THE PREVALENCE, RISK FACTORS AND TREATMENT METHODS FOR TUNGIASIS AMONG RESIDENTS OF MUSOKOTO SUB-LOCATIONIN KENYA

BY

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DECLARATION

THE STUDENT

I, Albert KiprotichNgetich do hereby declare that this thesis is my original work and has not been submitted for the award of a degree or diploma in any other university or college.

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DEDICATION

To my lovely wife Linet and daughters Lorrele and Abrielle.

ABSTRACT

Tungiasis is a parasitic skin disease caused by sand flea Tungapenetrans. The disease is endemic in Latin America, the Caribbean and Africa.In Kenya, little data has been published regarding tungiasis generally. In Nambale health centre, tungiasisaccounted for 4% of total morbidities at the outpatient department. The prevalence of tungiasis among residents of Musokoto sub-location, the risks factors associated with tungiasis infestations and treatment methods used by Musokotoresidents to treat tungiasis are uncertain. Therefore this study sought to assess the prevalence of, risk factors and treatment methods for tungiasis among residents of Musokoto, in Kenya. Purposive sampling method was used to select Musokoto sub-location based on the previous reports of tungiasis prevalence from the health center. The 8 villages in the sub location were used in the study and 333 households were sampled using proportionate systematically random sampling.Prevalence was determined as percentage of infested individual out of total household population examined for tungiasis. Logistic regression was used to determine the risks factors associated with tungiasis. A total 1557 participant from 333 randomly selected households took part in the study. Of the 1557 participants, a total of 441(28.3%) at least had jiggers at one point in their life. Out of the 441, 287(65%) were confirmed to have jiggers on examination whereas 9(2%) did not have jigger by the time of the study. Toes on the extreme sites were more infested however the distribution of infestation was moral less the same for the all toes. Above 50% of those infested were aged 10 years and below. Logistical regression analysis revealed that place of sleeping ($P<0.001$, OR = 1.319, CI = 1.180 - 1.474) significantly influenced jiggers infestation. The type of floor of the house ($P = 0.036$, OR = 3.608, CI = 1.089 - 11.955) was also found to significantly influence jiggers infestation. Source of water was more likely to influence jigger infestation ($P = 0.001$, OR = 2.050, CI = 1.334 - 3.150) than waste disposal site ($P<0.001$, OR = 0.564, CI = 0.409 - 0.776). Having a dog or a cat and the number of such animals significantly influence jiggers infestation with the number of dogs present more likely to significantly influence jiggers infestation ($P=0.001$, OR=1.719, CI = 1.702 – 1.299) as opposed to the number of the cat ($P=0.006$, OR=1.145, CI = 1.040 – 1.261). Removal of jiggers was the predominant control method 441(100%) and this was mainly through the use of sewing needles 247(56.1%) and by use of sticks/thorns 193(43.9%). The treatment products mainly used in the treatment of wounds resulting from jiggers infestation were kerosene 402 (91.4%) though 38 (8.6%) did not adopt any treatment method. The results are essential for community, local Public Health Officers, national and international public health agencies for interventions aimed at controlling jigger's infestation.

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Abbreviations and Acronyms

AIDS – Acquired Immune Deficiency Syndrome.

BDSP– Busia District Strategic Plan.

C.H.W– Community Health Worker.

EPSD– Epidermal Parasitic Skin Diseases.

HIV – Human Immunodeficiency Virus.

KM– Kilometer.

MM– Millimeter.

NTD's – Neglected Tropical Diseases.

PHO– Public Health Worker.

WHO– World Health Organization.

Definition of terms

Tungapenetran – is a parasitic arthropod found in most tropical and sub tropical climates, lives in soil and sand and it feeds on warm blooded animals e.g. man.

Tungiasis – is a condition caused by the parasite *Tungapenetran*.

Ectoparasitosis – is an infestation with an ectoparasite, a parasite that lives on the skin such as tungiasis.

Community Health Extension Worker (CHEW) – these are members of the community who are chosen by community members or organizations to provide basic health and medical care to their community through outreach services.

Coatis – also known as crackoons, are members of the raccoon family (Procyonidae) they are diurnal mammals native to south and central America.

Armadillos – these are new world placental mammals with a leathery armor shell. The dasypodidae family in the order Cingulata.

Laterite soil – are soil type rich in iron and alluminium formed in hot and wet tropical areas.

Rattusrattus – is a common long tailed rodent of the genus Rattus (rats) in the family Murinae.

Hyperkeratotic – is thickening of the stratum corneum of the skin often associated with qualitative abnormality of the keratin.

Fecundation - is the fusion of gametes to produce a new organism

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CHAPTER 1: INTRODUCTION

1.1. Background Information.

Tungiasis is a parasitic skin disease caused by female sand flea *Tungapenetran*, which burrows into the skin usually, on the feet (Collins *et al.,* 2009). It is also a neglected public health problem in endemic areas in Latin America, the Caribbean and Africa, and causes considerable morbidity in the affected communities.Ugbomoiko*et al.,* 2007 stated that, despite its notoriety tungiasis is not regarded a serious health problem of which this is a misconception.

This flea lives in the soil or sand and feeds intermittently on hosts such as humans, domestic animals such as cattle, sheep, pigs, chickens, dogs, mice and wild animals. The preferred habitats of *Tungapenetrans* are warm, dry environments with sandy soil and dust (Sanusi *et al.,* 1989; Winter *et al.,* 2009). They enter human hosts through penetration in the skin.Theectoparasitosis is associated with poverty and occurs in many resource-poor communities in the Caribbean, South America and Africa and these communities prevalence may be as high as 50% in the general population.(Feldmeier*et al.,* 2004).

Tungapenetrans is known to cause significant debilitation in areas of deprived resources and infrastructure. The jigger flea is the smallest known flea, measuring less than 1mm in length (Feldmeier *et al.,* 2004). After entering its host (both humans and domesticated animals), the gravid female flea undergoes substantial growth, growing to around 2000 times its size (640 um) in six days.

The sand flea became known to the Spaniards not long after Christopher Columbus had landed at the American continent in 1492 and was probably inadvertently introduced into Angola in the 17th till 19th century by ship, subsequently spreading all over Africa, Pakistan and West India along the trade routes and by expeditions (Heemskerk *et al.,* 2005). Although endemic in tropical America, Africa and West India, knowledge of this infection is rare in Europe and Northern America. The sand flea originally occurred only on the American continent and the Caribbean Islands, but spread in the late 19th century throughout sub-Saharan Africa and to Madagascar (Hoeppli, 1963);(Heukelbach, 2004)). Two recent studies from Nigeria and Cameroon indicate that still today tungiasis is a major public health problem in West Africa (Njeumi *et al.*, 2002).A study conducted in Northwest Cameroon by Collin *et al.*, 2009) showed that out of 1,151 individuals that were examined, 610 individuals (53%) were infested with *Tungapenetrans* with the prevalence highest in children, diminishing in adults and then increasing again in the elderly. Ahadi Kenya Trust, an organization that works in Kenya to eradicate the jigger flea, estimates that the jigger flea may infect over 2.6 million Kenyans. Many people have been suffering from jigger infestation in silence. No comprehensive survey has been carried out, making it difficult to give actual number of those affected (Ahadi Trust, 2010).

Studies done in Muranga and UasinGishu by Njau*et al.*,(2012) and Choge*et al.*,(2006)respectively showed that prevalence in those districts among children 5-14 years was 67% and 21% respectively. Further interventional studies carried out in neighboring Emuhaya constituency revealed that 39% of Ematsuli primary school had tungiasis. Majority of the children walked barefooted to school increasing the risk of infestation (BDSP, 2010). Prevalence in the hospital was reported to be 4% of the total morbidities.However, the prevalence of tungiasis is uncertain in the entire Musokoto community and other adjacent locations. Therefore the study sought to establish the prevalence of Tungiasis in the location.

Despite its notoriety, the jigger flea is not regarded as a serious threat to health (Ugbomoiko *et al.*, 2007). Unfortunately this is a common misconception. Tungiasis results in significant morbidity, manifesting itself in a number of symptoms such as severe local inflammation, auto-amputation of digits, deformation and loss of nails, formation of fissures and ulcers, gangrene and walking difficulties. Secondary infection also poses considerable risk; many lacking immunisation are vulnerable to tetanus (*Clostridium tetani*), often proving fatal. Complaints of insomnia are also common due to the intolerable itchiness of the infestation (Muehlen *et al.*, 2006).

Muenhlen*et al.*, (2006) states that the common factors that are seen to aggravate tungiasis include poor housing conditions, lack of water, poor hygiene and wearing open shoes. He further revealed that viable prevention and intervention methods for combating the disease include paving of public areas and house floors and the use of closed shoes when feet touch contaminated soil. While shoes could serve well in reducing invasion of the *Tungapenetrans*, the problem here lies in affordability. Given that where tungiasis prevails the population is poor, shoes may not be seen as a priority. A probable intervention could be regular inspection of feet and immediate extraction of embedded fleas with subsequent disinfection of the lesion to protect against infections (Wachira, 2012).

In the past few years, the public health importance of tungiasis in resource-poor populations has been highlighted from different countries, including Brazil, Argentina, Haiti and Nigeria (Joseph *et al.*, 2006). Pilger*et al.* (2008) argues that tungiasis is much more prevalent in communities who usually wear flip – flop (slippers) and often sleep on dirty floors. The challenges with the term dirty floor that Pilger and colleagues, (2008) did not clarify the meaning of dirty floors. However, risk factors for infestation have only been addressed in a single study from Brazil (Muehlen *et al.*, 2006) nevertheless sustainable intervention measures have never been assessed

systematically. In Kenya, a study done in Muranga by Njau*et al.*, (2012) concluded that the risk factors for tungiasis in the area were walking barefoot, keeping domesticated animals especially pigs and dogs and living in mad build houses. No risk factor studies have been conducted in the neighboring location of Musokoto.

Ahadi Trust (2010) outlines the treatment of tungiasis through washing of affected areas with soap and water, dry the cleaned areas, soaking the affected areas with potassium permanganate or disinfect with savlon solution for 15 minutes, then application of petroleum jelly to the affected area.A clinical trial study by Heukelbach, (2002) shows that ivermectin 200mg tablets are effective in treatment of tungiasis for a period of two weeks.However, due to the zoonotic aspect of Tungiasis, control of affected communities is much more complicated and challenging than in other ectoparasites associated with poverty, such as scabies and pediculosis, which do not have animal hosts (Heukelbach *et al.*, 2004). Domesticated animals such as dogs, cats, pigs and goats should be treated with available on-animal insecticides, including collars, shampoos and sprays. In addition, environmental insecticides could be used during the early and late stages of the flea to break the life cycle. With the challenge of having virtually non-existent epidemiologic data on tungiasis, control measures can only be planned when the weight of the disease, underlying forces behind the spread and risk factors are better understood (Ugbomoiko, 2007).

1.2. Statement of the Problem

At Musokoto most residents have built temporary structures for housing with roofs made of either tin/metal and/or thatched. Floors and walls are smeared with mad or clay, which could be associated with tungiasis infestation. Treatment of tungiasis at Nambale health center is an ongoing process and accounts for 4% of the total morbidities. The majority of the cases are children and the elderly. The prevalence of tungiasis cases in the outpatient department of

Nambale health center serving Musokoto residents is known but the prevalence in the entire community is not yet established. Lack of knowledge on the overall prevalence of tungiasis in Musokoto could deter the government and other stakeholders to put in place interventions that could help in controlling and prevent further cases of tungiasis. Treatment methods and products used by the residents of Musokoto sub-location is still not known. Knowing the treatment methods used by residents of musokoto is critical in as so much that this would highlight whether or not the residents are using effective methods that eventually would put under control tungiasis infestation. Lack of knowledge on the risk factors associated with tungiasis impedes advice measures that could be given to residents of musokoto to enable community led interventions in controlling tungiasis by taking care of such risk factors. Hence this study aims at identifying prevalence of tungiasis infestation, risk factors associated with tungiasis and modes of treatment used by Musokoto residents to treat tungiasis cases.

1.3. Justification

Epidermal parasitic skin diseases (EPSD) occur worldwide and have been known since ancient times. Despite the considerable burden caused by EPSD, this category of parasitic diseases has been widely neglected by the scientific community and health-care providers (WHO, 2010). Tungiasis has many clinical features of a neglected tropical disease and thus can be considered as a paradigm: it is endemic in poor communities and rural areas, it is associated with stigma, and there are no products in the commercial markets targeting the treatment of the disease(Heukelbach*et al.*, 2001; Molyneux *et al.*, 2005). Despite the fact that the prevalence of tungiasis in Musokoto is 4% according to the hospital data (BDSP, 2010), the actual prevalence of tungiasis in the entire community of musokoto is not known and so it is important that a study

of this nature was carried out to establish the actual prevalence of tungiasis in the entire population.

Tungiasis is a manageable parasitic infestation and the use of proper treatment methods should put tungiasis under control. Nevertheless, the treatment methods used by residents of Musokoto to control tungiasis are uncertain and so it was imperative that an investigation of this nature carried out to establish the treatment methods used by these residents. Sustainability of treatment outcomes depends on several factors including but not limited to household risk factors that could favor persistent tungiasis infestation of Musokoto residents. Knowing of such risk factors would assist in devising appropriate interventions to control tungiasis. It was thus necessary to investigate the risk factors associated with tungiasis infestation among residents of Musokoto sub location.

1.4. Objectives

To determine prevalence, risk factors and treatment methods for tungiasis among residents of Musokoto sub-location, in Kenya

1.4.1. Specific objectives

1. To determine the prevalence of tungiasis among residents of Musokoto sub-location.
2. To establish the risk factors associated with tungiasis in Musokoto sub-location.
3. To explore the different methods used by Musokotoresidents to treat tungiasis.

1.5. Research Questions

1. What was the prevalence of tungiasis in Musokoto sub-location?
2. What are the risk factors associated with tungiasis at Musokoto sub-location?
3. What was the different treatment methods used for the treatment of tungiasis by Musokotoresidents?

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Tungiasis is an ectoparasitic infection caused by infestation of the female sand flea *Tungapenetrans* into the epidermis of a host (Heemskerk *et al.,* 2005).This flea lives in the soil or sand and feeds intermittently on hosts such as humans, domestic animals such as cattle, sheep, pigs, chickens, dogs, mice and wild animals. This parasitic infestation is commonly found in developing countries, especially in resource-poor neighborhoods and where basic hygiene standards are poor (Wachira, 2012).In humans, tungiasis most commonly affects the feet and legs, especially the toes and sub-ungual and peri-ungual areas (Chieh- Wen *et al.,* 2010; Macias & Sashida 2000).

2.1. Life Cycle

The insect's life cycle lasts about 1 month and begins when the eggs expelled by the gravid female fall onto the ground. Larvae hatch from the eggs under suitable environments with loose and dry soil. The larvae pupate after burrowing into the soil. Adults hatch from the pupae, and both males and females feed on their warm-blooded host. Males die after fecundation, and only the mated females burrow into the epidermis of the host (Pampiglione *et al.,* 2009). The female parasite penetrates the epidermis, thrusts its head into the superficial dermis, and punctures blood vessels for nourishment. The parasite orients its posterior aspect toward the surface, with its external orifice in the keratin layer to aid breathing and to serve as a passage for the expulsion of eggs and excretion. After the growth of the ovaries, female fleas may grow up to 1 cm in size and may contain many fertilized eggs. The females expel about 100 eggs over a 2-week period and die, and are sloughed from the host's skin (Bauer *et al.,* 2005).

2.2. Clinical Description

Early symptoms of infestation are usually mild and, therefore, go unnoticed. Itching intensifies and swelling develops as the female flea increases in size. The affected individual also develops soreness or pain, which limits walking ability (Feldmeier *et al.,* 2004). The parasite preferentially infects the peri- and subungual folds of the toes, interdigital spaces, soles, and heels. Infection at other sites, including the hands, genitals, groin, face, elbows, wrists, breasts, back, thighs, knees, and legs, has also been reported in a few cases (Chieh- Wen *et al.,* 2010; Feldmeier *et al.,* 2004). Indications for Tungiasis in humans and animals alike include a red-brownish spot of approximately 1-3 mm in diameter, with visible posterior segments of penetrated flea occurring in the early stage. Towards maturity of the *Tungapenetrans*, there is evidence of circular lesions of about 1-4 mm in diameter, presenting as a white patch with a central black speck showing posterior segments (Heukelbach, 2004).

2.3Epidemiology

The sand flea *T. penetrans* is one of the few parasites, which has spread from the Western to the Eastern hemisphere. Originally, the ectoparasite occurred only on the American continent. The flea came to Angola with ballast sand carried by the ship Thomas Mitchell that left Brazil in 1872. Within a few decades, *T. penetrans* spread from Angola along trading routes and with advancing troops in the entire sub-Saharan Africa, including areas with tropical rainforest. At the end of the 19th century the sand flea reached East- Africa and Madagascar(Heukelbach*et al.,* 2001). In 1899, returning British troops brought *T. penetrans* to the Indian Subcontinent; the parasite, though, never established there. Today, tungiasis is prevalent on the American continent from Mexico to northern Argentina, on several Caribbean islands, as well as in almost every country of sub–Saharan Africa (Heukelbach *et al.*, 2001). Within the endemic areas the parasitosis has a patchy distribution: it occurs in underdeveloped communities in the rural

hinterland, in secluded fishing villages along the coast and in the slums of urban centres. (Cestari *et al.*, 2007).

Tungiasis is associated with the presence of dry sandy soils, but may also be found in the rain forest as well as in banana plantations located on laterite soil. Similar to other parasitic skin diseases, the occurrence of severe tungiasis is linked to poverty. In poor communities in Brazil, Trinidad and Nigeria, studies have shown a point prevalence rates ranging between 16% and 54% (Muehlen *et al.,* 2006; Wilcke *et al.,* 2002). Prevalence and parasite burden are correlated, and commonly individuals harbor dozens of fleas. Tungiasis shows a characteristic seasonal variation with highest prevalence in the dry season (Heukelbach *et al.,* 2004). Tungiasis has been observed in different animals such as elephants, monkeys, cattle, sheep, goats, sylvatic rodents, coatis and armadillos. Domestic animals such as dogs, cats and pigs, but also rats are important animal reservoirs. In a survey in a slum in Northeast Brazil, 67% of dogs and 50% of cats were found to be infested. Rodents also seem to be an important reservoir (Heukelbach *et al.,* 2004). In 59% of Rattusrattus captured in a poor urban neighborhood of Fortaleza, North East Brazil, tungiasis was diagnosed and pigs and cattle are known reservoirs for *T. penetrans*(Heukelbach*et al.*, 2004; Wilcke *et al.*, 2002).

2.3.Prevalence of tungiasis

This section describes the prevalence of tungiasis under global, Africa and Kenya information. Mention of the tungiasis parasite can be traced back to the 16th century when Gonzales Fernandez de Oviedo Valdes noted that Spanish conquerors in Haiti frequently suffered from the disease (Heukelbach *et al.,* 2001). Originally, the *Tungapenetrans* was restricted to Latin America, South America and the Caribbean. Between the 18th and 19th centuries, however, the parasite is said to have stowed-away on one of the numerous ships carrying sand, possibly the vessel Thomas Mitchell, travelling from Brazil toAngola in West Africa (Jeffreys, 1952; Sachse

et al., 2007). From Angola, the parasite spread to other parts of sub-Saharan Africa. At the turn of the 20th century, the *Tungapenetrans* reached the Indian subcontinent and thirty years later, the first case of the parasite was reported in New Orleans in the United States (Wachira, 2012).

2.3.1 Global prevalence of *Tungapenetrans*

Tungiasis has been a common disease in many parts of Latin America and the Caribbean for many years. This is reflected by the innumerable popular names for the ectoparasitosis, such as *nigua* (Argentina, Venezuela, and the Caribbean) (Rapini *et al.*, 2007), *bicho de pé*, *bicho de porco* (Brazil) (Nagy *et al.*, 2007), *pique* (Argentina, Chile, Uruguay, and Paraguay), *piqui* (*quéchua*), and *tü* (*tupíguaraní*) (Heukelbach, 2004). It remains unclear whether socioeconomic changes have led to a decrease of occurrence of the ectoparasitosis since the 1970s, or whether it became neglected as a disease entity associated with extreme poverty (Heukelbach *et al.*, 2002). In Brazil, infestation by *T. penetrans* is still common in economically disadvantaged communities, urban centers, and the rural hinterland (Cestari *et al.*, 2007). This is of concern since in impoverished populations tungiasis is associated with considerable morbidity. In a door-to-door survey done to endemic community in Fortaleza Northeast Brazil the population of a randomly selected area (n = 1,460) was examined on four occasions for the presence of embedded sand fleas. Prevalence rates were 33.6% in March (rainy season), 23.8% in June (end of the rainy season), 54.4% in September (peak of the dry season), and 16.8% in January (begin of the rainy season) (Heukelbach *et al.*, 2004).

The study in Fortaleza Northeast Brazil showed that children 5–9 years of age had the highest prevalence rates of tungiasis. It also revealed that it was more common in males than in females and had considerable seasonal variation, with the prevalence being highest at the peak of the dry season (September, 54.4%) and lowest after the first rain of the rainy season (January, 16.8%) (Heukelbach *et al.*, 2004).

2.3.2 Prevalence of *Tungapenetrans*in Africa

In North West Cameroon, the parasitosis caused by *Tungapenetrans* is considered to be an important public health problem that requires attention from health officials, the medical community, educationists and infected persons (Collin *et al.*, 2009). A study conducted in Northwest Cameroon by Collin *et al.*, 2009) showed that out of 1,151 individuals that were examined, 610 individuals (53%) were infested with *Tungapenetrans* with the prevalence highest in children, diminishing in adults and then increasing again in the elderly.

Other parts of Africa, such as Tanzania, have not gone unscathed by this ectoparasitic disease. Tungiasis has caused severe cases and deformation in high-risk individuals living under perilous conditions. A study that focused on a 19 year-old male who had epilepsy and mental disability and who lived in poverty, reports infestation of approximately 800 jigger fleas on his feet (Mazigo et al., 2010). The Kigoma region of western Tanzania bears some resemblance to Erekiti in western Nigeria in that the community is resource-poor and lacks essential services such as electricity, water and health services combined with the risk factor of the community keeping domesticated animals in close proximity. The epidemiological situation and geographical occurrence of the disease is not well known but accounts of community members indicate that Tungiasis is highly endemic to this village (Wachira, 2012).

2.3.3 Prevalence of *Tungapenetrans* in Kenya

Hundreds of rural communities in Kenya are similarly infested with jigger flea. Ahadi Kenya Trust, an organization that works in Kenya to eradicate the jigger flea, estimates that the jigger flea may infect over 2.6 million Kenyans. Many people have been suffering from jigger infestation in silence. No comprehensive survey has been carried out, making it difficult to give actual number of those affected (Ahadi Trust, 2010).

A cross sectional study carried out in Muranga South district, Central Kenya to describe the prevalence of tungiasis and associated risk factors in a sentinel group (children 5-12 years of age) on a 385 randomly selected households showed that 57% had tungiasis(Njau *et al.,* 2012) A study by Choge *et al.,* 2006 in UasinGishu district in Rift valley province, Kenya showed a tungiasis prevalent rate of 21% with majority being school going children aged 5-14 years.

According to Ahadi Trust, (2010) they started launching campaigns in other parts of Kenya in 2009. In Western province, Emuhaya constituency, Ematsuli primary school they treated more than 500 school pupils that year. Coast province named by Ahadi Trust, (2010) as the second highly infested by tungiasis in Kenya, cases revealed in Burani village of Kwale district whereby an old man in the village assembles kids and other neighbors to remove jiggers at his compound.

The vicious cycle that jigger infestation triggers on may trap people in poverty for a long time unless timely and appropriate intervention breaks the cycle at one or at several points. The jigger is a parasite capable of visiting untold misery on its victims, especially children. Yet the jigger vicious cycle is among the easiest to break because it mostly afflicts small populations of the uneducated poorest of the poor within the endemic areas (Ahadi Trust, 2010). According to BDSP, 2010Nambale division is among the poorest in Busia district with a majority of population being children. In reference to that Nambale is not excluded from tungiasis infestation.

2.4 Risk Factors

As in many resource-poor communities in Africa, it is not uncommon to find domesticated animals such as pigs, goats, dogs, cats and others that share compounds with humans. This could be attributed to the lack of adequate land to shelter animals, fear of theft or cultural practices (Arena, 2003). Due to their domesticated nature and interactions with people, including sharing of common resting places, these animals serve to spread the jigger flea and ultimately the

tungiasis. Another factor that sustains Tungiasis is that the community lacks appropriate urban services such as health centres, piped water, and sewage systems, as well as poor housing and personal and soil hygiene, leaving individuals susceptible with little protection. As the majority of people in the village walk barefooted, further infestations result from not wearing closed footwear (Ugbomoiko *et al.*, 2007).

Another study done by Winter *et al.*, 2009 on tungiasis-related knowledge and treatment practices in two endemic communities in northeast Brazil whereby two hundred ninety household leaders were interviewed in the urban slum and 136 in the fishing village. Knowledge about the etiological agent of tungiasis and its transmission was high in both communities: 90% knew the flea as the etiological agent of tungiasis. Transmission of tungiasis was thought to be related to sandy soil (72% and 84% in the urban slum and in the fishing village, respectively), presence of animals (52% and 59%), walking barefoot (5% and 23%), and with the presence of garbage littering the area (23% and 21%). Thus this showed that above risk factors should not be ruled out at Musokoto sub-location.

2.5 Effects of *Tungapenetrans*

2.5.1 Personal bodily development

Tungiasis is characterized by the development of single or multiple, white, gray, or yellowish papular or nodular lesions with brown-black-colored opening at the center and peripheral reddening (WHO, 2010). Affected individuals may also develop crusty, plantar wart-like, bullous, pustular, or ulcerative lesions. In cases of tungiasis, bacterial superinfections are the most common complications, and were observed in 29% of the patients in one study. Furthermore, the lesions can develop into septic ulcers or abscesses and may cause cellulitis, gangrene, phlegmon, thrombophlebitis, lymphangitis, or autoamputation of toes. The risk of tetanus should also be considered in affected individuals (Chieh- Wen *et al.*, 2010).

According to WHO (2010), the debilitating impact of persistent itch has repeatedly been stressed for a variety of non-infectious diseases but remains to be assessed for EPSD especially tungiasis. In neurophysiology it is known that chronic itch leads to persistent firing of specialized A (delta fibers) and C (nociceptors) itch fibers in the skin. As a consequence, pain fibers in the neighborhood are transformed into itch fibers, eventually leading to a sensitization of spinal neurons. A similar consequence can be anticipated to occur in EPSD. Since the pruritus intensifies at night, disturbance of sleep is to be expected. Recently, alterations of sleep have been confirmed in 84% of patients with tungiasis(Heukelbach *et al.*, 2005).

2.5.2 Economic effects

A study in Cameroon showed that the impact of the disease is felt heavily among poverty-stricken rural agricultural communities and is believed to inhibit progress and development. Farmers and breadwinners in this community have difficulties working due to morbidity including difficulty in walking, persistent itching and insomnia. (Collin *et al.*, 2009).

2.5.3 Attitudes and perception towards tungiasis

Wangui, (2008) describes Kiangage village (meaning jigger village) in Kenya that infected villagers seem oblivious to the pain caused by the tungiasis and are more concerned and afraid of the social stigma associated with the disease. A mother of six whose whole family is jigger infested prefers to stay home and hide rather than seek medical attention. She believes seeking medical assistance would make her family ‘a laughing stock’. For her, the stigma associated with jigger infestation is similar to that of HIV & AIDS (Wangui, 2008). Most families in the Kiangage village live in utter poverty and rely on farming for their livelihood. Due to their low

social-economic status, pins and other unsterilized equipment could be shared for jigger removal, leading to the spread of HIV & AIDS and other communicable diseases (Ahadi Trust, 2003).

2.5.4 Social development

Among population in a study in Northwest Cameroun, by Collin *et al.,* 2009 majority children who were infected with tungiasis were unable to walk to school, write properly or even participate in learning activities to the same level as their un-infected peers. Their inabilities become a source of ridicule and scorn among their peers, both in and out of school. Given the challenges that people suffering from tungiasis are faced with, including the inability to walk and fear of social stigma, they are unable to participate in democratic processes of the country(Wachira, 2012).

2.6 Treatment/interventions

Standard therapy for tungiasis consists of surgical extraction of embedded parasite under sterile condition (Brane *et al.,* 2005; Feldmeier *et al.*, 2004). Topical application of kerosene, plant extracts, chlorophenothane, chloroform, 4% formaldehyde solution, turpentine and yellow mercury oxide have been used but without any controlled study (Heukelbach *et al.,* 2001).

Chemotherapeutic approaches to attempt to kill embedded fleas without mechanical extraction include administration of oral niridazole,(Ade-serano*et al.,* 1982)thiabendazole(Cardoso A, 1981) and ivermectin(Heukelbach*et al.,* 2004). Only Ivermectin worked. A study by winter et al., (2009) in a fishing village in Northeast Brazil showed that surgical extraction of embedded sand fleas using unsterile sewing needles was the most common treatment applied. In addition, a variety of topical products and medical ointments was used. Mothers were almost exclusively responsible for treatment and knowledge transfer to the next generation.Tungiasis is usually a self limited condition with a few complications consequent to the infestation. In economically

depressed urban neighborhoods, however, poor housing conditions and inadequate health care lead to high transmission potential resulting in high parasite loads and secondary complications (Cestari *et al.,* 2007).

Different case studies have been done around the world. For example a 22-year old Dutch female developed two painless itchy lesions on the fifth toe of her left foot on the medial side of the nail rim, after she returned from Kenya, working there as an intern. Physical examination showed two adjacent bullous hyperkeratotic lesions with a dark-black centre. The central black lesion seemed to move within the abscess-like whitish hyperkeratotic lesions. After disinfection and application of loco-regional anaesthesia using 5cc 1% xylocaine solution, the lesion was excised. The wound healed uneventfully and no antibiotics were prescribed (Veraldi et al., 2007). Other case studies also showed that travelers to Africa and South America are infected by the T. *penetrans* during their tour (Winter *et al.,* 2009).

Superinfection of the lesion may lead to pustule formation, suppuration and ulceration (Feldmeier *et al.,* 2002). In this case oral antibiotics should be prescribed and appropriate local care given. Tetanus prophylaxis is recommended especially those living in endemic areas (Cestari *et al.,* 2007).

However, due to the zoonotic aspect of Tungiasis, control of affected communities is much more complicated and challenging than in other ectoparasites associated with poverty, such as scabies and pediculosis, which do not have animal hosts (Heukelbach *et al.,* 2004). Domesticated animals such as dogs, cats, pigs and goats should be treated with available on-animal insecticides, including collars, shampoos and sprays. In addition, environmental insecticides could be used during the early and late stages of the flea to break the life cycle. With the challenge of having virtually non-existent epidemiologic data on tungiasis, control measures can

only be planned when the weight of the disease, underlying forces behind the spread and risk factors are better understood (Ugbomoiko, 2007).

Common factors that are seen to aggravate tungiasis include poor housing conditions, lack of water, poor hygiene and wearing open shoes. Viable prevention and intervention methods for combating the disease include paving of public areas and house floors and the use of closed shoes when feet touch contaminated soil (Muehlen *et al.*, 2006). While shoes could serve well in reducing invasion of the *Tungapenetrans*, the problem here lies in affordability. Given that where tungiasis prevails the population is poor, shoes may not be seen as a priority. A probable intervention could be regular inspection of feet and immediate extraction of embedded fleas with subsequent disinfection of the lesion to protect against infections (Wachira, 2012).

Ahadi Trust (2010) outlines the treatment of tungiasis through washing of affected areas with soap and water, dry the cleaned areas, soaking the affected areas with potassium permanganate or disinfect with savlon solution for 15 minutes, then application of petroleum jelly to the affected area. The procedure is then repeated three times a day for 2 weeks.

CHAPTER 3: METHODOLOGY

3.1 Study Site.

Musokoto sub-location is a region in western Kenya 30km to theBusia border between Kenya and Uganda. Its coordinates are 0°26'N 34° 9'E. It borders three sub-locations namely Bukhayo central, Kwilare and Bukhayo East. (BDSP, 2010).The Musokoto sub-location and its villages are governed by assistant chief and village elders respectively. Majority of the population has lived in the area since birth except for migrants working in various organizations/institutions in the little town of Nambale.

The community can be regarded as a typical rural settlement. Majority of the residents live in temporary houses of thatched houses with mud smeared walls and floor. Different weather patterns of dry seasons and rainy seasons occur i.e. January – March dry season and April – august are rainy seasons. Economically they depend on agriculture for a living as major source of income through cattle keeping, fishing and farming (majorly maize and beans). Domestic animals (pigs, goats, sheep and dogs) roam around in the villages. There is poor infrastructure of road networks as roads in the division are not tarmac (BDSP, 2010).

The community lacks appropriate urban services like electricity, pipe-borne water and a public sewage system. Open wells, boreholes and the nearby rivers serve as the source of water. It is served by only one major health facility other being dispensaries in other sub-locations. The majority of the people walk barefooted, defecates in the surrounding bush and scatter domestic waste in the vicinity of their homes as observed (BDSP, 2010). Its position is as shown in appendix G: study site map.

3.2 Study Population

The total population of Musokoto sub-location is 3,335 persons and with 667 households. It is composed of eight villages namely Kaludeka, katomei, logiri, Walatsi, Makutano, Otiri, Musoma and Ongaroi. The Public health officers in the area estimated that the sub-location had frequent cases of tungiasis as reported from the school go;ling children. Nambale division, where Musokoto location is based has poverty levels stand at 64.5 percent hence a high risk factor for tungiasis (BDSP, 2010).

3.2.1 Inclusion criteria

1. All consenting residents of Musokotosub location were recruited into the study.
2. The participants must have lived in the study area for a period not less than three months prior to the study time.

3.2.2 Exclusion criteria

1. Hospitalized household members were not visited in the hospitals.
2. Refusal to consent for participation.

3.3 Study Design

A cross sectional study design using mixed data collection method i.e. semi-structured questionnaire for quantitative data and key informant interviews for qualitative data was adopted.Cross sectional designinvolves observation of all of a population, or a representative subset, at one specific point in time (Groove, 2003).

3.4 Sample Size Determination and Sampling

3.4.1 Sample size determination

To get the representative sample for the household's population a sample size estimation formula of Yamane was use (Yamane, 1967).

$$\boldsymbol{n = \frac{N}{1 + N(e)^2}}$$

Where by

n = the sample population.

N = the population.

E = level of precision (0.05) (at 95% confidence interval)

Hence n= 667/1+667(0.05)² = 250 + 10% = 275

3.4.2 Sampling procedure

Purposive sampling method was used to select Musokoto sub-location based on the previous reports of tungiasis prevalence from the health center. This is because most treated cases of tungiasis at Nambale health center originated from Musokoto sub-location. The 8 villages in the sub location wereused in the study and 333 households were sampled using proportionate systematically random sampling at a sampling interval of 2. Table 3.1.Shows proportions of sample size according to population of the villages.

Table 3.1: Village sampling proportions.

Village in Musokoto	**Population**	**No. of Households**	**Proportion (No.)**
Kaludeka	615	123	61
Katomei	470	94	47
Logiri	350	70	34
Walatsi	610	122	61
Makutano	340	68	34
Otiri	325	65	33
Musoma	295	59	30
Ongaroi	330	66	33
Total	**3335**	**667**	**333**

3.5 Data collection

Before the onset of the study information meetings was held with the community administrative leaders such as chiefs, sub-chief and the village elders at their respective territories. Selection and recruitment of a nurse and 8 community health workers (from respective village) was done. The nurse recruited aided in supervision and collection of data. Community health workers were given codes and identification cards. Training and a pilot study was carried out in two of the villagesinKwilare sub-location in the division and 20 households picked at random for piloting. Details shown in table 3.2 below. Validity and reliability was accepted at a reliability co-efficient of 0.70.

Table 3.2: Pilot study proportions.

Villages	No. of Households	Proportions (%)
Akulonyi	80	10
Kayengai	78	10
Totals	**158**	**20**

3.5.1 Data collection tools

Quantitative data collection methods were adopted for the study. During the study, randomly sampled households were visited and members examined for the presence of embedded sand fleas. The pre-tested questionnaire was then applied in English.

3.5.2 Measurement of variables

The information collected consisted of five categories: (1) socio-demographic factors (such as sex, age, education); (2) housing and associated factors (such as type of construction of the house, type of floor inside house, sanitary conditions, presence of electricity, waste disposal); (3) ownership and presence of domestic animals; (4) clinical and personal effects brought about by *Tungapenetrans* infestation (5) knowledge, attitudes and practices related to tungiasis (such as knowledge on transmission, regular use of footwear, common resting place, preventive measures, treatment). Children of 6 years and above to provide information directly, while in the other cases information will be obtained from the guardians after their consent. Legal guardians/parents will sign their consents forms. A household was revisited when a family member was absent.

Clinical examinationperformed by inspecting carefully the legs, feet, hands and arms. To guarantee privacy, other topographical regions of the body not examined. This approach is

considered acceptable, as in endemic communities more than 99% of tungiasis lesions occur on legs, feet, hands and arms (Heukelbach *et al.*, 2002).

During clinical examinations the following findings was considered diagnostic for tungiasis: an itching red-brownish spot with a diameter of 1-3 mm, a circular lesion presenting as a white patch with a diameter of 1-4 mm with a central black dot, black crust surrounded by necrotic tissue, as well as partially or totally removed fleas leaving a characteristic sore in the skin (Eisele *et al.*, 2003). Localization and number of lesions recorded. As defined by Muehlen *et al*., 2006 the presence of less than 5 lesions considered as mild, of 6–30 as moderate and of more than 30 lesions as heavy infestation. All clinical examinations and interviews was done by a single person, to eliminate inter-observer bias. If a household member is found positive of tungiasis, ServinDudu dust applied in the living area.

3.6 Statistical Analysis

Data was entered using Epi Info software (version 6.04; Centers for Disease Control and Prevention, Atlanta, USA) and checked for entry errors by rechecking all data entries with the original data forms. Then, data was transferred to IBM Statistical package software (version 17.0) for analysis.

Prevalence was determined as percentage of infested individual out of total household population examined for tungiasis. Logistic regression was used to establish the risk factors that affected the jiggers infestation. Bivariate analysis was also carried out to calculatehow different combined variables could affect the risks factors.

3.7 Ethical Considerations

Permission to perform the study was obtained from Maseno University Graduate studies (SGS) and authorizationsought from Maseno university ethics committee. Participation was voluntary

after counseling using a participants counseling form and consent by participants was on the basis of participation. Potential risks and benefits were explained in the form.

Confidentiality of the participants assured prior to filling of the questionnaires and all data collected was not shared and stored by only the investigator in his private computer. The participants explained to about the purpose of the study, its duration and benefits of the research stud and they were given an opportunity to ask questions where need arises.

CHAPTER 4: RESULTS

4. Introduction

This chapter presents the study findings starting with a social demographic profile i.e. gender, age distribution, and marital status of the study participants. The study also gives description of social economic characteristics such as level of education, main occupation and religion of study participants. The findings on the specific objectives of the study are presented in sections 4.2 which is on the prevalence of tungiasis among residents of Musokoto Sub-location. Section 4.3 explains the risks factors associated with tungiasis and finally section 4.4. Presents the findings on the modes of treatment used by jiggers infested residents of Musokoto to manage tungiasis.

4.1 Socio-demographic and economic profile of the household members

4.1.1 Socio-demographic characteristics of the study participants

A total of 1557 participants randomly selected from 333 households took part in the study. Out of this study participants 768(49.3%) were males whereas females were 789 (50.7%). Almost half, 777(49.87%) were aged 15 years and below, 652(41.87%) were aged between 16-50 years old and only 128(8.2%) were more than 50 years old. About two thirds, 927(59.5%) of the study participants were single; 247(15.9%) were married with 144(9.2%) and 239(15.4%) being separated/divorced and widowed respectively. The details are contained in table 4.1 below.

Table 4.1: Socio-demographic characteristics of the study participants

Variable	Frequency n(%)
Gender	
Male	768(49.3)
Female	789(50.7)
Age distribution (years)	
1 - 5	300(19.3)
6 - 10	285(18.3)
11 - 15	192(12.3)
16 - 20	175(11.2)
21 - 25	124(8.0)
26 - 30	132(8.5)
31 - 35	75(4.8)
36 - 40	76(4.9)
45 - 50	70(4.5)
>50	128(8.2)
Marital status	
Single	927(59.5)
Married	247(15.9)
Separated/divorced	144(9.2)
Widow	239(15.4)

N = 1557.

4.1.2 Socio-economic characteristics of the study participants

The socio-economic parameters of the study participant that were investigated included level of education, main occupation and religion. Majority of the participants, 1369(87.9%) had at least completed primary level of education 65(4.2%) did not complete their primary education, 47(3.0%) completed their secondary education with 27(1.7%) not completing secondary

education, only 10(0.6%) had at least tertiary/university education and lastly 40(2.6%) were illiterate. Approximately a third, 477(30.6%) of the study participants were students, 300(19.3%) were considered as under-aged and so were not in any employment, 278(17.9%) worked as house helps, 223(14.3%) were farmers, 126(8.1%) were housewives yet 121(7.8%), and 7(0.4%) were traders and civil servants respectively. A paltry 25(1.6%) were not employed. On religion the study established that 1552(99.7%) were Christians and only 5(0.5%) were of the Muslim faith. Table 4.2 is on socio-economic characteristics of the study participants.

Table 4.2: Socio-economic characteristics of the study participants

Variable	Frequency n(%)
Level of education	
Illiterate	40(2.6)
Primary complete	1369(87.9)
Primary incomplete	65(4.2)
Secondary complete	47(3.0)
Secondary incomplete	26(1.7)
Technical/university	10(0.6)
Main occupation	
Under-age	300(19.3)
Farmer	223(14.3)
Trader/town	121(7.8)
House help	278(17.9)
House wife	126(8.1)
Civil servant	7(0.4)
Students	477(30.6)
No work	25(1.6)
Religion	
Christian	1552(99.7)
Muslim	5(0.3)

N = 1557.

4.2 To establish the prevalence of tungiasis among residents of Musokoto sub-location

Of the 1557 that participated in the study a total of 441(28.3%) said they at least had jiggers at one point in their life whereas 116(71.7%) said they never had jiggers. Of the 441 who said they had jiggers, 287(65%) of them had jiggers on examination whereas 9(2%) did not have jiggers found on them while 145(33%) refused to be examined by the nurse. See figure 4.1.

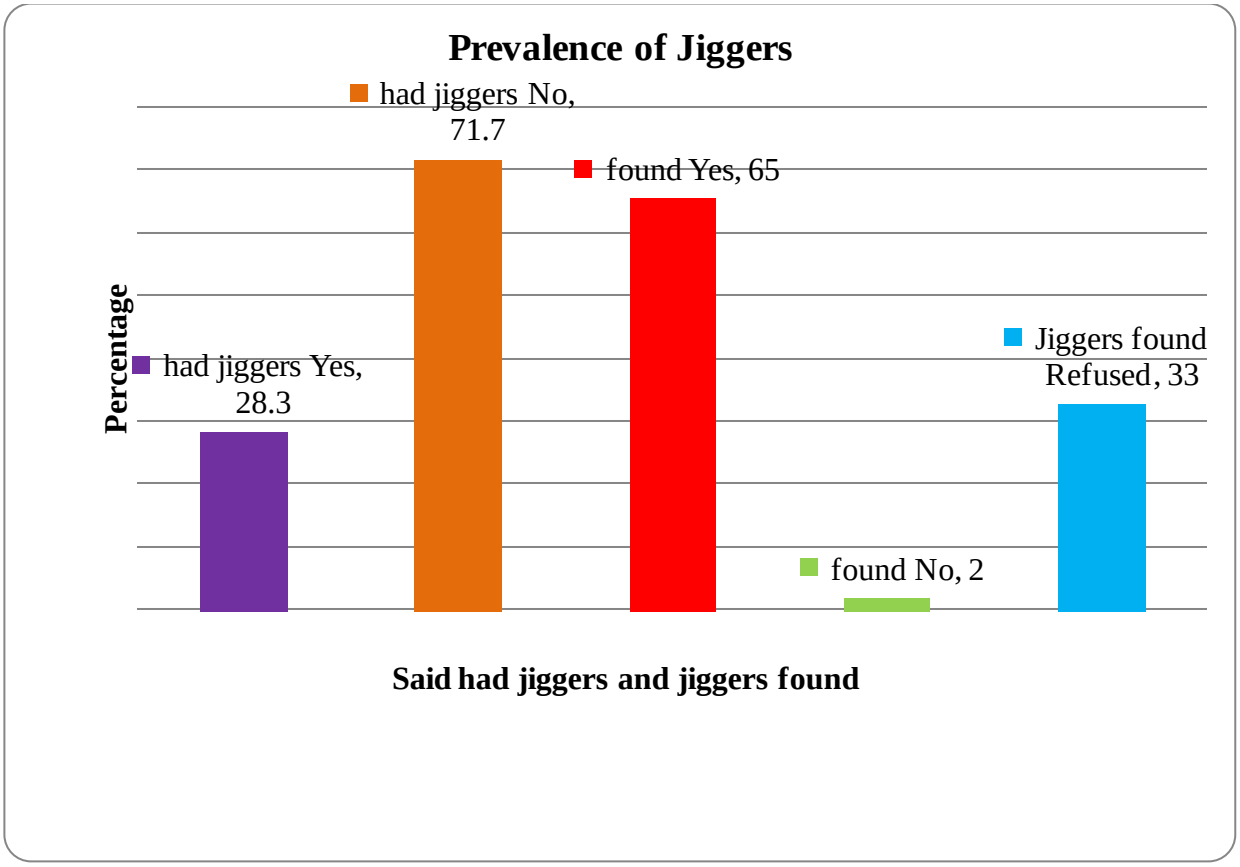

Figure 4.1: Percentage of participants who said they had jiggers and Jiggers were found on screening.

4.2.1 Prevalence of *Tungiasis*, socio-demographic and economic characteristics of the study participants

The jiggers infestation was significantly influenced by the household size (P=0.002, OR=1.424, CI=1.137 – 1.784), occupation(P<0.001, OR=1.129, CI=1.085 – 1.175) and education(P=0.025, OR=1.187, CI = 1.021 – 1.379) of the participants. See table 4.3.

Table 4.3: Association between jiggers infestation and socio-demographic and economic factors.

Variable	**Df**	**Sig**	**OR**	**95% C.I**	
				Lower	**Upper**
Household size	1	0.002	1.424	1.137	1.784
Gender	1	0.738	0.963	0.772	1.201
Age	1	<0.001	0.888	0.852	0.926
Marital status	1	<0.001	0.749	0.672	0.837
Occupation	1	<0.001	1.129	1.085	1.175
Education	1	0.025	1.187	1.021	1.379

4.2.1 Site infested and severity of the infestation

On assessment on severity of *tungiasis*it emerged that toes on the extreme sites were more infested even though the distribution of infestation was more or less the same for all the toes. Severity reveals that the first toes were less severely infested as opposed to the fourth and fifth toes in regardless of site of infestation.

Table 4.4: Severity of infestations of the toes

	Frequency n(%) of severity of infestation of toes			
Toe infested	**Mild**	**Moderate**	**Severe**	**Total infested n(%)**
1st Left toe	91(46.2)	74(37.6)	32(16.2)	197(12.80)
1st Right toe	48(52.2)	44(47.8)	0(0.0)	92(5.97)
2nd Left toe	37(20.56)	33(18.33)	110(61.11)	180(11.69)
2nd Right toe	31(20.7)	30(20.0)	89(59.3)	150 (9.74)
3rd left toe	20(21.7)	32(34.8)	40(43.5)	92(5.98)
3rd Right toe	23(19.5)	31(26.3)	64(54.2)	118 (7.67)
4th Left toe	56(32.2)	21(12.1)	97(55.7)	174(11.30)
4th Right toe	29(18.7)	19(12.3)	107(69.0)	155 (10.08)
5th Left toe	83(45.9)	42(23.2)	56(30.9)	181(11.77)
5th Right toe	88(44.0)	49(24.5)	63(31.5)	200 (13.00)
Totals	506	378	658	1539(100)

Table 4.5: Pathology of infestations of the toes

	Pathology					
	hypertrophic nail rim	**Fissure**	**Ulcer**	**deformation of nails**	**loss of nail**	**deformation of toe**
1st Left toe	7(3.6)	25(12.7)	16(8.1)	33(16.8)	93(47.2)	28(14.2)
1st Right toe	52(56.5)	27(29.3)	13(14.1)	0(0.0)	0(0.0)	0(0.0)
2nd Left toe	29(18.6)	22(14.1)	42(26.9)	24(15.4)	21(13.5)	18(11.5)
2nd Right toe	57(38.0)	33(22.0)	24(16.0)	23(15.3)	10(6.7)	3(2.0)
3rd left toe	5(5.4)	15(16.3)	22(23.9)	35(38.0)	13(14.1)	2(2.2)
3rd Right toe	23(19.5)	41.0(34.7)	25(21.2)	15(12.7)	7(5.9)	7(5.9)
4th Left toe	15(8.6)	13(7.5)	18(10.3)	39(22.4)	45(25.9)	44(25.3)
4th Right toe	13(8.4)	69(44.5)	23(14.8)	6(3.9)	22(14.2)	22(14.2)
5th Left toe	36(19.9)	30(16.6)	33(18.2)	57(31.5)	25(13.8)	0(0.0)
5th Right toe	16(8.0)	46(23.0)	27(13.5)	35(17.5)	63(31.5)	13(6.5)
Total Pathology	253(16.59)	323(21.18)	243(15.93)	270(17.70)	299(19.60)	137(8.98)

NOTE: total pathological cases were 1525

Table 4.6: Severity and pathology of infestations of other body sites

Site of infestation	Mild	Moderate	Sever	Desquamation of skin	Ulcer of the skin
Sole	14(24.56)	27(47.36)	16(28.08)	41(71.92)	16(28.08)
Lateral rim	11(20.37)	10(18.52)	33(61.11)	17(31.49)	37(68.51)
Heel	6(54.55)	1(9.1)	4(36.35)	6(54.55)	5(45.45)
Right arm	3(30)	3(30)	4(60)	6(60)	4(40)
Left arm	3(23.07)	4(30.77)	6(46.16)	5(38.5)	8(61.5)

4.2.2 The age groupofMusokoto residents mostly infested by *tungapenetrans*

The study revealed that 52.5% of those with tungiasis were aged below 10 years. The remaining victims were aged above 10 years of age. Table 4.7 shows the details on the prevalence of *tungapenetrans* with age.

Table 4.7: Prevalence of *tungapenetrans* with age

Age range	Frequency n(%)
1 - 5	86(19.5)
6 - 10	135(33.0)
11 - 15	64(14.5)
16 - 20	34(7.7)
21 - 25	20(4.5)
26 - 30	14(3.2)
31 - 35	14(3.2)
36 - 40	11(2.5)
45 - 50	17(3.9)
>50	35(8.0)

4.3 To establish the risk factors associated with tungiasis in Musokoto sub-location

4.3.1 Individual risk factors

The individual risks factors that were investigated in this study were on where one sleeps, what is put on feet while inside the room, where time is spent, and participant's opinion on source of jiggers. A total 440 household heads/guardians responded to these questions. The study findings revealed that 389(88.4%) slept on traditional made beds, 46(10.5%) used mattresses on modern beds, 3(0.7%) used mattresses laid on the floor whereas 2(0.5%) used mats laid on the floor. Out of the 440 household head/guardians 394(89.5%) mentioned that they put on slippers while

inside the rooms whereas 46(10.5%) said they walk barefooted while inside the room. Majority of the household heads/guardians 388(88.2%) said members of their families spent most of their times resting within their yards. Another 115(26.13%) said they spent most their time inside the house. When asked about the sources of jiggers a sizeable number of the household/guardians, 364(82.7%) did not have an idea where jiggers come from. About 43(9.8%) were of the opinion that jiggers from sand, 19(4.3%) and 14(3.2%) said that jiggers come from pigs and dogs respectively. Other sources of jiggers that were also mention included dirt 22(5%), dust 11(2.5%) whereas 3(0.68%) and 2(0.45%) respectively argued that jiggers were as a consequence of drought and climate change. When the association between jiggers infestation was computed using logistical regression analysis it emerged that where one sleeps i.e. mattress/bed, mattresses/floor, mat/floor and traditional beds was more likely to significantly influence jiggers infestation ($P < 0.001$; OR=1.319; CI = 1.180 – 1.474). Other individual risk factors such as what one put on feet while inside or outside the house and where time is spent were significantly less likely to influence jiggers infestation (what is put on inside the house – $P<0.001$, OR=0.134, CI= 0.106 – 0.171; what is put on feet outside the house – $P<0.001$, OR= 0.107, CI = 0.08 – 0.144 and where time is spent – $P< 0.001$, OR = 0.159, CI = 0.129 – 0.197. See table 4.9.

Table 4.8: Individual risk factorsandtungiasis in Musokoto.

Variable	Frequency n(%)	P-Value
Where one sleeps		
Matress/bed	46(10.5)	<0.001
Matress/floor	3(0.7)	
Mat/floor	2(0.5)	
Traditional bed	389(88.4)	
What is put on feet inside a room		
Slippers	394(89.5)	<0.001
Barefoot	46(10.5)	
Resting place		
Veranda	7(1.6)	<0.001
Yard	388(88.2)	
Backyard	45(10.2)	
Where else time is spent		
House	115(26.13)	**0.015**
Under a tree	30(6.81)	
Source of jiggers		
Pig	19(4.3)	<0.001
Sand	43(9.8)	
Dog	14(3.2)	
Don't know	364(82.7)	

Table 4.8: Individual risk factorsandtungiasis in Musokoto

Variable	Frequency n(%)	P-Value
Other sources of jiggers		
Dirt	22(5)	0.382
Dust	11(2.5)	
Drought	3(0.68)	
C*limate change*	2(0.45)	
Don't know	402(91.37)	

Table 4.9: Association between jiggers infestation and individual risk factors

Variable	**df**	**P= value**	**OR**	**95.0% C.I.**	
				Lower	**Upper**
Where one sleeps	**1**	**<0.001**	**1.319**	**1.180**	**1.474**
What is put on feet inside the house	1	<0.001	0.134	0.106	0.171
What is put on feet outside the house	1	<0.001	0.107	0.080	0.144
Where time is spent resting	1	<0.001	0.159	0.129	0.197

4.3.2 Accommodation risk factors associated with tungiasis

The study revealed that all the households 440(100%) were mud walled structures with only 3(0.7%) of concrete/cement house floor and 437(99.3%) of the households were of sand/mud floor. However 417(94.8%) of the houses had zinc/iron roofing whereas only 23(5.2%) being grass thatched. The other aspects of accommodation that were also investigated in relation to

jiggers infestation were type of street and type of lighting system used by a household. It emerged that 423(96.1%) of the households were situated along sand/murram roads or paths whereas 17(3.9%) of the households were in areas where the street was of clay type of soil. When asked about the lighting system 439(99.8%), which is almost 100% of the participants said they used kerosene or lamp to light their houses. Table 4.10.

Table 4.10: Family and individual risk factors and tungiasis in Musokoto.

Variable	Frequency n(%)	P-Value
House structure		
Concrete	0(0)	**0.003**
Mud	440(100)	
House floor		
Concrete/cement	3(0.7)	**0.024**
Sand/mud	437(99.3)	
House roof		
Zink/iron	417(94.8)	0.065
Grass thatched	23(5.2)	
Type of street		
Sand/murram	423(96.1)	0.766
Clay	17(3.9)	
House light		
Electricity	0(0)	0.393
Kerosene/lamp	439(99.8)	
Solar	1(0.2)	

Logistical regression analysis was performed to establish the association between jigger's infestations and accommodation risk factors highlighted above. The analysis revealed house

floor types was significantly associated with *tungiasis* and that house hold floor types was three times more likely to influence jigger's infestation. (P = 0.036, OR = 3.608, CI = 1.089 – 11.955). The type of street or soil type was less likely to influence jiggers infestation (P = 0.789, OR = 1.802, CI = 0.607 – 1.930). See details in table 4.11.

Table 4.11: Association between jigger's infestation and family and individual risk factors

Variable	**df**	**P= value**	**OR**	**95.0% C.I.**	
				Lower	**Upper**
House floor type	**1**	**0.036**	**3.608**	**1.089**	**11.955**
House roof	1	0.054	0.629	0.393	1.009
Street	**1**	**0.789**	**1.082**	**0.607**	**1.930**
House light	1	0.927	0.937	0.235	3.745

4.3.3 Water and sanitation risk factors

Water and sanitation risk factors associated with *tungiasis* infestation were also investigated. The water risk factors looked at the sources of water whereas the sanitation risk factors that were investigated included where waste sources are put; and treatment given to the waste products as well as the site of the waste bin. Approximately 413(93.9%) of the household sourced there water from the river whereas 27(6.1%) sourced their water from the wells. Other water sources were boreholes 1(0.2%) and spring 20(4.5%). On sanitation 396(90.0%) disposed-off their waste in the household garden and 26(5.9%) disposed in the yard and 18(4.1%) disposed-off their waste in the compost pit. When asked whether they burned their waste or not, only 18(4.1%) answered in the affirmative whereas 422(95.9%) did not burn their waste. All the 440(100%) of the household did not have a waste bin within the house compound.

Logistical regression analysis (table 4.12) confirmed that source of water, household waste disposal and treatment significantly influenced jiggers infestation (P = 0.001, OR = 2.050, CI = 1.334 – 3.150) for source of water implying that source of water was more likely to influence jiggers infestation compared to waste disposal site (P <0.001, OR = 0.564, CI = 0.409 – 0.776) and waste treatment e.g. burning (P = 0.002, OR = 0.449, CI = 0.268 – 0.751). See details in table 4.13

Table 4.12: Water and sanitation risk factorsassociated with tungiasis in Musokoto.

Variable	Frequency n(%)	P-Value
Source of water supply		
Well	27(6.1)	**0.001**
River	413(93.9)	
Other water sources		
Borehole	1(0.2)	<0.001
Spring	20(4.5)	
Waste product (place to put)		
Yard	26(5.9)	**0.001**
Garden	396(90.0)	
Compost pit	18(4.1)	
Burn the waste?		
Yes	18(4.1)	**0.002**
No	422(95.9)	
Waste bin in the home?		
Yes	0(0)	**0.001**
No	440(100)	

Table 4.13: Association between jigger's infestation and water and sanitation risk factors

Variable	df	P= value	OR	95.0% C.I.	
				Lower	Upper
Source of water	1	0.001	2.050	1.334	3.150
Where is household waste put	1	<0.001	0.564	0.409	0.776
Burn the waste	1	0.002	0.449	0.268	0.751

4.3.4. Type of Domesticated animal and Risk factors associated with tungiasis

Of the 440 households only 19(4.3%) of the households domesticated dogs and 421(5.7%) did not have dogs. A total of 9(42.90%) had at least one dog whereas 1(4.80%) had four and five dogs each. When asked about domestication of cats only 15(3.4%) confirmed that they domesticated cats of this 14(45%) had at least one cat and only 1(5%) had up to four cats. Pigs were domesticated by 12(3.4%) of the households. Of the twelve households that domesticated pigs 7(58.33%) had a pigsty whereas 5(41.67%) practiced free range pig keeping. The participants also mentioned domestication of other animals e.g. goats 2(0.5%), chicken 18(4.1%) and cows 27(6.1%). See table 4.14.

Logistical regression analysis revealed that having a dog or cat and numbers of such dogs or cats significantly influenced jiggers infestation and the number of dogs present was more likely to significantly influence (P = 0.001, OR = 1.179, CI = 1.070 – 1.299) jiggers infestation compared to the number of cats (P =0.006, OR = 1.145, CI = 1.040 – 1.261). Having other animals was more likely to significantly influence (P < 0.001, OR = 1.517, CI = 1.234 – 1.864) jiggers

infestation. The presence of rats in the house was less likely to influence (P < 0.001, OR = 0.477, CI = 0.334 – 0.680). See table 4.15.

Table 4.14: Risk factors of type of animal domesticated and tungiasis in Musokoto

Variable	Frequency n(%)	P-Value
Domesticate a dog?		
Yes	19(4.3)	**0.001**
No	421(95.7)	
How many dogs?		
1	9(42.90)	**0.013**
2	6(28.60)	
3	4(19.00)	
4	1(4.80)	
5	1(4.80)	
6	0(0)	
Do you have a cat?		
Yes	15(3.4)	**0.005**
No	(96.6)	
How many cats?		
1	14(45)	**0.037**
2	1(30)	
3	4(20)	
4	1(5)	
Domesticate a pig?		
Yes	12(3.4)	0.360
No	428(97.3)	
If YES how do they live?		
Pigsty	7(58.33)	0.271
Free	5(41.67)	

Table 4.14: Risk factors of type of animal domesticated and tungiasisinMusokoto

Variable	Frequency n(%)	P-Value
Other animals domesticate?		
Yes	47(10.7)	<0.001
No	393(89.3)	
What type of animals?		
Goat	2(0.5)	<0.001
Cow	27(6.1)	
Chicken	18(4.1)	
N/A	393(89.3)	

Table 4.13: Association between jigger's infestation and Risk factors of type of animal domesticated.

Variable	df	P= value	OR	95.0% C.I.	
				Lower	Upper
Have a dog	1	0.001	0.422	0.256	0.696
No. of dogs	1	0.001	1.179	1.070	1.299
Have a cat	1	0.006	0.541	0.257	0.792
No. of cats	1	0.006	1.145	1.040	1.261
Have a pig	1	0.282	0.700	0.366	1.341
No. of pigs	1	0.160	1.090	0.967	1.228
Where the animals live	1	0.538	1.140	0.750	1.733
Have other animals	1	<0.001	1.517	1.234	1.864
Rats present in the house?	1	<0.001	0.477	0.334	0.680

4.4 To establish the modes of treatment used by the residents to manage the disease

When participants were asked if they removed jiggers, 440(100%) said they do using needles 247(56.1%) and sticks/thorns 193(43.9%). To treat the jiggers, kerosene 402(91.4%) was mostly used while 38(8.6%) used no products in the market. No participant used savlon antiseptic. Other products mentioned to be used include hydrogen peroxide 1(0.22%), cattle dip 2(0.45%), Omo 5(1.13%), magadi (sodium bicarbonate) 3(0.68%) and warm water 2(0.45%). See table 4.14.

Table 4.14: Modes of treatment used by the residents of Nambale to manage *tungiasis*.

Variable	Frequency n(%)	P-Value
What do you do in case of a jigger infestation?		
Remove the jigger	440(100)	<0.001
How do you remove the jiggers?		
Needle	247(56.1)	<0.001
Stick/thorn	193(43.9)	
Products used in treating jigger wounds		
No product used	38(8.6)	<0.001
Kerosene	402(91.4)	
Savlon	0(0)	
Other products used in treating jigger wounds		
Hydrogen peroxide	1(0.22)	0.216
Cattle dip	2(0.45)	
Magadi	5(1.13)	
Omo	3(0.68)	
W*arm water*	2(0.45)	

CHAPTER 5: DISCUSSION

In this chapter the study findings are discussed objective wise while cross - reference with similar studies done elsewhere. The first specific objective was to establish the prevalence of tungiasis among residents of Musokoto sub-location. The study findings point that out of the study participants (1557), only a third said they had had jiggers at one time in their lives and on clinical examination of those who answered in the affirmative sixty five percent were found to be slightly higher compared to a similar study done by Ade-Serrano and Ejezie (1981) in a rural Lagos State, Nigeria. In the Lagos study the prevalence of tungiasis was forty percent. In another study done in two towns of South – West Trinidad revealed a tungiasis prevalence of thirty one and forty percent, respectively for the two towns i.e. Icacos and Fullarton (Chadee*et al.,* 1991a, 1991b). In another study Ade-Serrano and Ejezie (1982) found a prevalence of 42 percent in a Southern town of Nigeria.

The prevalence of jiggers in males and females was almost equal implying that gender did not significantly influence the prevalence of jiggers ($p = 0.743$). Looked at by age it emerged that age of an individual significantly influenced the prevalence of jiggers. This finding corroborates that of Heukelbach (unpublished observation) that equally revealed that jiggers was more prevalent in children than in adults. Looking at prevalence by specific age groups, the observation in the current study is similar to that of Heukelbach*et al.* (unpublished observation).

Arene (1984) and Chadee (1994) argues that decline in tungiasis by increase in an individual's age could be a function of keratinization. Nevertheless, this could be due to a number of socio-economic and personal factors such as evidenced in the current study.Previous studies have linked *tungiasis* infestation to families of poor socio-economic status. The study participants in the current study were living in the rural areas of Musokoto and were of very poor socio-

economic status (table 4.2). Additionally, Heukelbach, (2005) and Litvoc*et al.*, (1991) equally linked poor socio-economic status to high prevalence of tungiasis. The other aspect of prevalence that was investigated was body sites infested and severity of the infestation. The current study has demonstrated that jiggers can infest any part of the body i.e. toes, sole, lateral rim of sole; heel and arms. Jiggers infestation presented in the form of fissures; hyperthropic nail rim; ulcerations; nail and toe deformation and loss of nails. Others included desquamation and ulceration of the skin. Feldmeier et al., 2003; Feldmeier and Heukelbach, 2009 in separate reports on epidermal parasitic skin diseases sheds light on pathology and severity of *tungiasis* on finger nails and heels, toes confirming similar jiggers manifestation by *tungiasis*as was observed in the current study.

Ferran*et al.* (2009) also realized that a nodular lesion on the sole of a patient who had visited Venezuella contained *Tungapenetrans* flea. Nordlund, (2009) was also able to diagnose tungiasis from the hands, skin, toes, nails and sole of his patients. Also according to Nordlund (2009) the cases presented in the form of fissures, abscesses, suppurations. The lesions, according to Nordlund (2009) can progress into osteomyelitis or gangrenes and nails can be lost in most cases. The second specific objective of the study explored the risk factors associated with tungiasis.

Pilger*et al.* (2008) argues that tungiasis is much more prevalent in communities who usually wear flip – flop (slippers) and often sleep on dirty floors. The challenges with the term dirty floor that Pilger and colleagues, (2008) did not clarify the meaning of dirty floors. But assuming that' dirty floors' is synonymous to mud floors then the findings of the current study is in agreement with the views of Pilger and his colleagues (2008). Mazigo*et al.*, (2010) while conducting a *tungiasis* prevalence survey in a rural village in Ruseas ward of Tanzania describes the housing condition of the infested as one with mud walls made of tree poles and a dusty dirty floor littered with garbage. This clearly confirms that *tungiasis* is associated with dirty living environments. In

this view, therefore it is critical that residents of Musokotoimprove on their housing conditions especially materials used in flooring.

Unregulated disposal of household waste can lead to animals such as rodents residing within the homestead and this can lead to difficulty in controlling the jigger flea, which can reside and feed even on rats (Witts*et al.*, 2004). Cleanliness and tidiness of the household and its environments is very important not only in controlling *Tungapenetrans* but also other household bugs (Curtis *et al.*, 2003). In this study, it is in agreement with Witts and colleagues above information since Musokoto residents with unregulated disposal of waste associated with tungiasis infestation on table 4.12.

Reportedly, Pampiglione*et al.* (2003; 2009) revealed that sand flea (Tunga*spp.*) infestations in humans and domestic animals were positively correlated i.e. domestication of animals was linked to *Tungapenetrans* infestation in humans. The animals that Pampiglione linked to *Tungapenetrans* infestation in humans were dogs and pigs. The domestic animals previously associated with *Tungapenetrans* (Pampiglione*et al.*, 2003; 2009) and were also mentioned in the current study included goats, cats, pigs, bovines and chickens. Other studies (Ribeiro*et al.*, 2007; Heukelbach, 2004; Linardi and Guimaraes, 2000; Fioravanti*et al.*, 2003; Pampiglione*et al.* 2003; 2009) have also reported and linked domestic animals as hosts to *Tungapenetrans* flea, which the causative agent of tungiasis.

The third specific objective investigated treatment modes used by residents of Musokoto to treat tungiasis. In many cases *tungiasis*is a self-limiting infestation upon removal of the *Tungapenetrans* ball. However, due to the resulting skin rupture, infections may result, especially in cases of poor personal hygiene and environmental sanitation. It is therefore imperative that *tungiasis* is treated. In the current study, the study participants indicated use of various modes of treatment including physical removal of the jigger. Products mentioned to be

used to treat jigger infestation/infections after removal of the jigger ball are kerosene, savlon, hydrogen peroxide, cattle dip, sodium bicarbonate (soda ash), omo and use of warm water. Nordlund (2009) recommends that jiggers should be removed surgically under sterile conditions. Heukelbach (2006) has advised that there are no effective oral or topical drugs that can be used in the treatment of *tungiasis*. Nevertheless, in a study using a plant-based repellant - Zanzarin, a lotion made from coconut oil; jojoba oil and aloe vera, applied twice daily reduced newly imbedded fleas by 92% and the number of skin lesions by 87%. The limitation of the current study was that it did not capture the success through follow up of the modes of treatment used by Musokotoresidents infested with jiggers on their reduction of imbedded jigger fleas and also in the reduction of skin lesions. Worth noting is the high prevalence of *tungiasis* among the study participants, which in itself is a pointer that the modes of treatments used by the study participants are not effective and so a more effective anti-tunga ointment such as Zanzarin could be recommended for topical use by Musokotoresidents. This recommendation is supported by the documented success of Zanzarin by the previous studies (Feldmeier*et al.,* 2006; Schwalferberg*et al.,* 2004). In the Tanzania study Mazigo*et al.* (2010) advised the caretakers of the jiggers infested individuals to clean the wounds of the victims using Dettol and also to take the infested persons for tetanus vaccination. In the current study it was not known whether persons infested with jiggers were actually vaccinated against tetanus. Lack of tetanus vaccination of those infested with jiggers may be a health threat to such persons, especially young children who play with soil and so may be exposed to infections by *Clostridium tetanii*.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1. CONCLUSION

6.1.1. Prevalence

There was a high prevalence of *tungiasis* in the division and most of the cases were found in children of schooling age. This is attributed to barefoot walking to school and domesticating animals in the homestead.

6.1.2. Risks factors

As evident from the study, where one sleeps and spends time while at home determines human infestation of jiggers. If persons spend most time resting outside the house and sleeps on the floor they will get infested with jiggers. Mud floor types and sand streets is also the habitat for jiggers. Pigs, dogs and cats also harbor jiggers and the more they are in the compound and living with humans, the more the chances of getting tungiasis among the family members. People fetching water from long distances i.e. rivers have higher chances of infestation.

6.1.3. Modes of treatment

Most residents used crude methods for surgical removal of the jigger and also used none recommended products for its treatment. These products could cause infection and other complications such as tetanus and gangrene among others.

6.2. RECOMMENDATIONS

1. More emphasis/strategies to be put in the control and management of *tungiasis* at Nambale division because of the high prevalence in the area.
2. Health education regarding *tungiasis* to be provided to the community on its management, stigma, and control. School children to wear shoes while they go to school to avoid infestation.
3. Regular domesticated animals spraying with insecticides will help reduce the fleas in the animals hence reduced egg larvae.
4. It emerged that victims of jiggers infestations do not receive tetanus vaccination, it is herby recommended that the government should consider vaccinating residents of jigger endemic areas with tetanus vaccines.

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APPENDIX A: RESEACH INFORMATION FORM

I Albert Ng'etich is a second year masters student in public health at Maseno university of and will be conducting a research as part of the requirements of the Masters course. The topic of this study is **prevalence, risk factors and treatment methods for tungiasis among residents of Musokoto Sub-location, Kenya.** The study will be conducted for 4 weeks and you will be visited by two interviewers for clinical examinations and other for questionnaires.

The following considerations are important.

1. Your participation in to the study is voluntary basis and you have a right not to participate without any disadvantage for you or your family.
2. There is no risk or dangers for your health as there will be only a visual exam on your skin without any invasive procedures such as cutting or skin scratching.
3. Your data will be kept confidential and your identification kept in secret.
4. You will be able to desist from participation at any moment without disadvantage.
5. You should sign the informed consent form only after explanation of the study objectives.
6. By signing the document you agree to participate in the study.

For further information contact me through the following cell phone numbers: 0722656316 or 0733796009

Thank you in advance.

APPENDIX B: CONSENT BY PARTICIPANT FORM

I hereby consent to participate in this research study on prevalence, risks factors and treatment methods for*tungiasis*among residents of Musokoto Sub-location, Kenya. I have been explained to and understood the nature and purpose of the study.

Participants signature…….

Guardian signature (legal guardian in case of minors)…….

Date…….

Interviewers name……..

Interviewers signature……

Date……

Interviewers I.D…….

APPENDIX C: QUESTIONNAIRE

"Prevalence, risk factors and treatment methods for tungiasis among residents of Musokoto sub-location, Kenya"

Family Record.

Data ___/_____/____ **FAMILY NUMBER:_____**

Address ….……..…….. Site…….

SECTION A: HOUSEHOLD PROFILE AND PREVALENCE OF TUNGIASIS

How many people live in the household……..

Individual number	Initials of the individual	Sex	Age	Ask: Do you have jiggers	Who Answered?	Exam: Are there any jiggers around the
1				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
2				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
3				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
4				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
5				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
6				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
7				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
8				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
9				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
10				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
11				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal
12				( ) No ( ) Yes ( ) doesn't know		( ) No ( ) Yes ( ) Not present ( ) Refusal

End (Hour): _____

APPENDIX C: QUESTIONNAIRE CONT'D

"Prevalence, risk factors and treatment methods for tungiasis among residents of Musokoto Sub-location, Kenya"

SECTION A: TUNGIASIS CLINICAL EXAM FORM.

Date (data) _____/ _____/ _____ House hold number/ ……

Start (hour): _____Name (initials):_____ Age _____

FOOT

SITE	STAGES.				PATHOLOGIES.													
TOES	Mild	Moderat	Severe	Rating.	Erythema	Edema	Shinning Skin	Hyperthropic nail rim	Descuamation of skin	Fissure	Ulcer	Deformation of nail	Loss of nail	Aliscess	Deformation of toe.		Other	
1 Lt																		
1 Rt																		
2 Lt																		
2 Rt																		
3Lt																		
3 Rt																		
4Lt																		
4 Rt																		
5Lt																		
5 Rt																		
SOLEs																		
LAT.RIMs																		
HEELs																		
Arm Rt																		
Arm Lt																		

OTHER PATHOLOGIES (1) NO (1) YES	PICTURES (1) NO (1) YES
ITCHING ……Yes=0 No =1	Left foot ( ) No ( ) Yes
SPONTANEOUS PAIN……Yes=0 No =1	Right foot ( ) No ( ) Yes
PAIN UPON PRESSURE……Yes=0 No =1	Both foot ( ) No ( ) Yes
PAIN WHILE WALKING ……Yes=0 No =1	
DIFFICULTY OF WALKING……Yes=0 No =1	
SLEEP DISTURBANCE DUE TO ITCHING PAIN……..Yes=0 No =1	

APPENDIX C: QUESTIONNAIRE CONT'D

"Prevalence, risk factors and treatment methodsfortungiasis among residents of Musokoto sub-location, Kenya"

SECTION B: RISK FACTORS **FAMILY NUMBER _____**

IDNUM: _____ **Name: (Initials) _____ (1) Respondent (2) Own person**

1. Marital Status? (1) Single (2) Married (3) Separ/ Divorced (4) Widow
2. Main occupation? (1) Farmer (2) Fisherman (3) Trade/ town (4) Trade/ house/com
   (5) house cores. (6) Civil Servant (7) Retired (8) Student
   (9) P/time STD (10) No work (11) No school (12) Oth……
3. Level of education? (1) Illiterate/ No form (2) Nursery (3) Prim-comp (4) Prim Not-comp
   (5) Sec comp (6) Sec Not-comp (7) Tech/University (8) Oth_____
4. Do you sleep in (…) (1) Mattress/ bed (2) Mattress/floor (3) Mat/floor
   (4) Oth _____ (Traditional bed)
5. What do you put on inside room? (1) Slippers (2) Barefoot (3) Oth _____
6. what do you put on outside your room? (1)Slippers (2) Barefoot (3) Oth _____
7. Where do you spend your time? (1) Veranda/ Frontage (2) Yard (3) Backyard
   (4) Other……
8. For you, what is most important (1) Pig (2) Sand (3) Dog (4) Oth……
9. Familiar religion 1) Christian (2) Muslim (3)traditional relig (4) oth
10. House structure 1) Concrete block (2) Mud (3)wood (4) oth
11. House Floor 1) Concrete/cement (2) Sand/mud (3)Wood (4) oth
12. House roof 1) Zinc/Iron (2) Thatched (3)Mud/clay (4) oth
13. Type of street 1) Tarmac (2) sand (3)Clay (4) oth
14. House light 1) Electricity (2) Kerosene lamp (3)Solar (4) oth
15. Source of water supply 1) Tap water tank (2) well (3)River (4) oth
16. Waste product (place to put) 1) yard (2) Garden (3)Composite pit (4) oth
17. Burn the waste? 1) No (2) Yes
18. Yard in the house ? 1) No (2)Yes

If YES type floor ? 1) Cement (2) Sand (3) Clay (4) oth

19. Have dog ? 1) No (2)Yes, How many?(3) (1) (2) (3) (4) (5) (>6) (4) oth

20. Have cat? 1) No (2)Yes, How many?(3) (1) (2) (3) (4) (5) (>6) (4) oth

21. Have pig 1) No (2)Yes, How many?(3) (1) (2) (3) (4) (5) (>6) (4) oth

If YES how do they live? 1) Pigsty (2) Free

22. Other animals 1) No (2)Yes

If YES, what are they? 1) Goat (2)Cow (3) Chicken (4) oth

23. Presence of rats in comp/house? 1) No (2)Yes

24. Number of rooms_____

SECTION C: TREATMENT AND MANAGEMENT OF TUNGIASIS

1. What do you do when you have a jigger? (1) Nothing (2) Remove (3) Never had

4) Go to hospital (4) Oth_____

2. If Remove YES, how? (1) Needle (2) Stick (3) Blade

(4) Oth_____

3. Do you use any products/chemicals**?** (1) No (2) Kerosine (3) Savlon

(4) Oth_____

APPENDIX D: Maseno University Ethical Committee Clearance Letter

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221
Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: SECRETARY - MUERC **DATE**: 20th March, 2014

TO: Mr. Albert Kiprotich Ngetich, **REF**: MSU/DRPC/MUERC/000033/13
School of Public Health and Community Development,
Maseno University,
P.O. Box 333-40105, Maseno, Kenya.

RE: PREVALENCE AND RISK FACTORS FOR TUNGIASIS AMONG RESIDENTS OF NAMBALE DIVISION, BUSIA COUNTY. PROPOSAL REFERENCE NO: MSU/DRPC/MUERC/000033/13

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 20th day of March, 2014 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 19th March, 2015. If you plan to continue with the study beyond this date, please submit an application for continuation approval to MUERC Secretariat by 18th February, 2015.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach MUERC Secretariat by 18th February, 2015.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

Yours faithfully,

DIRECTORATE OF RESEARCH PUBLICATION & CONSULTANCIES 20 MAR 2014 MASENO UNIVERSITY

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED

APPENDIX E: LETTER OF CONSENT

Albert K. Ngetich

P.o Box 100301-00101,

Nairobi.

The district commissioner,

Nambale district,

P.o Box 222 – 50409,

Nambale.

Dear sir/madam,

RE: APPROVAL TO CONDUCT RESEARCH

I'm a student at Maseno University pursuing a Master Degree Program in Public Health. I have chosen a research topic on Prevalence, risks factors and treatment methods for*tungiasis* among residents of Musokoto Sub-location. This is in partial fulfillment in the award of the above master's degree.

Study population will be the residents of Musokoto and I will use semi structured questionnaires and key informant interviews during the interview and clinical examinations. This study seeks to establish prevalent cases, risk factors and the modes of treatment used by the community members in Musokoto Sub-location. Results to be used for programmatic interventions to control and manage cases. The study also seeks to bridge the knowledge gap about Tunga*penetrans* in Kenya and the world in general.

Yours faithfully

A. K. Ngetich.

APPENDIX F : STUDY SITE MAP