iii. The county government of Tana River should ensure supply of clean and safe water to all households within the county especially those in remote areas to avoid use of River Tana water which carries risk of infection.

iv. Snail survey revealed presence of the intermediate host snails in the river where human activities were many. Regular clearing of vegetation by the farmers along these points is recommended to allow smooth and fast movement of water which will reduce development of snails. The county government should come up with plans to control the intermediate host snails from the study area.
6.3 FURTHER RESEARCH

i. Further research is recommended among the adult population using suitable diagnostic tool that is sensitive and specific for example those that detect antibodies, to be used in adult patients who may not be shedding eggs in urine yet may have schistosome lesions affecting their organs. These would inform their inclusion in control strategies since they act as carriers infecting the rest of the population.

ii. Continued research efforts should be made to evaluate occurrence of the disease in rural school age children and other high risk groups in the most remote areas as they are least accessed by most researchers to generate data that can be used in the control programs.

6.4 LIMITATIONS OF THE STUDY

i. The study covered the area along River Tana close to the five primary schools and the area around rice irrigation scheme of TARDA, which means the data may not reflect the infection rate of *S. haematobium* in the entire County.

ii. The ethnic clashes between the Pokomo and Orma communities in 2012 led to many pupils transferring from the area to schools outside the county thus majority of the pupils were not captured.
REFERENCES


within informal settlements of Kisumu City, Western Kenya. *Journal of Parasites and Vectors* 14: 226.


**World Health Assembly (2012).** Elimination of schistosomiasis. *Sixty Fifth World Health Assembly Agenda item* 13. 11. WHA 65. 21


**World Schistosomiasis Risk Chart (2010).** International Association for Medical Assistance to traveller. *Tropical medicine and international health* 10: 1 -5.
APPENDICES

Appendix I

Questionnaire

A sample questionnaire prepared to collect data related to the prevalence of Schistosoma haematobium infection among the school Going Children in Garsen Constituency

My name is Clarice Ong'asia, a student from Kenyatta University taking a master’s degree in Medical Parasitology. I am here to collect information on the rates of Schistosoma haematobium infections among the school going children. You are supposed to answer all the questions in the questionnaire and then provide urine sample for laboratory diagnosis. Those found with the infection will be given drugs which will be provided by Ngao District Hospital.

CODE NO............

NAME OF STUDENT....................................................... AGE............... 

CLASS................................................................. SEX .................

Tick where necessary (   )

1 (i) Do you know a disease called Bilharzia (Kichocho).

(a) Yes (   )
(b) No (   )
(ii) If yes, what causes the disease?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

2, (i) Have you ever contracted the Bilharzia disease?

(a) Yes (     )

(b) No (     )

(ii) If yes, what did you do?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

3 (i) Has any of your family members experienced the symptoms of Bilharzia?

(a) Yes (     )

(b) No (     )

(ii) If yes, who was it?

(a) Father (     )
(b) Mother (     )
(c) Brother (     )
(d) Sister (     )
(e) Male relative (     )
(f) Female relative ( )

(iii) Did the affected individuals above visit a hospital?

(a) Yes ( )

(b) No ( )

(iv) If No, what did they do?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

4. Have you ever seen blood in your urine?

• Boys

(a) Yes ( )

(b) No ( )

• Girls

(a) Yes ( )

(b) No ( )

(iii) If yes, what did you do?

………………………………………………………………………………………………
………………………………………………………………………………………………
5. what is the source of domestic water at home?

a) Water from a borehole (  )
b) Tape water (  )
c) Water from River Tana (  )
d) Pools of rain water (  )

6. (i) Do you get in contact with waters of River Tana?

(a) Yes (  )
(b) No (  )

(ii) If yes, on what occasions?

   (a) Crossing the river to school (  )
   (b) Swimming (  )
   (c) Bathing (  )
   (d) Washing clothes (  )
   (e) Fetching water for domestic use (  )
   (f) Watering animals (  )
   (g) Irrigating farms (  )

7. Have you ever worked at TARDA irrigation scheme?

(c) Yes (  )
(d) No (  )

8 (i) what is the occupation of your parents?
(a) Farmer (  )

(b) Pastoralists (  )

(c) Business people (  )

(d) Civil servant (  )

(ii) If (a) do they wear protective clothes like gumboots and gloves while working?

(c) Yes (  )

(d) No (  )

(iii) Do you assist your parents in their farms?

(a) Yes (  )

(b) No (  )

(iv) If yes, do you wear gumboots and gloves while working?

(a) Yes (  )

(b) No (  )

9. Do your parents work at the TARDA irrigation scheme?
(a) Yes (  )

(b) No (  )

10. Do you have a latrine at home?

(a) Yes (  )

(b) No (  )

II) If no, how do you dispose your wastes?

..................................................................................................................................................

..................................................................................................................................................
Appendix II
Maps of Kenya showing location of Garsen constituency
Appendix III

A map showing location of the schools in Garsen constituency

Reuben Mwewe primary
Gamba primary
Gadeni primary
Kul esa primary
Garsen primary
Appendix IV

Photograph of the flooded plains in the rice fields
Appendix V

Photograph of primary pupils crossing a flooded river to school
Appendix VI

Photograph of pupils of Reuben Mwewe submitting their urine samples
Appendix VII

Sample consent form in Kiswahili language.

Mimi………………………………….., Mzazi wa……………………………,
Mwanafunzi wa shule ya msingi ya…………………… nampa ruhusa motto wangu
ashiriki katika zoezi la kupima ugonjwa wa kichocho shuleni kwa kupeana mkojo wake
upimwe. Kama mzazi nitakubali majibu ya zoezi hilo na kumtibu mototo ikiwa
atapatikana na kichocho.

Sahihi……………………… Tarehe…………………………
Appendix VIII

Results for Pre-testing of instruments at Garsen Primary

<table>
<thead>
<tr>
<th>Age set (Years)</th>
<th>No. of pupils sampled</th>
<th>Positive with <em>S. haematobium</em> eggs</th>
<th>Positive with haematuria</th>
<th>Eggs shed</th>
<th>Infection rate as a %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M  F</td>
<td>M  F</td>
<td>M  F</td>
<td>M  F</td>
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<td>0  0</td>
<td>0  0</td>
<td></td>
</tr>
<tr>
<td>11-13</td>
<td>3  2</td>
<td>2  1</td>
<td>3  3</td>
<td>152  8</td>
<td>30</td>
</tr>
<tr>
<td>14-16</td>
<td>1  1</td>
<td>0  0</td>
<td>0  1</td>
<td>0  0</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>5  5</td>
<td>2  1</td>
<td>3  4</td>
<td>152  8</td>
<td>30</td>
</tr>
</tbody>
</table>
Appendix I

X

Shells of snails intermediate hosts for S. mansoni and S. haematobium
Appendix X

A letter from the ministry of education

[Letter content]

TO WHOM IT MAY CONCERN

RE: ONYANSIA CLARICE KUTA—TSC NO. 519260

The teacher whose particulars appear above is one of our teachers undertaking a Masters Degree in Medical Parasitology at Kenyatta University.

As part of her studies, she is required to collect data on the prevalence and intensity of Schistoma haematobium among the schools within Garsen Constituency, which falls in our area.

Sir/Madam, I highly recommend her for your assistance in an attempt to fulfill her academic requirements, kindly accord her the necessary assistance to help her carry the project.

DISTRICT EDUCATION OFFICER
GARSEN

GEORGE MUGUTI
DISTRICT EDUCATION OFFICER
TANA DELTA DISTRICT
Appendix XI

A letter from the graduate school

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: 156/CE/22434/2010

DATE: 17th September, 2013

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
P.O. Box 30040,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION ONG’ASIA CLARICE KUTA – REG. NO. I56/CE/22434/2010

I write to introduce Ms. Ong’asia Clarice Kuta who is a Postgraduate Student of this University. She is registered for M.Sc degree programme in the Department of Zoological Sciences.

Ms. Ong’asia intends to conduct research for a M.Sc proposal entitled, “The Distribution and Occurrence of Schistosoma Haematobium Infections among Primary School Children in Garsen Constituency, Tana River County, Kenya.”

Any assistance given will be highly appreciated.

Yours faithfully,

[Signature]

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL
Appendix XII

A letter from KEMRI

KEMRI/CMR/KWAL/LAB/001

6th January 2013

To whom it may concern;

Dear Sir/Madam;

REF: ONGASIA CLARICE KUTA

The above named individual being a master’s student in applied medical parasitology at Kenyatta University successfully carried out her research experiments for testing of Schistosoma haematobium eggs in urine samples collected from primary school students in Tana Delta County.

Qualified staff members were assigned to assist her in her research and in classifying the Bullins species of snails obtained from River Tana using the shells sent to the laboratory.

Thanks in advance.

Yours faithfully

[Signature]

Amos Lewa Mvavita,
Laboratory Head.

In Search of Better Health