PREVALENCE OF *SCHISTOSOMA MANSONI,* GEOHELMINTHS AND MALARIA CO-INFECTIONS AND THEIR ASSOCIATIONS WITH ANEMIA IN PREGNANT WOMEN ATTENDING ANTENATAL CLINICS IN KISUMU, KENYA

BY

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MASENO UNIVERSITY

DECLARATION

I, Keziah Akinyi Odhiambo declare that the work presented herein is my original work and has not been presented for the award of any degree anywhere.

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We confirm that the candidate under our supervision performed the work presented in this thesis

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DEDICATION

This work is dedicated to my family.

ABSTRACT

It is estimated that about 10 million pregnant women could be infected with schistosomiasis in Africa. In Kisumu, schistosomiasis, soil transmitted helminths and malaria are endemic and studies done on school children and occupationally exposed adults had reported high prevalence levels of these infections. However, little was known about the prevalence of *S. mansoni*, geohelminths and malaria co-infections among pregnant women in Kisumu, Kenya. In order to determine the importance of *S. mansoni*, geohelminths and malaria co-infections among pregnant women in Kisumu, Kenya, a cross-sectional study was done to determine the prevalence of *S. mansoni*, geohelminths and malaria and to determine the association between worm and worm/ malaria co-infections and anemia among pregnant women. A total of 245 pregnant women attending antenatal care clinics in Usoma and Rota health centres in Kisumu were recruited. The Kato Katz technique was used to screen faecal samples for *S. mansoni* and other geohelminths. Giemsa stained thick and thin blood smears were analysed for the presence of malaria parasites and haemoglobin levels measured using the hemoglobinometer. Of the 245 women included in the study, 34.3% of the women were infected with *S. mansoni*, 5.3% with Ascaris, 6.9% with hookworm, 4.9% with *Trichuris trichuria* and 11% had malaria infections. Overall, 66.1% of the women had anemia. Increased risk of anemia was associated with malaria (OR = 2.91, 95% CI: 1.01-8.34) but not *S. mansoni,* other helminthes or co-infections with malaria. This study suggests that *S. mansoni* is prevalent among pregnant women in this study area. Malaria infection was associated with increased risk of being anemic, hence an integrated program for the control and treatment of these infections is recommended in order to reduce the degree of anemia during pregnancy.

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LIST OF ABBREVIATIONS AND ACRONYMS

BMI	:	Body Mass Index
CGHR	:	Centre for Global Health Research
G.O.K	:	Government of Kenya
KEMRI	:	Kenya Medical Research Institute
L. Victoria	:	Lake Victoria
SSC	:	Scientific Steering Committee
STH	:	Soil Transmitted Helminths
V.	:	Version
WHO	:	World Health organization

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

Schistosomiasis and geohelminth infections are parasitic diseases that are co–endemic in many regions of the world, where their devastating consequences are felt by communities least able to cope. High rates of co-infections with geohelminths, schistosomes and malaria parasites occur due to their wide overlapping geographical distribution (van Eijk *et al*., 2009).

Schistosomiasis and malaria are the major parasitic diseases in developing countries whose epidemiological co-existence was frequently observed (Sokhna *et al*., 2004). Mixed infection with these two parasites has now been reported to have epidemiological impact on either infections and may have influence on the clinical manifestation of either disease, development of acquired resistance to infection of either or both parasites and may also have an important role in the regulation of inflammatory factors associated with the development of these infections and their respective morbidity (Mutapi *et al.,* 2000). Helminthic infections in pregnancy have been associated with iron deficiency, maternal anemia, impaired nutritional status, decreased birth weight, intra-uterine growth retardation and adverse birth outcomes (WHO, 2002). While malaria infection is common in Africa and is an important contributor to anemia in women of reproductive age (Dreyfuss *et al.,* 2000). Given that the geographical distribution of malaria and helminthes infections widely overlap in sub-Saharan Africa, the occurrence of both parasites during pregnancy may contribute significantly to the degree of anemia in mothers.

Currently, it is estimated that schistosomes infect approximately 40 million women of child bearing age (Friedman *et al*., 2007), with available data showing that approximately 10 million pregnant women could be infected annually in Africa alone (Olds, 2003) and half of these women suffer from anemia (King *et al*., 2004). Although the association between anemia and

schistosomiasis or hookworm has not been clear since mixed results have been reported. In some studies there was an association while in others there were no associations. A study carried out in Tanzania showed a high prevalence of *S. mansoni* among pregnant women and demonstrated that heavy *S. mansoni* infection was associated with an increased risk of anemia with no significant association observed between hookworm and anemia (Ajanga *et al*., 2006). In Kenya, a study conducted in Gem constituency in western Kenya, showed a high prevalence of geohelminths among pregnant women, with 3 out of 4 women having one or more parasites, although their effects on maternal health were not clear (van Eijk *et al*., 2009). Other studies along Lake Victoria showed high levels of *S. mansoni,* for example a study carried out in areas surrounding Kisumu town among car washers (Karanja *et al*., 1997), suggested that communities along L. Victoria have high prevalence ranging between 36 – 90%. Additional study carried out among school-going children showed a high prevalence of *S. mansoni* and geohelminth infection in the area (Obonyo *et al*., 2010), though there are inadequate data that address schistosomiasis during pregnancy; hence the number of pregnant women who are infected with schistosomiasis and geohelminthes remains unknown. These populations are resident in malaria holoendemic, schistosome and geohelminths endemic regions of western Kenya, an overlap that favors multiple parasitic species survival and transmission, yet most parasitic diseases are still studied individually and data on prevalence and morbidity associated with multiple parasitic infections among pregnant women who are under studied but are more vulnerable to infections due to suppression of the immune system during pregnancy are limited. As such, this study determined the prevalence of *S. mansoni* and geohelminthes and associations between worm infections and worm/malaria co-infections and anemia in pregnant women attending antenatal care clinics in Kisumu, Kenya.

1.2 Statement of the Problem

Despite the extensive morbidity and mortality caused by schistosomiasis and geohelminths in sub- Saharan Africa, schistosomiasis during pregnancy has been inadequately investigated. Praziquantel (PZQ) which is the major drug used for the treatment of schistosomiasis and can prevent the development of irreversible consequences of schistosomiasis in adulthood has been available since 1979, though millions of pregnant women and lactating women have been excluded from treatment (Friedman *et al*., 2007). This is even after WHO recommended that pregnant women should no longer be excluded from treatment programmes, that failure to treat them may have adverse effects on them and their pregnancy outcomes (WHO, 2002). The most compelling reason for treating pregnant women comes from the impact of schistosomiasis on anemia (Olds, 2003), however the extent to which schistosomal infection contributes to anemia is unclear. In Kisumu, studies have shown high prevalence of *S. mansoni* and geohelminth infections among occupationally exposed adults (Karanja *et al*., 1997) and school going children along the shores of lake Victoria (Obonyo *et al*., 2010) but there are inadequate data that address schistosomiasis during pregnancy; hence the number of pregnant women who are infected with schistosomiasis and geohelminthes in a region where these infections are endemic remains unknown. As such this study aimed at determining the prevalence of *S. mansoni*, geohelminths and associations between anemia and *S. mansoni*, geohelminths and malaria co-infections in pregnant women attending antenatal clinics in Kisumu.

1.3 Objectives of the Study

1.3.1 General Objective

To determine the prevalence of *S. mansoni*, geohelminths and malaria co-infections and their associations with anemia in pregnant women attending antenatal clinics in Kisumu, Kenya.

1. 3. 2 Specific Objectives

i. To determine the prevalence and intensities of *S. mansoni* and geohelminth infections in pregnant women attending antenatal care clinics in Kisumu, Kenya.

ii. To determine the associations between worm infections and worm/malaria co-infections and anemia in pregnant women attending antenatal care clinics in Kisumu, Kenya.

1.3.3 Research Questions

i. What is the prevalence and intensity of *S. mansoni* and geohelminth among pregnant women attending antenatal care clinics in Kisumu, Kenya?

ii. What is the association between worm infections and worm/malaria co-infections and anemia in pregnant women attending antenatal care clinics in Kisumu, Kenya

1.4 Significance of the Study

Pregnant women who live in the tropics are exposed to parasitic diseases and are particularly vulnerable to infections due to suppression of the immune system during pregnancy. Even though studies in other areas had shown high levels of helminthic infections among pregnant women and their potential adverse effects, little was known about the prevalence of helminthes and their associations with anemia during pregnancy in this region. This study determined the prevalence of *S. mansoni,* geohelminths and malaria, prevalence of anemia and associations between worms and worm/ malaria co- infections and anemia among pregnant women attending antenatal care clinics in Kisumu, findings which are pertinent to estimating the disease burden of helminthes and malaria in pregnancy and can be used for the design and implementation of sound intervention strategies to mitigate morbidity and co- morbidity among pregnant women in endemic areas.

CHAPTER TWO

LITERATURE REVIEW

2.1 Background

Schistosomiasis and soil-transmitted helminthes (STH) or geohelminths are responsible for extensive morbidity and mortality in sub-Saharan Africa. Global estimates show that more than 207 million persons are infected with schistosomes (Steinmann *et al*., 2006) with 90% of these cases occurring in sub-Saharan Africa (WHO, 2002) and (Hotez and Kamath, 2009). Schistosomes are parasitic trematodes of public health concern and endemic in 76 tropical and sub-tropical countries worldwide (Chitsulo *et al*., 2000). Over 20,000 deaths are associated with severe consequences of infection, including bladder cancer or renal failure in *S. hematobium*, liver fibrosis and portal hypertension in *S. mansoni* (WHO, 2002). In Kenya it is estimated that about 9.1 million people are infected with schistosomiasis (WHO, 2010). People are infected by contact with infested water during their normal daily activities for personal or domestic purposes such as hygiene and recreation (swimming), or professional activities such as fishing, rice cultivation and irrigation.

Geohelminths or soil transmitted helminths are intestinal worms which can lead to death of the affected persons due to their clinical complications. They include hookworm, *Ascaris* and *Trichuris trichiura* among others. Similarly, STH infections are most prevalent in tropical and sub- tropical regions of the developing world where adequate water and sanitation are lacking with estimates suggesting that *Ascaris lumbricoides* infects 1221 million people, *Trichuris trichuria* 795 million people and hookworm 740 million people (de Silva *et al*., 2003) and over 9.1 million Kenyans are at risk of STH infections (WHO, 2010).

2.2 Prevalence and Intensities of *S.mansoni* and Geohelminth Infections in Pregnancy

There are inadequate data that address the *S.mansoni* and geohelminth infections in pregnancy; hence the number of pregnant and lactating women who are infected remains unknown. It is only estimated that 10 million women in Africa have schistosomiasis during pregnancy (Friedman *et al*., 2007). A study done among pregnant women in Ukerewe Island in Tanzania showed high prevalence and intensities of *S. manson*i and low hookworm intensity among this group (Ajanga *et al*., 2006). Other studies done in Entebe Uganda (Muhangi *et al*., 2007) and Ghana (Fuseini *et al*., 2010) also shown that pregnant women in endemic regions are infected with *S.mansoni* though the infection intensities were lower than what was seen in Tanzania.

High geohelminth infections among pregnant women have been reported in Nepal, with a distribution as follows; any geohelminth 89%, hookworm 74% (Dreyfuss *et al*., 2000), in Uganda, any geohelminth 71% and hookworm 66.6% (Ndyomugyenyi *et al*., 2008). In western Kenya, a study carried out in Gem constituency showed that intestinal infections with *A. lumbricoides, T. Trichiura* or hookworm were very common among pregnant women and three out of every four women had one or more parasites (van Eijk *et al*., 2009) while other studies have shown low prevalence of geohelminthes (Fuseini *et al*., 2010) in pregnant women. A small study in Gabon indicated that pregnancy is associated with an increase in *A. lumbricoides* and *T. trichiuria* compared to non-pregnant women (Adegnika *et al*., 2007). Infections with at least one geohelminth has been associated with the use of unprotected water source, lack of treatment of household drinking water (van Eijk *et al*., 2009) and soil-eating as was demonstrated in a study in Zanzibar (Young *et al*., 2007). In Kenya, prevalence of *S. mansoni* has been associated with contact with the waters of L. Victoria (Handzel *et al*., 2003).

At present millions of pregnant women are still being excluded from treatment, as such there is need for more studies to address schistosomiasis during pregnancy to support their inclusion in schistosomiasis control programmes (WHO, 2002). There are limited data on the prevalence and intensities of *S. mansoni* and geohelminth infections in pregnant women attending antenatal care clinics in Kisumu, Kenya even though studies done on other populations in this region show high prevalence(Verani *et al*., 2011). This study therefore determined the prevalence and intensities of *S. mansoni* and geohelminth infections in pregnant women attending antenatal care clinics in Kisumu, Kenya.

2.3 Effects on Maternal Health and Birth Outcomes

The health status of a woman before pregnancy is a crucial determinant of gestational morbidity and pregnancy outcomes. Poor nutritional status, deprived living environments and higher rates of infectious diseases contribute to maternal mortality, infant mortality and low birth weight (Kramer *et al*., 2003). Women who are underweight, those with anemia or infections are at increased risk of delivering low weight babies (Steketee, 2003). Helminthic infections in pregnancy have been associated with iron deficiency, maternal anemia, impaired nutritional status, decreased birth weight, intra-uterine growth retardation and adverse birth outcomes. Due to overlapping geographical distributions of geohelminths, schistosomiasis and malaria parasites, these infections can further result in high rates of co-infection (van Eijk *et al*., 2009). Malaria is known to cause anemia in primigravidae (Shulman *et al*., 1996), though it has been observed that women become more resistant to *P. falciparum* malaria with successive pregnancies as they acquire antibodies to the parasites (Duffy, 2007).

Iron loss from the body occurs when blood is passed in the stools, for example during *S.mansoni* and *S. japonicum* infection, and this is thought to occur because eggs pass through the intestinal

wall into the lumen of the gut (Mahmoud, 1989). Hookworm causes intestinal bleeding, iron deficiency and protein loss proportional to the worm burden, *T. trichiuria* causes blood loss and *Ascaris* is associated with impaired fat digestion, reduced vitamin absorption and lactose intolerance (Stephenson *et al*., 2000), hence impaired nutritional status. Anorexia or loss of appetite due to pro-inflammatory cytokines produced during helminthic infections could reduce weight gain in pregnancy, which in turn causes a decrease in infant birth weight. Since the effects of these infections during pregnancy are not very clear, the most compelling argument for treating pregnant women with helminthic infections comes from data on the relationship between the parasites and iron deficiency anemia (Olds, 2003). Pregnant and lactating women for a long time have been excluded from treatment programmes due to lack of enough evidence on the safety of Praziquatel and Albendazole, which are the drugs of choice for treatment of *S. mansoni* and geohelminth infections, respectively. In a previous study (Olds, 2003), it was also indicated that delaying schistosomiasis treatment for more than a year can induce hepatomegaly and lead to hepatic deposition of extracellular matrix.

2.4 Association between Helminthic Infections and Anemia

Anemia is often an adverse outcome of severe parasitic infections during pregnancy in developing countries. An estimated 10 million pregnant women in Africa are said to be infected with Schistosomiasis and half of these women suffer from anemia (King *et al*., 2004). It is also suggested that helminthes particularly hookworm and schistomiasis, may be important causes of anemia in pregnancy. A study carried out in Entebbe, Uganda showed that the prevalence of anemia was more common among women heavily infected with *S. mansoni* and hookworm (Muhangi *et al*., 2007).

Other studies have also shown that heavy *S. mansoni* infection was associated with an increased risk of anemia, with no significant association observed between hookworm infection and anemia (Ajanga *et al*., 2006). This was also reported by a study of non- pregnant adolescent girls in Western Kenya, which found that girls heavily infected with *S. mansoni* were twice likely to be anemic as uninfected or lightly infected girls (Leenstra *et al*., 2004). Other studies have failed to show an effect of *S. mansoni* on hemoglobin levels (Olsen *et al*., 1998; Sturrock *et al*., 1996). The study by (Ajanga *et al*., 2006) reported no association between hookworm infection and anemia, which contrasts other studies that showed that hookworm intensity is strongly associated with anemia during pregnancy (Dreyfuss *et al*., 2000). Plasmodium and/or worm infections have an effect on hemoglobin level on their victims. The malaria parasite ingests the hemoglobin in the red blood cells to release the essential amino acids for the parasite growth (Yayon *et al*., 1984). Hookworm on the other hand, sustains its life by blood-sucking, a process that raptures the host capillaries and arterioles followed by the release of pharmacologically active polypeptide which in turn, induces intestinal blood loss which can lead to iron deficiency and protein malnutrition (Hotez and Pritchard, 1995). The most compelling reason for treating pregnant women comes from the impact of schistosomiasis and geohelminthes on anemia(Olds, 2003), however the extent to which these infections contribute to anemia remains unclear. To address the issue this study determined the prevalence of *S. mansoni* and geohelminthes and their associations with anemia among pregnant women attending antenatal care clinics in Kisumu, Kenya.

2.4.1 Associations between Anemia and Malaria/helminth Co- infections in Pregnant Women

In areas of Africa with stable malaria transmission, malaria infection during pregnancy is estimated to cause 400,000 cases of severe maternal anemia and from 75,000- 200,000 infant

deaths each year (Steketee, 2003). Local prevalence of risk factors for iron deficiency and anemia may vary broadly between populations. While malaria infection or acquired immunodeficiency syndrome are common in the African continent and are important contributors to anemia in women of reproductive age, hookworm infections whose prevalence and intensity vary by geographical region, may also serve as an important cause of anemia in women of reproductive age (Dreyfuss *et al*., 2000). Given that the geographical distribution of malaria and helminthes infections widely overlap in sub-Saharan Africa, the occurrence of both parasites during pregnancy may contribute significantly to the degree of anemia in mothers. The co-existence of these parasites may also influence their epidemiology, development of acquired resistance and/ or susceptibility to infection with either of the parasites and therefore have profound implications on the control of each of the diseases (Mutapi *et al*., 2000). Multiple infections of malaria, schistosomiasis and soil transmitted helminthes have been reported from various epidemiological settings in Africa (WHO, 2002), yet most parasitic infections are still studied individually and data on morbidity associated with co-infections among pregnant women is limited. Many studies have also focused on the effect of single infection on pregnancy outcome and maternal anemia, although few studies have attempted to understand the relative effects of multiple agents with conflicting results (Fairley, *et al*., 2013;Agu *et al*., 2013). This study was therefore conducted to determine the associations between worm infections and worm/ malaria co- infections and anemia in pregnant women attending antenatal care clinics in Kisumu, Kenya.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Site

The study was carried out in Usoma and Rota, which are government of Kenya registered health centers situated in Kisumu along the shore of L. Victoria in Nyanza Province in western Kenya (Appendix 1). Kisumu is a fast growing city and is the third largest city in Kenya with an area of 417sq. km (157sq.km of water and 260 sq. km of land) with a total estimated population of 500,000 people (G.O.K, 2009). The city with its environs is a focus of high endemicity for STHs, schistosomiasis and malaria. Studies among occupationally exposed adults in the area show almost 100% *S. mansoni* infection rates (Karanja *et al*., 1997). Other studies done on children (Verani *et al*., 2011) and adults show high levels of STHs, schistosomiasis and malaria in this region. There are two rainy seasons: the long rains which take place from March to May and short rains from October to December. Malaria is holoendemic and transmission occurs throughout the year. Majority of the population belong to the Luo ethnic group and practices subsistence farming and fishing in L. Victoria.

3.2 Study Design

A non-randomized cross-sectional survey was done to collect data from a sample of pregnant women attending antenatal clinics in Usoma and Rota public health facilities and their catchment areas along the shores of Lake Victoria in Kisumu in western Kenya. Women were recruited into the study after giving informed consent.

3.3 Study Population

The target population was pregnant women attending antenatal care clinics in Usoma and Rota in Kisumu, in western Kenya and their catchment areas. Most women in this area get water from

the lake and are mostly fish handlers and vendors; therefore, they have contact with the lake which is the main source of *S. mansoni* infection.

3.3.1 Inclusion Criteria

Study participants were included in the study if they were pregnant women residing in the study area, attending antenatal care clinic and willing to give informed consent.

3.3.2 Exclusion Criteria

Participants were excluded from the study if they reported any history of adverse reactions to antihelminthic drugs or were sick.

3.4 Sample Size

The sample size was calculated using the following formula

$n=Z^2 P (1-P)/C^2$

Where n = sample size

P = prevalence

Z = Corresponding value to the confidence level in the Z table (Daniel, 1999).

Taking prevalence to be 80%, **z** value 1.96 and **C**- confidence level at 0.05

$n= 1.96^2 \times 0.8 (1- 0.8)/0.05^2 = 245$

Sample size = 245 participants.

3.4.1 Sampling Procedure

All pregnant women attending antenatal clinics at Usoma and Rota health centers in Kisumu were invited to participate. A total of 245 pregnant women who met the inclusion criteria and gave informed consent were recruited into the study. The health centers were used because of their accessibility and proximity to L. Victoria and therefore pregnant mothers would be from the same catchment area.

3.5 Study Procedures

3.5.1 Stool Sample Collection and Quantification of Egg per Gram in Stool

Pregnant women enrolled into the study were asked to provide fresh stool samples which were collected in plastic stool cups marked with study numbers (Chemoquip Products, Kenya) and transported to KEMRI-Kisian Schistosomiasis Laboratory within six hours of collection. Quantitative *S. mansoni* and other soil-transmitted egg production in stool were examined microscopically by experienced microscopists by Kato/Katz fecal thick smear technique on duplicate slides (Katz *et al.,* 1972) as outlined in the Bench Aids for the diagnosis of intestinal helminthes. Using a wooden applicator stick, a small amount of fecal sample was placed on paper towel and a small plastic screen (60-105 µm mesh) pressed on top so that some of the fecal material was sieved through. The fecal matter accumulating on top of the screen was then scooped using a flat–sided plastic spatula. A hole of 41.7µm made at the center of the plastic plate was placed on the microscope slide and filled with feces from the spatula. The fecal material was covered with cellophane strip pre-soaked with a solution containing 3% malachite green, 50% glycerol and 47% water. The microscope slide was inverted and pressed against a smooth surface to spread the fecal material evenly. Glycerol was allowed to clear off for 20 minutes before hookworm screening and another *S. mansoni* screening after 24 hours. The slides were examined systematically and counted number of *S. mansoni* eggs multiplied by 24 in order to express infection intensities as the total number of eggs per gram(epg) of feces (WHO,1991). Ova of other helminthes were also counted. Egg intensities were grouped according to WHO standards of light intensity 1-99epg, moderate intensity of 100-399epg and high intensity ≥ 400 epg (WHO, 1991). Quality control was assured by randomized double counting at least every 25 samples by another technician unaware of the first results

3.5.2 Parasitological Examination of Malaria Parasites

Thick and thin blood smears were made in the field from finger-prick blood on slides that were labeled with study numbers. The slides were air dried then transported to the lab where they were stained with Giemsa solution and examined for malaria parasites by an experienced technician. Parasite density per microliter of blood was calculated by counting the number of parasites per 300 white blood cells and multiplying by 40, assuming an average white blood cell count of 8000/µl. Quality control was assured by randomly double counting at least every 25 samples by another technician unaware of the first results.

3.5.3 Measurement of Hemoglobin

Hemoglobin measurement was carried out in the clinic using blood from the pricked finger by a qualified technician using a portable hemoglobin photometer (Hemocue AB, Angelholm, Sweden). Amicro-cuvette preloaded with stable reagents was used to draw in approximately 20µl of blood from the punctured finger. The micro-cuvette was then placed into the spectro-photometric machine and the digital reading of hemoglobin for each subject recorded within 10-20 seconds. Based on the hemoglobin levels, the study participants were classified into anemic (Hb<11.0g/dL) and non-anemic (Hb≥11.0g/dL).

3.5.4 Demographical Data

At recruitment an interviewer-administered questionnaire was used to obtain socio-demographic information, reproductive health characteristics and medical history from the participants.

3.6 Data Management and Analysis

Data was entered, checked for entry errors and managed in Excel files. Kato Katz egg count results, and malaria test results were entered into scan forms, which were scanned into the database and data analyzed using SPSS for windows (Version 21). Percentages and prevalence ratios for the infections and hemoglobin means were calculated. Differences in proportions of helminth infections and differences in proportions of women with anemia were analyzed using chi-square test, multivariate regression analysis was done to determine associations and $P<0.05$ was considered significant.

3.7 Ethical Consideration

This protocol was reviewed by the Scientific Committee at Centre for Global Health Research (CGHR)/KEMRI, and considered for approval by the Scientific Steering Committee (SSC) and National Ethics Review Committee of KEMRI (See Appendix 3). Permission to carry out the study was obtained from the National Council for Science and Technology through the School of Graduate Studies of Maseno University. Additional approval was sought from the District Medical Officer of Health in Kisumu and the clinical officers in charge of the health centers. Study was done according to the international standards for the ethical conduct of research involving human study participants and the local rules and regulations in Kenya. Participation in the study was voluntary and a written informed consent form covering information on patients, risks and benefits, main contact persons, samples required and discomfort/effects, confidentiality and basic information on what the study was about was given in English and translated to Dholuo which is the local language (Appendix 2). Those below 18years were considered as

mature minors and the participants who could not read or write but were otherwise eligible to participate were allowed to indicate their approval with a thump print in the presence of a witness who signed the consent form. There was no screening of participants before a signed informed consent was obtained. Periodic evaluation of the experimental protocols and data by internal scientific committees and audits were done to assure good research process. Patients were allowed access to their medical records and those who were found positive for *S. mansoni*, other helminthes and malaria were treated with PZQ, Albendazole and a dose of sulfadoxine-pyrimethamine by the health centre nurses.

CHAPTER FOUR

RESULTS

4.1 General Characteristics of Study Population

Two hundred and forty five (245) pregnant mothers from the catchment of two health facilities Usoma and Rota were recruited into this baseline study done from January 2013 to November 2013. Up to 84 (34.29%) were infected with *S. mansoni* while 161 (65.71%) were negative for any form of schistosomiasis at recruitment. The two groups (*S. mansoni* –ve and +ve) were comparable in terms of age (p=0.782) (Table 4.1). The two groups were also comparable in terms of Body Mass Index (BMI) based on WHO index: (http://apps.who.int/bmi/index.jsp?introPage=intro_3.html) (p=0.447) with 12 (4.9%) were underweight, 175 (71.4%) were normal, 56 (22.9%) were overweight and 2 (0.8%) were obese (Table 4.1). BMI (Kgs/M^2)'s median and range were comparable as well (p=0.812) (Table 4.1). The range and median of Gestational age (months) and gravidity were also comparable between the two groups (p=0.921and p=0.913) respectively (Table 4.1).

Generally the majority of participants (35%) were between 20-25 years of age, 30% were between 15-20 years of age and over 80% of the participants were below 30 years old. There were no significant differences in age distributions between *S. mansoni* negative and *S. mansoni* positive groups but there were more *S. mansoni* positive mothers in 25-30 age groups (Figure 4.1).

Table 4.1: General characteristics of study population

		All participants (n=245)	By schisto status		P value*
			Schisto +ve (n=84)	Schisto –ve (n=161)	
Age (years)	LQ-UQ	14- 49	14- 45	15- 41	
	Median	22	22	22	0.782*
BMI (kg/m^2)	LQ - UQ	16.2- 30.5	17.8- 30.1	16.2- 30.5	
	Median	22.6	22.7	22.6	0.812*
BMI categories WHO classification: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html n (% within column)	Underweight	12 (4.9%)	2 (2.4%)	10 (6.2%)	
	Normal weight	175 (71.4%)	64 (76.2%)	111 (68.9%)	
	Overweight	56 (22.9%)	17 (20.2%)	39 (24.2%)	
	Obese	2 (0.8%)	1 (1.2%)	1 (0.6%)	0.447#
Gestational age (months)	LQ – UQ	2- 9	2- 9	2- 9	
	Median	6	5	6	0.921*
Gravidity	LQ- UQ	1- 10	1- 10	1- 8	
	Median	2	2	2	0.913*

LQ-lower quartile, UQ- Upper quartile

P-value* refer to difference in median between Schistosomiasis +ve and –ve women (calculated by Mann Whitney U test).

P-value# refers to difference in proportions between Schistosomiasis +ve and –ve women (calculated by Chi square test).

4.2 Prevalence and Intensities of *S. mansoni* and Geo-helminth Infections in Pregnant Women Attending Antenatal Clinics in Kisumu

Eighty-four (n=84) participants out of 245 were positive for *S. mansoni* infection accounting for 34.3% while n=161 (65.7%) were negative. Malaria was at 27 (11%), Ascaris was at13 (5.3%), Hookworm was at 17 (6.9%), *Trichuris trichuria* was at 12 (4.9%). Infection by at least one helminth (Ascaris/Hookworm/ *Trichuris trichuria*) accounted for 34 (13.9%). Using WHO classifications of intensity of infections/ infection burden, n=49 (20%) had light infection, n=23 (9.4%) had moderate infections and n=12 (4.9%) heavy *S. mansoni* infection (Figure 4.2). Infections by other helminthes were generally light.

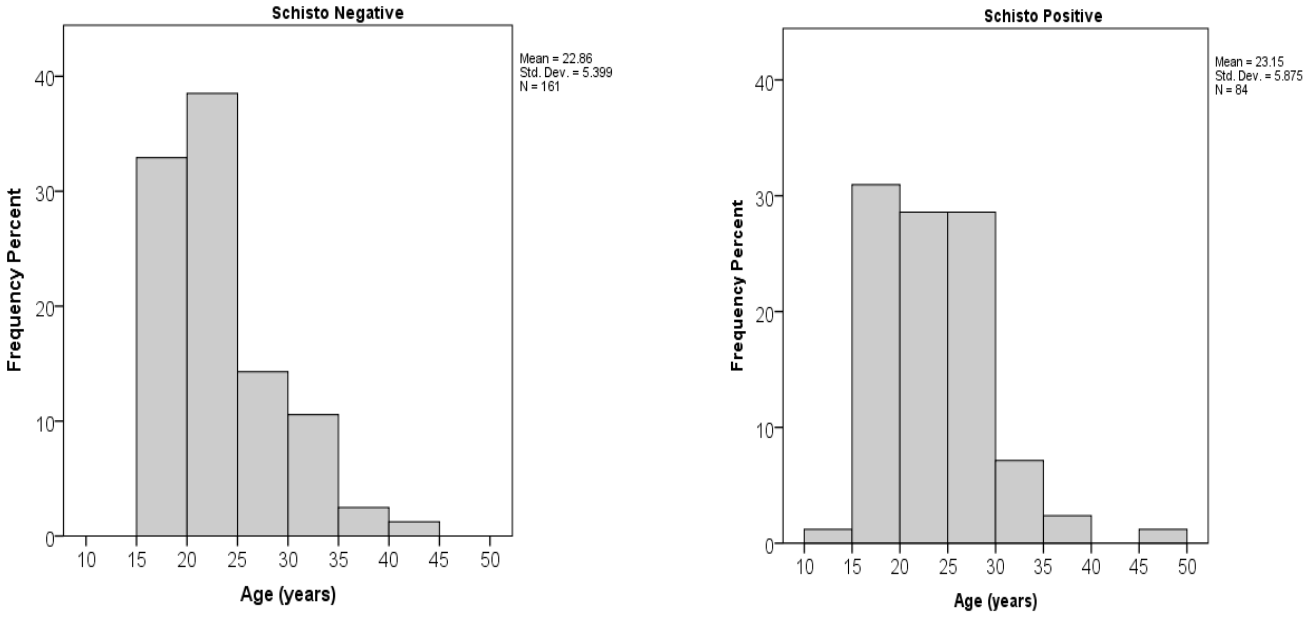

Figure 4.1. Age distribution of participants by Schisto status

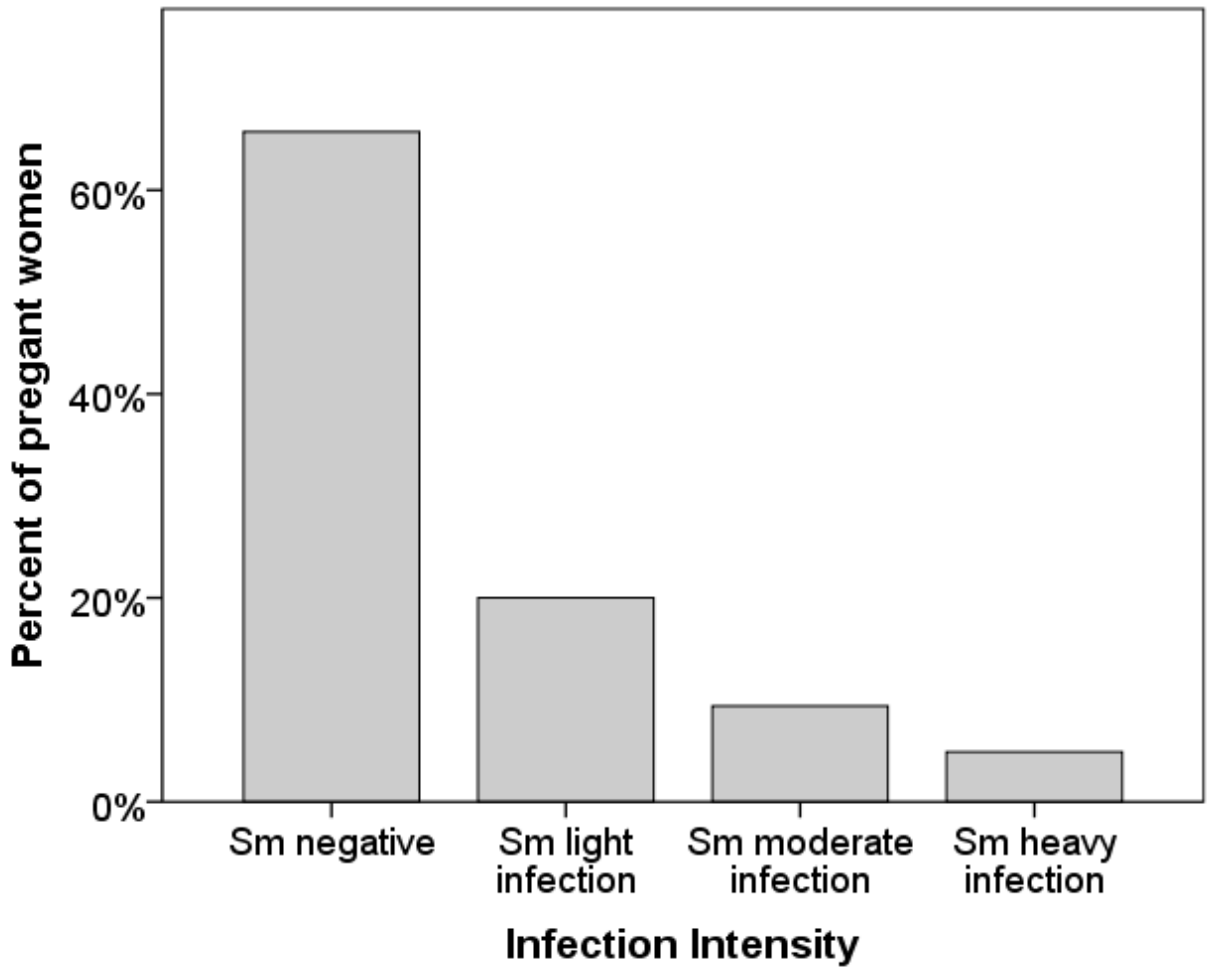

Figure 4.2. *S. mansoni* infection burden in 245 pregnant women in Kisumu, Kenya.

4.3 Association between Worm, Malaria Infection and Anemia in Pregnant Women Attending Antenatal Clinic in Kisumu

Hemoglobin measurement was carried out in the 245 study participants in order to determine the levels and classify their anemia status. Classification of anemia was done according to the WHO standards for pregnant women in the 245 study participants. A total of 83 (33.9%) of study participants had no anemia while 62 (25.3%) had mild anemia, 92 (37.6%) had moderate anemia and 8 (3.3%) had severe anemia. This data shows that over a third of the participants had moderate or severe anemia. Anemia was associated with *S. mansoni* status and Soil Transmitted Helminth infections in bivariate analysis. However, the prevalence of malaria parasitemia did not differ significantly with Anemia (p=0.074).

In multivariate analysis (controlling for age and gravidity status as confounders), *S. mansoni* and STH infections were associated with a reduction in risk of becoming anemic (OR = 0.37, 95% CI: 0.21-0.64) and (OR = 0.36, 95% CI: 0.17-0.77), respectively. Malaria parasitemia was associated with increased risk of becoming anemic (OR = 2.91, 95% CI: 1.01-8.34). Anemia was more common in malaria positive women (81.5%) than in malaria negative women (64.2%) (Table 4.2).

Table 4. 2: Association between worms, malaria and anemia in pregnant women attending antenatal clinic in Kisumu

Parasites	Category	Anemia n (%)	Unadjusted OR (95% CI)	#Adjusted OR (95% CI)	P value
Schistosoma Mansoni	Positive	44(52.4)	0.401(0.23-0.70)	0.37(0.21-0.64)	0.001
	Negative	118(73.3)	REF	REF	
	$\chi 2$; P value	10.78; 0.001			
Malaria parasitemia	Positive	22(81.5)	2.45(0.89-6.72)	2.91(1.01-8.34)	0.047
	Negative	140(64.2)	REF	REF	
	$\chi 2$; P value	3.196; 0.074			
Any STH	Positive	16(47.1)	0.40(0.19-0.82)	0.36(0.17-0.77)	0.008
	Negative	146(69.2)	REF	REF	
	$\chi 2$; P value	6.40; 0.011			

Table 4.2: Infections associated with Anemia
$\chi 2$: Pearson Chi-square test; OR: Odds Ratio
OR adjusted using multivariate regression analysis
STH: Soil transmitted helminths

4.3.1 Association between *Schistosoma mansoni* Infection Burden and Anemia

S. mansoni egg per gram plots were compared with the Hb level plots to establish if Hb levels tend to be generally lower in people with high egg burden. There was no relationship between *S. mansoni* epg and Hb levels (Figure 4.3). To establish if there was a relationship between different *S. mansoni* intensities (WHO categorization) and anemia, for each *S. mansoni* category (no infection, light, moderate, and heavy) comparisons were made on the proportion of pregnant women who had anemia (Figure 4.4). There was no relationship between the different intensities and anemia, since women with heavy infections tended to have no anemia even though very few women had heavy infections.

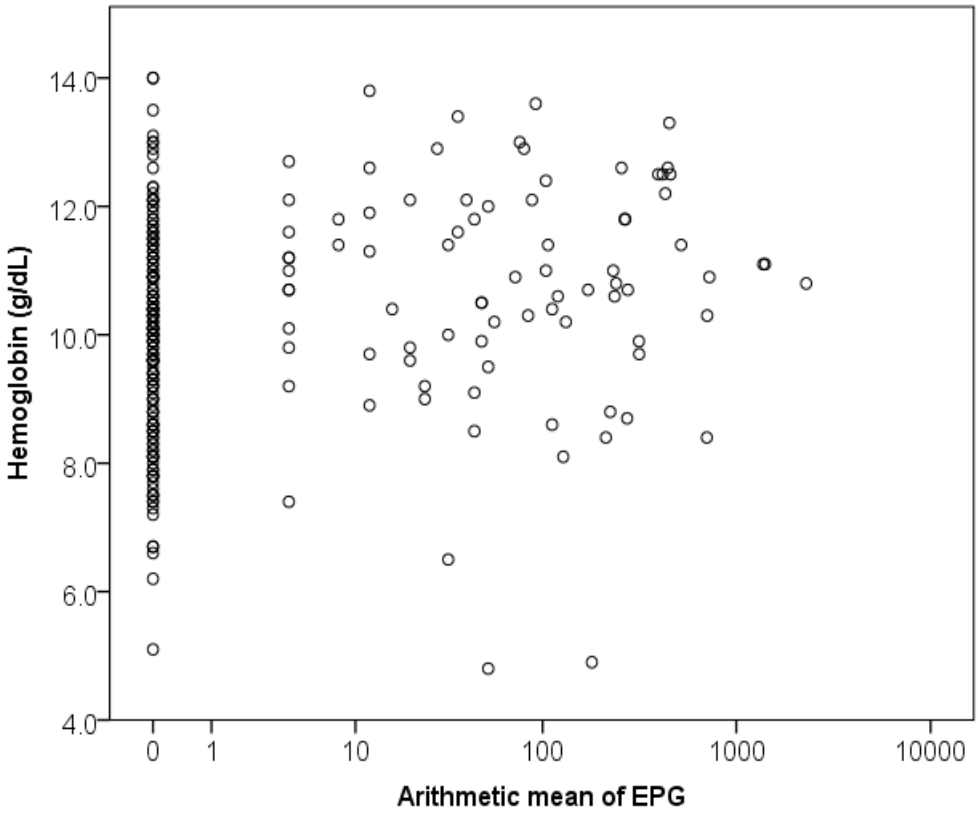

Figure 4.3. Association between *S. mansoni* infection burden and anemia.

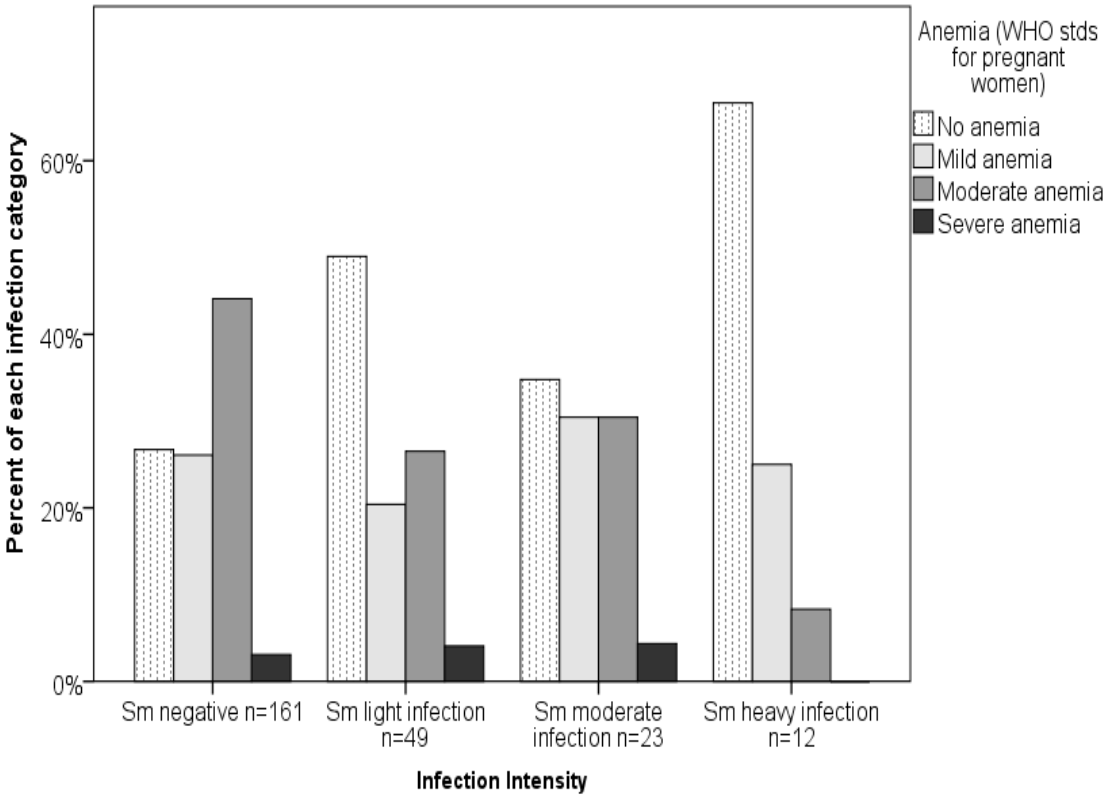

Figure 4. 4: Association between *S. mansoni* intensity categories and anemia

4.3. 2. Associations between Anemia and Malaria/helminth Co- infections in Pregnant Women

This study tested all of the most common parasites in the study area (*S. mansoni* hookworm, *Trichuris trichuria*, malaria and Ascaris). Total parasite burden 4(1.6%) of all the participants had at least 3 parasites, *S. mansoni*, malaria, *Trichuris trichuria* or *S. mansoni*, malaria, Hookworm or Malaria, Ascaris, Hookworm or *S. mansoni* , Hookworm, *Trichuris trichuria* . About 25 (10.2%) had at least 2 parasites of these, 9 had *S. mansoni* and malaria, 9 have *S. mansoni* and one STH, 1 had malaria and one STH and 6 had at least 2 STH. 91 (37. 1%) had single infection with 63 having *S. mansoni* only, 14 had malaria only, 6 had Ascaris only, 4 had Hookworm only and 4 had *Trichuris trichuria* only. Overall 124 (51%) had no parasitic infection at all.

Prevalence of anemia was higher among women infected with malaria only (92.9%) as compared to those uninfected with regard to any other parasites (73.4%), however, the prevalence of those infected with *S. mansoni* only, STH only and those co-infected with *S. mansoni* +STH, and Malaria+any other worm were relatively lower as compared to those uninfected with regard to any worm.

In multivariate analysis (controlling for age and gravidity status as confounders), *S. mansoni* infection was associated with a reduction in risk of becoming anemic (OR = 0.47, 95% CI: 0.25-0.88). Malaria parasitemia was associated with increased risk of being anemic (OR = 4.71, 95% CI: 0.59-37.5), although this association was not significant as compared to other co-infections (p= 0.143) (Table 4.3).

Table 4.3: Associations between anemia and Malaria/helminth co- infections in pregnant women

Parasites	Category	Overal n(%)	Anemia n (%)	Unadjusted OR (95% CI)	P value
Co-infections	Uninfected	124(50.6)	91(73.4)	REF	
	S. mansoni Only	64(26.1)	36(56.3)	0.47(0.25-0.88)	0.018
	Malaria Only	14(5.7)	13(92.9)	4.71(0.59-37.5)	0.143
	STH Only	21(8.6)	13(61.9)	0.59(0.22-1.55)	0.284
	S. mansoni + STH	9(3.7)	0	1	
	Malaria + Any worm	13(5.3)	9(69.2)	0.82(1.85-4.11)	0.748

CHAPTER FIVE

DISCUSSIONS

5.1 Prevalence of *S. mansoni,* Geohelminths and Malaria in Pregnant Women

Data from this cross-sectional study demonstrated that there is high prevalence of *S. mansoni* among pregnant women attending antenatal care in this region with more women aged between 25-30 years showing the highest prevalence, an association that has also been shown by other researchers (Downs *et al*., 2011). High prevalence of *S, mansoni* in pregnant women had also been seen among women in Ukerewe Island in Tanzania (Ajanga *et al*., 2006) and in Uganda (Muhangi *et al*., 2007) observations that may suggest that *S. mansoni* infection is prevalent among pregnant women living in *S.mansoni* endemic regions .Infection intensities for *S. mansoni* in pregnant women were light and only 4.9% of the women had heavy infections which was lower than what was reported from Tanzania.

Infections with the geohelminths were not common as 5.3%had Ascaris, 6.9% Hookworm and 4.9% had *Trichuris trichuria*. This was lower than what had been reported in studies done among pregnant women in Gem, Kenya where 52.3% had Ascaris, 39.5% Hookworm, 29% *Trichuris trichuria* (van Eijk et a*l*., 2009) , in Peru and Uganda where the overall geohelminth prevalence were 90.7%(Larocque *et al*., 2005) and71% (Ndyomugyenyi *et al*., 2008)respectively, but were comparable to the findings of (Fuseini *et al*., 2010) in Ghana. The differences seen could be as a result of the direct smear microscopic analysis of single stool sample which may have missed light infections because of poor sensitivity and day to day fluctuation in egg excretion (Booth *et al*., 2003). Future surveys may be enhanced by examining stool samples collected for at least three consecutive days. There is also the possibility of long term effects of health education and

primary health care interventions which have failed to have effect on the *S. mansoni* due to lack of alternative sources of water and occupational activities, though was not assessed.

Prevalence of falciparum malaria in this study area was relatively low (11%) in spite of the locality being within a malaria holoendemic area. Our findings showed similar prevalence with the study done in Tanzania (Ajanga *et al*., 2006) and in Entebe Uganda (Muhangi *et al*., 2007) but were lower than what was reported in Ghana (Fuseini *et al*., 2010).This difference could be attributed to high mosquito net coverage which was not assessed in this study.

5.2 The Association between Worm Infections and worm/ Malaria Co-infections and Anemia in Pregnant Women

In this study overall prevalence of anemia among pregnant women was high. More than a third of the women had their hemoglobin levels less than 11g/dl,(25.3%) , which is comparable to the findings of similar studies in other areas of Africa (Ajanga *et al*., 2006) and in other parts of the world (Larocque *et al*., 2005), although this was higher than what was reported in Uganda (Muhangi *et al*., 2007).

In this population malaria infection was associated with an increased risk of anemia. Such findings have potential public health importance as in many developing countries, anemia during pregnancy is an important contributor to maternal ill health and mortality, especially around the time of delivery(Steketee, 2003). Anemia is also associated with reduced birth weight which is a risk factor for infant mortality. Malaria is known to cause anemia (Bloland *et al*., 1999) and the importance of malaria as a cause of anemia in pregnancy is well established (Shulman *et al*., 1996), though this finding contrasts with other studies that showed no association between malaria and anemia in pregnant women (Ajanga *et al*., 2006). There were no associations observed between anemia and *S. mansoni*, other helminthes and malaria/ worm co- infections. It

was also noted that women with heavy *S. mansoni* infections tended to have no anemia which contrast other findings which showed that anemia was more common among women heavily infected with *S. mansoni* (Leenstra *et al*., 2004); (Muhangi *et al*., 2007). The absence of *S. mansoni* and STH associated morbidities may be related to the lower intensity infections that perhaps led to subtle or non measurable sequelae or could possibly be because of the low prevalence of the co-infections in this population.

There are compelling reasons for preventing and treating malaria during pregnancy (Shulman *et al*., 1996) and results from this study highlight that anemia is among them. On the other hand results from this study as well as recent literature suggest that there are no or there are weaker associations between helminth infections and anemia in pregnancy, with regional variations that may be based on nutrition and intensity of helminthic infection. These findings are relevant in estimating the relative disease burden of helminthes and malaria and the relative value of possible interventions in pregnancy.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

Despite the availability of effective and safe drugs for treatment, the prevalence of *S. mansoni* and malaria infections in pregnant women attending antenatal care clinics in Kisumu area are still high above the national average. Geohelminths were generally lower compared to other studies similar to this in other areas and different times. Based on WHO standards there was generally high prevalence of anemia among the pregnant women which is tandem with other studies in different settings. Lower Hemoglobin levels were associated with malaria infections, consistent with previous reports on contribution of malaria to anemia in pregnancy.

6.2 Conclusions

1. There was high prevalence of *Schistosoma mansoni* with light infection intensities and low prevalence and intensities of geohelminths among pregnant women in this study area.

2. Anemia was prevalent among pregnant women in this area and infection with malaria showed an increased risk of being anemic.

6.3 Recommendations from Current Study

1. Due to the high prevalence of *Schistosoma mansoni* in this region, health care providers should be informed to consider treatment of pregnant women infected with *Schistosoma mansoni* during antenatal visits and whenever there is mass drug administration as recommended by the WHO.
2. This study recommends an integrated programme for the control of these parasites in order to reduce the degree of anemia during pregnancy.

6.4 Recommendations for Future Studies

This was a small cross- sectional study and although this design provides a useful contribution in exploring the relationship between parasitic infection and anemia, large intervention studies are needed to establish the causal nature of the observed association and explore the impact of treatment on this group. This study has only shown the associations between malaria infections and anemia, more studies should be done to evaluate on the impact of the infections and co-infections on pregnancy and birth outcomes.

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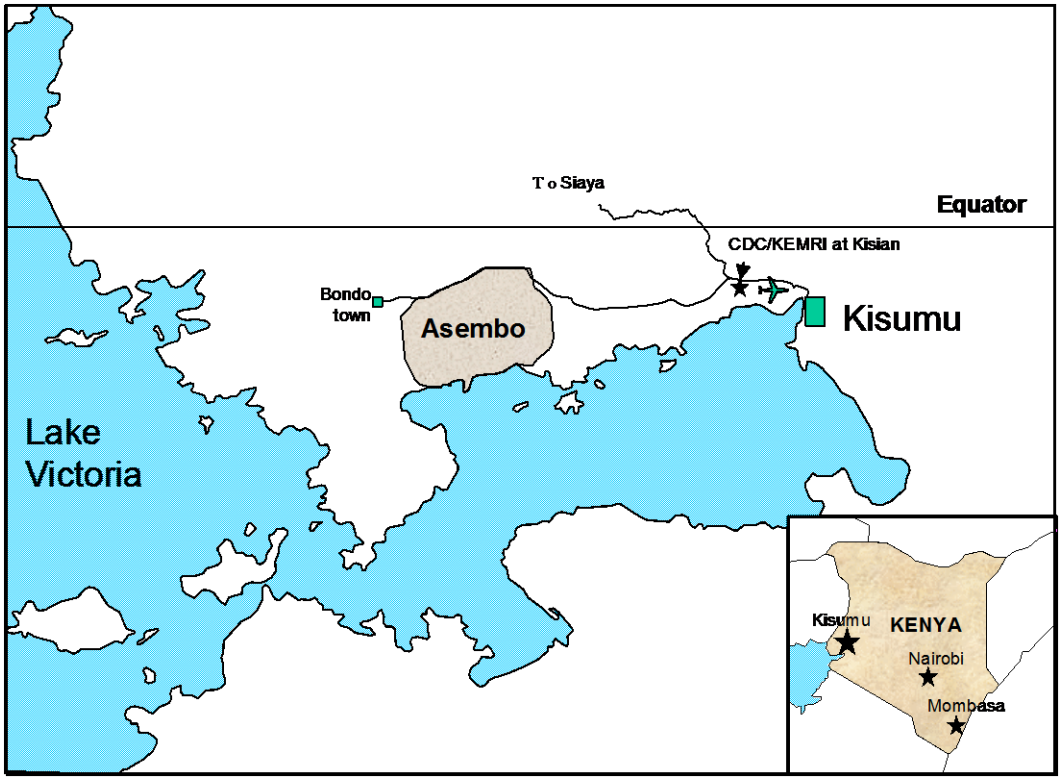
APPENDICES

APPENDIX 1: Map showing the study site (Kisumu), Western Kenya.



Adapted from KEMRI/CDC GIS-mapping department.

APPENDIX 2: CONSENT EXPLANATION AND CONSENT FORMS

TITLE OF THE STUDY: Prevalence and effects of *S. mansoni* and geohelminth infections among pregnant women attending ante-natal clinic around Kisumu, Kenya.

INSTITUTIONS:

Kenya Medical research Institute, Kisumu Kenya.

School of Public Health and Community Development, Maseno University.

PRINCIPAL INVESTIGATOR:

Odhiambo Keziah Akinyi

School of Public Health and Community Development.

CO- INVESTIGATORS:

1. Prof. Collins Ouma

School of Public Health and Community Development

2. Dr. Diana M.S Karanja

Kenya Medical Research Institute (Centre for Global Health Research)

Participation information

You are being asked to take part in a medical research study on Bilharzia (schistosomiasis) performed by Kenya Medical Research institute and Maseno University. Your participation in the study is entirely voluntary and you can refuse or come out of the study without any penalty and after reading about this study you can ask questions at any time during the study.

INTRODUCTION

This study is about Bilharzia a disease caused by worm parasites transmitted by snails and other intestinal worms. These infections are common in western Kenya. Snails live in different types

of water including ponds, rivers and even lakes. Persons whose activities cause them to come into contact with water where infected snails live, waters where transmission is going on are likely to suffer from bilharzia and those who eat soil or drink soil contaminated water are likely to suffer from other worm infections. Bilharzia and other worms can cause anemia or liver damage to an infected person and can sometimes cause death if not diagnosed and treated properly.

Purpose of the study

There is medicine for treatment of bilharzia but most of the time pregnant women do not get treatment for bilhazia either because they cannot afford or because they are not tested for the infections. Many people from areas where schistosomiasis transmission occur depend on the infected water for their livelihood and so cannot avoid being in contact with the infected water. As such they continue to get infected .Many people who are treated can get bilharzia again by going into the water again. We will test for bilharzia, other intestinal worms and malaria; to do this we will need to take stool samples and figure prick blood. This will be done once. If you are found positive you will be treated.

What is important for you to know

You can be in the study if you are pregnant. You can be in the study if you provide a written consent that you agree to be in the study. We will need to test your feces for bilharzia and other intestinal worms; finger prick blood for malaria and blood level. You will be offered treatment for intestinal worms and or bilhazia if the test shows that you have these worms. We will also test for malaria and if you have malaria you will be treated. This study is expected to last about one- two months, but your participation will only be once. You can always decide if you want to take part in this study or not. Taking part in this study will not cost you anything. You may also

leave the study at any time without any problems. If you decide to withdraw from the study your stool, blood sample and any data obtained from you will be destroyed and not used in any analysis.

Risks involved

There will be minimal discomfort when your finger will be pricked for a drop of blood, but to minimize any risks, hazard or discomfort it will be done by a qualified and well trained staff who will observe sterility during the process.

Benefits

There will be no payments. Participants will be tested for bilharzia, other worms and malaria. If found with any of these infections free treatment will be offered at the health center.

Confidentiality

If you agree to participate in this study, you will be assigned a study number that will be used on your stool sample and on the slide with your blood. The information collected in the study will be kept private and no names will be used on any of the study reports. Only study personnel will be allowed access to the information collected in this study.

Your rights as a participant in this study

You are free to be part of this study. Your participation is voluntary and you have the right to refuse or withdraw your services at any time without any penalty.

Questions about research

If you have any questions about this study you may contact Dr. karanja at the Kenya Medical Research Institute, Kisumu Tel no.057-2022929 during the study and in future. If you have

concerns about human rights, ethics and welfare issues you may contact the secretary, KEMRI Ethics Review committee, P.O Box 54840-00200, Nairobi; Telephone numbers: 020-2722541, 072225901, 0733400003; Email address:erc@kemri.org based at KEMRI.

CONSENT TO SERVE AS A SUBJECT IN RESEARCH

I ---------- ---------- agree to serve as a subject in the study entitled: ----------
---
---------.

The nature and general purpose of the research procedure and the known risks involved have been explained to me by----------.

The investigator is authorized to proceed on the understanding that I may terminate my services at any time I so desire. I understand the known risks are----------
----------. I believe that reasonable safeguards have been taken to minimize both known and the potentially unknown risks.

Participant's signature ---------- Date ----------

Name of person obtaining the consent ----------

Signature ---------- Date ----------

Witness ---------- Date ----------

Witness Signature----------

LER KUOM OBOKE MAR AYIE

WI NONRO: Pek gi hinyruok ma ikelo gi Aremo kod njokni ne mine mapek madhi e kilinik e aluora mar Kisumo, e Kenya.

MIGEPE:

Kar timo nonro touché mar Kenya (KEMRI), Kisumo, Skul mar ngima oganda gi dongruok mar gwenge mar Maseno University.

JATEND NONRO:

Odhiambo Keziah Akinyi

JO NONRO MAMOKO

Ngire Collins Ouma

Skul mar ngima oganda gi dongrouk mar gwenge mar Maseno University.

Lkt. Diana Karanja

Jatim nonro maduong

Migao mar nonro mar touché dhano e Kenya (KEMRI) bade ma Kisumo.

Weche ewi bedo e nonro

Ikwai mondo ibed e nonro mar thieth mar bilhazia ma itimo kod kar nono touché mar Kenya kod mbalariany mar Maseno.Bedoni e nonro en kuom yie mari to inyalo tamori kata wuok e nonro saa a saya maonge kum moro amora, Kendo bang somo weche e wi nonro ni inyalo penjo penjo sani kata saa moro amora ka nonro dhi nyime.

Ler e wi nonro

Nonroni en e wi tuo mar bilhazia(Aremo) ma ikelo kod kute ma ilando gi kamnio gi njokni ma moko. Tuoche gi yudore mang'eny e Kenya ma imbo. Kamnio dak kwonde mopogore opogore kaka yao, aora kata nam. Jogo matijegi chuno donjo e pige man gi kamnio ma oting'o kute nyalo bedogi bilhazia, kendo jogo machamo loo kata modho pige mokikore gi lowo bende nyalo

yudo njokni mamoko. Bilhazia gi njokni ma moko nyalo kelo rem mar remo e del kata ketho chuny mar ng'ato ma nigi tuoni, kendo samoro nyalo kelo tho ka ok opime kendo othiedhe maber.

Gima omiyo itimo nonro

Nitie yath ma inyalo thiedho go bilhazia to mon ma pek seche mang'eny ok yud thieth kuom touni nikech ok gin gi nyalo kata samoro nikech ok otimne gi pim. Ji ng'eny ma nitie kuonde ma kute makelo bilhazia landoree bende ngimagi otenore kod pigegi kendo ok yot mondo giwe donjo ei pi man kod tuoni, kuom mano gi siko giyudo tiuoni. Bende ji mangeny' ma ose thiedhi nyalo yudo bilhazia ka gi siko gidok e pi. Wabiro pimo bilhazia, Njokni mamoko kod malaria bende; to mondo watim ma wabiro kao oko mari kod remo mar lith lwedo. Ma ibiro tim dichiel. Kaponi oyudi gi tuo , ibiro thiedhi.

Gigo maber mondo ing'e

Inyalo donjo e nonro ka in mio ma pek. Inyalo bedo e nonro ka iyie chiwo ayie mar bedo ei nonro kuom ndiko. Wa biro dwaro mondo wapim bilhazia gi njokni ma moko kokalo kuom oko mari, m alarai gi rom mar remo kokalo kuom remo mar lith lweti. I biro miyi thieth mar njoki mamoko, kata bilhazia kaponi pim onyiso ni in kod kute gi. Wabiro bende pimo malaria, to ka oyudi gi malaria ibiro thiedhi kaluwore gi chenro mar migao mar thieth. Nonro ni igeno ni biro kaw dwe achiel kata dweche ariyo, to in ibiro bedo e nonro dichiel. Inyalo yiero bedo e nonnro kata tamori. Bedo e nonro en nono. To inyalo wuok e nonro maonge chandruok moro amora. Ka iwuok e nonro to losruok,rembi kata wach mora mora mo a kwomi ibiro witi e yo makare kendo ok bi tigo e yo mora mora.

Hinyruok madibedi e nonro

I biro bedo gi rem matin ka ochwo lith lweti ka igolo remo, mak mana ni mondo odwok rem kata hinyruok piny, ibiro kaw remo e yo maler gi jogo motiegi kendo nigi lony mabiro ng'iyo ler eseche ma itimo ma.

Yuto e nonro

Onge chudo. Joma nitie e nonro I boro pim bilhazia, njokni ma moko gi malaria. To ka oyudi moro kuom touché gi to ibiro timnegi thieth nono e kar thieth ma itimoe nonro ni.(osibtal).

Kano weche

Ka iyie bedo e nonroni, ibiro miyi namba ma ibiro ti godo e okoni gi gilas ma omien e rembi. Weche ma ochoki e nonro ibiro kan maling' ling' kendo nyingi ok bi wuok e ripot moro amora. Jotich mantie e nonroni kende ema ibi yienigi neno weche maochoki e nonro.

Adiera (Ratiro) mari mar bedo e nonroni

In thuolo mar bedo ei nonroni. In gi adiera / ratiro mar tamori kata wuok e saa a saya ma onge kum moro amora.

Penjo e wi nonro

Ka in kod penjo moro amora e wi nonroni, inyalo tudori gi Lkt. Karanja mantie kar nono tuoche (KEMRI) Kisumo. Namba simbe en 057-202-2929 e kinde mar nonro kata bang'e. Ka in kod penjo e wi adiera magi kaluwore gi bedo e nonroni, inyalo tudori gi Secretari, KEMRI Ethics Review Committee, P.O.Box 54840-00200Nairobi;Namba0202722541,072225901,0733400003; Email adres en erc@kemri.0rg mar KEMRI .

A YIE MAR BEDO E NONRO.

An ---------- ayie mar bedo e nonro ma iluongo ni---------

----------.

Chal gi gima omiyo nonro ni gi hinyruok madibedie osepimna gi----------

Ayie mondo jatim nonro odhi nyime e wi winjruok ni, anyalo wuok /weyo e saa asaya ma ahero.

Ang'eyo ni hinyruok ma ong'e gin----------.

An gi yie ni chenro ma owinjore osekaw mondo odwok piny hinyruok ma ong'e kata ma pok ong'ere.

Sei----------Tarik

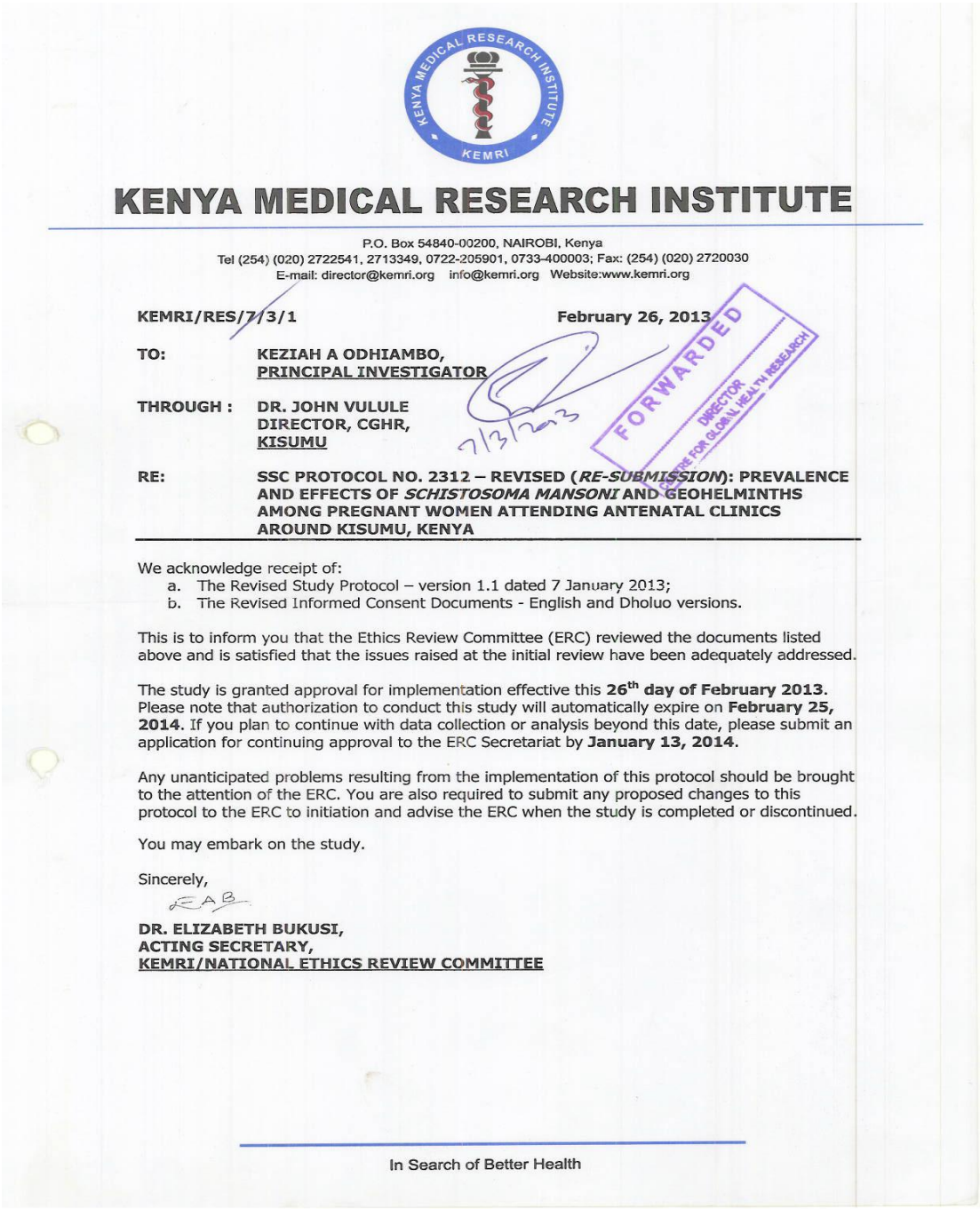
Nying ng'a makao yie----------

Sei----------Tarik----------

Janeno----------

Sei mar janeno----------Tarik----------

Appendix 3: Study Approval



KENYA MEDICAL RESEARCH INSTITUTE

P.O. Box 54840-00200, NAIROBI, Kenya
Tel (254) (020) 2722541, 2713349, 0722-205901, 0733-400003; Fax: (254) (020) 2720030
E-mail: director@kemri.org info@kemri.org Website:www.kemri.org

KEMRI/RES/7/3/1 **February 26, 2013**

TO: **KEZIAH A ODHIAMBO,**
PRINCIPAL INVESTIGATOR

THROUGH : **DR. JOHN VULULE**
DIRECTOR, CGHR,
KISUMU

FORWARDED
DIRECTOR
CENTRE FOR GLOBAL HEALTH RESEARCH

RE: **SSC PROTOCOL NO. 2312 – REVISED (*RE-SUBMISSION*): PREVALENCE AND EFFECTS OF *SCHISTOSOMA MANSONI* AND GEOHELMINTHS AMONG PREGNANT WOMEN ATTENDING ANTENATAL CLINICS AROUND KISUMU, KENYA**

We acknowledge receipt of:

a. The Revised Study Protocol – version 1.1 dated 7 January 2013;
b. The Revised Informed Consent Documents - English and Dholuo versions.

This is to inform you that the Ethics Review Committee (ERC) reviewed the documents listed above and is satisfied that the issues raised at the initial review have been adequately addressed.

The study is granted approval for implementation effective this **26th day of February 2013**. Please note that authorization to conduct this study will automatically expire on **February 25, 2014**. If you plan to continue with data collection or analysis beyond this date, please submit an application for continuing approval to the ERC Secretariat by **January 13, 2014**.

Any unanticipated problems resulting from the implementation of this protocol should be brought to the attention of the ERC. You are also required to submit any proposed changes to this protocol to the ERC to initiation and advise the ERC when the study is completed or discontinued.

You may embark on the study.

Sincerely,

DR. ELIZABETH BUKUSI,
ACTING SECRETARY,
KEMRI/NATIONAL ETHICS REVIEW COMMITTEE