PREVALENCE AND INTENSITY OF THE COMMON PARASITIC INFECTIONS AND ANAEMIA IN STREET CHILDREN COMPAIRED TO SCHOOL GOING CHILDREN IN KISUMU CITY, KENYA.

BY

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DECLARATION

I declare that this thesis is my original work and has not been presented to any other University or Institution for a degree or any other award.

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DEDICATION

I dedicate this achievement to my mother, my mentor and best friend, The Late Holliness Zighe for her dedication and sacrifice to ensure I got the best in my education. Today I celebrate you for the milestone I have achieved.

My dear husband Charles Nyawade and Children Abby Henry and Mariah thank you for the perseverance, encouragement and emotional support when I was burning the late-night candle. A toss for you!!

My family and friends, thank you for your prayers and encouraging words. May the Lord above bless each one of you in a special way.

ABSTRACT

Street children are exposed to environmental, socioeconomic and behavioural factors that increase risk of parasitic infections and are excluded from disease control programmes. The prevalence and intensity of parasitic infections as well as the link between the parasitic infections and anaemia status of these children is not known. Epidemiologic information on parasitic infection among street children in Kenya is required for developing appropriate control programs. This was a comparative cross-sectional study that aimed to determine differences in prevalence and intensity of the common parasitic infections and level of anaemia between street children and age matched school going children, in Kisumu city, Kenya. Stool and blood samples were collected from 132 purposively sampled children below 18 years of age who lived in the streets of Kisumu and were age matched to randomly selected 132 school going children of Manyatta primary school, Kisumu. Stool samples were examined for intestinal parasitic infections using Kato-Katz. Blood samples were examined for malaria by microscopy and parasite densities was estimated in giemsa-stained thick blood films. Significant differences in the prevalence of parasitic infections between street and school going children were determined using Chi-square test. Significant differences in intensities of parasitic infections and anaemia between street children and school going children was determined using Mann Whitney test. Odds ratio was calculated to determine the strength of associations between parasitic infection and study residence site. All tests were two-tailed and P value < 0.05 was considered statistically significant. The prevalence of hookworm, *S.mansoni*, and *Plasmodium falciparum* malaria were significantly higher in street children than school going children ($\chi2$=6.652, df=1, P= 0.019; $\chi2$=66.027, df=1, P<0.001 and $\chi2$=6.177, df=1, P=0.013, respectively). The mean parasite densities of *Plasmodium falciparum* malaria (P<0.001) and infection intensities for hookworm (P< 0.001), *Ascaris lumbricoides* (P=.031) and *S.mansoni* (P<0.001) were also found to be significantly higher in street children than in school going children. The mean haemoglobin density was significantly lower in street children than in school going children (P = 0.023). Binary logistic regression showed that street children had significantly higher odds of having hookworm (OR=18.2; 95% CI=2.29 to 143.8; P<0.006), *Ascaris lumbricoides* (OR=2.68; 95% CI=1.06 to 6.75; P< 0.036), *S. mansoni* (OR=23.53; 95% CI=10.31 to 53.68; P<0.001) and *Plasmodium falciparum* malaria (OR=4.22; 95% CI=2.01 to 8.85; P<0.001) infections than school children. The study demonstrated that parasitic infections are more prevalent among street children than in school going children. Thus, intervention programs for prevention and control of parasitic infections, such as deworming, should be extended to cover the street children who may act as reservoirs of the parasites.

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ACRONYMS AND ABBREVIATIONS

CDC	Center for Disease Control
CRA	County Assessment
DALY	Disability-adjusted Life Year
g/l	gram per liter
GBD	Global Burden of Disease
Hb	Haemoglobin
HIV	Human Immune Virus
ID	Identity
IRS	Indoor Residual Spraying
IQR	Interquartile Range
ITN	Insecticide Treated Net
KIHBS	Kenya Integrated House Hold Budget Survey
Nacl	Sodium Chloride
NGO	Non-Governmental Organisation
QC	Quality Control
RBM	Roll Back Malaria
RDT	Rapid Diagnostic Tests
SBD	School Based Deworming
SPSS	Statistical Package for Social Sciences.
STH	Soil Transmitted Helminthes
TB	Tuberculosis
UNDCCP	United Nations Office for Drug Control and Crime Prevention
UNICEF	United Nations Children Fund
WHO	World Health Organisation
P. vivax	*Plasmodium vivax*
P. Ovale	*Plasmodium Ovale*
S. mansoni	*Scistosomiasis mansoni*
A. lumbricoides	*Ascaris lumbricoides*
G. lamblia	*Ganglia lamblia*
E. histolytica	*Enterobiais Histolytica*
T.trichuria	*Trichuria trichuris*

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

Street children are labelled as *children in difficult circumstances*, which represent a minority population and have been under- represented for too long in health research (UNICEF, 2005). They are also defined as persons under 18 years of age who spend all or most of their time on the streets, maintaining little or no contact with their families, hence lacking supervision, protection and guidance (UNODCCP, 1997).

It was estimated in 2007, that the number of street children in Kenya was between 250,000 and 300,000 with more than 60,000 in Nairobi (IRIS, 2007). In Kisumu, the population of street children is estimated at 1069, of which 782 are boys and 287 are girls (Personal Communication, Charles Odongo, Head of Children Department, Kisumu, (2014). Street children bear a greater disease burden (UNICEF 2012). Street children including those in Kisumu city, Kenya, are exposed to environmental, socioeconomic and behavioural factors that increase risk of parasitic infections (Kwamboka *et al*., 2013). Children are the most affected group and serve both as source of infection and as victims, thus contributing to transmission of most parasitic infections within the community (Roma *et al*., 1997). These infections have detrimental effects on their survival, growth, physical fitness, school attendance and cognitive performance (Noor *et al*., 2014).

Most endemic countries for soil transmitted helminthes infections (Pullan *et al.*, 2010) are implementing mass drug administration either through School based deworming (SBD) Programme or Lymphatic Filariaisis control program (WHO, 2014). In 2012, The Kenyan Ministry of Health and Education began school based deworming programme in 66 districts (now sub-counties) with high STH and schistosomiasis infection in Western, Nyanza, Rift valley and Coast regions for school age children. The goal of SBD was to reduce the prevalence of moderate to heavy infection to less than 1% such that the infections are no longer of public health importance (Kenya National School-Based Year 1 (2012–2013, 2013). A mid-term assessment on impact of school based deworming programme showed the prevalence of ascariasis, hookworm disease, trichuriasis in school children to have reduced from 18% to 11.9%, 15.4% to 2.3% and 6.7 to 4.7% respectively but because of reinfection due to ongoing transmission, infection levels are yet to fall to very low levels (Okoyo *et al*., 2016). School based deworming has many benefits for treated children but it does not prevent re-infections, which can occur rapidly after treatment (Jia *et al*., 2012). To interrupt transmission of these parasites all members of the community must be included in helminth control strategy, this includes street children (Mwinzi *et al*., 2013).

Globally, the number of malaria deaths was estimated to be 214 million in 2015 in which most cases are estimated to have occurred in the African children (WHO, 2016). The age distribution of cases of malaria is influenced strongly by the intensity of malaria transmission. In high transmission areas, the main burden of malaria, including nearly all malaria deaths, is in young children (Snow & March 2002; Carneiro *et al*., 2010). Malaria remains a leading cause of morbidity and mortality in Kenya where the lake endemic zone has the highest prevalence of malaria (27%) compared to other zones among children aged 6 months -14 years (malaria indicator survey, 2016).

Malaria is inextricably linked with poverty (Kenya Malaria Report, 2012). According to World malaria report (2012), countries with higher proportions living in poverty have higher death rates from malaria. Poor populations (street children included) are prone to malaria infection because they are not likely to be living in housing that offers little or no protection against mosquitoes bites, with no access to preventive measures such as insecticide treated bed nets (ITNs) or indoor residual spraying (IRS) (World malaria Report, 2012). Intensified control efforts in pregnant and young children have reduced the level in transmission in many parts of Sub Sahara Africa (O' Meara *et al*., 2010; Noor *et al*., 2014). These efforts may increase disease risks among older children who attend school. Many school-aged children continue to harbour asymptomatic parasitaemia, which can cause anaemia. As a consequence children are acquiring immunity to malaria more gradually than in the past and clinical attacks, sometimes severe, are occurring in school-age children more frequently. However, the epidemiology and management of malaria in school-age children has, until recently, received little attention (Brooker *et al.* 2008; Brooker 2009).

Anaemia has serious public health significance in the world and it is an important indicator of poor health (Anaemia Policy Brief, 2012). Anaemia affects all stages of life but children and pregnant women are the most at risk segment of the community (Aikawa *et al*., 2006). Although iron deficiency is an important cause of anaemia, globally, other co-founding factors such as intestinal parasites and *P. falciparum* malaria are also major causes of anaemia in children (WHO report, 2003; WHO, 2012). Hookworms *(Necator americanus and Ancylostoma duodenale)* (Smith *et al*., 2010) and *S. mansoni* infection (Mwandawiro *et al*., 2013) have been seen to be associated with anaemia. The continuous presence of intestinal parasites in marginally nourished children can cause severe anaemia and subsequently affect growth and development in these children. Anaemia also affects the health of older girls as they reach puberty, potentially impacting upon future motherhood and the nutrition of the next generation of learners (School, 2005; Dharmalingam *et al*., 2010).

Fortunately, there are a number of cost effective interventions to avert the burden of anaemia, this include malaria control (Clarke *et al*., 2008) deworming, school feeding (Bundy *et al*., 2009), iron supplementation (Leenstra *et al*., 2009) which are increasingly delivered as part of an integrated school health package. However, street children may not benefit as they are not considered in the school intervention control programs. The limited available data consistently indicate that street children often suffer from many health problems including anaemia. Interventions for such vulnerable group such as street children must be based on epidemiological information. This study shall determine the epidemiology of anaemia levels in street children in Kisumu.

1.2 Statement of the Problem

Street children comprise members of a vulnerable society with less access to consistent healthcare. They are exposed to environmental, socioeconomic and behavioural factors that increase risk of parasitic infections. These parasitic infestations can result in malnutrition, anaemia, stunted growth, impairment in intellectual and cognitive development of children, with potential long term consequences for productivity in adulthood and economic development.

Kenya Implemented mass drug administration through School based deworming (SBD) Programme to control intestinal helminths infections in school aged children. School based deworming has many benefits for treated children but it does not prevent re-infections, which can occur rapidly after treatment. To interrupt transmission of these parasites, all members of the community must be included in helminth control strategy, this includes street children. Therefore, epidemiologic information on the prevalence and intensities of common parasitic infections among street children in Kisumu city, Kenya is important for more effective parasite control programs among street children.

The continuous presence of intestinal parasites in marginally nourished children can cause severe anaemia and subsequently affect growth and development in these children. Fortunately, there a number of cost effective interventions to avert the burden of anaemia, this include malaria control deworming, school feeding, iron supplementation which are increasingly delivered as part of an integrated school health package. However, street children may not benefit as they are not considered in the school intervention control programs. Interventions for such vulnerable group such as street children must be based on epidemiological information. This study shall determine the epidemiology of anaemia levels in street children in Kisumu.

1.3 Objectives of the Study

1.3.1 General Objective

To compare the prevalence and intensities of common parasitic infections and anaemia between street children and school going children in Kisumu city, Kenya.

1.3.2 Specific Objectives

i. To compare the differences in the prevalence and intensity of (ascariasis, hookworms, trichuriasis, shistosomiasis, amoebiasis, and *P. falciparum* malaria) between street children and age matched school going children.

ii. To compare the differences in the level of anaemia in street children and age matched school going children.

1.4 Null Hypothesis

i. There are no differences in prevalence and intensity of parasitic infections in street children and age matched school going children.

ii. There are no differences in the level of anaemia in street children and age matched school going children.

1.5 Significance of the Study

The results of the study has provided epidemiological information on the prevalence and intensity of parasitic information and anaemia which is necessary to formulate intervention measure for such vulnerable group. The results of the study may provide an opportunity for scholars who have main interests in the health of street children to have access to a wide scope of evidence to inform their research. The study provides more understanding on the health of street children which will be essential for children department in implementing and formulating policies that regards to the health of street children. The study has provided gaps for further research such as anaemia in street girls and also factors that are contributing to high prevalence of soil transmitted helminthes and malaria in these street children.

CHAPTER TWO

LITERATURE REVIEW

2.1 Intestinal Helminthes

Soil transmitted helminthes are distributed globally and constitute a considerable public health problem, mostly in developing countries. The estimated global prevalence of geo helminthes is over 1 billion cases of ascariasis, 740 million cases of hookworm disease and 795 million cases of trichuriasis (WHO, 2010). In which ascariasis and trichuriasis is seen to be the most prevalent geo-helminth affecting collectively 2 billion adults and children worldwide and of these, about 90 million school children are infected in sub-Saharan Africa including Kenya (WHO, 2010). Infection is associated with ingestion of eggs from contaminated soil (*A. lumbricoides* and *T. trichuria*) or by an infective penetration of the skin by larvae in the soil (hookworms) Vandemark *et al*., 2010).

Schistosomiasis remains a serious public health issue in Kenya (WHO, 2012). The World Health Organization (WHO) estimates that over 237 million persons required treatment of schistosomiasis in 2010 (WHO Schistosomiasis, 2010) with estimates of up to an additional 779 million at-risk globally (Steinmann *et al*., 2006). In Kenya, over 6 million people are estimated to be infected with schistomiasis and many more are at risk (Chitsulo *et al*., 2000).

Children are infected more often than adults (Bethony *et al*., 2006). The age distribution of infection rates and intensity of schistosomiasis is generally attributed to high levels of contact with cercariae-contaminated water among school-aged children and adolescents followed by less water contact and the development of an acquired protective immunity against infection in older adolescents and adults (Dalton *et al*., 1978). Protozoan intestinal infections are the cause of over 58 million cases of diarrhoea in children every year (Savioli *et al*., 2013) Amoebiasis is the second most common cause or death due to parasitic infection after malaria as estimated by the World Health Organization (WHO, 1997). Although amoebiasis is transmitted by direct contact with dirty hands or objects or through sexual contacts, the primary mode of transmission is through faecal contamination of drinking water and foods (Ravdin, 1988). The little information available from developing countries suggests that amoebiasis occur most frequently in children. Generally, infection rates in children less than ten years of age are 2-3 times higher than those in adults. Similar studies have confirmed high prevalence of *G. lamblia and E. histolytica* in children (Abbas *et al.*, 2011; Ngojo *et al*., 2012; Chala *et al*., 2013). In Kenya, amoebiasis has been reported in school age children in Thika and Webuye (Ngonjo *et al*., 2012; Obala *et al*., 2013).

Children are the most affected group and serve both as source of infection and as victims, thus contributing to transmission of most parasitic infections within the community (Roma *et al*., 1997). These infections have detrimental effects on their survival, growth, physical fitness, school attendance and cognitive performance (Noor *et al.*, 2014*).* Geo helminthes are endemic in 166 countries (Pullan *et al.*, 2010) with majority implementing mass drug administration either through School based deworming (SBD) Programme or Lymphatic Filariaisis control program (WHO, 2014).

In 2012, The Kenyan Ministry of Health and Education began school based deworming programme in 66 districts (now sub-counties) with high STH and Schistosomiasis infection in Western, Nyanza, Rift valley and Coast regions for school age children. The goal of SBD was to reduce the prevalence of moderate to heavy infection to less than 1% such that the infections are no longer of public health importance (Kenya National School-Based Year 1 (2012–2013, 2013). A mid-term assessment on impact of school based deworming programme showed the prevalence of ascariasis, hookworm disease, trichuriasis in school children to have reduced from 18% to 11.9%, 15.4% to 2.3% and 6.7 to 4.7% respectively but because of reinfection due to ongoing transmission, infection levels are yet to fall to very low levels (Okoyo *et al*., 2016). School based deworming has many benefits for treated children but it does not prevent re-infections, which can occur rapidly after treatment (Jia *et al*., 2012). To interrupt transmission of these parasites all members of the community must be included in helminth control strategy, this includes street children (Mwinzi *et al*., 2013).

Street children are prone to parasitic infections because of the unhealthy habits while on the street which include, eating exposed and dirty foods, lack of personal hygiene due to sleeping on the streets and working in various unhealthy environment, and washing in rivers and fountains in public squares (UNDCCP, 1997). Intestinal parasitic infections are associates with poor sanitation and limited access to drinking water, both of which are more common in resource -constrained settings (WHO, 1997). Many street children do not seek treatment for infections hence they remain as reservoir for infectious diseases transmission (Mekonnen *et al.,* 2013). Street children are considered "hard to reach population" because they are difficult for researchers to access. Parasitic infections in street children is understudied. The prevalence of parasites amongst street children has been reported in other countries; however, these reports are few (Bailey *et al*., 2013). Parasitic infections are more prevalent among street children than non-street children (Greksa *et al*., 2007).

Studies in Africa have shown that parasitic infections among street children are caused by worms such as: *Ascaris lumbricoides* and schistosomes (Cumber *et al*., 2015). In Addis Ababa, a study was done in street dwellers on the prevalence of intestinal parasites that showed *A. lumbricoides* to be the most common helminthic infection due to consumption of leftover food (Mekonnen *et al*., 2013). High prevalence of soil transmitted helminths is seen as a good indicator of improper faecal disposal among the street children participants (Mekonnen *et al*., 2013). Studies that were done in Phillipines where the study participants were street children also showed *A. lumbricoides* and *T. trichiuris* which are the hand to mouth infection mode had the highest prevalence of 40 per cent (Baldo *et al*., 2004). Intensity of infection with *A. lumbricoides* and *T.trichuria* generally reaches its peak in school age children (WHO, 1967). A Study was conducted in Nigeria and Kenya and the results showed that school children are mostly affected by *A. lumbricoides* (Bassam *et al*., 2008, Mwandawiro *et al*., 2013). Further studies have also been done in Kenya, Thika District that showed the varying intensity of Ascaris infection among children living in urban and rural areas. In rural and slum areas, the intensity of *A. lumbricoides* was higher than in peri urban and urban areas (Ngonjo *et al*., 2012). Any number of Ascaris can be dangerous to the host, since a single worm can cause liver abscess or block the common bile duct. However, large number of Ascaris infection increases this possibility (WHO, 1967; WHO, 2002).

From a public health point, any infected person with ascariasis can be a source of reinfection, but those with heavy infections are more dangerous (WHO, 1967). Studies conducted in Babile showed that the prevalence of hookworm infection was significantly lower in children who wore shoes regularly (Tadesse, 2005). Another study done in Kenya showed that hookworm infection was significantly higher in the rural and peri-urban schools than in urban and slum school (Ngojo *et al*., 2012). Although hookworm infections also occur in childhood, frequency and intensity commonly remain high in adulthood (WHO, 2002). The adult stages of the blood sucking nematode *Anylostoma duodenale* are found attached to the mucosa of the small intestine, particularly of the jejunum (Marsden, 1978).

High intensity infection of *T. trichiura* include *T. trichiura* dysentry syndrome, chronic dysentry, reduced iron status and iron deficiency anaemia, and poor growth rate (Stephenson *et al*., 2000). *T. trichiura* often occurs concurrently with hookworm infections and so may well accelerate the onset of iron deficiency anaemia (WHO, 2012).

Malaria

Despite global efforts, malaria is increasing worldwide (World Malaria Report, 2015). In 2015, approximately 3.2 billion people – nearly half of the world's population – were at risk of malaria. Most malaria cases and deaths occur in sub-Saharan Africa (World Malaria Report, 2015). The age distribution of cases of malaria is influenced strongly by the intensity of malaria transmission. In high transmission areas, the main burden of malaria, including nearly all malaria deaths, is in young children (Snow & March 2002). Malaria remains a leading cause of morbidity and mortality in Kenya where the lake endemic zone has the highest prevalence of malaria (27%) compared to other zones among children aged 6 months -14 years (Malaria indicator survey, 2016). A study that involved school going children showed marked variation across the country, with prevalence being highest in western and Nyanza provinces (Gitonga *et al*., 2010). *Plasmodium falciparum* is the most prevalent parasite species where malaria infections are endemic (World Malaria Report, 2012; Kenya Malaria Indicator Survey, 2010; Nwaorgu *et al.,* 2010).

However, intensified control efforts in pregnant and young children have reduced the level in transmission in many parts of Sub sahara (O' Meara *et al*., 2010; Noor *et al*., 2014). These efforts may increase disease risks among older children who attend school. Many school-aged children continue to harbour asymptomatic parasitaemia, which can cause anaemia. The epidemiology and management of malaria in school age children has, until recently received little attention (Brooker *et al*., 2008; Brooker *et al*., 2009). Asymptomatic parasitemia is prevalent in malaria endemic areas of Africa (Meta *et al.*, 2004). Since asymptomatic carriers do not seek treatment of their infection and are not identified by clinical diagnosis in health facilities, they serve as source of infection for vector mosquitoes (Andrade *et al.*, 2010) and may lead to anaemia (Kurtzhals *et al*., 1999).

Malaria is inextricably linked with poverty (Kenya Malaria Report, 2012). World Malaria Report (2012) indicates that countries with higher proportions of their population living in poverty have higher death rates from malaria. For example, the National Commission for Children in Rwanda reported that the most frequent disease amongst street children was malaria, with 52.9 per cent in Rwanda in the year 2012 (National Commission of Rwanda, 2012). Poorer populations (street children included) are prone to malaria infection and disease as they live in housing that offers little or no protection against mosquitoes and are generally less likely to have access to bed nets, and are less likely to visit health facilities that can offer effective diagnostic tests and treatment (World Malaria Report, 2012).

Anaemia

Anaemia is an important indicator of poor nutrition and health (WHO, 2011). Yet many children enrolled in school suffer from poor health and malnutrition and as a result likely hood of not attending school and hence not achieving their potential (UNESCO, UNICEF, WHO & World Bank, 2000). Childhood anaemia remains a significant global health problem that is estimated to affect over 25% of the world's population. It is estimated to affect half the school age children and adolescents in developing countries (WHO, 1994). Despite the fact that iron deficiency is considered as the primary cause of anaemia, other co-existing factors such as intestinal parasites and malaria are also major causes of anaemia in children (WHO report, 2003; WHO, 2012). Studies conducted in Palestine showed that the risk of anaemia in children with intestinal parasitic infections appeared to be attributed to the robust contribution of double parasitic infections rather than single parasitic infections except for *A. lumbricoides* and *G. lamblia* (Bassam *et al*., 2009).

There is a strong association between heavy intensity of *S. mansoni* infection, anaemia and haemoglobin levels. Hence children heavily infected with *S. mansoni* are more likely to be anaemic compared with uninfected children (Koukaunari *et al*., 2008). In Kenya, studies have shown evidence on association of anaemia with *S. mansoni* (Mwandawiro *et al*., 2013). Trichuriasis often occurs concurrently with hookworm infections and so may accelerate the onset of iron deficiency anaemia (WHO, 2002). In a situation where the worm burden is significantly high in an individual, infection is normally severe with iron deficiency anaemia. In most developing countries, for instance, anaemia in pregnancy has been associated with worm infestation, especially hookworm (Hotez *et al*., 2009). The continuous presence of intestinal parasites in marginally nourished children can cause severe anaemia and subsequently affect growth and development in these children.

Anaemia also affects the health of older girls as they reach puberty, potentially impacting upon future motherhood and the nutrition of the next generation of learners (School, 2005; Dharmalingam *et al*., 2010). Fortunately, there a number of cost effective interventions to avert the burden of anaemia , this include malaria control (Clarke *et al*., 2008) deworming, school feeding (Bundy *et al*., 2009), iron supplementation (Leenstra *et al*., 2009) which are increasingly delivered as part of an integrated school health package. The limited available data consistently indicate that street children often suffer from poor health. Street children suffer from many health problems including anaemia. However, street children may not benefit as they are not considered in the school intervention control programs. Interventions for such vulnerable group must be based on epidemiological information.

CHAPTER THREE

STUDY DESIGN METHODS

3.1 Study Area

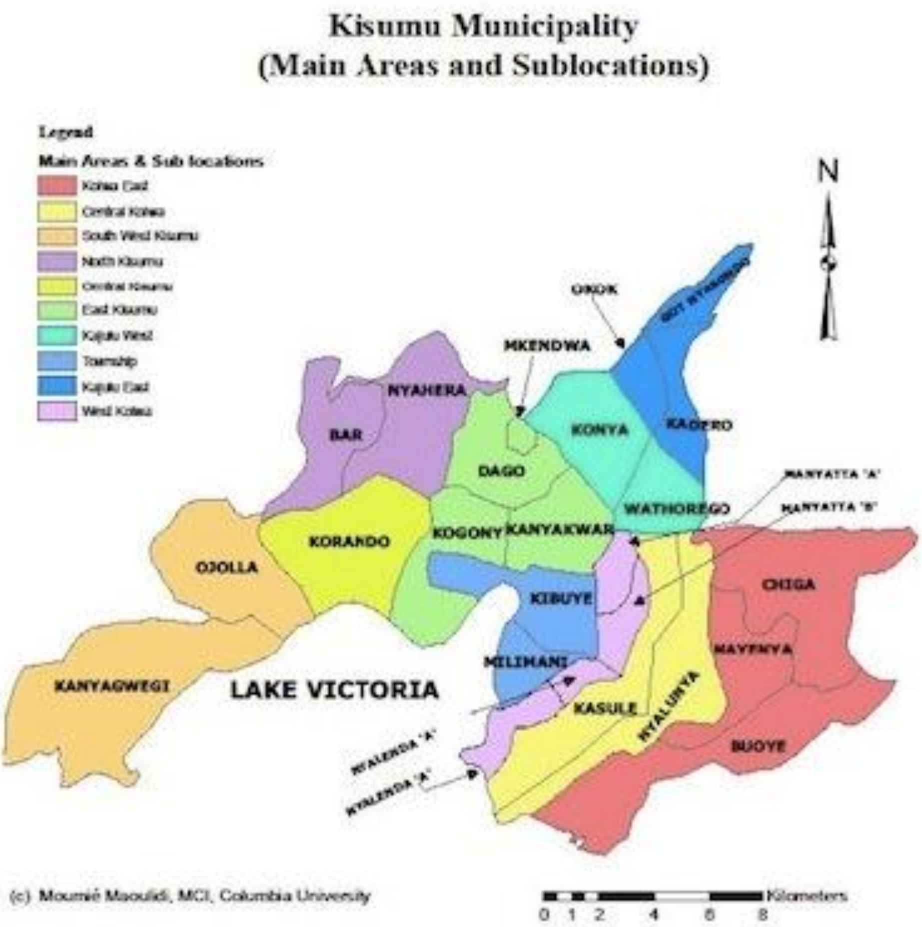


Figure 3.1 Study Area (Latitude 0° 6′ 0″ S, Longitude 34° 45′ 0″ E)

Kisumu County sits on the shores of Lake Victoria. It has 7 sub counties of which Kisumu East District has the highest population of 388,311 persons (Kenya National Bureau of Statistics, 2009). Kisumu east district has the highest population of street children who are estimated to be 700 (Kisumu County Children Department). The county has an annual relief that ranges from 200mm to 1300mm in different sectors. Kisumu is warm throughout the year with a mean of 23^{0}C. Humidity is relatively high throughout the year.. Kisumu agricultural sector is thriving with rich sugar and rice irrigation projects. Livestock farming is on a subsistence basis.

3.2. Study Design

This was a comparative cross-sectional study.

3.3 Study Population

Kisumu East has the largest population of street children in Kisumu County, Kenya, with 700 children on the streets (481 boys and 219 girls) (Kisumu Children department, 2016). Study participants included street children and their age- matched school going children who are below 18 years of age and residents of Kisumu Town. In Kenya, schistosomiasis and Malaria remains a major public health concern particularly around Lake Victoria (Nagi *et al*., 2014, Noor *et al*., 2009).

3.4 Sample Size Determination

The following formula was used to determine sample size (Whitley and Ball, 2002);

$$n = \frac{r+1}{r}\frac{(p^*)(1-p^*)(Z_{\beta}+Z_{\alpha/2})^2}{(p_1-p_2)^2}$$

Where;

- **n** is the sample size in the case group.
- **r** is the ratio of controls to cases.(r=1 for equal number of cases and controls)
- **p*** = Average proportion exposed= (Proportion of exposed cases + proportion of control)/2
- **(p_1-p_2)** is the effect size or difference in proportion expected based on previous studies; p1 is in proportion in cases and p2 proportion in control
- **Z_{β}** = Standard normal variate for power= typically 0.84 for 80% power
- **Z_{α}** = Standard normal variate for level of significance= typically 1.96 for $P< 0.05$
- The odds ratio (OR) to be detected = 2.0 or greater
- Based on previous study (Kirorei *et al.*, 2014), the proportion exposed in the control group (school children) is 41%

- To get proportion of cases exposed:

$$p_{\text{(cases exposed)}} = \frac{OR\,p_{\text{(controls exposed)}}}{p_{\text{(controls exposed)}}(OR-1)+1}$$

$$p_{\text{(cases exposed)}} = \frac{2.0\,(0.41)}{0.41(2-1)+1} \qquad p_{\text{(cases exposed)}} = 0.582$$

- Average proportion exposed = (0.582 + 0.41)/2 = 0.496

- $n = 2 \frac{(0.496)(1-0.496)(0.84 + 1.96)^2}{(0.582 - 0.41)^2} = 132.4$

Therefore, required sample size = 264 (132 cases and 132 controls)

3.5 Participant Sampling Procedure

Purposive sampling was used to select both street children and age matched school going children who participated in the study. All the street children who were under age of 18 years were selected from the town area.

3.6. Inclusion and Exclusion Criteria for Study Participants

3.6.1 Inclusion Criteria for Street Children

Study participants were included in the study if:

a) They self-confessed they are street children and be below 18 years of age and willing to participate in the study.

b) Had a characteristic of begging, seeking social favours (piece of work) and scavenging for food in the streets.

c) They were living in the streets of Kisumu city.

3.6.2 Exclusion Criteria for Street Children

Study Participants were excluded from the study if:

a) They were of unsound mind.

b) Not willing to participate in the study.

3.6.3 Inclusion Criteria for School going Children

Study participants were included in the study if:

a) They were below 18 years of age and willing to participate in the study,

b) They were residents of the study area,

c) They were school going children and age matched with street children.

3.6.4 Exclusion Criteria for School going Children

Study participants were excluded in the study if:

a) They were on other medical treatment.

3.7 Data Collection Method

3.7.1 Collection of Stool Specimen

Participants were provided with a labelled wide mouthed stool container for stool collection, a piece of plain paper, a piece of applicator stick and a piece of toilet paper. The plastic containers had a coded number, and the name of the children who took that particular container were recorded in a standard form (this was to avoid the accidental exchange of specimens among children). The children were instructed to defecate on a piece of paper provided, to avoid contamination from the toilet environment, and then using an applicator stick to pick a portion of the stool on a piece of paper and put it into the clean plastic container provided. These fresh stool sample collected from the participants were transported in a cold condition (cooler box with ice pack) to the laboratories and were analysed by Kato Katz method while the other portion was preserved in 10% formalin for formal ether concentration method.

3.7.1.1 Kato Katz Method

Fresh stool samples screening for helminthes was based on double 47.1mg kato katz smear (Peters *et al*., 1980). A stool sample was passed through a metal sieve to remove any fibrous material. Some amount of stool was collected and filled in a template using a spatula. Glycerine-impregnated cellophane was then placed on the sample after removing the template and turned upside down, pressed and allowed to spread evenly. The slides were examined within one hour for hookworm eggs (they are cleared by glycerine after one hour). *Schitosoma mansoni, Ascaris lumbricoides* and *Trichuris Trichiuria* eggs were examined later. The total numbers of eggs were expressed as eggs/gm of faeces (epg). Quality control was performed by systematic random examination, by the team leader for 10% of the daily examined Kato-Katz slides. The intensity of infection was determined by multiplying the average egg counts by factor 24 (WHO standard). Wooden sticks, gloves, blotting papers, other consumables were disposed according to standard guidelines for waste disposal in the health facility.

Table 3.1: Intensities of Soil Transmitted Helminthes according to WHO Standards

Parasite	Intensity
A. lumbricoides	Light (1-4,999 epg)
	Moderate (5,000 - 49,999 epg)
Hookworm	Light (1-1,999 epg)
	Moderate (2,000 - 3,999 epg)
S. mansoni	Light (1-99 epg)
	Moderate (100 - 399 epg)
	Heavy (≥400 epg)
T. trichura	Light (1-999 epg)

3.7.1.2 Formal Ether Concentration Method

Formal ether concentration method was used to for screening of intestinal protozoan helminthes. A small sample (the size of a peanut), from the stool sample were put into a labelled Falcon centrifuge tube. 7 ml Formal saline -solution was added and the tube thoroughly shaken. Using a funnel, the stool sample was poured through gauze into another labelled Falcon centrifuge tube.

The preparation was centrifuged at 2000U/min for 1 minute and the supernatant discarded. 7 ml of 0.9% NaCl solution and 2-3 ml Ether were added to the filtrate. The tube was thoroughly shaken for 2-3 minutes keeping the tube close with the thumb or rubber cork. Four (4) layers were obtained after 3 minutes' centrifugation at 2000U/min. and the top three (3) layers were discarded. The concentrate was divided into two portions. One portion in a 15 ml falcon tube was stained with lugol's iodine. Preparation was smeared on clean dry 76 mm x26 mm microscopy slide for microscopy.

3.7.2 Collection of Blood Samples

The tip of middle finger was cleaned with alcohol pads and then pricked with a blood lancet, and then one drop of blood was wiped away with dry cotton. The next drop was used to fill the microcuvette by touching the micro-cuvette tip into the middle of the drop until completely filled while avoiding air bubble. The filled micro- cuvette was then placed into the HemoCue photometer. After approximately 30 seconds Hb value displayed in g/dl were recorded as the Hb concentration. Another drop of blood was put on a blood slide and thin and thick smear were prepared for malaria examination.

3.7.2.1 Blood Slides for Malaria Parasites

10% Giemsa solution was prepared in buffered distilled or deionised water, pH 7.2. The slide thin smear was then fixed for a few seconds with methanol. After drying giemsa stain solution was gently poured onto the slide using a pipette. The slide was left to stain for 5-10 minutes and gently flushed off from the slide by adding drops of clean water until no stain drips.

The slide was placed on a drying rack, making sure the film does not touch the rack. On the thick film, the background was cleaned and freed from debris; leukocyte nuclei were deep, rich purple, and the malaria parasites were deep red chromatin and pale purplish blue cytoplasm. At the periphery of the thick film, erythrocytes were not lysed and schuffner's stippling were apparent in *P.vivax* and *P.ovale* infections. The slides were examined using a compound microscope - 100x power and malaria parasite identified (deep red chromatin and pale purplish blue cytoplasm). Malaria parasite densities were calculated by counting the number of asexual parasites per 200 leukocytes (or per 500 leukocytes, if the count is < 10 asexual parasites /200 leukocytes), assuming a leukocyte count of 8,000/µl. (WHO, 2007). A blood smear was considered negative when the examination of 100 high power fields did not reveal asexual parasites. Gametocytes were also determined from the thick blood smears.

Thin smears were used to differentiate the different Plasmodium species. 10% of all the slides were then read again for quality control.

3.7.3 Haemoglobin Determination

Blood sample was obtained by pricking one finger using a lancet. A hemocue cuvette was filled with blood and then inserted into the haemoglobinometer. Haemoglobin concentration (Hb) was estimated to an accuracy of 1 g/L using a portable, battery-operated haemoglobinometer (haemoCue Ltd, Anglom Sweden). Results were read from the screen after 60 seconds and recorded in grams per deciliter. Children found to had Hb level below <11g/dl were considered anaemic, with Hb concentrations of <7g/dl, 7.0 - 9.9g/dl, 10.0 - 10.9g/dl and ≥11g/dl indicating severe anaemia, moderate anaemia, mild anaemia and normal respectively (Mazigo *et al*., 2010). Normal haemoglobin distributions vary with age, sex, and physiological status, e.g., during pregnancy. WHO Hb thresholds were used to classify individuals living at sea level as anaemic (WHO, 2008).

Table 3.2: Levels of HB signifying Anaemia according to Age, Sex and Physiological Status. g/dl(grams per decilitre)

Age or gender group	Hemoglobin threshold (g/dl)
Children (0.50–4.99 yrs.)	11.0
Children (5.00–11.99 yrs.)	11.5
Children (12.00–14.99 yrs.)	12.0
Non-pregnant women (≥15.00 yrs.)	12.0
Pregnant women	11.0
Men (≥15.00 yrs.)	13.0

3.8 Data Management and Analysis

Coded data were entered in Microsoft Excel. Analyses was conducted using IBM SPSS Statistics v. 22.0 (Armonk, NY: IBM Corp.). Chi square tests was used to determine significance differences in prevalence of parasitic infection between street and school children. Intensities of infections with *S. mansoni* and STH infections were expressed as arithmetic mean of eggs per gram of stool. Malaria parasite densities were estimated assuming an average white blood cell count of 8,000 per µl. Haemoglobin levels was tested by haemoglobinometer and reported in grams per deciliter (HaemoCue Ltd).

Chi-square test for independence was used to determine significant differences in prevalence of infection between street and school children. Mann Whitney test was used to determine the significance differences in intensity of parasitic infections between street and school children. Odds ratio was calculated by binary logistic regression to determine the strength of associations between parasitic infections and study residence sites. All tests conducted were two-tailed. A P-value < 0.05 was considered statistically significant.

3.9 Ethical Considerations

Ethical approval for the study was obtained from Maseno University Ethical review committee. Approval to conduct study on street children was given by county authorities in charge of these children; these include Children department Kisumu and street children organisations that act as guardians for street children. Head teacher of primary school gave consent for participation into the study for school going children. Participants were recruited once they have read/ or been read to, have understood and verbal assent obtained from them. Their questions were addressed at any time during the study.

Confidentiality was maintained on the study participants; their names and results were not disclosed to third parties and they were kept under lock and key and only accessible by the principal investigator. All children participating in the study were administered deworming drugs while participants who were for positive to malaria test were treated according to WHO guidelines.

CHAPTER FOUR

RESULTS

4.1 Characteristics of Study Participants

The current survey enrolled a total of 264 children from the schools and streets of Kisumu city in the ratio 1:1 using age as the matching factor. The characteristics of the study participants are outlined in Table 4.1. The mean ± standard deviation age of the enrolled children was 10.4 ± 1.7 years with the minimum and maximum ages being six and sixteen years respectively.

Among the school children enrolled, majority were girls (56.1%) while the street children group comprised of all boys (100.0%). The median (interquartile range (IQR)) duration of being in the streets were 4 (2 - 5) years with 34.1% and 49.2% of the street children having been on the streets for two years or less and three to five years respectively.

Table 4.1: Characteristics of Study Participants. n=Number of children sampled, different letters mean significant differences ($\chi 2$ test, d=1, p<0,05) OR=odds ratio

Characteristic	**School going children (n=132)**		**Street children (n=132)**	
	Number	**%**	**Number**	**%**
Age (years)				
6 - 8	13	9.8	13	9.8
9 - 10	66	50	66	50.0
11 - 12	40	30.3	40	30.3
> 12	13	9.8	13	9.8
Gender				
Male	58	43.9	132	100.0
Female	74	56.1	0	0.0
Duration of being in the streets (years)				
≤ 2			45	34.1
3 - 5			65	49.2
6 - 8			19	14.4
> 8			3	2.3

4.2 Prevalence of soil transmitted helminthes, *S.mansoni*, *E.histolytica and P. falciparum*

Table 4.3 shows the results from microscopic examination of faecal specimens' processed using Kato Katz technique and Formal ether concentration. Overall, 89 of the 264 children (33.7%) examined had at least one parasitic infection. Residential site was associated with parasitic infection with 19 school children (14.4%) being infested with at least one parasite compared with 70 street children (53.0%) ($p<0.001$).

The prevalence of hookworms was lower in school children than in the street children (0.8% versus 6.8% respectively, $p=0.019$). *A. lumbricoides* prevalence was 5.3% and 9.1% in school and street children respectively with chi square test results indicating no significant difference in the two groups ($p=0.234$). *T. trichiuris* was reported in 3.8% and 9.8% of the school and street children respectively. The prevalence of *T. trichiuris* was not significantly different in the two groups ($p=0.051$). A significantly lower prevalence of *S. mansoni* infection was reported in school children than in street children (1.5% and 43.2% respectively, $p<0.001$).

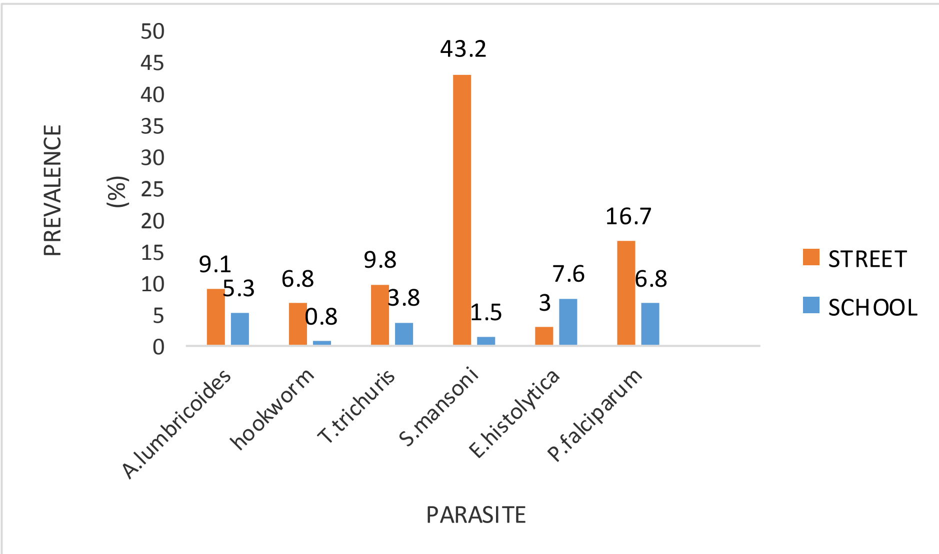
The prevalence of *E. histolytica* was 7.6% and 3.0% in school and street children respectively ($p=0.168$) with no significant variations in prevalence of infections between school and street children (($p=0.168$). Results on malaria parasite prevalence using microscopy differed significantly by site ($p=0.013$). Nine school children (6.8%) were positive for malaria parasites while 22 street children were positive for malaria parasites (16.7%).

Table 4.3: Microscopy results based on Kato Katz, Formal ether Concentration and Thick Blood Film Technique. n=Number of children sampled, different letters mean significant differences (χ2 test, d=1, p<0,05) OR =odds ratio

Characteristic	School (n=132)	Street (n=132)	OR (95% CI)	χ2, df, p-value
	n (%)	n (%)		
Parasite				
A. lumbricoides	7(5.3)	12(9.1)	1.786(0.680-4.688)	χ2=1.418, df=1, p=0.234
Hook worm	1(0.8)	9(6.8)	9.585(1.197-76.771)	χ2=6.652, df=1, p=0.019
T. trichiuris	5(3.8)	13(9.8)	2.775(0.960-8.019)	χ2=3.816, df=1, p=0.051
S. mansoni	2(1.5)	57(43.2)	49.400(11.723-208.162)	χ2=66.027, df=1, p=<0.001
E. histolytica	10(7.6)	4(3.0)	2.623(0.801-8.585)	χ2=2.715, df=1, p=0.168
P.falciparum	9(6.8)	22(16.7)	0.366(0.162-0.828)	χ2=6.177, df=1, p=0.013

Hookworm, S.mansoni and ***P.falciparu****m* were seen to have statistical significance difference of χ2=6.652, df=1, p=0.019, χ2=66.027, df=1, p=<0.001 χ2=6.177, df=1, p=0.013 respectively as shown in table above.

Figure 4.1: Showing Prevalence of Soil Transmitted Helminthes, *S. mansoni* and *P. falciparum*



4.3 Assessment of Anaemia

Table 4.4 shows results on the assessment of haemoglobin levels a higher proportion of street children were anaemic when compared to the school children though this variation was not statistically significant (2.3% and 6.3% respectively, p=0.193).

Table 4.4: Prevalence of Anaemia. n=Number of children sampled, different letters mean significant differences (χ2 test, d=1, p<0,05) OR =odds ratio

Characteristic	Overall (n=264)	School (n=132)	Street (n=132)	OR (95% CI)	χ2, df, p-value
Non-anaemic/Normal (≥ 11.0 g/dL)	234(88.6)	129(97.7)	105(93.8)	2.867(0.723-11.359)	χ2=2.439, df=1, p=0.193
Anaemia (< 11.0 g/dL)	10(11.4)	3(2.3)	7(6.3)		

4.4 Intensity of Soil Transmitted Helminthes and *S.mansoni*

Eight street children had light intensity infections while one street child had moderate infection. Only one child from those in the school had a hookworm infection and it was of light intensity Light (1-1,999 epg).Four school children (28.6%) had light intensity of *A. lumbricoides* infection as compared to ten (71.4%) of the counterparts who were enrolled from the streets. Out of the five-moderate intensity *A. lumbricoides* infections, three and two were found in the school and street children respectively. One case of moderate *T. Trichura* infection was observed in a child recruited from a school.

Analysis of *S. mansoni* infected cases showed that light intensity infections were reported in thirty children with 29 cases (96.7%) being from the streets and one case from the school (3.3%). Twenty-four moderate intensity infections with *S. mansoni* were observed. The light and moderate intensities were significantly higher in the street children (p<0.001 in both cases). Those who were from the street were 23 (95.8%) while one case was from school (4.2%). All the heavy intensity infections were found in street children as shown in Table 4.6.

Table 4.6: Intensity of Soil Transmitted Helminthes and *S.mansoni*n= The number of children n=Number of children sampled, different letters mean significant differences (χ2 test, d=1, p<0,05) OR =odds ratio

Parasite	**Intensity**	**School**	**Street**	**OR (95% CI)**	**χ2, df, p-value**
		n (%)	**n (%)**		
A. lumbricoides	Light (1-4,999 epg)	4(28.6)	10(71.4)	2.623 (0.801-8.585)	χ2=2.715, df=1, p=0.168
	Moderate (5,000 - 49,999 epg)	3(60.0)	2(40.0)	0.662 (0.109-4.025)	χ2=204, df=1, p=0.999
Hookworm	Light (1-1,999 epg)	1(11.1)	8(88.9)	8.452 (1.042-68.557)	χ2= 5.637 df=1, p=0.036
	Moderate (2,000 - 3,999 epg)	0(0.0)	1(100.0)	0.889 (0.706-0.120)	χ2= 0.123, df=1, p=0.725
S. mansoni	Light (1-99 epg)	1(3.3)	29(96.7)	36.883 (4.941-275.304)	χ2=29.484, df=1, p<0.001
	Moderate (100 - 399 epg)	1(4.2)	23(95.8)	27.642 (3.674-207.997)	χ2=22.183, df=1, p<0.001
	Heavy (≥400 epg)	0(0.0)	5(100.0)	0.490 (0.433-0.555)	χ2=5.097 df=1, p=0.060
T. trichiura	Light (1-999 epg)	4(23.5)	13(76.5)	3.496 (1.109-11.020)	χ2= 5.093, df=1, p=0.042

4.6 Intensity of Malaria Parasite

Table 4.7 shows the results on the mean malaria parasite densities were 496 and 311 parasites/µL of blood in school and street children respectively (p=0.172).

Table 4.7: Malaria Parasite Density (parasites/µL of blood) n=Number of children sampled, different letters mean significant differences ($\chi 2$ test, d=1, p<0,05) OR =odds ratio

Characteristic	Overall (n=264)	School (n=132)	Street (n=132)	OR (95% CI)	$\chi 2$, df, p-value
Mean	364.4	496.0	310.6		p=0.172
Std. error	61.1	100.2	73.9		

4.7 Level of Anaemia

Table 4.8 shows the result on the difference on the level of anaemia between street and school going children were not significant.

Table 4.8: Level of Anaemia. n=Number of children sampled, different letters mean significant differences ($\chi 2$ test, d=1, p<0,05) OR =odds ratio

Characteristic	Overall (n=264)	School (n=132)	Street (n=132)	OR (95% CI)	$\chi 2$, df, p-value
Mild/moderate (>7.5 -11.0 g/dL)	8(80.0)	2(66.7)	6(85.7)	3.000(0.122-73.642)	$\chi 2$=0.476, df=1, p=0.999
Severe (≤7.5 g/dL)	2(20.0)	1(33.3)	1(14.3)		

CHAPTER FIVE

DISCUSSION

In this study the prevalence of *hookworm*, *S.mansoni* and *P. falciparum* malaria were seen to have statistical significance difference of $\chi2=6.652$, df=1, p=0.019, $\chi2=66.027$, df=1, p=<0.001 $\chi2=6.177$, df=1, p=0.013 respectively. In relation to the school going children, a study was done in Kenya in 2008 that showed a prevalence of 12.9% (Mwathi *et al*., 2008) and 17% in Kisumu (Ngojo *et al*., 2012) as compared to 14.4% of school children in this study. The high rates of infection observed in street children in these countries are consistent with the figures observed in this study indicating health implications for this population (street children) all over the world. This high prevalence of parasitic infections in street children than the school going children could be attributed to first, lack of hygiene and sanitation among the street children in accordance to their lifestyle. Secondly reason, could be that street children do not seek treatment as much as school going children hence the high prevalence of parasitic infections. Thirdly, this could be attributed to the fact that the school going children are routinely dewormed in school through the Kenya National School Based Deworming program where street children are not part of the program.

Ascaris lumbricoides prevalence was 5.3% and 9.1% in school and street children respectively in this study. This agrees with another study conducted in Ethiopia, where the prevalence of *A.lumbricoides* was 9.9% (King *et al*., 2013). The present findings of prevalence of *A. lumbricoides* in school going children was lower as compared to other countries school going children probably due to the intervention in the deworming. Furthermore, the samples from school going children may have been collected just after the deworming exercise in Kisumu County. Similar school based studies show prevalences of *A.lumbricoides* was 72.9% in Gondar, Ethiopia (Endris *et al*., 2010), Jimma 83% (Mengistu *et al*., 2007). These variations of prevalence in school going children compared to the current study might be due to the differences in climatic conditions, environmental sanitation, economic and educational status of the parents and study subjects and more so school based deworming programme that is run in Kenya schools from 2009. The high prevalence of *A.lumbricoides* in street children than in school going children may be attributed to lack of sanitation and the absence of regular deworming among the street children.

The prevalence of hookworm in this study was 6.8% in street children as compared to 0.8% in school going children. These results are similar to a study that was done in Phillipines that showed prevalence of hookworm among street dwellers to be 7% (Baldo *et al*., 2004). However, due to the on-going deworming in schools the prevalence may have dropped.

Other studies conducted in Jimma Ethiopia showed similar results where hookworm infection was 9.5% among street beggars (Ashebir *et al*., 2015). This was also the case in a study done in India among school going children that found the prevalence of hookworm to be 0.8% (Faisal *et al*., 2013). Similar results have been observed in our present study in school going children (0.8%). From these results it is evident that street children who resided at “Swan Center” which is few meters from Lake Victoria had higher infections with hookworm. Probably nearer the Lake the conditions for parasite development are more cool and favourable, thus hookworm eggs hatch well unlike in the drier areas of the city.

Shistosoma mansoni prevalence was higher in street children (43.2%) than in school going children (1.5%) in this study. Previous studies have also shown higher prevalence of *S. mansoni* among street beggars (Ashebir *et al*., 2015). In Ethiopia, prevalence of school going children was 1.3% which is similar to the prevalence of school going children in this study. Other studies conducted in Ethiopia showed a higher prevalence of *S.mansoni* of 21.2% in street children (Mengistu *et al*., 2004). Previous studies in Kenya have shown higher prevalence of *S.mansoni* in schools (Mwandawiro et al 2013). In Uyoma for example, the prevalence of *S.mansoni* was 17.8% (Mwinzi *et al.*, 2012).. The higher prevalence of *S.mansoni* observed in street children may be attributed to the absence of deworming programme extended to them.

The high prevalence of *T.trichiuris* in street children was also found in a study among street children in Jimma (Ashebir *et al*., 2005). Finding consistent with a previous study in Bachok in which 66% of the children studied had trichuriasis (Anees *et al*., 2003).

Four of seventeen *T. Trichiuris* infections which were of light intensity, four were observed in school children with the) being observed in the street children. The high prevalence and intensity of *T.trichiuris* in street children than in school going children in this study might be due to high chances of street children ingesting contaminated food from the streets. This is supported by another study that showed children who ate food items sold on the street had a higher prevalence of *T.trichiuris* and *A. lumbricoides* (Tadesse, 2005).

Intestinal protozoan infections observed in this study was Amoebiasis among the study participants. Prevalence of *E. histolytica* was 3.0% and 7.6% in street and school going children respectively in this study. A similar study was done in Ethiopia that showed prevalence of *E.histolytica* was 6.7% among school going children (Workneh *et al*., 2014). Similar study was done in Philistine among street children that showed prevalence of 2. 9% of *E .histolytica* (Baldo *et al*., 2004). *Entamoeba histolytica* parasite was also the most common diagnosed among school going children in a study that was conducted in Yemen with a prevalence of 64% (Alwabar *et al*., 2016). In Kenya, studies were done in Thika District that showed prevalence of *E. histolytica* to be 14.6% (Ngojo *et al*., 2012). In Ethiopia they also reported prevalence of *E. histolytica* in street children was 8.2% (Mekonnen *et al*., 2014).

In this study street children infected with *S.mansoni* had higher light, moderate and heavy infections as compared to school going children. These results can be compared to light and moderate infections in school going children in Thika before the school deworming programme in schools (Ngojo *et al*., 2012). Higher prevalence and intensities of *S.mansoni* in schools and street children can be associated by poverty and poor living conditions, inadequate sanitation and water supply, development of water resource and poor health awareness. School age children often exhibit greater prevalence and higher infection intensity than adults due to a combination of high exposure and immunological factor (Muchiri *et al*., 1996). In addition, there has been a school based deworming programme that might have contributed to the lower prevalence of *S.mansoni* in this study. The presence of schistosome infected children can be a source of reinfection. A study showed that the high presence of schistsome infected children in Langano school still present a risk for the introduction of a new transmission focus where the snail hosts are already available (Mengistu *et al*., 2004).

Malaria prevalence was 6.8% and 16.7% in school going and street children respectively. In Kenya, similar studies were done that showed a prevalence of 4.4% in school going children (Gitonga *et al*., 2010). These findings were consistent with national level malaria prevalence estimate observed in Kenya (MIS in 2007) where the malaria prevalence in schools by microscopy was 3.4% (Kenya Malaria Indicator Survey, 2007). Other studies that have been conducted in Senegal showed prevalence rates in school -age Children of less than 10% (Dia *et al*., 2009; Ouldabdallahi *et al*., 2011; Thuilliez *et al*., 2010).

There is a higher prevalence of malaria among street children in this study than in school going children. This finding is consistent with one reported in Ghana where a high prevalence was observed in street children from a clinic run by the Salvation Army (The Ghanaian Street Child, 2002). Many studies have regarded malaria as a disease of the poor. The poor have comparatively less access to anti-malarial and anti- mosquito measures, since they cannot afford personal protection measures, a clean environment free of mosquito breeding sites, and are particularly vulnerable to the impact of effective diagnosis and treatment due to financial and cultural implications (World Malaria Report, 2012).

The use of nets can be a major contributor of high prevalence of malaria in street children. This was explained in another study in Uganda where the risk of infection was lower for those study subjects that were reported to be sleeping under bed nets (*Pullan et al., 2010*). In India, a study was done that found that Lower income, house type, distance to health sub centre, knowledge and awareness about malaria, number of mosquito bites per day and use of bed nets were positively associated with malaria occurrence (Yadav *et al*., 2014). A recent study in Laos suggested that good quality houses could reduce disease transmission by reducing the human -mosquito contact (Hiscox *et al*., 2013).

The prevalence of anaemia in this study was observed to be 6.8% and 16.7% in school going and street children respectively. In one study by Berad *et al* 2014 reported overall prevalence of anaemia in street children of 30.66% (Berad *et al*., 2014). The findings on the assessment of the association between parasitic infections and anaemia are shown in Table 4.8. Nine children (3.8%) who were diagnosed with hookworm infections were also anaemic, however, analysis of the association between Hookworm and anaemia was not statistically significant (p=0.280). *S.mansoni* was significantly associated with anaemia in street children in this study.

It is known that in many tropical regions, anaemia, iron deficiency, malaria and multiple helminths (Geohelminths and Schistosomes) infections coexist and are interrelated (Stoltzfus *et al*., 2000). The prevalence of parasitic infections has been higher in street children in this study than the school going children. These could be possible explanation of the observed high and prevalence of anaemia in street and school children respectively. It is believed that most street children sleep on the streets and do not have bed nets for coverage. This could be another possible explanation of the high levels of anaemia due to malaria infection in the street children.

5.1 Study Limitation and Biases

The street children in Kisumu may be many; however, it is not easy to assemble them together for health related issues. Street children live in hostile environment and as a result have developed hostile attitude towards the public. The researcher offered food and music and collected their demographic and laboratory specimen under the presence of respondents who they felt free with. The turnout number expected for street girls was lower or even absent in the study. This could be attributed by the cultural factors of Kisumu, where girls fetch bride price for the family hence are not allowed to be independent in the street. Unlike boys, who wants their independence from an early age hence go to the street to live there without supervision from their guardians. The prevalence of anaemia in street children was biased as there was no turn out of girls to check their haemoglobin levels.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

1. The study has revealed high prevalence of parasitic infections in street children than in school aged children which could be attributed to regular deworming of school going children. Epidemiological information on the prevalence of parasitic infection among street children is very important to develop appropriate control strategies.
2. The results on anaemia of street children did not include that of girls which creates a bias in the results as the results on school aged children had both for boys and girls.

6.2 Recommendation

1. Policy makers to develop appropriate parasitic control strategies for street children. These could be mass drug administration, health education, strengthening rehabilitation programs in settling street children in better habitable areas or houses where bed net can be used.
2. Policy makers can avert the high prevalence of anaemia in street children by offering food to street children, iron supplementation and deworming which all have a direct link to anaemia reduction.

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APPENDICES

APPENDIX 1: CONSENT FORM

MASENO UNIVERSITY
PRIVATE BAG
MASENO

RESPONDENTS' CONSENT FORM

Title: Prevalence and intensity of parasitic infections and anaemia in street children in Kisumu Town, Kenya.

I, [being a guardian of ________________________________ has had the research explained to me. I have understood all that has been read and had my questions answered satisfactorily. I understand that I can change my mind at any stage and it will not affect the benefits due to me/my child.

Please insert the boxes below or add others where relevant

☐ Yes ☐ No *please tick* I agree to participate/allow the child to take part in this research

☐ Yes ☐ No *please tick I* agree to blood and stools samples being stored

Subject/Parent/guardian's signature: ________________________Date ___________

Subject/Parent/guardian's name: _______________________ Time ____________

(Please print name)

I certify that I have followed all the study specific procedures described in the SOP for obtaining informed consent.

Designee/investigator's signature: _______________________ Date ____________

Designee/investigator's name: ________________________Time ____________