RISK FACTORS ASSOCIATED WITH JIGGER INFESTATION IN KITANY LOCATION, KEIYO MARAKWET COUNTY, KENYA.

BY

JUDITH J. CHELIMO

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DECLARATION

Declaration by the candidate

I, Chelimo Judith Jepkosgei, declare that this is my original work and has not been submitted for examination at any other University

Name: Chelimo Judith Jepkosgei

Signature_____ Date: _____

Registration Number: SPH/PGH/27/10

Declaration by the supervisors

This thesis has been submitted for examination with our approval as University supervisors

Dr Diana Menya, (Ph.D)
Department of Epidemiology, School of Public Health,
Moi University
Signature_____ Date: _____

Dr. Christina A. Otieno, (Ph.D)
Department of Environmental Health, School of Public Health,
Moi University
Signature_____ Date: _____

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DEDICATION

I dedicate this work to my dear husband Allan and our daughter Coyote.

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ABSTRACT

Background: The jigger menace in Kenya has of late gained Public Health importance in rural and urban-slum settings and 10 million people are vulnerable. The regions affected include Central, Western, Coast, Rift Valley, and Nyanza. In 2011/12 Keiyo Marakwet County reported 2,222 households with jiggers and 4,612 cases of jigger infestation among the villagers. Virulence; known as tungiasis, results from infestation by the fertilized female flea, which embeds into the epidermis usually of the feet, feeds on lymph and swells as the eggs grow. The mature eggs are extruded onto the ground, where the larvae feed, pupate and metamorphose into the adult flea. Knowledge on risk factors, personal hygiene and environmental sanitation has the potential for reducing jigger infestation in Kitany location.

General objective: To determine the prevalence and risk factors associated with tungiasis in Kitany Location, Keiyo Marakwet County, Kenya.

Specific objectives: To determine the prevalence of tungiasis among different age groups in Kitany Location and factors associated with tungiasis: knowledge, attitudes and practices towards jigger infestation.

Methods: This cross-sectional study involved 300 randomly selected households and 1,439 individuals. A semi-structured interviewer administered questionnaire and an interview schedule was used to collect data on socio-demographic factors, housing, ownership and presence of domestic animals, knowledge, attitude and practice. Analysis was carried out using Chi square, the Mann-Whitney U-test and multiple logistic regression model to determine the factors significantly associated with the prevalence of tungiasis. SPSS V.16.0 was used to analyze data. All results were considered significant at 95% confidence level.

Results: The median age of the respondents was 18 years (interquartile range 10-36 years). Most of the respondents were female (750/52.12%) and majority (887/61.64%) had primary level of education. A total of 260 individuals (18%) were infested with *Tunga penetrans*. There was little difference in prevalence between children 5 to 9 years (16.0%) and adults (15%). Infestation was highest in the elderly (40.1%). Itching (85.7%) and pain (85.7%) were the most common associated symptoms, followed by walking difficulties (76.7%), and ulceration (72.3%). Surgical extraction of embedded sand fleas using unsterile sewing needles (67%) and thorns (65%) was the most commonly used treatments. A variety of topical products such as insecticides (31.7%), washing detergent (31.3%) and potassium permanganate (28.7%) were used. Family members were mostly responsible for treatment of jigger (80.7%). Multiple logistic regression analysis showed that tungiasis was associated with age ($p<0.001$), level of education ($p<0.005$), status of the compound ($p<0.018$), type of housing (0.009), state of walls ($p<0.001$), state of beddings ($p<0.008$), and lighting ($p<0.018$) in the household.

Conclusions and Recommendations: The presence of tungiasis in the Kitany community was associated with a set of modifiable variables. Effective and sustainable intervention measures addressing these factors need to be implemented in the study area, to reduce the burden of this neglected tropical disease. An integrated approach combining the control of, housing and environmental factors, and health education is needed.

LIST OF ABBREVIATIONS

DPHO District Public Health Office

GOK Government of Kenya

HMIS Health Management Information Systems

KAP Knowledge, Practice and Attitude

KDDP Keiyo District Development Plan

KNBS Kenya National Bureau of Statistics

MOMS Ministry of Medical Services

NGO Non Governmental Organization

NTD Neglected Tropical Diseases

PHO Public Health Office

PPHO Provincial Public Health Officer

SPH School of Public Health

SPSS Statistical Package for Social Sciences

W.H.O World Health Organization

OPERATIONAL DEFINITIONS

Endemic- The constant occurrence of a disease or infectious agent in a given geographical area or population group.

Fissure - A break in the skin that usually produces a crack-like sore or ulcer.

Fortaleza classification – The diagnosis of tungiasis by clinical inspection of the lesions, based on the presence of a dark and itching epidermal spot with a diameter of 1–2 mm (early stage), the presence of a yellow-white watch glass–like patch with a diameter of 3–10 mm with a central dark spot (mature stage), a brown-black crust with or without surrounding necrosis, a circular residue punched out in the keratin layer, and a characteristic crater-like sore in the skin and suppurative lesion.

Gangrene - Death and decay of body tissue, often occurring in a limb, caused by insufficient blood supply and usually following injury or disease.

Prevalence - The proportion of individuals affected by a disease or condition within a particular time or period.

Pruritis – severe itching

Reportable/Notifiable diseases - Diseases of public health importance which when they occur and are diagnosed should be reported to the relevant health authorities so that necessary preventive action may be taken.

Reservoir - The habitat in which an infectious agent normally lives, grows, and multiplies. Humans, animals and the environment may serve as reservoirs.

Risk - Probability that an outcome will occur following a particular exposure.

Risk Factor – A factor that predisposes an individual to disease

Suppuration - Formation of pus.

Tungiasis – A parasitic skin disease caused by infestation with *Tunga penetrans.*

Vector – An organism or vehicle that transmits the causative agent from the reservoir to a susceptible host.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Tungiasis is a parasitic skin disease caused by infestation with the sand flea (*Tunga penetrans*) in the epidermis of the host. The parasite embeds itself under the soft skin, usually of the feet or in other areas including elbows, neck, buttocks and the genital region (Veraldi and Schianchi. 1999). Tungiasis has been reported to affect domestic animals and wild game seasonally; natural hosts of the parasite include dogs, cats and pigs, with man as an accidental host (Ibanez- Bernal and Velasco-Castrejon, 1996).

In 1525, Gonzalez Fernandez de Oviedo y Valdes is thought was the first to document the flea in South America. It is believed the jigger flea eventually left the confines of the Americas amongst the sand ballast of the Thomas Mitchell, a ship travelling from Brazil to Angola in 1872 (Gordon, 1941). From here, the flea infiltrated Western Africa and then into the heart of the continent leading to its widespread presence in Sub-Saharan Africa (Joseph *et al*., 2006).

Currently *T. penetrans* is endemic in Latin America, the Caribbean and sub-Sahara Africa; only sporadic occurrence has been reported in America, Asia, Oceania and Europe, mainly in citizens returning from tropical areas after tourism and military expeditions (Goldman 1976, Difonzo *et al.,* 1990, Lowry et al., 1996, Veraldi *et al*., 2000). In Brazil, tungiasis has a high prevalence of between 16-54% (Heukelbach *et al*., 2005). The prevalence of tungiasis is poorly known or neglected because it is not a reportable disease (McKinney & McDonald, 2001).The problem has also been reported in Africa countries. In Nigeria, a prevalence of 42.5% was observed to be

highest in children 5 to 9 years of age, 10 to 15-years old adolescents and the elderly (Ugbomoiko *et al.,* 2007). In East Africa, Tanzania has reported this ectoparasitic disease. A study that focused on a 19 year-old male who had epilepsy and mental disability and who lived in poverty, had infestation of approximately 800 jigger fleas on his feet. The Kigoma region of western Tanzania is resource-poor and lacks essential services such as electricity, water and health services combined with the risk factor of the community keeping domesticated animals in close proximity (Mazigo *et al*., 2010).

Hundreds of rural communities in Kenya are similarly infested with jigger flea (Wachira, 2012). According to Ahadi Kenya Trust (2009), an organization that works in Kenya to eradicate the jigger flea, jigger flea is estimated to infect over 2.6 million Kenyans. Among this population are children who are unable to walk to school, write properly or even participate in learning activities to the same level as their un-infected peers. Their inabilities become a source of ridicule and scorn among their peers, both in and out of school (Ahadi Trust, 2003). In Murang'a district, which is about two hours drive from Nairobi, the extent of infection is termed by a Kenyan reporter as "shocking and of unbelievable magnitude"(Wangui, 2008). Given the challenges that people suffering from Tungiasis are faced with, including the inability to walk and fear of social stigma, they are unable to participate in democratic processes of the country (Ahadi Trust, 2003). According to Njau *et al.,* (2012), prevalence of tungiasis was 57% among children 5–12 years of age in rural Central Kenya. In Kitany Location of Keiyo Marakwet County, tungiasis is associated with severe morbidity an issue that needs to be addressed.

This study sought to determine the risk factors, knowledge, attitudes and practices associated with jigger infestation in Kitany.

1.2 Problem statement

As of 2009, tungiasis is present worldwide in 88 countries with varying degrees of incidence (Kaimbo, 2010). The zoonosis occurs in Latin America, the Caribbean and Sub-Saharan Africa where the prevalence ranges from 15%-40% in the general population. The current epidemiological situation on the African continent is not well known and is mainly based on anedoctal observations (Rosmaninho *et al.*, 2010), Tungiasis has of late been gaining public health importance in Kenya's rural setups and there is no plausible explanation. According to public health officer in charge of surveillance in Rift valley province Mr. Mwangi, the condition is widespread in many parts of Kenya including Coast, Central, Western, Nyanza and parts of Rift Valley province (PPHO Rift Valley, personal information). According to Ahadi Kenya Trust (2009), an organization that works in Kenya to eradicate the jigger flea, estimates that the jigger flea may infect over 2.6 million Kenyans. Among this population are children who are unable to walk to school, write properly or even participate in learning activities to the same level as their un-infected peers. Although by its nature a self limiting infestation, tungiasis is a debilitating disease associated with significant morbidity (Heukelbach, 2005), manifesting itself in a number of symptoms such as severe local inflammation, auto-amputation of digits, deformation and loss of nails, formation of fissures and ulcers, gangrene and walking difficulties. Secondary infection also poses considerable risks and many lacking immunization are vulnerable to tetanus (*Clostridium tetani*), which is often

fatal while complaints of insomnia are also common due to the intolerable itchiness of the infestation (Muehlen *et al.*, 2006).

The families affected by tungiasis in Kitany location of Keiyo Marakwet County live in dirty environment and houses with poor hygiene status, a conducive habitat for the jigger. Most families in the Kitany location live in poverty and rely on farming for their livelihood. Due to their low social-economic status, pins and other unsterilized equipment could be shared for jigger removal, leading to the risk of secondary infection. In 2011/12 the Keiyo North and Keiyo South sub-Counties DPHO, recorded 2,222 households with jigger and 4,612 cases of jigger infestation among villagers and school going children that resulted in isolation and stigmatization of the affected people in the county. The affected people accept jigger infestation as part of their livelihood and do not consider seeking medical attention for treatment (PHOs Keiyo North and Keiyo South sub-ounty).

1.3 Justification

Many people affected in Kitany do not consider Tungiasis a major health threat despite the effects which has resulted to lowered food production therefore food insecurity, deformity of limbs hence infected people are immobile and unproductive. Furthermore absenteeism is common with school going children who eventually drop out of school, due to difficulty in walking, low self-esteem and more often they are stigmatized due to the crippled feet and fingers (Ahadi Kenya Trust, 2003). A variety of Topical remedies has been used in the study area in an attempt to control jigger infestation with little success and none of the topical applicants is effective. To ensure non recurrence of jiggers the topical remedies combined with knowledge on risk factors has a potential of reducing jigger infestation drastically in the

location. Therefore, this study identified the risk factors associated with tungiasis in Kitany location; findings which will enable stakeholders address to facilitate development of appropriate strategies for prevention at the community setting and promote control to the exposed.

1.4 Objectives.

1.4.1 General objective.

To determine the prevalence and risk factors associated with tungiasis in Kitany Location.

1.4.2 Specific objectives were to:-

1. Determine the prevalence of human tungiasis among different age groups.
2. Determine the association between tungiasis, the type of housing and environment.
3. Analyze the role of domestic animals in the transmission of tungiasis.
4. Determine the knowledge, attitudes and practices (KAP) of the people of Kitany location with regard to jigger infestation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Tungiasis disease.

Tungiasis is a common, but neglected, public health problem in economically depressed communities in South American, Caribbean and sub-Saharan African countries (Heukelbach *et al.,* 2001). This ectoparasitosis is caused by *Tunga penetrans,* the sand flea, also called the jigger flea. The female jigger flea penetrates into the skin of its host, undergoes a peculiar hypertrophy and reaches the size of a pea. Embedded head first with its hindquarters at the surface of the skin, the flea is evident as a distinct, characteristic lesion on the skin; a globular white mass with a black dot at its Centre (Joseph *et al.*, 2006). The excretory pore which opens outwards through the skin allows the flea to respire, excrete and discharge newly produced eggs (Gordon, 1941, Eisele *et al.,* 2003). Tungiasis is a zoonosis, that affects a broad range of domestic and peridomestic animals, such as dogs, cats, pigs, and rats, other animals have been found infested such as cattle, sheep, goats, horses, chicken, rats, mice, elephants, monkeys and other wild mammalians (Ibanez- Bernal & Velasco-Castrejon, 1996 and Nagy *et al.,* 2007). Where humans live in close contact with these animals and where environmental factors and human behavior favor exposure, the risk of infection is high although man is an accidental host (Heukelbach *et al.,* 2002).

2.2Transmission

Transmission of tungiasis is strictly by infestation of *Tunga penetrans* and humans become infested when walking in sandy soil in which female fleas are present. Infestation tends to involve the ankles and feet, particularly between the toes, it can

also occur anywhere in the body, including the head if the individual lies on the infested ground. In small children, lesions can occur at ectopic sites as far as the hands, elbows, neck, anus and the genitals (Veraldi *et al.*, 1996). Patients with reduced sensation in their feet may have more severe infestations (Beverley, 2001).

2.3 Hosts and Vectors

Tungiasis has a high number of hosts including pigs, dogs, cats, rats, sheep, cattle, donkeys, monkeys, elephants, and other mammals; however human is an accidental host. (Nagy *et al.*, 2007), since the gravid female will expel at least 100 to at most 200 eggs; hosts are the vectors themselves because they can easily spread the eggs to other mammals.

2.4 Life cycle of *Tunga penetrans.*

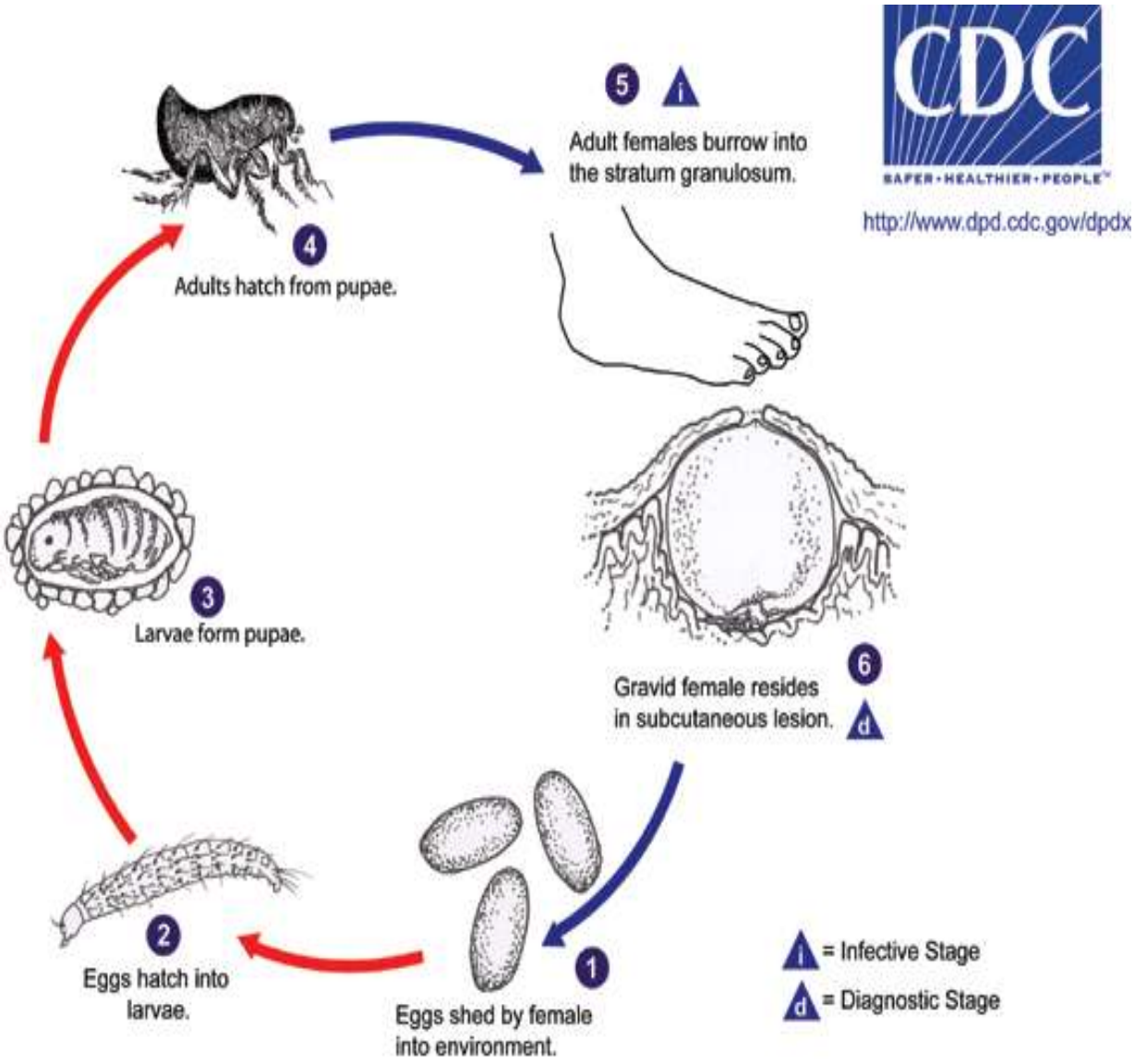

Fig 2.1: Life cycle of *Tunga penetrans.*

Source: Center of Disease Control and Prevention, (2009)

The life cycle of *Tunga penetrans,* the jigger flea, begins when the eggs are shed by the gravid female into the environment, hatch into larvae in about 3-4 days and feed on organic debris in the environment. The larva molts twice and becomes a pupa with the adult hatching in 3-4 weeks. The pupae are in cocoons that are often covered with debris from the environment including sand, and pebbles. The larval and pupal stages take about 3-4 weeks to complete the life cycle. Adults seek out a warm-blooded host for blood meals. Both males and females feed intermittently on their host, but only mated females burrow into the skin of the host, where they cause a nodular swelling. Females do not have any specialized burrowing organs, and simply claw into the epidermis after attaching with their mouthparts. After penetrating the *stratum corneum*, the flea burrows into the *stratum granulosum*, with only their posterior ends exposed to the environment. The female fleas continue to feed and their abdomens extend up to about 1 cm. Females shed about 100 eggs over a two-week period, after which they die and are sloughed by the host's skin, (CDC, 2009).

In a seminar paper on the biology and pathology of *Tunga penetrans*, Eisele *et al*, (2003) described the five stages of tungiasis, based on the Fortaleza classification.
Stage I starts with penetration of the adult flea into the epidermis, leading to a rigorous inflammation and dilation of blood vessels in the dermis. This causes an early lesion, a dark and itching epidermal spot measuring1-2mm in diameter with or without local pain.

In stage II the parasite measuring 3-10mm thrusts its head into the superficial layers of the dermis, feeding on blood vessels. The posterior end is oriented towards the

surface, maintaining communication with the outside through *stratum corneum*. This provides air for breathing and passage for both excretion and eggs.

Stage III (mature flea) a brownish black circular crust with or without necrosis of the surrounding epidermis, the parasite produces till up to 200 white ovoid eggs, causing her body to swell up to 7mm. The insect can now be seen as a yellow-whitish halo-formed lesion under a hard hyperkeratotic skin.

Stage IV (dead parasite) a circular residue punched out in the keratin layer of the foot sole or irregular thickening of the rim of the nail. The female flea dies and is expelled.

Stage V lesions are altered through manipulation of the patient such as partially or totally removed fleas, leaving a characteristic crater like sores in the skin and suppurative lesions caused mainly by use of non-sterile instruments such as needles and thorns. During phase V, reorganization of the epidermis takes four weeks, leaving minor residues that will stay for months. Meanwhile, the eggs that where left during phase III, hatch in three to four days liberating larvae that develops into pupae. After two weeks, the pupae become adults and flea, completing the cycle.

2.5 Epidemiology

Human being both biological vectors and definitive hosts, have contributed to the spread of jiggers from its isolated existence in the West Indies to all of Latin America and most of Africa via sea travel (Nagy *et al.,* 2007). Within 20 years, from 1873, the flea spread from Angola to the West Coast of Africa and throughout the sub-saharan region eventually to East Africa and Madagascar. In 1899, Indian soldiers brought the flea to Bombay, India, Karachi and Pakistan. Today, the jigger

flea is endemic to Latin America, the Caribbean, sub-Saharan Africa, India and Pakistan. In endemic areas, prevalence is 15% on the lower side and 40% on the higher side . In 1981, the prevalence of jigger infestation among children in rural Lagos State, Nigeria, was 40%, with a similar prevalence noted for villages in Southern Nigeria and Trinidad (Beverly, 2001).

The longitudinal study conducted in Brazil from March 2001 to January 2002 revealed that, the incidence of tungiasis in an endemic community varies significantly seasonally with the occurrence of tungiasis varying throughout the year and which seemed to follow local precipitation patterns, suggesting that the correlation was due to high humidity in soil interfering with larval development during the rainy season and also that rain washed away all stages of *T. Penetrans* due to its small size of 1mm. From the study prevalence was highest at the peak of the dry season and lowest at the end of the rainy season due to high humidity in the soil which impairs the development of free-living stages of *T. penetrans*. (Heukelbach *et al.,* 2005).

Jigger infestation is mainly found in Africa, especially in Nigeria, the Caribbean, mostly in Trinidad, Central and South America and India, (Gibbs, 2009).
The jigger flea lives 2-5cm below sand , since temperature is generally too hot for the larvae to develop on the surface of the sand and the deeper sand does not have enough oxygen, (Heukelbach *et al.,* 2005).

The jigger flea has no reservoir and the female can cause infestation in any mammalian organism whose skin it can penetrate usually softer parts between toes and fingers, this means the flea can have relatively large number of hosts and

victims. This is important epidemiologically because tungiasis aften causes secondary infections (Gibbs, 2009).

2.6 Prevalence of tungiasis among different age groups and gender.

Tunga penetrans has many common synonyms, which provides a good indication of its internationally widespread prevalence (Sachse, 2007). A study in North-east Brazil Heukelbach *et al*., (2005) indicated a large seasonal variation in prevalence of *Tunga penetrans* with the prevalence rates at 16.8% in January at the beginning of the rainy season, 33.6% in March during the rainy season, 23.8% in June at the end of the rainy season and 54.4% in September at the peak of the dry season. Prevalence was observed to be greatest at the peak of the dry season and lowest after the first rains of the rainy season and was reported to be more common in males than in females.

Epidemiological data for tungiasis in Africa is scarce. A study in Cameroon Muehlen *et al.*, (2006) recorded a prevalence of 49% in the dry season with a high of 60% in children, and least (43%) in the elderly. The many aspects of the culture, traditions and way of life in the region place children more at risk; children are often left to play in the dry, sandy courtyards, where villagers walk through and spread the eggs of the flea. In addition, children work on farms from a young age, the youngest farmer in this study was 9 years old. Young adults become more proficient at detecting and eliminating a gravid female flea as they gain experience, until they are hindered by the eyesight and reduced flexibility associated with old age. Furthermore illiterate people were 9% more likely to suffer than the literate, and men were shown to have a higher parasitic load (59%) than females (47%). The

explanation was that the data difference was related to exposure and environmental factors, rather than difference in susceptibility.

In Nigeria, the younger and older age groups were described as most vulnerable to tungiasis infestation (Ugbomoiko *et al.*, 2007). . Prevalence was highest between the ages of 5-9 years, decreased in adults, and increased again in the elderly and the explanation given was that children in the community played around mostly barefooted, and the elderly had more difficulties in removing embedded fleas than young people (Ugbomoiko *et al*. 2007). Gender difference seemed to differ from community to community. In Nigeria no gender difference was observed however, it was speculated that gender differences were similar to age related to different exposure and disease-related behavior. A study in rural central Kenya on KAP reported 57% prevalence of tungiasis among children 5–12 years of age (Njau *et al.*, 2012).

2.7 Association between tungiasis and housing.

In a study done in a poor fishing community in Brazil (Muehlen *et al*., 2006), the importance of housing in the transmission dynamics was described. It was observed that living in a palm product house built on dunes and having a sand or clay floor inside the house were important risk factors for infestation. In Nigeria it was observed that the type of house was not an independent factor predisposing for infestation, but confounded by the type of floor inside the house, type of construction of the house, sanitary conditions, presence of electricity and waste disposal (Ugbomoiko *et al*, 2007).

2.8 Role of domestic animals in the spread of tungiasis.

It is known that the animal reservoirs play an important role in the transmission of tungiasis (Heukelbach *et al,* 2004), with cats, dogs, and rats described as being commonly infested (Carvalho *et al.,* 2003, Trentini et *al.*, 2000); although pigs and goats are important reservoirs (Cooper, 1967, 1976). The clinical picture and natural history in the animal hosts does not differ considerably from human tungiasis.

In Brazil it was observed that severe disease in dogs with a prevalence of 67.0% presented the potential infestation source to humans with the disease burden on pigs and cats decreasing to 0.9% and individually the prevalence in pigs was at16.6%, which was more than in cats at 7.7% (Heukelbach *et al.,* 2004). In Nigeria however, the presence of pigs on the family compound was an important predictor for human tungiasis (Ugbomoiko *et al.*, 2007). The presence of a variety of domestic and sylvatic animals possibly serving as reservoirs, pose a problem to the control of tungiasis (Heukelbach *et al.*, 2002). Additionally, eggs, larvae and pupae of *Tunga penetrans* may persist in the environment for days (Heukelbach *et al.*, 2002).

2.9 Knowledge, attitude, and practice towards jigger infestation.

A major prerequisite for obtaining community support for control measures is to understand the knowledge, attitude and practices of the affected individuals. A cross sectional study done on knowledge and practices in two resource-poor communities where this parasitic skin disease is highly prevalent in northeast Brazil, showed knowledge on tungiasis was high, but that individuals did not follow appropriate treatment as directed. More than 90% of all families had experienced tungiasis at least once and almost all respondents were sure that the disease was caused by a penetrating flea (Winter *et al.*, 2009).

In addition, it was observed that the environmental determinants of tungiasis including, sandy soil, domestic animals, and garbage littering were well known by the respondents from the fishing village and from the urban slum with most participants associating the occurrence of *Tunga penetrans* with sandy soil and a few of the respondents mentioning walking barefoot as a reason for affection by tungiasis. In rural Kenya, more than half of the respondents (70.1%) reported that tungiasis was caused by dirty environment and almost all the respondents (94.8%) reported frequent itching as early jigger sign and symptom of tungiasis. The reasons for jigger persistence at this time and era were also sought where 79.3% reported poor hygiene and sanitation, 43.5% (Kimani *et al*., 2012).

The embedded sand fleas must be extracted surgically to avoid severe inflammation. However, in practice, this knowledge is not consistently applied since appropriate medical instruments such as scalpels or sterile hypodermic needles are almost never at hand and attempts to extract embedded fleas with sewing needles, nails or thorns may lead to secondary bacterial infection (Feldmeier *et al.,* 2003).

In Brazil the following disinfectants in descending order of frequency were used to extract jiggers: mercurochrome, ethanol, organic iodine, hydrogen peroxide, ether and potassium permanganate. Oily preparations and ointments were applied on the embedded sand fleas by 35% of the families in the fishing village and by 34% in the slum. Other therapies used were the application of olive oil, candle wax, coconut oil, cooking oil, and various antibiotic and antimycotic ointments, singly or in combination with detergents such as washing powder (Winter *et al.,* 2009).

A study in Nigeria showed that skillful older children carry out flea extraction for their friends and younger children at school and that such assistance is rarely rendered to less skillful, poor sighted elder people (Ugbomoiko *et al.,* 2007).

2.10 Prevention Strategies.

Eradication of the jigger flea remains a challenge due to the high number of hosts with prevention strategies including elimination by practicing good hygiene in the households, regular watering of sand floor whic lowers the rates of infestations significantly, (Feldmeier *et al.*, 2006).

Vaccination against jigger fleas has not been successful because they are ectoparasitic in nature. However, due to increased cases of secondary infection, those at risk of infestation should be vaccinated against tetanus (Feldmeier *et al.*, 2006).

Zanzarin, a derivative of coconut oil the major component, jojoba oil and aloe vera is a strong repellant and has been effectively used in the management of jigger flea. In a recent study involving two cohorts, the infestation rates dropped by 92% on average for the first one and by 90% for the other. Similarly, the intensity of infestations dropped by 86% and 87% in the two cohorts respectively (Feldmeier *et al.*, 2006).

The use of pesticide like DDT which is highly persistent and lipid soluble (Niki, 2009), has also led to elimination of the jigger flea, but this prevention srategy should be utilized carefully because harmless insects like bees, fish, birds and other animals were being killed or harmed as a result of exposure to DDT. Mothers exposed to DDT while pregnant put their children at a higher risk for obesity also

female children of mothers exposed to DDT had higher rates of diabetes and animal studies have suggested possible cancer risk though at very high dose. Resistance to DDT and other insecticides were reported in other species but not in *T. penetrans*. As a result of DDT use the incidences of jigger infestation in Mexico is very low when compared to the rest of Latin America, especially Brazil, where rates in poor areas have been known to be as high or higher than 50% (Ibanez – Bernal *et al.*, 1996).

Treatment of domestic animals with anti-flea compounds can be done and it helps in lowering the number of reservoirs and consequently reducing the total population of *T. penetrans.* Impregnating clothes with anti- flea compounds can be a cost effective option in areas where long garments are worn (Jorg *et al.*, 2001).

Avoidance of contaminated areas, personal cleanliness, and disinfecion of clothing, bedclothes and furniture can also be important. Floors or ground sprayed with 1% Malathion insecticide is also effective in reducing the incidence of tungiasis in infested traditional fishing villages of River State of Nigeria (Beverly, 2001).

2.11 Diagnosis

There are no diagnostic tests for tungiasis most likely because it is ectoparasitic with visible symptoms. Localization of the lesion and identification of the parasite through removal may be a useful diagnostic method for the clinician (Heukelbach *et al.*, 2001).The diagnosis of tungiasis is made even by untrained persons who can diagnose the ectoparasitosis taking into account the typical topographic localization of lesions and the natural history of the disease. The patient typically complains about local itching, pain and the sensation of a foreign body. Expelled eggs are

attached to the skin and the release of brownish threads of feaces is a pathognomonic sign of tungiasis. According to Franck *et al.*, (2003), histological sections are often done to confirm the diagnosis in European and North American travellers after their return from the endemic area, the sections demonstrating the presence of the parasite, eggs or chitinous fragments.

CHAPTER THREE

METHODOLOGY

3.1 Study design.

This was a cross sectional study design**.**

3.2 Study area

The study was carried out in Kitany Location a rural community situated in Keiyo Marakwet County, Rift valley Province, Kenya, (GoK, 2010). Kitany is located 35km North-East of Eldoret town, off the Eldoret-Eldama Ravine road. The study area lies between N 00° 20’ and N 01° 20’ latitude and E 035° 11’ and E 035° 50’ longitude and covers an area of 71.5 square kilometers. Kitany area is generally a highland and on an elevation of between 2000m and 8000m above sea level. The area has two rainy seasons: long rains (March to July) and short rains (September to December). It has an average mean temperature of 17° Celsius, with a maximum of 25° Celcius and a minimum of 10° Celcius. Kitany location has a population of 7,277 people and 1,377 households. There are two sub-locations namely Kitany with a population of 4, 094 people and 753 households and Chebiyor with a population of 3,183 people and 624 households. The area has sandy loam soil and agriculture is the main economic activity with tea as the main cash crop while maize is also grown for subsistence, alongside, sorghum, millet, potatoes and a wide variety of vegetable crops and small scale dairy farming is widely practiced. The living standards are generally low and social amenities like pipe-borne water, public sewage, and electricity are not available to the majority of the residents. The location is accessible by one dry weather road. The area has two health facilities, one at the district, and the other at the sub-district. Majority of the people walk barefoot due to

lack of money to buy footwear. Domestic animals including goats, sheep, chicken, dogs, and cats roam around freely and at night they sleep in their respective shades.

3.3 Study population.

The study targeted 1,377 households in Kitany location, from which the study sample was drawn.

3.4 Sample size determination.

The sample size was determined in accordance with the Fishers formula (Mugenda, 1999) follows.

$N=Z^2 (PQ)/D^2$

Where;

N: is the desired sample size if the target population is more than 10,000.

Z: is the standard normal deviation at the required confidence level (Z-Score for a 95% Confidence interval the respective confidence intervals in a normal distribution table)

P: proportion of characteristic of interest (households) with at least an individual infected with jiggers. (Since there is no previous study that has documented this in Kitany Location a proportion of 50% was to be assumed).

Q: is the compliment of P (P-1)

Therefore

$N= (1.96)^2*0.5(0.5)/ (0.05)^2$

N=384 households

But the number of households in Kitany Location is known to be 1,377 as per the census report of March, 2009, therefore less than 10,000; hence the number of households to be studied was:-

nf = (N*n)/ (N+ n)

Where:

nf: desired sample size when the population is less than 10,000

N: is the sample size when the population is more than 10,000

n: is the estimate population size.

Therefore

nf = (384*1377)/(384+1377)

nf = 300 households.

Three hundred households participated in the study involving all the household occupants who totaled1439. According to KNBS, 2009, the household size on average on the study area is approximately 5 and this constituted 1500 study individuals.

3.5 Sampling procedure

Stratified random sampling proportionate to sub-location size techniques was used in the study. The households to be selected from each sub-location were determined using the formula:

(Households in a sub-location/ Total households in the location)* sample size

The households selected from Kitany sub-location were:

753/ 1377 * 300 = 164 households

The households selected from Chebiyor sub-location were:

624 /1377* 300 = 136 households

From each village in the two sub-locations, the household that participated in the study were selected proportionately using the formula:

Households in a village/ Total households in the sub location) * sub location sample size

Table 3.1: Households that participated in the study (Kitany sub-loaction)

Kitany sub-location		
Village	**No. of households**	**Sample size**
Kitany	104	23
Kapalbarakwa	96	21
Lelin	54	12
Orapno	46	10
Kimamoi	37	8
Kabore	43	9
Kapserton	46	10
Terkekia	74	16
Chepteran	45	10
Kiebor	70	15
Cheserek	65	14
Mutwa	73	16
Total	**753**	**164**

Table 3.2: Households that participated in the Study (Chebior sub-location)

Chebior sub-location		
Village	**No. of households**	**Sample size**
Kapkomol	60	13
Matungen	38	8
Chebior	68	15
Torok	58	12
Sertet	63	14
Kipkalwa	28	6
Tarakwa/ Keiyo	20	4
Kamoi	44	10
Ngenyilel	60	13
Kokoo	38	8
Chebarusio	62	14
Toot	62	14
Sabor	23	5
Total	**624**	**136**

The households that participated in the study in each of the village were randomly picked by use of computer program (Excel) based on the unique numbers assigned by the researcher. The randomly picked households were visited and every member was examined for the presence of embedded fleas.

3.6 Inclusion criteria

All members of the household, who had lived in the location for 3 months and willing to participate, were included irrespective of whether they were affected or

infested with various stages of jiggers according to the Fortaleza classification. Children were included and examined with the informed consent of parents who also answered the questions.

3.7 Pretesting.

A pre-test was conducted by the investigator to determine the feasibility, validity and reliability of the research instruments in the neighboring Kipsaos community which had similar characteristics to the community where the study was done. The sample size for the pre-test was 30 households (10%) of the study sample size (Mugenda, 1999).

3.8 Data collection tools and procedures

Interviewer administered questionnaires were used to collect data on socio-demographic factors, housing, ownership and presence of domestic animals, knowledge, attitude and practice. In addition observation was also used to collect data on the hygiene of the household and the environment.

Three retired nurses were trained by the researcher prior to data collection on the skills of the administration of questionnaires and various stages of clinical examination of jiggers considered diagnostic for tungiasis based on Fortaleza classification.

The actual study was carried out for four weeks in the month of July at the end of wet season because the seasonal variation of jigger infestation was learned during thesis writing, hence the components of the dry season where not included in the study. In addition the approval to carry out research was obtained from IREC in the month of July at the end of the rainy season and that is when the study commences.

Examination was performed by the researcher and the research assistants who carefully inspected the legs, feet, hands and arms of the respondents. This approach is considered acceptable, as in endemic communities more than 99% of tungiasis lesions occur on these areas (Heukelbach, *et al*., 2002). At the examination the findings were considered diagnostic for tungiasis, based on the Fortaleza Classification. To reduce observation bias and clinical examination, interviews were done by different persons.

3.9 Variables

The variables that sought to meet the objective of this study included:

Independent variables were:-

- Socio-demographic characteristics (age, gender, education, income and employment).
- Housing (house type, state of repair, wall, floor, furniture, ventilation, lighting, partitioning, and animals sleeping in the house), and Environmental factors.
- Ownership and presence of domestic animals.
- Knowledge, attitude and practice (etiology, transmission, prevention, and treatment of jigger infestation).

Dependent Variable was:-

- Presence of tungiasis.

3.10 Data Management and Analysis.

Data was coded, entered and analyzed using SPSS version 16.0. Questions on qualitative data were transcribed and analyzed by categorizing and coding. The

codes were entered into SPSS for analysis. Descriptive statistics namely percentages, frequency tables, was used. Association between prevalence and related categorical variables (age, gender, education, occupation, and household headship) were analyzed using the Pearson's Chi square. The Mann-Whitney U-test was used in case of continuous variables because the data was skewed. Multiple logistic regression model was used to determine the factors significantly associated with the prevalence of tungiasis controlling for confounding factors. The results were considered significant at 95% confidence levels.

3.11 Ethical considerations.

Approval to carry out the research was obtained from Institutional Research and Ethics Committee (Approval Number: 000846), Moi University through the review of the proposal since human subjects were involved in the study. Permission was sought from the District officer and the Chief of Kitany Location before the commencement of the study. To ensure confidentiality, patient informed consent was sought and information gathered was treated confidentially. People who examined the patients used disposable gloves before coming in contact with the lesions; this protected them from contamination. Patients were treated by the Public Health Officer in charge of the sub-district hospital and complicated cases were referred to the nearby health Centre. No monetary benefits were involved in the study.

CHAPTER FOUR

RESULTS

4.1 Demographic characteristics of study participants.

4.1.1 Gender, Level of Education, Employment

Table 4.1: Demographic characteristics of study participants

Demographic Characteristics	Frequency (%)
Gender	
Male	689(47.9)
Female	750(52.1)
Education level	
None	188(13.1)
Primary	887(61.6)
Secondary	305(21.2)
Post secondary	47(3.3)
University	12(0.8)
Employment status	
Yes	301(39.1)
No	469(60.9)

Three hundred households participated in the study involving all the household occupants who totaled1439 of these 750 (52.1%) were female and 689 (47.9%) males. The median age of the interviewees was 18 years (interquartile range 10-36 years). The youngest participant was 1 month old while the eldest was 99 years. More than half of the respondents 887 (61.6%) had a primary level of education. Among the 770 adults (18 years and above), 301 (39.1%) were employed while 469 (60.9%) were not employed as seen in table 4.1.

4.1.2 Occupation of the household

Majority of the household heads 230 (76.7%) were farmers and the median (IQR) monthly income in Kenyan Kshs. was 3,000(2000, 6000).

4.1.3 Prevalence.

Among the respondents, 260(18%) were infested with jiggers. Of these individuals, majority 231(88.9%) were infested in the legs while only 1(0.4%) was infested on the head as shown in the figure below.

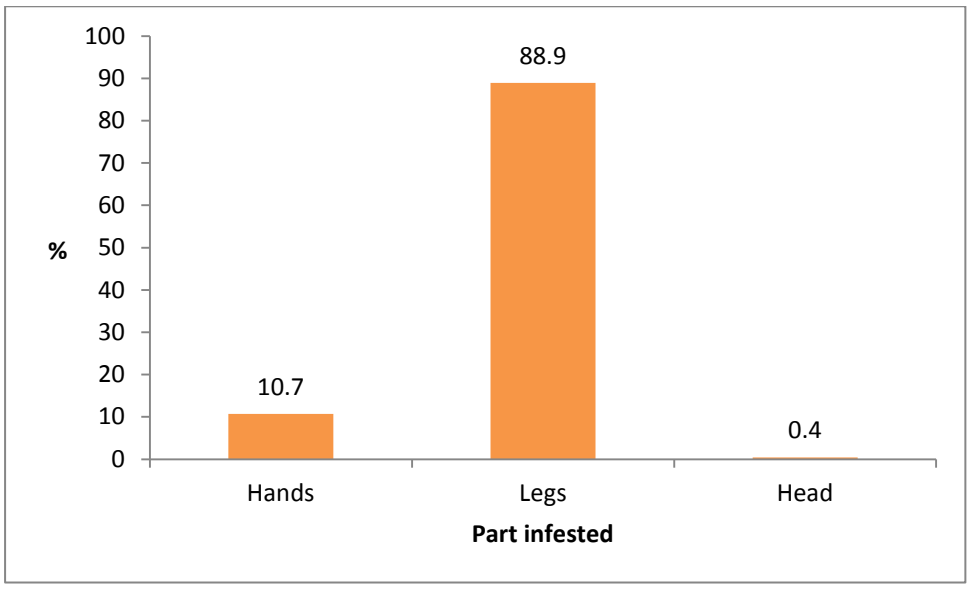

Figure 4. 1 : Body part infested with jiggers

4.2 Type of housing and housing conditions

Slightly more than half of the houses, 159 (53%) were wooden and only 4 (1.3%) were made of dressed stones. Slightly more than half of the households 156 (52%) were partially repaired and majority 233 (77.7%) had mud floor with only 60 (20%) having cemented floors. Close to half of the houses 146 (48.7%) and 100 (33.3%) respectively had walls and furniture that were dusty. More than half of the houses 166 (55.3%) had ventilation of less than 10% of the wall area. More than half of the

households 162 (54%) had clean beddings and 147 (49%) were moderately lit. Two hundred and seven of the households 207 (69%) had cooking areas separated from the main house. 125 (41.7) of the households were dirty and poorly maintained with only 134 (44.7%) being clean and well maintained as shown in figure 4.2

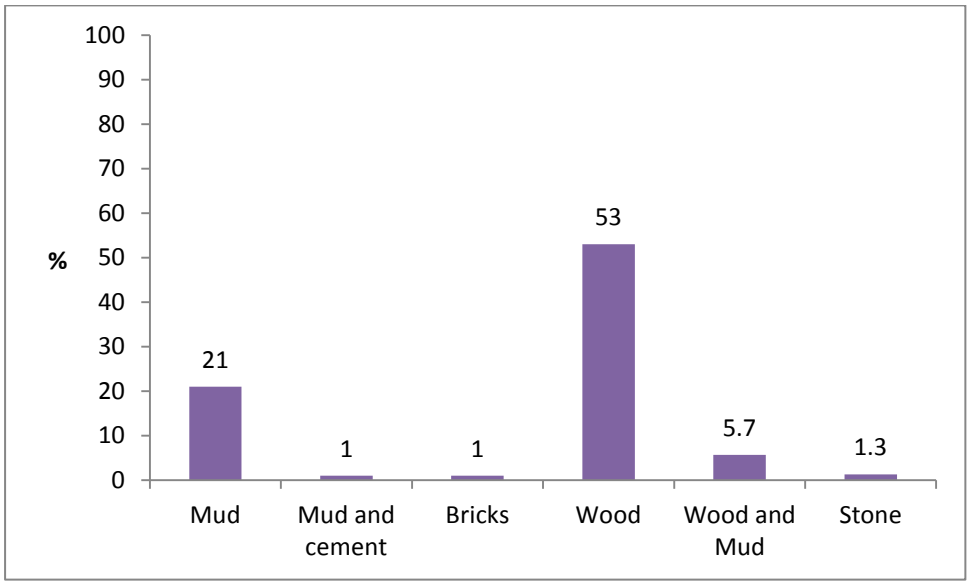

Figure 2: Type of house

4.3 Environmental conditions

Only 127 (42.3%) of the compounds had well maintained livestock sheds and 160 (64%) had barbed wire fence and droppers sheds. A hundred and twenty one of the sheds 121 (48.4%) were clean and 196 (77.5%) were well lit. More than three quarters of the livestock sheds 209 (82%) had ventilation of 10% of the wall. Only 14 (5.2%) of the household heads reported jigger infestation in the livestock. Slightly more than half of the households 154 (51.3) % had cats, 141 (47%) dogs and 94 (31.3%) had chicken/duck /turkey as indicated in figure 4.3. Among these animals 14 (4.7%) were infested with jiggers.

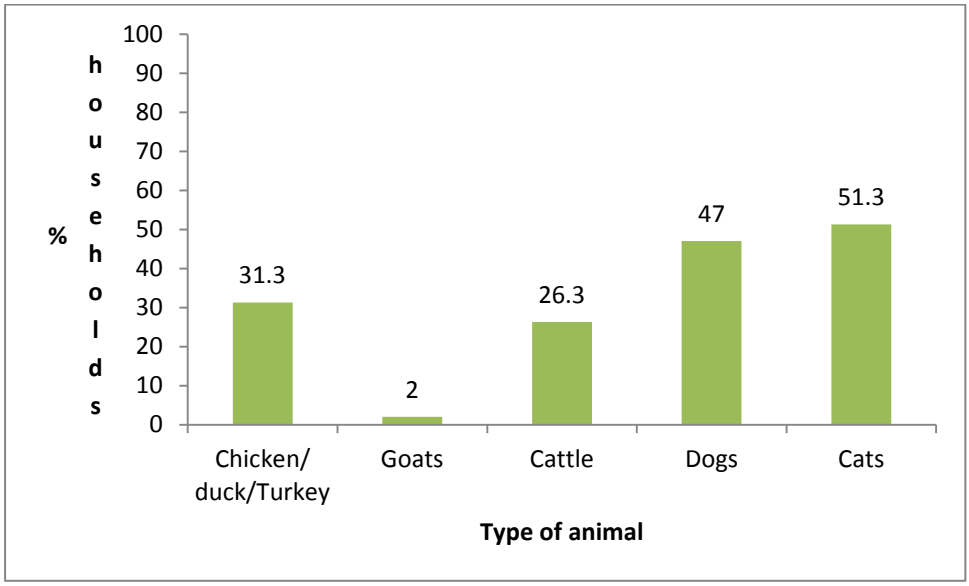

Figure 3: Types of livestock kept and percentage of households keeping them

4.4 Knowledge regarding jigger infestation

4.4.1 Source of information about jiggers

The entire household heads 300 (100%) had heard about jiggers. Of these 136 (45.3%) heard from the neighbor while 174 (58%) had been infected. Majority 228 (76%) of the household heads reported that jigger infestation is caused by penetrating flea similarly a high number stated that it can be prevented through practicing proper personal hygiene 239 (79.7%) and through practicing proper environmental hygiene 230 (76.7%).

4.4.2 Transmission

Two hundred and nineteen of the respondents reported that jiggers are transmitted through walking bare feet in infested soil 219 (73%) as seen in figure 4.4

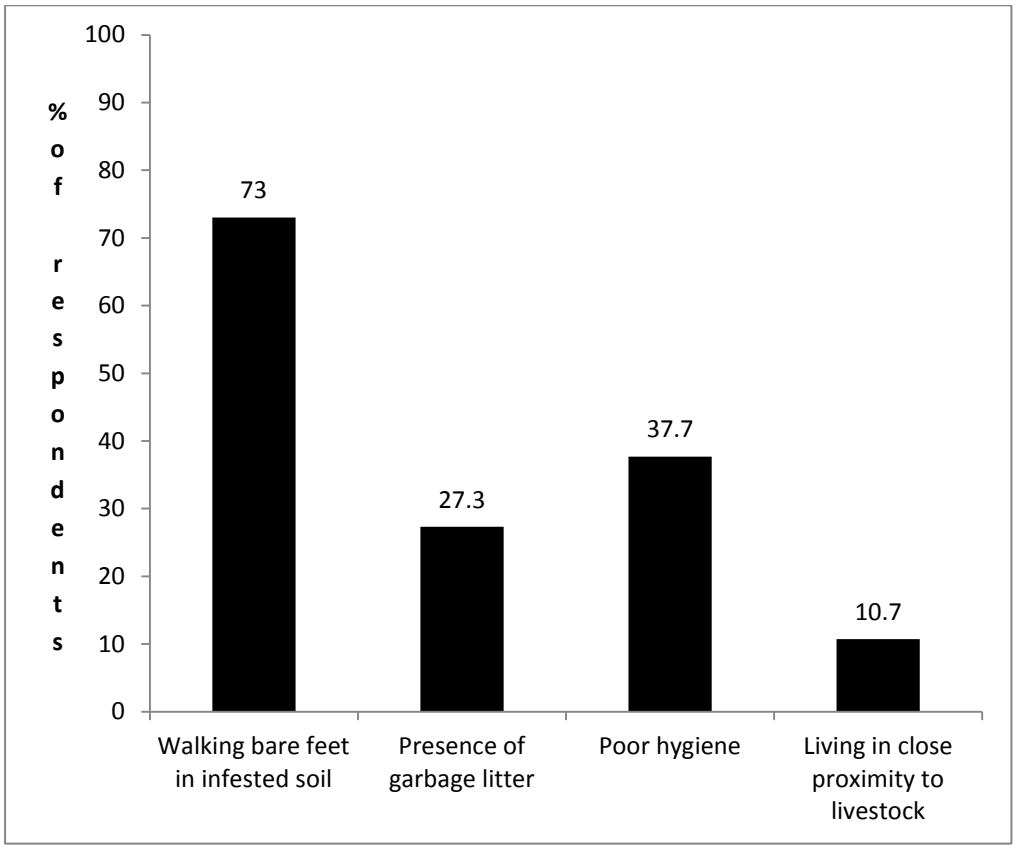

Figure 4: Peoples' knowledge of how jiggers are transmitted

4.4.3 Effects of jiggers

More than three quarters 243 (81%) of the respondents reported disability as the effect of jiggers. Poverty was also reported 248 (82.7%).

4.4.4 Signs and symptoms of jiggers

Majority reported severe itching 257 (85.7%), walking difficulties 230 (76.7%) and pain 257 (85.7%) as the signs and symptoms of jiggers as indicated in figure 4.5 below

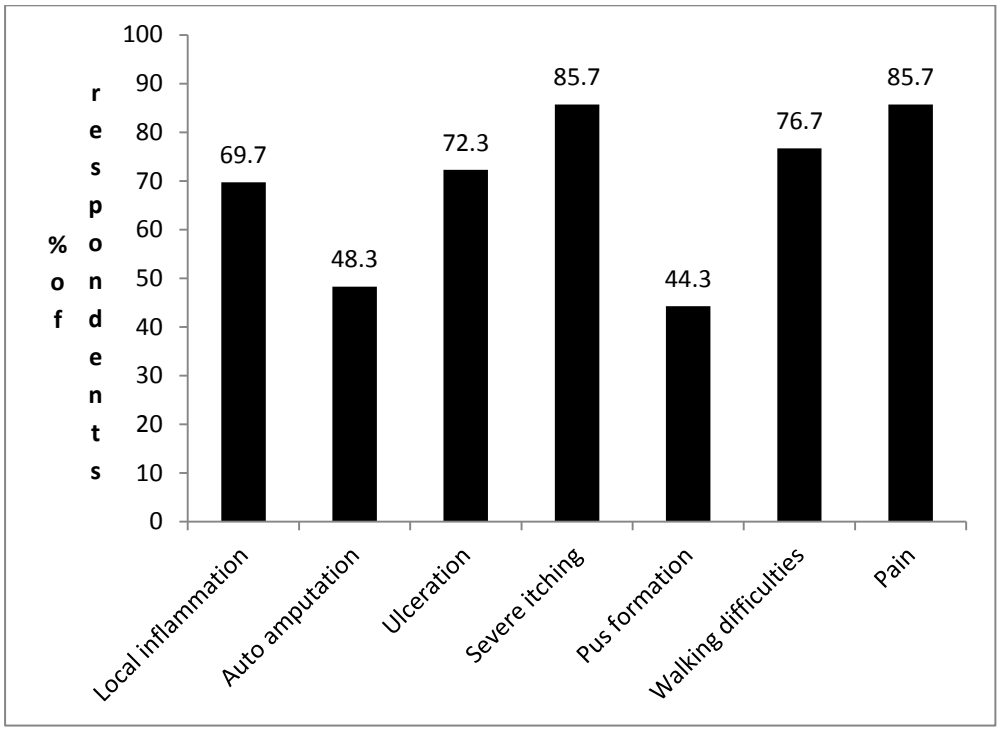

Figure 5: Signs and symptoms of jigger infestation in humans

4.5 Attitude regarding jiggers

4.5.1 Perception of jiggers

More than half of the household heads 162 (54%) perceived jiggers as nuisance while 105 (35%) regarded it as a disease. More than three quarters 253 (84.3%) of the household heads thought that those infected with jiggers were dirty while 99 (33%) thought they were poor.

4.5.2 Community behavior towards infected individuals

It was reported by 162 (54%) of the respondents that jigger infested individuals are isolated by the community while 171 (57%) are ridiculed.

4.6 Practice regarding jigger infestation

4.6.1 Treatment of jiggers

Table 2.2 Methods of treatment in ascending order (n=300)

Treatment	Frequency (%)
Vicks VapourRub	1(0.3)
Olive oil	1(0.3)
Ethanol	2(0.7)
Antibiotics	5(1.7)
Hydrogen Peroxide	13(4.3)
Paraffin	17(5.7)
Tobacco	30(10)
Lysol	23(7.6)
Washing detergent	94(31.3)
Potassium Permanganate	86(28.7)
Insecticide (Diazinol)	95(31.7)

Majority 263 (87.7%) of the respondents agreed that there was a cure for jiggers of which 187 (73.5%) reported complete removal of the embedded flea. More than half 195 (65%) reported use of thorn to extract imbedded fleas while 201 (67%) used sewing needles. Ninety five 95 (31.7%) of the respondents used insecticides (Diazinol) and 94 (31.3%) washing detergents for the treatment of tungiasis. Eighty six (28.7%) used potassium permanganate. Vicks Vapor Rub and olive oil were the least used methods.

4.6.2 Persons helping in jigger treatment

The majority of the respondents 242 (80.7%) reported that family members help in the treatment of jiggers while 162 (54%) reported receiving help from healthcare professionals. Some of the treatments including the hydrogen peroxide, potassium permanganate Lysol and insecticides were provided by the district public health officer in charge of the sub-district hospital to the households and the same officer gave the respondents advice on how to use them. However for the rest of the treatments respondents reported to have purchased them from the shops by themselves and used them on their own without advice from anybody.

4.7 Socio-demographic characteristics related with jigger infestation.

Table 4.3 Socio-demographic characteristics related with jigger infestation.

Characteristic	Jigger infected		Chi-value	P-value
	Yes	No		
Gender				
Male	129(19.7)	525(80.3)	1.942	0.163
Female	119(16.8)	589(83.2)		
Education level				
None	52(28)	134(72)		
Primary	171(19.6)	701(80.4)		
Secondary	30(10.1)	268(89.9)	31.471	<0.001*
Training past secondary	3(8.1)	34(91.9)		
University	0(0)	12(100)		

As in table 4.4, there was a significant relationship between jigger infestation and level of education ($\chi 2=31.471$, $p<0.001$) and the proportion of those infested with jiggers decreased with increase in the level of education. The proportion of male

infested with jiggers was higher compared to that of female (19.7 vs. 16.8) though the difference was not statistically significant ($\chi 2=1.942$, p=0.163).

Table 4.4: Prevalence of jigger infestation by age-group

Age-group (in years)	**Total examined**	**No. positive**	**Prevalence (95%)**
0-4	155	23	14.9(9.7-21.6)
5-9	178	28	16.0(10.9-22.3)
10-14	232	27	11.9(8.0-16.9)
15-19	179	15	8.5(4.8-13.6)
20-39	374	56	15(11.6-19.1)
40-59	182	56	30.9(24.3-38.2)
60+	139	55	40.1(31.9-48.9)
Total	1439	100.0	100.0

Chi-square value=85.303, P-value <0.003

There was a significant relationship between age-group and jigger infestation ($\chi 2=85.303$, P-value <0.003). The highest infestation was in the age group 60 years and above (40.1%) while the lowest was in the age-group 15-19 years (8.55) as indicated in table 4.4.

The distribution by age followed a characteristic curve (S- shaped). The prevalence in the young (5-9 years) was high, dropped in adults and then there was greatest increase in the older population as shown in figure 4.6 below.

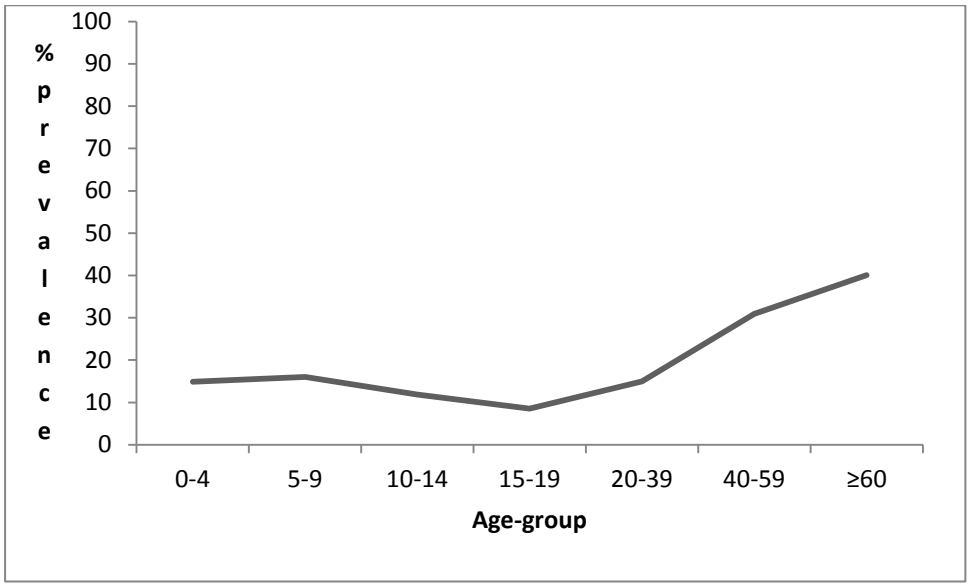

Figure 4.6: Distribution of prevalence by age

Table 4.5: Differences in mean rank of age and income by jigger infestation

Variable	jigger infestation		Z-value	p-value
	yes	No		
Age (mean rank)	854.38	670.87	6.553	<0.001*
Income(mean rank)	598.1	706.1	3.821	<0.001*

Using the Non-parametric Mann-Whitney U-test, there was a significant difference in the mean rank of age and income between those infested and those not (Z=6.553, P<0.001, Z= 3.821, P< 0.001) respectively as indicated in table 4.5.

4.8 Housing characteristics associated with jigger infestation

Table 4.6: Housing characteristics associated with jigger infestation

Characteristic	Jigger infestation		Chi-value	p-value
	Yes	No		
Type of house				
Mud	41(17.9)	188(82.1)	18.200	0.003*
Mud and cement	4(20)	16(80.0)		
Bricks	0(0)	26(100)		
Wood	127(15.9)	167(84.1)		
Wood and Mud	61(25.3)	180(74.7)		
Stone	6(27.3)	16(72.7)		
State of repair				
All repaired	44(17.4)	209(82.6)	4.215	0.122
Partially repaired	153(19.9)	616(80.1)		
Not repaired recently	61(15.1)	343(84.9)		
State of floor				
Mud	217(20.6)	838(79.4)	17.832	<0.001*
Wooden	3(6.7)	42(93.3)		
Cement	38(11.6)	290(88.4)		
State of wall				
Clean	59(15.3)	327(84.7)	85.449	<0.001*
Dusty	98(13.7)	618(86.3)		
Cracked and dusty	58(47.9)	63(52.1)		
Dirty	43(21.1)	160(78.8)		
Ventilation				
10% of wall	92(15.4)	506(84.6)	29.758	<0.001*
Less than 10% of wall	134(18.3)	599(81.7)		
No windows	30(41.7)	42(58.3)		
lighting				
Well lit	50(10.1)	447(89.9)	60.484	<0.001*
Moderately lit	135(19.2)	569(80.8)		
Poorly lit	73(34.6)	138(65.4)		
Partitioning				
Cooking, sitting and sleeping area	16(18.2)	72(81.8)	6.407	0.079
Cooking and sleeping area only	61(23.6)	197(76.4)		
Cooking area separated from main house	179(16.9)	880(83.1)		
Cooking areas only	19(20)	4(80)		
Bedding				
Clean	96(11.6)	748(88.8)	68.573	<0.001*
Dirty	162(28.8)	400 (71.2)		
Furniture				
Clean	62(13.7)	392(86.3)	61.627	<0.001*
Dusty	60(12)	440(88)		
Dirty	55(24.7)	168(75.3)		
No furniture	75(33.3)	148(65.4)		

As indicated in table 4.6, there was a significant relationship between type of house, state of the floor of the house, state of the wall, ventilation of the house , lighting of the house, state of beddings, cleanliness of the furniture and jigger infestation (all $p<0.05$).

4.9 Environment characteristics associated with jigger infestation

Table 4.7 Environment characteristics associated with jigger infestation

Characteristic	Jigger infestation		Chi-value	p-value
	No	Yes		
Compound				
Clean and well maintained	612(85.7)	162(14.3)	41.585	0.001*
Dirty and poorly maintained	457(80.9)	108(19.1)		
Dirty	77(61.6)	48(38.4)		
Livestock sheds				
Present and well maintained	579(86.7)	89(13.3)	20.69	<0.001*
Present and poorly maintained	449(79.5)	116(20.5)		
No animal shed	108(73)	40(27)		
Type of livestock shed				
Barbed wire and droppers	691(88.5)	90(11.5)	42.489	<0.001*
Wood	337(75.2)	111(24.8)		
Mud	6(75)	2(25)		
Bricks	0(0)	1(100)		
Bricks and mud	3(75)	1(25)		
Mud and cow dung	1(50)	1(50)		
State of Livestock shed				
Clean	536(85.2)	93(14.8)	9.712	0.019*
Dusty	203(86)	33(14)		
Cracked and dusty	18(90)	2(10)		
Dirty	300(78.3)	83(21.7)		
Ventilation				
10% of wall	900(84.4)	166(15.6)	13.187	<0.001*
Less than 10% of wall	149(79.3)	39(20.7)		
No windows	1(20.0)	4(80.0)		
lighting				
Well lit	864(87.1)	128(12.9)	63.214	<0.001*
Moderately lit	141(72.7)	53(27.3)		
Poorly lit	33(14.6)	28(45.9)		

Compound status, livestock sheds, type of livestock shed, state of livestock sheds, ventilation of livestock shed and lighting of livestock sheds were significantly associated with jigger infestation ($P<0.005$). As indicated in Table 4.7.

4.10 Role of domestic animals in spread of jiggers

There was no significant relationship between animals sleeping in the house, infestation of livestock with jiggers and jigger infestation ($\chi2=2.342$, $p=0.126$) and ($\chi2=2.604$, $p=0.107$) respectively. Nonetheless they could be contributing to human infestation.

Multiple logistic regression

Table 4.8: Multiple Logistic regression of factors for jigger infestation

Factor	B	OR	95.0% C.I		P-value
			Lower	Upper	
Age	.028	1.028	1.020	1.036	.000*
State of floor (ref=mud)					.356
wooden	-.193	.824	.493	1.380	.463
Cement	-1.461	.232	.028	1.914	.175
state of wall (ref=Dirty)					.000*
Clean	-.038	.962	.364	2.544	.938
Dusty	-.196	.822	.360	1.873	.640
Cracked and dusty	1.474	4.366	2.045	9.322	.000*
state of furniture (ref=none)					.248
Clean	.258	1.295	.532	3.149	.569
Dusty	-.392	.676	.299	1.528	.347
Dirty	-.283	.754	.372	1.529	.433
Ventilation state(ref=none)					.149
10% of wall	-.206	.814	.356	1.859	.625
less than 10% of wall	-.562	.570	.267	1.214	.145
Bedding (clean)	-.684	.505	.288	.884	.017*
Lighting (ref=poorly lit)					.008*
Well lit	-.842	.431	.179	1.040	.061
Moderately	.043	1.044	.534	2.040	.900
Compound (ref=dirty)					.018*
Clean and well maintained	-.354	.702	.309	1.592	.397
Dirty and poorly maintained	-.857	.425	.210	.857	.017*
House type (brick &mud)					.009*
Mud and cement	-.966	.380	.187	.774	.008*
Wood	-.504	.604	.318	1.149	.124
wood and mud	-.730	.482	.303	.767	.002*
Level of Education (Tertiary)					.005*
None	.951	2.589	.859	7.804	.091
Primary	.224	1.252	.395	3.963	.703
Secondary	1.193	1.298	1.035	10.508	.044*
Shed ventilation(<10% of wall)	.008	1.008	.602	1.686	.976
Constant	-.942	.390			.228

Multiple logistic regression indicated that Age, level of education, state of the wall, state of bedding and lighting state of the house, compound and house type were significant predictors of jigger infestation ($p<0.05$) as indicated in table 4.8. Respondents living in houses with cracked and dusty walls (AOR 4.366) were 4 times more likely to be infested than those living in houses with dirty walls. A unit increase in age was associated with 2.8 % increase in jigger infestation (AOR; 95% CI: 1.027 (1.020-1.034). The proportion of jigger infestation decreased with increase in level of education and those with no education were almost 3 times more likely to be infested compared to those with tertiary level of education. Respondents in houses without any ventilation were more likely to be infested compared to those in houses with some ventilation. Respondent with clean beddings were less likely to be infected with jiggers compared to those with dirty beddings (AOR; 95%CI: 0.505; 0.288-0.884). Those with clean and well maintained compound were less likely to be infested with jigger compared to those with dirty compound (AOR; 95%CI: 0.702; 0.309-1.592)

CHAPTER FIVE

DISCUSSION

5.1 Demographic characteristics of the participants.

This study was carried out at the end of the rainy season because the seasonal variation of jigger infestation was learned during thesis writing, hence the components of the dry season where not included in the study. In addition the approval to carry out research was obtained from IREC in the month of July at the end of the rainy season and that is when the study began. Therefore, further research should be carried out on prevalence during the dry season in the study area to ascertain if there is a variation in tungiasis prevalence rate. The overall tungiasis prevalence was 18% this prevalence was attributed to the rainy season, in which the run-off water may simply have washed away eggs, larvae, pupae, nymphs, and adults hence reducing the transmission rate. Furthermore, high humidity in the soil impaired the development of free-living stages of *T. penetrans.* It could be expected that the flea infestation will be greatest at the peak of the dry season as was seen in Brazilian study by Heukelbach *et al*., (2005), if the pattern is the same as that of Brazil.

The distribution of prevalence by age followed a characteristic curve (S- shaped). Prevalence was high in the children of between 5-9 years and the elderly above 60 years, this finding agrees with the study results by George Collins *et al*., (2009). This was attributed to the fact that children are allowed to go to school barefooted and play around in the community without shoes as they interact with contaminated ground. On the other hand, the elderly have compromised personal hygiene and environmental sanitation.

A non significant difference (p=0.163) in prevalence was observed between the sexes, much like a study in Nigeria (p=0.35). This findings, however has not been consistent across studies and seem to differ from community to community. Research in Cameroon and Trinidad found statistically significant differences between the sexes with which males carried higher disease burden compared to females (Collins *et al.*, 2009, Chadee; 1998). These data differences were attributed to exposure and environmental factors, rather than difference in susceptibility.

From this study the majority 231(88.85%), of the individuals were infested in the legs, and (10.7%) in the hands, due to the fact that the flea is a poor jumper, the host's must be close to the ground in order to facilitate access (Heukelbach *et al*. 2001). These results are similar to findings by Collins *et al*. (2009) who reported that majority of lesions occurred on the feet and to a lesser degree on the hands.

In this study, it was found that the level of education was an important predictor of jigger infestation ($p<0.05$), and the proportion of those infested with jiggers decreased with increase in the level of education attained. This was attributed to the fact that those who have attained higher education level have better average monthly income hence improved living standard and can make informed choices about improved hygiene, sanitation and changed health behaviors. This is in agreement with the findings of a study by Collins *et al.* (2009) in Cameroon where high prevalence of tungiasis existed in the illiterate (59%) than in the literate (50%) (p=0.05). In order to reduce the impact of this flea on the exposed parts of the body, the public should be educated, informed and made aware of the risk factors of jigger infestation and ways and means of prevention and control through community education, print, electronic and media.

5.2 Association between tungiasis and type of housing.

In the present study the type of housing was an independent factor predisposing for infestation ($p<0.05$), however the type of floor inside the house was not a predictor of tungiasis but was confounded by the state of wall, house type, state of beddings, and lighting of the house. This was attributed to the use of diazinon insecticide regularly in the treatment of the infested floors by spraying surfaces of other floor types with liquid insecticide or mixing the insecticidal dusts with the mud for smearing the infested earthen floors. This prevention strategy should be utilized carefully because diazinon, as carbamate, poisons humans and insects through its effects on nerve enzymes (WHO, 1998-1999). A study by Muehlen *et al, (*2006) contradicts the above findings in his study, the floor of sand or clay inside the house was an important risk factors for jigger infestation. In this study, the respondents living in houses with cracked and dusty walls (OR 4.366) were 4 times more likely to be infected than those living in houses with dirty walls, this was attributed to fact that cracked and dusty walls are dark and warm hence preferred habitat for *Tunga penetrans* this agrees with the findings of a study by Muehlen, *et al.* (2006). As an intervention measure, dusty surfaces, cracks and crevices in the walls and floors should be avoided through regular repair; as a result blocked eggs cannot hatch and fleas are killed through suffocation.

5.3 Association between tungiasis and the environment.

The environmental factor that was found to be an important predictor of tungiasis in the multiple logistic regression was the status of the environment. Individuals living in a dirty and poorly maintained environment were more likely to be infested compared to those living in clean and well maintained environment. It speculated

that dirty and poorly maintained environment is a preferred breeding site for the flea, as there is abundant organic material for the larvae to feed on. Heukelbach *et al.*, (2002) reported that improving sanitation and waste collection reduced the incidence of tungiasis.

5.4 The role of livestock in the spread of tungiasis.

From the study, there was no significant relationship between animals living in the house, infestation of livestock with jiggers and jigger infestation, though some cats, dogs, goats and cattle were found to be infected between the hooves. The livestock were treated regularly against the sand fleas with the use of acaricides by dipping and spraying, reducing the role of livestock in the transmission of the jigger. Although some households did not sleep with livestock inside the house, the practice did not seem to confer them any protection against tungiasis. However, study in Brazil by Heukelbach *et al.*, (2004) reported that severe tungiasis in dogs (67.0%) presented the potential infestation source to humans, though cats were found to be infected, they played no significant role to increase the prevalence in the community. Although no relationship was statistically found between infected animals and human infections, possibility of humans getting infections from animals still remain. Therefore an exclusive study should be carried out to ascertain the role of animals in the spread of tungiasis.

5.5 Knowledge

The reported knowledge on jigger was relatively high. However, this did not translate to jigger prevention and control in the area. To enable households to make informed choices about improved hygiene and sanitation, there is need for provision of better information to enable them make informed choices and change their health

behaviors. To provide such information, careful research needs to be done to identify information gaps to suit the ability of both the Government and communities at large (Kimani *et al.* 2012). The knowledge on early signs and symptoms should act as a trigger mechanism for the household members to take appropriate action to prevent and control infestation. Similarly a high degree of knowledge on the infectious agent of a disease was noted in Brazil by Winter *et al.*, (2009), where 90% knew the flea as the etiological agent of tungiasis.

In this study, itching (85.7%) was the most common reported signs and symptoms of jiggers, followed by walking difficulties among the respondents. The infected reported that they could not sleep at night due to itching and walking difficulties was as a result of pain experienced, a sign of acute inflammation from the lesions. The findings are similar to a study by Kimani *et al.* (2012), where almost all the respondents (94.8%) reported frequent itching as early jigger sign and symptom of tungiasis. The knowledge on early signs and symptoms should act as a trigger mechanism for the household members to take appropriate action to prevent and control infestation.

5.6 Attitude.

In this study more than half of the participants (54%) perceived jiggers as nuisance and accept jigger infestation as part of their lives and did not consider seeking medical attention for treatment. These results were consistent with findings by Collins *et al.*, (2009) in Cameroon, who reported that 59% of the study population accepted tungiasis as part of everyday life and did not consider visiting a medical centre for treatment. It is therefore important to inculcate the right attitude in household members in order to develop a positive behavior change for sustainable

jigger prevention and control among household members. Scientific knowledge on how to deal best with tungiasis is scanty (Kimani *et al.*, 2012). Consequently, addressing comprehensive and sustainable solutions to these neglected health problems cannot be the sole responsibility of the health sector but it also requires community participation and multi-sectoral approaches to the health determinants.

Most participants associated the occurrence of *T. penetrans* with walking bare feet in infested soil, almost everybody walks without shoes, and this behavior was not seen as a risk-factor by the inhabitants of this community. Viable prevention is the use of closed shoes when feet touch contaminated soil, while shoes could serve well in reducing invasion of the *Tunga penetrans*, the problem here lies in affordability. Therefore, a probable intervention could be regular inspection of feet and immediate extraction of embedded fleas with subsequent disinfection of the lesion to protect against infections. The results were similar to a study done by Winter *et al.* (2009), associated the occurrence of *T. penetrans* with sandy soil and walking barefoot as a reason for being affected by tungiasis.

5.7 Practice

In this study almost all the respondents (87.7%) knew that embedded sand fleas should be completely removed. However, in practice, this knowledge was not consistently applied and appropriate medical instruments such as scalpels or sterile hypodermic needles are almost never at hand, thus the attempts to extract embedded fleas with sewing needles, nails or thorns that potentially lead to bacterial infection. Therefore the Public should be informed on the use of safety pins sterilized by flaming which should be cheap, readily available and very effective for removal of jiggers. This study agrees with findings by Winter *et al.* (2009).

A study in Brazil by Winter *et al*, (2009), reported that topical remedies were commonly used including acaricides and insecticides due to pain felt during surgical treatment of lesions. Similarly, a great variety of substances were used in this study, some of them (Diazinol and acaricides) potentially toxic. The broad spectrum of substances used topically may be taken as a hint that none of them is really effective, However, environmental sanitation and household hygiene should be practiced at all times in order to cub the jigger menace.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

- This population-based survey provides some of the first reliable data on the prevalence of jigger infestation in Kitany Location, and confirms the initial reports that tungiasis is a public health problem in Keiyo Marakwet County.
- This study was carried out at the end of the rainy season and prevalence of 18% was observed which was attributed to the rainy season in which the study was conducted. Therefore, further research should be carried out on prevalence during the dry season in the study area to ascertain if there is a variation in tungiasis prevalence rate
- In this study, the level of education was an important predictor of jigger infestation and the proportion of those infested with jiggers decreased with increase in the level of education attained.
- The type of housing was an independent factor predisposing for infestation, however the type of floor inside the house was not a predictor of tungiasis but confounded by the state of wall, house type, state of beddings, and lighting of the house.
- Knowledge on jigger infestation was high but this did not translate to jigger prevention and control in the area. Therefore, careful research needs to be done to identify information gaps to suit the ability of both the Government and communities at large.
- A reduction of intensity of infestation, bacterial superinfection and associated morbidity is feasible with minimum support from the health sector, such as supplying hypodermic needles and disinfectants to the

household members. It is Therefore important to inform the public about the use of safety pins sterilized by flaming which should be cheap, readily available and very effective for removal of jiggers

- From the findings more than half of the participants regarded jiggers as nuisance and accept jigger infestation as part of their livelihood and did not consider seeking medical attention for treatment. It is therefore important to inculcate the right attitude in household members in order to develop a positive behavior change for sustainable jigger prevention and control among household members**.**

6.2 Recommendations

- Information and awareness should be provided for the public through media in order to be able to reduce the impact of this flea on the exposed.
- Educating people about the risk factors and potential causes is paramount in addressing the problem.
- It is important to inform the public about the use of safety pins sterilized by flaming which should be cheap, readily available and very effective for removal of jiggers
- It is critical to inculcate the right attitude and empower household members to be able to effectively prevent and control jigger infestation within the households for sustainable health and development.
- Further research should be carried out on prevalence during the dry season in the study area to ascertain if there is a variation in tungiasis prevalence rate.

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APPENDICES

APPENDIX I. Serial No. 001
Letter of informed consent

Principal Investigator-Judith J Chelimo.
Moi University
School of Public Health
PO Box 4604-30100
Eldoret
KENYA
Date

Ref: Letter of informed consent.

Dear respondent,
I' am a 2nd year Master of Public Health student of Moi University and studying risk factors associated with jigger in Kitany Location. I would like to recruit you into the study during which I shall ask you questions, perform clinical examination by inspecting carefully your legs, feet, hands and arms, for the presents of embedded fleas. I shall also visit your homestead and assess the state of housing and surroundings. After making observation I shall give you information on how best you can control jigger problem in your family.

I shall undertake to help in managing uncomplicated cases and refer complicated patients to hospital for medical attention. There will be no risk involved. If you accept to participate in the study please sign in the space provided below. All the information gathered in this study will be confidential and will only be used for academic purposes. Participation in the study is entirely voluntary and you are free to accept or decline to participate in the study. No monetary benefits will be involved in the study.

Name.....

Signature of the investigator.....

Date.....

APPENDIX II Serial No.002

Consent form.

I agree to take part in this study to its conclusion. I reserve to withdraw if I find conditions unfavorable.

Signature.....

Date.....

APPENDIX III. Demographics Questionnaire

Please tick as appropriate

Locations.....sub location.....Village…….

Respondent No.....

Demographic Data

a) Sex

1. Male ☐ 2. Female ☐

b) How old are you…….

C) Educational Level

1. Primary ☐ 2. Secondary ☐ 3.University ☐ 4.None ☐

5. Training post secondary school ☐

d) Employment (Adults)

1) Yes ☐ 2. NO ☐

e) Infestation with tungiasis.

1) Yes ☐ 2) NO ☐

f) Parts of the body affected.

1) Hands ☐ 2) Legs ☐ 3) Head

g) Others specify.....

Appendix IV. Risk factors Questionnaire

(Please tick as appropriate)

Location……

Sub-location……Village……..

a) Household Headship

1. Father ☐ 2. Mother ☐ 3.Grandparents ☐ 4.Child ☐ 5 Care taker ☐

b) Type of occupation…… Monthly income Kshs……

c) Type of house

1. Mud ☐ 2. Mud and cement ☐ 3 Bricks ☐ 4. Wood ☐

5. Wood and mud ☐ 6. Brick and mud ☐ 7. Stone ☐

d) State of repair

1. All repaired ☐ 2. Partially repaired ☐ 3 not repaired recently ☐

e) State of floor

1. Mud ☐ 2.Wooden ☐ 3. Cement ☐

f) State of wall

1. Clean ☐ 2.Dusty ☐ 3. Cracked and dusty ☐ 4 Dirty ☐

g) State of furniture

1. Clean ☐ 2.Dusty ☐ 3. Dirty ☐ 4 No furniture ☐

h) Ventilation

1. 10% of wall ☐ 2. Less than 10% of wall ☐ 3.No windows ☐

i) Bedding

1. Clean ☐ 2. Dirty ☐

j) Lighting

1. Well lit ☐ 2. Moderately lit ☐ 3 Poorly lit ☐

k) Partitioning

1. Has cooking, sitting, sleeping areas ☐ 2. Has cooking and sleeping areas only ☐

3. Has cooking areas separated from the main house ☐ 4. Has cooking areas ☐ only

l) Animals sleeping in the house

1. Yes ☐ 2. No ☐

m) State type of animal (Tick as appropriate)

1. Chicken/ duck/ turkey ☐ 2.Goats ☐ 3.Cattle ☐ 4.Pigs ☐

5. Dogs ☐ 6. Cats ☐

Observation check list for domestic animals

a) Compound

1. Clean and well maintained ☐ 2. Dirty and poorly maintained ☐ 3Dirty ☐

b) Livestock sheds

1. Present and well maintained ☐ 2. Present and poorly maintained ☐

3. No animal shade ☐

c) Types of livestock sheds

1. Barbed wire and droppers ☐ 2. Wood ☐ 3. Mud ☐ 4. Bricks ☐

5.Bricks and mud ☐ 6. Mud and cow dung ☐ 7. Stone ☐

d) State of livestock Sheds

1. Clean ☐ 2. Dusty ☐ 3. Cracked and Dusty ☐ 4.Dirty ☐

e) Lighting of livestock sheds

1. Well lit ☐ 2. Poorly lit ☐ 3. Moderate lighting ☐

f) Ventilation

1. 10% of wall ☐ 2. Less than 10% of wall ☐ 3. No windows ☐

g) Jigger Infestation of the livestock

1. Yes ☐ 2. No ☐

Please state the species and the part(s) affected……..

……

Appendix V. Knowledge, attitude and practice regarding tungiasis Questionnaire

A. Knowledge

Instructions (tick all that apply)

a) Have you ever had about jigger?

1. Yes ☐ 2. No ☐

b) If yes, where did you hear about the jigger?

1. Relative ☐
2. Health worker ☐
3. Radio/TV/News paper ☐
4. Church ☐
5. Neighbor ☐
6. Provincial administration ☐
7. Have been infected ☐
8. Other (specify)…….
   …….....

c) What do you think causes jigger infestation?

1. Penetrating flea ☐ 2. Insect ☐ 3. Don't know ☐
4. Others (specify)……

d) How can one prevent jigger infestation?

1. Regular use of closed footwear ☐ 2. Practicing proper personal hygiene ☐
3. Practicing proper environmental hygiene ☐
4. Avoid living in close proximity with the livestock ☐
5. Others (specify……

e) How is tungiasis transmitted?

1. Walking bare feet in infested soil ☐
2. Presents of garbage litter ☐
3. Poor hygiene ☐
4. Living in close proximity to the livestock ☐
5. Others (specify)…… …

f) What are the signs and symptoms of tungiasis?

1. Local inflammation ☐

2. Auto amputation of digits ☐
3. Formation of fissures ☐
4. Ulceration ☐
5. Purities (severe itching) ☐
6. Suppuration (pus formation) ☐
7. Walking difficulties ☐
8. Pain ☐
9. Others (specify) ☐

g) What are the effects of tungiasis?

1. School going children dropping out of school ☐ 2. Disability ☐
3. Spread of HIV/Aids among the infested through sharing of needles ☐
4. Poverty ☐ 5. Jigger victims also have to deal with stigmatization ☐
6. being unable to exercise their voting right ☐ 6. Death. ☐
7. Others (specify)……

h) Is there a cure for tungiasis?

1. Yes ☐ 2. No ☐

I) If yes. What is the cure?

1) Removal ☐ 2) Removal and clean surrounding ☐
3) Clean surrounding ☐ 4. Others specify……..

B. practice regarding tungiasis

Instructions (tick all that apply)

j) What do you use in the attempt to extract embedded fleas?

1. Sewing needles ☐ 2. Hypodermic syringe ☐ 3. Knives ☐
4. Thorns ☐ 5. Pliers ☐
6. Others (specify)……

k) what do you use for the treatment of tungiasis?

1.Mercurochrome ☐ 2. Ethanol ☐ 3. Hydrogen peroxide ☐
4. Potassium Permanganate ☐ 5. VicksVaporRub ☐ 6. Olive oil ☐
7. Candle wax ☐ 8. Cooking oil ☐ 9. Antibiotics ☐
10. Washing detergents ☐ 11. Insecticides ☐ 12. None of the above ☐
12. Others (specify)**……**

l) Who helps in the treatment of tungiasis?

1. Individuals affected ☐ 2. Family members ☐ 3. Neighbors ☐
4. Healthcare professional ☐ 5.Others (specify)……

C. **Attitudes regarding tungiasis**

Instructions (tick all that apply)

m) How do you classify tungiasis?

1. Disease ☐ 2. Nuisance ☐ 3. Develops from nuisance to disease ☐
4. Others specify……..

n) What do you think about people who are infected with jiggers?

1. They are dirty ☐ 2. They are poor ☐ 3. They are a curse to the community ☐ 4. Others specify……

o) How does the community behave towards the affected individuals?

1. They are discriminated upon ☐ 2. They are ridiculed ☐
3. They are isolated. ☐ 4. They are excommunicated ☐
4. Others specify……..

Thank you very much for your cooperation and answers on jigger infestation.

Appendix VI: Pictures taken during the study.

1. Pictures of different parts infested by jiggers.

Infested toes.

Infested sole.

Infested fingers.

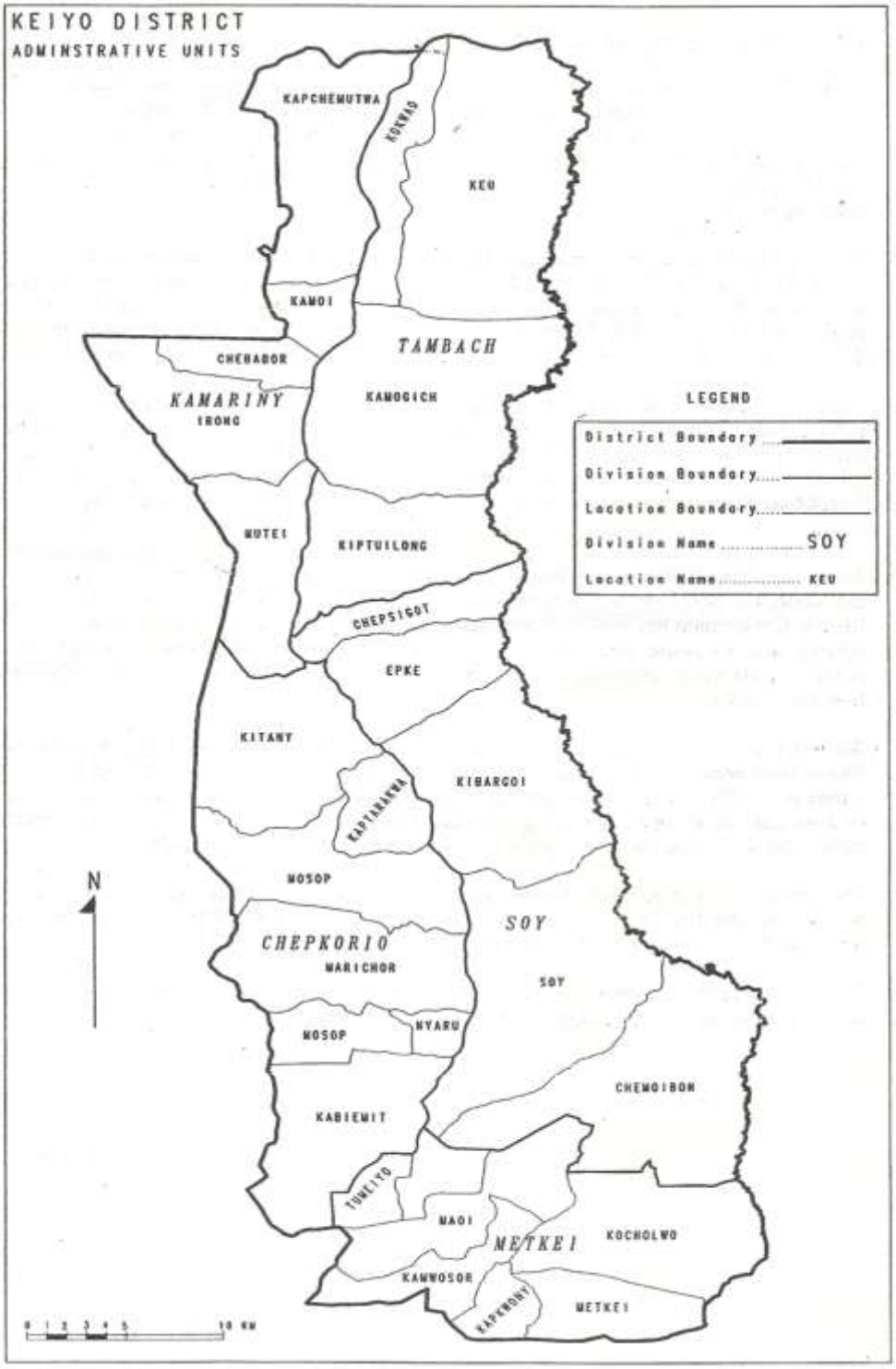
Infested ankle.

2. Pictures showing housing conditions.

Condition of the wall.

Condition of the beddings

Appendix VII: Map of Keiyo District showing Kitany Location.



Appendix VIII: Research authorization letter.

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2012/83
Approval Number: 000846

13th July, 2012

Judith J. Chelimo,
Moi University,
School of Public Health,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
APPROVED
13 JUL 2012
P.O. Box 4606 ELDORET

Dear Ms. Chelimo,

FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Risk Factors Associated with Jigger Infestation in Kitany Location, Keiyo Marakwet County, Kenya".

Your proposal has been granted a Formal Approval Number: **FAN: IREC 000846** on 13th July, 2012. You are therefore permitted to start your study.

Note that this approval is for 1 year; it will thus expire on 12th July, 2013. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Yours Sincerely,

17/07/2012

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	Director	-	MTRH
	Principal	-	CHS
	Dean	-	SOM
	Dean	-	SPH
	Dean	-	SOD
	Dean	-	SON