DETERMINANTS AND MANAGEMENT OF TUNGIASIS (*Tunga penetrans*): IN TRANS-NZOIA COUNTY, KENYA

BY:

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MOI UNIVERSITY.

DECLARATION

Declaration by the Student

I, the undersigned declare that this thesis is my original work, which has never been submitted, to any institution or organization for examination. Reproduction of this work in part or whole is prohibited unless with the author's express permission or the Moi University.

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DEDICATION

I dedicate this thesis to my beloved wife, Margaret Yotomuk, and children; Beatrice Cheruto, Cosmas Mtai, Addah Cheptoo, Raphael Krop, Robert Pyatich, Pascaline Chebet, Anthony Plimo, and my grandchild, Fetalis Kibet for their moral support during the development and processing of this thesis report.

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TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

FGD	Focused Group Discussions
NGO	Non-Governmental Organization
SPSS	Statistical Package for Social Scientists
WHO	World Health Organization

DEFINATION OF TERMS

Burden	Impact of a health problem in an area measured by the financial cost, morbidity, and mortality, among many other factors in a community
Causative Agent	Pathogen or biological agent that causes a disease
Host	refers to an animal or a person infested by a parasite (jigger flea) and is affected negatively by the parasite (jigger flea)
Housing	Refers to the structure in which the community members inhabit to protect themselves from the bad weather, cold, etc.
Knowledge	These are acquired skills and level of understanding of new ways of controlling and preventing infestation of tungiasis and its widespread within a home or in the society as a whole.
Management	Refer to practices and procedures that would be used by the community to prevent themselves from the cause and spread of Tungiasis in their localities.
Morphology	Form, structure, and relationship between structures of an organism
Practices	Refers to common customs, behavior, habits, and traditions of the communities that contribute towards the spread/control of tungiasis.
Prevalence	Refers to the rate of spread or number of people who have contacted or shown signs, symptoms of tungiasis, and other related diseases.
Socio-economic	Refers to issues that relate to both social and economic, for instance, ownership of land by a resident.

Tungiasis Ectoparasitic disease caused by penetration of the fertilized female sand flea, *Tunga penetrans,* into the epidermis of the host.

ABSTRACT

Introduction: *Tunga Penetrans* is a flea (chigoe) that causes infestation known as jiggers. It affects approximately 3 million Kenyans in the Central, Eastern, and Western parts of Kenya. Jigger victims are stigmatized, children's education is negatively impacted and individuals' productivity is compromised.

Objectives: The objective of the study was to assess the determinants of *Tungiasis* infestation, assess the community's knowledge and management approaches, and assess the housing conditions of inhabitants in Trans Nzoia County. The study was carried out in rural areas of Trans Nzoia County believed to have a high prevalence of *Tungiasis* infestation.

Methods: A cross-sectional study design involving 167 households in Trans Nzoa County, and data obtained via multi stage-sampling procedures. Interviewer-administered questionnaires focused group discussions and observation checklists were used to collect data. *R-statistical software* was used to manage and analyze data. Frequency tables, bar graphs, and pie charts were used to summarize the presentation of data. Chi-square tests and Odds Ratios were used to assess risk factors associated with *Tungiasis* infestation. A logistic regression model was also fitted to determine predictors of *Tungiasis* infestation in the area while controlling for confounders.

Results; Prevalence of *Tungiasis* was found to be high at 82.3%. Among the residents, Removal of jiggers using thorns was the most common crude method of management though with a risk of transmission of blood-derived pathogens, 85.4 %. Only 11.6 % of the cases would visit government clinics while 55.5 % burnt vegetation around their compound in an attempt to manage *Tungiasis* infestation. Other forms of management executed by residents include the application of paraffin, Vaseline, and hydrogen peroxide on the affected area to kill or block the breathing of the jigger species. No traditional herb was reported to be used to manage *Tungiasis*, nor is the use of dung to smear the floor of houses useful in the reduction of jigger infestation. The study found out that 95% of the respondents occupied semi-permanent houses, 81.7% of which had an earthen floor. Knowledge on causes of *Tungiasis* was low and 57.3 % of the households had no form of alternative host. While family size, education level, and family ownership were found to be significantly associated factors, education remained the only significant predictor for *Tungiasis* infestation.

Conclusion: The prevalence of jigger infestation in Trans Nzoia County was found to be high in this study. The socio-economic factors associated with tungiasis especially poverty was a determinant factor in transmission of the disease. Majority of the respondents had poor knowledge on the causes of Tungiasis disease and the most common way of management was to remove the jiggers fleas and the eggs. Community intervention strategies were inefficient in lowering the prevalence and could cause potential risks of transmitting blood-borne pathogens.

Recommendations: The study recommends the need to empower households on causes and preventive measures to reduce the prevalence of *tungiasis.*

CHAPTER ONE

INTRODUCTION

1.1 Background

Tungiasis is an ectoparasitic disease caused by the female flea *Tunga penetrans* penetrating the host's body, primarily the epidermis. It is acquired when people walk barefoot or rest on soil where sand fleas have completed off host cycle. Tungiasis is identified as one of the most common parasitic skin diseases acquired by mostly tourists who visit tropical beaches. This flea, also known as the jigger flea or chigoe flea, lives in the dirt or sand and feeds on natural animal hosts such as cattle, sheep, pigs, chickens, dogs, mice, and wild animals on an occasional basis. Man is an alternative host. This characteristic makes *Tunga. penetrans* infestation a zoonosis (Deka, 2020).

Tungiasis is evidenced by intense inflammation of the surrounding tissues of the affected part of the body. Acute and chronic inflammation usually results in painful and debilitating clinical pathology, which impairs physical fitness and mobility. Most of the infected patients normally manifest with one or a complex of symptoms of itching, irritation, inflammation, erythema, oedema, bullous-type lesion, fissure, ulceration, lymphangitis, lympho-edema, ascending neuritis, pain, hyperkeratosis, nail deformation, tissue necrosis, feet disfigurement and difficulty walking. The female flea normally is known to permanently penetrate the skin of its host then it remains there till it dies, in which after two weeks of penetration, the burrowed flea increases in volume by a factor of 2000. The affected region is mostly characterized by oedema, itching and a lot of pain (Coates *et al.*, 2020).

This parasite infestation is frequent in impoverished countries, particularly in areas with few resources and where basic hygiene requirements are lacking. In resource-

poor settings, stray dogs and cats which host the parasites usually litter organic wastes frequently on the soil. When garbage is not collected, sewage is not properly disposed of, and food is not stored properly, the fleas find a good breeding cite thus increasing the rate of infection in this areas. Rats, which are also normal hosts, are drawn to this food refuse and garbage's poorly disposed hence releasing more fleas into the environment. Infestation is more likely where personal hygiene is neglected, or where feet are not protected by shoes and socks, either because they are too expensive or because wearing shoes is not a local norm (WHO, 2020).

The translation of knowledge into practice has been adopted by so many people living in the infested communities. This is evidenced by the practice of removing the embedded sand fleas with sharp instruments and daily washing of the feet. The mothers cleaned their houses and compounds regularly while those with mud houses smeared the floors with cow-dung to reduce the number of cracks on the floors and burrows created by the rats. Some community members sprayed insecticide on the habitats of their animals so as to prevent the spread of these fleas. Application of greasy substances such as petroleum jelly was applied repeatedly to the lesions to help in healing. A sufficient number of intact wells and water sources must be established since moisture plays an important role of suffocating the larvae breathing system thus leading to die (Thielecke et al., 2023).

The prevalence of children between the ages of 5-10 is significantly higher than that of the adults in most of the studies. This is because of the less exposure to the fleas, immediate extraction after penetration of the parasite and also the acquired immunity by the people of older age. Therefore, it is much easier for them to prevent themselves from the disease compared to the young children. Since the infection occurs after

contact with soil contaminated by the fleas and the fleas cannot jump very high, the infestation is normally limited to the feet although penetration can occur in any part of the body. However, as almost invariably itching is severe, the fleas disturb the patient's sleep for a prolonged period. Secondary infection, particularly because of scratching, is common in poor settings (Coates *et al.*, 2020).

Majority of the people in communities have an overall knowledge on tungiasis disease. Many people are aware of the signs and symptoms of the disease but do not know the causative agents of the disease. Majority of the people are aware of the animal tungiasis, it is said that animals are less often and less severely affected. The knowledge was acquired through experiences of the previous occurrences with tungiasis infections. The people of the community observe the disease pattern and could clearly describe the signs and symptoms and how it presented itself after infection. Treatment options are derived from this observation such as use the use of pins and tree ointments to treat the lessions. The relevant animals host were said to be the pigs because they describe it as the main fleas carriers. They were also associated with dirt and dirty environments. People from the infested community were not aware of how they contracted the disease since they did not know if the animals they reared were contributing factors (Thielecke *et al.*, 2023).

Sand flea disease is prevalent in resource-poor areas in South America and Sub-Saharan Africa, with prevalence rates of up to 60% in the general population. It has recently resurfaced in epidemic proportions in East Africa. *Tunga penetrans* was almost entirely transmitted indoors in resource-poor rural and indigenous people in Brazil's hinterland. Dwellings in these locations generally lack a solid floor, or the ground is covered with rough concrete or broken tiles with many crevices, giving a

favorable environment for *Tunga penetrans* off-host development. Tungiasis spreads in urban slums, where roads and walks are unpaved, wastes litter the neighborhood, and yards are made of sand or mud (Mtunguja *et al.*, 2023).

Dimethicone is an effective treatment of tungiasis, although it may not be available in all endemic areas. In areas where resources are limited, treatment is usually limited to surgical extraction of the whole flea and its eggs. Some of the local communities seek to extract the fleas with a non-sterile instrument or use of blunt and improper implements to manipulate burrowed sand fleas which increases the transfer of blood-derived diseases and viral infections such as hepatitis and human immunodeficiency virus infection (Nájera Villagrana & García Naranjo Santisteban, 2019).

Majority of the people were not aware that failure to wear appropriate shoes highly exposed them to tungiasis infection. It is expected that wearing closed shoes acts as a protective mechanism to penetration of fleas into the feet. Those who were heavily infested with fleas could not wear the shoes properly since it created discomfort and also added more pressure to the lesions thus making it difficult to walk and move around. Those who were infested with tungiasis faced a lot of stigma since the lesion produced unpleasant odor, majority of them were ashamed of the disease out especially the body deformities and its appearances. Most people lack the knowledge of avoiding stigmatization of the victims which posed a huge challenge to the infected persons (Thielecke *et al.*, 2023).

1.2 Statement of the problem

Tungiasis has been largely ignored by the scientific community, politicians, and healthcare stakeholders throughout the years. Tungiasis is not even included as a disease control priority in the endemic locations on the regional, national, and international agendas. In parts of Africa, South America, and the Caribbean, human tungiasis is a public health problem requiring safe and simple treatment. Observations demonstrate that in impoverished communities with insufficient housing and healthcare, there is a significant potential for transmission and, as a result, large parasitic burden of *Tunga penetrans* infestation (Deka, 2020).

Tungiasis is common among impoverished communities in the tropics, but the related risk factors are frequently misidentified and unregulated. Despite the fact that it is a self-limiting condition with significant morbidity, the parasite can cause secondary morbidity through life-threatening complications and infections such as cellulitis, tetanus, and death. Tungiasis's immediate and indirect socio-cultural, economic, and health effect, on the other hand, is sometimes underestimated and misinterpreted. A comprehensive estimate of disease burden remains unavailable (Nájera Villagrana & García Naranjo Santisteban, 2019).

In Kenya, Tungiasis is a re-emerging neglected disease that is highly endemic in central, eastern Nyanza, and western regions. It is associated with considerable morbidity coupled with poverty in the affected communities. A cross-sectional study in Muranga south showed a high disease prevalence of 57%. In the study, modifiable risk factors were determined, which should be the focus of long-term and control strategies (Kong *et al.*, 2022).

A research conducted in In Tanzania revealed a prevalence of 71 percent with significant morbidity in the community. Tungiasis was a public health hazard in the study communities, and health officials required to detect the condition in order to affect therapies. Additional research on risk factors, animal reservoirs, and evidence-based management approaches were required (Nájera Villagrana & García Naranjo Santisteban, 2019)

In the current study, we sought to assess the health risk factors that were associated with tungiasis infestation in Trans-Nzoia County.

1.3 Justification of the study

Despite the numerous anti–jigger campaigns by different institutions, media coverage of the problem, the magnitude of the problem was still enormous in the rural setting of Trans Nzoia County. This was because resource-poor communities were largely unknown and lived away from the limelight with little or no access to information or as was found in urbanized service centers.

The societal ramifications of tungiasis-related morbidity were many. Children with Tungiasis were humiliated and mocked by their classmates, while adults were embarrassed and ostracized. Children below the age of 15 years were mostly affected and boys are more infected than girls. There is anecdotal evidence that tungiasis has a negative impact on academic performance. Impaired mobility and physical fitness would have a negative impact on household finances (Elson *et al.,* 2019).

In Kenya, Jigger had been reported in the central region and some parts of Western Kenya, Rift valley included. The problem had not been reported then, meaning no one had come forward boldly to declare that the disease was real, present, and was

costing lives thus not regarded as a problem. However, much has not been done to the general population to sensitize it to reduce the morbidity of the disease.

It would, therefore, be important to identify risk factors leading to jigger infestation and management, so that proper intervention methods would be planned and implemented. And this would only be sorted out when the community perceived the disease since there were no clear records kept of those who had been affected, treated, and the areas most affected earlier.

The study results would be used by the County Government of Trans Nzoia County and NGOs to lay strategies and policies aimed at preventing and managing the morbidity and suffering from jigger infestation.

1.4 Research question

1. To what extent do socioeconomic factors contribute towards the prevalence of Tungiasis in Trans Nzoia County?
2. Does the community know about tungiasis in Trans Nzoia County?
3. How does tungiasis infestation managed in Tran Nzoia County?

1.5 Broad objective

The study aimed at assessing determinants and management of tungiasis in rural areas of Trans Nzoia County, Kenya.

1.5.1 Research objectives

1. To determine the socio-economic factors associated with tungiasis transmission in Trans Nzoia County.
2. To assess the community's knowledge on tungiasis in Trans Nzoia
3. To determine management practices of tungiasis in Trans Nzoia County.

1.6 Basic Assumptions of the Study

There was limited influence to the study by environmental factors because the area covered was within the same locality and shared the same environmental factors. Personal attitude and family disparities may have affected responses by the respondents concerning their perception of tungiasis. The researcher designed instruments with consideration of some moderate levels of illiteracy in the population; therefore, this factor did not affect the research. Instruments were structured in such a way that they were self-explanatory for ease of understanding by the respondents. It's also assumed that the respondent provided credible and accurate information during the study.

1.7 Organization of the study

The following study was majorly orchestrated into six chapters. Chapter one covers the background; the problem statement, purpose, objectives, research questions, the significance of the study, delimitations of the study, limitations to the study, assumptions of the study, and operational definition of significant terms. Chapter two handles the literature review of socio-economic, knowledge, presence of alternative hosts, management practices, and housing conditions in relation to tungiasis. Chapter three provides the methodology adopted for the study; the research design used, the target population, sampling procedures, research instruments, data collection procedures and methods of data analysis, and ethical issues considered in the study. Chapter four covered; data analysis, presentation, and interpretation, and last, but not least, chapter five contain the discussions of the findings, chapter six consists of a summary of the findings, conclusions, and recommendations from the study with suggestions for further research and contribution to the body of knowledge.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Tungiasis has been largely ignored by scientists, politicians, and healthcare stakeholders for many years. Tungiasis is not mentioned among other illnesses in the endemic regions for disease control priority at the regional, national, and international levels. The majority of epidermal parasite skin disorders, including tungiasis, require long-term global scientific study and management programs. Increase in urbanization among many countries, improved housing and wearing of appropriate footwear has led to an overall reduction in the prevalence of tungiasis disease worldwide. Many countries are facing a great challenge of fighting poverty hence making it a challenge when it comes to total eradication of this disease. Additionally, majority of the communities members have neglected the disease therefore, it remains to be an important public health problem that needs to be solved (Obebe & Aluko, 2020).

Tunga penetrans was first identified in the 16th century by Gonzales Fernandez de Oviedo Valdes, who observed that Spanish invaders in Haiti, South America, commonly suffered from the ailment. The *Tunga penetrans* was once limited to Latin America, South America, and the Caribbean. However, the parasite is thought to have stowed away aboard one of the several ships carrying sand, likely the vessel Thomas Mitchell, going from Brazil to Angola in West Africa between the 18th and 19th centuries. The ecto-parasite is thought to have followed the trader's routes and was highly propagated by military expeditions. During the colonial period, the disease was a key factor of health concern, majority of solders were affected by the disease especially for those who did not have the appropriate footwear. This also increased

the spread of the disease across the world because of the increase rate of migration (Kositz *et al.,* 2021).

Tungiasis has resurfaced as an epidemic in East Africa in recent years. Recently dimethicone has been established as the most effective drug for treatment against tungiasis. Traditional therapy, i.e., manipulating burrowed sand fleas with blunt and unsuitable equipment, may accelerate the spread of blood-derived diseases since these crude tools are shared. Regular application of a repellent based on coconut oil can help prevent infestations. Some communities applied a mixture of candle wax and kerosene, volatile medicinal oils or extracts of various plants onto the lesions. Bathing the foot of dogs with metrifonate and subcutaneous injection has been reported to be effective in veterinary medicine. Because of its close relationship with poverty, sand flea illness would be a good starting point for a community-based battle against rural poverty (Tardin Martins *et al.*, 2021)

Tunga penetrans infection is often a minor and self-limiting illness. Individuals living in endemic areas may experience huge and recurring infestations, which can lead to super-infection and consequences like gangrene, bacteremia, or tetanus. Individuals living in endemic areas may experience huge and recurring infestations, which can lead to super-infection and consequences like gangrene, bacteremia, or tetanus. Tungiasis appears to have a large and generally underestimated role in the development of tetanus, with 50 percent of tetanus cases in endemic regions resulting from secondary infection after *Tunga Penetrans* infestation. Although the lesions have a distinct look, dermos copy at a magnification of 20 times can assist to quickly establish the diagnosis of tungiasis (Obebe & Aluko, 2020).

According to a research conducted in Muranga, Kenya, the majority of respondents (65.9 percent) saw jiggers as a nuisance rather than a health concern. Jigger infestation was considerably related to age, education, work status, site of residence, and dusty floor-roomed conditions. Daily inspection of the feet with immediate extraction of the embedded fleas was a significant precaution measures that enabled survival in the affected regions. Children were more affected than the adults, this is because they were considered less careful and could even play within the contaminated soils hence increases the chances of contamination (Kong *et al.,* 2022).

Life Cycle of Human Tungiasis

Clinical human tungiasis has a five-stage natural history.

Phase I begins with the adult flea penetrating the epidermis of its human host, causing severe inflammation and dilatation of blood vessels in the dermis.

In phase II, the flea thrusts its head into the superficial layers of the dermis, feeding on capillaries, while the flea's hind end stays on the skin's surface, communicating with the outside world. The rear portion offers breathing air as well as a channel for excretions and eggs.

The parasite produces up to 200 white ovoid eggs during **phase III**, causing her body to grow up to 7 mm. The bug can then be observed as a yellow-whitish lesion beneath a human host's hard hyperkeratosis skin.

Phase IV begins after egg deposition under subcutaneous tissue and ends when the female flea dies and the corpse is ejected.

During **phase V,** the epidermis reorganizes over a four-week period, leaving small residues that will remain for months. Meanwhile, the eggs left in the epidermis during phase III hatch in three to four days, releasing larvae that mature into pupae. The

pupae mature into adult fleas after two weeks, completing the cycle (Mutebi *et al.,* 2021)

2.2 Socio-Economic Factors of Tungiasis

Globally, research have indicated that children aged 3 months to 14 years bear the largest burden of jigger infestation, with adults experiencing a drop and the elderly experiencing an increase. This is due to children's lack of shoes as well as their inability to eliminate fleas from their feet quickly. Because jiggers primarily target open feet and beneath toenails, a lack of shoes is a key risk factor. Furthermore, age-specific behaviors indicated a higher prevalence especially children who are more active than adults, the habit of playing in the sand and dusty areas posed a high risk of infection since the areas may host fleas (Girma *et al.,* 2018).

The elderly, on the other hand, are less energetic and hence stay in one spot for lengthy periods of time, allowing the flea to embed itself on the human skin. Furthermore, the young and old may not bathe on a regular basis, putting them at danger of sand flea assault. It is also mentioned that the young and old are the most vulnerable to jigger infection because they have very sensitive skin that is readily penetrated by the jigger flea and most of the sites penetrated by this jigger fleas are hands, elbows, knees, neck, buttocks or genitals. Similarly, the elder are more likely to lag behind when it comes to personal hygiene and therefore when it comes to taking out the embedded fleas, it was a little bit difficult requiring more attention (Nsanzimana *et al.,* 2019).

The situation is said to be more intricate when transmission occurs inside the house, without the involvement of an animal reservoir. Intra-domiciliary transmission indicates that the off-host cycle of *T. penetrans* is completed inside the house. Usually, these rooms are where family members spend many hours a day, such as the

sleeping room. In the case that the floors consists of sand, dried mud or rugged cement with holes and cracks, the eggs that have been expelled by embedded female sand fleas overnight fall on the floor, when they are swept, they fall into crevices of the floor or into the cracks between floor and wall during cleaning in the morning. Eggs can develop into larvae and pupae in such cracks. Sleeping directly on the floor therefore increases the chances of spreading since they can move freely from the human body into the floors (Wiese *et al.,* 2017).

Tungiasis is more prone in low-income communities in tropical and sub-tropical parts of the world. Since it is mostly associated with poverty, areas with scarce financial resources, poor personal hygiene and lack of sanitation in residential areas have a high prevalence of tungiasis disease. It is noted that, the presence of reservoirs for this parasites in the environment has greatly contributed to its spreading. Domestic animals such as pigs, dogs, cats and rats are also considered to be among the contributing risk factors. There is a higher prevalence of tungiasis disease in human during the dry season compared to the rainy seasons this is due to the factors associated with population and parasitic development (Silva Paranhos *et al.,* 2022).

The jigger threat knows no age limit, its impacts are felt by people of across all ages. However, the majority of jigger-related deaths have been observed among small children and the elderly. For example, in Muranga, a region extensively infested with jiggers, a child was reported dead owing to the effects of jiggers caused by microbial infections in a family of eight children. Furthermore, incidents of school dropouts have been extensively documented in several regions of Kenya, with Teso registering 500 cases of tungiasis-related school dropouts, while in Muranga, 50 percent of

youngsters infected with the illness missed school owing to the jigger infestation (Kong *et al.,* 2022).

The intensity of infection is strongly associated with the type of socio-economic activity carried out in a specific area. Community members who practiced animal farming tend to have more cases of infection compared to those who did land farming. This could be seen with the number of lesions observed in the community members who practiced these socio-economic activities. The people who did pig farming prevailed with a lot of lesions especially on their feet, this is because, despite the fact that pigs were described as the carriers for thus fleas, the people cleaning these animals or coming into contact with them were more at risk and presented with more lesion compared to the other family members. Majority of these farmers did not use pesticides to clean their animals and thus the number of fleas kept increasing day by day. Some had limited knowledge on how to keep their animals' healthy while others did not care as long as the animals seemed healthy from their appearances (Wiese *et al.,* 2017).

Other socioeconomic variables that may influence the low uptake of tungiasis information include illiteracy, the kind of water source, and the usage of soap, which may imply an indirect association with disease transmission. Families with greater access to water, soap, and higher hygiene standards, for instance, appeared to be more protected against the disease. Furthermore, Tungiasis is a disease associated with impoverishment, and improved cleanliness and refuse collection have been considered as variables to minimize the prevalence of tungiasis (Tardin Martins *et al.,* 2021).

Jigger infestation was a serious health concern in poor areas such as rural Nigerian villages , Tanzania, North West Cameroon, Uganda, and Burundi, with a prevalence of 50%. *Tunga penetrans* infested 45.2 percent of the 557 persons studied in Erikiti, a tiny impoverished town in western Nigeria, according to a research. It was linked to poverty since most instances of tungiasis were recorded in poor areas where basic services such as sanitation, health facilities, substandard housing, domesticated animals living close where humans resided, and a lack of footwear or wearing open shoes were common (Heukelbach *et al.*, 2021).

Poverty and ignorance highly contributed to the spread of tungiasis infections. The people who lacked interest of wearing shoes or putting on clothes were more likely to contract the infections because they exposed the respective body parts to thes jigger fleas. This could also be evidenced in people who did not observe personal hygiene due to ignorance and laziness. They are characterized by dirty clothes, irregular wearing of shoes and walking barefoot without taking note of where they stepped. The surroundings were majorly evidenced with bad odor and disorganized rags. The food remains could be spread all over thus attracting rodents which are hosts to these fleas. Majority would have poor housing conditions majorly made of mud and earthen floors (Nsanzimana *et al.*, 2019).

A similar study carried out in Madagascar indicated that majority of the infected patients were from rural regions and since the area is among the endemic regions, the most affected population were the young population. Infected patient with one or a complex of symptoms like itching, edema, ulceration, tissue necrosis and feet disfigurement experienced difficulty in walking. They lived in poor housing condition

built with mad and floors which were not cemented, which indicated the possible means of transmission (Rasoamialy-Soa Razanakolona *et al.,* 2022).

Communities with semi-nomadic lifestyles who keep moving from one place to another were considered to play a vital role in transmission of the jigger fleas from one place to another. This is because majority of them moved from one place to another in search of food for themselves and their animals; this was done mostly during the dry season. Majority of the men were more affected compared to females because they spent most of the time with the animals. Cattle rustling in these areas were rampant hence it contributed more the disease transmission. Many residents who were displaced moved randomly to various places hence those who were already infected carried along the fleas thus spreading the diseases (Mutebi *et al.,* 2023).

The jigger menace has been observed to affect economically disadvantaged communities. People who lived alongside domesticated animals such as goats, dogs, cats, and chickens due to poverty were more prone to being infected because animals are the primary vectors of fleas, ticks, and jiggers, As a result, more individuals were highly infested with jiggers. This was apparent from the deplorable living circumstances, which were single-roomed and shared by all members of the family, regardless of family size. In addition to poverty, impoverished individuals living in filthy surroundings got jiggers as a result of the unhygienic condition. The infestation resulted in low economic output among such people, rendering impoverished people unable to rise out of poverty or making them poorer, trapping them in the vicious cycle of poverty (Nsanzimana *et al.,* 2019).

2.3 Communities Knowledge about tungiasis

Jigger infestation is a parasitic skin illness and its prevalence among humans is due to lack of information about it. Some of the affected people in rural Uganda, like Dakaba kaala, thought they were be-witched and simply waited to die instead of trying to remove the jiggers from their feet. A few of the community members had a limited knowledge on how to treat the infections; some used tree extractions on the lessions so as to ease the pain. Those who thought it was associated with witchcraft opted to visit traditional doctors so that they could provide a solution to them and sometimes they performed traditional sacrifices to please their ancestors in case it was a curse projected to them (Mutebi *et al.,* 2018).

A research done in Kwale, Kenya showed that the overall level of knowledge on tungiasis among the members of that community was poor although they were aware of the fleas. Majority of the family members were aware of the signs and symptoms of the infection but could not clearly define the ways of treating them. Instead they employed traditional methods which included extraction of the embedded fleas and use of alcohol as a way of disinfection. Most of them could not tell the causative agents of the infection hence they casually related it to casual wounds that normally appear especially during the dry seasons. It is also noted that the mothers were more knowledgeable compared to the fathers (Mwai *et al.,* 2022).

Psychosocial and educational knowledge has a huge impact on the day to day human existence. People who have suffered tungiasis infection have a difficult time associating with other people. This is because majority of them already have a low self-esteem hence they have already subjected themselves to self-stigmatization before the society does. Additionally, stigma contributes to social exclusion especially

for the case of itching, the appearance of the wounds and body deformities associated with the disease. For the case of school going children, it causes a lot of destruction to them especially while studying in class hence lack of concentration and discrimination which in turn leads to poor performance in class. The elderly on the other hand are limited to their daily activities such as farming or business due to face stigma they face while carrying out their social-economic activities (Mutebi *et al.*, 2023).

The overall knowledge on how to handle tungiasis disease in the community is not well addressed by most communities. Majority of them have basic knowledge and others are not fully aware of tungiasis disease as a health concern. Without timely treatment of the infections, secondary contagious infections such as tetanus may arise since extracting jiggers cause blood to ooze from the body creating entry points for bacteria thus leading to further complications of the affected body parts. The knowledge of the associated health problems is limited since most of the people treat these lesions as regular wounds that need little attention. Some associated it with seasonal wounds that arise especially during the dry season and therefore they wound leave it until it heals on its own which resulted to many more lesions. Due to this ignorance, majority would contribute to spreading of the infections to other family members (Gitau & Maroko, 2021).

Majority of the communities have heard about the disease and there are a lot of myths and misconceptions which may have contributed to stigmatization of the affected person. Some of the community members lack proper knowledge on how to manage and the best treatment options of the disease. Majority will employ the traditional methods which posed more risks to animal and human health. The health methods

used are a health hazard and increases more risk of the disease transmission. There is a relatively high knowledge on human tungiasis compared to the knowledge on animal tungiasis (Mutebi *et al.,* 2018).

In north-east Brazil, most communities suffering from tungiasis did not recognize tungiasis as an important disease of health concern, despite the fact that severe disease was presented in the many of the children. Mothers rarely took the children with overt lesions to primary health care centers; they seem to be ashamed because of the presence of multiple tungiasis lesions which would indicate that they were not concerned with their children. The health care attendants were not fully aware of the disease, since fleas were normally removed by the patient or a caretaker, and lesions were not brought to the attention of medical professionals, hence physicians considered tungiasis to be nuisance rather than an important infection that requires more concern. Moreover, in case more complications arise at a later stage, it was rarely attributed to *T. penetras* (Saboyá-Díaz *et al.*, 2022).

Due to a lack of sufficient proper understanding on facts linked to the consequences of tungiasis (jigger infestation) on disadvantaged populations, the illness has been labeled as neglected. A recent research on tungiasis knowledge in two endemic communities in northeast Brazil found that knowledge on the etiological agent of transmission was high in both communities (90 percent). Tungiasis transmission was assumed to be associated with sandy soil (72 percent and 84 percent in urban slums and fishing communities, respectively). The knowledge of jigger infestation has grown significantly, with its natural history documented in detail, various treatment investigations undertaken, and the epidemiology, morbidity, and resource-poor context characterized (Harvey *et al.,* 2019).

Some studies have shown that, majority of the community members are not aware of the association between poor living condition and increase of tungiasis infections. A study in Brazil indicated that, tungiasis disease is closely associated with poor living conditions and failure to observe high levels of hygiene. Those who reused the building materials of the infected buildings were evidenced with recurrent infections and mostly they could not tell where the problem is arising from. Un-cemented floors were also reported to be a contributing factor, the community members were not aware of how to employ preventive measures to avoid contact between the sand flea and the skin of humans. Due to this, there were more cases of reinfections of tungiasis disease (Saboyá-Díaz *et al.,* 2022).

People with low level of knowledge on tungiasis and poor hygienic practices are likely to be exposed to tungiasis disease. A study carried out in Tanzania indicated that low levels of hygienic practices and lack of enough knowledge on tungiasis contributed to a high prevalence of tungiasis disease. Those who were aware of the disease tried their level best to maintain high level of hygiene which in turn resulted to reduced infections. They were also aware that sharing of the extraction objects such as the needles, scissors, thorns and other sharp objects could result to further contraction of transmitted diseases hence leading to more illnesses. They also observed the sigh and symptoms and could tell from a simple sign like itching (Mtunguja *et al.,* 2023).

Oral drugs with anti-septic effects are considered for the treatment of cutenous ecto-parasitoses because of their easy administration. However, a study shown that, use of topical drugs proved to be the most successful treatment. Although, the oral drugs were limited to side effects such as gastro-intestinal effects and lack of efficacy, in

this study, it proved to be effective compared to topical drugs. In addition, observing environmental measures highly contributed as the treatment mechanism. When the environment is clean and conducive for human residence, it is much easier to protect the people living there compared to those who lived in poor living conditions (Tardin Martins *et al.*, 2021).

2.4 Availability of Alternative Hosts (livestock)

Tungiasis is a zoonosis that affects both people and animals. Within two weeks, the parasite burrows rapidly into the skin of the toes, sole, and lateral border of the foot or heel, increasing its body volume by a factor of 2000. This is accompanied by severe local irritation, which makes walking difficult. Bacterial super-infection of the lesions is nearly always present, resulting in the formation of abscesses, suppuration, or lymphangitis. In non-vaccinated individuals, against tetanus, tungiasis may expose one to lockjaw disease (World Health Organization, 2020).

Domesticated animals such as pigs, goats, dogs, cats, and others that are maintained as pests on compounds, and near homes are widespread in many resource-poor areas in Africa. This might be ascribed to a lack of suitable area for animal sheltering, a fear of theft, or cultural customs. Because of their domestication and contact with people, particularly the sharing of common resting spots, these animals help to transmit the jigger flea and, eventually, the tungiasis illness. Jigger adults that have just emerged are nimble, jumpy, and crawl on the ground until they find a suitable host, generally a man. Sand flea reservoir hosts include pigs, dogs, cats, cattle, sheep, and *Rattus rattus* species of rats. Dogs and cats serve as key reservoirs for intra-domiciliary and per domiciliary transmission of sand fleas, and man is an alternative host (Harvey *et al.*, 2021).

The presence of dogs and living closely to animals are possible determinants of human tungiasis. These results might suggest that dogs play an intermediate role between wildlife tungiasis and human tungiasis. The wider range of movement of dogs may put wildlife at risk of contracting tungiasis disease because it serves as a carrier to both species. Allowing dogs to access both where the human reside and the wildlife habitat enables the spread of these fleas from one place to another. This is facilitated by dogs being able to bring eggs in and around the compound. They mature into adult fleas and proceed to infest humans and human living areas. Tungiasis cases are more concentrated to areas closer to the parks, the people livng around the place were more affected compared to those who stayed far away (Larson *et al.*, 2021).

Animal reservoir plays a vital role when it comes to transmission of tungiasis, animals such as pigs which are economic activities for other communities were emphasized as the main carriers of these fleas. The presence of these pigs in the compound was described as a predator to the human population and therefore it posed risks to the families living with these animals. The presence of free roaming pigs served as distributors of these fleas to various parts of the compound and its surrounding hence increasing the spread of the parasites within the community thus increasing disease transmission within the community. Dogs and cats were commonly infested with these fleas although it was not as intensive as those for the pigs. Many families who lived with dogs and cats were less infested with tungiasis compared to those who lived with pigs. Some studies indicated that if pigs were treated and well taken care of, then number of tungiasis cases would reduce in families who rare these pigs (Wiese *et al.,* 2017).

Both sexes of jiggers feed on blood, however unlike the male, who quickly departs the host after consuming blood, the impregnated female burrow into soft wet warm regions of the skin, such as toe webs or under toenails, using its sharp and well-developed mouthparts. Soles, elbows, and knees may also be infected; the females permanently penetrate the skin of their host in which they suffer hypertrophy hence expelling hundreds of eggs over a period of two to three weeks. These result to inflammation, cracking, loss of toes and severe pain (Ahadi Kenya Trust, 2003).

A study carried out in Amazon rain forest showed the indigenous people lived in wooden huts and they slept on wooden floor or in hammocks. They also lived with their domestic animals such as dogs, pigs, chickens, free-living pigs and wild rodents in the same households hence increasing the chances of transmission. Two of the children among those who shared the same household with the domesticated animals were infected and it is reported they were in contact with the animals despite the fact that they wore open sandals. One of the lesions on one of the child was located on the right foot; it had a blackish central point which was really painful whenever pressure was applied especially while walking (Calvopiña & Bezemer, 2021)

Some studies have shown that, Animals can also be seriously affected by tungiasis such as dogs, cats, monkeys, anteaters and jaguars. In some regions, dogs and pigs are considered to be the main carriers of these fleas. Since some of these animals reside with human beings and the relationship of sharing the environment, they highly contribute to the transmission of human tungiasis particularly through coming into contact with the infected grounds by the female fleas hence leading to more exposure to the human beings. Intervention and measures to treat the infected host is highly

recommended so as to reduce the parasites which will in turn reduce cases in humans (Dos Santos *et al.,* 2023).

2.5 Management Practices of tungiasis among the communities.

Tungiasis treatment comprises removing all embedded fleas quickly with sterile needles or curettes, delivering tetanus prophylaxis, and treating subsequent wound infections with suitable medicines. To eradicate tungiasis, the epidemiological cycle of parasite transmission must be disrupted. The use of biological repellents, applied twice a day, had positive results in the fight against Tungiasis in endemic regions. Another intervention trial in a disadvantaged neighborhood in Brazil found that intermittent application of a plant-based repellent might reduce tungiasis-associated morbidity in a situation with high transmission. Some mixed insecticidal dust into the infected soil or sprayed its surface with liquid insecticide (Coates *et al.,* 2020).

A study carried out in the Amazon indigenous communities indicated that three out of eight family members who travelled to this region acquired tungiasis. Mothers or the wife of the adult patient were the ones responsible for taking care of the lesions, a child who was infected was helped by the mother to manage the wounds. This was done by perforating the lesions transversely and longitudinally with a clean needle using antiseptic alcohol which produced a lot of whitish eggs. The lesion is then smeared with herbs to disinfect it and observed for more days after extraction. It was reported that the self-treatment was effective although it increased the chances of bacterial infections and risk of transmission of HIV, hepatitis B and C viruses (Calvopiña & Bezemer, 2021).

The success of treatments of tungiasis disease, however, has been difficult to anticipate, and they are more expensive than cementing home floors, limiting pigs to pigpens, and implementing health education in endemic populations. Sensitizing the community members on the importance of hygiene is important especially areas where the animals are reared so as to prevent the spread of these fleas. The use of pesticides within communal housing was reported as a protective factor in a Brazilian research, where adult illiteracy was 30%, unemployment was significant, and crime was prevalent. The success of treatments of tungiasis disease, however, has been difficult to anticipate, and they are more expensive than cementing home floors, limiting pigs to pigpens, and implementing health education in endemic populations. (Tardin Martins *et al.,* 2021).

A research conducted in Madagascar found that using a natural repellent based on coconut oil (Zanzarin) twice day was significantly efficient in reducing sand flea illness in a badly impacted population. The attack rates dropped to nil shortly after the repellent was applied. Within 10 weeks, the level of tungiasis-related morbidity was decreased to nil. Immediate removal of the embedded fleas and subsequent disinfection of the lesions was applied so as to protect the region against more complications. Indigenous knowledge is also known by the community residing in Trans- Nzoia that applying extracts from the marabou plant can treat jiggers (Lv *et al.,* 2023).

On the implanted sand fleas, oily preparations and ointments were used, including Vicks VapoRub ointment (a topical compound consisting of menthol, camphor, eucalyptus oil, and thymol in white Vaseline). Other treatments included the use of olive oil, candle wax, coconut oil, cooking oil, cerumen, and other antibiotic

ointments, either alone or in conjunction with detergents such as washing powder. 25 percent of the informants had used insecticides such as pyrethroids, carbamates or transfluthrin, or kerosene on the lesions at least once (Abrha *et al.*, 2021).

According to a Cameroonian research, the most prevalent treatment approach, utilized by 98 percent of people afflicted in the community, was manual removal of the flea with a pointed stick (augering), and 59 percent would not contemplate attending a medical institution to receive tungiasis treatment. Despite the development of new medications, the usual therapy for Tungiasis is surgical extraction of the flea under sterile setting. Treating of domestic animals was another mechanism applied which reduced the population of the *T.penetrans* (Girma *et al.*, 2018).

Appropriate wearing of footwear has been reported to be the best preventive measure of tungiasis disease. Community members who worn shoes frequently were reported to have less infections or no infections at all since there foots are covered most of the time. Walking barefooted at home exposed the feet to these parasites because they could easily penetrate into the skin. The presence of dogs and pigs in the compound posed more risk to the individuals who walked barefoot around the same compound. Fleas which have fallen off from the animals directly penetrated into the skin of the victims. Alternatively, the fleas hide in the grasses or soil hence once the come into contact with the skin, it becomes easier for it to penetrate through (Mtunguja et al., 2023).

2.6 Housing Conditions as a determinant in the transmission of tungiasis

Poor living circumstances are found to increase tungiasis. Multivariable analysis revealed that both instances of tungiasis and the heavy infestation were substantially connected to poor home conditions (odds ratio OR =4.7) lack of water, poor cleanliness, and wearing open shoes. Paving public common spaces and residential floors, as well as the usage of closed shoes, are viable preventative and intervention approaches for battling the illness in families (Jorga *et al.,* 2022).

Soil infestation serves as a good predator for the occurrence of tungiasis at the household. Houses which have been built with mud served as reservoirs for these fleas thus exposing the general members living in the household to tungiasis infections. Children sitting on the ground with little cloth protection or without clothing were at high risk of contracting coccygeal lesions which were really severe and painful. More interventions to reduce the transmission rate of off-host stages in the soil should be implemented. A study done in Brazil indicated that soil infestation was significantly related to occurrence of tungiasis at the household level. Behavioral factors such as having unprotected contact with infested soil contributed highly to this disease depending with the immunity of the person in contact (Santana *et al.,* 2023).

Several studies have indicated the association of tungiasis and poor housing conditions. Families who have semi- permanent households especially those who build their houses with mud, wooden huts or have un-cemented floors were reported to have a high case of tungiasis infections compared to those with permanent houses. This is evidenced in a study carried out in Amazon rain forest where there houses were made of palm leaf or zinc and the floors were made of sand, dry earth or wood. Due to the scarce resources of building more houses, majority lived together with

their animals thus increases the chances of spreading the fleas (Calvopiña & Bezemer, 2021).

According to an Ahadi Kenya Trust report on the jigger situation in rural schools in Busia and Teso Counties, Classrooms with un-cemented flooring created a good breeding site for these pests (Ahadi Kenya Trust, 2009). A survey in Baringo Central, Baringo County, Kenya, found that 88 percent of respondents had mud and crumbling walls on their houses, with dusty floors, and that poverty hampered ownership of cemented buildings in the region.

High levels of hygiene and sanitation need to be observed in order to prevent and control the spread of tungiasis disease. Both physical and environmental behaviors should be changed so as to ensure a smooth transition towards its eradication. It is evidenced that people who live in poor resource settings with lack of clean water and sanitation in their households are characterized with frequent prevalence of the disease. Inadequate housing, poor knowledge of hygiene and healthy behaviors are also the key contributing factors. Some research showed that, most of the family members especially the children spend of their time bare foot while walking around the household environments which increased the chance of infection and transmission of tungiasis. Moreover, the grasses and leaves falling from trees surrounding the homestead provided a suitable environment for sand fleas living in the soil (Hyuga *et al.*, 2021).

In the environment, the embedded *T. penetrans* habits in the crevices, cracks and dust. Poor housing conditions serve as a good reservoir for this parasite especially houses with made of mad and it is characterized by dust and poor hygienic conditions. The hosts are infected by skin penetration then it protrudes from the epidermal surface

particularly for aeration purposes, defecation, copulation and release of the eggs by expulsion which normally takes two to three weeks after penetration. Sharing the same habitat with animals such as dogs or pigs is considered a as a contributing factor to the spread of these parasites. This is because majority of these animals are poorly maintained and coupled with poor hygiene hence once they have picked the fleas; they automatically become carrier of these parasites (Mtunguja *et al.,* 2023).

Houses whose floors were cemented helps in lowering the prevalence of tungiasis disease. When the floors are in good condition and well cemented, the jigger fleas are prevented because it interferes with its ecology. Presence of moisture tends to clog the spiracles of the larvae thus causing them to die before moving to the next stage of their cycle. The variation in soil PH also serves as a preventive mechanism since it affects the osmotic balance of the jigger flea. Earthen floors are prone to being affected by rats which make burrows especially in the corners. This increases the chances of letting in the fleas hence exposing the members of the household to tungiasis infection. Poorly disposed food remains could also attract more rats which will in turn come in with the jigger fleas (Jorga *et al.,* 2022).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the various methods that were used in conducting this research. The chapter encompasses the following sub-sections; research design, target population, instruments, data collection procedure, data analysis, ethical considerations, and operationalization of variables.

3.2 Study site

The study was carried out in Trans-Nzoia county, Kiminini sub-county, Kapkoi sisal location. The area was chosen because it had the highest population hence allowing room for adequate collection of data.

3.3 Study Design

The study utilized a cross-sectional design. With this approach, a snap short study on the target population was conducted to obtain data relating to household socio-economic factors, knowledge, and practices of the community on dealing with tungiasis infestation.

3.4 Target Population.

The target population was only the residents of Trans Nzoia County at the time of the study. From the population census of 2019 of persons and households, this was estimated at 990,341 and 222,989 respectively.

3.5 Study Population

Study participants were permanent inhabitants of the study villages that were selected. In this study, a permanent inhabitant was considered as one who had lived in the

village of study for more than one year, and was above age of 18yr, and willing to be interviewed.

3.6 Sample Size

Fischer's formula was applied to determine the sample size for this study

$$n = \frac{Z^2\, p(1-p)}{d^2}$$

where;

n - desired sample size

z -value associated with 95% confidence interval.

p – proportion of households with at least one member infested with jiggers.

d = amount on precision allowed on p taken as 7.58%.

Therefore $n=1.96^{2*}0.5^2/0.\ 00575=167$.Therefore, the desired sample size for the study was 167 households.

NB: No adjustment was made since the Total numbers of households were in excess of 12,000.

3.7 Sampling Procedure

A Multistage sampling approach was adopted in this study with different sampling strategies applied at different stages.

Step 1: Selection of the study area

Trans Nzoia County comprises 5 Sub Counties namely; Cherangany, Kiminini, Saboti, Endebbes, and Kwanza. Kiminini sub-County was purposively sampled because of its high population among all the other sub-Counties in Trans Nzoia

Step 2: Selection of locations.

Kiminini Sub-County has four locations namely Kiminini, Sikhendu, Kapkoi Sisal, and Kipsongo. Kapkoi Sisal was predominately a location composed of large farms

compared to Kiminini, Sikhendu, and Kipsongo. Thus stratification according to farm size was done so that Kapkoi sisal location was selected for this study, alongside any other location chosen randomly from the remaining three locations.

Step 3: Selection of sub-locations.

From the selected Kapkoi location, the following sub-locations were selected randomly: kapkoi sisal and mabonde sub-location. Households in the selected sub-locations were identified using a systematic sampling approach. The number of households in each sub-location was determined through proportional allocation according to the size of the selected sub-locations.

Step 4: Selection of villages and households.

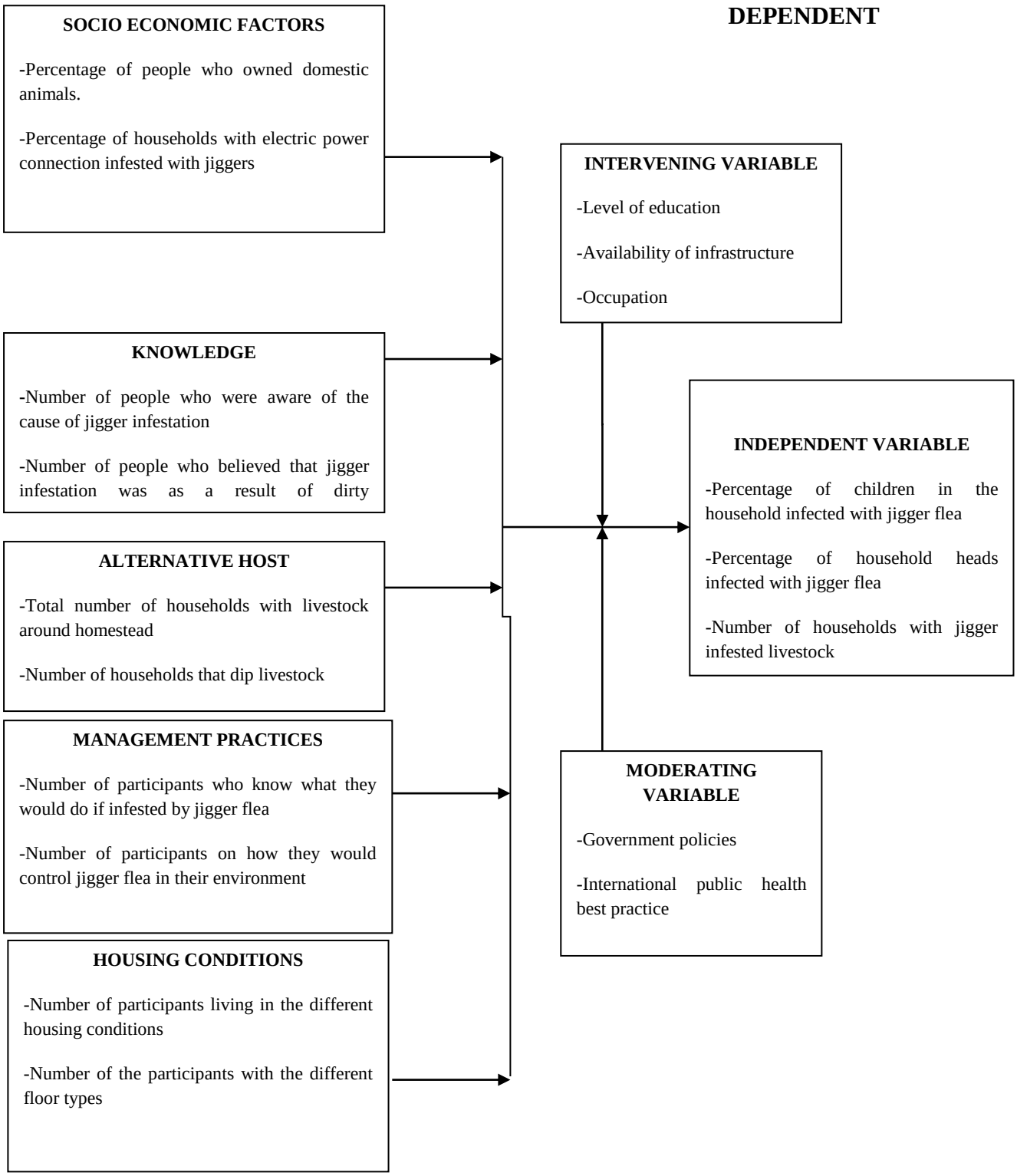
Once the sub-locations were identified, a random sample of the villages was picked. Depending on the size of the village that was selected, the interval at which households were recruited was determined differently for each of the sub-locations. For each selected village, Landmark/point (road junction) which was centrally placed within the village was identified as a starting point. While at the identified central point, a starting village direction was selected by spinning a bottle for the random walk method, and where the bottle's head direction lands and facing was used. The nearest eligible household in the selected direction was the first to be selected and visited. Subsequently, households were identified by skipping k (sampling interval) number of households to reach the second eligible household. The process was repeated until the desired sample size was achieved.

$$k = \frac{Size\ of\ the\ selected\ house\ holds}{sample\ size\ allocated\ to\ the\ selected\ sub\ location}$$

Table 3.1: Total household in the sub-location (KNBS-2019)

Sub-County	Location	Sub-Location	Number of Households	Population
Kiminini	Kiminini	Sikhendu	3,788	16,662
		Baraton	8,610	38,462
		Matunda	4,204	19,995
		Weonia	3,513	17,114
		Kiminini	3,738	15,118
		Nabiswa	2,973	12,793
	Waitaluk	Mabonde	6,854	30,130
		Kapkoi Sisal	5,537	24,386
		Sirende	6,488	28,356
		Naisambu	6,491	23,902
		Milimani	4,417	15,905
	Total		**56,613**	**242,823**

3.8 Conceptual Framework



3.9 Data collection tools

Data was collected using structured questionnaires, interviews of key informants, and focused group discussions.

3.9.1 Questionnaires

The questionnaires were administered by the research assistants who interacted with the heads of sampled households one on one as they took note of their response. Questionnaires contained sections on socio-economic factors, knowledge, the presence of alternative hosts, management practices, and housing conditions. Quantitative data was collected by administering a structured questionnaire with both closed and open-ended questions, daily routine checks were performed on the data to ensure that correct information was collected.

3.9.2 Key informant interviews

Verbal interviews, face-to-face were administered to the key informants among them one public health officer, one nurse, and three program officers all attached to the community dispensary at the area of study. The interview was administered by the principal researcher assisted by two field assistants. The questionnaire interviews lasted between twenty and thirty minutes.

3.9.3 Observation

Objective observations of children and adults with tungiasis infestation were done in the selected households. Observation checklists were effectively used to collect data from households that had their members affected by jiggers.

3.9.4 Focus Group Discussions

The FGDs were conducted at the selected villages to obtain additional information. This involved organizing 3 FGDs with 5-12 volunteering participants comprising of

the youth, elderly, middle-aged, CHVs, and other leaders who were invited the neighboring villages. Information was collected using Kiswahili language. This was done in different settings to establish whether or not they understood the origin of tungiasis and how they perceived it and consequently how to deal with it to prevent and control the disease.

3.9.5 Pilot testing of the instruments

Mugenda and Mugenda (2008) indicate that piloting before the actual study is done would be necessary to make necessary adjustments to the study instruments. The tools were pilot-tested among 25 respondents selected at random at the neighboring village. The pilot study took 4 days after which data was analyzed and adjustments were made on the instruments for reliability reasons. This was justified by asking the same questions to different people giving the same answers without hesitation.

3.9.6 Validity of the instrument

Validity is the degree to which results obtained from the analysis of the data represent the phenomena under study (Mugenda & Mugenda, 2008). Validity is the success of probing or assessing what it sets out to probe or assess. To enhance validity in this study content-related validity of the questionnaire on the schedule was determined with the help of experts, such as the research supervisor. The supervisor gave guidance and ensured that the instruments were well constructed, to address the information being sought by the set research objectives.

3.9.7 Reliability of the instrument

Reliability is the extent to which a measuring device or a whole research project would yield the same results if used again on different occasions, but with the same population. The reliability of the instruments was ascertained for internal consistency

using the split half-reliability method. The questionnaires were administered once to the same individuals and then split into two equal parts. The parts were scored and the scores correlated using the SPSS program during analysis. The instrument was considered reliable after attaining a reliability coefficient of 0.88.

3.9.8 Data analysis techniques

Polit and Hungler (1997) provide that data analysis is the process of adding value to raw data so that it can be understood. The data obtained were organized, coded appropriately, and analyzed using Statistical Package for Social Scientists (SPSS) version 20. The results were presented in tables using descriptive statistics (frequency counts and cross-tabulations). Inferential statistics (chi-square test and correlation analysis) were used to measure the degree of association. Besides the above-mentioned analyses, further tests such as normality tests, bivariate analysis, and Pearson's Chi-square were also conducted with a p-value tested at <0.05.

3.10 Ethical considerations

i. IREC- **Institution for Research Committee** of Moi University approved the research proposal and gave the respondent the go-ahead. Permission was also sought at the County, then later at the sub-County respective offices. At the community level, community health workers, community leaders, the area assistant chief, chief, nyumba Kumi, and village elders were informed of the activity before commencement.

ii. Informed Consent- This was sought from the individual or the respondent.

The major ethical issues considered during the research were IREC approval of the research topic, informed consent of the participants, privacy and confidentiality of the information provided by the participant, anonymity, and researcher responsibility. Participants were not coerced to participate in the study as well as there was no form

of inducement to them to participate. The researcher ensured informed consent by making sure that every respondent was adequately informed on the purpose and procedures of the study.

Collected data following the study were availed to the community through subsequent meetings held with the community and other relevant stakeholders. Patent rights of the author of materials used were protected by the researcher by making correct references to materials used.

Table 3.2: Operational variables

OBJECTIVE	VARIABLE	INDICATORS	DATA COLLECTION TOOL	MEASUREMENT	DATA ANALYSIS
1. To determine the socio-economic factors associated with tungiasis in Trans-Nzoia County	Socio-economic factors	-Percentage of people who own land -Percentage of households with electric power connection	Questionnaire Focused groups discussions Interviewing key informants Observation	Ordinal Nominal	Descriptive statistics Inferential statistics
2. To assess the community knowledge on tungiasis in Trans Nzoia County	Knowledge	-Proportion of people who are aware of the cause of jigger infestation -Proportion of people who believe that jigger infestation is a result of dirty environments	Questionnaire Focused groups discussions Interviewing key informants Observation	Ordinal Nominal	Descriptive statistics Inferential statistics
3. To determine management practice of tungiasis in Trans Nzoia County	Management practices	-Proportion of participants on where they would seek treatment when infested by jigger flea -Proportion of participants on how they would control jigger flea in their environment	Questionnaire Focused groups discussions Interviewing key informants Observation	Ordinal Nominal	Descriptive statistics Inferential statistics

CHAPTER FOUR

FINDINGS

4.1 Introduction

This chapter presents the findings of the study. The findings are based on the determinants and management of the prevalence of tungiasis in the rural areas of Trans- Nzoia County. The obtained data were analyzed and interpreted based on the objectives and the research questions. Descriptive and inferential statistical analyses were done. The results were presented using frequency tables, pie charts, and percentages.

4.2 Questionnaire return rate

This study realized a sample size of 167 as per Fisher's formula beneficiaries. It was important to establish the return rate to know the exact number of questionnaires that were valid for the study. According to Mugenda and Mugenda (2003), a response rate of 70% and over in social sciences is considered appropriate for the study.

Table 4.2: Respondents

Target respondents	Actual respondents	Response rate %	Non-response rate%
167	164	98.20	1.80

The response results indicated in table 4.2 suggested that the questionnaire return rate was at 98.20%. This is considered very excellent in providing very accurate findings for the study (Mugenda and Mugenda, 2003), and was attributed to the good sensitization and mobilization for the activity by the research team.

4.3 Socio-economic factors associated with tungiasis in Trans Nzoia.

The study sought to assess the socio-economic position of the household in response to the prevalence of tungiasis at the site.

The research questioned whether the households owned any piece of land and size of land, kept domestic animals and their habitats which could predispose them to tungiasis.

Table 4.3: Socio-Economic characteristics of the respondents

Variable	Category	Frequency	Percentage
Land Ownership	Owned	140	85.4
	Did not own	24	14.6
Land Size	No land	24	14.6
	< 1 acre	115	70.1
	1-5 acres	25	15.2
	>5	0	0
Presence of Electric Power	Yes	33	20.1
	No	131	79.9

Table 4.3: is a presentation of the socio-demographic characteristics of the respondents in the study. The majority of the respondents owed land, 85.4% with the majority having less than 1 acre. The rest owned between 1-5 acres and none of the respondents owned more than 5 acres. A few of the respondents, 20.1% had electricity connection to their houses with the majority, 79.9% were unconnected.

4.4 Knowledge of jigger infection among community members.

The study sought to assess the knowledge of participants on awareness of the jigger infestation and the root cause of tungiasis. As shown in Table 4.4, the majority, 93.3% of the respondents were aware and believed that jigger infestation had a close association with the dirty environment as compared to 6.7% who were not. While 53.0 % believed that jigger infestation resulted due to exposure to jigger flea. A high 40.2 % believed that jigger infestation was due to bacteria transmission, while 3.0 % believed that the disease was due to a virus. Some 1.8 % of the respondents believed it was caused by witchcraft while another 1.8 % had no idea on the cause of the disease.

Table 4.4: Respondents' Knowledge on Jigger infestation

Variable	Category	Frequency	Percentage
Awareness of jigger Infestation & its association with the dirty environment	Aware	153	93.3
	Not aware	11	6.7
Cause of jigger infestation	Virus	5	3.0
	Bacteria	66	40.3
	Witchcraft	3	1.8
	Jigger flea	87	53.0
	Had no knowledge	3	1.8

The study sought to assess the knowledge of the participant on the jigger infestation and the root cause of Tungiasis.

4.5 Factors associated with Jigger Infestation

The table 4.5 below is an analysis of factors associated with jigger infestation in Trans-Nzoia County. Jigger Infestation is associated with family size, education level, and family status in terms of ownership of Electric Power, p=0.008, P<0.00, and 0.035 respectively. It is however not influenced by marital status, land size, Animal ownership, and where animals are kept.

Table 4.4: Associated factors with jiggers infestation in Trans-Nzoia County.

Factors	Presence of Tungiassis YES	NO	Test Value	Sig.
Family Size			t=2.75	0.008
Marital Status (in relation to Jigger infestation) Married	107	19	$x_2^2 = 3.998$	0.262
Single	11	4		
Widowed	13	5		
Divorced	4	0		
Education Level in respect of knowledge of disease	97	8	$x_3^2 = 20.961$	<0.001
Primary	32	15		
Secondary	5	5		
Tertiary	1	1		
University				
Economical status of a household whether owning land and power connection	18	7	$x_1^2 = 1.947$	0.122
Land Size	97	18		
1-5 Acres				
>5				
Electricity				
Yes	23	10	$x_1^2 = 0.044$	0.038
No	112	19		
Presence of Animals				
kept	55	15	$x_1^2 = 0.306$	0.190
Not kept	80	14		
Where Animals Kept				
Animal Pen	9	3	$x_2^2 = 1.754$	0.416
Indoor	11	1		
Outside	35	11		
Type of Floor				
Earthed	128	6	$x_2^2 = 87.757$	0.000
Cemented	7	23		

4.6 Predictors of Tungiasis

A logistic model was fitted to examine predictors of tungiasis in this study

Controlling for Household size and family status with respect to having kept domestic animals, animal pens, indoor keeping with some of the factors associated with the presence of Tungiasis among families in TransNzoia.

Table 4.5: Logistic Regression models

	Unadjusted Model			**Adjusted Model**		
Factors	**B**	**Sig.**	**OR**	**B**	**Sig.**	**Adj.OR**
Household Size	0.196	0.019	1.217	0.110	0.189	1.116
Education Level		0.000			0.004	
Primary	2.495	0.0882	12.125	1.899	0.218	6.682
Secondary	0.758	0.601	2.133	0.239	0.874	1.278
Tertiary	0.000	1.000	1.000	-0.199	0.899	0.820
Presence of Electricity	-0.941	0.038	0.390	-0.258	0.631	0.773

4.7 Presence of alternative host (livestock)

The study sought to assess the presence of jigger alternative hosts at the household level in respect to the prevalence of jigger flea in the area.

The research also sought to find out the existence of jigger alternative hosts (domestic animals) at the household level.

Table 4.6: Presence of alternative host (Livestock)

Presence of alternative host	Frequency	Percent %
Present	70	42.7
Not present	94	57.3
Total	164	100.0

The study in table 4.6 revealed that 57.3 % of the households had no form of alternative hosts e.g chicken, dogs, cats, goats, sheep, cows, pigs and donkeys while 42.7 % had alternative hosts at the household level.

4.8 Distance of livestock from the main habitable house.

The research also sought to establish the distance where livestock was kept from the main house of the respective respondents.

Table 4.7: Distance of livestock shed from the habitable main house

Distance of livestock from the main house	Frequency	Percent %
No distance within the house	4	2.4
Less than15 Meters	55	33.5
Greater than 15 Meters	11	6.7
Do not own livestock	94	57.3
Total	164	100.0

The study as indicated in table 4.7 found out that 33.5 % of the participants had livestock kept within a distance of fewer than 15 meters from the main houses, 6.7 % had their livestock kept within a distance of more than 15 meters from their main houses while 2.4 % had their livestock very close to the main houses actually within their households

4.9 Management practices and treatment

The study sought to assess the community's management practices and treatment of jigger fleas with respect to the prevalence of jigger infestation. Also, the study tries to find out where the participant would seek treatment once they were infested by jigger flea.

Table 4.8: Places where respondents sought treatment

Points where treatment was sought.	Frequency	Percent %
Government clinics	19	11.6
Private chemists	1	.6
Traditional healer	3	1.8
Private clinics	1	.6
Remove personal removal	140	85.4
Total	164	100.0

Table 4.8 showed that 85.4 % would remove jiggers personally using crude appliances, 11.6 % would go to government clinics, 1.8 % would go to traditional healers, 0.6 % would go to the chemists and private clinics respectively to seek treatment for tungiasis.

The study sought to establish how the participants managed jigger menace in their environment and the following methods were found.

Table 4.91: Management of jiggers in the environment

How to manage jigger in the environment	Frequency	Percent %
Burning of vegetation	91	55.5
Spraying domestic animals with acaricide	11	6.7
No action	62	37.8
Total	164	100.0

The study found out, as shown in table 4.9, that 55.5 % of respondents burnt vegetation around their compound while, 37.8 % did nothing and 6.7 % sprayed vegetation in their compounds with insecticides and domestic animals with acaricides.

4.10 : Housing conditions

The study sought to assess the housing conditions of the households with respect to jigger infestation.

Table 4.10: Type of housing

Type of housing	Frequency	Percent %
Permanent	7	4.3
Semi-permanent	156	95.1
Mud houses	1	.6
Total	164	100.0

The results from table 4.10 indicated that 95 % of the participants occupied semi-permanent houses, 4.3 % permanent, and 0.6 in mud or timber houses.

The research also sought to know the floor type of the houses occupied by the research participant.

4.11 Type of the house floor

The study sought to assess the type of the housing condition in relation to jigger infeststion.

Table 4.11: Type of house floor

Type of floor	Frequency	Percent %
Earthen	134	81.7
Cemented	30	18.3
Total	164	100.0

The study as shown in table 4.11 revealed that, as indicated on table 4.11, 81.7 % of the participants had earthen floors, while only 18.3 % of them had cemented floors.

4.12 Information Obtained from Focused Group Discussions

4.12.1 The Elderly's socio-economic factors associated with the transmission of tungiasis disease.

It featured from the elderly chaired by Sibuta Patric and Lokichan that; most parts of Trans-Nzoia County was still forested land and up until 1966, no case of jiggers had been reported, then it was believed by the local community that *Funza jivenjeje* (jiggers) was brought to the area in 1978 by a businessman who was engaged in batter trade in Tobacco and swords/ knives. This was during the "kipande" system when people were seeking the issuance of National Identification cards (IDs) from the administration then situated at Katatha ADC farm near Mount Elgon National Park in Mt Elgon sub-County, Bungoma County.

4.12.2 The Elderly's Knowlegde of tungiasis disease in Trans Nzoia.

It was reported that the disease was common and was with them even after treatment and that people could still get it in the houses or along footpaths, roads household compounds, etc. They noted that Jigger fleas were very small and tinny compared to those which affected dogs, goats, cats, and poultry which were big. A retired teacher claimed to have known the disease earlier at Mount Elgon and sometimes related it to have affected some people of certain blood groups and those who were dirty. He claimed that people had to observe personal hygiene, high standards of environmental hygiene and emphasized that jiggers were not associated with witchcraft as he claimed.

4.12.3 The Elderly's management practices of tungiasis disease.

It was further narrated that any person could be affected if one could not observe personal hygiene. After removal of the impeded flea in the feet or toes/fingers, the first remedy was to trim the nails, then appropriate chemical/lotion could be applied on the affected area aimed at killing or blocking the breathing of the jiggers species e.g. Vaseline or paraffin, hydrogen peroxide.

One of the respondent who was born in West Pokot County and a resident of the area but working at the coast (Mombasa) had noted that *jigger had infected his children in the year 2011, and later on his hands, buttocks, legs especially the toes and the face were affected with the jigger fleas. He bought chemicals (Sevin) dust mixed with cow dung and smeared the floor of his house that was the time they become more as if it were activated. Jiggers have got no respect it can infest any part of the body. Sometimes he mixed water and chemical acaricide then sprayed the house, this worked for sometimes then they reappeared then he worded but he met a friend who advised him to use kevol mixed with the (smearing material)l soil and cow dung. It reduced jigger in the house but those in sofa sets remained.*

He claimed seriously that a jigger is a serious disease that requires the government to have a way to assist. When affected by jiggers, the affected part itches a lot, that you can be embarrassed especially when you are attending a meeting, workshop, or a church service. In the village (friends see you or can notice that you have a problem and if they are also affected then no one will be shamed or embarrassed but become unfriendly to people who do not have them. he observed the difficult moments that children with affected hands underwent while eating or taking food and for him. He used hydrogen peroxide after extracting the flea to disinfect the wound and the affected part of the body

4.12.4 Middle-aged men and women socio-economic factors associated with tungiasis transmission.

One of them said they discovered that, the white settlers kept pigs in a wet and dumpy area and were using Kapotox (Dip) to spray them to control external parasites, jiggers included. When Africans started to keep pigs, they kept them in a dry and dusty place. No one had seen these parasites before then and it was believed that they originated from the forest.

4.12.5 The middle-aged men and women's knowledge on tungiasis disease.

One lady said to have been born in Soy Uasin-Gishu County, narrated that the community had stayed with the disease with minimum attention and it was perceived as a normal case that did not require special attention. She removed the jiggers from her 3-year-old child.

4.12.6 The middle-aged men and women's management practices of tungiasis disease.

She acknowledge that jiggers depended on an untidy environment that was dry and dusty, and to control or to prevent them from spreading, one must maintain high standards of personal hygiene. She noted that if the jigger was punctured in the affected part of the body then it would develop and spread, thus widening the affected area. After removing the flea, the affected part was oiled using Vaseline, paraffin and the child could be taken to a clinic only if the wounds refused to heal or respond.

4.12.7 The youth

Some youth indicated that they first saw a case of jiggers in old people in 2013, and they linked the infestation to the poor sanitation of households and personal hygiene. They also thought that dogs, donkeys and cats, mice, and rats could have spread the infection.

4.12.8: Key informants.

This group comprised of public health officers, nurses, community health volunteers (CHVs) all had the same feeling that regardless of frequent health talks, the community was slow in adopting their ideas and no one bothered to follow what they were told by healthcare professionals, several cases of tungiasis were registered in the CHV'S notebooks for follow-up, but those that presented themselves with big wounds were registered in outpatient register and not considered as tungiasis cases and so documentation was always a problem. They reported that the community did not treat the disease as a priority because it was associated with the way one lived or one's status in life.

CHAPTER FIVE

DISCUSSIONS

5.1 Socio-economic factors associated with tungiasis transmission in Trans-Nzoia County

The study found a high prevalence of tungiasis infestation of 82.3%. The inhabitants of the study area were of low living status which was evidenced by the small land size ownership, poor living conditions including the predominance of semi-permanent home structure types, and limited electricity supply in the households. The houses contributed greatly to the spread of these fleas since they mud served as good reservoirs and breading site for the fleas. Additionally, it is easier for rats to make burrows in the corners of mud houses compared to permanent houses. This study agrees with a study carried out in the Amazon rain forest where majority of the houses were made of mud and roofed with palms hence the grasses and the palms acted as habitat for these fleas thus increasing the prevalence cases (Calvopiña & Bezemer, 2021).

Tungiasis infestation was associated with family size, low education level, and lack of electricity connectivity at the bivariate level, and upon controlling for other factors, results showed a decline in the prevalence of t*ungiasis* infestation with increased education level. These is due to the awareness of the few people who were educated on the dangers of poor hygiene. This was even higher than the prevalence level of tungiasis infestation reported in Muranga South with a prevalence of 57%. Jigger infestation was significantly associated with age, lack of education, employment status, poor residential areas. Studies have shown that poverty contributed to high prevalence of tungiasis infestation in resource-poor communities (Kong *et al.,* 2022).

In this study, the odds of jigger infestation in home-states without electricity is 2.5 times higher compared to those connected to electricity, p=0.038. Similarly, the probability of getting jigger infestation by those who lived in homes with earthen floors was 0.99. This probability was significantly higher compared to 0.58, the probability of getting a jigger infestation for those whose floors were cemented. This was in line with the findings in a study carried out in Uganda which showed that, jigger infestation was high among the poor folks. The study revealed tungiasis as an epidemic in Uganda having affected residents of twelve districts. In Basoga district, exposed dirt walls, dirty compounds, and lack of health services was a common feature among villages owing to poverty. Most of the resource-poor communities were associated with a lack of appropriate urban services such as health facilities and good housing conditions (Nsanzimana *et al.*, 2019).

This study observed that up to 37.8 % of the residents of Trans-Nzoia did not clear and burn vegetation around their compounds while up to 93.3% did not spray debris around their compound with any form of insecticides. This contributed to the high level of prevalence of tungiasis infestation in this study led by the state of the housing condition which was considered as the main contributing factor. It was observed that most houses had rough, cracked walls made of mud with a lot of crevices and dusty earthen floors which was a good habitat for sand fleas. In this study, 95 % of the respondents occupied semi-permanent houses, and 81.7% of them had earthen dusty floors. This study agrees with a report by WHO (2020) which indicated that, the risk for infestation was high where personal hygiene including the surrounding environment was not observed or if personal feet were not protected (WHO, 2020).

Most studies have reported a high prevalence of tungiasis infestation which was associated with the presence of alternative hosts. A study in Muranga showed that

people lived in close proximity or shared habitats with domesticated animals including goats, dogs, cats, and chickens. Due to their domesticated nature, and interactions with people, including sharing of common resting places, these animals served to spread the jigger flea and ultimately the tungiasis disease. Coupled with compromised hygiene standards and poor housing conditions, tungiasis infestation was often elevated and in this study, livestock was the identified alternative host in the community. The findings in this study did not, however, link the prevalence of *tungiasis* to the presence of livestock in the household, OR=1.56, CI [0.7, 3.49]. Analysis of proximity of livestock sheds to households did not reveal any significant relationship with the prevalence of tungiasis. The odds ratio of tungiasis infestation for those who kept animals indoors to those whose livestock are kept outdoors was not significant, OR=3.5, CI [0.41, 29.56].

5.2 Knowledge of jigger infestation among community members.

This study indicated that majority (93.3%) of the respondents were aware and believed that jigger infestation had a close association with dirty environment. These could be observed from those who had suffered from the disease and how they behaved in their respective homesteads. This study agrees with a study done in Brazil which indicated that poor living conditions highly contributed to the increase in tungiasis infestations (Saboyá-Díaz *et al.*, 2022). 53.0 % believed that jigger infestation resulted due to exposure to jigger flea. 40.2 % believed that jigger infestation was due to bacteria transmission, while 3.0 % believed that the disease was due to a virus. Some (1.8 %) of the respondents believed it was caused by witchcraft while another (1.8 %) had no idea on the cause of the disease. This study agrees with a study carried out in Uganda which reported that, majority were aware of the disease

existence and some associated it with myths and misconceptions of witchcraft (Mutebi *et al.,* 2018).

From the focused group discussion (FGD), middle-aged men and women, the study found out that the community had stayed with the disease with minimum attention and it was perceived as a normal case that did not require special attention. The elderly reported that the disease was common and was with them even after treatment. They noted that Jigger fleas were very small and tinny compared to those which affected dogs, goats, cats, and poultry which were big. Some claimed to have known the disease earlier at Mount Elgon and sometimes related it to have affected people of certain blood groups and those who were dirty.

5.3 Management practices of tungiasis by the community in Trans-Nzoia county

Ever since the presence of tungiasis was noticed in Trans-Nzoia, the community had sought different ways of disease management. Common approaches reported in this study included the use of unsterilized objects such as pins, needles, thorns, or any other sharpened objects to remove the flea after which cow dung, traditional herb paraffin, coconut oil, hydrogen peroxide, would be applied to disinfect the affected body parts according to focused group discussion. This finding, in this study, agrees with who noted that removal of burrowed sand fleas with traditional blunt and inappropriate instruments remained a commonly applied method, yet it increased the risk of transmission of blood-derived pathogens, particularly when used on multiple victims with jigger infestation (Girma *et al.,* 2018).

A finding in this study from Key informants (KI), comprising public health officers, nurses and community health volunteers (CHVs) showed that despite the frequent health talks to the community on the safe management of jigger infestations, the community had either been slow to adopt, or in other instances, not bothered to adhere

to the management strategies. They seemed to have considered or adopted it as a status issue. The study noted, from the KI"s findings that while cases were registered in the CHVS notebooks for follow-up when they presented at the hospital with big wounds on their feet, they were not captured as wounds resulting from tungiasis infestation. Instead, the cases were registered in the Outpatient register as general wounds. This trend may have led to an understatement of the seriousness of tungiasis in the affected areas. Subsequently, the understatement could have a weakening effect on policy strategies and resource allocation to deal with the tungiasis menace.

The tungiasis-causing parasite can be traced back to the 16th century when Gonzales Fernandez de Oviedo noted that Spanish conquerors in Haiti frequently suffered from the disease. Between the 18th and 19th centuries, however, the parasite is believed to have stowed away on one of the numerous ships carrying sand, possibly the vessel Thomas Mitchell, which was traveling in from Brazil to Angola in West Africa. It emerged from the focused group discussions (FGDs) in this study that until 1966 jigger's infestation had not been witnessed in Trans-Nzoia. By 1978, however, the first cases were reported and largely believed to have been brought by a businessman engaged in batter trade in tobacco and swords and knives. This was during the "kipande" system when people were seeking the issuance of National Identity cards from the administration then situated at the ADC farm near Mount Elgon National Park.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

This research concludes the following;

Socio-economic factors associated with the transmission of tungiasis included; poverty, poor living conditions, semi-permanent structures, dusty floors and generally unhygienic conditions.

There was an inverse relationship between education and knowledge of awareness of tungiasis infestation in Trans-Nzoia County, in that, the higher the level of education among the respondents, the higher the awareness of disease transmission, strategies of prevention and control.

Even though there were community management strategies being practiced by the inhabitants of Trans-Nzoia County, they were inefficient in lowering the incidence of the infestations that could also have the potential to transmit other disease-pathogens in the study area.

6.2 Recommendations

The following is recommended from this study;

- The study recommends the need to empower households to Access health education especially on living in hygienic conditions as a long term strategy to eliminate tungiasis infestation.
- The study recommends that County and National governments, private sectors, and non-government organizations should come up with advocacy strategies aimed at increasing awareness among the inhabitants of Trans-Nzoia on the causes, prevention, and adoption of safe management practices of tungiasis to lower and eventually eliminate the infestation.
- Health facilities should profile tungiasis health problems so as to influence resource allocation, control and to eliminate the spread of jiggers among the residents of Trans-Nzoia.
- There is need to educate the residents in Trans-Nzoia on the potential risks of other disease transmissions that may result from these management approaches being employed.

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APPENDICES

Appendix 1: Introductory Letter

YOTOMUK WILSON CHEMERII,

KAPENGURIA,

RE; REQUEST FOR PARTICIPATION IN THE STUDY

I am a post-graduate student at the Moi University undertaking a Master's degree in Public Health. I am undertaking a research study on determinants and management of TUNGIASIS (*Tunga penetrans*): in Kiminini sub-county IN TRANS-NZOIA COUNTY.

Am kindly requesting you to honestly assist me to participate in filling in the questionnaire, participating in focused group discussions, or being interviewed as a key informant for the study. The information you provide will be treated with the utmost confidentiality and will only be used for this particular study. Please tick or fill in the required information on the spaces provided in the questionnaire.

Thank you for your sincere cooperation.

Yours faithfully,

Yotomuk Wilson Chemerii.

Appendix 2: Consent to participate in research study

I am Yotomuk Wilson a second-year student from Moi University, School of Public Health; SPH/PGH/08/13 I intend to carry out this research as part of my degree program.

Purpose: The purpose of the study is to determine the Risk factors of Tungiasis in Trans -Nzoia County. I wish to find out the major determinants of Jigger infestation among the residents and how they manage Tungiasis.

The subject is expected to participate in this study for a maximum of twenty-five minutes.

Procedure: Participants in this study will be required to answer the questions. The researcher will take the respondent through the introductory session and explain the whole purpose of the study and ask if the respondent will willingly participate and thereafter present the questionnaires to the participant.

Voluntary nature of participation in the study: Participation in this study is entirely voluntary. If an eligible research participant opts to decline to participate in the study, his/her decision will be respected and updated.

Confidentiality of Information: Confidentiality will be observed in the dispensation of the questionnaire and the keeping of the information of the respondents. The information will only be used for the intended purposes of the studies only. Anonymity will be ensured in the study/no names of the participants shall be used during data collection.

Benefits: Participation in this study will not, in turn, benefit directly those who participate in the study i.e. the respondents. The public and mostly the health

institutions will benefit from the results of the research which will translate to benefitting the community.

Risks: The respondents will be assured that there are no risks that are related to the research. Respondent identity will not be revealed to anyone not involved in the study.

Right to withdrawal or Refuse: Respondents will withdraw from the research at their own will at any time.

Questions: Questions, comments, and complaints related to the study will be addressed by the researchers by the contacts on 0728406625 or box 3979- Kitale.

PARTICIPANTS CONSENT

I……. declare that I have read about this study/have been fully explained to the contents of the study by the researcher and have fully understood. I hereby voluntarily agree to participate in this study. By signing, I agree to participate in the study above, with knowledge that=withdraw from the study at any time.

Participant's Signature……..Date……

I certify that the nature, purpose, potential of benefit, and possible risks associated with regard to participating in this research has been explained to the above individuals.

Researcher's sign …….

Date……

Appendix 3: Questionnaire

Household interviewer schedule:

Village……. location ……..
division…….

Interviewer No…….interview date……..2016

Personal information

1. Sex.....1. male 2. female
2. Age …….Yrs

Household details

3. How many people in the house…….
4. No of adults……..
5. No of children……..
6. Sex of children…….Male…….female…….

7) Head of household (please circle)

1. Father

2. Mother

3. Grandfather

4. Grandmother

5. Son

6. Daughter

8) Marital status

1. Married 2.single 3 widow 4 widower

9) What is your religion

1 Christian 2.Islam 3 Indigenous 4 non-believer/atheist

10) Educational background

1) Primary ☐

2) Secondary ☐

3) Tertiary ☐

4) University ☐

Socio-economic factors associated with Tungiasis

11) What is your professional/what do you do?

1) Teacher ☐ 2) Businessperson ☐ 3) Farmer ☐

4) Other specify……

12). Do you own land 1) YES ☐ 2) NO ☐

13) What is the size of your land? tick appropriate

1) 100 acres

2) 5-10 acres

3)1 -5 acres

4) Less than 1 acre

14) Who owns the land (please circle)

1. Clan trust land
2. Father
3. Mother
4. Grandparents
5. Children
6. Bought by(1]parents (2) children

15). Do you have electricity in your house 1) Yes ☐ 2) NO ☐

Knowledge

16. Do you know about jiggers 1) YES ☐ 2) NO ☐

17. What is the cause of Jiggers?

1. Virus ☐
2. Bacteria ☐
3. Witchcraft ☐
4. Jigger Fleas ☐
5. do not know ☐
6. others specify…….

18. Which age Is associated with jiggers (circle) 1) 2 years and below 2) 3-18 yrs 3)19-34yrs 4) 35-44YRS. 5) 45-59 YRS. 6) 60 and above yrs

19. Is jiggers associated with dirty environment 1) Yes ☐ 2) NO ☐

20). Do jiggers affect the following domestic animals (please circle)(1)dogs 2)cats 3)cows 4), sheep 5)goats 6)pigs 7) poultry ☐ 8) Do not know

Presence of Alternative Hosts

21). Do you rear any animals? 1. (Yes) ☐ 2. (No) ☐

22). If "Yes," which animals (Circle all that apply (1)dogs 2), cats,3)cows 4),sheep5)goats

23). How many animals do you have at home?)

1. Cat… 2. Dog… 3. Pig…… 4. Cattle……. 5. Other (Specify)……..

24). Where do you keep the animals? (Circle all that apply)

1. Animal pen 2. Indoors 3. Outside 4. Other (Specify).....

.25) How often do you spray/dip animals?

1. Do not spray 2. Once a month 3. Once a year 4.Other (Specify).....

26) What do you use to spay/dip them Name the 1) chemical .2) water 3) none

27)What is the distance of the animal shed from the living house?

No distance 2)15 M. 3) 30 and above.

Practices

28. How do you remove jiggers in man, animal, and environment? (Circle Appropriately)

Specify in man

1) Pins 2) scalpels 3) thorns

Are the instruments sterilized 1)pins 1)yes 2) no 2) scalpels1)yes 2) no 3) thorns 1)yes 2) no

Are the instruments cleaned) pins 1)yes 2) no 2) scalpels1)yes 2) no 3) thorns 1)yes 2) no

.....

29) Specify in animals

1) Pins 2) scalpels 3) thorns 4)dip/spray

Are the materials sterilized

Pins 1) yes 2) no 2) scalpels1) yes 2) no 3) thorns 1)yes 2) no

30) Specify in environment

1) Burn vegetation

2) Spray with acaricide

3) Nothing

.....

31). Are these pins and needles sterilized?

1) Sterile ☐ 2) shared ☐

32) Where do jigger-affected people seek treatment?

1) Private clinic ☐

2) Government clinic ☐

3) Traditional healer ☐

4) Clinic run NGO or church ☐

5) Left at home ☐

6) self-treatment ☐

33) What measures do you take to prevent the spread of jiggers?

1) Clean the environment ☐

2) Put on shoes ☐

3) Treat the sick ☐

4) Disinfect the animals by spraying/dipping ☐

5) No mixing of herds by each farmer ☐

34. How do you perceive Tungiasis?

1) Very serious ☐

2). somehow serious ☐

3). Very serious ☐

4). Do not know ☐

35. Do you think you could personally be infected with Jiggers?

1).yes ☐

2) NO ☐

3) Do not know ☐

36). Do you know the signs of jigger infestation 1) Yes 2) No

if yes describe them ……..

37). what would you do if you thought you had signs of jiggers infestation?

1) Go to a Government health clinic or hospit...
2) Go to the pharmacy for drugs
3) Go to a traditional healer
4) Go to a private clinic
5) Remove personally
6) Others specify .....

38) what would discourage you from visiting the following for treatment?

I) government facility

Not sure where to go
Cost
Distance to the clinic
Do not trust medical workers
Do not like the attitude of health workers

f) Others specify…….

39) What would discourage you from visiting the following for treatment?

II) Pharmacy

Not sure where to go
Cost
Distance to the clinic

Do not trust medical workers ☐

☐

Do not like the attitude of health workers

f) Others specify…….

40) What would discourage you from visiting the following for treatment?

III) Traditional healer

Not sure where to go ☐

Cost ☐

Distance to the clinic ☐

Do not trust medical workers ☐

☐

Do not like the attitude of health workers

f) Others specify…….

41) What would discourage you from visiting the following for treatment?

IV) Private clinic

Not sure where to go ☐

Cost ☐

Distance to the clinic ☐

Do not trust medical workers ☐

☐

Do not like the attitude of health workers

f) Others specify…….

42) What would be your reaction if you found that you had Jiggers?

Fear ☐

Shame ☐

Embarrassment ☐

No change ☐

Others specify……..

43) Whom could you talk to if you had Jiggers? state……

Doctor or other medical workers

Spouse ☐

Parent ☐

children ☐

Close friend ☐

Grandfather

Grandmother. ☐

Other family members

44) In your own opinion what kind of people are mostly affected by jiggers

Dirty

Mentally retarted

Women

Children

Men

Rich

Poor

Cursed

Herdsmen

Anybody

Others state……

45) In your community how is a person infested with Jiggers usually regarded/treated?

Most people usually reject him or her ☐

Most people are friendly ☐

The community mostly supports him or her ☐

Others specify……..

46) Do you feel well informed about Jiggers?

Yes ☐

No ☐

47) Do you wish you could get more information about Jiggers?

Yes ☐

No ☐

Treatment of tungiasis

48. What type of treatment do people use when affected by jiggers?

1) Herbal, ☐ 2) chemical ☐ 3) extraction ☐ 4) ☐ do not know

49) Do you know any traditional herb used to treat jiggers in your community?

a) If Herbal name type……

b) If chemical name the type ……..

50. Which part of the herb listed above is used?

1) Bark. ☐ 2) Fruits. ☐ 3) Leaves. ☐ 4) Flowers. ☐ 5) Roots.

51. How many times is it used in a day or applied?. ☐

1) Once daily. ☐ 2) Twice daily. ☐ 3) More than twice daily. ☐

52. How long does the herb used to take to treat the disease?

1) 1 day. ☐ 2) L 2)2 days. ☐ 3) more than 3 days ☐

53) I would like you to think about the following statements and tick as appropriate on a Likert scale of 1 to 4 where.

1. = Strongly disagree

2= Disagree

3= Agree

4=. Strongly agree

no	Statement	1	2	3	4
1	Tungiasis is a serious public health problem				
2	People should always seek medical attention when infected with Jiggers				
3	People with jiggers get discriminated against in the community				
4	Jiggers is a disease of that ill-gotten wealth				

Housing /conditions

54) What is the type of house? observe

Permanent ☐

Semi-permanent ☐

Makeshift timber ☐

55) Ownership;

Personal ☐

Rental ☐

56. type of floor?

Earthed ☐

Cemented ☐

57) Type of roof?

Iron sheets ☐

☐

Tiles

Grass thatched

Others specify…….

58) What is the frequency of smearing/maintenance of the house?

	Mud	Semi-permanent	Permanent	timber
Daily				
Weekly				
Two weeks				
Monthly				
Others specify				

59) What type of material is used for smearing?

Clay soil /mud

Cow dung

Mud&cowdung

Others specify……..

Appendix 4: Focused group discussions

The interviewer will also carry an FGD in 3 different sites with 5-12 respondents;

Youth Men Women Old

1. the main focus of each group will be to ask about
2. history of the community
3. community migration
4. major parasitic diseases outbreak eg malaria and Tungiasis

5. predisposing factors towards Tungiasis
6. Knowledge about Tungiasis
7. community perception about Tungiasis
8. treatment of Tungiasis
9. control measures of tungiasis
10. Knowledge of Tungiasis in animals
11. management of Tungiasis in animals
12. impact of dipping/spraying of animals in relation to Tungiasis

KEY INFORMANTS IN A HEALTH FACILITY SETUP

Key Areas:

cases of Tungiasis in a health facility

treatment of tungiasis

Documentation

any control measures

health education and impact

community perception about Tungiasis

Challenges.

Suggest a way forward

Appendix 5: Observation checklist

Personal identification

ID of respondent: …….. Sex: 1. (male) 2. (Female)

Household number: …….. Observation Date: ……

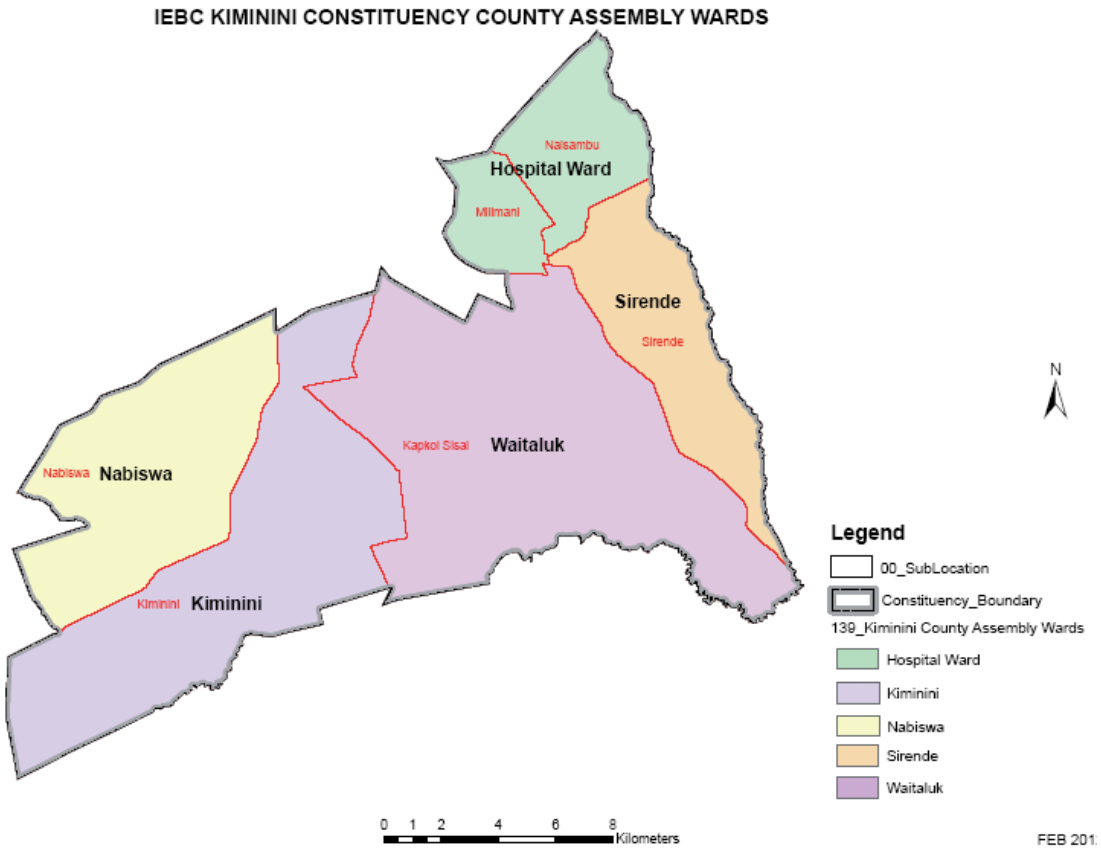
Village: …….. Observers Name: ……

Q1. The presence of tungiasis? 1. (Yes) 2. (No)

The interviewer has to observe the following:

- Who is mostly affected by jiggers?
- Who in particular participated in the removal of jiggers?
- Instruments used, type of treatment, and how they are prepared and applied.
- Observe the type of housing, walling, floor, and roofs.
- Take photographs if they can allow of the surrounding- houses, refuse pits, food stores, domestic animals sheds, and estimate the distance to the living house.

Appendix 6: Map of Kiminini Constituency



Appendix 7: IREC Approval Letter

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

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

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2015/72
Approval Number: 0001653

7th June, 2016

Mr. Yotomuk Wilson Chemerii,
Moi University,
School of Public Health,
P.O. Box 4606-30100,
ELDORET-KENYA.

07 JUN 2016
APPROVED

Dear Mr. Yotomuk,

RE: FORMAL APPROVAL

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

"Determinants and Management of Tungiasis (Tunga Penetrans) in Rural Areas of Trans-Nzoia County, Kenya".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1653*** on 7th June, 2016. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 6th June, 2017. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

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

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD