

**GEOPHAGY AND PARASITIC INFECTIONS IN  
PREGNANT WOMEN ATTENDING AN ANTE-NATAL  
CLINIC IN THIKA LEVEL-5 HOSPITAL, KIAMBU  
COUNTY, CENTRAL KENYA**

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**Geophagy and Parasitic Infections in Pregnant Women attending an  
Ante-Natal Clinic in Thika Level-5 Hospital, Kiambu County, Central  
Kenya**

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**2017**

**DECLARATION**

This thesis is my original work and has not been presented for a degree in any other University

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## **DEDICATION**

This thesis is dedicated to my family for their support, encouragement and prayers throughout the period of this study.

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## **ABBREVIATIONS AND ACRONYMS**

<b>CDC</b>	-	Centers for Disease Control and Prevention
<b>ERC</b>	-	Ethical Review Committee
<b>Hb</b>	-	Haemoglobin
<b>HIV</b>	-	Human Immuno-Deficiency virus
<b>ITROMID</b>	-	Institute of Tropical Medicine and Infectious Diseases
<b>KEMRI</b>	-	Kenya Medical Research Institute
<b>NTDs</b>	-	Neglected Tropical Diseases
<b>PI</b>	-	Principal investigator
<b>RBC</b>	-	Red Blood Cell
<b>SPSS</b>	-	Statistical Package for the Social Sciences
<b>SSC</b>	-	Scientific Steering Committee
<b>STH</b>	-	Soil Transmitted Helminthiases
<b>STHs</b>	-	Soil Transmitted Helminthes
<b>TL5H</b>	-	Thika Level 5 Hospital

**UNICEF** - The United Nations Children's Fund

**UNU** - United Nations University

**WBC** - White blood cells

**WHO** - World Health Organization

## ABSTRACT

Geophagy, the regular and deliberate consumption of non-food substances like soil is said to be common among pregnant women in Sub-Saharan Africa. This study aimed to investigate geophagy among pregnant women who attended the antenatal care clinic at Thika Level-5 Hospital, in relation to parasitic infections. Study objectives were to determine the prevalence of geophagy and intestinal parasitic infections among the study women, and association between geophagy and intestinal parasitic infections. A total of four hundred and ten (410) study participants were enrolled in this cross-sectional, hospital-based study. A questionnaire was administered to collect personal and behavioural information; faecal samples were collected for microscopic diagnosis of intestinal parasitic infections on direct faecal smears and Kato-Katz smears, and finger prick blood taken for haemoglobin determination. Out of the 410 participants enrolled, 26.1% (n=107) practiced geophagy, majority of whom practiced it only occasionally. It was observed that 92.5% of the study participants preferred soil purchased from market places and 11% of the study women examined were infected with intestinal parasitic infections. The parasites detected in faecal samples were *Entamoeba histolytica* (8.8%), *Trichuris trichiura* (1%), *Ascaris lumbricoides* (1%), *Schistosoma mansoni* (0.7%), and *Strongyloides stercoralis* (0.2%). None of the 5 intestinal parasites detected were, however associated with geophagy,  $P>0.05$ . Interestingly, only *E. histolytica* (8.4%) was found in women who practised geophagy. Furthermore, gestation period was associated with *E. histolytica* infection,  $p=0.049$ , with those who ate soil from the garden being more likely to have an *E. histolytica* infection, ( $p=0.026$ ). Also closely associated with geophagy were level of education ( $p=0.009$ ), feeding problems ( $p=0.000$ ) and history of practising geophagy ( $p=0.000$ ). Majority of the women (64.9%, n=266) had normal levels of haemoglobin (11gm/dl and above), (32.7%, n=134) were mild anaemic (Hb levels 10.0-10.9gm/dl), 1.5% (n=6) were moderately anaemic (Hb levels 7-9.9gm/dl), and 1% (n=4) were severely anaemic (<7gm/dl). Those who practised geophagy (34.6%) had mild anaemia, while <5% had moderate or severe anaemia based on the WHO

classification for anaemia in pregnant women. While geophagy was not significantly associated with parasitic infections in the pregnant women attending Thika Hospital, geophagy was found to be significantly associated with education and feeding problems. Besides, pregnancy trimester and the source of soil were found to be associated with *E. histolytica* infection. This study recommends a need for extensive and intensive public health education to advocate for the necessity of hygiene and sanitation and also impact knowledge on the risks and benefits of geophagy, provision for a mineral supplementation program, formulation of a policy on the routinely deworming of pregnant women in their 2<sup>nd</sup> trimester, have a routine testing of amoebiasis in pregnant women and treatment of the infected especially in the 2<sup>nd</sup> trimester and need for the Bureau of Standards to ensure that soil sold in markets, supermarkets or by the vendors is 100% safe from parasites and heavy metals, also set rules and regulations on sterilization and packaging. Further studies are recommended to determine the role played by soil from different sources in the transmission of parasitic infections in pregnant women practicing geophagy and to compare the immune systems of pregnant women in the different gestation trimesters.

## CHAPTER ONE

### INTRODUCTION AND BACKGROUND

#### 1.1 Introduction

Geophagy is a type of pica, a regular and deliberate eating of non-food substances seen worldwide (Callahan, 2003). Pica describes behaviour of craving and subsequent purposeful ingestion of non-food substances (Young, 2010; Thihalolipavan *et al.*, 2012). Pica was documented as early as 400 B.C. by Hippocrates and continues to be practiced today. Pica is generally considered to be a chronic behaviour (Young, 2010). There are three commonly described forms of pica, corresponding to three most frequently consumed non-food substances: geophagy – ingestion of earth (soil, clay or baked clay), amylophagy – ingestion of raw starch, and pagophagy – ingestion of ice.

Geophagy is nearly universal around the world in tribal and traditional rural societies (although apparently it has not been documented in Japan and Korea). It is extremely widespread in the animal kingdom. This type of geophagy has been documented in “many species of mammals, birds, reptiles, butterflies and isopods, especially among herbivores” (Jared 1999). “The oldest evidence of geophagy practiced by humans comes from the prehistoric site at Kalambo Falls on the border between Zambia and Tanzania” here, calcium-rich white clay was found alongside the bones of *Homo habilis* (the immediate predecessor of *Homo sapiens* (Olle, 2005). Also, the eating of clay (a form of geophagy) has been documented in historical sources beginning with Ancient Mesopotamia and Egypt.

Geophagy was practiced by Native Americans in California and Peru who ate earth with acorns and potatoes to neutralize potentially harmful alkaloids (Callahan, 2003). Clay was used in the production of acorn bread in California and Sardinia, Italy. Among the



Jews in the second and third centuries, a type of earth was consumed for medical purposes, but the Talmud warns about possible physiological damage from eating it.

In parts of Africa, rural areas of the United States, and villages in India, clay consumption is correlated with pregnancy and some women eat clay to eliminate nausea, possibly because the clay coats the gastrointestinal tract and may absorb dangerous toxins. The clay may also provide critical calcium for fetal development (Vermeer and Frate 1979). In Africa, kaolin, sometimes known as *kalabain* in Gabon (Hamilton, 1998) and Cameroon (Harvey *et al.*, 2000), *calaba*, and *calabachop* (in Equatorial Guinea), is eaten for pleasure or to suppress hunger (Harvey *et al.*, 2000). Consumption is greater among women, especially during pregnancy (Kwong & Henry, 2003).

Geophagy being a common practice among southerners may have been caused by the high prevalence of hookworm disease, in which the desire to consume soil is a symptom (Reid, 1992). It was common among slaves who were nicknamed "clay-eaters" because they had been known to consume clay, as well as spices, ash, chalk, grass, plaster, paint, and starch (Vermeer, 1971). The author cites a recent survey by Obstetrics-Gynecology Clinic at Duke Medical Center in North Carolina, according to which one quarter of patients were clay-eaters. Cooked, baked, and processed dirt and clay are sold in health food stores and rural flea markets in the South (Walker & Walker, 1997; Wiley, 2003). Clays like activated attapulgite and diosmectite have been used in active ingredients in over-the-counter antidiarrheal medications. The US version of Kaopectate, for example, contained kaolinite clay until a reformulation in 2003 (Wiley & Solomon, 1998). Researchers have noticed that geophagy is not as prevalent as it once was as rural Americans assimilate into urban culture (Wong & Simeon, 1993).

Geophagy, the deliberate consumption of soil, is prevalent among pregnant women across Sub-Saharan African countries, such as Kenya, Ghana, Rwanda, Nigeria, Tanzania, and South Africa. It is practiced in approximately 50% of pregnant women in Africa, and in Uganda up to 84% of pregnant women reported daily consumption of soil/

clay (Njiru *et al.*, 2011). In Nigeria, the most populous country in Africa, the prevalence of geophagy in pregnancy is estimated at 50%. The prevalence among pregnant women also ranged from 65% in Kenya, 46% in Ghana, 42% in Namibia to 28% in Tanzania (Vermeer, 1971; Thomson, 1997; Antelman *et al.*, 2000; Luoba *et al.*, 2004). Among pregnant women in a coastal district of Kenya, 73% of the women ate clay regularly.

In Tanzania, pregnant women commonly eat soil sticks sold in the market (*Pemba*), soil from walls of houses, termite mounds, and ground soil (*kichuguu*) (Nyanza *et al.*, 2014). There are obvious risks to the consumption of earth that is contaminated by animal or human feces. Parasite eggs and cysts can stay dormant for years in the soil and can present a problem. The predilection of children and pregnant women to engage in geophagy makes them more susceptible to parasitic infestations, for instance geophagy is speculated to be a risk factor for the transmission of soil-transmitted helminthiasis (STH) such as *Ascaris lumbricoides*, *Trichuris trichiura* through ingestion of helminth eggs with contaminated soils.

Other STH that often infect pregnant women and children are hookworm and *Strongyloides stercoralis*. Although these may not necessarily be transmitted through geophagy, they nevertheless cause severe morbidity in pregnant women (Young *et al.*, 2007).

Although, it is often regarded as a response to compulsive physiologic demand during pregnancy (Young *et al.*, 2007), it's a cultural and widely accepted practice in African societies, where this practice has been associated with religion, culture and famine (Geissler *et al.*, 1999). Women consume a variety of soil types, the most preferred being hardened clay soils often sold in shops and markets and soils from the walls of houses or termite mounds (Kwong & Henry, 2003).

## **1.2 Statement of the Problem**

There are obvious risks to the consumption of earth that is contaminated by animal or human faeces. Parasitic eggs and cysts can stay dormant for up to 10 or more years in the soil and can present a problem. The predilection of children and pregnant women to engage in geophagy makes them more susceptible to parasitic infestations. Geophagy is speculated to be a risk factor for soil transmitted helminthiases. Despite their potential to supply micronutrients, soils interfere with bioavailability of micronutrients leading to micronutrient deficiency and can also act as a pathway for ingestion of soil transmitted helminths and heavy metals, putting the women and foetuses at risk (Callahan, 2003).

In Sub-Saharan African countries, it has been associated with a high prevalence of infection with *Ascaris lumbricoides*, which can contribute to malnutrition and the development of iron deficiency anaemia in pregnant women (Njiru *et al.*, 2011).

There is therefore a need to carry out an empirical research to investigate the role of geophagy in parasitic infections in pregnant women attending Thika Level 5 Hospital in Central Kenya. The results would act as a guide in coming up with the recommendations for the control and management purposes.

## **1.3 Justification of the Study**

Geophagy, the regular and deliberate consumption of non-food substances like soil is said to be common among pregnant women in Sub-Saharan Africa. In Kenya, previous studies on geophagy in pregnant women have been done in Western, Coastal Kenya, Nairobi and none in Central Kenya. Parasitic infections affect tens of millions of pregnant women worldwide. These infections directly and indirectly lead to a spectrum of adverse maternal and foetal/placental effects, hence the need to investigate the role of geophagy in parasitic infections in pregnant women attending Thika Level 5 Hospital in Central Kenya so as to make recommendations for control and management purposes.

#### **1.4 Null Hypothesis**

Geophagy is not associated with the transmission of parasitic infections in pregnant women in Thika area, Central Kenya.

#### **1.5 Research Questions**

- 1) What is the prevalence of geophagy in pregnant women attending antenatal clinic in Thika Level 5 Hospital?
- 2) What is the prevalence of parasitic infections and anaemia among pregnant women attending antenatal clinic in Thika Level 5 Hospital?
- 3) Is there an association between geophagy and parasitic infections among pregnant women attending antenatal clinic in Thika Level 5 Hospital?
- 4) Are the pregnant women attending antenatal clinic in Thika Level 5 Hospital aware of the potential risks and benefits of geophagy?

#### **1.6 Objectives of the Study**

##### **1.6.1 General Objective**

To investigate the role of geophagy in parasitic infections in pregnant women attending Thika Level 5 Hospital.

### **1.6.2 Specific Objectives**

- 1) To determine the prevalence of geophagy in pregnant women attending antenatal clinic at Thika Level-5 Hospital.
- 2) To determine the prevalence of parasitic infections and anaemia in the pregnant women seen at the Hospital.
- 3) To determine the association between geophagy and parasitic infections among the study women seen at the Hospital
- 4) To assess the awareness of potential risks and benefits of geophagy among the study women.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Geophagy and Pregnancy

Geophagy is the practice of eating earthy or soil-like substances such as clay and chalk (Callahan, 2003). It's a type of pica, a regular and deliberate eating of non-food substances seen worldwide (Callahan, 2003). It exists in animals in the wild and also in humans, most often in rural or pre-industrial societies among children and pregnant women (Peter, 2003). While geophagy is most often seen in tribal and rural societies among children and pregnant women, it is practised by members of all races, social classes, ages and sexes (Callahan, 2003).

In parts of Africa, rural areas of the United States and villages in India, clay consumption is correlated with pregnancy and some women eat clay to eliminate nausea, possibly because the clay coats the gastrointestinal tract and may absorb dangerous toxins. It may also provide critical calcium for foetal development (Vermeer and Frate 1979). Bentonite clay is available worldwide as a digestive aid; kaolin is also widely used as a digestive aid, as the base for some medicines and is also eaten for pleasure or to suppress hunger. There is a trend in recent scientific research to study geophagy not as pathology, but rather as an adaptive practice that supplements the diet with essential nutrients or treats a disorder such as diarrhoea (Callahan, 2003). Researchers' attention was directed mainly towards pregnant and postpartum women and their emotional states. Geophagy was attributed to feelings of misery, homesickness, depression, and alienation (Callahan, 2003). Women also use geophagy for oral satisfaction in handling anxiety (layman *et al.*, 1963).

Geophagy is common in Sub-Saharan Africa in pregnant women and children who deliberately consume soil (Geissler *et al.*, 1999). The prevalence of geophagy varies

between and within countries, but is estimated between 10-75% (Antelman *et al.*, 2000; Corbett *et al.*, 2003; Ngozi, 2008; Njiru *et al.*, 2011). It is likely that underreporting of geophagy occurs, for a variety of reasons, including embarrassment regarding the behaviour, lack of knowledge and sensitive questioning on the part of investigator inquiring about geophagy and differing perceptions, beliefs, and cultural norms (Corbett *et al.*, 2003; Young, 2010).

In some African countries, prevalence of geophagy during pregnancy of up to 84% has been observed. In Nigeria, the most populous country in Africa, the prevalence of geophagy in pregnancy is estimated at 50%. The prevalence among pregnant women also ranged from 65% in Kenya, 46% in Ghana, 42% in Namibia to 28% in Tanzania (Vermeer, 1971; Thomson, 1997; Antelman *et al.*, 2000; Luoba *et al.*, 2004). Among pregnant women in a coastal district of Kenya, 73% of the women eat clay regularly. In this region geophagy is a culturally accepted behaviour during pregnancy and is practised by women exclusively for its symbolic ties to fertility, reproduction, and ancestral blessing (Njiru *et al.*, 2011).

The timing of soil ingestion and amounts consumed vary with tribes and individual persons but soil comes consistently from certain sites. In some cultures, well-established trade routes and clay traders make rural clays available for geophagy in urban settings. Clays from termite mounds are especially popular among traded clays, perhaps because they are rich in calcium (Wiley & Solomon, 1998).

Women engage in geophagy during the first, second and third trimesters of pregnancy (Wiley & Solomon, 1998), often throughout the day and about 30-50 mg are consumed a day (ATSDR, 2000).

It is postulated that geophagy in pregnancy is due to micronutrient deficiencies, cultural influences and gastrointestinal upsets (Callahan, 2003). Despite their potential to supply micronutrients, soils interfere with bioavailability of micronutrients leading to

micronutrient deficiency and can also act as a pathway for ingestion of soil transmitted helminths and heavy metals, putting the women and foetuses at risk (Callahan, 2003).

The aetiology of geophagy remains elusive. Both physiologic (e.g., mineral deficiency or hunger) and psychological (e.g., craving, obsessive-compulsive spectrum disorder) models have been proposed (Knudsen, 2001; Herguner *et al.*, 2008; Young, 2010). Cultural and socioeconomic factors have also been identified as influencing the practice of geophagy, thereby highlighting its complex and little understood nature (Young, 2010).

## **2.2 Geophagy and Parasitic Infections**

There are obvious risks to the consumption of earth that is contaminated by animal or human faeces. Parasitic eggs and cysts can stay dormant for up to 10 or more years in the soil and can present a problem. The predilection of children and pregnant women to engage in geophagy makes them more susceptible to parasitic infestations. Geophagy is speculated to be a risk factor for soil transmitted helminthiases. Despite their potential to supply micronutrients, soils interfere with bioavailability of micronutrients leading to micronutrient deficiency and can also act as a pathway for ingestion of soil transmitted helminths and heavy metals, putting the women and foetuses at risk (Callahan, 2003).

In Sub-Saharan African countries, it has been associated with a high prevalence of infection with *Ascaris lumbricoides*, which can contribute to malnutrition and the development of iron deficiency anaemia in pregnant women (Njiru *et al.*, 2011).

A cohort study conducted in Western Kenya on “the role of geophagy and other risk factors for helminthiases in pregnant and lactating women” showed that it significantly increased the risk of infection with *Ascaris* after anthelmintic treatment (Luoba *et al.*, 2005) while among pregnant women in a coastal district of Kenya, 73% of the women ate clay regularly (Njiru *et al.*, 2011). In this region geophagy is a culturally accepted



behaviour during pregnancy and is practised by women exclusively for its symbolic ties to fertility, reproduction and ancestral blessing (Njiru *et al.*, 2011).

An estimate of 4600 species of prokaryote microorganisms were found per gram of natural soil using DNA hybridization analysis (Torsvik *et al.*, 1990; Kent & Triplett, 2002). However, all parasites that infest to the soil do not readily infect people who practice geophagy (Callahan, 2003). In the United States, the most common parasitic infection associated with geophagy is toxocariasis, most often caused by *Toxocara canis* (Callahan, 2003). Among children in Nigeria, the most common parasitic infection associated with geophagy is ascariasis (Ozumba & Ozumba, 2002). Additionally, geophagy is a common route of infection with amoebiasis in certain cultures; Amoebiasis is caused by the protozoan *Entamoeba histolytica* (Stanley, 2003). Amoebiasis is often asymptomatic but may cause dysentery and invasive extra-intestinal disease (Ximenez *et al.*, 2011). *Entamoeba dispar*, another species, has been thought in the past to be non-pathological but in vitro and in vivo experiments suggest it is capable of causing liver damage (Dolebella *et al.*, 2012). Humans are the only reservoir and infection occurs by ingestion of mature cysts in food or water, or on hands contaminated by faeces.

### **2.2.1 Parasitic infections and their Public Health Significance**

At a global level, the most important soil transmitted helminths are roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*) and hookworms (*Necator americanus* or *Ancylostoma duodenale*) and are estimated to have infected 807 million, 604 million and 576 million people, respectively (Hotez *et al.*, 2007). The greatest numbers of STH occur in Sub-Saharan Africa (SSA), East Asia, China, India and South America (de Silva *et al.*, 2003). Soil-transmitted helminthes form one of the most important groups of infectious agents and are the cause of serious global health problems. More than a billion people have been infected by at least one species of this group of pathogens (WHO, 2005; Hotez *et al.*, 2007). STH are important public health

problems in Sub-Saharan Africa causing malnutrition, anaemia and retardation of physical and cognitive development (Brooker *et al.*, 1999; WHO, 2005).

In Kenya, the prevalence of soil transmitted helminthes (STHs) is prominently attributed to *Ascaris lumbricoides*, hookworm and *Trichuris trichiura* (Brooker *et al.*, 2000; Clements *et al.*, 2010). It is estimated that approximately 10 million Kenyans are infected with STHs and over 12 million people living in rural endemic areas in the country are at risk of infection with these parasites (Brooker *et al.*, 2000; Clements *et al.*, 2010).

A high prevalence of STHs, when combined with poor hygiene and malnutrition, is an indicator of a country's future problems, indicating that priority is given to eradicating STHs worldwide (Bundy & de Silva 1998).

Soil transmitted helminthes are considered together since it is common for an individual, especially a child living in a less developed country, to be chronically infected with all three worms. Some of the most common health indicators affected by chronic STH infections are iron status, nutrition and growth, vitamin A status and cognitive development (Brooker *et al.*, 1999; WHO, 2005).

Soil transmitted helminthiases are more prevalent among children living in conditions of poor sanitation and their impact on morbidity and mortality is more severe in malnourished populations (Brookers *et al.*, 2006). As adult worms, the soil-transmitted helminths live for years in the human gastrointestinal tract. These few seriously infected individuals are at a higher risk of disease and are also the prime source of environmental contamination (Bundy and De Silva 1998). In the last decade, an increasing number of international initiatives have established the aim to either reduce or to eliminate the disease burden caused by STHs and other helminthic parasites prevalent in the resource-poor regions of the world (Chai & lee 2001; Hara, 2001).

Inadequate hygiene and poor health care systems and facilities, as well as social indifference, make this situation worse. In the developing world, inadequate water supply and sanitation, as well as crowded living conditions, combined with lack of access to health care and low levels of education, make the poor particularly susceptible to infection and disease, including STHs (de Silva *et al.*, 2003). According to the Joint Monitoring Programme (JMP) 2012 report, access to safe water supplies throughout Kenya is 59% and access to improved sanitation is 32%. There is still an unmet need in rural and urban areas for both water and sanitation. Kenya faces challenges in water provision with erratic weather patterns in the past few years causing droughts and water shortages. She also has a limited renewable water supply and is classified as a water scarce country (WHO, UNICEF, 2012). Urban migration contributes to challenges in sanitation, as people crowd into cities and urban growth is unregulated eventually leading to slums.

Thika located in Kiambu County has several slums like Kiandutu, Kiangombe, Kiganjo, Gachororo, Gachagi, Matharau, and Majengo that are characterized by high populations, poor socio-economic status, lack of proper water and sanitary facilities: hence residents' particularly pregnant women and children are more susceptible to soil transmitted helminthiases.

Amoebiasis, an infection by the protozoan parasite *E. histolytica* is globally considered as a leading parasitic cause of human mortality besides malaria and schistosomiasis (Walsh, 1986). It is estimated that *E. histolytica* may infect half a billion people annually, with 100,000 deaths worldwide (WHO, 1997). In developed countries, amoebiasis tends to be more common in older individuals and occurs mostly among homosexual men or in institutions (Hung *et al.*, 2008). However, in tropical regions, the epidemiology of amoebiasis is completely different and is more common among the general population and particularly among patients attending health care centers with diarrhea (Haque *et al.*, 2006). Clinical features of amoebiasis range from asymptomatic colonization to amoebic dysentery and invasive extra intestinal amoebiasis which is

manifested most commonly in the form of liver abscess. Out of 10% of the world's population infected by *E. histolytica*, only 1% develops invasive form of the disease. The rate of infection by *E. histolytica* differs among countries, socio-economic and sanitary conditions and populations (Al-Harthis and Jamjoom 2007). It is highly endemic throughout poor and socio-economically deprived communities in the tropics and subtropics. Environmental, socio-economic, demographic and hygiene-related behaviour is known to influence the transmission and distribution of intestinal parasitic infections (Norhayati *et al.*, 2003).

Transmission is through the ingestion of fecal contaminated food or drinks, fresh vegetables or fruit washed with contaminated water, sexual exposure (usually anal sex) or through the unwashed hands of an infected food handler. Flies may also act as vectors of cyst-laden feces. Trophozoites can also be passed in diarrheal stools but are promptly destroyed once outside the body. A study in Brazil identified place of residence, age, ingestion of raw vegetables and drinking water quality as important risk factors (Benetton *et al.*, 2005). Wastewater, human and animal excreta are used as fertilizer for a wide variety of crops, and 10% to 30% increases in crop yields have been reported (Asano, 1998). The use of wastewater and human and animal excreta in agriculture and aquaculture continues to be common in China, South and South East Asia as well as various areas in Africa (Cross, 1985; Timmer & Visker 1998; Drechsel *et al.*, 2010) in particular where water scarcity is becoming more severe.

### **2.2.2 Parasitic Infections and Pregnancy**

Parasitic infections affect tens of millions of pregnant women worldwide. These infections directly and indirectly lead to a spectrum of adverse maternal and foetal/placental effects (WHO, 2002). Infections in pregnancy have been associated with iron deficiency, maternal anaemia, impaired nutritional status, as well as decreased infant birth weight, intra-uterine growth retardation and adverse birth outcomes (Dreyfuss *et al.*, 2000; Egwunyenga *et al.*, 2001).

Effects of STH among pregnant women may differ by area and helminth burden (Villar *et al.*, 1989). Hookworm disease is caused by *Ancylostoma duodenale* and *Necator americanus*. Mature hookworms can cause intestinal bleeding and protein loss, proportional to worm burden; however, the severity of the effect is dependent on the host's underlying nutritional status (Muhangi *et al.*, 2007). Hookworm infections can cause or exacerbate iron deficiency and anaemia. Blood loss can be a feature of *Trichuris trichiura* infection, but it is less prominent than in hookworm infection; however, it often occurs along with hookworm infections and so may accelerate the onset of iron-deficiency anaemia (Ndyomugenyi *et al.*, 2008; Diemert *et al.*, 2008).

*Ascaris lumbricoides* infections are commonly asymptomatic, although clinical complications of extra-intestinal or high numbers of ascarids have been well described. *A. lumbricoides* infection has been associated with impaired fat digestion, reduced vitamin absorption, temporary lactose intolerance and treatment has shown to improve nutritional status (Holcombe, 1995). Immunological effects of STH can differ by species and may affect both a pregnant woman and her fetus (Stephenson *et al.*, 2000).

The combination of Human Immuno-Deficiency virus (HIV), helminthic and plasmodial infection in the host creates an immunologically complex profile and substantially increases the risk of anaemia, which is caused by all three types of infections (Gallagher *et al.*, 2005). Therefore, in terms of co-infection with these diseases, pregnant women in Sub-Saharan Africa represent a highly vulnerable group, particularly in light of data showing that helminth infection increases the risk of mother-to-child transmission of HIV (Gallagher *et al.*, 2005).

The World Health Organization has recommended three interventions to control morbidity due to STH infections i.e. regular drug treatment/chemotherapy of high-risk groups for reduction of the worm burden over time, health education and sanitation.

In accordance with the WHO (2005), the recommended drugs for use in public health interventions to control STH infections are: Albendazole (400mg) tablets given in a single dose, reduced to 200mg for children between 12 and 24 months; Levamisole (40mg) tablets given in a single dose by weight (2.5mg/kg). The drug Levamisole at a dose of 80mg has been successfully used in primary school-age children; Mebendazole (500mg) tablets given in a single dose; Pyrantel Pamoate (250mg) tablets given in a single dose by weight (10mg/kg).

A combined preparation of Pyrantel-Oxantel has been proved to be more effective than Pyrantel alone in treating *Trichuris trichiura* infection, the limitations of chemotherapy is that they are not 100% effective, possibility of re-infection and drug resistance may occur, health education and sanitation supported by personal hygiene aimed at reducing soil contamination other interventions for prevention and control are vaccines for STH and remote sensing (WHO, 2005).

Amoebiasis is known to be more severe in pregnant women (Lewis and Antia 1969; Abioye and Edington 1972; Abioye, 1973). This is thought to be due to raised progesterone levels (Biagi & Beltran 1969) and failure of immunoglobulin levels to rise in infection (Abioye *et al.*, 1972).

During pregnancy, amebic disease appears to be more frequently associated with acute exacerbations of the disease and with more prominent symptoms (Lewis & Antia 1969; Rivera, 1972; Abioye, 1973). Infected pregnant women may have bloody, dysenteric stools with moderate abdominal pain and tenderness. The diarrhea is marked, and secondary signs include fluid loss and electrolyte imbalance, which may adversely affect the outcome of pregnancy (Wagner *et al.*, 1975). There is no documentation of placental involvement or transmission of the parasite to the fetus. Fulminating attacks of amebic dysentery may be precipitated by pregnancy or the administration of corticosteroids (Charles, 1980).

Therapy for amoebiasis should be aimed at relief of symptoms; replacement of fluid, electrolytes, and blood; and eradication of the organism. Many of the drugs recommended as amebicide may be toxic during pregnancy, and drug therapy during pregnancy should be tailored to the severity of symptoms. Asymptomatic women who are known passers of *E. histolytica* cysts should have treatment delayed until after 14 weeks of gestation or until after delivery. Metronidazole 750 mg three times a day orally for 5 to 10 days may then be given (Kean, 1976). An alternative drug for asymptomatic infection is iodoquinol 650 mg three times a day for 20 days. However, there is no information about the safety of iodoquinol in pregnancy. However, the use of the drug for non-life-threatening situations is attended with some controversy, and many clinicians prefer not to use it in pregnancy, particularly during the first trimester. If a patient is treated with metronidazole, she should avoid alcoholic beverages because a disulfiram (Antabuse)-like effect has been reported. In addition, urine discoloration, vertigo, nausea, and diarrhea have been noted as side effects. Due to this concern, metronidazole is not recommended during the first trimester of pregnancy.

Dehydroemetine and iodoquinol are appropriate for use in a non-pregnant patient, but are contraindicated during pregnancy. Paromomycin, an effective luminal amebicide, is considered safe to use in pregnancy because it is poorly absorbed from the gastrointestinal tract. Another drug similar in effectiveness to paromomycin is diloxanide furoate, given as 500 mg three times a day for 10 days. This drug is a luminal amebicide, and because absorption from the gastrointestinal tract is low, it is believed to be safe for use during pregnancy. However, no data concerning possible teratogenic effects are available.

Schistosomiasis is a disease caused by infection with parasitic blood flukes. The three major species are *Schistosoma mansoni* (Africa and South America), *S. japonicum* (East Asia), and *S. haematobium* (Africa and the Middle East). The two minor species are *S. mekongi* (Laos, Cambodia) and *S. intercalatum* (West and Central Africa). It is estimated that in Africa up to 10 million women per year have schistosomiasis during

pregnancy (WHO, 2003) and 40 million women of child-bearing age have schistosomiasis (Friedman *et al.*, 2007). World Health Organization has placed schistosomiasis as the third most devastating tropical disease after malaria and intestinal helminthiases.

Infections with the blood fluke *Schistosoma mansoni* that cause schistosomiasis (also called Bilharzia) were not usually treated during pregnancy until 2002. In 2002 a World Health Organization team of experts recommended the praziquantel treatment of *S. mansoni* during pregnancy.

### **2.3 Geophagy and Anaemia**

Anaemia is a qualitative or quantitative deficiency of Hb or red blood cells (RBC) in circulation resulting in a reduced oxygen-carrying capacity of the blood to organs and tissues. Anemia is the most common disorder of the blood with it affecting about a quarter of people globally (Janz *et al.*, 2013). Iron-deficiency anemia affects nearly 1 billion (Vos *et al.*, 2012). It is more common in females than males, among children, during pregnancy and in the elderly ((Vos *et al.*, 2012; Janz *et al.*, 2013). Anemia increases costs of medical care and lowers a person's productivity through a decreased ability to work (Smith, 2010).

Anemia affects nearly half of the pregnant women in the world, and it is one of the most prevalent problems stemming from nutritional deficiency (WHO, UNICEF & UNU 2001). Anemia and iron deficiency during pregnancy is an important risk factor for maternal mortality, poor pregnancy outcomes, including preterm delivery and low birth weight, and infant mortality in developing countries (Allen, 2000; Brabin *et al.*, 2001; Marchant *et al.*, 2004). Furthermore, anemia is a common hematologic complication in human immunodeficiency virus (HIV)-infected women and associated with disease progression and an increased risk of mortality (Mocroft *et al.*, 1999; O'Brien *et al.*, 2005). Numerous cross-sectional studies found that geophagy was correlated with



anemia and iron deficiency among pregnant women in sub-Saharan Africa (Thomson, 1997; Geissler *et al.*, 1998; Antelman *et al.*, 2000; Adam *et al.*, 2005). However, these cross-sectional studies do not explain whether geophagy causes anemia, or anemia induces a craving for soil.

There is an ongoing controversy regarding whether soil eating is nutritionally beneficial or harmful, however, it may be harmful and could result in anemia (Stokes, 2006). The practice of geophagy has been long thought to help supplement mineral nutrients and have detoxifying effects (Johns & Duquette, 1991). The nutritional benefit has been speculated, because soil contains large quantities of macronutrients and micronutrients (Hunter, 1973; Abraham, 1997). However, recent studies showed that soil can impair the absorption of micronutrients and cause micronutrient deficiency (Harvey *et al.*, 2000; Hooda *et al.*, 2004). The authors replicated the gastrointestinal condition *in vitro* and demonstrated that soil can effectively bind and remove nutrients that were already present particularly iron and zinc (Hooda *et al.*, 2002; Hooda *et al.*, 2004). Alternatively, the soil contains high levels of aluminium and research showed that aluminium could reduce serum ferritin and deplete iron stores (Lin & Leu, 1996). Eating soil can also physically damage the intestinal mucosa and reduce the absorption of nutrients. These possible mechanisms may explain the association between geophagy and the increased risk of anemia.

Anaemia in pregnancy is defined as an Hb concentration of < 11gm/dl or a haemocrit < 0.33 In first and third trimesters, while in the second trimesters a fall of 0.5gm/dl is adjusted for an increase in plasma volume and a value of 10.5 gm/dl is used (WHO, 1968; CDC, 1989). Anaemia in pregnancy can be defined as mild, moderate or severe anaemia with WHO, classifying mild anaemia as Hb level of 10.0-10.9gm/dl, moderate anaemia as 7-9.9gm/dl and < 7gm/dl as severe anaemia (Idowu *et al.*, 2005).

## **CHAPTER THREE**

### **MATERIALS AND METHODS**

#### **3.1 Study Site**

The study was carried out at the antenatal clinic of Thika Level 5 Hospital. The hospital is one of Kiambu county`s teaching and referral hospital and is located about 40 Km North East of Nairobi, within the Thika municipality. It is a hospital serving a cosmopolitan community.

The hospital is mostly frequented by middle and low income earners from around Thika region who include pregnant women seeking for antenatal care from various rural areas like Karibaribi, Kiahuria, Mangu, Ngoliba, Murera among others, formal estates like Bahati, Ngoigwa, Makongeni, Jogoo, Witeithie among others and informal estates (slums) like Kiandutu, Kiangombe, Kiganjo, Gachororo, Gachagi, Matharau and Majengo slums that lack proper water and sanitary facilities.

#### **3.2 Study Design**

This was a cross-sectional, hospital-based study.

#### **3.3 Study Population**

The study population was pregnant women attending antenatal care clinic at Thika Level 5 Hospital who are estimated to be 9,600 per year. The study participants were those who met the selection criteria i.e. passing the screening procedure for their eligibility in the study. This involved ascertaining whether the woman was pregnant by getting the go ahead from the attending nurse at the Thika Hospital antenatal care clinic once the nurse was through with the routinely pregnancy tests.

After receiving the patient, explanations on what the study entails was relayed by the principal investigator to the patient in a language they spoke fluently and understood clearly (English, Kiswahili or Kikuyu) this included explaining the purpose of the study, the procedures to be used in the study (administration of a questionnaire, fecal sample collection for STH diagnosis and drawing of finger prick blood for Hb determination), explaining the benefits, risks, hazards and discomforts associated with the study procedures, emphasizing on the confidentiality of the patients data that was to be managed strictly in accordance with the research ethics approval for this project, giving contacts that could be used in the need for further clarification on any information regarding this study, informing the participant that the study was absolutely voluntary and subjects were free to withdraw from the study at any point and were not to be penalized in any way and were also not to be waived any of their legal rights by signing the informed consent form. After the explanation and clarification, consent was sought from the pregnant woman who were 18 years and above. The participant gave permission to the principal investigator to handle her sample, by consenting to participate in the study, participation was absolutely free and voluntary (Appendix 1 and 2).

### **3.4 Study Eligibility**

#### **3.4.1 Inclusion Criteria**

Participants were pregnant women who were at any gestation period attending antenatal care clinic at Thika Level 5 Hospital and those who consented to participate in the study. Those who were either eating or not eating soil, aged 18 years and above, and had no history of anthelmintic drug hypersensitivity i.e. they did not exhibit any of the following symptoms after treatment with anthelmintic drugs:- nausea, vomiting, headache, dizziness, drowsiness, fever, chills, sore throat, anorexia (eating disorder), asthmatic attacks, urticaria (skin rashes), abdominal pains, low back pains, gastrointestinal disturbances, insomnia (sleeplessness), sweating, dark urine, blurred

vision, epileptic seizures, jaundice, loss of appetite, dryness of the mouth and eyes, ringing in the ears, diarrhoea, extreme weakness and hallucinations.

### 3.4.2 Exclusion Criteria

The study excluded pregnant women who did not consent to participate in the study and those who had a history of antihelminthic drug hypersensitivity

### 3.5 Sample Size Determination

Using the formula by Fisher (Fisher *et al.*, 1998) and using an estimated prevalence of 50%, the sample size was calculated as follows,

$$n = \frac{Z^2 1 - \alpha / 2 P (1 - P)}{d^2}$$

n = Minimum sample size

P = Prevalence rate 50%

d<sup>2</sup> = Absolute precision (5%) 0.05

$$\frac{Z^2 1 - \alpha}{2} = 1.962$$

$$n = \frac{1.962 \times 0.5(1 - 0.5)}{0.052}$$

$$n = 386$$

A total of 410 pregnant women meeting the selection criteria were to be enrolled into the study.

## **3.6 Study Procedures**

### **3.6.1 Questionnaire survey**

A questionnaire having the patient and laboratory numbers (for confidentiality) was administered to each enrolled participant by the principal investigator (PI). The participant responded to the questionnaire with the help of the PI, done in a language that was well understood to her. The questionnaire aimed to obtain bio-data (age of the consenting study woman, gestational age, marital status, education levels and occupation), epidemiological variables (walking barefooted, site of defecation, source of drinking water, appetite disorders), and determine if they practiced geophagy and if they were aware of the potential risks and benefits of the practice.

### **3.6.2 Faecal sample collection**

The subjects were given a sterilized dry stool container and instructed on how to provide a faecal sample for diagnosis of parasitic infections. Upon submission of the stool specimen by the subject, the stool samples were labelled with patient number and transferred into a bio safety bag and transported back to the Thika hospital laboratory in a cool box for further processing.

The fecal samples were processed for diagnosis of parasitic infections as soon as they arrived in the laboratory. The Kato Katz technique (Katz *et al.*, 1972, WHO, 1991) was used to prepare the sample for examination under a microscope at x400 magnification. Faecal matter was pressed through a sieve with 200 micrometers mesh size. An amount of sieved stool (41.7mg measured by a template of 6mm diameter hole and 1.5mm depth) was transferred to a slide and covered with Malachite green pre-soaked cellophane strip to help clear the fecal debris. The microscope slide was then inverted and firmly pressed against the cellophane strip. Double microscope slides were made per specimen for examination. The material was then spread evenly and followed by careful

removal of the slide by gently sliding it sideways to avoid separation of the cellophane strip. The slide with the cellophane was then placed facing upwards. The faecal smear on the microscope slide examined for parasite ova as soon as it was prepared. Advantages of this method were its simplicity, low cost, small amount of faeces used, its quantitative, the limitation is that the method is messy and the fecal sample must be tested within 20-40 minutes to avoid over clearance of hookworm eggs due to the glycerol soaked cellophane strip.

Quality control reading of 80 slides that represents 10% of the total slides were picked at random and re-examined by an independent microbiologist who was unaware of the findings to verify the results.

### **3.6.3 Haemoglobin Determination**

In addition, haemoglobin levels were determined using a finger prick blood. A qualified medical laboratory technologist drew blood through finger pricking and performed the test on the consenting study participant using the Hb meter test kit that required a drop of blood for the procedure. This was done to determine the prevalence of anaemia in pregnant women attending antenatal clinic at Thika Level 5 Hospital.

### **3.7 Data Management and Analysis**

Privacy and strict confidentiality of the patient's data was ensured. Patient data was recorded in special designed data sheets and stored under lock and key. It was entered into computer using Ms-Excel software. Data was also recorded in the laboratory work book and later transferred into a password protected computer at KEMRI.

Data was analysed using statistical tools available in SPSS version 20 (SPSS Inc, Chicago, IL, USA), the difference in prevalence was tested by Chi square ( $\chi^2$ ), association of different explanatory variables namely educational levels, occupation, marital status, gestation age, consenting woman's age, walking barefooted, site of

defecation, source of drinking water, with the prevalence of the soil transmitted helminths and other parasites was determined using Chi square ( $\chi^2$ ). Significant associations were identified based on a p-value of <0.05 at 95% confidence interval.

### **3.8 Study Approvals**

The proposal was submitted for review and approval to KEMRI, JKUAT and Thika Level 5 Hospital. Both scientific and ethical approvals were sought from these institutions.

### **3.9 Ethical Considerations**

Consent to participate in the study Geophagy and Parasitic Infections among Pregnant Women attending an Antenatal Clinic in Thika Level 5 Hospital, Central Kenya was sought from each subject that met the selection criteria. The study procedures were explained to each consenting participant in a language they spoke fluently and understood. Each participant was requested to give a faecal sample for STH diagnosis and a finger prick blood for Hb determination; this presented a minimal discomfort to the patient and caused no harm to the participant or the pregnancy. In addition, each participant was requested to respond to a simple questionnaire to obtain bio data, epidemiological variables data and to determine the awareness of potential risks and benefits of geophagy among the pregnant women (Appendix 2). None of these procedures posed any harm to the participant or the pregnancy.

The benefits that the consenting women got by participating in the study were free investigation, patients infected with any of the parasitic infection were referred to the attending physician for further free treatment and management. The participant were given an opportunity to ask questions and seek clarifications on issues not well understood on the study, if they had additional questions or concerns about the study later, the participant were free to contact the researcher in charge of the study Alice W.

Mutura, 0721 704 263/0737 104 453 or through the email address [muturaalice@gmail.com](mailto:muturaalice@gmail.com). If they had questions or concerns about their rights as a participant in the study, they were free to contact: The Secretary, KEMRI Ethics Review Committee, P.O. Box 54840-00200, Nairobi, Telephone numbers: 020-2722541, 0722205901, 0733400003; Email address : [ERCAdmin@kemri.org](mailto:ERCAdmin@kemri.org)



## **CHAPTER FOUR**

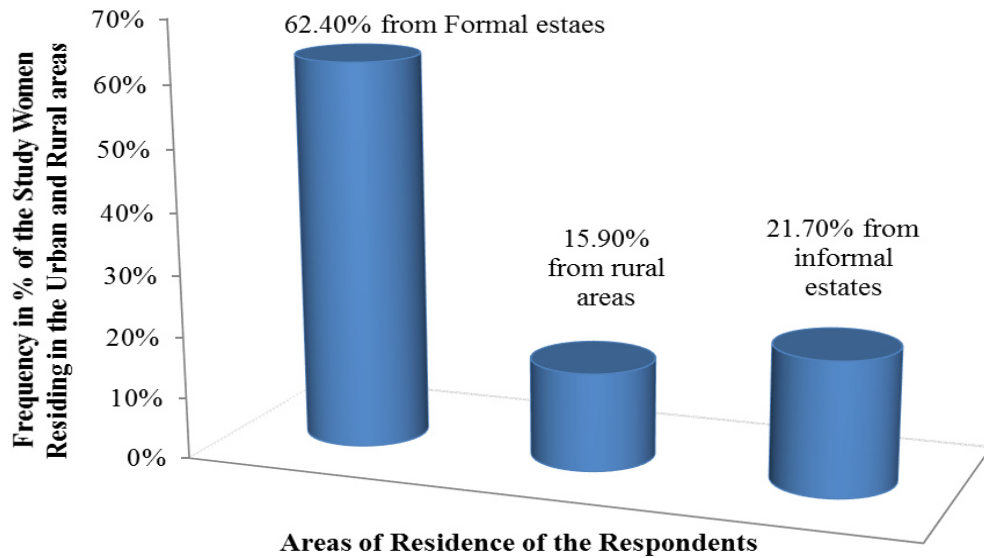
### **RESULTS**

#### **4.1 Overview**

The study involved 410 study participants who attended Thika level-5 hospital for their ANC and who willingly consented and met the criteria to participate in the study that aimed at investigating the role of geophagy on parasitic infections in the study women.

The study established the demographic data of all the patients who participated in the survey by completing the questionnaire.

The descriptive statistics obtained from the study indicated that majority 84.1% (345) of the respondents lived in urban areas, of which 62.4% (256) were from the formal estates, while 21.7% (89) were from the informal estates (slums) while the remaining 15.9% (65) from rural areas (Fig.4.1).



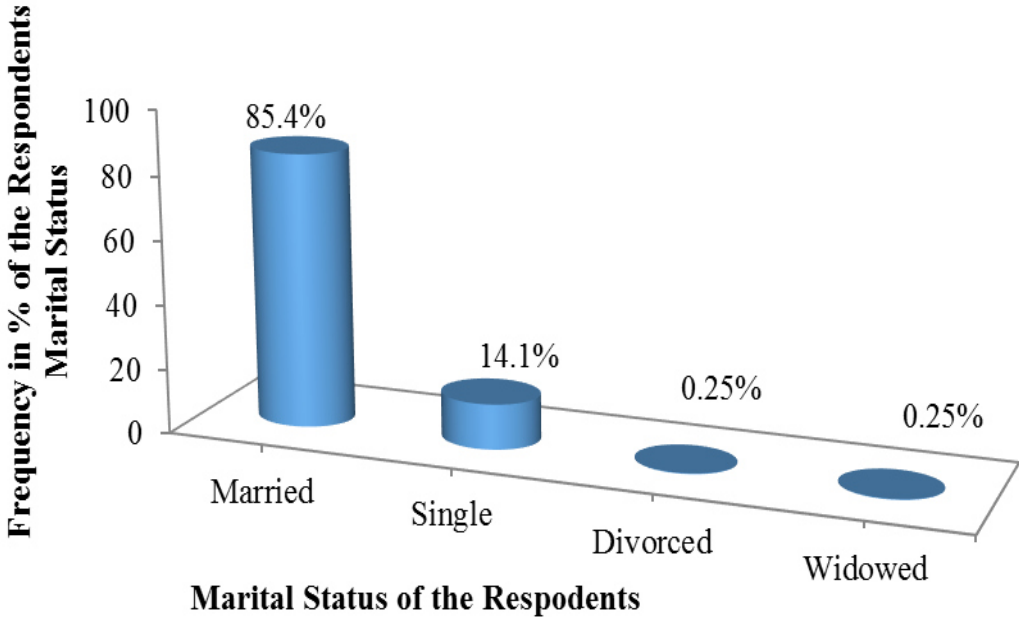
**Figure 4.1: Residence of the Respondents**

Majority of the respondents 44.9% were aged between 21-25 years while 12.4% were below 20 years (Table 4.1).

**Table 4.1: Age Bracket of the Respondents**

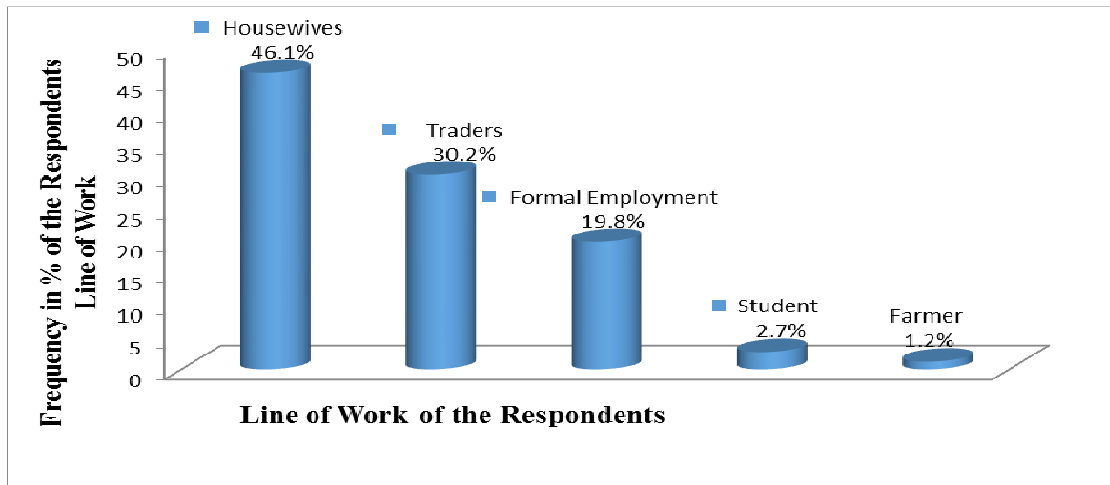
Age	Frequency	Percent
20 and Below	51	12.4
21-25	184	44.9
26-30	122	29.8
31-35	40	9.8
36 and Above	13	3.2
Total	410	100

From the study, it was revealed that most of the responders were married accounting for 85.4% (350) while 14.1% of them were single and the rest were divorced at 0.25% and 0.25% widowed (Fig. 4.2).



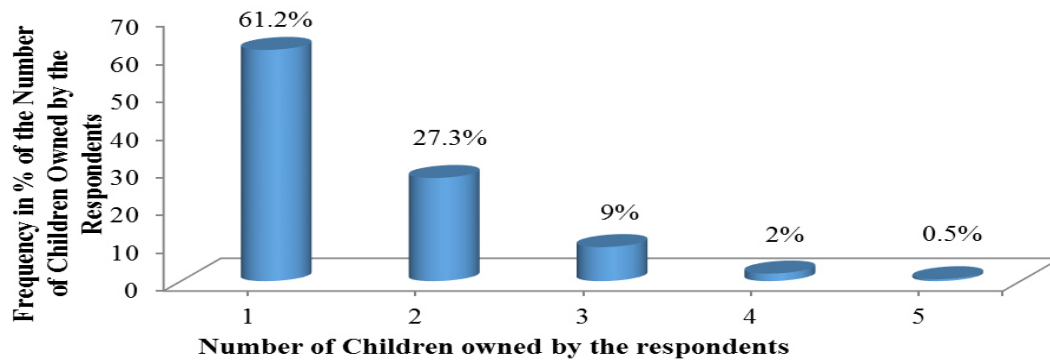
**Figure 4.2: Marital Status of the Respondents**

From the study, it was found that majority of the respondents 46.1% (189) were housewives, 31.4% were in the informal sector either traders/farmers, 19.8% in the formal sector, while the least were students at 2.7% (Fig 4.3).



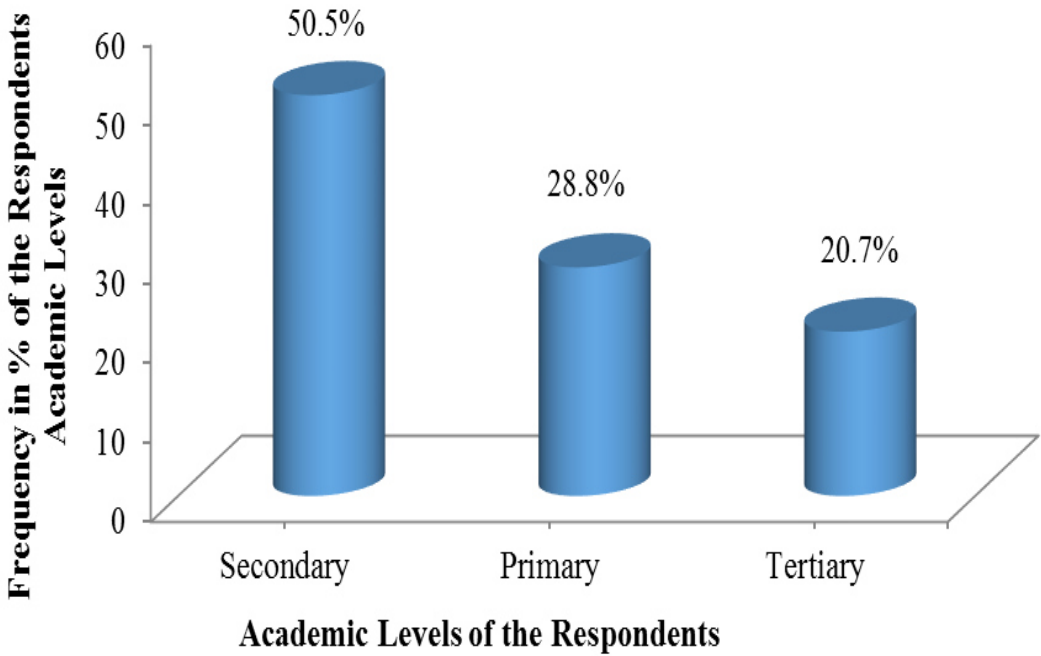
**Figure 4.3: Occupation of the Respondents**

Majority of the respondents 251 (61.2%) had one child, 112 (27.3%) had two children, 37 (9%) had 3 children, 8 (2%) had 4 children and only 0.5% had 5 children (Fig. 4.4).



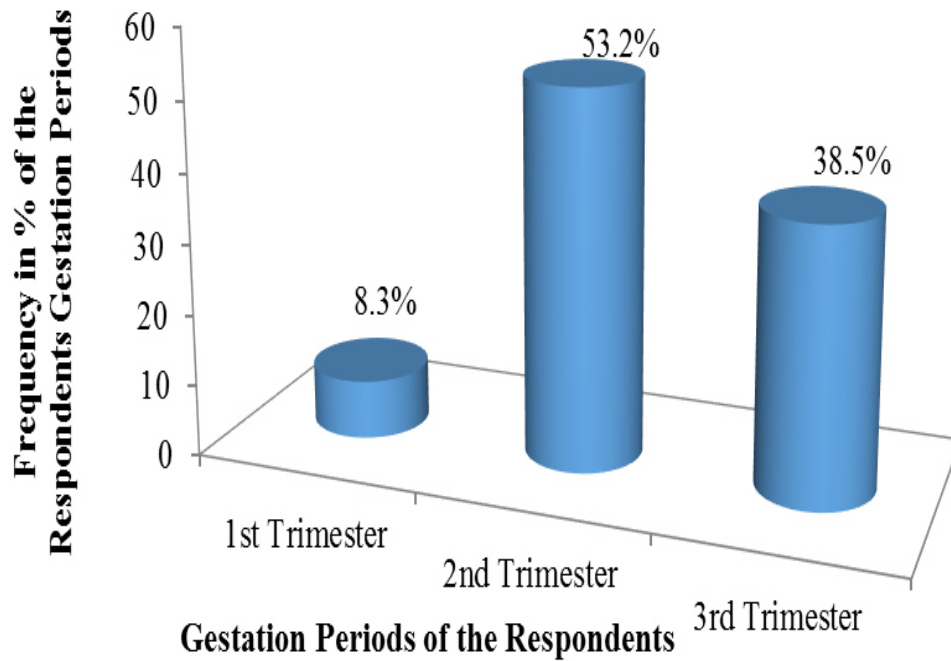
**Figure 4.4: Number of Children owned by the Respondents**

The study investigated the education levels of the respondents, it was revealed that majority of the respondents 207 (50.5%) had Secondary education, 118 (28.8%) were primary school leavers and 85 (20.7%) had College education (Fig. 4.5).



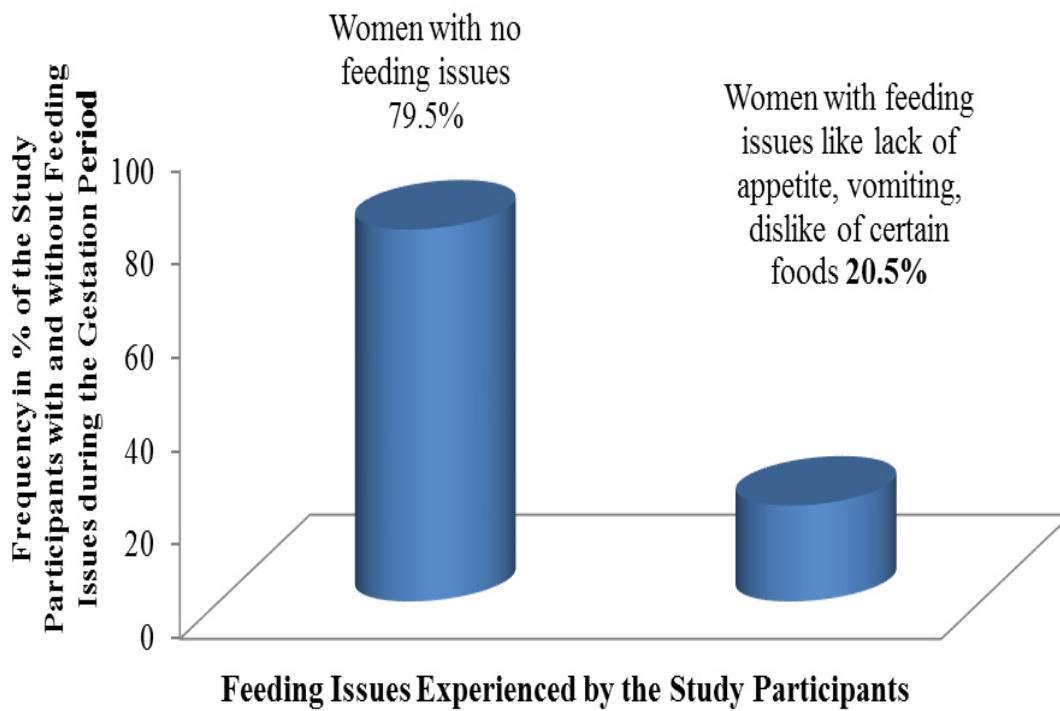
**Figure 4.5: Academic Levels of the Respondents**

The study found out that majority of the respondents 53.2% (218) were in the second trimester, 38.5% (158) were in the third trimester while the rest were in the first trimester (Fig. 4.6).



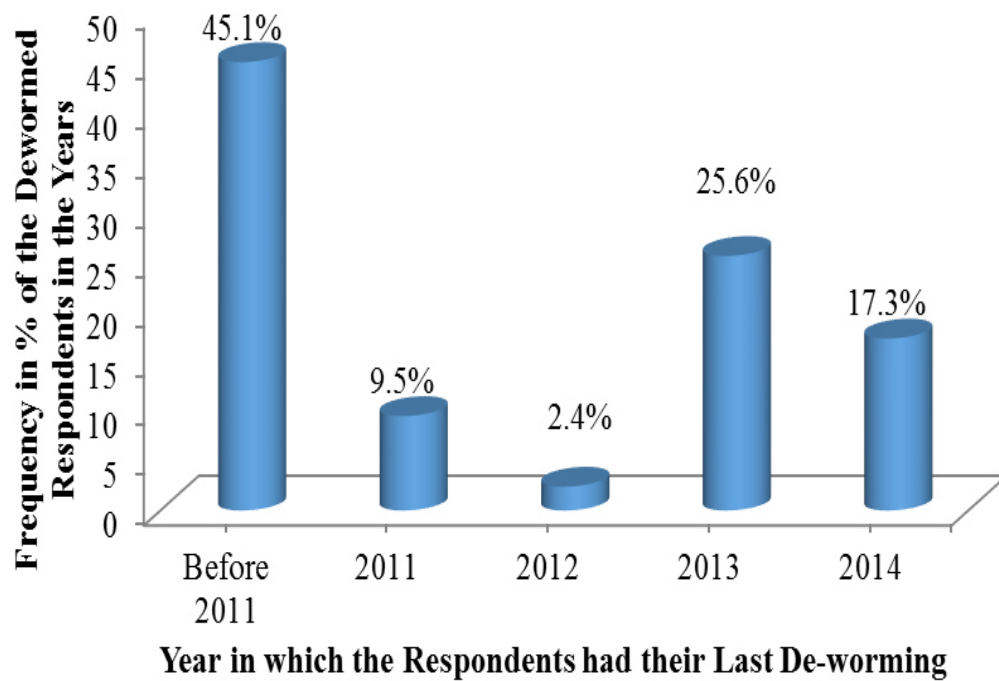
**Figure 4.6: Gestation Period of the Respondents**

The study sought to investigate whether the respondents had experienced any feeding problems ranging from lack of appetite, dislike of some types of food to vomiting after eating. From the results, majority of the respondents 79.5% (326) indicated that they had not experienced any feeding problems while 20.5% had experienced feeding problems (Fig. 4.7).



**Figure 4.7: Feeding Issues experienced by the Respondents during the Gestation Period**

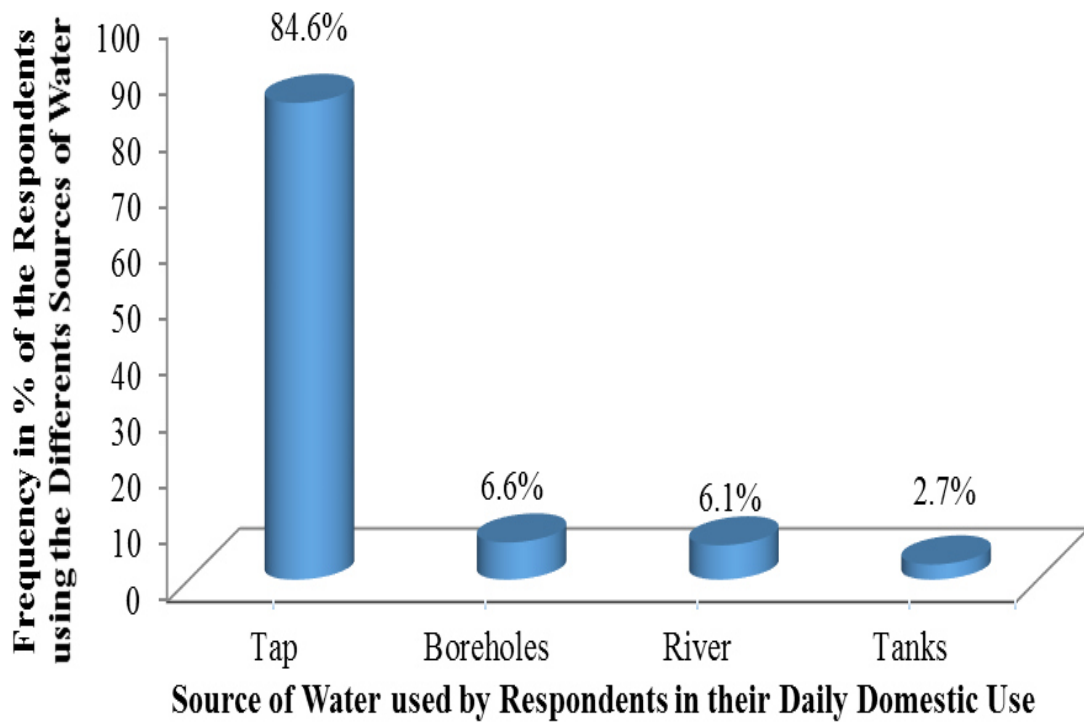
From the study, it was determined that majority of the respondents 45.1% (185) did their last de-worming 4 years prior to this study while 9.5% (39) sometime in 2011, 2.4% (10) respondents indicated that they did their last de-worming in 2012 while 25.6% (105) and 17.3% (71) indicated that their last de-worming was done in 2013 and 2014 respectively (Fig. 4.8).



**Figure 4.8: Last Deworming Date by the Respondents**

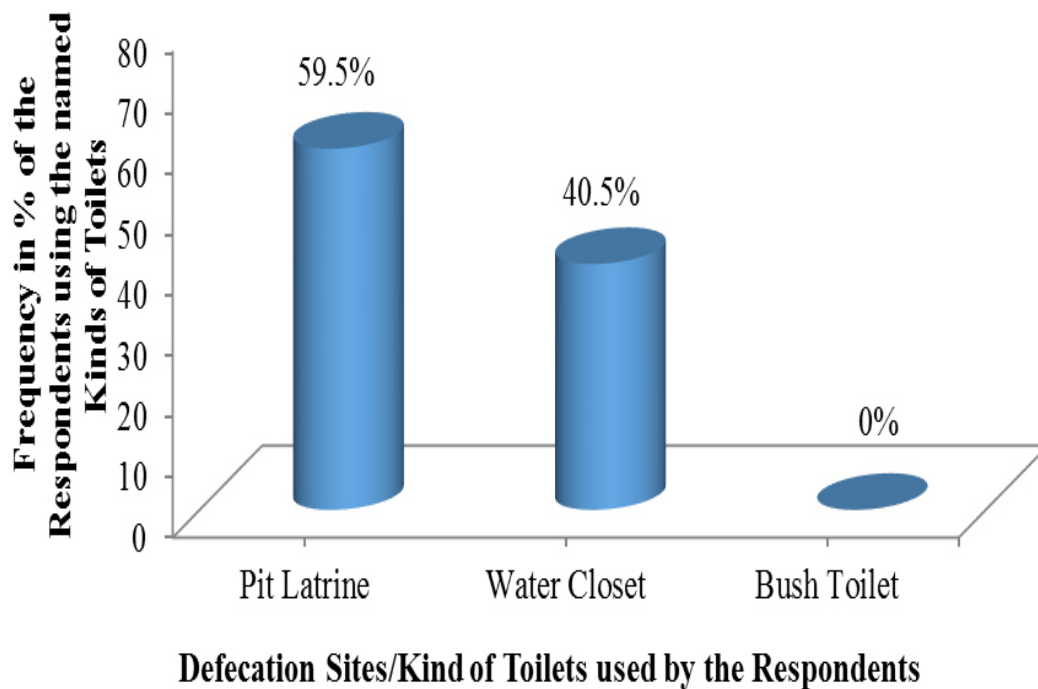


Majority of the respondents 84.6% got their water from taps supplied by the city council. Twenty-seven of the interviewed (6.6%) indicated that they use water from wells or boreholes, 25 (6.1%) from river while 11 (2.7%) used rain water that is collected in tanks (Fig. 4.9).



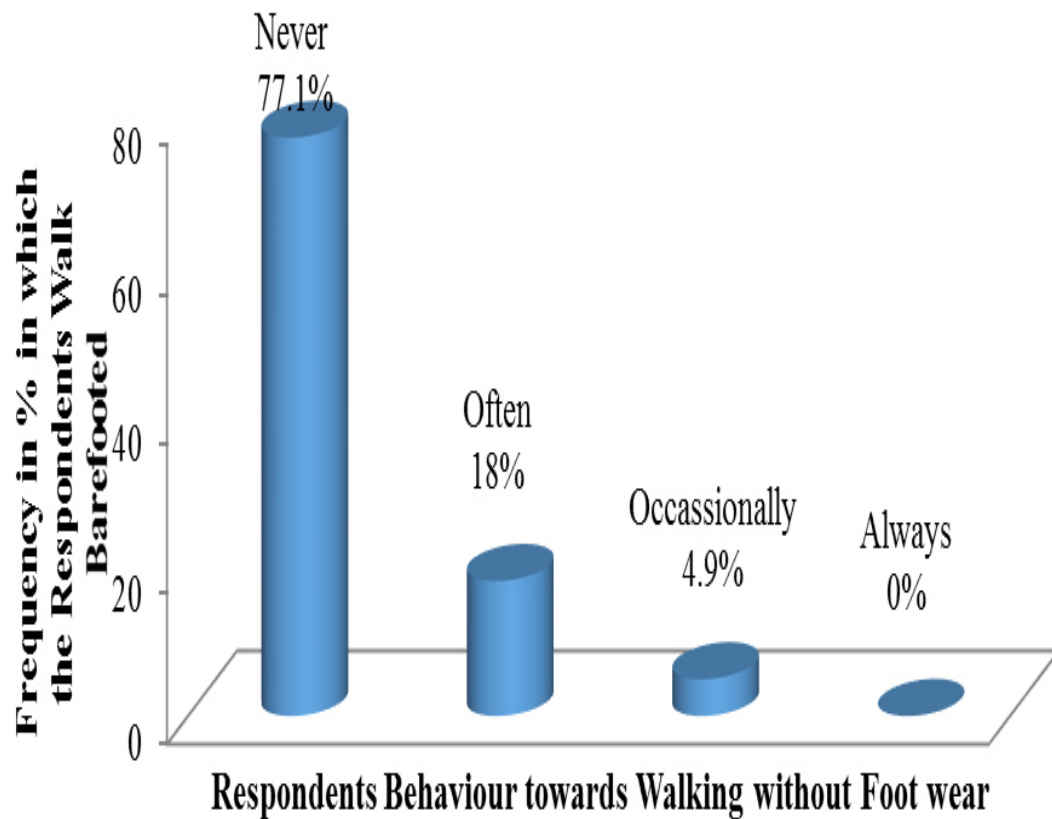
**Figure 4.9: Source of Water for the Respondents Domestic Use**

The study sought to investigate the kind of toilets used by the participants, in order to determine the chances of being exposed to parasites or chances of transmitting to other individuals. Majority of the respondents 59.5% (244) used pit latrine while 166 (40.5%) water closet toilets, none of the participant indicated the use of bushes (Fig. 4.10).



**Figure 4.10: Defecation Sites used by the Respondents**

The study also sought to investigate frequencies at which the respondents walk barefooted in order to determine the chances of being exposed to helminths found on the ground. Majority of the respondents 77.1% (316) wore shoes always or had never walked barefooted especially outside their houses, 18.0% (74) indicated that they often wore footwear/ rarely go barefooted, while 4.9% (20) indicated that they occasionally walk barefooted (Fig.4.11).



**Figure 4.11: Frequency of Walking Barefooted**

## 4.2 Geophagy and the Soil Types Consumed by the Study Women

From the study, it was determined that 26.1% (107) of the respondents practiced geophagy. Out of those who practice geophagy, 47.7% (51) do it occasionally, 27.1% (29) do it rarely while 25.2% (27) do it on regular basis. One hundred (92.45%) of the respondents preferred soil that is obtained from the market places, while 4.72%, 1.89% and 0.94% preferred soil from dry termite mound or anthills, quarry and shamba respectively (Fig. 4.12).

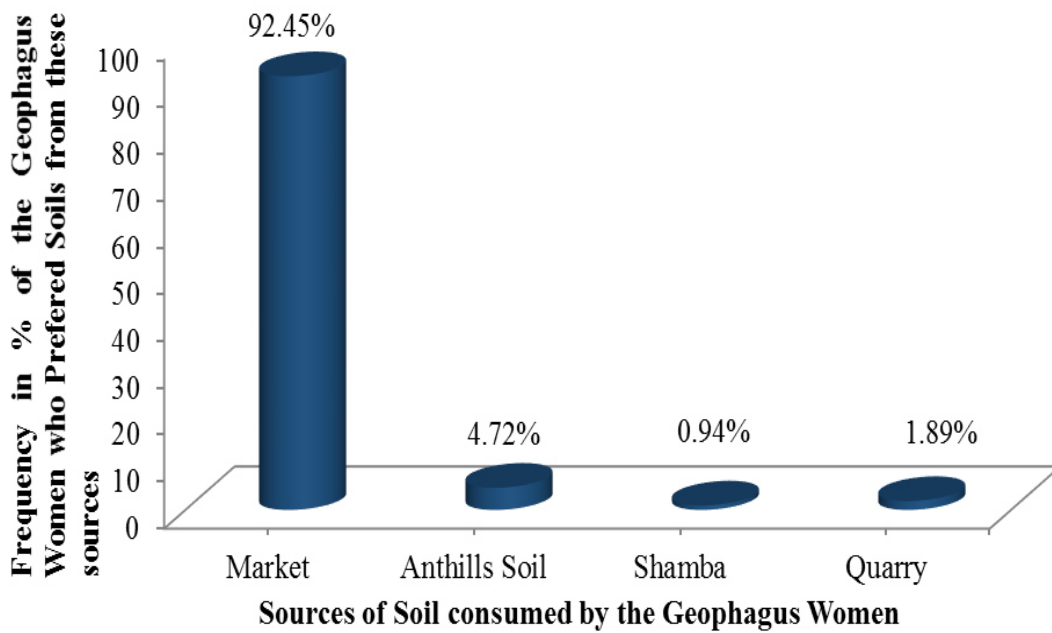


Figure 4.12: Sources of Soil Consumed by the Geophagus Women

### 4.3 Prevalence and Intensity Patterns of Infection

Prevalence of soil-transmitted helminths and other parasites in pregnant women attending Thika level-5 hospital showed that *E. histolytica* had the highest prevalence (8.8%) followed by *T. trichiura* and *A. lumbricoides* each at 1% prevalence, *S. mansoni* at 0.7% while *S. stercoralis* had the lowest prevalence of 0.2%. The overall prevalence was 11.7%, a total of 41 study participants were found to have the parasites, with 4 showing polyparasitism of the helminths (Table 4.2).

**Table 4.2: Prevalence of Parasitic Infections in the Respondents**

Parasite	Number Infected	Percentage Infection	Intensity			
			Negative	Low	Medium	High
<i>E. Histolytica</i>	36	8.8	-	-	-	-
<i>S. histolytica</i>	1	0.2	-	-	-	-
<i>T. trichora</i>	4	1	99	0.5	0.5	-
<i>A. lubricoides</i>	4	1	99	0.2	0.5	0.2
<i>S. mansoni</i>	3	0.7	99.3	0.7	-	-

The intensity of infection was measured on the basis of egg counts, expressed as eggs per gram (epg) of stool (Melvin and Brooke, 1989) counted by the Kato-Katz method. Multiplication factor of 24 was used for all parasite ova detected by the Kato-Katz method. The “epg” values obtained were used to estimate the infection intensity for the STHs and *S. mansoni* cases detected in the study they were classified as light, moderate and heavy in accordance with WHO (2002) criteria (Table 4.3).

**Table 4.3: Classification of Infection Intensities by the Kato Katz (WHO, 2002)**

Parasite	Light intensity	moderate intensity	Heavy intensity
<i>A. lumbricoides</i>	1-4,999 epg	5,000-49,999 epg	≥50,000 epg
<i>T. trichiura</i>	1- 999 epg	1,000- 9,999 epg	10,000 epg
Hookworms	1-1,999 epg	2,000- 3,999 epg	4,000 epg
<i>S. mansoni</i>	1-99 epg	100-399 epg	≥400 epg

Most of the infections were of low intensity, followed closely by moderate intensity and only one patient who exhibited a high intensity (heavy infestation) of *Ascaris lumbricoides* (Table 4.4).

**Table 4.4: Infection Intensity of STH's and *S. mansoni* in the Study.**

Parasite	Number Examined	Number Infected	Infection Intensity		
			Low	Moderate	Heavy
<i>T. trichiura</i>	410	4	2	2	0
<i>A. lumbricoides</i>	410	4	1	2	1
<i>S. mansoni</i>	410	3	3	0	0

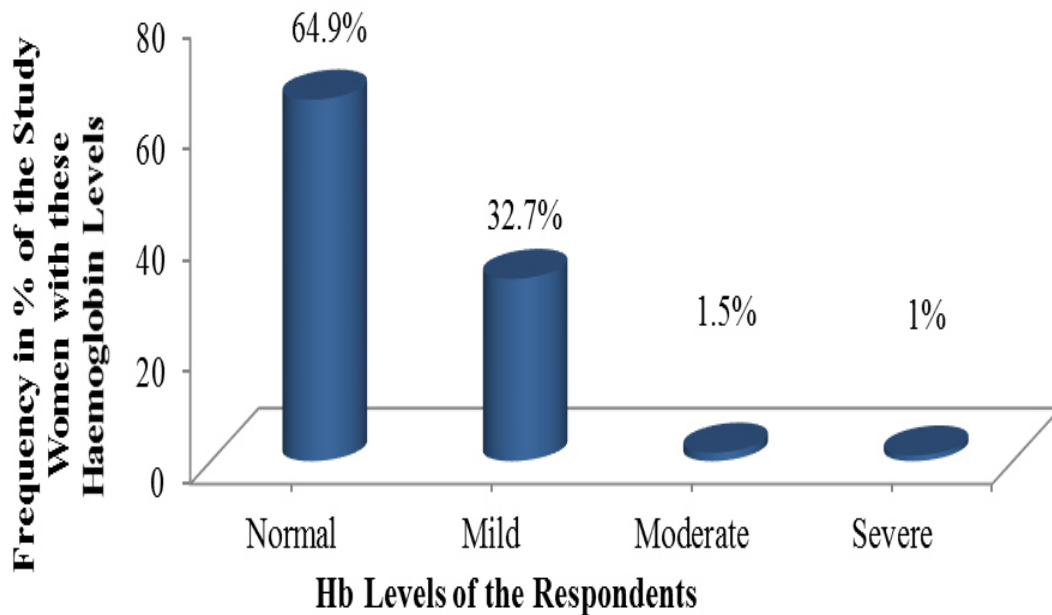
#### 4.4 Prevalence of Anaemic Condition

Anaemia in pregnancy is defined as an Hb concentration of < 11 gm/dl or a haemocrit < 0.33 In first and third trimesters, while in the second trimesters a fall of 0.5gm/dl is adjusted for an increase in plasma volume and a value of 10.5 gm/dl is used (WHO, 1968; CDC, 1989). Anaemia in pregnancy can be defined as mild, moderate or severe anaemia with the World Health Organisation, classifying mild anaemia as Hb level of

10.0-10.9gm/dl, moderate anaemia as 7-9.9gm/dl and < 7gm/dl as severe anaemia (Idowu *et al.*, 2005).

Among those who practised geophagy 60.7% had normal levels of haemoglobin, 34.6% had mild anaemia, 1.9% had moderate anaemia and 2.8% were severely anaemic, while 66.3% of those that did not practice geophagy had normal levels of haemoglobin, 32% had mild anaemia, 1.3% moderate anaemia and 0.3% had severe anaemia.

Majority of the respondents 64.9% (266) had normal levels of haemoglobin, 32.7% (134) were mild anaemic, 1.5% (6) moderately anaemic and 1% (4) severely anaemic (Fig.4.13).



**Figure 4.13: Prevalence of Anaemic Condition in the Respondents**

#### 4.5 Prevalence and Intensity of Parasitic Infection by Geophagy

The prevalence of the five parasites had no significant association with geophagy at  $p \leq 0.05$ . *E. histolytica* had the highest number of infections both in those who practiced geophagy 9 (8.4%) as well as in those who did not practice geophagy 27 (8.9%).

*E. histolytica* was the only parasite found on the study participants that practiced geophagy, they were found negative of the other parasites. However, low prevalence of the parasites was noted in those participants that did not practice geophagy (Table 4.5).

**Table 4.5: Prevalence of Parasitic Infections by Geophagy**

Parasite Species		Geophagy		Total	p-value
		No	Yes		
<i>S. stercoralis</i>	Negative	302 (99.7%)	107 (100%)	409	0.552
	Positive	1 (0.3%)	0 (0%)	1	
<i>T. trichiura</i>	Negative	299 (98.7%)	107 (100%)	406	0.232
	Positive	4 (1.3%)	0 (0%)	4	
<i>A. lumbricoides</i>	Negative	299 (98.7%)	107 (100%)	406	0.232
	Positive	4 (1.3%)	0 (0%)	4	
<i>E. histolytica</i>	Negative	276 (91.1%)	98 (91.6%)	374	0.875
	Positive	27 (8.9%)	9 (8.4%)	36	
<i>S. mansoni</i>	Negative	300 (99%)	107 (100%)	407	0.302
	Positive	3 (1%)	0 (0%)	3	

The prevalence of each of the five parasitic species did not vary significantly with the respondent's age. *E. histolytica* recorded the highest prevalence compared to the other parasites. In the *E. histolytica* category, respondents aged 26-30 years had the highest number of incidents at 10.7%, followed closely by those in the age group of 21-25 years with 9.2%. *Strongyloides stercoralis* had the least prevalence with only one respondent



aged between 31-35 years being infected. The infections with *Trichuris trichiura* and *Ascaris lumbricoides* parasites was noted in those respondents with 25 years of age and below (Table 4.6).

**Table 4.6: Prevalence of Parasitic Infections by Age**

Parasites	<20yrs (n=51)	21-25 (n=184)	26-30 (n=122)	31-35 (n=40)	>36yrs (n=13)	ρ-value
	Number of Infections					
<i>E. histolytica</i>	2 (3.9%)	17 (9.2%)	13(10.7%)	3 (7.5%)	1(7.7%)	0.701
<i>S. stercoralis</i>	0 (0%)	0 (0%)	0 (0%)	1 (2.5%)	0 (0%)	0.055
<i>T.trichiura</i>	1 (2.0%)	3 (1.6%)	0 (0%)	0 (0%)	0 (0%)	0.549
<i>A.lumbricoides</i>	1 (2.0%)	3 (1.6%)	0 (0%)	0 (0%)	0 (0%)	0.549
<i>S. mansoni</i>	0 (0%)	3 (1.6%)	0 (0%)	0 (0%)	0 (0%)	0.446

The test for the association between occupation and the parasites revealed no significance. Although the relationship was not significant, those who engaged in business had the highest prevalence of *E. histolytica* infection (12.1%) followed by those who were employed with (8.6%) and the house wives (7.4%). Students and farmers showed no infection of either of the parasites. The prevalence of *Trichuris trichiura*, *Ascaris lumbricoides* and *Schistosoma mansoni* was highest in those who were employed (2.5%) compared to the other occupations (Table 4.7).

**Table 4.7: Association between Occupation and the Parasites**

Variables	<i>E. histolytica</i>		<i>S. stercoralis</i>		<i>T. trichiura</i>		<i>A. lumbricoides</i>		<i>S. mansoni</i>	
	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value
Occupation										
None	14 (7.4%)	0.45	1 (0.5%)	0.883	1 (0.5%)	0.653	1 (0.5%)	0.653	0 (0%)	0.299
Employed	7 (8.6%)		0 (0%)		2 (2.5%)		2 (2.5%)		2 (2.5%)	
Farmer	0 (0%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Business	15 (12.1%)		0 (0%)		1 (0.8%)		1 (0.8%)		1 (0.8%)	
Student	0 (0%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	

The test for the association between gestation period and the parasitic infections revealed a significant association between gestation period and infection with *E. histolytica* ( $\rho=0.049$ ). Those in the second trimester had the highest risk of *E. histolytica* infection (11.9%) compared with the other trimesters, 2.9% in the 1<sup>st</sup> trimester and 5.7% in the third trimester. The prevalence rate was also higher for the other parasites in those respondents who were in their second trimester compared to the other trimesters although not significant (Table 4.8).

**Table 4.8: Association between Gestation period and Parasitic Infections**

Gestation Period	<i>E. histolytica</i>		<i>S. stercoralis</i>		<i>T. trichiura</i>		<i>A. lumbricoides</i>		<i>S. mansoni</i>	
	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value
1st Trimester	1 (2.9%)	0.049	0 (0%)	0.643	0 (0%)	0.641	0 (0%)	0.641	0 (0%)	0.829
2nd Trimester	26 (11.9%)		1 (0.5%)		3 (1.4%)		3 (1.4%)		2 (0.9%)	
3rd Trimester	9 (5.7%)		0 (0%)		1 (0.6%)		1 (0.6%)		1 (0.6%)	

The test for the association between source of soil and the parasitic infections revealed a significant association between source of soil and infection with *E. histolytica* ( $\rho=0.026$ ). Those who ate soil from the shamba had a highest prevalence (100%) of having *E. histolytica* infection followed by those who ate soil from quarry (50%) while those who ate soil from the market had a prevalence rate of 8.1%. Soil obtained from anthills resulted in no infection with any of the five tested parasites. There were no other parasitic infections that were recorded in those respondents who ate soil (Table 4.9).

**Table 4.9: Association between the source of Soil and the Parasites**

Source of Soil	<i>E. histolytica</i>		<i>S. stercoralis</i>		<i>T. trichiura</i>		<i>A. lumbricoides</i>		<i>S. mansoni</i>	
	Positive	$\rho$ -value	Positive	$\rho$ -value	Positive	$\rho$ -value	Positive	$\rho$ -value	Positive	$\rho$ -value
None	27(8.9%)	0.026	1 (0.3%)	0.986	4 (1.3%)	0.843	4 (1.3%)	0.843	3 (1.0%)	0.902
Market	8 (8.1%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Anthills Soil	0 (0%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Quarry	1 (50%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Shamba	1 (100%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	

The test for the association between last deworming and the parasites revealed no significant association between the last deworming with any of the helminthic infections (Table 4.10).

**Table 4.10: Association between Deworming and the Parasitic Infections**

Last De-worming	<i>E. histolytica</i>		<i>S. stercoralis</i>		<i>T. trichiura</i>		<i>A. lumbricoides</i>		<i>S. mansoni</i>	
	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value
Before	19	0.648	1	0.875	2	0.958	2	0.958	1	0.914
2011	(10.3%)		(0.5%)		(1.1%)		(1.1%)		(0.5%)	
2011	3 (7.7%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
2012	0 (0%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
2013	10		0 (0%)		1		1		1	
	(9.5%)				(1.0%)		(1.0%)		(1.0%)	
2014	4 (5.6%)		0 (0%)		1		1		1	
					(1.4%)				(1.4%)	

The test for the association between water source and the parasitic infections revealed no significant association between water source and infection with any of the five parasites tested. The prevalence rate of *E. histolytica* was highest in those respondents who obtained their water from the rivers (12.0%) followed by those who obtained water from the tanks (9.1%), 8.9% for those who used tap water and 3.7% for those who used boreholes as their water source. Minimal infections with *E. histolytica* were noted in those who obtained their drinking water from boreholes and tanks. Infection levels with the other four parasites were only noted in those respondents who obtained their water from taps (Table 4.11).

**Table 4.11: Association between the Source of Water and Parasitic Infections**

Water source	<i>E. histolytica</i>		<i>S. stercoralis</i>		<i>T. trichiura</i>		<i>A. lumbricoides</i>		<i>S. mansoni</i>	
	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value	Positive	ρ-value
Tap	31(8.9%)	0.752	1 (0.3%)	0.98	4 (1.2%)	0.865	4 (1.2%)	0.865	3 (0.9%)	0.908
River	3 (12.0%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Boreholes	1 (3.7%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Tanks	1 (9.1%)		0 (0%)		0 (0%)		0 (0%)		0 (0%)	

#### 4.6 Perceived Knowledge of Risks and Benefits of Geophagy

Two thirds of the participants 272 (66.3%) had no knowledge on the risks and benefits associated with geophagy while 138 (33.7%) believed that there were risks and benefits associated with geophagy. Some of the risks named were constipation, appendicitis, parasitic transmission and abdominal discomfort, while the benefits were that geophagy was a source of calcium and iron and lowered their natural cravings, reducing vomiting and salivating that is common in pregnant women.

## CHAPTER FIVE:

### DISCUSSION, CONCLUSION AND RECOMMENDATIONS

#### 5.1 Discussion

In the present study more than a quarter of the respondents 26.1% practised geophagy. The prevalence of geophagy varies between and within countries, but is estimated between 10-75% (Antelman *et al.*, 2000; Corbett *et al.*, 2003; Ngozi, 2008; Njiru *et al.*, 2011). The prevalence among pregnant women also ranged from 65% in Kenya, 46% in Ghana, 42% in Namibia to 28% in Tanzania (Vermeer, 1971; Thomson, 1997; Antelman *et al.*, 2000; Luoba *et al.*, 2004). This study thus found out that the prevalence of geophagy is low 26.1% in Thika, Central Kenya compared to the other studies done in the country, 56% in Kilifi, coastal Kenya, 45.7% in Bondo, Western Kenya and 74% in Nairobi, Kenya (Geissler *et al.*, 1998; Luoba *et al.*, 2004; Ngozi, 2008) though it is consistent with a study conducted in Tanzania where the prevalence was estimated between 5.2% and 28.5% (Knudsen, 2001; Kawai *et al.*, 2009).

Majority of the women 92.45% preferred soil got from the market; these findings are similar to those got from a study on pregnant women in Dares Salaam, Tanzania who commonly ate hardened clay soil sold in the local market (Kawai *et al.*, 2009). Majority of the women said they preferred this soil as it's cheap, easily accessible and they believe it is free from contamination as it's dried in the sun hence sterilization.

Overall prevalence of soil-transmitted helminths and other parasites in the study women was 11.7%, the study showed that *E. histolytica* had the highest prevalence of 8.8% followed by *T. trichiura* and *A. lumbricoides* with 1% each, *S. mansoni* at 0.7% while *S. stercoralis* had the lowest prevalence of 0.2%.

The study results on haemoglobin levels showed that those who practised geophagy had an increased risk of being anemic compared to those who didn't practice geophagy, the

normal levels could be as a result of iron supplements given freely by the hospital to the women during each of the antenatal visits. Numerous cross-sectional studies found that geophagy was correlated with anemia and iron deficiency among pregnant women in sub-Saharan Africa (Thomson, 1997; Allen, 2000; Antelman *et al.*, 2000; WHO, UNICEF and UNU, 2001).

There is an ongoing controversy regarding whether soil eating is nutritionally beneficial or harmful, however, it may be harmful and could result in anemia (Stokes, 2006). The practice of geophagy has been long thought to help supplement mineral nutrients and have detoxifying effects (Johns and Duquette, 1991). The nutritional benefit has been speculated, because soil contains large quantities of macronutrients and micronutrients (Hunter, 1973; Abraham, 1997). However, recent studies showed that soil can impair the absorption of micronutrients and cause micronutrient deficiency (Harvey *et al.*, 2000; Hooda *et al.*, 2004). The authors replicated the gastrointestinal condition *in vitro* and demonstrated that soil can effectively bind and remove nutrients that were already present particularly iron and zinc (Hooda *et al.*, 2002; Hooda *et al.*, 2004). Alternatively, the soil contains high levels of aluminium and research showed that aluminium could reduce serum ferritin and deplete iron stores (Lin and Leu, 1996). Eating soil can also physically damage the intestinal mucosa and reduce the absorption of nutrients. These possible mechanisms may explain the association between geophagy and the increased risk of anemia. In this study 39.3% of the study women that practised geophagy had anaemia.

Only *E. histolytica* was found in those patients, who practiced geophagy, this could likely be because most women preferred the clay soil sold in markets, this soil has been sun dried hence sterilized from the viable soil transmitted helminthiasis ova that perhaps become dehydrated as they require moisture to remain viable, but the soil may still be infected with *E. histolytica* cysts that are able to survive the sun drying heat and other unfavorable conditions. Humans are the only reservoir and infection occurs by ingestion of mature cysts in food or water, or on hands contaminated by faeces. Additionally,

geophagy is a common route of infection with amoebiasis in certain cultures. The test for the association between source of soil and the parasitic infections revealed a significant association between source of soil and infection with *E. histolytica* ( $p=0.026$ ). This significant association may be due to pure chance especially due to the small number as it was only one woman out of the 107 who ate soil from the shamba and who happened to be infected with the *E. histolytica*.

Women engage in geophagy during the first, second and third trimesters of pregnancy (Wiley and Solomon, 1998), often throughout the day and about 30-50 mg are consumed a day (ATSDR, 2000). In this study the test for association between gestation period and the parasitic infections revealed a significant association between gestation period and infection with *E. histolytica* ( $p=0.049$ ).

The study women in the second trimester had the highest risk of the parasitic infections as compared to the other trimesters. Although not significant, this could be because women increasingly start practicing geophagy with increasing gestational age (Geissler *et al.*, 1998; Geissler *et al.*, 1999; Kawai *et al.*, 2009), and with the findings that the main source of the soil was got from the market could be infected with *E. histolytica* cysts, and no other parasites this might arise from the contamination of the consumable soil by the excavators and traders and from faecal contamination of the soils at the site of excavation by humans. This would probably explain as to why there is an increase of amoebiasis infection in women in the second trimester. This in turn may indicate women's response to an increased physiologic need for iron because of an increase in red blood cell mass and growth of the foetus around the middle of the second trimester.

Two thirds of the participants had no knowledge on the risks and benefits associated with geophagy during pregnancy. Extensive and intensive public health education would be of paramount importance in impacting knowledge on the risks and benefits of geophagy and enlightening women on the alternative healthy sources of minerals instead of soil; there is also a need to educate the women and those trading the soil on the



nessesity of hygiene and sanitation, to lower the instances of the transmission of the parasitic ova and cysts and re-infections with the same.

This study also noted that the epidemiological variables (walking barefoot, site of defecation, source of drinking water and appetite disorders) had no significant association ( $p>0.05$ ) in the transmission of the parasitic infections.

## **5.2 Conclusion**

- Public health education campaigns on the risks of geophagy and poor sanitation, targeting pregnant women and soil traders have the potential to lower parasitic infections.
- Most soil transmitted helminths ova require moisture to remain viable and when the soil ingested is recently contaminated by viable helminth eggs, the risk of infection becomes inevitable.
- To prevent any parasitic infections in the geophagous women there is need for controlled sterilization of the soils by applying heat, chemicals, irradiation, high pressure or combination thereof, and followed by proper packaging before they are dispersed to the traders for sale.
- The Bureau of Standards need to set standards to ensure that soils sold in the markets is of no risk to the pregnant women and the unborn as the immune status of the pregnant women is not competent and such renders them susceptible to a myriad of infections after exposure.

### 5.3 Recommendations

1. There is need for extensive and intensive public health education to advocate for the necessity of hygiene and sanitation to impact knowledge on the risks and benefits of geophagy.
2. There is a need to provide for a mineral supplementation program for the pregnant women especially during the 1<sup>st</sup> trimester when the morning sickness sets in., due to the feeding problems they are deprived of the essential minerals from most of these foods and this may be the main reason for the cravings of non-food substances like soil that increase their chances of infection with parasitic infections. Hence mothers should be encouraged to visit the antenatal clinic from the first month of pregnancy so that their health can be monitored.
3. There is a need for the formulation of a policy on the routinely deworming of pregnant women in their 2<sup>nd</sup> trimester to offer significant and relatively inexpensive long term health benefits for both the mother and her unborn child as it is done in Madagascar, Nepal and Sri Lanka.
4. There is also a need to have a routine testing of amoebiasis in pregnant women and treatment of the infected.
5. There is need for the Kenya Bureau of Standards (KEBS) to ensure that soil sold in markets, supermarkets or by the vendors is 100% safe from parasites and heavy metals, also set rules and regulations on sterilization and packaging and ensure that they have been adhered too and the soils are sold at an affordable price.
6. Further studies are recommended to determine the role played by soil from different sources in the transmission of parasitic infections in pregnant women practising Geophagy.
7. There is need for research studies to compare the immune systems of pregnant women in the different gestation trimesters.

## REFERENCES

- Abioye, A. A.** (1973). Fatal amoebic colitis in pregnancy and the puerperium; *J Trop Med Hyg*, **76**, 97-100.
- Abioye, A. A. & Edington, G. M.** (1972). Prevalence of amoebiasis at autopsy in Ibadan; *Trans R Soc Trop Med Hyg*, **66**, 754-763.
- Abioye, A. A., Lewis, E. A. & McFarlane, H.** (1972) Clinical evaluation of serum immunoglobulins in amoebiasis; *Immunology*; **23**, 937-946.
- Abrahams, P.W.** (1997). *Geophagy (soil consumption) and iron supplementation in Uganda. Trop Med Int Health*, **2**, 617–623.
- Adam, I., Khamis, A.H. & Elbashir, M.I.** (2005). *Prevalence and risk factors for anaemia in pregnant women of eastern Sudan; Trans R Soc Trop Med Hyg*, **99**, 739–743.
- Al-Harathi, S. & Jamjoom, M.** (2007) Diagnosis and Differentiation of Entamoeba infection in Makhah Al Mukarramah using microscopy and stool Antigen Detection Kits; *W J Med Sci*, **2**, 15-20.
- Allen, L. H.** (2000). *Anemia and iron deficiency: effects on pregnancy outcome; Am J Clin Nutr*, **71**, 1280S–1284S.
- Antelman, G., Msamanga, G.I., Spiegelman, D., Urassa, E.J., Narh, R., Hunter, D.J. & Fawzi, W.W.** (2000). Nutritional factors and infectious disease contribute to anemia among pregnant women with human immunodeficiency virus in Tanzania; *J Nutr*: **130**, 1950–1957.
- Asano, T.** (1998). *Waste water reclamation and reuse: Technomic Publishing Company Inc*; Pp. 1-56.

- Beaver, P. C.** (1950). The standardization of faecal smears for estimating egg production and worm burde, *J. Parasitol*, **36**, 451-6.
- Benetton, M. L., Goncalves, A. V., Meneghini, M. E., Silva, E.F. & Carneiro, M.** (2005). Risk factors for infection by the *Entamoeba histolytica*/E. dispar complex: an epidemiological study conducted in outpatient clinics in the city of Manaus, Amazon Region, Brazil.*Trans R Soc Trop Med Hyg*, **99**, 532-540.
- Biagi, F.F. & Beltran, H. F.** (1969). The challenge of amoebiasis: understanding pathogenic mechanisms; *Int Rev Trop Med*, **3**, 219-239.
- Brabin, B.J., Hakimi, M. & Pelletier, D.** (2001). An analysis of anemia and pregnancy-related maternal mortality, *J Nutr*, **131**, 604S–614S discussion 614S–615S.
- Brooker, S., Miguel, E.A., Moulin, S., Luoba, A.I., Bundy, D.A. & Kremer, M.** (2000). Epidemiology of single and multiple species of helminth infections among school children in Busia District, Kenya; *East Afr Med*, **77**(3), 157-161.
- Brooker, S., Peshu, N., Warn, P., Mosobo, M., Guyatt, H., Marsh, K. & Snow, R.W.** (1999). The epidemiology of hookworm infection and its contribution to anaemia among pre-school children on the Kenya coast; *Trans R Soc Trop Med Hyg*, **93**, 240–246.
- Brookers, S., Clements, A. & Bundy, D.A.P.** (2006). Global epidemiology, ecology and control of soil-transmitted helminth infections. *Adv Parasitol*: **62**, 223–65.

- Bundy, D.A.P. & de Silva, N.R.** (1998). Can we deworm this wormy world? *Br Med Bull*, **54**, 421–32.
- Callahan, G.N.** (2003). Eating Dirt. *Emerging Infectious Diseases*, **9**(8), 1016–1021.
- Centers for Disease control (CDC).** (1989). CDC criteria for anaemia in children and child bearing –aged women. *MMWR Morb Mortal Rep*, **38**, 400- 4.
- Chai, J.Y. & Lee, S.H.** (2001). The successful implementation of the nationwide control programme of ascariasis; In: **Hayzshi S, editor**. *Collected Papers on the Control of Soil-Transmitted Helminthiases*; Pp. 267-71.
- Charles, D.** (1980). *Infections in Obstetrics and Gynecology*, Philadelphia: WB Saunders.
- Clements, A.C., Deville, M.A., Ndayishimiye, O., Brooker, S. & Fenwick, A.** (2010). Spatial co-distribution of neglected tropical diseases in the east African great lakes region, revisiting the justification for integrated control. *Trop Med Int Health*, **15**(2), 198-207.
- Corbett, R.W., Ryan, C. & Weinrich, S. P.** (2003). Pica in pregnancy: does it affect pregnancy outcomes? *MCN Am J Matern Child Nurs*, **28**, 183-189.
- Cross, P.** (1985). Health Aspects of Nightsoil and Sludge Use in Agriculture and Aquaculture-Part I: Existing Practices and Beliefs in the Utilisation of Human Excreta. *International Reference Center for Waste Disposal*: (No 04/85), Dubendorf, Switzerland.

- DeSilva, N.R., Brooker, S., Hotez, P. J., Montessor, A., Engels, D. & Savioli, L.** (2003). Soil-transmitted helminth infections: updating the global picture. *Trend Parasitol*, **19**, 547-51.
- Diemert, D. J., Bethony, J. M. & Hotez, P. J.** (2008). Hookworm vaccines, *Clin Infect Dis*, **46**, 282–288.
- Dolabella, S.S., Serrano-Luna, J., Navarro-García, F., Cerritos, R., Ximénez, C., Galván-Moroyoqui, J.M., ... & Shibayama, M.,** (2012). Amoebic liver abscess production by *Entamoeba dispar*. *Ann Hepatol*. **11**(1), 107-17.
- Drechsel, P., Scott, C. A., Raschid-Sally, L. & Redwood, A. B.** (2010). *Waste water irrigation and health - Assessing and mitigating risk in low-income countries*; Sterling, VA, London: Earthscan.
- Dreyfuss, M. L., Stoltzfus, R. J., Shrestha, J. B., Pradhan, E. K., LeClerq, S. C., Khatri, S. K., .. & West, K. P. Jr.** (2000). Hookworms, malaria and vitamin A deficiency contributes to anemia and iron deficiency among pregnant women in the plains of Nepal. *J Nutr*, **130**, 2527–2536.
- Egwunyenga, A.O., Ajayi, J.A., Nmorsi, O.P. & Duhlinska-Popova, D.D.** (2001). Plasmodium/intestinal helminth co-infections among pregnant Nigerian women; *Mem Inst Oswaldo Cruz*, **96**, 1055–1059.
- Friedman, J. F., Mital, P., Kanzaria, H. K., Olds, G.R. & Kurtis, J.D.** (2007). Schistosomiasis and pregnancy, *Trends Parasitol*, **23**, 159–164.
- Gallagher, M., Malhotra, I., Mungai, P. L., Wamachi, A. N., Kioko, J. M., Ouma, J. H., Muchiri, E. & King, C. L.** (2005). The effects of maternal helminth and malaria infections on mother-to-child HIV transmission. *AIDS*, **19**, 1849–1855.

- Geissler, P. W., Prince, R. J., Levene, M., Poda, C., Beckerleg, S. E., Mutemi, W. & Shulman, C. E.** (1999) Perceptions of soil-eating and anaemia among pregnant women on the Kenyan coast. *Soc Sci Med*, **48**, 1069–1079.
- Geissler, P.W., Shulman, C.E., Prince, R. J., Mutemi, W., Mnazi, C., Friis, H. & Lowe, B.** (1998). Geophagy, iron status and anaemia among pregnant women on the coast of Kenya. *Trans R Soc Trop Med Hyg*, **92**, 549–553.
- Hamilton, G.** (1998). Let them eat dirt. *New Scientist*, **159**(2143), 26–31.
- Haque, R., Mondal, D., Duggal, P., Kabir, M., Roy, S., Farr, B. M., Sack, R. B. & Petri Jr, W. A.** (2006). *Entamoeba histolytica* infection in children and protection from subsequent amoebiasis. *Infect Immun*, **74**, 904–909.
- Hara, T.** (2001). Large scale control against intestinal helminthic infections in Japan, with special reference to the activities of Japan Association of Parasite Control; In: *Hayashi S, editor. Collected Papers on the Control of Soil-Transmitted Helminthiasis*; Pp. 267-71.
- Harvey, P., Dexter, P. & Darnton-Hill, I.** (2000). The impact of consuming iron from non-food sources on iron status in developing countries. *Public Health Nutrition*, **3**(4), 375–383.
- Hergüner, S., Ozyildirim, I. & Tanidir, C.** (2008). Is pica an eating disorder or an obsessive-compulsive spectrum disorder? *Prog Neuropsychopharmacol Biol Psychiatry*, **32**, 2010-2011.
- Holcombe, C.** (1995). Surgical emergencies in tropical gastroenterology; *Gut*, **36**, 9–11.

- Hooda, P. S., Henry, C. J. K., Seyoum, T. A. & Armstrong, L. D. M.** (2002). The potential impact of geophagia on the bioavailability of iron, zinc and calcium in human nutrition. *Environ Geochem Health*, **24**, 305–319.
- Hooda, P.S., Henry, C.J., Seyoum, T.A., Armstrong, L.D. and Fowler, M.B.,** (2004). The potential impact of soil ingestion on human mineral nutrition. *Sci Total Environ*, **333**, 75–87.
- Hotez, P. J., Molyneux, D. H., Fenwick, A., Kumaresan, J., Sachs, S. E., Sachs, J. D. & Savioli, L.** (2007). Control of neglected tropical diseases. *N. Engl. J. Med*, **357**, 1018-1027.
- Hung, C. C., Ko, N. Y., Ko, W.C., Lee, H. C., Ji, D. D., Liu, W. C. & Chang, S. C.** (2008). Amoebiasis among patrons visiting gay saunas in Taiwan. *HIV Med*, **9**, 787–789.
- Hunter, J.M.,** (1973). Geophagy in Africa and in the United States: *a culture-nutrition hypothesis*. *Geogr Rev*, **63**, 170–195.
- Idowu, O. A., Mafiana, C. F. & Sotiloye, D.** (2005). Anaemia in pregnancy: A survey of pregnant women in Abeokuta, Nigeria. *Afri Health Sci.*, **5**, 295-9.
- Janz, T.G., Johnson, R.L. & Rubenstein, S.D.** (2013). Anemia in the emergency department: evaluation and treatment. *Emergency medicine practice*, **15** (11), 1–15.
- Jared, M.D.** (1999). Evolutionary biology: Dirty eating for healthy living..*Nature*, **400**, 120-121.
- Johns, T. & Duquette, M.** (1991). *Detoxification and mineral supplementation as functions of geophagy*: *Am J Clin Nutr*, **53**, 448–456.



- Katz, N., Chaves, A. & Pellegrino, J.** (1972). A simple device for quantitative stool thick-smear technique in *Schistosomiasis mansoni*; *Rev Inst Med Trop Sao Paulo*, **14**, 397-400.
- Kawai, K., Saathoff, E., Antelman, G., Msamanga, G. & Fawzi, W. W.** (2009). Geophagy (Soil-eating) in Relation to Anemia and Helminth Infection among HIV-Infected Pregnant Women in Tanzania. *Am. J. Trop. Med. Hyg.*, **80**(1), 36– 43.
- Kean, B. H.** (1976).The treatment of amoebiasis. *Jama*, **235**, 501.
- Kent, A. & Triplett, E. W.** (2002). Microbial communities and their interactions in soil and rhizosphere ecosystems. *Annual Review of Microbiology*, **56**, 211 – 236.
- Knudsen, J.W.** (2001). Akula udongo (earth eating habit): a soil and cultural practice among Chagga women on the slopes of the Mount Kilimanjaro. *Afr J Ind Know Systems*, **1**, 19-26.
- Kwong, A. M. & Henry, J.** (2003). “Why is geophagy treated like dirt?” *Deviant Behavior*, **24**(4), 353-371.
- Lewis, E. A. & Antia, A. U.** (1969). Amoebic colitis: review of 295cases. *Trans R Soc Trop Med Hyg*; **63**, 633.
- Lin, J. L. & Leu, M. L.,** (1996). Aluminium-containing agents may be toxic in predialysis chronic renal insufficiency patients. *J Intern Med*,**240**, 243– 248.
- Luoba, A. I., Geissler, P. W., Estambale, B., Ouma, J. H., Alusala, D., Ayah, R., ... & Friis, H.** (2005). Earth-eating and reinfection with intestinal helminths

among pregnant and lactating women in western Kenya. *Trop Med Int Health*, **10**, 220–227.

**Luoba, A.I., Geissler, P.W., Estambale, Ouma, J.H., Magnussen, P., Alusala, D., ...& Friis, H.** (2004). *Geophagy among pregnant and lactating women in Bondo District, Western Kenya*. *Trans R Soc Trop Med Hyg*, **98**, 734–741.

**Marchant, T., Schellenberg, J.A., Nathan, R., Abdulla, S., Mukasa, O., Mshinda, H. & Lengeler, C.** (2004). Anaemia in pregnancy and infant mortality in Tanzania, *Trop Med Int Health*, **9**, 262–266.

**Melvin, D. & Brooke, M.** (1989). *Laboratory Methods for Diagnosis of Intestinal Parasites.*, Mexico: Editorial Mexicana.

**Mocroft, A., Kirk, O., Barton, S. E., Dietrich, M., Proenca, R., Colebunders, R., ...& Lundgren, J. D.** (1999). Anaemia is an independent predictive marker for clinical prognosis in HIV-infected patients from across Europe. *EuroSIDA study group. AIDS*.**13**, 943–950.

**Muhangi, L., Woodburn, P., Omara, M., Omoding, N., Kizito, D., Mpairwe, H., ... & Elliott, A.M.** (2007). Associations between mild-to-moderate anaemia in pregnancy and helminth, malaria and HIV infection in Entebbe, Uganda. *Trans R Soc Trop Med Hyg*, **101**, 899–907.

**Ndyomugenyi, R., Kabatereine, N., Olsen, A. & Magnussen, P.** (2008). Malaria and hookworm infections in relation to haemoglobin and serum ferritin levels in pregnancy in Masindi district, western Uganda. *Trans R Soc Trop Med Hyg*,**102**, 130–136.

**Ngozi, P. O.** (2008). Pica practices of pregnant women in Nairobi, Kenya. *East Afr Med J*, **85**(2), 72-79.

- Njiru, H., Elchalal, U. & Paltiel, O.** (2011). Geophagy during pregnancy in Africa: a literature review. *Obstet Gynecol Surv.* **66**(7), 452-459.
- Norhayati, M., Fatmah, M. S., Yusof, S. & Edariah, A. B.** (2003). Intestinal parasitic infections in man: a review. *Med J Malaysia,* **58**, 296-305.
- Nyanza, E. C., Joseph M., Premji, S. S., Thomas, D. S. K. & Mannion, C.** (2014). Geophagy practices and the content of Chemical elements in the Soil eaten by pregnant Women in Artisanal and Small scale gold mining communities in Tanzania. *BMC Pregnancy and Childbirth,* **14**, 144.
- O'Brien, M. E., Kupka, R., Msamanga, G. I., Saathoff, E., Hunter, D. J. & Fawzi, W. W.** (2005). Anemia is an independent predictor of mortality and immunologic progression of disease among women with HIV in Tanzania. *J Acquir Immune Defic Syndr,* **40**, 219–225.
- Olle Selinus, B. J. & Alloway, O.** (2005). Essentials of medical geology: impacts of the natural environment on public health. New York: Academic Press.
- Ozumba, U. C & Ozumba, N.** (2002). Patterns of helminth infection in the human gut at the university of Nigeria teaching Hospital, Enugu, Nigeria. *Journal of Health Sciences,* **48**, 263 – 268.
- Peter, A.** (2003). Human Geophagy: A review of its distribution, causes and implications. In **H. Catherine, W., Skinner. Antony, R., and Berger:** Geology and health: Closing the gap. Oxford University Press US, p.33.
- Reid, R.** (1992). Cultural and medical perspectives on geophagia. *Medical Anthropology,* **13**(4), 337–351.

- Rivera, R.** (1972). Fatal postpartum amoebic colitis with trophozoites present in peritoneal fluid. *Gastroenterology*, **62**, 314.
- Smith, R. E. Jr.** (2010). The clinical and economic burden of anemia. *The American journal of managed care*, **16**(Suppl), S59–66.
- Stanley, S. L. Jr.** (2003). Amoebiasis. *Lancet*, **361**(9362), 1025-34.
- Steketee, R. W.** (2003). Pregnancy, nutrition and parasitic diseases. *J Nutr*, **133**, 1661S–1667S.
- Stephenson, L. S., Latham, M. C., & Ottesen, E. A.** (2000). Malnutrition and parasitic helminth infections. *Parasitology*, **121**(suppl), S23-S38.
- Stokes, T.** (2006). The earth-eaters. *Nature*, **444**, 543–544.
- Thihalolipavan, S., Candalla, B, M & Ehrlich, J.** (2012). Examining Pica in NYC Pregnant Women with Elevated Blood Lead Levels; *Matern Child Health J*; 22302239.
- Thomson, J.** (1997). *Anaemia in pregnant women in eastern Caprivi, Namibia*; *S. Afr Med. J*, **87**, 1544–1547.
- Timmer, L & Visker, C.** (1998). Possibilities and Impossibilities of the use of human excreta as fertiliser in agriculture in sub-Saharan Africa. *Royal Tropical Insitute and University of Amsterdam, The Netherlands*; **36**, 449-452.
- Torsvik, V., Salte, K., Sorheim, R & Goksoyr, J.** (1990). Comparison of phenotypic diversity and DNA heterogeneity in population of soil bacteria. *Applied Environmental Microbiology*; **56**, 776 – 781.

- U.S. Agency for Toxic Substances & Disease Registry (ATSDR)** (2000). Summary report for the ATSDR soil – pica workshop, Atlanta, Georgia.
- Vermeer, D.** (1966). Geophagy among the Tiv of Nigeria; *Annals of the Association of American Geographers*, **56**(2), 197.
- Vermeer, D.** (1971). Geophagy among the Ewe of Ghana. *Ethnology*, **10**(1), 56–72.
- Vermeer, D.E & Frate, D.A.** (1975). Geophagy in a Mississippi County. *Annals of the Association of American Geographers*, **65**(3), 414–416.
- Vermeer, D.E & Frate, D.A.** (1979). Geophagia in rural Mississippi environmental and cultural contexts and nutritional implication. *The American Journal of Clinical Nutrition*, **32**, 2129-2135.
- Villar, J., Klebanoff, M. & Kestler, E.** (1989). The effect on fetal growth of protozoan and helminthic infection during pregnancy. *Obstet Gynecol*: **74**, 915–920
- Vos, T., Flaxman, A.D., Naghavi, M., Lozano, R., Michaud, C., Ezzati, M., ...& Aboyans, V.** (2012). Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*, **380** (9859), 2163–96.
- Wagner, V. P., Smale, L. E. & Lischke, J. H.** (1975). Amebic abscess of the liver and spleen in pregnancy and puerperium. *Obstet Gynecol*, **45**, 562.
- Walker, A. & Walker, B.** (1997). Pica. *Journal of Social Health*, **117**(5), 280–284.
- Walsh, J.A.** (1986). Problems in recognition and diagnosis of amoebiasis: estimation of the global magnitude of morbidity and mortality. *Rev Infect Dis*, **8**, 228–238.

**WHO**, (1968). Nutritional Anaemias, Report of WHO Scientific Group; *Teh Rep Ser*, **405**, 5-37.

**WHO**, (1991). *Basic Laboratory Methods in Medical Parasitology*, Geneva: World Health Organization.

**WHO**, (1997). World Health Organization/Pan American Health Organization/UNESCO report of a consultation of experts on amoebiasis. *Wkly Epidemiol Rec*, **72**, 97–100.

**WHO**, (2002). Prevention and Control of Schistosomiasis and Soil-Transmitted Helminthiasis: Report of a WHO Expert Committee. Geneva, Switzerland: World Health Organization. WHO Technical Report Series # 912.

**WHO**, (2003). *Report of the WHO Informal Consultation on the use of Praziquantel during Pregnancy/ Lactation and Albendazole/ Mebendazole in Children Under 24 Months*. Geneva: WHO/CDS/CPE/PVC.

**WHO**, (2005). *Deworming for Health and Development; Reports on the Third Global Meeting of the Partners for Parasite Control*. Geneva: WHO.

**WHO, UNICEF & UNU**, (2001). *Iron Deficiency Anaemia; Assessment, Prevention, and Control: A Guide for Program Managers; WHO/NHD/01.3*. Geneva: World Health Organization.

**WHO & UNICEF**, (2012). Joint Monitoring Programme (JMP) Report for Water Supply and Sanitation.

**Wiley, A. S.** (2003). Geophagy; In Katz, Solomon H. Ed. *Encyclopedia of Food and Culture*, **2**, 120–121.

- Wiley, A. S. & Solomon, H. K.** (1998). Geophagy in Pregnancy: A Test of a Hypothesis, *Current Anthropology*, **39**(4), 532 – 545.
- Wong, M. & Simeon, D.** (1993). The Silica Content of Faeces as an Index of Geophagia: Its Association with Age in Two Jamaican Children's Homes. *Journal of Tropical Pediatrics*, **39**(5), 318–319.
- Ximénez, C., Morán, P., Rojas, L., Valadez, A., Gómez, A., Ramiro, M., ... & Oswaldo, P.** (2011). Novelties on Amoebiasis; A Neglected Tropical Disease, *J Global Infect Dis*, **3**, 166-74.
- Young, S.L.,** (2010). Pica in Pregnancy: New Ideas about Old Condition. *Annu Rev Nutr*, **30**, 403-422.
- Young, S.L., Goodman, D., Farag, T.H., Ali, S.M., Khatib, M.R., Khalfan, S. S., Tielsch, J.M. & Stoltzfus, R.J.** (2007). Geophagia is not associated with *Trichuris* or hookworm transmission in Zanzibar, Tanzania. *Trans R Soc Trop Med Hyg*, **101**, 766-772.

## APPENDICES

### Appendix 1: Informed Consent Form

ADULT CONSENT FORM (ADULTS / SUBJECTS)

**PROJECT TITLE:** GEOPHAGY AND PREVALENCE OF SOIL TRANSMITTED HELMINTHIASES IN PREGNANT WOMEN ATTENDING ANTE-NATAL CLINIC IN THIKA LEVEL 5 HOSPITAL.

**INVESTIGATORS:** The Principal Investigator is Alice Wairimu Mutura, (student ITROMID, JKUAT) while the Research Supervisors are Dr. Gerald M. Mkoji (ITROMID, KEMRI) and DR. Jesca O. Wesongah of Jomo Kenyatta University of Science and Technology (JKUAT)

**INTRODUCTION:** My name is Alice Wairimu Mutura a Master degree student at Jomo Kenyatta University of Agriculture and Technology, ITROMID-KEMRI.

This research aims at investigating geophagy and prevalence of soil transmitted helminthiases among pregnant women attending antenatal clinic at Thika Level 5 Hospital level 5. The results of this study will be given to Thika hospital level 5 who will take the necessary action depending on the outcomes, the results will also be written up as an MSc degree thesis in Medical Parasitology and Entomology at the Jomo Kenyatta University of Agriculture and Technology.



This study will be absolutely voluntary. Subjects will be free to withdraw from the study at any point and will not be penalized in any way they will also not be waiving any of their legal rights by signing this informed consent document.

I therefore request your permission to allow me to enroll you into this study. Please read the information about the study and feel free to ask questions or seek further clarification about the study or about your participation in it.

**PURPOSE OF THE STUDY:** The purpose of this research study is to: help in determining the prevalence of geophagy and soil transmitted helminthiases in pregnant women, determine the association between geophagy and soil transmitted helminthiases in pregnant women and also determine knowledge of potential risks and benefits of geophagy among pregnant women attending antenatal clinic in Thika Level 5 Hospital level 5.

**PROCEDURES TO BE USED:** Each pregnant woman accepting/consenting to participate in this study will be requested to respond to a simple questionnaire to obtain bio data information and determine knowledge on geophagy and soil transmitted helminthiases. In addition, each participant will be requested to give a fecal sample for soil transmitted helminthiases diagnosis and a finger prick blood for Hb determination. None of these procedures pose any harm to the participant or the pregnancy. There will be no storage of the sample materials as they will only be necessary in this study.

**BENEFITS:** There are direct benefits to the study subjects; free investigation, prescription and results of the study will upon consent from the subject be given back to the attending physician for further management.

**RISKS, HAZARDS AND DISCOMFORTS ASSOCIATED WITH THE PROCEDURES:**

None of the procedures pose any harm to the participant or the pregnancy, though a little discomfort may be felt while pricking the finger to draw blood from for Hb determination.

**CONFIDENTIALITY:** The identity and test results will be kept confidential and you will be given an identification number. Your results of the tests done will be referred to or identified using this number even in any correspondence, reports or publications related to this study. All the information and records about you will remain confidential and will be kept in a lockable cabinet at KEMRI. Only authorized personnel carrying out this study will have access to these results.

**CONTACTS FOR FURTHER INFORMATION:** If you need more information about this study, please contact: The principal investigator, Alice Wairimu Mutura, MSc student JKUAT, P.O Box 6628 Thika; Cellphone 0721704263/0737104453, or by E-mail: [muturaalice@gmail.com/wairimohwairimoh@gmail.com](mailto:muturaalice@gmail.com/wairimohwairimoh@gmail.com). Or the Supervisors namely; Dr. Gerald Mkoji, CBRD, KEMRI, PO Box 54840-00200; Office Phone: 020-2717131 or Cell Phone: 0721-585 696, or by e-mail: [gmkoji@kemri.org](mailto:gmkoji@kemri.org) or Dr. Jesca O. Wesongah, JKUAT, Cell phone 0723958983 or by Email: [JWESONGAH@HOTMAIL.COM](mailto:JWESONGAH@HOTMAIL.COM). If you have questions on your rights as a research participant, please contact: The Secretary, KEMRI Ethics Review Committee, PO Box 54840-00200, Nairobi; Telephone numbers: 020-2722541, 0722205901, 0733400003; Email address: [ERCadmin@kemri.org](mailto:ERCadmin@kemri.org).

### **INFORMED CONSENT AGREEMENT FOR THE PATIENT**

I, Mrs/Miss/Ms \_\_\_\_\_, being an adult aged 18 years and over, do hereby give permission to Alice Wairimu Mutura to handle my samples in relation to this research study known as geophagy and prevalence of soil transmitted helminthiases in pregnant women attending ante-natal clinic in Thika Level 5 Hospital, which has been explained to me in \_\_\_\_\_, a language

I speak fluently and understand clearly and I now know what the study is all about, the tests to be done on me and benefits that I will receive for taking part in the study; free investigation, free prescription that will be given, if found to be sick with soil transmitted helminthiases/intestinal illnesses caused by parasites. The discomfort which I have been told is minimal and should not cause any harm to me and my pregnancy. I was given an opportunity to ask questions and to seek clarifications of the issues I had not understood clearly about the study, I am satisfied with the answers and the explanations I was given. I have also been told that if I have additional questions or concerns about the study later, I can contact the researcher in charge of the study, in case I have questions or concerns about my rights as a participant in this study I can contact: The Secretary, KEMRI's Ethics Review Committee, P.O. Box 54840-00200, Nairobi, Telephone numbers: 020-2722541, 0722205901, 0733400003; Email address: [ERCAdmin@kemri.org](mailto:ERCAdmin@kemri.org).

I accept to take part in this study, and agree that I can give stool samples, finger prick blood for the tests needed in this study and in addition respond to the questions in the questionnaire. I have been told that i can leave the study at any time I decide to and I have been assured that I will not suffer any penalty or loss of benefits that I should get through this study.

Signature (or Thumb Print) of the participant.....

Date.....

Name of the Person Obtaining Consent and Signature.....

Name and Signature (or Thumb Print) of Witness.....

**Appendix 2: Questionnaire**

**TITLE:** GEOPHAGY AND PREVALENCE OF SOIL TRANSMITTED HELMINTHIASES IN PREGNANT WOMEN ATTENDING THIKA LEVEL-5 HOSPITAL.

**INVESTIGATOR:** ALICE WAIRIMU MUTURA

**PATIENTS QUESTIONNAIRE**

All answers in this questionnaire are strictly confidential and information will be managed strictly in accordance with the research ethics approval for this project. After informed consent is obtained, the patient is to complete the 2page questionnaire with the principal investigator.

**CONFIDENTIAL**

PATIENT NUMBER ..... LABORATORY NUMBER .....

Address ..... Telephone .....

Residence ..... Mobile .....

E-mail..... Age .....

Sex..... Male /Female (Tick the appropriate)

Date of Birth .....

Marital Status ..... Single / Married / Divorced/ Widowed. (Tick the appropriate)

Number of live births.....

Occupation (Nature of work) .....

Level of Education: Primary / Secondary / University (tick the appropriate)

1. When was your last menstrual period? .....
2. In which trimester is your pregnancy? .....1<sup>st</sup> (1<sup>st</sup> -12<sup>th</sup> week), 2<sup>nd</sup> (13<sup>th</sup> -28<sup>th</sup> week) or 3<sup>rd</sup> (29<sup>th</sup> -40<sup>th</sup> week) (tick the appropriate).
3. Do you have any problems of feeding, like lack of appetite, vomiting, nausea?.....
4. If yes which ones? .....
5. Many women are known to crave for non-food substances like soil when pregnant. Yourself do you deliberately eat soil? .....
6. If yes, how often? (Tick the appropriate) .....rarely/occasionally/regularly
7. When did you start eating soil? ..... (1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> pregnancy, please specify any other.)
8. State the reasons that make(s) you deliberately eat soil?
  - a) Desire
  - b) Hunger
  - c) The smell
  - d) The taste
  - e) Any other (List them)
9. Briefly discuss the benefits you derive by eating soil.....

10. Are you aware of any risks of eating soil? Yes/No. If yes, name them  
 .....
11. Were you eating soil before the pregnancy? Yes/No (tick the appropriate)
12. Have you ever been tested for the presence of helminth/intestinal worms e.g. *Ascaris lumbricoides* (round worms), *Trichuris trichiura*, *S. stercoralis* and hookworms? Yes/No (tick the appropriate).
13. If yes, were there any drugs prescribed to treat the intestinal worms? .....
14. Was there any allergy observed after taking the drugs to treat the intestinal worms, some of which may have included any of the following symptoms after treatment with antihelminthic drugs:- nausea, vomiting, headache, dizziness, drowsiness, fever, chills, sore throat, anorexia(eating disorder) ,asthmatic attacks, urticaria(skin rashes), abdominal pains, low back pains, gastrointestinal disturbances, insomnia(sleeplessness), sweating, dark urine, blurred vision, epileptic seizures, jaundice, loss of appetite, dryness of the mouth and eyes, ringing in the ears, diarrhea, extreme weakness and hallucinations?.....
15. When was the last time your family was dewormed? Before 2011/during 2011/during 2012/during 2013/in the year 2014 (Tick the appropriate)
16. Name the site of defecation in your area? ..... water closet/pit latrine/bush or no toilet (tick the appropriate)
17. Where do you get water for domestic use? .....borehole/wells or tanks/tap water/river or stream. (tick the appropriate)
18. Do you walk barefooted? ..... I don't/regularly/occasionally (tick the appropriate).
19. Any extra remarks or information that you would like to add? e.g were you happy/unhappy with our services, are you satisfied with the information given on this study, what are your recommendations  
 .....

### **Appendix 3: Karatasi Ya Kufahamisha Idhini**

#### **KICHWA**

UCHUNGUZI KUHUSU ULAJI WA MCHANGA AMA VITU AMBAVYO SIO VYAKULA HALISI NA MAAMBUKIZI YA NEMATODI KAMA VILE MINYOO KWA WANAWAKE WAJAWAZITO WANAHUDHURIA KLINIKI KABLA YA KUJIFUNGUA KATIKA HOSPITALI YA THIKA NGAZI LA 5 NCHINI KENYA

#### **WACHUNGUZI**

Mpelelezi Mkuu ni Alice Wairimu Mutura (mwanafunzi, ITROMID, JKUAT). Wasimamizi wa Utafiti ni Dr. Gerald M. Mkoji (ITROMID, KEMRI) na DR. Jesca O. Wesongah (JKUAT)

#### **UTANGULIZI**

Jina langu ni Alice Wairimu Mutura mwanafunzi katika Chuo Kikuu cha Jomo Kenyatta cha Kilimo na Teknolojia, ITROMID-KEMRI. Kwa wakati huu ninafanya utafiti; shahada ya pili, kuchunguza ulaji wa mchanga ama vitu ambavyo sio vyakula halisi na maambukizi ya nematodi kama vile minyoo kwa wanawake wajawazito wanaohudhuria kliniki kabla ya kujifungua katika hospitali ya Thika ngazi la tano, Kenya. Uchunguzi utakaniwezesha kufuzu shahada hii na pia, matokeo ya utafiti huu yatawasilishwa kwa hospitali ya Thika ngazi la tano ambayo itachukua jukumu la; kuelimisha na kusaidia kina mama wajawazito na uma kwa njia mbalimbali kutokana na matokeo ya utafiti huu. Ningeshukuru sana kama ungejitolea kuwa mmoja wa washiriki wangu katika utafiti huu.

Utafiti huu utakuwa wakujitolea na uchunguzi utakuwa bure na mshiriki anaweza kujiondoa kutoka kwa utafiti huu na hakuna hatuazozote zitachukuliwa. Tafadhali soma karatasi hii yenye taarifa kuhusu utafiti huu, na ujisikie ukiwa huru kuuliza maswali au kutafuta ufafanuzi zaidi kuhusu utafiti au kuhusu ushiriki wako katika utafiti.

## **MADHUMUNI**

Lengo la somo hili ni kumsaidia mtafiti katika kuamua kiwango cha maambukizi ya ulaji wa udongo ama vitu visivyo vyakula halisi na maambukizi ya nematodi kama vile minyoo miongoni mwa wanawake wajawazito wanaohudhuria kliniki ya wajawazito katika Hospitali Kuu ya Thika, utafiti pia utalenga kufahamu kama mhusika anayo maarifa ya uwezekano wa hatari na faida za ulaji wa udongo.

## **TARATIBU ZA UTAFITI**

Utafiti utahusisha kuyajibu maswali rahisi na kukusanya sampuli za kinyesi, kutoa damu ndogo kwa kidole kutoka kwa wanawake wajawazito wanaohudhuria kliniki kabla ya kujifungua katika hospitali ya Thika na kufanya mbinu ya “Kato Katz” kuamua uwepo wa mayai ya nematode katika kinyesi na kiwango cha damu mwilini.

## **FAIDA**

Kunayo faida ya moja kwa moja katika masomo ya utafiti huu, kama vile uchunguzi utakuwa bure na matokeo ya utafiti kutoka somo hili kwa mapenzi ya mhusika yatarejeshwa kwa daktari ili ampatie mhusika mawaidha zaidi na ampatie dawa ambazo hazitamdhuru mama wala mtoto angali tumboni.



## **MADHARA**

Utafiti huu hauna madhara yoyote kwa mshirika au mimba, ingawa usumbufu mdogo waweza patikana wakati wa mchomo/kudunga kidole kuteka damu kwa ajili ya kupima kiwango cha damu mwilini.

## **SIRI YA HALI YAKO**

Majibu na matokeo ya utafiti huu yatawekwa kama siri kuu. Mchunguzi mkuu ndiye pekee atakuwa na idhini. Hakuna jina litakalochapishwa popote wakati wa uchunguzi na hata baada ya uchunguzi kukamilika. Washirika watajulikana kwa nambari za siri zitakazopeanwa na mchunguzi mkuu.

## **MAWASILIANO KWA AJILI YA HABARI ZAIDI:**

Kama unahitaji habari zaidi kuhusu somo hili, tafadhali wasiliana na: mpelelezi mkuu, Alice Wairimu Mutura, mwanafunzi, JKUAT, SLP 6628 Thika; Simu ya mkononi 0721 704 263 /0737 104 453, au kwa barua pepe: [muturaalice@gmail.com/wairimohwairimoh@gmail.com](mailto:muturaalice@gmail.com/wairimohwairimoh@gmail.com) au wasimamizi yaani: Dr Gerald Mkoji, CBRD, KEMRI, SLP 54840-00200, Nairobi; Simu ya ofisi: 020-2717131 au simu ya mkononi : 0721-585 696, au kwa barua pepe: [gmkoji@kemri.org](mailto:gmkoji@kemri.org) ama Dr . Jesca O. Wesongah, JKUAT, simu ya mkononi 0723-958 983 au kwa barua pepe: [JWESONGAH@HOTMAIL.COM](mailto:JWESONGAH@HOTMAIL.COM). Kama una maswali kuhusu haki yako kama mshiriki wa utafiti, tafadhali wasiliana na: Katibu, KEMRI, Kamati ya Uchunguzi, SLP 54840-00200, Nairobi; Simu: 020-2722541, 0722205901, 0733400003; Barua pepe: [ERCadmin@kemri.org](mailto:ERCadmin@kemri.org).

## **IDHINI YA MUHUSIKA**

Mimi, Bibi /binti, -----, mwenye umri wa miaka kumi na minane na zaidi nampa ruhusa kwa Alice Wairimu Mutura kupeleleza sampuli

zangu, kuhusiana na utafiti huu wa kuamua kiwango cha maambukizi ya ulaji wa udongo ama vitu visivyo vyakula halisi na maambukizi ya nematodi kama vile minyoo na pia kuyajibu maswali nitakayoulizwa ili kusaidia kuamua kiwango cha maarifa ya uwezekano wa hatari na faida kwa ulaji wa udongo miongoni mwa wanawake wajawazito wanaohudhuria kliniki ya wajawazito katika Hospitali Kuu ya Thika, ambayo nimeelezwa kwangu katika lugha ya \_\_\_\_\_, ambayo naongea na kuelewa wazi, na sasa, najua matakwa yote kuhusu utafiti huu, na vipimo vitakavyo fanywa kutoka kwa sampuli zangu, nimezifahamu faida na madhara nitakayopokea kwa ajili ya kushiriki katika utafiti huu. Nimepewa nafasi ya kuuliza maswali na ufafanuzi wa masuala yote kuhusu upelelezi/ utafiti huu, na nimeridhika na majibu na maelezo niliyopewa. Ni meelezwa pia, kwamba kama nina maswali ya ziada au wasiwasi juu ya utafiti huu baadaye, naweza kuwasiliana na mchunguzi mkuu, na nikiwa na maswali au shaka kuhusu haki zangu kama mshiriki katika utafiti huu, naweza kuwasiliana na : Katibu, KEMRI ,Kamati ya Uchunguzi, Kenya Medical Research Institute (KEMRI), Sanduku la Posta 54840 -00200, Nairobi, Simu: 020-2722541, 0722-205901, 0733-400003;Baruapepe: [ERCadmin@kemri.org](mailto:ERCadmin@kemri.org). Mimi nakubali kushiriki katika utafiti huu, nimekubali kwamba naweza kutoa sampuli ya kinyesi, na kutolewa damu kutoka kwa kidole kwa ajili ya vipimo vinavyohitajika katika utafiti huu na kuyajibu maswali kuhusiana na upelelezi huu. Nimeelezwa kwamba naweza kujiondoa katika utafiti huu wakati wowote nikihisi kufanya hivyo, na nimekuwa na uhakika kwamba sitateseka kwa lolote lile, nanimefahamu pia madhara na faida zitokanayo na utafiti huu.

Mambo haya yote yameelezwa kwangu katika lugha ya ..... lugha ninayo ongea na kuielewa kwa uwazi.....Sahihi (au alama ya kidole ghuba) ya mshiriki

Tarehe.....

Jina la mtu anayechukua idhini.....

Jina na Saini (au alama ya kidole ghuba) ya Shahidi.....

**Appendix 4: Fomu Ya Kunakiri Taratibu Za Ugonjwa Kichwa**

UCHUNGUZI KUHUSU ULAJI WA MCHANGA AMA VITU AMBAVYO SI VYAKULA HALISI NA MAAMBUKIZI YA NEMATODI KAMA VILE MINYOO KWA WANAWAKE WAJAWAZITO WANAOHUDHURIA KLINIKA KABLA YA KUJIFUNGUA KATIKA HOSPITALI YA THIKA NGAZI LA 5 NCHINI KENYA

**MCHUNGUZI MKUU**

Alice Wairimu Mutura (JKUAT)

**FOMU YA MASWALI**

Maswali yote yatakayojibiwa kwa fomu hii yatakuwa ni siri na habari zote zitakazo chukuliwa zitahifadhiwa kulingana na utaratibu na kanuni zilizowekwa na shirika la utafiti. Baada ya kuitikia ufahamisho wa idhini, mgonjwa atajaza kurasa mbili za fomu hii ya maswali akisaidiwa na mchunguzi mkuu.

Nambari ya mgonjwa----- Nambari ya mahambara .....

Anwani.....Nyumbani.....

Nambari ya simu.....

Simu                                ya                                ofisi.....

Rununu.....

Barua pepe.....

Miaka.....

Jinsia: Mume                                 Mke

Tareha ya kuzaliwa..... Hali ya ndoa.....

Namba ya kizazi.....

Kazi unayoifanya kupata riziki.....

Elimu..... Msingi / Sekondari / Chuo kikuu (Jibu sahihi)

1. Tarehe ya mwisho ulipopata kipindi cha hedhi ilikuwa lini?.....

2. Je, mimba yako iko katika wiki ama ukuaji upi?.....ukuaji wa kwanza (wiki 1-12), ukuaji wa pili (wiki 13-28), ukuaji wa tatu (wiki 29-40).

3. Je, una matatizo yoyote katika ulaji wa chakula kama vile kutapika, kuumwa na tumbo, kukosa hamu ya kula? Ndio/La.....

4. Kama unayo matatizo ni yapi?.....

5. Wanawake wengi wanajulikana kula vitu visivyo vyakula halisi kama mchanga wakati wako wajawazito. Je wewe wala mchanga? .....

6. Kama ni kweli wala mara ngapi? .....chache/ mara kwa mara/ mara nyingi (Jibu sahihi)

7. Ulianza kula mchanga katika mimba yako ya?.....kwanza, pili, tatu, nne, elezea mengine yoyote.

8. Eleza sababu zinazokusambambisha kula udongo?

a) Hamu

b) Njaa

c) Vyenye inanuka

d) Sababu zingine

9. Elezea umefaidika kwa jinsi gani kutokana na ulaji wa udongo?.....

10. Unafahamu hatari yoyote ya ulaji wa udongo?.....

11. Je, ulikuwa wala udongo kabla ya kutunga mimba? Ndio/La.....

12. Umewahi kupimwa uwepo wa maambukizi ya nematodi kama vile minyoo...  
Ndiyo/la (Jibu sahihi)

13. Uliagizwa kunywa dawa yoyote ya kutibu ugonjwa wa nematodi kama vile minyoo?.....

**14.** Baada ya kunywa dawa hizo ulipatwa na madhara yoyote kama vile: - kichefuchefu, kutapika, kuumwa na kichwa, kizunguzungu, uchungu kooni, taabu ya malisho, mashambulizi ya pumu, maumivu ya tumbo, maumivu ya nyuma upande wa chini, usumbufu wa utumbo, kukosa usingizi, jasho, mkojo nyeusi?.....

15. Mara ya mwisho familia yako kutibiwa na dawa za kutibu magonjwa yanayosababishwa na nematodi kama vile minyoo ilikuwa lini? Mbele ya mwaka 2011/20111/2012/2013/mwaka huu wa 2014.....

16. Mnayateka maji ya matumizi nyumbani wapi.....kisima/tenki/maji ya mferenji/mtoni (Jibu sahihi)

17. Je, watu wa eneo lako hutupa kinyeshi wapi?.....choo cha mbombo/choo cha shimo/kichakani (Jibu sahihi)

18. Je huwa watembea bila viatu?.....la/mara chache/mara nyingi.

(Jibu sahihi)

19. Unayo ya ziada au mambo mengine ungependa kuongezea? kama vile umeridhika na matibabu yetu ama la.....

**ASANTE SANA.**

## **Appendix 5: Fomu Ya Guitikira Gukorwo Wi Umwe Wa Athuthurio**

### **KIONGO KIA UTHUTHURIA**

URII WA TIRI NA MIRIMU YA IGUNYO TA NJOKA (IRIA YUMANAGA NA URII WA TIRI KANA MAHIGA) THIINII WA ATUMIA ARIA MOHITE NDA NA MARACARIA URIGITI THIBITARI-INI WA MUINGI WA THIKA URIA WI NGATHI YA GATANO HARI MATHIBITARI MA KENYA.

### **ATHUTHURIA**

Muthuthuria munene ni Alice Wairimu Mutura (murutwo wa cukuru munene wa JKUAT, arugamiriri a uthuthuria (Supervisors) ni Dagitari Gerald M. Mkoji ITROMID, KEMRI na Dagitari Jesca O. Wesongah, JKUAT.

### **KWIMENYITHANIA**

Ha maritwa njitaguo Alice Wairimu Mutura, ndirathomera thumbi yakwa ya Masters cukuru munene wa JKUAT, ITROMID-KEMRI. Kuria ndireka uthuthuria wa urii wa tiri/mahiga na mirimu ya igunyo ta minyoo thiinii wa atumia aria mohete nda na maracaria urigiti wao thiinii wa thibitari ya muingi ya Thika wa kiwango gia ithano hari mathibitari thiinii wa Kenya, ni ingikena muno ungingeithiriria githomoini giki niundu wa gwitikira na wirutiri waku. Githomo giki ni kia tuhu na nigia kwirutira hatari kwirwo na hinya, mutumia uria werutira ndari na kigiririria ona kimwe na no oime uthuthuria ini uyu hindi oyothe angienda na gutiri makinya ona mariku angioyerwo na hatiri mahinya ona mariku ma muthuthurio me kweherio, muthuthuria arikia guitikira githuthurio nie guchaina fomu ino.

Kwa uguo ni ndakuria na gitio witikirie gukorwo wi umwe wa athuthurio. Thoma mohoro maya me karatathini gaka maria makonainie na uthuthuria uyu na wiigwe utari na kigiriria ogiothe kuria kiuria/ciuria kumana na uthuthuria uyu na wirutiri waku.

## **GITUMI KIA GITHOMO GIKI**

Githomoini giki ndirageria guthuthuria urii wa tiri/mahiga na mirimo ya igunyo ta njoka thiinii wa atumia aria aritu maretha urigiti thibitariini wa muingi wa Thika uria wi ngathi ya gatano hari mathibitari ma Kenya. Moimirira ma uthuthuria uyu makaneo thibitari ino ya Thika nigetha mamateithiririe kuoya makinya maria magiriire. Uthuthuria uyu niugukoruo wina uteithio hari mutumia uria ukwirutira na hamwe na guteithiriria kuoywo kwa makinya maria makinyaniriru thiiniiwa thibitari ini uyu.

## **GITHOMO GIKI KIRENDA ATIA**

Githomo giki nigia kuungania tucunji (samples) twa kiorona twa thakame kuma kiara-ini kia muthuthurio na gucokia gwa ciuria kuma kuri atumia aria mohete nda na maretha urigiti thibitariini uyu wa muingi wa Thika. Na kumathimira kana mena matumbi ma mirimu ya igunyo ta njoka na kana thakame yao ni ya muigana uria wagiriirwo. Hatiri ugwati owothe ukuoneka kuri muthuthurio ona kuru mwana uria wi nda, tucunji twa kioro ona twa thakame tutikuigwo tondu tukuhuthika uthuthuriaini uyu tu.

## **MOGWATI MA GITHOMO GIKI**

Gutiri na mogwati omothe mangiumana na uthuthuria uyu, otiga muthuthurio ni ekuigua ataiganiire akirutwo thakame kiara-ini giake.

## **MOGUNI MA KWIRUTIRA GITHOMOINI GIKI**

Moguni mamwe ni taa, uthuthuria wa tuhu tondu hatiri na marihi omothe, na gwathirwo gwa tuhu kwa ndawa iria ekuhuthira hamwe na kuneana maumithio ma uthuthuria uyu kuri ndagitari angikorwo ni wendi wa murigitwo nigetha amutare makiria.



## **THIRI**

Moimirira ma uthuthuria uyu nimekuigwo me ma-thiri nene na nimekuhingirwo wega. Ritwa ria muthuthurio ritikuhuthika handu ohothe, no muthuthurio ni ekuheo namba iria angimenyeka nayo ni muthuthuria munene tu.

## **NAMBA CIA THIMU:**

Ungikoruo na kiuria o giothe ihinda oriothe hindi ino ya uthuthuria uyu no uhure thimu namba ici,muthuthuria munene, Alice Wairimu Mutura, Namba ya thimu; 0721704263/0737104453, kana Email address; [muturaalice@gmail.com/wairimohwairimoh@gmail.com](mailto:muturaalice@gmail.com/wairimohwairimoh@gmail.com) : kana arugamiriri a uthuthuria uyu ti Dagitari Gerald M. Mkoji, Namba ya thimu; 0721 585 696, Email address: [gmkoji@kemri.org](mailto:gmkoji@kemri.org) kana Dagitari Jesca O. Wesongah, Namba ya thimu; 0723 958 983, Email address; [JWESONGAH@HOTMAIL.COM](mailto:JWESONGAH@HOTMAIL.COM) .

Ungikorwo na kiuria o giothe gia haki yaku ta muthuthurio no warie **Karani wa Kamiti ya uthuthuria KEMRI, Ithanduku ria marua 54840-00200, Nairobi, Namba cia thimu: 020-2722541, 0722205901, 0733400003; Email address: [ERCAdmin@kemri.org](mailto:ERCAdmin@kemri.org).**

## **RUTHA**

Nii, Mrs./Miss/Ms ..... nindarikia guthoma na kunyita na kumenya kiria kira batarania ona kwendeka uthuthuriaini uyu, ona ciuria ciakwa ciothe ni ndacokerio, ni ndeeretherwo mogwati na mawega ma uthuthuria uyu, na nindarikia kuiruo ati ingi igua ndikwenda guthii na mbere na githomo gikii no nyume na hatiri mukana owothe na ati ingikorwo na kiuria ogiothe hindi ino ya uthuthuria uyu no njeretherwo kana kuheo utaro na anja kuma kuri muthuthuria muene na kuma kuri **Karani wa Kamiti ya uthuthuria KEMRI, Ithanduku ria marua 54840-00200,**

**Nairobi, Namba cia thimu: 020-2722541, 0722205901, 0733400003; Email address:  
ERCadmin@kemri.org.**

Ni undu wo uguo, nindetikira gukoruo ndi umwe wa aria megukoruo githomoini giki kiria ndataririo na ruthiomi rwa .....ruria njaragia na njuihatari nganja na nindetikira kuheana tucunji takwa twa kioro ona thakame na gucokia ciuria ociothe ngurio na nindamenyithio ati no nyume uthuthuria ini uyu hatari na mukana uriku na ati hatiri mahinya makwa ta mundu megucenjia.

Kirore kia muthuthurio.....

Mweri.....

Ritwa na kiore kia muthuthuria munene.....

**Appendix 6: Fomu Ya Ciuria**

**KIONGO KIA UTHUTHURIA**

URII WA TIRI/ MAHIGA NA MIRIMU YA IGUNYO TA NJOKA (IRIA YUMANAGA NA URII WA MAHIGA) THIINII WA ATUMIA ARIA MOHITE NDA MARACARIA URIGITI THIBITARI-INI WA MUINGI WA THIKA URIA WI NGATHI YA GATANO HARI MATHIBITARIINI MA KENYA.

**MUTHUTHURIA MUNENE**

ALICE WAIRIMU MUTURA

Macokia mothe maria ukuheana thiinii wa fomu ino mekuhuthiruo tu niundu wa githomo giki na megukoruo me ma thiri nene kuringana na mawatho maria maigitwo ma uthuthuria.

**THIRI**

Namba ya murwaru..... Namba ya githimirwo (lab).....

Ithanduku ria marua.....

Namba ya thimu.....Giikaro.....

Ukuru.....Guciarwo.....

Muikarire/kihiko.....ndi wiki/ ndi muhiku/ ndi wa ndigwa// nitutiganite na muthuri (thura anja imwe ya ici)

Namba ya ciana ciaku iria ci muoyo.....Wira.....

Gikiro gia githomo giaku.....



1. Kahinda gaku ka muico ka mweri kari ri?.....
2. Nda ino wi nayo iri mweri ini uriku?.....
3. Niukoragwo na mathina omothe ma kuria, ta gutahika, kuira ngoro kana kuigua ta utekwenda irio?.....
4. Ongoruo ni uri mathina ni ta mariku?.....
5. Atumia aingi nimoikaine kuria tiri hindi iria mohete nda. Weeri niuriaga tiri?.....
6. Angikoruo ni uriaga tiri ri, uriaga?..... hanini/rimwe na rimwe/maita maingi (thura anja imwe ya ici)
7. Wanjiriirie kuria tiri woha nda ya kaigana?.....ya mbere, keri, gatatu, kana, gweta ingi oyothe
8. Niitumi iriku iria itumaga urie tiri/ mahiga?.....
  - a) Kuigua wendo wa tiri
  - b) Kuhuta      c) Muruki
  - d)Munungo    e) Maundu mangi
9. He mawega wonaga kumana na urii wa tiri/mahiga?.....
10. Niui thina owothe umanaga na urii wa tiri/mahiga?.....
11. Ni wariaga tiri/mahiga mbere ya kuoha nda (Aca/ Iii).....
12. Ni uri wathimirwo tugunyu ta njoka?.....
13. Niwaathiirwo kunywa ndawa ociothe cia tugunyo ta njoka?.....
14. Niwagiire na thina owothe warikia gucinyua ta umwe wa maya :- kuigua kwenda gutahika, gutahika, guturwo ni kiongo, kuigua thiurura, kuigua guchungirira, rugari,kuigua heho, kuigua ruo mumero ini, kugia thina wa mirire, kuaga riera riiganu, munyegerera mwiri ini, kurio ni nda, ruo mugongo ini mwena wa kianda, kuthumburwo ni nda, kwaga toro, guthithina, mathugumo mairu, kuona

marundurundu, kibaba, guchenjia rangi mwiri ini (ukeruha makiria), kwaga kwenda irio, kumagara miromo na maitho, kuigua ta kurahurwo ngengere thiini wa matu, kuharwo, kwaga hinya mwiri ini na kubongotha?.....

15. Mucii waku wirigite kuhuthira ndawa cia tugunyo ta njoka ri (mbere ya mwaka wa 2011/mwakaini wa 2011/mwakaini wa 2012/mwakaini wa 2013/mwaka uyu ?.....
16. Mai ma mahuthiro ma mucii waku murutaga ku?.....irima/itangi/muberethi ma kanju/rui kana githima. (thura anja imwe ya ici)
17. Mwiteithagiria ku? kioro kia irima/ kioro kia mbombo/githakaini. (thura anja imwe ya ici)
18. Nikuri hindi utiaga utari na iratu? aca/rimwe na rimwe/ kaingi. (thura anja imwe ya ici)
19. Nihari undu ungienda kuongerera ungiethiriria uthuthuria uyu?.....

## **THENGIU MUNO**

## Appendix 7: Approval Letter by the SSC KEMRI



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### **KENYA MEDICAL RESEARCH INSTITUTE**

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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](mailto:director@kemri.org) [info@kemri.org](mailto:info@kemri.org) Website: [www.kemri.org](http://www.kemri.org)

**KEMRI/SSC/1023/** **29<sup>th</sup> November, 2013**

Alice Mutura

Thro' *Forwarded  
3/12/13*  
Director, CBRD  
NAIROBI

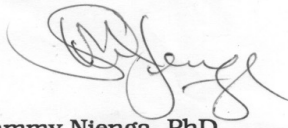
**REF: SSC No. 2717 (Revised) – Geophagy and prevalence of soil transmitted helminthiases in pregnant women attending Thika General Hospital**

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Thank you for your letter dated 28<sup>th</sup> November, 2013 responding to the comments raised by the KEMRI SSC.

I am pleased to inform you that your protocol now has formal scientific approval from SSC.

The SSC however, advises that work on the proposed study can only start after ERC approval.



**Sammy Njenga, PhD**  
**SECRETARY, SSC**

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In Search of Better Health

**Appendix 8: Approval Letter by the ERC KEMRI EAMJ July issue**



**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](mailto:director@kemri.org) [info@kemri.org](mailto:info@kemri.org) Website: [www.kemri.org](http://www.kemri.org)

**KEMRI/RES/7/3/1**

**March 4, 2014**

**TO: ALICE MUTURA  
PRINCIPAL INVESTIGATOR**

**THROUGH: DR. KIMANI GACHUHI,  
DIRECTOR, CBD,  
NAIROBI**

Dear Madam,

**RE: SSC PROTOCOL NO. 2717 – (RESUBMISSION): GEOPHAGY AND  
PREVALENCE OF SOIL TRANSMITTED HELMINTHIASES IN  
PREGNANT WOMEN ATTENDING THIKA GENERAL HOSPITAL.**

Reference is made to your letter dated February 20, 2014. The ERC Secretariat acknowledges receipt of the revised proposal on February 25, 2014.

This is to inform you that the Ethics Review Committee (ERC) reviewed the documents submitted and is satisfied that the issues raised at the 223<sup>rd</sup> meeting held on 21<sup>st</sup> January 2014 have been adequately addressed.

The study is granted approval for implementation effective this **March 4, 2014**. Please note that authorization to conduct this study will automatically expire on **March 3, 2015**. 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 20, 2015**.

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 SSC and ERC prior to initiation and advise the ERC when the study is completed or discontinued.

Yours faithfully,


**DR. ELIZABETH BUKUSI,  
ACTING SECRETARY,  
KEMRI ETHICS REVIEW COMMITTEE**

In Search of Better Health

**Appendix 9 : Approval Letter by the ERC Thika Level-5 Hospital**

**MINISTRY OF HEALTH**

Tel.Thika 067 21621/2 fax 21778  
All correspondence should be addressed to  
MED.SUPT.  
When replying please quote  
Ref: NO. MOH/TKA/



THIKA LEVEL 5 HOSPITAL  
P.O. BOX 227  
THIKA  
Date: 22<sup>nd</sup> April,2014

---

To Alice Wairimu Mutura

**REF: RESEARCH APPROVAL**

Title: **REQUEST FOR PURSUING MY REASERCH TITLED "GEOPHAGY AND SOIL TRANSMITTED HELMINTHIASES IN PREGNANT WOMEN ATTENDING THIKA LEVEL 5 HOSPITAL".**

Having discussed your research proposal, the Thika Level 5 Hospital research and ethics committee hereby gives you the green light to conduct above research after you clear the requisite fees.

You are advised to strictly adhere to the data collection period as you outlined in the proposal. Request for extra data collection time must be made to the committee in writing. You are further advised to strictly stick to research ethics and staff and patients/clients confidentiality must not be breached.

Any data or information you may come across which does not form part of your research must not be used/ broadcast/divulged to other people without express authority of the hospital Medical Superintendent.

As you conduct your research you will be attached to Nurse Lucy Thuo and Dr. Njenga who is the head of department where you will be conducting the research.


On completion of the research you are expected and required to inform the hospital of your findings. This gives you an opportunity to help improving the provision of quality health care at Thika Level 5 hospital.

In case you are found to contravene or violate the code of ethics the hospital reserves the right to terminate your research without prior warning.

We look forward to the findings of the research and we wish you the best.

Thank you.  
*Githinji*  
DR. C. MURTA FER  
DR. MBOGO

I, *Alice Wairimu Mutura*  
Signed.....  
Date.....*22/04/2014*



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## Appendix 10: Certificate of Translation

February 20, 2014

TO: THE SECRETARY,  
KEMRI ETHICS REVIEW COMMITTEE,  
NAIROBI

THROUGH: THE DIRECTOR,  
CBRD KEMRI,  
NAIROBI

Dear sir/Madam,

RE: CERTIFICATE OF TRANSLATION

This is to certify that we, FESTUS MBITHUKA WAMBUA of Identification number: 22817824, Telephone number: 0726 615 557 and T.S.C number: 483284 and ALICE WAIRIMU MUTURA of Identification number: 20182258, Telephone number: 0721 704 263/0737 104 453 and Email address: [muturaalice@gmail.com](mailto:muturaalice@gmail.com) did the translation for the proposal referenced SSC NO. 2717 and titled GEOPHAGY AND PREVALENCE OF SOIL TRANSMITTED HELMINTHIASES IN PREGNANT WOMEN ATTENDING THIKA GENERAL HOSPITAL and confirm that the translation in Kiswahili and Kikuyu is accurate to the best of our knowledge and the study tools were translated properly and accurately in a way that it can be understood by any person who speaks the language(s).

Thank you.

Yours,

FESTUS MBITHUKA WAMBUA,

Signature.....

Date.....20/02/2014.....

ALICE WAIRIMU MUTURA,

Signature.....

Date.....20/02/2014.....

## Appendix 11 : CITI Certificate (1)

**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI)  
BIOMEDICAL RESEARCH - BASIC/REFRESHER CURRICULUM COMPLETION REPORT**  
Printed on 11/27/2013

<b>LEARNER</b>	alice mutura (ID: 3277094)
<b>DEPARTMENT</b>	CBRD (center for biotechnology, research and development)
<b>EMAIL</b>	kemri@org.com
<b>INSTITUTION</b>	Kenya Medical Research Institute
<b>EXPIRATION DATE</b>	11/27/2014

**BIOMEDICAL RESEARCH - BASIC/REFRESHER** : Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in biomedical research with human subjects.

<b>COURSE/STAGE:</b>	Basic Course/1
<b>PASSED ON:</b>	11/27/2013
<b>REFERENCE ID:</b>	11609148

REQUIRED MODULES	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction	02/03/13	3/3 (100%)
History and Ethical Principles	10/25/13	6/6 (100%)
Basic Institutional Review Board (IRB) Regulations and Review Process	10/25/13	5/5 (100%)
Informed Consent	10/25/13	4/4 (100%)
Social and Behavioral Research (SBR) for Biomedical Researchers	10/25/13	4/4 (100%)
Records-Based Research	10/25/13	2/2 (100%)
Genetic Research in Human Populations	10/25/13	2/2 (100%)
Research With Protected Populations - Vulnerable Subjects: An Overview	10/25/13	4/4 (100%)
Vulnerable Subjects - Research Involving Prisoners	11/26/13	4/4 (100%)
Vulnerable Subjects - Research Involving Children	11/26/13	3/3 (100%)
Vulnerable Subjects - Research Involving Pregnant Women, Human Fetuses, and Neonates	11/26/13	3/3 (100%)
International Studies	11/26/13	3/3 (100%)
FDA-Regulated Research	11/26/13	5/5 (100%)
Research and HIPAA Privacy Protections	11/26/13	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees	11/27/13	4/4 (100%)
Conflicts of Interest in Research Involving Human Subjects	11/27/13	5/5 (100%)
Avoiding Group Harms - U.S. Research Perspectives	11/27/13	3/3 (100%)
Avoiding Group Harms - International Research Perspectives	11/27/13	3/3 (100%)
I Have Agreed to be an IRB Community Member. Now What?	11/27/13	5/5 (100%)
Stem Cell Research Oversight (Part I)	11/27/13	2/5 (40%)
Kenya Medical Research Institute	02/03/13	No Quiz

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI Program participating institution or be a paid Independent Learner. Falsified information and unauthorized use of the CITI Program course site is unethical, and may be considered research misconduct by your institution.

Paul Braunschweiger Ph.D.  
Professor, University of Miami  
Director Office of Research Education  
CITI Program Course Coordinator

## Appendix 12: CITI Certificate (2)

**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI)**  
**BIOMEDICAL RESPONSIBLE CONDUCT OF RESEARCH CURRICULUM COMPLETION REPORT**  
Printed on 11/27/2013

**LEARNER** alice mutura (ID: 3277094)  
**DEPARTMENT** CRRD (center for biotechnology, research and development)  
**EMAIL** kemri@org.com  
**INSTITUTION** Kenya Medical Research Institute  
**EXPIRATION DATE**

**BIOMEDICAL RESPONSIBLE CONDUCT OF RESEARCH** This course is for investigators, staff and students with an interest or focus in Biomedical Research. This course contains text, embedded case studies AND quizzes.

**COURSE/STAGE:** 1RCR/1  
**PASSED ON:** 02/03/2013  
**REFERENCE ID:** 9553004

<b>ELECTIVE MODULES</b>	<b>DATE COMPLETED</b>	<b>SCORE</b>
Introduction to the Responsible Conduct of Research	01/13/13	No Quiz
Research Misconduct (RCR-Biomed)	01/22/13	5/5 (100%)
Data Management (RCR-Biomed)	01/22/13	4/5 (80%)
Authorship (RCR-Biomed)	01/26/13	4/5 (80%)
Peer Review (RCR-Biomed)	01/26/13	8/8 (100%)
Mentoring (RCR-Interdisciplinary)	01/26/13	5/5 (100%)
Using Animal Subjects in Research (RCR-Interdisciplinary)	01/30/13	8/8 (100%)
Conflicts of Interest (RCR-Biomed)	02/03/13	5/5 (83%)
Collaborative Research (RCR-Biomed)	02/03/13	5/5 (100%)
Research Involving Human Subjects (RCR-Interdisciplinary)	02/03/13	5/5 (100%)
The CITI RCR Course Completion Page	02/03/13	No Quiz

**For this Completion Report to be valid, the learner listed above must be affiliated with a CITI Program participating institution or be a paid Independent Learner. Falsified information and unauthorized use of the CITI Program course site is unethical, and may be considered research misconduct by your institution.**

Paul Braunschweiger Ph.D.  
Professor, University of Miami  
Director, Office of Research Education  
CITI Program Course Coordinator

Appendix 13: EAMJ July issue

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