TUNGIASIS RISK FACTORS IN RURAL COMMUNITY IN MURANG’A COUNTY, KENYA

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A Research Thesis Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Public Health (Monitoring and Evaluation) in the School of Public Health of Kenyatta University

JUNE 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

I dedicate this work to the Almighty God for the strength and gift of good health that He granted me throughout that period of the study.
ACKNOWLEDGEMENT

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My special thanks go to the National Council for Science, Technology and Innovation for granting me permit to carry out the research. A word of thank you is also due to the County Public Health Officer, County Education Officer and County Commissioner for Murang’a County for allowing me carry out my study within their area of jurisdiction. Finally, I would like to express my heart-felt gratitude to all my wonderful respondents who spared their precious time to volunteer accurate information that saw this study a success.
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### ABBREVIATIONS AND ACRONYMS

<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AIDS</td>
<td>Acquired Immune Deficiency Syndrome</td>
</tr>
<tr>
<td>CHEW</td>
<td>Community Health Extension Worker</td>
</tr>
<tr>
<td>CHV</td>
<td>Community Health Volunteer</td>
</tr>
<tr>
<td>GOK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immuno-deficiency Virus</td>
</tr>
<tr>
<td>KNBS</td>
<td>Kenya National Bureau of Statistics</td>
</tr>
<tr>
<td>MM</td>
<td>Millimeter</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>MOPHS</td>
<td>Ministry of Public Health and Sanitation</td>
</tr>
<tr>
<td>NACOSTI</td>
<td>National Commission for Science, Technology and Innovation</td>
</tr>
<tr>
<td>PBO</td>
<td>Public Benefits Organization</td>
</tr>
<tr>
<td>PHO</td>
<td>Public Health Officer</td>
</tr>
<tr>
<td>SHMT</td>
<td>Sub-county Health Management Team</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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</table>
DEFINITION OF TERMS

Community: Group of people sharing a common understanding who reveal themselves by using the same language, manners and tradition.

Permanent house: House made of blocks, bricks or stone walls with a cemented floor and a roof of galvanized corrugated iron sheets or tiles.

Semi-permanent house: House made of timber walls with a cemented floor and a roof of galvanized corrugated iron sheets.

Temporary house: House made of mud walls with an earthen floor and a roof of either galvanized corrugated iron sheets or grass thatch.

Tunga penetrans: Ectoparasite flea which is mostly found in dusty and dirty places and it causes tungiasis by burrowing into the skin of man.

Tungiasis: Ectoparasitic skin disease caused by the penetration of Tunga penetrans into the epidermis of man.
ABSTRACT

Tungiasis is high in many resource-poor communities in sub-Saharan Africa, Latin America and the Caribbean. *Tunga penetrans* is an ecto-parasite which thrives well in sandy and dirty environments and it causes a skin disease called tungiasis. This study assessed tungiasis risk factors in rural community in Murang’a East Sub county. Murang’a East Sub county is one of the twenty Sub counties which are considered to have high prevalence of tungiasis by the Ministry of Health. The Sub county total area is approximately 110 square kilometers with a population of 98,629 and 26,812 households. The study utilized cross sectional descriptive study design. The research adopted systematic random sampling design to identify the households to be studied where a total of 334 households were selected to participate in the study as determined by Fisher et al 1998 formula. Household heads or their representatives were interviewed using interview schedule and observation checklist gathered data on environmental factors related to tungiasis. The collected data was entered and coded using Statistical Package for Social Sciences version 20.0. Both descriptive and inferential statistics were used to analyze data. Chi-square test of independence and Fisher’s Exact Test were used to draw generalization and inferences. Out of the 334 households sampled, 6.9% had at least tungiasis at the time of the study with a total of 35 cases. Most (65.8%) of those affected were children and 60% were males. Most (83.3%) of them were living in temporary houses and had domestic animals especially chicken which they interacted with. Majority (62.9%) of those suffering from tungiasis were not wearing shoes while 28.6% were wearing open shoes at the time of the study. There was significant relationship between wearing shoes and tungiasis (Wearing shoes, p = 0.015). Over half (53%) of the respondents said that tungiasis was still a problem in their community and 52.1% attributed it to poor personal hygiene and sanitation. Generally, respondents perceived those who were suffering from tungiasis as poor and lazy and 49.4% suggested that continuous health promotion on personal hygiene and environmental sanitation could go a long way in controlling tungiasis in their community. The study recommends that the County Government of Murang’a should consider subsidizing acquisition of closed shoes for children and the elderly in households with recurrent tungiasis cases to curtail the penetration of *Tunga penetrans* into their skin.
CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Tungiasis is highly prevalent in many resource-poor communities in sub-Saharan Africa, Latin America and the Caribbean (Winter, Oliveira, Wilcke, Heukelbach, & Feldmeier, 2009). Jigger flea, scientifically known as *Tunga penetrans*, is an ecto-parasite which is mostly found in dusty and dirty places. It causes a skin disease called tungiasis. The parasite is common in urban slums, traditional fishing communities and rural communities (Ugbomoiko, Ofoezie, & Heukelbach, 2007). Hundreds of millions of people are at risk of infection in more than 70 nations, mostly in developing countries. The importance of tungiasis is localization in the foot causing serious difficulty in walking and reducing the infected person’s ability to work normally. In endemic areas, prevalence ranges from 15-40% (Julian, Fioravanti, Onore, Mantovani, & Trentini, 2009). Prevalence and infestation intensity are particularly high in children 5-15 years of age and the elderly (Winter, Oliveira, Wilcke, Heukelbach, & Feldmeier, 2009).

Direct transmission of *Tunga penetrans* from one person to another is not possible but it occurs through the insanitary environment. Tungiasis causes debility in resource-poor communities of developing countries where it is usually considered an entomologic nuisance and does not receive much attention and therefore remains an important public health problem for the poor (Kimani, Nyagero, & Ikamari, 2012).
From the existing literature, *Tunga penetrans* seems to be native to the West Indies. The first case of tungiasis was described in 1526 by Gonzalo Fernández de Oviedo Valdés, where he discussed the skin infection and its symptoms on crew members from Columbus’s *Santa Maria* after they were shipwrecked on Haiti (Gordon, 1941). Through ship routes and further expeditions, *Tunga penetrans* was spread to the rest of the world, particularly to the rest of Latin America and Africa (Hoeppli, 1963). The spread to greater Africa occurred throughout the 17th and 19th centuries, specifically in 1873 when the infected crewmen of the ship Thomas Mitchell introduced it into Angola, having sailed from Brazil (Gordon, 1941). From Angola, *Tunga penetrans* spread to other parts of sub-Saharan Africa (Hicks, 1930; Sachse, 2007). The ectoparasite followed trade routes and was propagated through military expeditions and within 20 years reached East Africa including Kenya (Hoeppli, 1963). It is also thought that jiggers were brought to East Africa by migrants from India who constructed the railway from Mombasa to Kampala in the 19th century (Ministry of Health [MOH], 2014a).

Although there has not been a comprehensive national survey on tungiasis in Kenya, Ahadi Kenya Trust has registered over 2.6 million people suffering from tungiasis and over 10 million are at risk of infection (Ahadi Kenya Trust, 2010). The Public Benefit Organization (PBO) further reveals that all the former eight provinces have reported cases of tungiasis, with a few isolated cases in Nairobi region. In Western region, it was estimated that 15% of Emuhaya constituency residents were suffering from tungiasis. Grouped by regions, Central region had the highest infection rate followed by Coast
region where over 40,000 children were infested (Ahadi Kenya Trust, 2010). In Eastern region, Ahadi Kenya Trust estimates that more than 400,000 people were affected by this menace. In Murang’a County, Ahadi Kenya (2010) reported more than 1358 people who were suffering from tungiasis in just one Division out of which 700 were school going children from 13 primary schools.

1.2 Statement of the Problem

Many people in Murang’a County continue to silently suffer from tungiasis especially children (Ahadi Kenya Trust, 2010). This may be partly attributed to the fact that there is little political goodwill in the fight against this menace, as political leaders may feel embarrassed to come out and talk about tungiasis (Ahadi Kenya Trust, 2008).

According to the Ministry of Health, Murang’a Eas Sub county is one of the 20 Sub counties which are considered to have the highest prevalence of tungiasis (Ministry of Public Health and Sanitation [MOPHS], 2012). The categories of people mostly affected by tungiasis are children and the elderly. Children are particularly hit hard because they could be ignorant of the menace and end up suffering in silence.

A lot of attention, as far as tungiasis is concerned, has been put on Murang’a County by some PBOs that are involved in jigger control but the County Public Health Office reports still indicate that the study area is not free of tungiasis (MOH, 2014). Over 5,000 school going children have been reported to be affected by tungiasis and as a result, they dropped out of school because they were not able to walk (Kimani, Nyagero, &
Ikamari, 2012). In addition, there is stigma that surrounds tungiasis and children are ridiculed and isolated by their peers. High intensity of tungiasis in adults hampers their working capacity due to reduced mobility which confines them to a non productive life and poverty. Previous studies in the region only concentrated on prevalence of tungiasis. This study therefore examined the factors contributing to tungiasis with a view to addressing the gap that existed.

1.3 Justification

The Ministry of Health continues to address the problem of tungiasis in the country with more emphasis in this region but children and other members of the community especially the elderly are still affected. Tungiasis interferes with schooling of children forcing them to drop out. Their parents are forced to spend their substantial time in removing *Tunga penetrans* from their toes and other parts of the body that are infested. The infested senior members of the community are further debilitated making them to entirely depend on the other members of their families. The presence of *Tunga penetrans* in the skin causes a severe itching sensation and general discomfort (Kiprono, Omondi, & Wanyama, 2012). Heavy tungiasis can lead to severe inflammation and tetanus may emerge as a secondary infection (Pilger, Schwalfenberg, Heukelbach, Witt, & Mehlhorn, 2008). To win the war against tungiasis, it is prerequisite to determine demographic, socio-economic and environmental factors that are associated with tungiasis as well as the perception of Murang’a East residents on tungiasis.
1.4 Research Questions

1. What are the demographic and socio-economic factors related to tungiasis among rural households in Murang’a East Sub county?

2. What are the environmental factors associated with tungiasis in Murang’a East Sub county?

3. What is the perception of rural households in Murang’a East Sub county towards tungiasis?

1.5 Objectives

1.5.1 Broad Objective

To determine tungiasis risk factors in rural community in Murang’a East Sub county, Murang’a County, Kenya.

1.5.2 Specific Objectives

1. To establish demographic and socio-economic factors related to tungiasis among rural households in Murang’a East Sub county.

2. To determine environmental factors associated with tungiasis in Murang’a East Sub county.

3. To assess the perception of rural households in Murang’a East Sub county towards tungiasis.
1.6 Significance of the Study

The findings of this study would be useful to policy makers in the Ministry of Health especially when it comes to reviewing tungiasis control policy to combat the menace among the high prevalence communities. The findings would also benefit the County Government of Murang’a in formulating county specific policy and guidelines that will address tungiasis at the county level. Health workers and PBOs that are engaged in tungiasis control would also find the results of this study useful in their day to day work. The people of Murang’a county would know and appreciate the risks related to tungiasis and the best ways to prevent it since it seems tungiasis menace has not been adequately addressed. Further, the findings are expected to contribute to the existing body of knowledge on tungiasis. It is also hoped that the study would elicit and catalyze further research on tungiasis in Murang’a county and other parts of the country.

1.7 Limitation

The research focused on tungiasis risk factors in rural community in Murang’a East Sub county hence the findings could not be generalized to cover other counties or the entire country.
1.8 Conceptual Framework on tungiasis risk factors

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent</th>
</tr>
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<tbody>
<tr>
<td>Demographic and socio-economic factors (age, sex, education, household income, source of water)</td>
<td>Tungiasis</td>
</tr>
<tr>
<td>Environmental factors: type of house, state of household compound, presence of domestic animals e.g. dogs and chicken</td>
<td></td>
</tr>
<tr>
<td>Perception on tungiasis</td>
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Figure 1.1: Conceptual framework on tungiasis risk factors

People living in poor houses may get tungiasis because of the unsanitary nature of those dwellings. It is because of low economic status that forces people to inhabit such poor dwellings. Tungiasis renders the infested individuals unable to walk and work thus minimizing their socio-economic contributions to the society. This makes it hard for them to rise out of poverty and they continue living in poor environments which enhance tungiasis. Children suffering from tungiasis may end up dropping out of school since they cannot walk to school and their parents may not afford to buy them even shoes. Close interaction of people with domestic animals such as dogs and chicken by sharing the living house with such animals due to inability to put up separate structures for them or fear of theft can be a source of tungiasis. Perception plays an important role in health seeking behavior. Poor attitude about tungiasis may cause those that are affected and their families to believe that their health condition is justified given their socio-economic status.
CHAPTER TWO: LITERATURE REVIEW

2.1 Tunga penetrans

*Tunga penetrans* is an ectoparasite which causes an inflammatory skin disease called tungiasis (Nagy *et al.*, 2007). The flea is found in the tropical parts of Africa, the Caribbean, Central and South America and India and it measures 1 mm across (Nagy *et al.*, 2007). Its head is angular, it has no comb of spines and the thoracic segments are narrow at the top. The female feeds by burrowing into the skin of its host. The abdomen becomes enormously enlarged between the second and third segments so that the flea forms a round sac with the shape and size of a pea. The impregnated female flea embeds itself in the skin under the toe nails and fingernails of man where the resultant sores may fill with pus and become infected (MOH, 2014a). Pigs, dogs, cats, cattle, sheep and rats are important reservoirs. The dogs and cats act as important reservoirs for the intra- and peridomiciliary transmission of sand fleas (Pilger Schwalfenberg, Heukelbach, Witt, & Mehlhorn, 2008).

The first evidence of infestation by *Tunga penetrans* is a tiny black dot (lesion) on the skin at the point of penetration. Because the flea is a poor jumper, most lesions occur on the feet, often on the soles, the toe webs and around or under the toenails (MOH, 2014a). Heavy infestations may lead to severe inflammation, ulceration and fibrosis. Lymphangitis, gangrene, sepsis, the loss of toenails, auto amputation of the digits, and death may also occur. In most cases, however, this lesion heals without further complications. Nonetheless, the risk of secondary infection is high. Tetanus is a
common secondary infection that has reported associations with death (Kiprono, Omondi, & Wanyama, 2012).

![Figure 2.1: Tunga penetrans in the environment (Ahadi Kenya, 2010)](image)

### 2.2 Tunga penetrans Cycle

*Tunga penetrans* eggs are on average 604 μm long. The larva will hatch from the egg within one to six days, assuming the environmental conditions (such as moisture, humidity, etc) are favorable (MOH, 2014a). After hatching, the flea will progress through two instar phases. This is unique in that most fleas go through three, instead. Over the course of that development, the flea will first decrease in size from its just-hatched size of 1,500 μm to 1,150 μm (first instar) before growing to 2,900 μm (second instar) (Nagy *et al*., 2007).

About 6–8 days after hatching, the larva pupates and builds a cocoon around itself. Because it lives mostly on and below the surface of sand, sand is used to stabilize the cocoon and help to promote its development (Nagy *et al*., 2007). An environmental disturbance such as rain or a lack of sand have been shown to decrease incidence, most
likely due to decreasing the environmental factors on which the flea depends for overall growth. Barring any disturbances to the cocoon, an adult flea will emerge from the puparium after 9–15 days (Nagy et al., 2007).

In the adult phase, the flea will occasionally feed on unsuspecting animals. Only once the female burrows into the skin can reproduction occur, as the male and female show no interest in each other in the wild (Nagy et al., 2007). The male flea dies after copulation and the next phase of life for the female flea is in vivo ecto-developmental, and it is commonly referred to as the Fortaleza classification of tungiasis (Fortaleza cycle) (Nagy et al., 2007).

Figure 2.2: The life cycle of *Tunga penetrans* (MOH, 2014a)
2.3 Fortaleza Cycle

In a seminal paper on the biology and pathology of *Tunga penetrans*, Eisele *et al.* (2003) provided and detailed the five stages of tungiasis. Stage 1 is characterized by the penetration of the skin by the female *Tunga penetrans*. Running along the body, the female uses its posterior legs to push its body upward by an angle between 45–90 degrees. Penetration then starts, beginning with the proboscis going through the epidermis. By stage 2 (day 1–2), penetration is complete and the flea has burrowed most of its body into the skin. Only the anus, the copulatory organs, and four rear air holes in the flea called stigmatas remain on the outside of the epidermis. The anus will excrete feces that is thought to attract male flea for mating. The hypertrophic zone between tergites 2 and 3 in the abdominal region begins to expand a day or two after penetration and takes the appearance of a life belt. During this time, the flea begins to feed on the host’s blood (Eisele *et al.*, 2003).

Stage 3 is divided into two sub-stages, the first of which being 2–3 days after penetration is complete. Here, maximum hypertrophy is achieved and the flea’s midsection swells to the size of a pea. Due to the expanding flea, the outer layer of the skin is stretched thin, resulting in the appearance of a white halo around the black dot (rear end of the flea) at the center of the lesion. In the second sub-stage, the chitin exoskeleton of tergites 2 and 3 increase in thickness and gives the structure the look of a mini caldera. Egg release is common in this sub-stage as are fecal coils. The eggs tend to stick to the skin (Eisele *et al.*, 2003).
At about the 3rd week after penetration, stage 4 begins, which is also divided into two sub-stages. In the first sub-stage, the flea loses its signs of vitality and appears near death. As a result, the lesion shrinks in size, turns brown and appears wrinkled. The death of the flea marks the beginning of the second sub-stage (around day 25 post-penetration) as the body begins to eliminate the parasite through skin repair mechanisms (e.g. shedding and subsequent skin repair). At this phase, the lesion is seen as brown or black. By the 5th stage of tungiasis, the carcass of the *Tunga penetrans* flea has been expelled and there are circular skin residues of the infection that remain. There are only lingering symptoms at this time (Eisele *et al*., 2003).

**2.4 Epidemiology of *Tunga penetrans***

For the most part, *Tunga penetrans* lives 2–5 cm below sand, an observation which helps explains its overall distribution. The 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. This preferred ecological niche offers a way to decrease transmission among humans by investing in concrete grounds as opposed to the sand that is usually used in shacks. Indeed, Nagy *et al.* (2007) reported that in shacks with concreted ground being cleaned every day with water, *Tunga penetrans* larvae were hardly found.

In a longitudinal study conducted from March 2001 to January 2002, incidence of tungiasis was found to vary significantly with the local seasons of an endemic community in Brazil (Nagy *et al*., 2007). In particular, the study found that occurrence of tungiasis varied throughout the year and seemed to follow local precipitation patterns. Maximum and minimum prevalence rates differed by more than a factor of
three. The authors suggest that the correlation is due to the high humidity in the soil impairing larval development during the rainy season, as well as the more obvious reason that rain may simply wash away all stages of *Tunga penetrans* due its small size of 1mm (Nagy *et al*., 2007).

Acting as both biological vectors and definitive hosts, humans have spread *Tunga penetrans* from its isolated existence in the West Indies to all of Latin America and most of Africa via sea travel (Gibbs, 2009). Since *Tunga penetrans* technically has no reservoir species and the female will cause tungiasis to any mammalian organism it can penetrate, this means the flea will have a relatively large amount of hosts and victims. Epidemiologically, this is important as tungiasis often causes secondary infections (Gibbs, 2009).

Tungiasis is potentially endemic in 88 countries worldwide. Approximately 45.2% of a Nigerian community in Lagos State was observed to be infected, with most of the cases occurring in children between the ages of 5 and 14 years (Ugbomoiko, Ofoezie, & Heukelbach, 2007). In a traditional fishing village in northeastern Brazil, the overall prevalence was 51% (Damazio & Silva, 2009). In a village in rural Haiti, nearly 75% of the population was observed to have tungiasis lesions (Joseph *et al*., 2006). As of the year 2000, twenty cases of tungiasis had been reported in the United States, with fifteen of them being reported prior to 1989. Since 2000, sporadic cases have been reported in the United States although all of these cases were imported from outside of the United States (Hager, Jacobs, Orengo, & Rosen, 2008).
2.5 Tungiasis in Kenya

There are over 2.6 million Kenyans suffering from tungiasis who are registered by Ahadi Kenya Trust and many more continue to suffer from tungiasis in silence since no comprehensive survey has been carried out, making it difficult to give the actual number of those affected (Ahadi Kenya Trust, 2010). In the country, all the eight former Provinces have reported cases of tungiasis. In Western region, areas affected by tungiasis include Kimilili, Kakamega, Bungoma, Butere and Teso. In nyanza, Bondo, Gem, Siaya, Kogelo and Kitutu Masaba are among the affected areas. In Nairobi, slums of Kibera and Mji wa Huruma, Kasarani as well as Dagoretti have reported cases of tungiasis. Ahadi Kenya Trust further reveals that in North Eastern region, Wajir and Garissa have reported tungiasis cases.

So far, Coast region has the second highest number of people suffering from tungiasis in the country (Ahadi Kenya Trust, 2010). Some of the most affected counties in the region include Kwale, Kilifi, Malindi, Tana River, Taita Taveta and Lamu. In the Rift Valley region, Narok County has over 5,000 people affected by tungiasis. Nakuru, Sotik, Bomet, Kericho and Baringo Counties are some of the other areas in the Rift Valley affected by tungiasis. It is estimated that more than 400 000 people are affected by tungiasis in Eastern region with Makueni, Kitui and Masinga being the most affected. Central region leads the pack with the highest number of those affected being children (Ahadi Kenya Trust, 2010). The Counties that are most affected in Central region include Nyeri, Kiambu, Kirinyaga and Murang’a. Areas in Murang’a County
affected include Mathioya, Kiharu, Maragua, Gatanga, Kigumo, Kandara and Kangema Sub counties (MOH, 2014). Kandara Sub county has an estimated 6,200 school going children affected by tungiasis and this has led to high school drop-out rates as well as poor education standards (Ahadi Kenya Trust, 2010).

According to the Ministry of Health (2014a), an estimated 1.4 million Kenyans translating to 4 percent of the total population suffer from tungiasis, with the highest prevalence rates found in Central, Nyanza, Western, Coast and Rift valley regions. These are Baringo, Bomet, Bungoma, Busia, Elgeyo Marakwet, Homa Bay, Kakamega, Kericho, Kiambu and Kilifi. Others are Kirinyaga, Kisii, Kwale, Marsabit, Migori, Murang’a, Nandi, Nyamira, Nyeri, Samburu, Siaya, Taita-Taveta, Uasin Gishu and Vihiga counties. The most at risk population age groups are children 5 to 14 years, the elderly, and the physically and mentally disabled persons in the affected areas, that is, approximately 10 million Kenyans. A study conducted by Kamau, Ngechu, Haile, and Mwitari (2014) in Murang’a North District on an exploration of factors associated with tungiasis showed that majority of the respondents (65.9%) viewed jiggers as a nuisance rather than a health condition.

2.6 Demographic and Socio-economic Factors Related to Tungiasis

In population studies conducted in rural area of Lagos State, Nigeria and south-western Trinidad, tungiasis prevalence in children was significantly higher than in adults with a peak in the 5-10 year-old age group (Winter, Oliveira, Wilcke, Heukelbach, &
Feldmeier, 2009). The prevalence was consistently higher in boys than in girls, presumably because males are more frequently exposed to *Tunga penetrans* than females. Tungiasis is mostly a disease of the poor and occurs in resource poor countries in the Caribbean, South America and Africa (Winter, Oliveira, Wilcke, Heukelbach, & Feldmeier, 2009).

Tungiasis may trap people in poverty for a long time unless timely and appropriate intervention breaks the trend. Improving hygiene and sanitation in the existing dwellings to eradicate the fleas, creating better housing with smooth, clean walls and floors where the fleas cannot hide and raising economic standards of the poor will help to contain *Tunga penetrans* Other measures include observing high standard of personal hygiene and avoiding contact with dogs and chicken which may have fleas on their bodies, killing the fleas using insecticides in the dwellings and disinfectants on the victims’ bodies as well as awareness creation on the simple ways to prevent tungiasis.

### 2.7 Environmental Factors Related to Tungiasis

Determinants of health include healthy human activities and environmental determinants that create conditions which impact on the epidemiological pattern of diseases and conditions. These determinants also increase susceptibility to environmental factors leading to more breeding sites for the vectors and increase the risk of *Tunga penetrans* transmission (Ehrenberg & Ault, 2005).

A study conducted in Brazil by Winter, Oliveira, Wilcke, Heukelbach, and Feldmeier (2009) showed that respondents were well aware of the environmental determinants of tungiasis. Most participants associated the occurrence of *Tunga penetrans* with sandy
soil (72%) and 23% mentioned walking barefoot as a reason for being affected by tungiasis. The presence of animals (dogs and cats) was thought by 52% to contribute to the occurrence of disease. The presence of garbage in the streets as well as lack of hygiene in the houses were also cited as factors associated with tungiasis. 12% were convinced that there was a causal relationship between the occurrence of *Tunga penetrans* and the blossoming of cashew trees around September, although the vast majority of the respondents had no explanation how these two observations were linked. Some persons assumed that cashew flowers and fruits fallen on the ground would attract reservoir animals (pigs and dogs), which in turn would spread *Tunga penetrans*. Tungiasis shows a highly characteristic pattern of seasonal variation with a peak in the middle of the dry season when cashew trees blossom (Heukelbach, Wilcke, Harms, & Feldmeier, 2005). Others believed that the off-host-stage of *Tunga penetrans* would propagate better if the soil was littered with decaying cashew fruits.

A study on tungiasis prevalence in Kituro Sub-location in Baringo Central District revealed that most of the respondents’ compounds were not adequately clean, prompting the heavy tungiasis in the area (Kiprono, Omondi, & Wanyama, 2012). This is because dirty environment provides good breeding grounds for jiggers. The same study revealed a low rate floor smearing further escalating infestation (Kiprono, Omondi, & Wanyama, 2012). Frequent smearing could have checked the spread as it keeps the dust down hence depraving *Tunga penetrans* adequate breeding ground.
Classrooms which often had earthen floors were also found out to be points of infestation. This was according to Ahadi Kenya’s report on tungiasis in rural schools in Busia County (Ahadi Kenya, 2010). Classrooms made of mud walls and earthen floors increase the attack in pupils as the floors are normally dusty and the situation is aggravated by the high pupil enrolment and the small size of the classrooms (Kiprono, Omondi, & Wanyama, 2012).

### 2.8 Perception Towards Tungiasis

According to Winter, Oliveira, Wilcke, Heukelbach, and Feldmeier (2009) in a study carried out in Brazil, 29% of participants classified tungiasis as a nuisance, being part of their normal life and not a disease. However, 20% of the respondents spontaneously mentioned that tungiasis may develop from a nuisance into a disease.

In a study on knowledge, attitude and practices on tungiasis conducted in Kenya, Kimani, Nyagero and Ikamari (2012), found out that 59.8% of the respondents reported that persons suffering from tungiasis were lazy, 8.3% reported that they were irresponsible, 26.2% reported that they were poor while 12% reported that they were either persons from specific families who must suffer from tungiasis, people with certain blood group, elderly, illiterate or neglected children. The reasons for tungiasis persistence at that time and era were also sought where 79.3% reported poor hygiene and sanitation, 43.5% reported poverty, 9.6% reported varied reasons (that included illiteracy, drought and laziness), and 5.5% reported soil type while 2.6% reported that tungiasis is normal.
Although the respondents reported mixed attitude towards tungiasis, the tungiasis problem is often brushed off as a thing of the past or as a minor problem that can be relegated for more pressing issues (Kimani, Nyagero & Ikamari, 2012). Public health experts warn that heavy tungiasis goes beyond mere discomfort and can lead to loss of toe/finger nails, amputation of the digits and could even cause death which only exacerbate the problem further (Ehrenberg & Ault, 2005).

2.9 Presentation of Tungiasis in Human

The clinical presentation in humans follows the Fortaleza classification as the stage of infection will determine the symptoms present. Symptoms begin in stage two of life cycle because patients are not likely to present themselves at the early stages of infection, mostly because the flea’s burrowing is usually not felt. This may be due to a keratolytic enzyme secreted during stage one (Gibbs, 2009).

The patient with a single flea may present as early as stage two when, though the erythema is barely perceptible, a boring pain and the curious sensation of pleasant itching occur (Eisele et al., 2003). This inflammatory reaction is the initial immunological response to the infestation. Heavily infested patients may not notice a stage two infection due to the other fleas’ causing irritation as well. Feces may be seen, but this is more common in the 3rd stage (Eisele et al., 2003). Around the third day after penetration, erythema and skin tenderness are felt, accompanied by pruritus (severe itching) and a black furuncular nodule surrounded by a white halo of stretched skin
caused by the expansion of the flea. Fecal coils may protrude from the center of the nodule where the flea’s anus is facing upward (Eisele et al., 2003). They should be washed off quickly as the feces may remain in the skin unless removed. During this initial sub-stage of the third stage, pain can be severe, especially at night or if the nodule is on the foot, while walking. Eggs will also begin to be released and a watery secretion can be observed (Eisele et al., 2003). The radical metamorphosis during the 3rd to 6th day after penetration or neosomy, precedes the formation of a small caldera-like rim rampart as a result of the increased thickness of the flea’s chitin exoskeleton. During the caldera formation, the nodule shrinks a bit and it looks as if it is beginning to dry out; this takes 2 weeks and comprises the final sub-stage of the third stage (Eisele et al., 2003).

At the third week after penetration and the fourth stage, the eggs release will have stopped and the lesion will become smaller and more wrinkled. As the flea is near death, fecal and water secretion will stop altogether (Eisele et al., 2003). Pain, tenderness, and skin inflammation will still be present. Around the 25th day after penetration, the lesion looks like a black crust and the flea’s carcass is removed by host repair mechanisms and the skin begins to heal. With the flea gone, inflammation may still persist for a while (Eisele et al., 2003). Although patients would not present within the 5th stage of tungiasis as the flea would be dead and no longer in the body, this stage is characterized by the reorganization of the skin (1–4 weeks) and a circular residue of 5–10 mm in diameter around the site in penetration. An intraepithelial abscess, which developed due to the presence of the flea, will drain and later heal. Although these
disease residues would persist for a few months, tungiasis is no longer present (Eisele et al., 2003).

In severe cases, ulcers are common as well as complete tissue and nail deformation. A patient may be unable to walk due to severe pain if too many of the lesions are present in the feet. Suppuration (pus formation), auto-amputation of digits (via ainhum) and chronic lymphedema may also be seen (Gibbs, 2009). If the patient is not vaccinated, tetanus is often a complication due to secondary infection. Gangrene is another common complication of severe infestation and super infection. *Staphylococcus aureus* and *Wolbachia endobacteria* can be transmitted by *Tunga penetrans* as well as nearly 150 other different pathogens (Gibbs, 2009). For these reasons, the flea should be removed as soon as possible.

### 2.10 Management and Treatment of Tungiasis

As the disease is self-limiting, at least when exposure to the parasite is limited, management is mostly confined to treatment (Gibbs, 2009). Due to the secondary infection that can cause serious medical issues, the recommended course of action upon diagnosis is surgical extraction of the flea followed by the application of a topical antibiotic. Care should be taken to avoid tearing the flea during the extraction procedures as severe inflammation will result (Gibbs, 2009). The same will occur if part of the flea is left behind. Sterile equipment should always be used, as contaminated instruments could act as mechanical vectors for pathogens to enter the body (Gibbs, 2009).
There is no drug that has proven to be effective against embedded fleas. Oral niridazole was once considered a therapeutic drug, but well-designed studies are lacking and given the severe adverse effects, this is one drug that is likely to cause more harm than good. However, it has some anecdotal evidence of lysing the fleas altogether (Gibbs, 2009). Oral ivermectin is considered by some in endemic areas to be a panacea against the fleas but studies using high doses have failed to validate this hypothesis. Other drugs such as topical ivermectin and metrifonate have been somewhat successful, but not enough to be significant (Nagy et al., 2007). For super infections, trimethoprim, sulfamethoxazole, metronidazole, amoxicillin, (with/without clavulanate) have been used successfully, though these treat only secondary infections (Joseph et al., 2006).

Successful topical treatments also include cryotherapy and electrodesiccation of the lesion. If formaldehyde or chloroform is used topically, care should be taken when dealing with the resulting morbidity. *Tunga penetrans* flea can also be suffocated using occlusive petrolatum, while Vaseline will kill the organism as well, most likely due to suffocation as the stigmatas would be covered (Gibbs, 2009). Even without treatment, the burrowed fleas will die within five weeks and are naturally sloughed off as the skin sheds.
CHAPTER THREE: MATERIALS AND METHODS

3.1 Study Design
This was a cross sectional study basically designed to survey a sample of population elements at one point in time. The design was useful in providing a snapshot of what was going on with the variables of interest and establishing association between the variables. The limited time for carrying out this research also made this to be an appropriate study design.

3.2 Measurement of Variables
3.2.1 Independent Variables
The independent variables in this study were demographic, socio-economic and environmental factors as well as perception towards tungiasis. Demographic variables in this study were age, sex, religion and level of education. Age was categorized with interval of 10 years between the categories with the first category being that of respondents who were 19 years and below followed by those who were between 20 and 29 years. The final category was of those respondents who were 60 years and above. The study did not interview any respondent below the age of 18 years.

Sex of respondents was either male or female. In terms of religion, the study classified respondents as either Christians or Muslims. Christians were taken to include all those who profess the Christian faith regardless of their various groupings. Muslims were all those respondents who profess the Islamic faith. Education was measured using educational levels with the highest level being post secondary. This was for the
respondents who had either attained a college or university certificate. This was followed by secondary level which captured respondents who had attained Kenya Certificate of Secondary Education (KCSE). The next level was primary which recorded respondents who had attained Kenya Certificate of Primary Education (KCPE). The final level was for those who had no formal education.

The socio-economic variables that were included in this study were occupation of respondents, average monthly income for households, the main source of water for households’ use and wearing of shoes by household members. Occupationally, respondents were classified as employed, self employed or unemployed. Those working for salary or wages either in the public or private sector were considered as employed whereas those operating their own businesses or engaging in farming activities or both were self employed. Those not employed or self employed were treated as unemployed.

Average household income was the money that on average a household could get per month from any source including from household members who were 18 years and above. Monthly household income was put into Kshs. 5,000 categorization with the least category being that of less than Kshs. 5,000 followed by Kshs. 5,000 to Kshs. 9,999. The final category was that of Kshs. 25,000 and above.

The main source of water for households’ use was either river, well, rain water or tap. Those households that mostly used water from the nearby rivers were considered to have river as their main water source. Those households that mostly obtained their water from shallow dug wells were treated as majorly receiving their water from well.
Those households that had erected a rain water harvesting system and mostly relied on the harvested rain water to meet their domestic water demand were considered as sourcing their water from rainfall. Those households connected to main water supply from the local water provider and had a tap inside the house or stand pipe on the compound were considered as getting their water from tap.

Wearing of shoes by respondents at the time of the study was done through direct observation by the researcher. Those who had shoes completely covering their feet were grouped as wearing closed shoes while those wearing shoes that did not entirely cover their feet were grouped as wearing open shoes. Those walking bare foot were grouped as wearing no shoes at all.

Environmental variables in this study were type of house occupied by respondents, type of house floor, presence of domestic animals particularly chicken, where domestic animals slept and the sanitary state of the household compound. Type of house was permanent, semi permanent or temporary. A permanent house was one made of blocks, bricks or stone walls with a cemented floor and a roof of galvanized corrugated iron sheets or tiles. A semi permanent house was one made of timber walls with a cemented floor and a roof of galvanized corrugated iron sheets. A temporary house on the other hand was one made of mud walls with an earthen floor and a roof of either galvanized corrugated iron sheets or grass thatch. The type of house floor was either cemented or earthen. A cemented floor was one with a floor finish of cement sand screed while an earthen floor was one with a floor finish of smeared cow dung or plain mud.
The presence of domestic animals majorly targeted chicken. Domestic animals were either present or absent. A chicken in the household was sufficient to consider that household as having domestic animals. The study also sought to know where the domestic animals slept. Next to the living house was where the structure for the domestic animals to sleep in was erected adjacent to the living house while away from the living house was where the structure for the domestic animals to sleep in was erected and detached from the living house. Domestic animals sleeping in the living house was where they shared the house with the household members. The sanitary state of household compound was measured in terms of being clean, dusty, dirty or bushy. A clean compound was one free of dirt and refuse as well as being well kept. A dirty compound was one with refuse or rubbish thrown anyhow. A bushy compound was one with long and unkempt grass and shrubs. A dusty compound was one with loose top soil which could easily be blown by wind.

Perception of respondents towards tungiasis was measured qualitatively by analyzing questions that respondents were asked. The questions sought to find out how respondents viewed those who were suffering from tungiasis, whether they considered tungiasis to be a problem in their community and the ways of addressing the problem of tungiasis.

3.2.2 Dependent Variable

The dependent variable was tungiasis. Tungiasis is an ectoparasitic skin disease caused by the penetration of *Tunga penetrans* into the epidermis of man. In this study, tungiasis
was nominally measured where any household member who had one or more *Tunga penetrans* embedded in the skin under the toe nails and or fingernails with the resultant visible posterior segments of the penetrated flea or circular whitish lesions with a central black speck showing posterior segments was considered to have tungiasis. It was the presence of *Tunga penetrans* that determined tungiasis in an individual and this was done through observation.

### 3.3 Study Site

The research was carried out in Mbiri Division of Murang’a East Sub county. Murang’a East Sub county is one of the eight Sub counties in Murang’a County. The Sub county total area is approximately 110 square kilometers. Murang’a East Sub county was conveniently chosen for this study because it is one of the twenty Sub counties in the country which the ministry of health considers to have the highest tungiasis prevalence (MOPHS, 2012). In Murang’a county, Murang’a East Sub county accounts for 14% of all tungiasis cases (MOH, 2014). The study was conducted in Mbiri Division of Murang’a East; a rural Division within the Sub county. The Division was randomly chosen among other Divisions in the Sub county and it has two Locations namely Muchungucha and Gikandu. The Division accounts for 28% of tungiasis in the Sub county (MOH, 2014). The other Divisions in the Sub county are Township and Gaturi.

### 3.4 Study Population

The study targeted household heads living in Gikandu and Muchungucha Locations of Mbiri Division; Murang’a East Sub county. Gikandu Location had 1,107 households
while Muchungucha Location had 1,462 households with a total population of 13,403 (Kenya National Bureau of Statistics [KNBS], 2010).

3.4.1 Inclusion Criteria

Household heads who consented to participate in the study whether they had tungiasis or not and regardless of whether other household members had tungiasis or not were included in the study. In the absence of the household head, any other responsible member of that household who was above 18 years old and consented to be part of the study was included. Observations were made on all other household members who were suffering from tungiasis regardless of their age. Direct recruitment of potential study participants was undertaken by explaining to the household heads or their representatives in person of what the entire study was all about. This was done by the researcher and his trained research assistants.

3.4.2 Exclusion Criteria

The study excluded all households within the study area whose heads did not consent to participate in the study. Households whose heads or any other responsible member were absent at the time of the study were also excluded from the study.

3.5 Sample Size Determination

Fisher et al. (1998) formula \( n = \frac{Z^2pq}{d^2} \) was used to determine the sample size of actual number of households for the study.

Where \( n \) = the desired sample size (if the target population is greater than 10,000).

\[ Z = \text{the standard normal deviate at the required confidence level, 95\% (1.96).} \]
p = the proportion in the target population estimated to have tungiasis.
q = 1 - p (the proportion without tungiasis).
d = the level of statistical significance (0.05).

\[ n = (1.96)^2 \times (0.5) \times (0.5) / (0.05)^2 \]
\[ = 384 \]

For 2,569 households, \( n_f = n/(1+n/N) \) was used to calculate sample size, where \( n_f = \) the desired sample size and
\[ N = \] the estimated total population less than 10,000
\[ n = \] the estimated sample when the estimated total population is greater or equal to 10,000.

\[ 384/(1+384/2569) \]
\[ = 384/1.149 = 334 \]

### 3.6 Sampling Techniques

A total of 334 households participated in the study from the two Locations. Based on proportionate sampling, 190 households from Muchungucha and 144 households from Gikandu were included in the study. Households in the two Locations formed the sampling frame where simple systematic random sampling of the households was done in order to select the actual households. The sampling interval was determined by the formula below;

\[ K = N/n \]

Where \( N = \) total population (2,569 household),
\[ n = \] sample size (334 household),
\[ K = \] sampling interval.

Therefore \( K = 2569/334 = 7.7 \) households
This was approximated to 8 households.

Therefore, households were sampled at an interval of 8. The total number of households in the study area were listed in an arbitrary order and selecting every 8th household starting with a randomly selected household between 1 and 8.

3.7 Construction of Research Instruments

The instruments developed for data collection in the study were structured interview schedule and observation checklist. Structured interview schedule collected quantitative data on demographic and socio-economic characteristics of the respondents as well as data about their perception on tungiasis. Observation checklist was used to gather data that could be observed directly from the respondents’ households.

3.8 Pre-test

Five research assistants were recruited and trained on how to administer interview schedule and observation checklist. Prior to data collection, pre-testing was conducted in 33 selected households in the neighboring Njogu-ini Location. The aim of the pre-test was to see if the questions in the interview schedule were simple, clear and relevant. It was also meant to check for their reliability and validity. After the pre-test, the interview schedule was amended to enhance it. The final interview schedule had three sections: Section A was on demographic and socio-economic factors and it had eight questions. Section B was on perception and it had seven questions. Section C was on environmental factors with eight areas for observation.
3.9 Data Collection Techniques

Data collection methods were interview and observation. Data was collected using structured interview schedule and observation checklist.

3.9.1 Demographic and Socio-economic Data

Interview schedules were used to collect data from respondents on demographic and socio-economic characteristics. Data collected included age, sex, religion, educational level and occupation of respondents. Also collected were household average monthly income and the main source of water for domestic use. Interviews were conducted by the researcher and his research assistants with household heads at their homesteads. They were asked structured questions and given multiple choices to choose from. Demographic and socio-economic characteristics were analyzed for the 334 households as well as for the 23 households that had at least tungiasis case.

3.9.2 Data on Environmental Factors

Observation checklist was used to gather data on environmental factors related to tungiasis. The researcher and his research assistants basically observed the households to establish the following variables: type of house occupied by respondents, type of house floor, presence of domestic animals (particularly chicken) and where the domestic animals slept as well as the sanitary state of household compound.
3.9.3 Data on Perception

Interview schedules were used to collect data on respondents’ perception regarding tungiasis. The researcher posed both multiple choice and open ended questions to the respondents. The questions sought to find out how the respondents viewed persons who had tungiasis, whether they thought tungiasis was a problem in their community and why they thought so. Finally, the respondents were asked to give possible solutions for addressing tungiasis in their community. Perception was measured by analyzing those questions that were asked.

3.10 Data Analysis and Presentation

Data collected was coded and statistically analyzed using Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics such as mean, percentages and frequencies were useful in ensuring that the large amount of numerical data was organized and summarized in such a way that it was meaningfully understood and communicated. Chi-square Test of independence and Fisher’s Exact Test were used to draw generalization and inferences. The results of the study were presented in tables, graphs and charts. Conclusions were made from the findings while recommendations were based on conclusions.

3.11 Ethical and Logistical Considerations

The researcher sought approval to conduct the study from Kenyatta University Graduate School and clearance from Kenyatta University Ethics Review Committee. Research permit was obtained from the National Commission for Science, Technology and
Innovation. At the county level, the County Commissioner and the County Public Health Officer for Murang’a County as well as the County Director of Education were consulted and they gave their written permission before the research started.

Signed consent was sought from participants after explaining and describing to them pertinent information about the study. These included the study design, name and address of researcher, the purpose of the research, criteria that would be used to determine eligibility, significant risks (if any), benefits of participation, time commitment required, the location of the research, person or office to contact for further information and the means of consenting and withdrawing to the study if need arose. The degree to which the information collected about respondents was to be kept confidential was also explained to them. In case of withdrawal from the study, no victimization or coercion were to be used against those opting out and their information collected thus far was kept confidential and destroyed. The researcher forthwith linked those who had tungiasis with community health volunteers (CHVs) for treatment at the household level since CHVs are trained and supplied with tungiasis treatment medicine and *Tunga penetrans* control chemicals. All participants were interviewed in places where they were comfortable to ensure their privacy.

Data collection instruments were designed in a manner that was not to allow collection of information that could readily identify participants thus no name, addresses, date of birth, mobile phone number, email address and such like information about respondents was collected. Only relevant information that enabled the researcher to achieve the study’s objectives was collected.
CHAPTER FOUR: RESULTS

4.1 Demographic and Socio-economic Factors

Table 4.1 shows the demographic and socio-economic characteristics of respondents.

The results indicate that 17.3% of the respondents were aged 19 years and below while those in the age bracket of 20 to 29 years were 21%. Those respondents aged between 30 to 39 years accounted for 19.2% while those aged between 40 to 49 years were 17.7%. The least (7.5%) were in age bracket of 50 to 59 years and those 60 years and above were 17.3%. Majority (71.3%) of respondents were females while 28.7% were males. Almost all (99.4%) of the respondents were Christians with Muslims comprising of a paltry 0.6%. Analysis of level of education revealed that 58.7% had attained primary level education and 19.8% had attained secondary level. Only 5% had attained post secondary education level and 16.5% had no formal education. More than half (64.4%) were self employed while 6% reported to be in formal employment whereas those unemployed were 29.6%.

Majority (41.6%) of households reported an average monthly income of between Kshs. 5,000 and Kshs. 9,999 while 39.5% reported a monthly income of less than Kshs. 5,000. Those with monthly income of between Kshs. 10,000 and 14,999 were 5.7% just like those whose monthly income was between Kshs. 15,000 and 19,999. 2.1% of households reported an average monthly income of between Kshs. 20,000 and 24,999 while 5.4% reported Kshs. 25,000 and above. Over half (71.9%) of households relied on rivers as the main source of domestic water. 17.4% and 10.2% obtained their water from wells and rainfall in that order. Only 0.5% had tap water.
Table 4.1: Distribution of respondents by demographic and socio-economic characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequencies (n=334)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 19 years</td>
<td>58</td>
<td>17.3</td>
</tr>
<tr>
<td>20 - 29 years</td>
<td>70</td>
<td>21.0</td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>64</td>
<td>19.2</td>
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<tr>
<td>40 - 49 years</td>
<td>59</td>
<td>17.7</td>
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<td>50 - 59 years</td>
<td>25</td>
<td>7.5</td>
</tr>
<tr>
<td>≥ 60 years</td>
<td>58</td>
<td>17.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>96</td>
<td>28.7</td>
</tr>
<tr>
<td>Female</td>
<td>238</td>
<td>71.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>332</td>
<td>99.4</td>
</tr>
<tr>
<td>Islam</td>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>196</td>
<td>58.7</td>
</tr>
<tr>
<td>Secondary</td>
<td>66</td>
<td>19.8</td>
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<tr>
<td>Post secondary</td>
<td>17</td>
<td>5.0</td>
</tr>
<tr>
<td>None (no formal education)</td>
<td>55</td>
<td>16.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
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</tr>
<tr>
<td>Employed</td>
<td>20</td>
<td>6.0</td>
</tr>
<tr>
<td>Self employed</td>
<td>215</td>
<td>64.4</td>
</tr>
<tr>
<td>Unemployed</td>
<td>99</td>
<td>29.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td><strong>Monthly income in Ksh.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5,000</td>
<td>132</td>
<td>39.5</td>
</tr>
<tr>
<td>5,000 - 9,999</td>
<td>139</td>
<td>41.6</td>
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<td>10,000 - 14,999</td>
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</tr>
<tr>
<td>≤ 25,000</td>
<td>18</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td><strong>Main source of water</strong></td>
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<td></td>
</tr>
<tr>
<td>River</td>
<td>240</td>
<td>71.9</td>
</tr>
<tr>
<td>Well</td>
<td>58</td>
<td>17.4</td>
</tr>
<tr>
<td>Rain water</td>
<td>34</td>
<td>10.2</td>
</tr>
<tr>
<td>Tap</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>334</td>
<td>100</td>
</tr>
</tbody>
</table>
4.2 Prevalence of tungiasis in the study area

Table 4.2 summarizes the results for the dependent variable. The results indicate that out of the 334 households visited, 6.9% reported at least one case of tungiasis. The total tungiasis cases were 35. This accounted for 2% of the total population of 1,738 in the 334 households. Majority (65.8%) of those infested were children, the elderly were 11.4% while adults accounted for 22.8%. 40% were females and 60% were male. Slightly more than half (55.7%) of them were pupils, 20% were self employed and 24.3% were unemployed. The study observed that 62.9% were not wearing shoes, 28.5% were wearing open shoes while 8.6% were using closed shoes at the time of the study.
Table 4.2: Demographic and socio-economic characteristics for those suffering from tungiasis

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequencies</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households with tungiasis</td>
<td>23</td>
<td>6.9</td>
</tr>
<tr>
<td>Households without tungiasis</td>
<td>311</td>
<td>93.1</td>
</tr>
<tr>
<td>Total</td>
<td>334</td>
<td>100</td>
</tr>
<tr>
<td>Total tungiasis cases</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children (0-17 years)</td>
<td>23</td>
<td>65.8</td>
</tr>
<tr>
<td>Adults (18-59 years)</td>
<td>8</td>
<td>22.8</td>
</tr>
<tr>
<td>Elderly (60 years and above)</td>
<td>4</td>
<td>11.4</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>60.0</td>
</tr>
<tr>
<td>Female</td>
<td>14</td>
<td>40.0</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100</td>
</tr>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>27</td>
<td>77.1</td>
</tr>
<tr>
<td>No formal education</td>
<td>8</td>
<td>22.9</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils</td>
<td>19</td>
<td>55.7</td>
</tr>
<tr>
<td>Self employed</td>
<td>7</td>
<td>20.0</td>
</tr>
<tr>
<td>Unemployed</td>
<td>9</td>
<td>24.3</td>
</tr>
<tr>
<td><strong>Wearing shoes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wore closed shoes</td>
<td>3</td>
<td>8.6</td>
</tr>
<tr>
<td>Wore open shoes</td>
<td>10</td>
<td>28.5</td>
</tr>
<tr>
<td>Wore no shoes at all</td>
<td>22</td>
<td>62.9</td>
</tr>
</tbody>
</table>

4.3 Relationship between Demographic and Socio-economic Factors with Tungiasis

Table 4.3 shows the relationship between demographic and socio-economic characteristics with tungiasis. The findings show that wearing shoes was significantly related with tungiasis: age ($p = 0.540$), sex ($p = 0.106$), educational level ($p = 0.797$), occupation ($p = 0.584$), household monthly income ($p = 0.995$), source of water for domestic consumption ($p = 0.529$) and wearing shoes ($p = 0.015$).
Table 4.3: Relationship between demographic and socio-economic factors with tungiasis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Household with tungiasis</th>
<th></th>
<th>χ²</th>
<th>df</th>
<th>p-value</th>
<th>FET (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 19 years</td>
<td>2 (4.0)</td>
<td>56 (54.0)</td>
<td>4.292</td>
<td>5</td>
<td>0.508</td>
<td>0.540</td>
</tr>
<tr>
<td>20 - 29 years</td>
<td>3 (4.8)</td>
<td>67 (65.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 - 39 years</td>
<td>5 (4.4)</td>
<td>59 (59.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 - 49 years</td>
<td>6 (4.1)</td>
<td>53 (54.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 - 59 years</td>
<td>1 (1.7)</td>
<td>24 (23.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 60 years</td>
<td>6 (4.0)</td>
<td>52 (54.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10 (6.6)</td>
<td>86 (89.4)</td>
<td>2.619</td>
<td>1</td>
<td>0.106</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>13 (16.4)</td>
<td>225 (221.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>14 (13.5)</td>
<td>182 (182.5)</td>
<td>1.028</td>
<td>3</td>
<td>0.795</td>
<td>0.797</td>
</tr>
<tr>
<td>Secondary</td>
<td>3 (4.5)</td>
<td>63 (61.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post secondary</td>
<td>1 (1.2)</td>
<td>16 (15.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>5 (3.8)</td>
<td>50 (51.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>0 (1.4)</td>
<td>20 (18.6)</td>
<td>1.702</td>
<td>2</td>
<td>0.427</td>
<td>0.584</td>
</tr>
<tr>
<td>Self employed</td>
<td>15 (14.8)</td>
<td>200 (200.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>8 (6.8)</td>
<td>91 (92.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monthly income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5,000</td>
<td>9 (9.1)</td>
<td>123 (122.9)</td>
<td>0.953</td>
<td>5</td>
<td>0.966</td>
<td>0.995</td>
</tr>
<tr>
<td>5,000 - 9,999</td>
<td>11 (9.6)</td>
<td>128 (129.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000 - 14,999</td>
<td>1 (1.3)</td>
<td>18 (17.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15,000 - 19,999</td>
<td>1 (1.3)</td>
<td>18 (17.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20,000 - 24,999</td>
<td>0 (0.5)</td>
<td>7 (6.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 25,000</td>
<td>1 (1.2)</td>
<td>17 (16.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Source of water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River</td>
<td>16 (16.5)</td>
<td>224 (223.5)</td>
<td>1.694</td>
<td>3</td>
<td>0.638</td>
<td>0.529</td>
</tr>
<tr>
<td>Well</td>
<td>3 (4.0)</td>
<td>55 (54.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain water</td>
<td>4 (2.3)</td>
<td>30 (31.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap</td>
<td>0 (0.1)</td>
<td>2 (1.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wearing shoes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed shoes</td>
<td>5 (9.9)</td>
<td>139 (134.1)</td>
<td>8.503</td>
<td>2</td>
<td>0.014</td>
<td>0.015**</td>
</tr>
<tr>
<td>Open shoes</td>
<td>10 (9.5)</td>
<td>128 (128.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No shoes at all</td>
<td>8 (3.6)</td>
<td>44 (48.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Significant at 0.05
4.4 Environmental Factors

4.4.1 Type of House Occupied by Respondents

Figure 4.1 shows the type of house occupied by respondents. The findings indicate that majority (39.5%) of the respondents were living in semi-permanent houses followed by 37.1% who lived in temporary houses. Only 23.4% lived in permanent houses. However, for those who were jigger infested, 83.3% lived in temporary houses compared to 16.7% who lived in semi-permanent houses.

![Figure 4.1: Type house occupied by respondents](image)

4.4.2 Type of House Floor

Table 4.4 indicates the type of house floor where 47.9% of house floors were earthen while 52.1% were cemented.
Table 4.4: Type of house floor

<table>
<thead>
<tr>
<th>Type of house floor</th>
<th>Frequencies (n=334)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthen</td>
<td>160</td>
<td>47.9</td>
</tr>
<tr>
<td>Cemented</td>
<td>174</td>
<td>52.1</td>
</tr>
</tbody>
</table>

4.4.3 Presence of Domestic Animals (chicken, dogs) at Respondents’ Households

Table 4.5 summarizes results on the presence of domestic animals whereby 88.6% of households had domestic animals (chicken and dogs) and 11.4% reported not having domestic animals. Those with chicken, 57.7% reported that the chicken slept next to the living house while 36.6% reported that their chicken slept away from the living house whereas 5.7% shared their living houses with chicken.

Table 4.5: Presence of domestic animals (chicken, dogs) at the respondents’ households

<table>
<thead>
<tr>
<th>Presence of domestic animals</th>
<th>Frequencies (n=334)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>296</td>
<td>88.6</td>
</tr>
<tr>
<td>Absent</td>
<td>38</td>
<td>11.4</td>
</tr>
</tbody>
</table>

4.4.4 Sanitary State of Household Compounds

Figure 4.2 shows the sanitary state of household compounds where 68.9% of the households’ surroundings was clean, 13.8% was dusty, 13.4% was dirty and 3.9% was bushy.
4.5 Relationship between Environmental Factors and Tungiasis

Table 4.6 reveals the relationship between environmental factors and jigger infestation. The results indicate that there was no significant relationship between environmental factors with tungiasis: type of house ($p = 0.151$), type of house floor ($p = 0.391$), presence of domestic animals ($p = 0.546$) and condition of household compound ($p = 0.209$).
Table 4.6: Relationship between environmental factors and tungiasis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Household with tungiasis</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of house</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent</td>
<td>2 (5.4)</td>
<td>76 (72.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi permanent</td>
<td>9 (9.1)</td>
<td>123 (122.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary</td>
<td>12 (8.5)</td>
<td>112 (115.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of house floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthen</td>
<td>13 (11.0)</td>
<td>147 (149.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cemented</td>
<td>10 (12.0)</td>
<td>164 (162.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Presence of domestic animals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>19 (19.8)</td>
<td>268 (267.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>4 (3.2)</td>
<td>43 (43.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>State of household compound</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean</td>
<td>12 (15.8)</td>
<td>218 (214.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dusty</td>
<td>&lt; 5 (3.2)</td>
<td>42 (42.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dirty</td>
<td>6 (3.1)</td>
<td>39 (41.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bushy</td>
<td>&lt; 5 (0.9)</td>
<td>12 (12.1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$</th>
<th>df</th>
<th>p-value</th>
<th>FET (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent</td>
<td>3.780</td>
<td>2</td>
<td>0.151</td>
<td></td>
</tr>
<tr>
<td>Semi permanent</td>
<td>0.735</td>
<td>1</td>
<td>0.391</td>
<td></td>
</tr>
<tr>
<td>Temporary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthen</td>
<td>0.225</td>
<td>1</td>
<td>0.635</td>
<td>0.546</td>
</tr>
<tr>
<td>Cemented</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>0.164</td>
<td>3</td>
<td>0.244</td>
<td>0.209</td>
</tr>
<tr>
<td>Dog</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.6 Perception of Respondents on Tungiasis

4.6.1 Whether Tungiasis was a Problem in the Community

Figure 4.3 shows the perception of respondents on tungiasis; whether it was a problem in their community or not. Results indicate that 53% were of the opinion that tungiasis was still a problem but 45.2% perceived that it was not a problem while 1.8% did not know.
Fig. 4.3: Response on whether tungiasis was a problem in the community or not

4.6.2 Why tungiasis was a Problem

Figure 4.4 shows reasons why respondents thought that tungiasis was a problem in their community. The findings revealed that majority (52.1%) observed that tungiasis was still a problem in their community because of poor personal hygiene and sanitation, 22.5% attributed it to poor housing while 9% thought the problem was persistent because of contact of people with chicken and dogs especially through sharing of the living room. Only 4.9% said that inadequate supply of insecticides was to blame. Ignorance of the community on *Tunga penetrans* prevention and control as well as walking bare footed were noted as contributing to tungiasis by 2.2% and 9.3% respectively.
4.6.3 How Respondents perceived those with tungiasis

Table 4.7 summarizes how respondents perceived those who were suffering from tungiasis. Majority (54%) of the respondents perceived them to be poor while 29% considered them to be lazy. Only 11% said they were illiterate and 6% perceived them to be mentally sick.

Table 4.7: Respondents’ perception towards those with tungiasis

<table>
<thead>
<tr>
<th>How those with tungiasis were perceived</th>
<th>Frequencies (n=334)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>180</td>
<td>54</td>
</tr>
<tr>
<td>Lazy</td>
<td>97</td>
<td>29</td>
</tr>
<tr>
<td>Illiterate</td>
<td>37</td>
<td>11</td>
</tr>
<tr>
<td>Mentally sick</td>
<td>20</td>
<td>6</td>
</tr>
</tbody>
</table>

Fig. 4.4: Reasons for tungiasis persistence in the community
4.6.4 Respondents’ Views on how to Address Tungiasis

Table 4.8 gives the views of the respondents on addressing the problem of tungiasis. The findings reveal that 49.4% reported continuous health education and promotion on personal hygiene and sanitation, 17% reported prompt treatment of the infested persons, 6.4% reported wearing of shoes while 14% reported use of insecticides for control of *Tunga penetrans*. House improvement (compacting earthen floors or changing earthen floors to cemented ones) was reported by 9.3% of the respondents while 3.9% reported use of adequate water for enhanced personal hygiene and sanitation.

**Table 4.8: Respondents’ views on how to address tungiasis**

<table>
<thead>
<tr>
<th>Solution</th>
<th>Frequencies (n=334)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous health promotion/education</td>
<td>165</td>
<td>49.4</td>
</tr>
<tr>
<td>Prompt treatment of infested persons</td>
<td>57</td>
<td>17</td>
</tr>
<tr>
<td>Use of insecticides</td>
<td>47</td>
<td>14</td>
</tr>
<tr>
<td>Wearing closed shoes</td>
<td>21</td>
<td>6.4</td>
</tr>
<tr>
<td>House improvement</td>
<td>31</td>
<td>9.3</td>
</tr>
<tr>
<td>Adequate water for hygiene and sanitation</td>
<td>13</td>
<td>3.9</td>
</tr>
</tbody>
</table>
CHAPTER FIVE: DISCUSSION

5.1 Demographic and Socio-economic Factors

Children were the most affected by tungiasis. This is in agreement with a study which was conducted in Western Nigeria where majority of those affected by tungiasis were children aged 5 to 14 years old and the elderly (Ugboroiko, Ofozie, & Heukelbach, 2007). Another study conducted in North West Cameroon realized that out of 1,151 individuals who were examined, 53% were infested with *Tunga penetrans* with the prevalence being highest in children, diminishing in adults and then increasing again in the elderly (Collins, 2009). These two groups (children and the elderly) are mostly helpless and rely on other people to help them address most of their needs. Children are particularly hit hard because they may be ignorant of tungiasis coupled with their inability to promptly remove *Tunga penetrans* and thus they end up suffering in silence (Pampiglione, 2009).

More than half (60%) of those affected by tungiasis were males and this could be due to the fact that males are less sensitive to their health compared to females. Education plays a major role in the health of people by enlightening them thus enabling them to make informed and prompt decisions pertaining to their health. In this study, majority (77.1%) of those with tungiasis were pupils.

The study was conducted in a rural set up where majority (64.4%) of respondents were self employed working on their small scale subsistence farms. Their average household monthly income was less than Kshs. 5,000. This could explain why many of them lived
in temporary and semi permanent houses of earthen floors. This study concurs with a research conducted by Njau, Wanzala, Mutugi, Ariza, and Heukelbach (2012) which realized that tungiasis was associated with among others, living in houses with earthen floors and walking barefooted because jigger fleas prefer dusty places and hiding in cracked floors. This study also noted that 62.9% of those affected by tungiasis walked barefooted and only 28.6% wore open shoes (sandals). A study by Kimani, Nyagero and Ikamari (2012) found that the type of floor and its status and the general maintenance of the compound were significantly associated with tungiasis among household members.

Water is an important driver for sanitation and other domestic uses. Most households (71.9%) obtained their domestic water from rivers some of which were far from their homestead making it difficult to ensure adequate supply of water for domestic use including for personal hygiene. Tungiasis is commonly found in developing countries, especially in resource-poor neighbourhoods and where basic hygiene standards are poor (Cestari, 2007).

Socio-economic factors are important when it comes to addressing many health conditions including tungiasis. A poor community causes its members to build houses that are made of mud walls and earthen floors since poverty among the people impedes ownership of cemented houses, shoes and other vital sanitary effects. This compels them to walk bare footed, reside in poorly built houses and share the houses with domestic animals which are reservoirs of the pest (Kiprono, Omondi & Wanyama, 2012). A study on tungiasis conducted in Brazil revealed that there was remarkable
reduction in tungiasis when people started using shoes as opposed to sandals (Winter, Oliveira, Wilcke, Heukelbach, & Feldmeier, 2009). Although the use of shoes can provide some measure of protection, it is unrealistic as a solution as neither eradication nor elimination of the parasite will occur. However, social efforts to improve hygiene, welfare and standard of living do provide additional protection against the jigger flea as tungiasis is mostly a disease of the poor. Tungiasis is associated with poverty and occurs in resource poor countries in the Caribbean, South America and Africa (Winter, Oliveira, Wilcke, Heukelbach, & Feldmeier, 2009).

5.2 Environmental Factors

All those who were suffering from tungiasis were living in temporary and semi-permanent houses. Those houses had either earthen or cemented floors. The floors were clean although some had cracks or they were chipped. Most (68.9%) household compounds were well maintained with exceptions which were dusty, dirty or bushy. Dusty surfaces, cracks and crevices in the walls and floors harbour *Tunga penetrans* and therefore should be avoided (Kimani, Nyagero & Ikamari, 2012). Hygiene is important in order to control pests and provide pleasant atmosphere to the household members (Kimani, Nyagero & Ikamari, 2012). Chicken and dogs in close vicinity to living quarters may harbour and transfer *Tunga penetrans* to man due to their domesticated nature and interactions with people, including sharing of common resting places. These domestic animals are invariably available in many households and even children find it enjoyable to play with them thus making it possible for the helpless children to come into contact with *Tunga penetrans* (Ugboroiko, Ariza, & Heukelbach, 2008). When
humans live in close contact with infested animals, the risk of infestation is high. Domestic animals live on compounds and in close proximity to homes either because of lack of adequate land to shelter animals, fear of theft or cultural practices. A study on tungiasis risk factors conducted in Nigeria indicated that co-habitation with pigs and dogs and poor housing condition played a pivotal role in the transmission of *Tunga penetrans* in the community. Other modifiable risk factors included the resting places of dogs on the compound (Ugomoiko, Ariza, Ofoezie, & Heukelbach, 2007a).

### 5.3 Perception on Tungiasis

Perception on tungiasis was varied whereby 45.2% of the respondents opined that tungiasis was not a problem in their community. Tungiasis, they said, was a thing of the past or a minor problem that had been blown out of proportion by the media and some PBOs engaged in *Tunga penetrans* control activities. Majority (53.6%) of the respondents perceived those persons who were suffering from tungiasis to be poor while the rest considered them to be lazy, illiterate and mentally sick. Similar observations were made in a study by Kimani, Nyagero and Ikamari (2012) where 59.8% reported persons with tungiasis to be lazy, 48.3% reported that they were irresponsible, 26.2% reported that they were poor while 12% reported that they were either persons from specific families who must suffer infestation, people with certain blood group, the elderly or neglected children.

Those who said that tungiasis was a problem in their community linked it to poor personal hygiene, poor housing, contact with infested chicken, inadequate supply of
insecticides and ignorance on *Tunga penetrans* prevention and control measures. Walking bare footed was also noted as contributing to tungiasis. This is also in agreement with the study by Kimani, Nyagero and Ikamari (2012) where they found out that people associated tungiasis with poor hygiene and sanitation (79.3%), poverty (43.5%), while the rest reported varied reasons that included illiteracy, drought and laziness.

On solution to address tungiasis, almost half (49.4%) of the respondents were in favour of continuous health promotion on hygiene and environmental sanitation. Poverty in most cases leads to poor hygiene and sanitation given that the essentials of hygiene and sanitation have a financial cost. Other measures proposed by respondents to address tungiasis were prompt treatment of the infested, wearing closed shoes, house improvement and maintenance of personal hygiene. These findings concur with the study by Kimani, Nyagero and Ikamari (2012) where they realized that maintenance of personal hygiene, improvement of dwelling place, health education and maintenance of environmental hygiene were suggested measures to tackle tungiasis.

Perception of community members towards tungiasis is critical since it influences their reaction toward tungiasis (Kimani, Nyagero & Ikamari, 2012). It is therefore important to inculcate the right perception in household members in order to develop a positive behaviour change for sustainable jigger prevention and control among household members.
6.9% of households sampled had at least a member who had tungiasis with a total of 35 cases being observed. This translated to a prevalence of 2% in the study area. That prevalence of tungiasis may not be significant in the study area due to the concerted efforts by health care workers, some PBOs and the locals in fighting tungiasis because the media had for quite some time described Murang’a East Sub county as the epicenter of tungiasis. Nationally, the Ministry of Health estimates that over 1.6 million (4%) of Kenyans are affected by tungiasis especially among the poorest households in endemic and high transmission counties (MOH, 2014a).
CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the findings, this study concludes as follows:

i) Children were the most affected by tungiasis and they were not wearing shoes at the time of the study.

ii) Majority of those who had tungiasis lived in temporary houses which had earthen floors.

iii) Most of the respondents opined that tungiasis was still a problem in their community and they attributed it to poor personal hygiene.

iv) Majority of the respondents perceived those who were suffering from tungiasis as poor and lazy persons.

v) 6.9% of the households sampled had at least one or more members who were suffering from tungiasis with a total of 35 cases.

vi) Wearing shoes was significantly related to tungiasis.

6.2 Recommendations

The study recommends the following:

i) The county government of Murang’a should consider subsidizing acquisition of closed shoes for children and the elderly in households with recurrent tungiasis cases to curtail the penetration of Tunga penetrans into their skin.
ii) The county government of Murang’a should also consider subsidizing house improvement (compacting earthen floors or cementing them) particularly for those households that experience persistent tungiasis cases.

6.3 Further Research

Further research should be carried out on knowledge or awareness on tungiasis among children and the elderly.
REFERENCES


Tungiasis risk factors in rural community in Murang’a County, Kenya

I am Wambani Zablon, a Master of Public Health student in the Department of Community Health, Kenyatta University. I am carrying out a research to determine the risk factors for tungiasis in this community. The information you provide will be kept confidential. Your name will not be written anywhere on this questionnaire. This study is primarily for academic purpose. Your cooperation in responding to this interview will be highly appreciated.

A. DEMOGRAPHIC AND SOCIO-ECONOMIC FACTORS

1. Age in years......................

2. Gender
   (a) Male       [   ]
   (b) Female     [   ]

3. Religion
   (a) Christian  [   ]
   (b) Islamic    [   ]
   (c) Others (specify)………………………………………………

4. Educational level
   (a) Primary    [   ]
   (b) Secondary  [   ]
   (c) Post secondary [  ]
   (d) None       [   ]
5. Occupation
(a) Employed [ ]
(b) Self employed [ ]
(c) Unemployed [ ]

6. What is the average income in Kenya shillings per month in this household?
.............................................

7. What is your main source of water?
(a) River [ ]
(b) Well [ ]
(c) Rain water [ ]
(d) Tap [ ]

8. What is the total number of your household members?....................................................

B. PERCEPTION ON TUNGIASIS

9. What leads to tungiasis?
(a) Poor personal hygiene [ ]
(b) Poor housing [ ]
(c) Witchcraft [ ]
(d) Others (specify).................................................................

10. How do you consider people suffering from tungiasis to be?
(a) Lazy [ ]
(b) Poor [ ]
(c) Illiterate [ ]
(d) Mentally retarded [ ]

11. Do you think tungiasis is a problem in this community?
(a) Yes [ ]
(b) No [ ]
(c) Don’t know [ ]

12. If yes to question 11 above, why do you think it is a problem?
.................................................................
.................................................................
.................................................................

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

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

13. What, in your opinion should be done to address the problem of tungiasis in this community?
14. Have you or any member of your household been affected by tungiasis in the last one week?

(a) Yes [ ]
(b) No [ ]

15. Characteristics of household member(s) who had tungiasis

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Age in years</th>
<th>Educational level</th>
<th>Occupation</th>
<th>Marital status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. ENVIRONMENTAL FACTORS (Observation Checklist)

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Description</th>
<th>Tick</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>To determine the type of house</td>
<td>Permanent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semi-permanent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temporary</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any other observation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To find out the type of house floor</td>
<td>Earthen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cemented</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Raised/Suspended</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any other observation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To find out the condition of the floor</td>
<td>Dirty</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cracked</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clean</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any other observation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To determine presence of domestic animals</td>
<td>Chicken</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dogs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To find out where domestic animals sleep</td>
<td>Any other observation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the living house</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Next to the living house</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Away from the living house</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any other observation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To determine the state of household surrounding (compound)</th>
<th>Any other observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td></td>
</tr>
<tr>
<td>Dusty</td>
<td></td>
</tr>
<tr>
<td>Dirty</td>
<td></td>
</tr>
<tr>
<td>Bushy</td>
<td></td>
</tr>
<tr>
<td>Any other observation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To find out whether household members wear shoes</th>
<th>Any other observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear closed shoes</td>
<td></td>
</tr>
<tr>
<td>Wear open shoes</td>
<td></td>
</tr>
<tr>
<td>Do not wear shoes at all</td>
<td></td>
</tr>
<tr>
<td>Any other observation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To determine the presence of tungiasis among household members</th>
<th>Any other observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td></td>
</tr>
<tr>
<td>Any other observation</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX II

INFORMED CONSENT FORM

I am Wambani Zablon, MPH (M&E) student from Kenyatta University undertaking a study on ‘Tungiasis Risk Factors in Rural Community in Murang’a County, Kenya’. The findings of this study will be useful to policy makers in the Ministry of Health and County government in designing *Tunga penetrans* prevention and control policy and guidelines to combat tungiasis among the high prevalent communities of Murang’a County.

**Procedures to be followed:** participation in this study will involve asking you some questions and examining you if you have tungiasis or any other member of your household. I will record your responses in interview schedule and observations in observation checklist. You have the right to refuse to participate in responding to the questions in this study and you will not be victimized for doing so or even withdrawing after you have started. Kindly note that your participation in this study is absolutely on voluntary basis and you may ask questions related to this study at any time.

**Confidentiality:** the information you will provide will not be revealed to anybody but only used for academic purpose in this study. The interview will be held in private and your name will not be recorded anywhere on the interview schedule.

**Discomforts and Risks:** if some questions make you uncomfortable, you will be at liberty to discontinue the interview without you suffering any consequences. This interview is about 20 to 30 minutes.

**Benefits:** your participation in this study will give more insights about risk factors for tungiasis and the best control measures to be adopted so as control and subsequently eliminate tungiasis in our county.

**Contact Information:** in case you have further questions, feel free to contact me on 0721871200 or my academic supervisors Dr. Jackim Nyamari on 0722589335 or Dr. Haron Kimani on 0725552475. You can still make your inquiries to Kenyatta
University Ethics Review Committee on chairman.kuerc@ku.ac.ke, secretary.kuerc@ku.ac.ke, ercku2008@gmail.com

**Respondent’s Statement:** the above information regarding my participation in this study has been clearly explained to me. I have consented to participate in the study without coercion or inducement whatsoever. I understand that my records will be treated with utmost confidentiality and only used for academic purpose of this study. Further, I know that I can leave this study at any time and I will not suffer any consequences as a result of such withdrawal.

Name of Respondent……………………………………………………………………………………………………………………………

Signature/Thumb print…………………………………………………Date…………………………………

**Researcher’s Statement:** I, the undersigned, have explained to the respondent in a language that s/he understands (Kikuyu/Kiswahili/English) the procedures to be followed in the study, confidentiality issues and the benefits as well as the risks that may be involved.

Name of Researcher: Wambani Zablon

Signature…………………………………………………Date…………………………………
APPENDIX III

KENYATTA UNIVERSITY GRADUATE SCHOOL RESEARCH APPROVAL LETTER

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke
P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: P57/PT/10510/20008
DATE: 17th June 2014

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

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION WAMBANI ZABLON—REG. NO.
P57/PT0510/2008

I write to introduce Mr. Wambani Zablon who is a Postgraduate Student of this University. He is registered for M.Phil. degree programme in the Department of Community Health.

Mr. Wambani intends to conduct research for a M.Phil. Proposal entitled, “Tungiasis-related Risk factors in Rural Communities in Murang’a County, Kenya”.

Any assistance given will be highly appreciated.

Yours faithfully,

MR. DAVID NJROGE
FOR: DEAN, GRADUATE SCHOOL
APPENDIX IV

KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE APPROVAL LETTER

Our Ref: KU/E/COMM/51/401

Date: 9th February, 2015

Wambani Zablon
Kenyaatta University,
P.O Box 43844,
Nairobi

Dear Wambani,

RE APPLICATION NUMBER PKU/266/1 242 – “TUNGIASIS-RELATED RISK FACTORS IN RURAL COMMUNITIES IN MURANGA COUNTY, KENYA” - VERSION 2

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic “Tungiasis-related risk factors in rural communities in Muranga County, Kenya” Version 2 received on 28th November, 2014.

2. APPLICANT

Wambani Zablon, Department of Community Health

3. STUDY SITE

Muranga, Kenya.

4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines AND APPROVED that the research may proceed for a period of ONE year from 9th February, 2015.

5. ADVICE/CONDITIONS

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.

ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.

iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.

iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.

If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

PROF. NICHOLAS K. GIKONYO
CHAIRMAN ETHICS REVIEW COMMITTEE

I hereby accept the advice given and will fulfill the conditions therein.

Signature........................................... Dated this day of........................................... 2015.

cc. Vice-Chancellor
APPENDIX V

NACOSTI RESEARCH AUTHORITY

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

Ref: No.

23rd June, 2015

NACOSTI/P/15/7028/5851

Zablon Wambani Wafula
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “Tungiasis related risk factors in rural communities in Muranga County, Kenya,” I am pleased to inform you that you have been authorized to undertake research in Murang’a County for a period ending 6th November, 2015.

You are advised to report to the County Commissioner and the County Director of Education, Murang’a County before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

Said Hussein
For: Director-General/CEO

Copy to

The County Commissioner
Murang’a County.

The County Director of Education
Murang’a County.
APPENDIX VI

NACOSTI RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. ZABLON WAMBANI WAFULA
of KENYATTA UNIVERSITY, 0-10200 muranga, has been permitted to conduct
research in Muranga County

on the topic: TUNGIASIS RELATED RISK
FACTORS IN RURAL COMMUNITIES IN
MURANGA COUNTY KENYA

for the period ending:
6th November, 2015

Applicant’s
Signature

Permit No: NACOSTI/P/15/7028/5851
Date of Issue: 23rd June, 2015
Fee Received: Ksh 1,000

Director General
National Commission for Science,
Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and
the County Education Officer of the area before
embarking on your research. Failure to do that
may lead to the cancellation of your permit
2. Government Officers will not be interviewed
without prior appointment.
3. No questionnaire will be used unless it has been
approved.
4. Excavation, filming and collection of biological
specimens are subject to further permission from
the relevant Government Ministries.
5. You are required to submit at least two (2) hard
copies and one (1) soft copy of your final report.
6. The Government of Kenya reserves the right to
modify the conditions of this permit including
its cancellation without notice.

RESEARCH CLEARANCE
PERMIT

CONDITIONS: see back page
APPENDIX VII

COUNTY COMMISSIONER’S RESEARCH APPROVAL

REPUBLIC OF KENYA

THE PRESIDENCY
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT

Telephone: 060-2030407
Email: ccmuranga@gmail.com

When replying please quote

COUNTY COMMISSIONER
MURANG’A COUNTY
P. O. BOX 7-10200
MURANG’A

REF. NO. PUB. 24/11/VOL. 1/169

26th June, 2015

Zablon Wambani Wafula
Kenyatta University,
P.O. Box 43844-01000,
Nairobi.

RE: RESEARCH AUTHORIZATION

In reference to a letter NACOSTI/P/15/7028/5851 dated 23rd June, 2015 from the National Commission for Science, Technology and Innovation regarding the above subject. You are hereby authorized to carry out research on “Tungiasis related risk factors in rural communities in Muranga County” for a period ending 6th November, 2015.

BENSON M. KAMAU
For: COUNTY COMMISSIONER
MURANG’A COUNTY.
APPENDIX VIII

COUNTY DIRECTOR OF EDUCATION'S RESEARCH APPROVAL

MINISTRY OF EDUCATION SCIENCE AND TECHNOLOGY

Telegram "SCHOOLING", Murang’a
Telephone: Murang’a 060-2030227
When replying please quote

REPUBLIC OF KENYA

COUNTY DIRECTOR OF EDUCATION
MURANG’A COUNTY
P.O.BOX 118 - 10200
MURANG’A

REF: M’GA/CTY/GEN/64/VOL. I/282

30th June, 2015

Zablon Wambani Wafula
Kenyatta University,
P.O. Box 43844-01000,
NAIROBI.

RE: RESEARCH AUTHORIZATION

The County Education office is in receipt of your request and authority letter from the National Commission for Science, Technology and Innovation, reference no. NACOSTI/P/15/7028/5851 dated 23rd June, 2015 to carry research on “Tungiasis related risk factors in rural communities in Murang’a County, Kenya”.

Authority is granted to carry out research in Murang’a East Sub-county - for a period ending 6th November, 2015.

MARY W. GATURU
COUNTY DIRECTOR OF EDUCATION
MURANG’A COUNTY
APPENDIX IX

COUNTY PUBLIC HEALTH OFFICER’S RESEARCH APPROVAL

MINISTRY OF HEALTH

Telegram
‘MEDICAL”, MURANGA
TELEPHONE: (060) 30244, 30245
Fax (060) 30244
When replying please quote

COUNTY PUBLIC HEALTH OFFICE,
MURANG’A COUNTY,
P.O. BOX 69-10200,
MURANGA.

REF: MRG/DPHO/SPHT/15/VOL.III/197
DATE: 24th June 2015

Zablon Wambani Wafula,
Kenyatta University,
P.O Box 43844-00100,
Nairobi.

RE: RESEARCH AUTHORIZATION

The above subject matter refers.

Permission is hereby granted for you to carry out research on ‘Tungiasis Related Risk Factors in Muranga East District’ for a period ending 6th November 2015.

JOHN MYANIKI
COUNTY PUBLIC HEALTH OFFICER
MURANG’A COUNTY.

Cc
County Director of Health, Murang’a County
APPENDIX X
MAP OF MURANG'A COUNTY SHOWING THE STUDY AREA (MURANG'A EAST SUB COUNTY)
DECLARATION

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

Signature................................. Date 9/6/2017

Wambani Zahlon- P57/PT/10510/2008
Department of Community Health

This thesis was submitted with our approval as university supervisors.

Signature ................................ Date..................................

Dr. Harun Kimani
Department of Community Health
Kenyatta University

Signature ................................ Date 9/6/2017

Dr. Jackini Nyamari
Department of Environmental and Occupational Health
Kenyatta University