IMPACT OF TUNGIASIS ON SCHOOL AGE CHILDREN IN MURANGA COUNTY, KENYA.

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Research Thesis submitted in Fulfillment of the Requirement for the Award of a Degree of Doctor of Philosophy in Tropical and Infectious Diseases of The University of Nairobi.

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DECLARATION

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

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Dedication

This work is dedicated to my parents Mr.and Mrs.Ngunjiri, siblings Esther, Samuel and Teresa as well as my nephew Chris for their great support during my studies. Also to all the children in the Tungiasis endemic areas globally, this is in hope of their better future through acquisition of education. It is also hoped that these children will enjoy their childhood years free from burden of disease caused by Tungiasis.

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Operational definitions

Absenteeism: Missing of at least one school day, and which may proceed to a continuous span of less than two weeks.

Burden of Disease; a load experienced as result of a disease at personal, community, national or global level as measured by financial cost, mortality, morbidity in terms of Disability Adjusted Life Years.

Community Health worker: a person with basic skills and training working in community providing health care in collaboration with a health facility.

Disability Adjusted Life Years; Measure of burden of disease indicated by years lost due to the disability and premature death equivalent to years of optimal health

Disability weight; the scale used to indicate the how different sequels differ on how severity

Disability weights: Number on a scale from 0 to 1 that represents the severity of health loss associated with a health state.

Disability; Deviation from optimum health, Tungiasis associated disability include limitation in participating in normal activities, socio ,school and cognition activities, mobility, self-care, pain and discomfort, amputation of limbs and wounds.

Disease; specific disorder that has a cause and features recognizable such as physical signs, symptoms and effects.

Dropout; Breaking school within a cycle, indicated by staying away from school for an indefinite period of time.

Endemic; The constant presence of a disease over a succession of years in an area

Epidemic; Sudden sharp increase in the amount of infection or disease in an area or community

Epidemiology; the study of factors affecting the transmission and distribution of diseases within populations

Health states: Groupings of sequelae that reflect key differences in symptoms and functioning.

Host; an organism on which another organism (parasite) depend on partially or completely for metabolic needs or shelter.

Impact; effects resulting from Tungiasis, these were measured in terms rate and frequency of burden of disease and acquisition of basic education.

Incidence; Number of new cases of a disease or infection appearing in a population within a given period of time divided by the number of uninfected individuals in the population at the beginning of the time period.

Infection; invasion of the body by pathogen such as bacteria, viruses, fungi and parasites causing damage by tissue damage and toxin mechanisms.

Infectious disease; ill health caused by pathogens such as bacteria, viruses, parasites or fungi. They can be spread directly or indirectly from one person to another.

Influence; capacity to produce effects either negative or positive.

Level 4 or 5 hospital: level 4 hospital is 1^{st} referral unit that provide more specialized patient surgical services and level 5 is 2^{nd} referral unit with more specialize services than level 4 .

Neglected diseases; Diseases given little attention by communities and health care providers, that affect almost exclusively resource poor people living in rural parts and urban slums in developing countries.

Over Dispersion: non-random distribution of individuals in a habitat.

Parent; Includes guardian or other persons having the care or control of a child.

Prevalence; Number of individuals of a host species infected with a particular parasite species divided by the number of hosts examined. It is usually expressed as a percentage.

Remission; A period during which symptoms and signs of disease are reduced.

School age children- : children who have attained years of attending school.

sequelae: Consequences of diseases and injuries.

Severity score; A scale indicating severity of infestation

Surveillance; Continued evaluation of epidemiological aspects of disease.

Temporary Dropout: Missing school for a continuous span of at least two weeks (14 school days) within a school term.

Vector; Any agent, such as water, wind or arthropod that transmits infections from one host to another.

Years lived with disability (YLDs): Years of life lived with any short-term or long-term health loss.

Years of Life Lost (YLLs): Years of life lost due to premature mortality.

List of abbreviations

AHADI	Africa Health and Development International
AIDS	Acquired Immune Deficiency Syndrome
DALYS	Disability Adjusted Life Years
DW	Disability Weight
GBD	Global burden of Disease
GoK	Government of Kenya
HIV	Human Immunodeficiency Virus
I	Number of incident cases
L	Average duration of the case until remission or death (years)
L	Standard life expectancy at age of death in years
N	Number of deaths/ or with disability
NGO	Non-Governmental Organization
WHO	World Health Organization
YLD	Years/days lost in premature death/disability
YLL	Years/days lived with disability due to disease or injury

Abstract

Background: Tungiasis is a parasitic tropical disease caused by female *Tunga penetrans* which causes different health disabilities. The objective of this study was to estimate the burden of disease and find out the impact of Tungiasis on acquisition of basic education among children aged 5 to 14 years. This was done by quantifying loss of health caused by the disease using Disability Adjusted Life Years metric and also determining the influence of disabilities caused by Tungiasis on children school absenteeism and retention.

Methodology: A cross-sectional descriptive research design in which 200 households were systematically randomly selected. From each household a maximum of two children aged 5-14 years were recruited adding to a total of 384 children. Data on mortality were collected through verbal autopsy and desk top review of medical records. Morbidity was determined by physical examination of the children and sequelae reported by the children, parents and teachers. Primary and secondary data were collected through questionnaires, interviews, observations and desk review. School attendance was determined from the attendance registers. Data analysis was carried out using Statistical Package for Social Sciences version 21 software. Correlations and regression tests, Wald chi square test were carried out in addition to descriptive statistics.

Results: A total of 347 children aged between 5-14 years participated in the study. Prevalence of Tungiasis at household level was 37% (74 households) while among children the prevalence was 44 % (153). It was shown that children who were aged below 11 years who had a prevalence of 37% were more vulnerable to Tungiasis at p= 0.048. A total of 0.3 Disability Adjusted live years were lost due to Mild Tungiasis while 2.51 Disability Adjusted Life Years were lost due to severe Tungiasis. There was zero mortality due to Tungiasis among the children aged 5-14 years. This study found that children suffering from Tungiasis were likely to repeat same class even more than one time (p= 0.007). Tungiasis status was found to influence negatively the ability of children to attend school at p= 0.001. Severe Tungiasis caused greater loss of health 8.4 times more than loss of health resulting from mild condition of the disease.

Conclusion: Tungiasis is highly prevalent among the children aged between 5-14 years in endemic areas. Acquisition of basic education can be improved by addressing and managing Tungiasis which would promote school attendance and retention. In order to reduce burden of disease caused by Tungiasis the health care providers should adopt effective and sustainable disease management measures.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Tungiasis is a parasitic tropical disease caused by female *Tunga penetrans* also known as sand flea or jigger flea. The disease is coded as B88.1 under International Classification of Diseases 10th Edition (WHO, 2008). Tungiasis morbidity often lead to loss of health due to various disabilities which include pain and itching, lack of sleep, difficulty in walking and grasping (Kehr *et al.*, 2007; Feldmeier *et al.*, 2004). Wounds are also common which create entry points for pathogens such as *Clostridium tetani, Staphylococcus aureus, Enteroccous faecalis, Streptococcus pyogenes, Pseudomona sp, Bacillus sp., Bifermantaos sp. and Peptosterptococcus sp.* (Feldmeier *et al.*, 2002). The disease is prevalent among children in Latin America, Caribbean and sub-Saharan Africa (Pampliglione *et al.*, 2009; Ugbomoiko *et al.*, 2008, Muehlen *et al.*, 2003; Heukelbach *et al.*, 2001). In the affected countries, millions of people are at risk of infection especially in stable endemic foci (Pampliglione *et al.*, 2009; Feldmeier and Heukelbach, 2009; Heukelbach *et al.*, 2001).

High level of morbidity has been described when an individual has high number of embedded female *T. penetrans* parasites (Feldmeier and Heukelbach, 2009). The resulting morbidity has been shown to reduce the children's ability to acquire basic education due to absenteeism, repetition and dropout from school (Ngunjiri *et al.*, 2015). Although the disease causes considerable morbidity, it has been described as a neglected disease since it receives minimal attention from health personnel and even by communities in endemic areas (Feldmeier *et al.*, 2014). In general Neglected Tropical Diseases are commonly prevalent among low socioeconomic groups and as a result may contribute to burden of disease at national and global levels (Arden, 2008; Sachs and Hotez, 2006; Molyneux *et al.*, 2005; Heukelbach, 2005). Children suffering from Tungiasis may often experience socio-economic inequalities due to the morbidity caused by the disease. Socio-economic inequalities affect access to health care, education, proper sanitation, clean water and basic needs (Helman, 2007). Education has been perceived as a tool in which the inequalities can be harmonized thus improving the living standards of individuals, families and communities (Ojiambo, 2009; Bogonko, 2006). Other socio inequalities among the children suffering from the disease may arise due to stigmatization and chronic state due to minimal efforts in prevention and management of the disease. Inequalities would limit access to quality health care, education, proper sanitation, clean water and basic needs (Helman, 2007).

Children of school going age may miss to enroll, attend or drop out of school due to various reasons. Poor health caused by Tungiasis has been perceived as one of the possible reasons that cause children to dropout from school. However, there are limited data on the magnitude of burden of disease caused by Tungiasis among children and hence the main center of interest of this study. Currently it is a Neglected Tropical Disease of socioeconomic health concern which is prevalent among children and the elderly (Feldmeier *et al.*, 2014; Ugbomoiko *et al.*, 2008). The burden of disease caused by Tungiasis has also not been estimated although its morbidity has been described (Kerh, 2007).

The study was carried in out in Kandara sub county, Murang'a County which is an endemic area of Tungiasis (MOH, 2014). The study aimed at establishing the impact of Tungiasis among children aged 5-14 years in regard to resulting health status, ability to attend to school, progress to the higher level and retention in school. Children the in most cases aged 5-14 years are in their formal schooling years during which they are expected to acquire basic education. In the year

2009 it was estimated that about 2.4 million primary school children in Sub-Saharan Africa were not schooling (UNICEF, 2009). The basic education forms a foundation of further education which is aimed at preparing the children for various employment opportunities in the future.

The burden of disease caused by Tungiasis has been estimated in terms of sequel severity scores and prevalence (Morkve, 2013, Njau *et al.*, 2012, Ngunjiri and Keiyoro, 2011, Pampliglione *et al.*, 2009, Ugbomoiko *et al.*, 2008 ; Kehr *et al.*, 2007;Muehlen *et al.*, 2003, Heukelbach *et al.*, 2001). These descriptions are not universal and hence the burden of disease is not comparable with that of other diseases in terms of Disability Adjusted Life Years (DALYS). For example, some of the neglected diseases among all the age groups worldwide in the year 2010 had different numbers of cases, this included Africa Trypansomiasis 37,000, rabies 1,100 and 100 for yellow fever and burden of disease they caused had been analyzed using DALY metric (Hotez *et al*., 2014).

In Kenya the burden of disease caused by Tungiasis has been estimated to affect more than one million people and others being at risk especially the children (MOH, 2014; AHADI, 2009). AHADI (2009) also cited hundreds of mortalities resulting from the disease. This indicated that the disease was a health concern in Kenya. As a result, National policy guidelines for prevention and control of jigger infestation was developed on the management and control of Tungiasis in Kenya by the government through the Ministry of Health, Department of Environmental Health (MOH, 2014). In this regard, there was need to use a universal metric such as Disability Adjusted life years (DALYs) to estimate the burden of disease resulting from Tungiasis. This may enhance efforts put in place that are necessary in management, control and prevention of Tungiasis. The objective of this study was therefore to estimate burden of disease caused by Tungiasis among children aged 5-14 years using Disability Adjusted Life Years (DALYs) metric and determine the impact of the disease on acquisition of basic education.

1.2 Life cycle of *Tunga penetrans*

Tungiasis is caused by *T. penetrans*, an ectoparasite whose origin is postulated to have been South America (Heukelbach and Ugbomoiko, 2007). It is thought that the parasite was transmitted into Africa through West Africa into other parts of the continent including East Africa and hence Kenya cited in Ngunjiri and Keiyoro (2011). The female *T. penetrans* belongs to the phylum Arthoropoda, class Insecta, order Siphonaptera, family Pulicidae and sub family Tungidae (Craig and Fausts, 1970). The disease may cause a significant level of health loss in endemic areas. It exhibits an over dispersed pattern whereby few people may be diagnosed with high parasite load in the endemic areas. Individuals suffering from Tungiasis in a population experience pain, physical disability, emotional turmoil, stigma and harassment and loss of economic productivity due to resulting morbidity (Morkve, 2013).

The life cycle of *T. penetrans* comprises of egg, two larval instars, pupa and adult as shown in Figure 1. *T. penetrans* males and females feed on blood from a wide range of mammalian hosts' mainly human beings, dogs and pigs. Other hosts include cats, horses and rodents which serve as reservoir (Eisele *et al.*, 2003; Ngunjiri and Keiyoro, 2011). The female *T. penetrans* takes the blood meal and embeds permanently in the host's epidermis resulting in a disease (Eisele *et al.*, 2003; Service, 1986). In the case of heavy infestation with hundreds of embedded fleas, loss of blood to the parasite may deprive the host iron that could lead to anaemia (Pilger *et al.*, 2011). This could affect the host's immunity thus increasing the susceptibility of the host to suffer multiple parasitic infections and other disease infections. Therefore, the disease is likely to cause physical disability, socio-psychological depression and economic deprivation to the individuals in endemic areas. The embedding process into the host epidermis destroys tissues in the skin causing inflammation and creates entry points for pathogens (Feldmeier *et al.*, 2002). Thus, the host is also exposed to life threatening numerous secondary infections such as tetanus through the lesions created by posterior abdominal segment of the embedded female parasite (Feldmeier *et al.*, 2002).

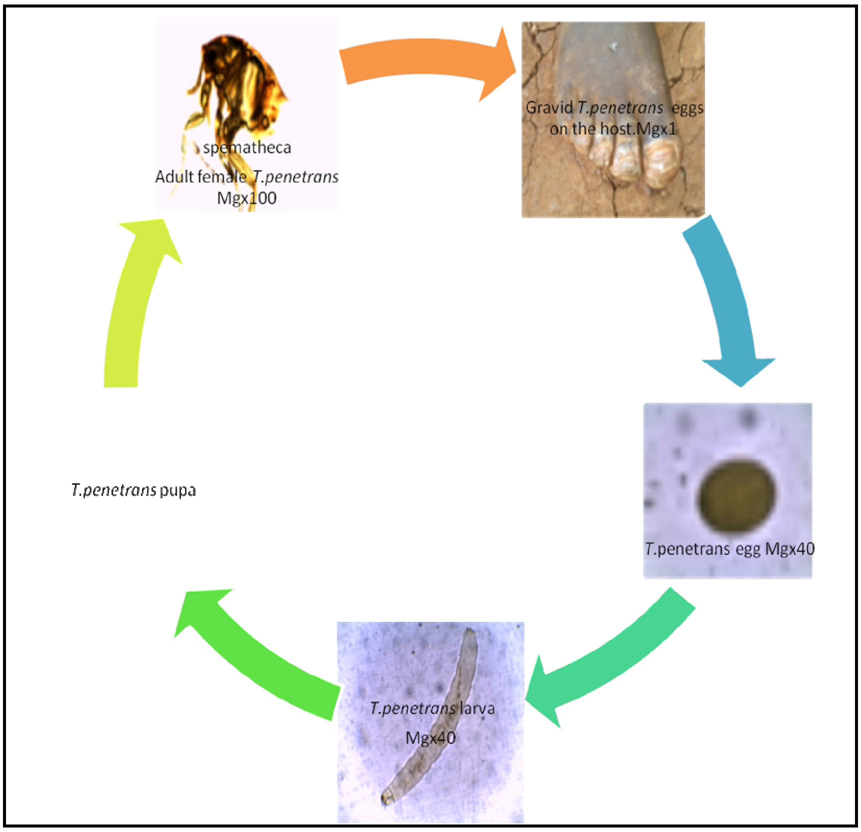

Figure 1: Lifecycle of *T. penetrans* (Modified by Ngunjiri and Keiyoro, 2011)

In endemic areas, individuals who suffer from the disease may have tens or even hundreds of embedded female *T. penetrans* parasites, expelling thousands of eggs (Feldmeier *et al.*, 2003). These eggs mature into fleas within less than three weeks, under suitable conditions increasing the infestation rate, parasite load and prevalence in households (Ngunjiri and Keiyoro 2011; Eisele *et al.*, 2003; Service, 1986). The host's movements affect the dispersion of eggs from the gravid female (Dryden, 1993). Children suffering from Tungiasis in schools may also disperse the eggs to schools especially in classrooms and play grounds in endemic areas. The adult female *T.penetrans* once in classrooms and playgrounds infests other children in the school. This leads to the spread of *T.penetrans* to more children and hence to households and other schools in endemic areas. Subsequently, the infestations acquired while the children are in schools could lead to new cases of occurrence of Tungiasis in households which were originally free of the infestation.

Once the eggs are expelled they undergo developmental phases which include two larval instars, pupa and adult stages (Eisele *et al.*, 2003; Ngunjiri and Keiyoro,2011). Transmission may be temporarily interrupted by targeting different stages of life cycle of *T. penetrans*. These stages include off host before the female *T. penetrans* embeds in the host and on host stages that occur after embedding process. In endemic areas individuals suffering from Tungiasis and domestic animals may serve as constant source and reservoirs

1.3 Problem statement

Tungiasis is a disease that is known to lead to negative impacts on an individual especially in terms of physical, psychological and socio economic wellbeing. The clinical manifestations of Tungiasis include pain, ulcer, itching, and difficulty in walking, lack of sleep and creation of entry points in the epidermis for secondary infections (Kehr *et al.*, 2007; Heukelbach *et al.*, 2004; Feldmeier, 2003; Feldemeier *et al.*, 2002). The disease burden caused by Tungiasis has not been adequately quantified. In cases in which efforts have been made to estimate the burden of disease, non-universal metrics have been applied such as severity score and sequelae prevalence. These metrics do not allow comparisons between burden of disease resulting from Tungiasis and other diseases. This has limited management of the disease in endemic areas, allocation of funds and availability of data on both mortality and morbidity.

Locally, approximately 2.7 million cases of Tungiasis were reported in 2009 among all age groups by Africa Health and Development International (AHADI) Trust cited in (Ngunjiri and Keiyoro, 2011). Another source indicated 1.4 million cases of Tungiasis and 25% of the children in Kenya were at risk of suffering from the disease in the country (MOH, 2014). In a period of a few years it was also estimated by AHADI that 275 people had died of Tungiasis related co morbidities and complications cited in Ngunjiri and Keiyoro (2011). Although the number of persons suffering from Tungiasis in these reports differed it is evident that this disease is of health concern in Kenya.

Even though there is low-level jigger of infestation in most parts of Kenya, prevalence in endemic areas is high and has been rated at 50% and above (Njau *et al.*, 2012; Ngunjiri and Keiyoro, 2011). These endemic areas are spread across the country and hence of national health concern (MOH, 2014). There is also inadequate information on control, the level of health burden and impact of Tungiasis among the children aged 5-14 years in Kenya and other endemic areas worldwide. The main control measure has always been physical removal of embedded adult females using unsterilized pins even in cases of high parasite load (Kimani *et al.*, 2012). Despite this, there is no specific drug for treating Tungiasis and intervention measures are insufficient and unsustainable although there is continued transmission of Tungiasis (MOH, 2014). Morkve (2013) noted that Tungiasis is a threat to learning process of the children and often lead to school dropout in endemic areas. The school dropout may occur after continued absenteeism from the school. This would deny the children access and acquisition of basic education and compromises quality and quantity of education offered to them in endemic areas in Kenya.

In spite of the sustained prevalence of the disease in Kenya, the disease has remained neglected in terms of mechanisms put in place for managing, control, elimination and surveillance. Thus, this study focused on quantifying burden of disease caused by Tungiasis using a DALY metric and its impact on acquisition of basic education. The findings provide desired data that is useful in the estimating the burden of disease caused by Tungiasis and resulting social impact among the children. This may lead to improved school attendance and retention, alleviation of health burden through health education, allocation of funds, research, policy implementation and effective control and management of the disease in endemic areas.

1.4 Significance of the study

The findings of the study provided data on the estimated burden of disease caused by Tungiasis in terms of DALYs among the children aged 5-14 years. Burden of Disease caused by the disease may limit child's ability to acquire basic education by reduced school attendance, retention and progressing to the next class. These would compromise participation in educational activities, access, equity and quality of education among the children suffering from Tungiasis. This study provides baseline information on the estimated burden of disease caused by Tungiasis and resulting consequences among the children. This is to highlight the need for intervention which may increase the efforts put in place in order to control and manage the disease. The lifecycle of *T. penetrans* has the off-host stages and on host stages, all of which can be targets of intervention. The off-host stage intervention may reduce the *T.penetrans* population thus reducing the infestations and hence lower loss of health and incidences of the disease (Ngunjiri and Keiyoro, 2011).

Utilization of the findings may be useful to the stakeholders in health and education sectors. These include policy makers, education specialists, nongovernmental organizations, government ministries especially ministry of education, ministry of health and scholars. The findings may also provide a platform for the health providers, policy makers and scholars to compare the DALYs caused by the Tungiasis with other infectious and non-infectious diseases and further research that would include all age groups. Furthermore, children may benefit from the findings of this study by ensuring that the burden of diseases caused by Tungiasis is reduced to enable them enjoy good health that would facilitate acquisition of basic education. Also the children who suffer from this disease can acquire health care once the burden of this disease is reduced. The findings can also be useful in reducing the burden of co infections that result due to weakened immune system. The research findings may also contributed to knowledge on use of metrics of estimating the burden of disease resulting from Tungiasis and provide evidence of impact of the disease among the children aged 5-14 years.

1.5 Justification

Neglected tropical diseases are given little attention despite the burden of disease they cause which is greater than malaria, tuberculosis and HIV/AIDS (Molyneux *et al.*, 2005). These neglected diseases include Tungiasis, soil transmitted helminthes, sleeping sickness, leprosy, buruli ulcer, trachoma, schistosomiasis, lymphatic filariasis, river blindness, dracunculiasis, and onchocerciasis (Feldmeier and Heukelbach, 2009; Molyneux *et al.*, 2005). Tungiasis causes severe morbidity although it has limited mortality (Feldmeier *et al.*, 2014; MOH, 2014). Tungiasis related infections may arise from lesions resulting from embedded female flea which may create entry points for pathogens and hosts' susceptibility to different types of microbes such as bacteria, viral and fungal. Treatment and management of diseases such as tuberculosis, malaria, diabetes mellitus, HIV and AIDS may be complicated among patients who are also suffering from the Tungiasis and other neglected diseases.

Individuals suffering from Tungiasis may suffer different levels of loss of health that may reduce the quality of life. Lesions that are caused by embedded female *T. penetrans* lead to tissue damage, loss of toes and nails (Heukelbach, 2005). The lesions that occur on feet result in difficulties in walking and in severe cases the person may become immobilized (Heukelbach *et al.*, 2004; Feldmeier, 2003). Among the children, this condition may lead to loss of valuable learning time due to reduced mobility which may lead to irregular school attendance and in turn increase rate of school dropout. In cases where the parents are suffering from Tungiasis, they may have reduced ability to address Tungiasis amongst themselves and their family, limit their productivity due low engagement in economic activities and finally lack of resources to meet the cost of basic needs for their children. This may encourage child school absenteeism, dropout and child labour.

1.6 Rationale of the study

Health burden attributed to diseases may prevent individuals, communities and nations to reach their full potential in socio economic development. When deliberate collaborative efforts are made to reduce the burden of disease among individuals and communities, lost productivity is restored and the living standards are improved. Good health among children may promote quality life, school attendance and retention which are likely to contribute to good academic performance and further education. Acquiring formal education may enable individuals to compete effectively in job opportunities that arise. Education also equips individuals with necessary skills and attitudes which lead to higher income that would enhance better living standards and reduce socio-economical inequalities in the communities. Reduced parasite population at any stage of lifecycle of *T. penetrans* is likely to reduce transmission and morbidity resulting from the disease. Preventive measures of a disease are bound to be more cost-effective and limit the burden of the disease compared to treatment measures. When a disease is prevented the morbidity and mortality in communities in endemic areas is reduced or are avoided all together.

Neglected Tropical Diseases are commonly prevalent among low socioeconomic groups, contributing to burden of disease at national and global levels (Arden, 2008; Sachs and Hotez, 2006; Molyneux *et al.*, 2005; Heukelbach, 2005). These diseases include Tungiasis, trachoma, leprosy, hookworms' infections and schistosomiasis. Neglected Tropical Diseases result in high burden in terms of DALYs when compared to malaria, tuberculosis and measles (Hotez *et al.*, 2014; Hotez *et al.*, 2006). Thus there is need to estimate the burden of disease caused by these neglected diseases to foster collaborative efforts in addressing the resulting prevalence, incidence, morbidities and mortalities.

The purpose of the study was to estimate the burden of disease caused by Tungiasis and its impacts on the children in an endemic area. This is in effort to bring on board collaborative efforts in addressing loss of health and capacity to acquire basic education. These collaborations efforts would be among the communities, policy makers, and relevant government ministries, researchers, research institutions, non-governmental organizations and funding agencies. This is because Tungiasis is a neglected disease at social, political, medical levels despite being prevalent in various endemic areas in Kenya and at global level. It was therefore necessary to estimate the level of burden of disease caused by Tungiasis and its influence on acquisition of basic education. Also, the research provided baseline information that may be useful in improving acquisition of basic education in endemic areas for Tungiasis and hence this would help in school retention of the children throughout their basic education cycle.

1.7 Objectives

General objective: The general objective of this study was to describe the burden of disease and the impact on health caused by Tungiasis among children aged 5-14 years in an endemic community in rural Kenya. The specific objectives were to:

i. Determine the prevalence of Tungiasis and the occurrence of its sequelae among the children aged 5-14 years.
ii. Establish the morbidity caused by Tungiasis among the children aged 5-14 years.
iii. Determine mortality resulting from Tungiasis among the children aged 5-14 years.
iv. Quantify the burden of disease caused by Tungiasis among the children aged 5-14 years using Disability Adjusted Life Years metric.

v. Determine how disabilities caused by Tungiasis influence acquisition of basic education among the children aged 5-14 years.

1.8 Research Questions

The study sought to answers for the following questions:

i. What is the prevalence of Tungiasis and the occurrence of its sequelae among children aged 5-14 years?
ii. What is the level of morbidity caused by Tungiasis among children aged 5-14 years?
iii. How many deaths are resulting from Tungiasis among children aged 5-14 years?
iv. What is the burden of disease in terms of Disability Adjusted Life Years metric among the children aged 5-14 years?
v. How does disability resulting from Tungiasis influence acquisition of basic education among the school-aged children?

1.9 Research hypothesis

The following hypothesis was tested in the study at 95% confidence interval. The hypothesis was stated in null form.

i. H_o Tungiasis has no influence on health and acquisition of basic education among children aged 5-14 years.

1.10 Organization of the study

The thesis is organized into five chapters. In Chapter 1 background of the study is laid out, followed by statement of the problem. Significance, rationale, objectives, research questions and hypothesis are detailed in this chapter. Chapter 2 entails the assessment of the previous studies relevant to the current study, theoretical framework in which theories have been identified to provide basis of content validity. Conceptual framework in this chapter elucidates the interrelationships between independent, dependent, intervening and moderating variables. Research gaps which are hoped to bridge in the study have also been identified in this chapter. Chapter 3 describes how the study was carried out, study design, target population, sample size and sampling procedure. The process of enhancing research instruments validity and reliability has been described in this Chapter. Other important aspects of data collection which include exclusion-inclusion criteria, ethical consideration data collection procedure and pilot study have also been discussed. The chapter ends with data management strategy and operationalization of variables table. Chapter 4 entails how the results and findings were analyzed, presented and interpreted in relation to research objectives, questions and hypothesis. In Chapter 5 the findings are summarized, discussed and conclusions made. Recommendations are also included and suggestions for further research in this Chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 Health Burden caused by Infectious Diseases

The world burden of disease is projected to reduce by 2030, whereas the Disability Adjusted Life Years (DALYS) are expected to be at 1.3 billion from the current 1.5 billion in sustained population growth (WHO, 2008). Neglected Tropical Diseases may hamper the reduction of DALYs by 2030 if not quantified, addressed and managed. Burden of disease caused by infectious and non-infectious diseases vary in terms of morbidity and mortality of a particular disease. Some parasitic infections result in loss of more DALYs than deaths. For example, in 2002 the DALYs lost due to the schistosomiasis was hundred times higher than the resulting deaths from the same disease (WHO, 2008). Malaria which is also a parasitic disease though not neglected caused two million deaths and 46 million DALYs in that same year (WHO, 2008). Burden of disease resulting from Tungiasis has not been determined using DALY metric though its prevalence in endemic areas is relatively high in Kenya (Morkve, 2013; Njau *et al.*, 2012; Ngunjiri and Keiyoro, 2011).

2.2 Prevalence of Tungiasis and its sequelae.

The prevalence of Tungiasis differs globally and although isolated cases have been diagnosed from different parts of the world, endemic areas mainly occur in Latin America, the Caribbean and sub-Saharan Africa (Pampliglione *et al.*, 2009, Ugbomoiko *et al.*, 2008, Muehlen *et al.*, 2003, Heukelbach *et al.*, 2001). It has been reported that millions of people are at risk of being infected with Tungiasis in stable endemic foci in the affected countries (Pampliglione *et al.*, 2009; Feldmeier and Heukelbach, 2009; Heukelbach *et al.*, 2001).Through the years Tungiasis has remained a neglected disease that mainly affect low income communities resulting in high disease disability especially among the school age children and elderly people (Ugbomoiko *et* *al.*, 2008). It is therefore necessary to provide data on the level of the disease burden caused by Tungiasis in Kenya in order to avert the disease as well as its co morbidities. Therefore, it was important to consider Tungiasis from medical condition point of view by expanding research towards estimating burden of disease. This was hoped to bring on board collaborative efforts in development of control methods, surveillance mechanisms and make available of relevant data to support the management of the disease.

In Africa Tungiasis can be traced in 17th century during which *T. penetrans* is postulated to have been introduced to West Africa from South America (Heukelbach and Ugbomoiko, 2007). In 1872, ship carrying infested ballast sand from Brazil arrived in Angola. In Angola during 19th century the disease caused severe morbidity and in Luanda general Hospital it was described as second cause of mortality after small pox (Heukelbach and Ugbomoiko, 2007). The disease is thought to have spread in Sub-Sahara Africa through trade routes and military routes reaching Kenya, Zanzibar and Madagascar. Therefore, the presence of the disease in Kenya can be traced to these disease episodes of 17th century when it is assumed to have spread in Eastern Africa cited in Ngunjiri and Keiyoro (2011).

Regardless of this, accurate medical data on burden of disease, its risk factors, epidemiological and geographical distribution in Kenya are limited (Ngunjiri and Keiyoro, 2011). In the country, Tungiasis is prevalent in specific foci where it causes substantial burden to the affected communities. In recent years, Kenyan government has recognized Tungiasis as a public health concern in endemic areas (MOH, 2014; MOH, 2009). Although mapping of this disease has not been done, it is known to be prevalent in Murang'a, Nyeri, Kwale, Malindi, Kericho, Narok, Emuhaya, Meru and Kakamega counties which can be considered endemic areas (MOH, 2014).

The prevalence in endemic foci for example in Murang'a County has been shown to be considerably high with some areas recording 50% prevalence per household and in the same area (Ngunjiri and Keiyoro 2011; Njau *et al.*, 2012). Other related studies have shown that in endemic rural areas locally, the disease is persistent and assumed to be due to poor hygienic and sanitary conditions (Kimani *et al.*, 2012). In Bungoma County, a qualitative study carried out by Morkve (2013) indicated that concerted efforts and individualized control measures would be effective in control of Tungiasis. It is thus probable that prevalence in other areas could be similar in endemic areas. This is in concurrence with other studies done in Nigeria and Brazil by Ugbomoiko *et al.* (2008) and Muehlen *et al.* (2003). These studies also indicated that Tungiasis had an age-specific peak with highest prevalence being among the school age children aged 5-15 years and the elderly.

In other areas in Africa for example in Western Nigeria, prevalence among the school age children was as high as 50% in endemic areas according to Njeumi *et al.* (2002). In Kenya, in the years 2008-2009, the ministry of public health fumigated 285,815 jigger infested households and targeted to increase the number of households to 573,026 in the year 2009-2010 (Ministry of Public Health, 2009). In the past it has been indicated that Tungiasis had caused more than 275 deaths in a few years in Kenya (cited in Ngunjiri and Keiyoro, 2011). Prevalence and sequelae may differ from individual to individual although pain and itching has been observed among all individuals diagnosed with Tungiasis. Other sequelae such as insomnia, difficulty in grasping, difficulty in walking was observed in half the population infested with the disease (Kehr *et al.*, 2007; Feldmeier *et al.*, 2004).

2.3 Morbidity resulting from Tungiasis in endemic areas.

The disease has been described to cause severe morbidity among patients in endemic areas (Feldmeier and Heukelbach, 2009). Different sequelae associated with Tungiasis include pain, itching, insomnia, difficulty in grasping and difficulty in walking who are infected (Kehr *et al.*, 2007; Feldmeier *et al.,* 2004). The infestation of *T. penetrans* triggers immune responses as the parasite embeds and establishes in the host epidermis (Ngunjiri and Keiyoro, 2011; Pilger *et al.*, 2011; Feldmeier and Heukelbach, 2009; Feldmeier, 2003; Eisele *et al.*, 2003). The hosts' tissues are damaged by the enlarged embedded female *T. penetrans* as well as by its secretions (Feldmeier, 2003; Heukelbach *et al.*, 2004).

Tissue damage creates entry points of pathogens that result in secondary infections. Tetanus which is a life threatening infection caused by *Clostridium tetani* has been identified as one of many secondary infections among those suffering from Tungiasis in endemic areas (Feldmeier *et al.*, 2002). Other pathogens that have been isolated from lesions caused by Tungiasis include *Staphylococcus aureus, Enteroccous faecalis, Streptococcus pyogenes, Pseudomona sp., Bacillus sp., Bifermantaos sp.,* and *Peptosterptococcus sp.* (Feldmeier *et al.*, 2002).

The process of penetration that causes entry points for pathogens and enlargement also leads to tissue damage and itching also known as pruritus which is likely due to histamine produced in an allergic reaction by the mast cells and loss of host tissue. In some individuals the allergic reaction could be severe and life threatening. The parasite load and rate of infestation affect the extent of damage caused by Tungiasis (Ugbomoiko et al; 2008). Loss of tissue on the hosts, skin, finger and toe nails and pain resulting from the lesions lead to difficulty in walking and grasping using hands (Feldmeier, 2003).

Tungiasis has been reported to cause anemia in children who become infected by the disease. This is also a common sequel in parasitic infections that cause severe morbidity in children especially those who suffer from hookworm infection, schistosomiasis and malaria (Ajanga *et al.*, 2006; Mackintosh *et al.*, 2004; Brooker *et al.*, 1999; Stoltzfus *et al.*, 1997). Chronic iron deficiency in children is detrimental to physical, motor and cognitive growth, and weakened immune system that could affect academic performance among children (Umbreit,2005; Grantham-McGregor and Ani ,2001; Brabin *et al.*, 2001; Lozoff *et al.*,2000). Iron deficiency in such health conditions could be further increase due to Tungiasis leading to greater health loss (Bleakley, 2003; Pilger *et al.*, 2011).

It has also been suggested that severe Tungiasis has the possibility of causing anemia in children (Pilger *et al.,* 2011). This may be due to depletion of host's body nutrients by the embedded female *T. penetrans* in children suffering from the disease and bleeding from the resulting wounds. This would thus slow down their growth, cognitive and motor development as well drain their daily energies to attend school and participate in school activities. Anemia amongst individuals suffering from Tungiasis may be caused by other co morbidities such as malnutrition and parasitic helminthes. The study focused on burden of disease in terms of the Disability Adjusted Life Years (DALYs) excluding anemia as a sequel and a possible health state and its impact on acquisition of basic education among the children aged 5-14 years. This was important in order to estimate the health burden caused by Tungiasis eliminating possible bias considering anemia can be caused by malnutrition and parasitic helminthes. In this study morbidity caused by Tungiasis on among the children was described in terms of Years Lived with Disability (Murray *et al.,* 2012b).

2.4 Mortality caused by Tungiasis

In most of the studies carried out data on mortality caused by Tungiasis is limited or unavailable. Severe cases of Tungiasis were reported in Angola in 19th century which was associated with deaths. It has also been reported that in between July and October 1877 Tungiasis was the second cause of death after small pox in Luanda general Hospital in Angola cited in (Heulkebach and Ugbomoiko, 2007). Much of the findings of studies have been mainly on morbidity, risk factors, knowledge and practices, epidemiology, its neglect and prevalence (MOH, 2014;

Feldmeier *et al.*, 2014; Njau *et al.*, 2012; Ngunjiri and Keiyoro, 2011; Kehr *et al.*, 2007; Pilger *et al.*, 2011; Feldmeier and Heukelbach, 2009; Feldmeier *et al.*, 2004; Feldmeier, 2003; Eisele *et al.*, 2003). However, in Kenya AHADI has associated Tungiasis with high mortality. In a period of several years it was estimated by AHADI that the disease had caused 275 deaths cited in Ngunjiri and Keiyoro (2011). This mortality data did not indicate the age and gender of these cases which is very important in determining Years of life Lost (YLL) due to a cause. The age at which an individual dies due to any cause is considered in relation to the life expectancy in specific geographical region which gives the number of years lost due to premature death (Murray *et al.*, 2012 b). The life expectancy in Kenya is shown in the table 2.1 between t 1990 to 2011.

Table 2.1; Life expectancy in Kenya (WHO, 2013).

Kenya Year	Life expectancy at birth years	Life expectancy at 60yrs
2011	M=58 F=61 Both sexes=60	M=16 F=18 Both sexes=17
2000	M=50 F=53 Both sexes=52	M=15 F=18 Both sexes=17
1990	M= 58 F=62Both sexes=60	M= 16 F= 18 Both sexes=17

The life expectancy though decreased in the year 2000 remained the same for the year 1990 for both sexes. This implies that if a child aged 5 years died due to Tungiasis then 55 years would have been lost due to the premature death. In this study children aged 5-14 years were the participants meaning that the years that were likely to be lost due to each premature death would range from 55 years for those aged 5years and 46 years for those aged 14 years. The Years of Life Lost are computed from number of deaths/ or with disability multiplied by standard of life expectancy at age of death in years (Murray *et al.*, 2012 b). This means that if only one child died of Tungiasis at age 5, YLL would be equal to 55, if two 110. This means that the burden of disease among young age groups is very high when deaths at early age occur due to any cause.

2.5 Disability Adjusted Life Years (DALYs) metric in quantifying burden of disease.

Burden caused by disease or injury is measured using Disability Adjusted Life Years (Kent and Yin, 2006). One Disability Adjusted Life Year (DALY) is the same as one year lost due to disease or injury equivalent to the same in absence of the disease or the injury in a particular population (Kent and Yin, 2006; Haag *et al.*, 2010; Kominski *et al.*, 2002; Gerald *et al.*, 2002). It also includes the years of life lost due to disability or injury caused by the disease (YLL) that could not have been lost in the absence of the disease. DALYs are thus the years due to premature death from specific cause(s) YLL and the years lived with disability until time of an individual recovery. DALY metric is thus a measure of burden of disease in a population which comprises of years of life lost from the disease (YLL) and the years of life spent with disability (YLD) (Murray *et al.*,2012b; Gerald *et al.*, 2002; Kent and Yin, 2006; Haag *et al.*,2010).

Disability encompasses short term (days) and long term (years) of loss of normal life, those that are recovered and permanent as well as fatal and non-fatal (Hotez *et al.*, 2009). Tungiasis results in short term disabilities such as pain and itching and in permanent ones such as lose of toe nails and disfigurement which lead to loss of health. Among the children, these disabilities may lead to loss of school days among children aged 5-14 years. This necessitated estimation of the burden of disease resulting from the disabilities caused by the disease using DALY metric. DALYs are a single indicator of burden of disease derived from multiple variables. This measure has been used to help in allocation of resources to reduce mortality and prevent disability even at political level (Murray, 1994). Other findings indicate that in co morbidity situations, disease with high disability determines the total amount of disability (Baal *et al.*, 2006). The burden of disease caused by Tungiasis may also be analyzed in terms of DALYs as a single indicator from other multiple indicators which include severity, prevalence, incidence, age, time and disability weights. The single indicator would then help in allocation of resource to reduce morbidity and mortality, research and policy making.

Infectious diseases cause disabilities and deaths worldwide although the level of burden they cause may differ from one disease to the other (Hotez *et al.*, 2009; Kent and Yin, 2006). Disability is deviation from optimum health (Hotez *et al.*, 2009). Infectious and non-infectious-diseases are burdensome to individuals, communities, governments and the world as whole. A significant proportion of the diseases burden in sub-Saharan Africa is due to infectious and parasitic diseases (WHO, 2008). The level of disease burden has been analyzed using a DALY metric and mortality data availed for malaria, HIV/AIDS, tuberculosis which are considered to contribute highest burden. This has enforced the need for international and local healthcare providers to address aspects that would reduce disease transmission, incidence and morbidity. These measures include treatment, prevention and control of these diseases, consequently resulting in reduction of disease burden (Kent and Yin, 2006).

DALYs metric estimate the gap caused by ill health that is, prevailing health in a population and the expected quality health without the disease (Murray *et al.*, 2012b; Haag *et al.*, 2010; Kent and Yin, 2006; WHO, 2001). DALYs provide a valuable metric of disease burden in a population for both infectious and non-infectious diseases which help in policy making and projection of health status in future (Kent and Yin, 2006; WHO, 2004). In developed countries, burden of disease is mainly due non-infectious disease. This is due to the fact that more people access immunization against the infectious diseases. It is also possible diagnosis and treatment of these infectious diseases is timely and effective thus reducing the source of the infectious agent and spread of the diseases.

Disabilities caused by these diseases vary in magnitude and permanency and range from psychological and socio-economic distress to severe physical disabilities and death (Hotez *et al.*, 2009). Governments spend billions of shillings every year in securing health care for the citizens from known causes of morbidity and mortality. The burden of disease resulting from each cause is likely to be considered when governments allocate resources terms of research, diagnostic tools and equipment, infrastructure, personnel, control, treatment, surveillance and prevention of these diseases. This is likely to be done in accordance with individual government policies and those of World Health organization (WHO). Thus the level of burden of disease of various causes should be made available in a common unit to facilitate decision making process.

In the Global Burden of Disease (GBD) 2010, 26.06 million DALYs were lost due to neglected diseases (Hotez *et al.,* 2014). Tungiasis was not among these neglected diseases which imply that its burden of disease had not been quantified globally. The DALYs of some of the neglected diseases such as hook worm disease, trichuriasis, lymphatic filariasis, food trematodiasis, onchocerciasis and trachoma were contributed by YLDs only with zero YLLs in the year 2010 (Hotez *et al.,*2014). This means that although the diseases caused morbidity there were no deaths caused by the same. DALYs lost due to various causes are shown in table 2.2

Table 2.2: Estimated DALYs (in millions) of the NTDs from the Global Burden of Disease Study 2010 (Hotez *et al.*, 2014).

Disease	DALYs from GBD 2010 (numbers in parentheses indicate 95% confidence intervals)
NTDs	26.06 (20.30–35.12)
Intestinal nematode infections	5.19 (2.98–8.81)
Hookworm disease	3.23 (1.70–5.73)
Ascariasis	1.32 (0.71–2.35)
Trichuriasis	0.64 (0.35–1.06)
Leishmaniasis	3.32 (2.18–4.90)
Schistosomiasis	3.31 (1.70–6.26)
Lymphatic filariasis	2.78 (1.8–4.00)
Food-borne trematodiases 1.88	(0.70–4.84)
Rabies	1.46 ((0.85–2.66)
Dengue	0.83 (0.34–1.41)
African trypanosomiasis	0.56 (0.08–1.77)
Chagas disease	0.55 (0.27–1.05)
Cysticercosis	0.50 (0.38–0.66)
Onchocerciasis	0.49 (0.36–0.66)
Trachoma	0.33 (0.24–0.44)
Echinococcosis	0.14 (0.07–0.29)
Yellow fever	<0.001
Other NTDs*	4.72 (3.53–6.35)

* Relapsing fevers, typhus fever, spotted fever, Q fever, other rickettsioses, other mosquito-borne viral fevers, unspecified arthropod-borne viral fever, arenaviral haemorrhagic fever, toxoplasmosis, unspecified protozoal disease, taeniasis, diphyllobothriasis and sparganosis, other cestode infections, dracunculiasis, trichinellosis, strongyloidiasis, enterobiasis, and other helminthiases.

2.6 Impact of health on acquisition of basic education

Acquiring education among the children can be derailed by various reasons such as ill health, need for children to work or care for sick family members, insecurity, natural calamities, inability to afford uniforms to inadequate sanitation and basic amenities. In the year 2010, 1.01 million primary school children were not schooling in Kenya due to various reasons which may have included disabilities caused by infectious diseases (UNESCO, 2012). This is in spite of major efforts made to increase literacy levels for example free compulsory education in Kenya (Ingubu and Wambua, 2011). Acquisition of education has been thought to be a tool of socio economic status that can be improved by enhancing the living standards and access to health care of individuals, families and communities (Ojiambo, 2009; Bogonko, 2006)

The disabilities caused by diseases among school age children can result in low school attendance and drop out (Endy *et al.*, 2002). Children who suffer from infectious diseases are more likely to miss school than those who have health life (Word Bank, 2003). Negative impact on education due to poor health has been shown to occur in parasitic infections associated with helminthes and malaria infections (Mackenzie *et al.*,2010; Clarke *et al.*,2008;Miguel *et al.*,2003, Stephenson *et al.*,1989; Stephenson *et al.*,1993). This effect may be similar among the children due to Tungiasis

On the other hand, poor health condition resulting from diseases such as parasitic infections can cause premature death among children before they attain the standard life expectancy (Kent and Yin, 2006). Child mortality has been shown to have a tendency to reduce after the age of five (Partnership for Child Development, 2002). Partnership for Child Development (2002) also hypothesized that children are prevented from participating in educational activities due to ill health. It is therefore probable that poor health among children of school going age caused by Tungiasis could lead to school absenteeism which may reduce participation in school activities, poor academic performance, low promotion to next class and school dropout.

In endemic areas, the resulting burden of disease caused by Tungiasis among children would derail the achievement of sustainable development goals, primary education for all and Kenya vision 2030 due its association with low school attendance, class repetition and dropout. Missing to attend school even for a few days for any reason has been found to contribute to low scores in standardized tests and substantial school dropout rates (Chang and Romero, 2008). The rate of school attendance at primary school has also been attributed to progressing and completion of secondary school education (McGiboney, 2012).This has been explained by the fact that when children attend school they socialize, play and develop attitudes and physical abilities. The skills and attitudes to socialize, complete task, take responsibility motivates these children to pursue further education and become responsible citizens. Morkve (2013) noted that children suffering from Tungiasis experience stigmatization which may result in low self-esteem, isolation and general lack of interest in education activities and other social activities. This further informed on the need to carry out the study to establish the impact of Tungiasis on acquisition of basic education among children aged 5-14 years.

Burden of disease attributed to parasitic infections such as malaria and soil transmitted helminthes include reduced memory, intellectual and stunted physical growth among school age children (Grantham-McGregor and Ani, 2001; Bleakley, 2003). Therefore, disease outcome may often compromise optimal health in a given population. This health status has been found to cause low productivity, stunted growth, poor physical and mental disability, low cognitive development and poor performance in education among children (Hotez *et al.*, 2006; Berkman *et al.*, 2002).

Most of the parasitic diseases result in malnutrition and mineral deficiency which further complicates the wellbeing of the children who may suffer from low daily energies requirements , low immune system that may leads to co-infections which subsequently could reduce children's ability to attend school (Ajanga *et al.*, 2006; Mackintosh *et al.*, 2004; Berkman *et* *al.*,2002). Tungiasis has been described as a threat to learning process due to continued absenteeism which may lead to poor performance in academics and increased rate of school dropout (Morkve, 2013).

Thus poor health among children due to Tungiasis is likely to pose a challenge to the implementation of education policy on free and compulsory basic education as envisioned in Kenyan constitution, 2010. The indirect morbidity such as stunted growth and malnutrition which may also be attributed to severe, chronic Tungiasis could also reduce energy levels among the children performing well. This would further reduce children participation in physical activities in the school. It should be noted, that, education for all policy is geared towards ensuring that all school age children access education in-order to improve literacy level and hence facilitate achievement of national goals of education and provision of man power needed for vision 2030 in Kenya (Ingubu and Wambua, 2005).

Parasitic infections have been cited to reduce learning ability among children, retard their growth and reduce their potential for future employability (Hotez *et al.*, 2006; Bleakley, 2003; WHO, 2003; Grantham-McGregor and Ani, 2001). School attendance has been used as an indicator of academic performance (Grigorenko *et al.*, 2006, Partnership for Child Development, 2002). Good performance in tests among children determines their promotion from one class/grade level to the next. Hence repetition in the same class may contribute to dropout rate in some cases. Valuable learning time for these children may also be lost due to absenteeism, getting to school late, reduced class concentration due to morbidity resulting from Tungiasis. The socio-economical inequalities would limit access to quality health care, education, proper sanitation, clean water and basic needs (Helman, 2007). It has been found that one year in primary school would improve income by 10% and individuals who have been in school for more than six years are likely to seek health care especially women of child bearing age (Psacharopoulos and Patrinos ,2004).

The standard materials used for construction of classrooms vary from one school to the other in Kenya. In some schools the walls are built of mud and while in others the walls are made of concrete. The substandard classrooms are likely to provide environment for habitation of *T. penetrans* off host stages which may promote transmission of the disease (Ingubu and Wambua, 2005). Thus, in the endemic areas the physical environment of most classrooms may promote transmission of Tungiasis among the children aged 5-14 years while they are in school. On the other hand, Kenyan government is committed to the provision of quality education and training as a right to all Kenyans in accordance with the Kenyan law, Education act 2013 and the international conventions, such as the Education For All (EFA) goals, and has developed strategies for moving the country towards the attainment of this goal (Ingubu and Wambua, 2011). The implementation of Free Primary Education (FPE) is critical to the attainment of Universal Primary Education as a key milestone towards realization of the EFA goals. The health issues including Tungiasis may complicate the realization of these goals.

2.7 Intervention measures used to address Tungiasis burden

The management and control of Tungiasis has been limited to short term mechanisms that reduce the prevalence to low levels that rise again after the strategies for the control are withdrawn, mostly due to sustainability challenges (MOH, 2014; Kimani *et al.*, 2012; Buckendahl *et al.*, 2010). These unsustainable control mechanisms incline towards continued transmission of Tungiasis and other parasitic infections in endemic foci causing a continuously burden of disease in these communities. Control mechanisms for Tungiasis have been by physical removal of embedded female fleas (Kimani *et al.*, 2012). Some other methods used to control Tungiasis such as use agrochemicals to target the interruption of the lifecycle at on-host stage may cause physical harm and could be poisonous if ingested (MOH, 2014). These modes of intervention do not prevent the sequel and risk of secondary infections is eminent.

Efforts to reduce Tungiasis transmission by and targeting off-host and on- host stages have been attempted using different methods. These methods include by using insecticides, repellents; traditional remedies involving plant extracts, kerosene and candle wax Potassium permanganate (MOH, 2014; Heukelbach, 2004; Heukelbach, 2001). In endemic areas in Kenya apart from removal of the embedded female *T. penetrans* with sharp object, disinfectants are also used. These include Potassium Permanganate, Hydrogen Peroxide, Liasol, Tincture of Iodine and Sodium Hypochlorite (Morkve, 2013). For instance Potassium Permanganate is dissolved in water to form a solution after which the patient soaks his/her feet and hands for fifteen minutes. The community health workers in the study area were applying Ingram cream, milking jelly or Vaseline to the patients after the exercise. This have been observed in Bungoma too where Jigex cream or Vaseline was used on the affected area to protect broken skin and wounds from infection (Morkve, 2013). This method targets the on-host stages and re- infestation is common although it offers temporarily remedy. These efforts have either been unsustainable or expensive due to the high cost, considering that endemic areas are characterized by populations that consist of resource poor communities (Buckendahl *et al.*, 2010; UNDP, 2006).

Animal reservoirs also pose a challenge to intervention measures that are used since they serve as source of the *T. penetrans* parasites even after when the lifecycle of the parasite is interrupted at off-host and on-host stages. A control measure should target to interrupt the parasite life cycle in order to reduce its population and subsequently eliminate disease incidences. Consequently, an effective control tool should reduce the burden of the disease. Interrupting the *T. penetrans* lifecycle at off-host stages therefore is paramount in order to avoid any sequel that would result from the on- host stages.

2.8 Theoretical frame work

Burden of disease can be reduced through various measures such as availability of affordable treatment, early diagnosis, change of lifestyle, reduction of risk factors, health policies and availability of economic resources. The success of preventive and control measures may depend on various factors. These factors include beliefs, practices, and willingness of the persons involved, attitudes, skills and knowledge. They are likely to influence the actions taken to address various causes of ill health at individual, community, national and global level. This may also apply to efforts made towards control measures used to address the impact of neglected tropical diseases.

In general Neglected Tropical Diseases are commonly prevalent among low socioeconomic status groups hence contribute to burden of disease at national and global levels (Arden, 2008; Sachs and Hotez, 2006; Molyneux *et al.*, 2005; Heukelbach, 2005). Among these members of the communities the magnitude of burden of disease caused by the neglected diseases may be attributed to the health seeking behavior within this social group. The nature of health seeking behavior among this low income groups can be explained through theories and models such as Theory of Reasoned Action and Health Belief Model. The Theory of Reasoned Action suggested that the strength of the intention and skills are important in carrying out a given action (Fishbein *et al.*, 2002; Fishbein, 2000; Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975).

This means that the behavior of a person towards taking a certain action is determined by the individual's attitude which is a function of beliefs about perceived consequences of taking the action. The other determinant is subjective norms which involve person's perception of what others think he or she should do and the motivation to comply. These influence the strength of intention and skills in performing a task (Fishbein *et al.*, 2002; Fishbein, 2000; Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). This is likely to be the cases among the patients suffering from Tungiasis who may perceive it as a negligible condition which does not require medical care. The community members may have similar beliefs like ridiculing the patients. This may discourage the patient suffering from Tungiasis to take any action for example seeking medical care, control or prevent infection by the disease. This could further be complicated by health care providers' beliefs. They may perceive the risk factors associated with Tungiasis as neglect to personal hygiene and hence view the disease as of no significant health concern. For instance in Tanzania Tungiasis is referred to as the disease of the dirty people (Mazigo *et al.*, 2011). The diseases may hence remain neglected as described by Feldmeier *et al.* (2014).

Health belief Model also postulates that an individual will carry out a recommended health behavior; if he/she believes that it is a risk for acquiring a serious and severe negative health consequence and also simultaneously believe that the benefits of performing the recommended protective behavior are more than the costs of taking that action (Janz and Becker, 1984; Rosenstock, 1974). Similar beliefs and cost benefit analysis might be the cause of neglect for Tungiasis in Kenya. In addition, the neglect may be justified further by the underestimated burden of disease, beliefs and norms among the patients suffering from Tungiasis and health care in endemic areas.

Acquisition of formal education requires learners to have the ability to interact and learn from experiences and be in a position to realize self-actualization while in school. This is likely to happen if the learners gain knowledge and skills and their basic needs are fulfilled. These can be explained by two theories Constructivist Learning Theory and Maslow's theory. According to Brooks and Brooks (1993), the Constructivist Learning Theory states that people construct personal understanding and knowledge of the world through experiences and reflecting on the said experiences. The theory is based on the perception that learners too, learn from their experiences as they interact with the phenomenon (Brunner, 1961).

Brunner (1961) emphasized that the learners should find out things for themselves in a school setting facilitated by the teacher which should empower them to be thinking independently after formal schooling. These learning experiences may be limited among the children suffering from Tungiasis if they miss to enroll, attend or drop out of school and also due to the resulting loss of health. The loss of health among children due to parasitic diseases include reduced memory, intellectual and physical growth (Grantham-McGregor and Ani, 2001; Bleakley, 2003). This may also be the case for among the children suffering from Tungiasis which would further compromise their capacity to learn. Morkve (2013) noted that Tungiasis is a threat to learning process among the children in endemic areas.

In Maslow's theory of Human Motivation (Maslow, 1943) it is stated human beings are motivated to achieve certain needs. When one need is fulfilled a person seeks to fulfill the next one, and so on in hierarchical order. In this theory the fundamental principal is that before achieving cognitive (thinking) needs of a learner then the basic needs such a need for food and clothing must be fulfilled first. These basic needs include biological and Physiological needs such as air, food, drink, shelter, warmth, sex, sleep. Safety needs - protection from elements, security, order, law, stability, freedom from fear. Love and belongingness needs - friendship, intimacy, affection and love, from work group, family, friends, romantic relationships. Esteem needs - achievement, mastery, independence, status, dominance, prestige, self-respect, and respect from others. Finally, self-Actualization needs, realizing personal potential, self-fulfillment, seeking personal growth and peak experiences.

Disabilities caused by Tungiasis among children such as pain, itching lack of sleep, difficulty in walking and grasping Morkve (2013) destabilizes the physiological state of the children. Pain among children has been described to give them a sense of despair and feeling anything can happen to them. It can therefore be said that children experiencing constant pain due to Tungiasis will be affected in the same way.

The need for love and sense of belonging may not be satisfied among the children suffering from Tungiasis. This may be due to stigmatization and isolation in the schools and community (Feldmeir *et al.*, 2013; Morkve, 2013). This then would hinder the affected children from unleashing their potential. Their self-esteem is also lowered due to ridicule in by their peers, isolation and inability to play when others are playing (Morkve, 2013). Thus denying the children the sense of belonging and love among their peers.

Maslow theory also depicts that children perform best in an orderly, predictable environment and households. Tungiasis is likely to cause disorderliness due to lose of productivity among other members of the household and also tension caused by stigma and isolation. This denies satisfaction of safety need. If a particular need is not satisfied for a long time the persons aspiration are lowered or undergo permanent phase out hence a person is satisfied by getting food only which is a basic need according to Maslow (1943). This is likely to discourage the children in the process of acquiring basic education, improving their lives and subsequently becoming unproductive members of society. Therefore, the vicious cycle of poverty would be perpetuated in the future generations. Tungiasis may therefore lead to loss of health, low sense of belonging and unfavorable environment important in nurturing children's capabilities and talents.

2.9 Conceptual framework

In the study, the independent variable DALYs was used as a measure of burden of disease caused by Tungiasis. Morbidity and mortality depend on prevalence, health states, incidence and intensity of the disease. Prevalence, incidence and intensity depend on level of infestation of *T. penetrans* which depends on control measures and prevailing conditions. Control measures and health seeking behaviors are likely to be influenced by level of education and skills at hand therefore empowered communities can participate in control Tungiasis thus reducing its disease burden among the children. This would improve access to quality education thus increasing individuals' employability and productivity as shown in the figure 2.

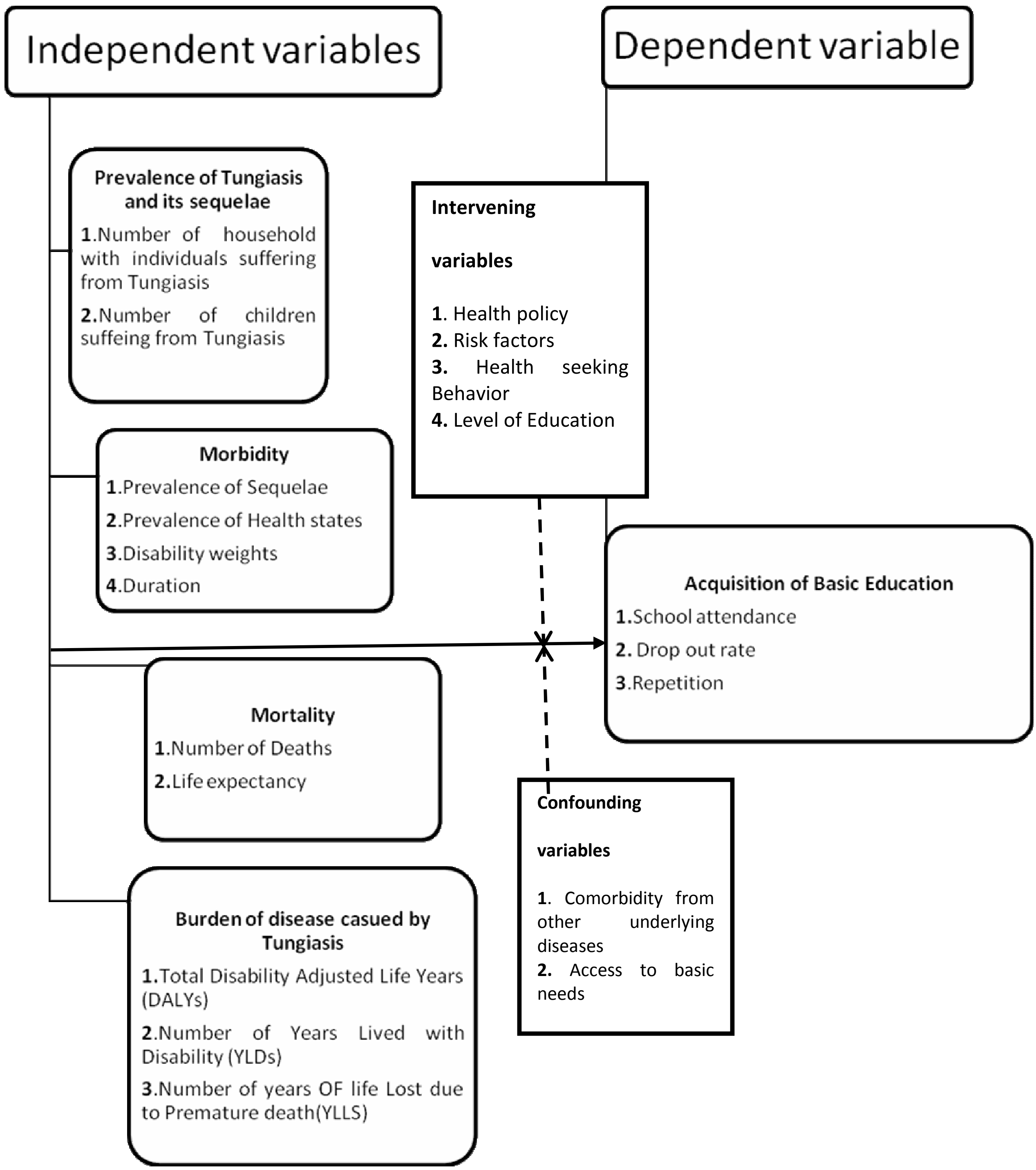

Figure 2; Conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Study design

This study adopted a mixed method research design. This involved different data collection methods which included use of questionnaires, observations and macroscopic diagnosis. Also primary data set and secondary data set were merged. Different sampling procedures were used. Cluster random sampling and simple random sampling were used to select households.

3.2 Study area

Murang'a County is located in central Kenya. The County covers 0.4% of the total land mass in Kenya, over an area of 2,558.82 km2 and lies between the latitudes 0034' and 0134' South and longitudes 3600 East and 3700 East1 (@geolocation -0.804314, 37.035566). It is bordered by the County of Nyeri to the North, County of Nyandarua to the West, County of Kiambu to the South, County of Machakos to the South East, County of Embu to the East, and County of Kirinyaga to the North East.

Kandara constituency in Murang'a County was the focus of this study and is among seven constituencies in the county. The other constituencies are Kingie, Mathioya, Kiharu, Kigumo, Maragwa and Gatanga. The population in Kandara is approximately 156,663 persons and occupies an area of approximately 236 square Kilometres. Geographical position of the study area in Africa, Kenya and Murang'a County is shown in figure 3.

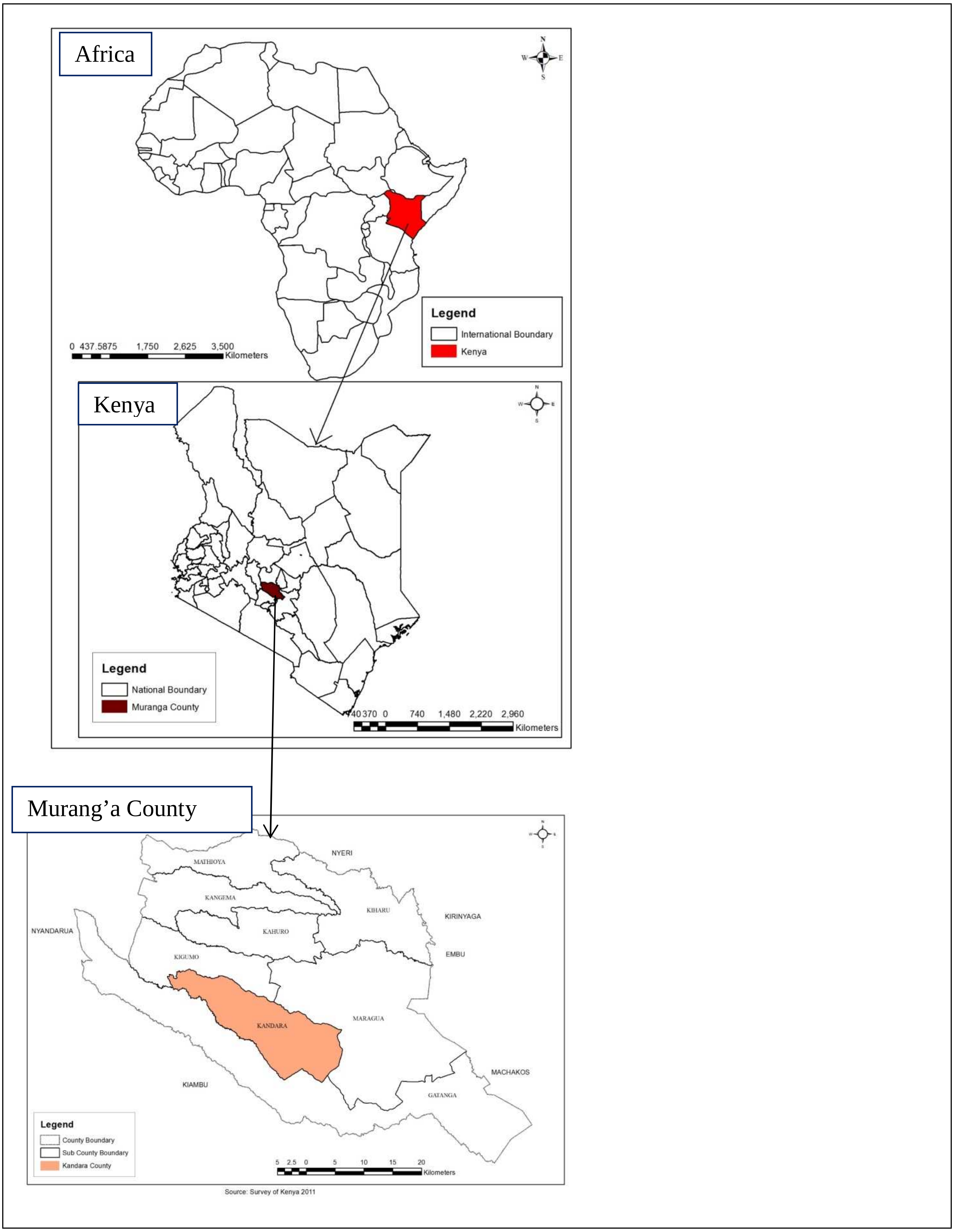

Figure 3: Map showing study area

Kandara constituency has six county assembly wards, these are Ngararia with population of ≈18,005 pesons,Muruka with ≈23,535 persons,Kagundu-ini with≈ 28,847 persons, Gaichanjiru with≈ 28,363 persons,Ithiru with ≈27,182 persons and Ruchu with ≈30,731 persons (2009 census). Kandara sub-county has 72 public primary schools.

3.3 Study population

The target population was 156,663 persons of all the age groups, residents of Kandara constituency. The study population consisted of children aged 5-14 years. A representative sample of 200 households was randomly drawn from clusters of households in the six constituency wards. This was done through cluster random sampling. Fifteen clusters were randomly selected from 25 clusters. This was followed identifying 384 children who were from these households. A total of 22 primary schools in the area were selected using simple random sampling procedure from the total of 72 primary schools in the study area.

3.4 Inclusion and exclusion criteria

Households were included if there was a child aged 5-14 years present during sampling process and was located in any of the six constituency wards of Kandara sub county. Children and parents who were present during the visits of 200 selected households were examined for presence of embedded female *T. penetrans.* Although the number of the children in each household was taken into account and in all the households there was an average of four children of different age groups. In each household a maximum of two children were randomly selected to participant in the exercise.

Children aged 5-14 years, both males and females were included in the study. All children in the households were randomly recruited without considering their Tungiasis status. Those suffering from Tungiasis must have had at least one health states. This is similar to a study carried out to describe morbidity caused by Tungiasis in which a patient must have had at least ten embedded female *T. penetrans* (Kerh *et al.*, 2007). Confirmation diagnosis of Tungiasis was by macroscopic examination of presence of the female *T. penetrans* to be positively identified as suffering from Tungiasis. The children attending school were included in the study if the school they were enrolled was in Kandara Sub County. The children who had embedded female *T. penetrans* but without clinical manifestations were not included in the study. This is because it was not possible to describe morbidity of the children who could be suffering from Tungiasis but without specific sequelae as defined in this study. Also those who were to be transferred to other schools during the study period were excluded from the study as well as those suffering from severe mental illness. Also children aged below 5 years and more than 14 years were excluded.

3.5 Determination of Sample size and Sampling procedure

The sample size was calculated using Fishers formula for prevalence studies (Fisher *et al.*, 1998).

$N=Z^2 P (1-P)/D^2$

Where

N=minimum sample size

Z=standard normal deviation for 95% confidence interval (=1.96)

P=estimated prevalence of Tungiasis in endemic areas which was averaged at 50 %(0.5)

D=degree of precision (5% i.e. 0.05)

$N=1.96^2 X0.5 (1-0.5)/0.05^2$

$=1.96^2X0.5 (0.5)/ 0.05^2$

$=384$

Total households =approximate population/approximate number of persons per household 156,663/5 persons =31,333 households (average fertility rate is 3.4, 2009 census that is 3 children and two parents). Against this background of three children per households, a maximum of two children were recruited from each Household. A total of 200 households were sampled from which 384 children were drawn. During the study it was established that average number of children per household was four. The households were clustered into geographical area a community health worker was in charge. A total of 15 clusters were sampled out of 25 clusters. The clusters were randomly sampled and numbers of the households were proportional to the total number of households as shown in table 3.1.A sample size of 22 schools which is 30% of the total number of schools in Kandara was selected through simple random design.

The children were then followed to their respective schools to establish school attendance. The teacher in charge of health and parents in selected households filled the questionnaires. In the households with more than two children aged 5-14 years simple random sampling technique was employed to select two children of either gender. In the households with only one and two children no selection was done but they were included if they met the inclusion criteria.

Ten community health workers who were in charge of Tungiasis in the sampled clusters of households assisted in the sampling procedure. Sampling frame included households, schools and the children.

The children who were recruited from sampled households from each ward were distributed as shown in table 3.1.

Table 3.1; Distribution of households and children in Kandara constituency wards.

Constituency ward	Approximate Population (persons)	Proportion Of household	Number of households	Maximum Number per ward of children,@ household male and female child.
Ngararia	18,005	0.11	21	42
Kangudu-ini	28,847	0.18	34.5	69
Gaicganjiru	28,363	0.18	34.5	69
Ithiru	27,182	0.17	33	66
Ruchu	30,731	0.21	40	80
Muruka	23,535	0.15	29	58
Total	156, 663	1	192	384

3.6 Recruitment and consenting procedures

The preliminary study was carried out prior to recruitment of the participants and data collection in the study. A copy of authorization documents were submitted to the sub-county authorities and local administration. In health facilities, community health workers were identified. In systematically randomly selected households the informed consent was sought from the parent. This was followed by recruiting children from the households to avoid non participation bias then parental consenting was formally requested from the parent of the each child. Objectives of the study were explained to all participants and they were made aware of the ethical considerations. The parent/guardian was requested to sign the consent form authorizing the child to participate in the study.

3.7 Diagnosis of symptomatic Tungiasis among the children

The participants were requested to clean their feet and hands for accurate macroscopic examination for the embedded female *T. penetrans*. This was done on all body parts except private parts. Parents of the same gender were requested to assist in macroscopic examination. Tungiasis was confirmed by the presence of the embedded female *T. penetrans at* various stages of development (Eisele *et al.*, 2003). These stages were five, stage 1-penetrating *T. Penetrans,* stage 2—Red brown itching spot, stage 3 white area with central black area, stage 4 black lesion with *T. Penetrans* dying and stage 5 manipulated lesion.

In addition the participants were interviewed to capture the symptoms experienced at the time of recruitment and duration each child had suffered from the disease. Sequelae were grouped into three health states. These health states were Open wound: short term, with or without treatment, disfigurement: level 1 with itch or pain and Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia) (Salomon *et al.,* 2012).

Tungiasis status was further subdivided into two disease categories, mild and severe Tungiasis. Mild Tungiasis was defined by two health states open wound: short term, with or without treatment and Infectious disease: post-acute consequences. However, severe Tungiasis was defined by all the three health states presenting in an individual. The sequelae were grouped into health states as shown in table 3.2.

Table 3.2: Sequelae and their corresponding health states.

Tungiasis Sequelae	Health state
Difficulty in walking Deformed feet Lose of toe nails and finger nails Itching Pain Persistent pain Burning sensation, Inflammation, Pus, Pain while wearing shoes, Unable to write	Disfigurement: level 1 with itch or pain
Lack of sleep, stigma, Docile, Fear of being stepped on, Reduced playing level, Withdrawal, Isolation, Headache	Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia)
Lesions on feet ,heels and toes, Lesion on hands	Open wound: short or long term, with or without treatment

Where possible macroscopic examination was done after all participants washed their feet using soapy water and a disinfectant. Those with open wounds benefited from Grabacin in powder form 10gm containing for each gm Neomycin Sulphate B.P. 5mg, Bacitracin Zinc B.P., 2.5 mg and Gramidicin D.N.F. 0.5mg. They were also advised to seek medical care from the nearest health facility where they could get further health care assistance and also vaccination against Tetanus. Community Health workers were also made aware of the households that had individuals suffering from Tungiasis for follow up process. Those who had a co infection of *Tinea capitis*, the ringworms benefited from whitefield′s skin ointment 20g containing benzoic Acid B.P.6% w/w and Salicylic Acid B.P. 3% w/w.

3.8 Prevalence of sequelae, health states and disease among age children

The prevalence was established per age bracket as provided by the Global Burden Disease (GBD) (Kent and Yin, 2006). The participants were requested to clean the feet and hands for accurate macroscopic examination. This was done on all body parts except private parts. Parents of the same gender were requested to assist in macroscopic examination. The infestation was confirmed by the presence of the embedded female *T. penetrans at* various stages of development (Eisele *et al.,* 2003). The prevalence was then expressed as percentage of the infested per age bracket, gender, school and household for each participating child (Ngunjiri, 2011).

3.9 Morbidity caused by Tungiasis among children.

The principles of the method used to determine Years Lived with Disability (YLDs) for Global Burden Of Disease (GBD) 2010 were used (Murray *et al.,* 2012b).Disability weights provided the bridge between mortality and non-fatal outcomes in DALYs. Disability weights quantify severity of outcomes as percentage reduction from perfect health, which are multiplied by prevalent cases of each sequel to give YLD. The health states that were likely to associated with Tungiasis were considered which included Open wound: short term, with or without treatment has a disability weight of 0·005, disfigurement: level 1 with itch or pain had a disability weight of 0·029 and Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia) 0·254. Other health states that were likely to occur if an individual suffered from Tungiasis were amputation of toe with disability weight of 0·008, Severe wasting 0·127 and anaemia: mild 0·005 (Salomon *et al.,* 2012). Sequelae are direct specific consequences of a disease and cannot be assigned disability weight. The sequelae caused by Tungiasis among the children were distributed into three health states. These health states were disfigurement level with itch or pain that had a disability weight of 0.029, infectious diseases post-acute consequences with disability weight of 0.254 and open wound short or long term with or without treatment with disability weight of 0.005. Disfigurement with itch or pain and open wound short or long term with or without treatment health states had high frequency contributed by the sequelae such as itching, pain, loss of toe nails and finger nails and lesions in various locations which were the most prevalent among the children.

3.10 Mortality due Tungiasis among children.

Mortality was determined by two methods: verbal autopsy and desk top review of health records to find out number of deaths caused by Tungiasis. These methods have been used previously to determine global burden of disease by Murray *et al.*, (2012b). Verbal autopsy involved inquiring about deaths caused by and related to Tungiasis from the individuals of the selected households and community health workers. Desk top review was carried out in five Health facilities in the study area, one level 4 hospital within the study area and one level 5 hospitals near the study area that had inpatient infrastructure. Desk top review involved perusal of medical records available for a period of one year and seven months (January 2014 to July 2015). Mortality and morbidity data recorded among different age groups were retrieved from computer system in level 5 hospitals but in level 4 hospital the medical records were retrieved manually since the data entry to a computer system was underway. The International Classification of disease 10th edition coding (ICD 10) was used to get the morbidity and mortality associated with Tungiasis, whose code was B88.1 (WHO, 2008).

3.11 Determination of Disability Adjusted life years (DALYS) resulting from Tungiasis

The burden of disease in DALY metric consists of two components, morbidity and mortality, and in this study efforts were made to include both components (Murray *et al.*, 2012b). Morbidity component is expressed by years/days lived with disability due to cause (x for example Tungiasis) (YLD) while mortality is derived from Years/days lost due to cause (x) in premature death/disability (YLL).

Therefore, 1 DALY=1 year of optimum health lost due to disability where Disability Adjusted Life Years =Years/days lost due to cause (x) in premature death/disability (YLL) +Years/days lived with disability due to cause (x) (YLD). Tungiasis DALYS were derived from the different mortality and morbidity. Years lived with disability were derived from the prevalence of health states multiplied by specifics disability weight of each health state. Tungiasis YLDs were sum of the YLDs for each of the three health state.

3.12 Determining variables of acquisition of basic education

School absenteeism was determined as described by Endy *et al.* (2002). The teacher was in charge of recording the school attendance every morning in daily class register. Then a follow up was done with the teacher and the pupil to determine the cause of absenteeism. Data on school attendance was done by checking class attendance for the year 2014 and the year 2015 from the class registers. The children recruited were followed to their respective schools. All the recruited children were attending schools in Kandara Sub County. In the schools, in attendance, questionnaires were administered and interviews carried out among the teacher in charge of health. In addition, a separate framework was used in order to follow the individual child's school attendance to increase reliability of capturing attendance (Endy *et al.*, 2002). Data of the children diagnosed with Tungiasis and those who were not suffering from the disease were collected in terms of days lost and this was related to total number of school days during the span of the study.

School dropout was determined from the schools by checking the registers, interviewing the head teacher and from the households. Class repetition was captured from, class registers, the age difference in which the age mates were enrolled in the current year and also interview from the parents. Observations and interviews were made to find out how disabilities caused by Tungiasis affected the children in engaging in learning activities which would promote acquisition of basic education.

3.13 Quality assurance procedure

The ethics code of conduct was observed before, during and after the process of data collection and processing. The researcher administered questionnaires to ensure 100% return of questionnaires, pretest of all questionnaires before data collection, determine reliability of the questionnaires. Cross check errors and missing information during data collection. Diaries of daily happening during data collection was used to record activities as they are carried out and monitor the school attendance.

3.13.1 Pre-testing of data collection instruments

In this study randomization was used to eliminate any possible bias. The schools were selected through simple random design. Demographic characteristics of the participants were captured in questionnaires. Questionnaires were pre-tested by a pilot study conducted on a population similar to the target population. Mulusa (1988) recommends about ten cases which represent the target population in all major aspects should be used in a pre-test. Isaac and Michael (1995) stated the objectives of pilot-study; is to enable the researcher to get feedback from research subjects that need improvements in the main study, leads to changes to some assumption, dropping some and developing new ones and increases the chances of obtaining clear-cut findings in the study. These were interviewed and analysis was done to test whether the research tools were valid. The questionnaires were then revised and time to respond taken into account.

3.13.2 Reliability

Reliability involved dividing the items into two equivalent halves (the odd-numbered and even – numbered items). All the odd-numbered items were placed in one subset, while all the even-numbered items were placed in another subset. Each of the two sub-sets was tested independently and scored accordingly. The scores of each of the two sub-sets were then computed and the two scores collated using Person's Product Moment Correlation Co-efficient. This was taken to be an estimate of reliability coefficient of the tool.

To following formulae were used to calculate correlation coefficient of the entire test (Re).

Re= 2r1/1+r Where: Re = Correlation Coefficient of the entire test and R = Correlation Coefficient of the even numbered statement with the scores of the odd numbers statements.

The value "r" obtained indicated the degree to which the two halves/subsets were internally consistent. Reliability coefficient rages from values of 0.000 and +1.00 indicating perfect reliability. If the two scores from the test were 0.1 and above up-to 1.0, the instrument is said to be reliable.

The questionnaires were pre-tested in one school where 10 ten teacher's respondents filled in the questionnaires and 10 households where 10 parents filled in the questionnaires. For the purpose of reliability testing of the instruments, 10 questionnaires were used. The questionnaires were accurately coded and the responses from the 30 questionnaires entered into SPSS version 20.0 for pretest analysis. To run a Reliability Analysis all the items to be measured were selected, and then Item in the Descriptive for group and Correlations in the Inter-Item group were selected.

The value of the coefficient of Cronbach's alpha for the research scale is 0.771=77.1%. Standardized Item Alpha was 0.771 meaning that the Cronbach's alpha coefficient of internal consistency when all scale items have been standardized was at 77.1%. This coefficient is used only when the individual scale items are not scaled the same. So, if we continue with the release of units in other words with the standardized value of the variables, then the coefficient Cronbach's alpha would slightly increase the value of α=77.1%. This means that whether we increase the number of the items, then Cronbach's alpha was to take the value of 0. 77.1%.

The split-half procedure; Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items in the scale. Based upon the formula _= rk /[1 + (k -1)r] where k is the number of items considered and r is the mean of the inter-item correlations the size of alpha is determined by both the number of items in the scale and the mean inter-item correlations.

Reliability for household questionnaire, the value of the coefficient of Cronbach's alpha for the research scale is 0.957=95.7%. Reliability of score of the instruments (Re) = 0.957. Reliability coefficient ranges from values of 0.000 and +1.00 indicating perfect reliability. In this investigation, the reliability coefficient was found to be good which meant that the instrument could be used ie relied on to make valid conclusions. The coefficient of internal consistency (reliability) Cronbach's alpha was statistically significant and equals to 77.1% for the 10 questionnaires for teachers and 95.7% for parents study tools.

3.14 Data Collection Instruments

Tools that were used in the study included questionnaires, observation check list and desk review guide of secondary data. Variables that were measured were prevalence, morbidity, school attendance, and mortality.

The research instruments adopted to achieve the objectives of this study included three categories of questionnaires which were administered in the sampled primary schools, personal observations in the sampled primary schools and personal interviews of head teachers and teacher's.

3.14.1 Questionnaires

This study used structured questionnaires with closed - ended and open-ended questions. The closed ended questions are included because they are easy to administer and analyze therefore, they are economical in terms of time and money and allowed collection of data from a large sample. The open-ended questions, on the other hand, are easy to formulate and helped to collect a more in-depth response from subjects.

Questionnaires are intended to elicit information about the burden caused by Tungiasis among school age children and its influence in school attendance. The variables of the questionnaire were drop out, class repetition and mortality. The questionnaires were pre-tested to reduce bias and ambiguity. There was a cover letter attached to each questionnaire explaining the purpose of the study and requesting the co-operation of the respondents. Respondents were given time to study and complete the questionnaires distributed to them.

Questionnaire for teachers which was to solicit information on the rate and trend of school dropout in their schools as result of Tungiasis infestation, availability of physical facilities to cater for infested pupils, availability of counseling and guidance lessons in their school, and burden of Tungiasis to the school. The questionnaire also sought any insights the Head teacher may have that can help reduce the Tungiasis in the area. The questionnaire for the teachers was administered to teachers in charge of health and First AID, the number of pupils who were suffering from Tungiasis, class attendance of infested pupils, their performance and what the school was doing to address the disease. It also allowed the teacher to give his/her own opinion on factors contributing to incidence of Tungiasis in the study region and means of reversing the trend.

Questionnaire for Pupils; The questionnaires for pupils gave information on the size of the family, Tungiasis consequences, class attendance, class performance, school dropout, the distance to their school. It also allowed the pupil to give his/her own opinion on factors contributing to Tungiasis in the study region and means of reversing the trend**.**

The type of questions used in the study required: -Ticking the applicable answer and filling in the blanks.

Coding of Closed-Ended Questions was needed in order to allocate a code to the answers of each question or variable. Coding is to give a distinctive number to each answer in a question. The number was fed into the computer. A pre-coding procedure was adopted for computer data analysis. This is because most of the questions (over 85%) were closed questions, with predetermined answers to each question. It is therefore necessary to allocate codes to the answers.

Coding of open-ended questions; open-ended questions often produce multiple responses that require the creation of several variables to capture the responses (Kothari and Garg,2014). It was therefore best to construct a number of variables into which responses were sorted out then coded. A multiple response approach was used for coding the open-ended questions in this study. A post-coding procedure was used. Categories were created from the responses received to a particular question. A code was allocated to a particular category, for respondents' answers.

3.14.2 Observations

Data collection through observation assumes that people's behavior is purposeful and can express deeper their values and beliefs. What people say they do and what they actually do can be two very different conditions. Observation is very useful when dealing with children because it may reveal patterns of behavior the children themselves are unaware of or cannot describe to a satisfactory degree (Kothari and Garg, 2014). During field visits to the primary schools to collect data from the various categories of respondents through questionnaires the researcher made the observations of the situation in the sampled schools and location and paid particular attention to the distance to the schools. The purpose of making personal observations was to obtain additional and collaborative data which would enhance the data gathered through questionnaires. Personal observations enabled the researcher to take note of some factors that cause Tungiasis in households and school that may difficult to describe in the format provided for in the questionnaire.

3.14.3 Desk top Review guide

To supplement the primary data the researcher utilized information from various secondary sources. These included school registers to capture attendance, medical and public health records to capture mortality and morbidity among the children aged 5-14 years.

3.15 Data collection procedures

Data collection was carried out for a period between June, 2014 and August 2015. Although, secondary data collected were for a period of one year and seven months (January, 2014 to July 2015). The administration of research instruments was done by the researcher. Data collection started after preliminary study was completed. Preliminary study was aimed at submitting copies of ethical approval and permit to the county administrators, pretesting research tools, selecting households, recruiting participants and familiarizing with study area. This was followed by visits in the households, schools, health facilities and government offices. Data on prevalence of Tungiasis and its sequelae were collected by macroscopic examination, disease history and reports from the children, parents and teachers. This was followed by filling of questionnaires, and observations made to gather data. Secondary data on mortality and morbidity were collected from essential records from the schools and health facilities. Data on school attendance, repetition and drop out was done by following the class attendance for the two terms in the year 2014 and three terms in the year 2013 from the class registers. These were verified by the either class teachers, senior head teachers, deputy head teachers or the head teachers. In health facilities, secondary data on prevalence, morbidity and mortality due to Tungiasis were collected from the health records for the year 2014 and 2015.

Questionnaires were administered and collected the same day from each school visited. This was aimed at encouraging 100% return of the questionnaires and also reduces the chances of respondents to give independent responses without discussing or modifying the responses. In cases where it is not possible for participants to respond to questionnaires during the first visit a subsequent visits was arranged.

The secondary data included treated cases, complications associated with Tungiasis incidences of mortality. A Geographical Position System (GPS) receiver and an iPhone 5c were used in data collection to capture the weather conditions, images of patients who were diagnosed with sequelae such as loss of toes and lesions.

3.16 Ethical considerations

The study had an ethical approval from Kenyatta National Hospital ethics research committee (KNH-ERC/A/163) and also a research permit to conduct the study was obtained from the Ministry of Education, Science and Technology ; National Commission for Science ,Technology and Innovations (NCST/RCD/12A/133). Authorization to carry out research at county level was granted by County Director of Health (MRG/VOL.1/68/16), County Commissioner (PUB.24/11/VOL.1/64) and County Director of Education (M′GA/CTY/GEN/64/VOL.I/102). Informed consent was given by all participants. The purpose of the study was explained in simple language to all teachers, children participating in the study, parents, health care providers and local administration. The parents and teachers were requested to participate in the study after signing a written consent form. All the information obtained in the course of the study was treated with confidentiality. Any additional information needed for improving the study was acquired only if written consent was signed.

3.17 Data management and statistical analysis

The data analysis was initiated by examining the gathered raw data for accuracy, usefulness and completeness. This was done to identify those items that may incorrectly responded to such as spelling mistakes and blank spaces left unfilled by the respondents. The normality test was carried out to determine if the data are normally distributed.

Quantitative Data Analysis, the data gathered from the structured questionnaires was edited for completeness and consistency before processing. Descriptive statistics was used to summarize the data, to enable the researcher to meaningfully describe a distribution of scores or measurements using a few statistics. The mean and standard deviation were calculated for the parameters such as age and number of days missed from school.

The Tungiasis burden was determined in terms of DALYS. Also clinical description of morbidity was carried out in terms of sequelae and health states (Salomon *et al.*, 2012). Pearson correlation was used to correlate Tungiasis burden among school age children and with school attendance. Tungiasis burden was also analyzed in relation to gender. Chi square test was used to determine whether there was significant association between variables. The variables were Tungiasis morbidity, age, gender, school attendance, class repetition and drop out.

Regression analysis was carried out to determine the relationships between school attendance and Tungiasis status. The Statistical package for the Social Science (SPSS) version 21.0 was used for these analyses.

3.18 Limitations of the study.

Tungiasis mainly affects the children and the elderly. This study was limited to the Tungiasis DALYS amongst the school age children. The study was also carried in Murang'a County which was purposively which has been identified as one of the endemic areas (MOH, 2014). The possibility of over research in the area on the topic was also real and the participant may respond depending on their earlier experiences from researchers and activities. This led to withdraw of ten heads of households during data collection phase that cited chronic Tungiasis challenges. Also there could have been a possible selection bias though this was mitigated as much as possible by randomization**.**

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Response rate and demographic information of the respondents

Response rate was high because only 10 parents (5%) withdrew out of the expected 200. For those who were not able to fill the questionnaires, discussions, and interviews facilitated data collection. Apart from the children, other participants' gender was 34.1% male while female were 65.9%. The age categories of respondents differed with most of them falling under between 31-40 years age group (46.18%). Those that were aged between 41-50 years were 19.5%, 51-60 years were 19.5% while those that were over 61 years were 14.6%. The participants aged below 30 years were 12.2%. In case of marital status most of the respondents (61.0%) indicated that they were married, 7.3% were widowers, 14.6% were widows, 12.2% were singles and only 4.9% were divorced. The respondents who had primary education were 56.1%, those with secondary education were 26.8% while 17.1% indicated they had no formal education.

A total of 347 (90%) children aged between 5-14 years participated in the study from a sample of 384 children drawn from 200 households. The mean age of the children that participated was 10.16 years with SD 2.195. The family size mean was 4 individuals for all the sampled households. Family size and Tungiasis status have a negative Pearson relationship -0.01. However the relationship was not statistically significant ($p = 0.979$).

4.2 Clinical manifestation of Tungiasis among the children

Children who were diagnosed for different symptoms which included lesions, itching, pain, lack of sleep, inflammation, loss of toes and finger nails, disfigurement, difficulty in walking and gripping. The clinical manifestations of Tungiasis among the children are as shown in table 4.1.

Table 4.1: Clinical manifestation of Tungiasis among the children.

symptoms	Both male and female	percent	male	Percent	Female	Percent
Lesions	153	44%	97	28%	56	16%
Pain	130	37%	77	22%	53	15%
Itching	127	37%	82	24%	45	13%
Lack of sleep	48	14%	23	7%	25	7%
Loss of toe nails and finger nails	33	9.5%	25	7.2%	8	2.3%
Difficulty in walking	14	4%	9	3%	5	1%
Deformed feet	11	3%	7	2%	4	1%
Stigma/withdrawal/isolation	11	3%	9	2.5%	2	0.6%
Inflammation	6	1.7%	4	1.2%	2	0.6%
Pustule	4	1.2%	1	0.3%	3	0.9%
Docile	3	0.9%	1	0.3%	2	0.6%
Burning sensation	2	0.6%	2	0.6%	0	0%
Unable to write	1	0.3%	1	0.35	0	0%

The common clinical manifestations were lesions on feet, pain, itching, and lack of sleep and loss of toe nails. The most prevalent clinical manifestations among the 153 children suffering from Tungiasis in both age groups were lesions on feet, heels and hands, pain and itching. The painful lesions on feet and hands resulted in difficulty in walking and limited use of hands. Continuous loss of tissue due to multiple embedded female *T. penetrans* was a risk to infections by pathogens due to broken skin and eventually disfigurement.

The other symptoms among those with severe Tungiasis were difficulty in walking, lesion on hands, loss of finger nails as shown in figures 4, 5, and 6 .

Figure 4; Tungiasis lesions on the sole.

Figure 5; Tungiasis lesions on hands and feet.

Figure 6; Tungiasis lesions beneath the toes and part of sole of a male child.

Lesions caused by Tungiasis among the children diagnosed with the disease were located at various parts of the body but the most common ones were located on the feet.

4.3 Prevalence of Tungiasis, its sequelae and health states among the children aged 5-14 years.

Prevalence of severe and mild Tungiasis, sequelae and heath states among the children differed. The disease prevalence is detailed in table 4.2.

Table 4.2: Prevalence of Tungiasis among the children.

Disease status	Number of the children	Prevalence of both male and female	Male	Prevalence of the male children	Female	Prevalence of female children
Tungiasis	153	44%	97	28%	56	16%
Mild Tungiasis	122	35.2%	77	22%	45	13%
Severe Tungiasis	31	8.9%	20	6%	11	3%

Out 153 children diagnosed with Tungiasis, 97 (28%) were males and 56(16%) were females. Majority of the children 77 (22%) were diagnosed with mild Tungiasis. Severe Tungiasis was diagnosed among 31(8.9%) 0f whom were mainly males 20(6%).

The duration the children had lived with Tungiasis differed between males and females. The duration was in average number of years as shown in table 4.3.

Table 4. 3: Duration lived Tungiasis among children.

Duration in years Lived with Tungiasis	Both Male and Female	Both male and female percent	Male	Male percent	Female	Female Percent
Less than 1 year	21	6%	15	4%	6	1.7%
1-2 years	63	18.2%	40	12%	23	6.6%
3-4 years	63	18.2%	37	11%	26	7.5%
5+ years	6	1.7%	5	1%	1	0.3%
Total	153	44%	97	28%	56	16%

The children who had lived with the disease for less than 1 year were 21(6%). Majority 126 (36.4%) had suffered from Tungiasis for 1-4 years and 6(1.7%) had lived with disease for more than 5 years. However the female had lived with the disease for a lesser duration.

4.3.1 Age and prevalence of Tungiasis

The age of a child affects their ability to take care of themselves in terms of removing embedded female *T. penetrans* and their tolerance of the pain when removing. In this study, 74(21%) children were aged below 5-9 years both male and female. The male children aged below 11 years were the majority 86 (25%). Among the female children who were suffering from Tungiasis 35 (10%) were also aged between 5 years and 11 years. Children aged 10-14 years both male and female suffering from Tungiasis were 79 (23 %). Distribution of the children who participated in the study in male and female categories is shown in Table 4.4.

Table 4.4:Age and Tungiasis prevalence

Age bracket	Number	Prevalence of Tungiasis	Mild Tungiasis	Prevalence mild Tungiasis	Severe Tungiasis	Prevalence severe Tungiasis
5-14 years (overall prevalence)	153	44%	122	35%	31	9%
5-9 years	74	21%	56	16%	18	5%
10-14 years	79	23%	66	19%	13	4%

The prevalence of Tungiasis varied across different age groups. Test results show that the age of the children had a statistical significance in relation to vulnerability to suffer from Tungiasis at ($p=0.048$). The distribution of children and Tungiasis prevalence among different age groups was as indicated in table 4.4.

The children who were younger (aged between 5 years and 11 years) were the most vulnerable than their older siblings or class mates. This could be because of their immunity is not as stronger as older children aged above 12 years and may have limited self-care. Also after the age of five years the child is likely to have less contact with the parent because the child may have started going to school. This could also be because the parents have younger siblings who require more attention which was the case in most households.

4.3.2 Prevalence of Health states among the children suffering from Tungiasis.

This study found in some cases that the children had lived with two health states for duration of 2.38 and 2.4 years compared with infectious disease post-acute consequences health state that had lasted 2.02 years. Although infectious disease post-acute consequences health state had lasted for a lesser period of time and had low frequency, its disability weight is the highest at 0.254 i.e. 50.8 times greater than disability weight of open wound short or long term with or without treatment and 8.8 greater than disfigurement with itch or pain. Headache was considered under the infectious disease post-acute consequences health state since it was thought to be a result of this health state other than direct sequel caused by Tungiasis. The distribution of the prevalence of different health states among children was as indicated in table 4.5.

Table 4.5: Prevalence of Tungiasis health states among children and duration lived with health state.

Health state	Duration In average years	No. of male children	Percent of male	No. of Female children	Percent of female	No. children aged 5-9years	Percent of 5-9years age group	No. children aged 10-14 years	Percent of 10-14 years age group
Disfigurement: level 1 with itch or pain	2.38	95	27%	55	16%	73	21%	77	22%
Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia)	2.02	10	3%	12	4%	12	4%	10	3%
Open wound: short or long term, with or without treatment	2.4	83	24%	53	15%	68	20%	68	20%

The disfigurement and open wound health states had the high prevalence 27% because of the sequelae that were associated with each health state which are also prevalent. These sequelae include lesions, itching and pain.

The prevalence of Infectious disease: post-acute consequences health state was high among female children and the children aged 5-9 years which had the same value of 4%. This could be the younger age group were likely not to tolerate the pain and itching resulting from lesions caused by Tungiasis and suffered severe Tungiasis. They could also have been suffering from severe cases of Tungiasis due to their limited self-care. Also the female children suffering from Tungiasis could have been in the younger group and as they grew older they could have increased their level of self-awareness, personal hygiene and self-care which may have reduced disabilities associated with Tungiasis.

4.4 Morbidity among the children resulting from Tungiasis

The health states had been derived from the sequelae observed or reported among the children aged 5-14 years. The total YLDs caused by Tungiasis were 3.06 years for all the children aged 5-14 years in a population of 347 children; the YLDs are usually expressed for 1000 individuals' population. This was carried out for both gender and age groups. The outcome was Years Lived with Disability (YLD) among the children as indicated in table 4.6.

Table 4.6: YLDS among children resulting from different health states caused by Tungiasis.

Health state	Duration Average in years	Disability weight	YLDS 5-14 yrs both male and female	YLDS Male	YLDS Female	YLDS 5-9 yrs	YLDS 10-14 yrs
Disfigurement: level 1 with itch or pain	2.38	0·029	1.25	0.79	0.46	0.61	0.64
Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia)	2.02	0·254	1.61	0.73	0.88	0.88	0.73
Open wound: short term, with or without treatment	2.4	0·005	0.20	0.12	0.08	0.10	0.10
TOTAL YLDs			**3.06**	**1.64**	**1.42**	**1.59**	**1.47**

The greatest contribution to total YLDs was Infectious disease: post-acute consequences health state at 52.6% due to its high disability weight although it had the lowest prevalence. Disfigurement health state YLDs were at 40% which were lower than infectious disease post consequence health state but greater than open wound health state YLDs. The least YLDS were observed among female who also had least number of YLDs 1.42 (6.5%) due to open wound: short term, with or without treatment. This is because the prevalence of two health states disfigurement with itch or pain and Open wound: short term, with or without treatment were lower among female children compared to their male counter parts. However, there was no statistical difference in YLDs between gender at p= 0.199 which and also between the age group there was no statistical difference at p= 0.199 which was greater than 0.001.

Mild Tungiasis YLDs were 10.7% compared to severe Tungiasis YLDs 89.3% hence high burden by 78.6% than mild Tungiasis. This was also evident in total number of YLDs among all the children attributed to severe Tungiasis which was found to be 8.4 times greater than the 0.3 YLDs attributed to mild Tungiasis. The average duration of the two health states defining mild Tungiasis was shorter among the children suffering from mild Tungiasis compared to the duration of health states of children diagnosed with severe Tungiasis. The YLDs among the children for mild and severe Tungiasis are shown in table 4.7.

Table 4.7: YLDs among children caused by mild and severe Tungiasis.

Tungiasis	Health state	Durati-on in years	Disab i-lity weig ht	YLDs 5-14yrs both male and female	YLDs Male	YLDs female	YLDs 5-9yrs	YLDs 10-14yrs
Mild Tungiasis	Open wound: short term, with or without treatment	2.13	0·005	0.08	0.06	0.02	0.04	0.04
	Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia)	1	0·254	0.22	0.15	0.07	0.07	0.15
Total Mild YLDs				**0.3**	**0.21**	**0.09**	**0.11**	**0.19**
Severe Tungiasis	Disfigurement: level 1 with itch or pain	2.5	0·029	0.71	0.40	0.31	0.38	0.33
	Infectious disease: post-acute consequences (fatigue, emotional lability, insomnia)	2.02	0·254	1.68	0.81	0.88	0.95	0.73
	Open wound: short term, with or without treatment	2.55	0·005	0.12	0.07	0.05	0.065	0.058
	Total YLDs for severe Tungiasis			**2.51**	**1.28**	**1.24**	**1.395**	**1.12**

Infectious disease: post-acute consequences health state for mild Tungiasis had lasted for 2.02 years while among children diagnosed with mild Tungiasis the same health state had duration of 1 year which was more than 50% less. Another observation was that with every unit increase in Duration, YLDs decreases by 2.5 times. This is caused by the Infectious disease: post-acute consequences health state with the greatest disability weight lasted for a shorter period after the onset of the disease and diminished in chronic cases. These gave a difference in loss of health between for the two forms of Tungiasis in which high burden of disease was suffered by few individuals for a long time.

4.5 Mortality caused by Tungiasis among the children

In all the health facilities visited during this study patients suffering from Tungiasis were placed under the care of community health workers. In the five health facilities the reference was to the community health workers (CHWs). The CHWs visited households and schools. They managed Tungiasis in different ways but they did not keep formal records of who had been treated, recovered or died. Thus mortality data was treated as verbal autopsy. The verbal autopsy data were faced with certain shortcomings. These included recall bias; the co-morbidities which were cited in all cases associated with Tungiasis deaths and age. In level 5 hospitals ICD 10 coding was used and Tungiasis code was B88.1.The code was under the main category of other infestations code B88. In Murang'a level 4 Hospital outpatient record data on Tungiasis were under public health department and causes were reported per budget year. The outpatient records included data on treated cases for all individuals and school age children.

Data among the children diagnosed with Tungiasis showed periods of decrease and increase in number, however lower number of children diagnosed with Tungiasis 182 children at the beginning of 2015-2016 was noted compared to the beginning of 2014-2015 budget year when 280 children were diagnosed with Tungiasis. The outpatient data on Tungiasis for 2014-2015 budget years and up to the month of July for 2015-2016 budget year as shown in table 4.8.

Table 4.8 Tungiasis: Outpatient data from Murang'a level 4 Hospital.

Year	2014						2015						
month	July	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	may	June	July
Number of Households fumigated	127	341	65	112	123	59	129	28	155	151	221	214	157
Percent of Households fumigated	7%	18%	3%	6%	7%	3%	7%	2%	8%	8%	12%	11%	8%
Number of people diagnosed with Tungiasis	400	631	554	561	511	257	610	269	577	543	267	390	368
Percent of people diagnosed with Tungiasis	7%	11%	9%	9%	9%	4%	10%	5%	10%	9%	4%	7%	6%
Number of cases treated	396	631	547	561	501	257	597	262	574	538	267	390	368
Percent of treated cases	7%	11%	9%	10%	9%	4%	10%	4%	10%	9%	5%	7%	6%
Number of schools with children diagnosed with Tungiasis	55	61	39	54	27	0	41	23	50	0	44	32	42
Percent schools with children diagnosed with Tungiasis	12%	13%	8%	12%	6%	0%	9%	5%	10%	0%	9%	7%	9%
Number of school age children suffering with Tungiasis	281	259	266	297	249	0	178	90	178	0	135	128	182
Percent children suffering from Tungiasis	12%	12%	12%	13%	11%	0%	8%	4%	8%	0%	6%	6%	8%
Number of children treated	280	259	266	297	249	0	178	90	178	0	135	128	182
Percent of children treated	12%	12%	12%	13%	11%	0%	8%	4%	8%	0%	6%	6%	8%

The zero value during December, 2014 and April, 2015 are because the children were on school holidays but that does not mean that there were no children suffering from Tungiasis during this period. The mean value of the children suffering from Tungiasis was 204 cases for the 11 months.

Although the mean did not give a clear picture because the number of schools and the number of children diagnosed was not constant .For instance in July 2014, 281 cases were recorded in 55 schools, while in November same year half the number-27 of schools , 249 cases were reported. In February 2015, there were 90 cases in 23 schools. Zero cases were recorded during school holidays on December 2015 and April 2015.

Verbal autopsy involved inquiry on deaths caused by Tungiasis among parents from the households included in the study, teachers in charge of health and community health workers. This was limited to the period of one year and seven months, between January, 2014 and July 2015. The data from verbal autopsy and desk top review of inpatient records of level 4 and level 5 hospitals mortality data indicated that no deaths were caused by Tungiasis among children aged 5-14 years as shown in table 4.9.

Table 4.9; Verbal autopsy, Morbidity and Mortality.

	Verbal autopsy		Level 4 and 5 hospitals inpatient medical records			
			Morbidity		Mortality	
Age in years	Male	Female	Male	Female	Male	Female
Under 5	0	0	1	0	0	0
5-14	0	0	0	1	0	0
30-34	0	0	0	1	0	0
40-44	0	1	1	1	0	0
65+	1	2	0	2	0	0

The patient in the age category 5-14 years who suffered from Tungiasis table 9 was a female aged 7 years. She was diagnosed with Bilateral Tungiasis, with lesions on both feet and hands and was unable to use right lower limb due to pain. He was treated in Murang'a level 4 hospital by soaking her feet and hands in potassium permanganate solution. It was also noted that she did not have adequate parental care. The wounds were described to be high risk for infection by pathogens due to the broken epidermis. In the other age groups Tungiasis was described with other co morbidities suffered by the patients. Morbidity caused by Tungiasis was ranked at position 818 in level 5 hospitals which had computerized medical records with 3 cases and 0.01% of the total morbidity cases. Out of the three cases two were female aged 70 years and 79 years and one was a male child aged two years. Mortality caused by Tungiasis was zero among all age groups.

During desk top review of medical records for the specified period the top ten causes of morbidity and mortality among the children aged 5-14 years were identified. The mortality and morbidity data from various causes in level 4 hospital including Tungiasis among children aged 5-14 years are recorded in table 4.10.

Table 4.10: Causes of mortality and morbidity among children aged 5-14 years in level 4 hospital January 2014-July 2015.

Rank	All causes of Mortality	Number of Cases	Morbidity	Number of cases
1	Head injuries	2	1 Upper respiratory pneumonia	3391
2	Tuberculosis in HIV patient	2	2 Diarrhoea	2016
3	Asyphyxia due to strangulation	1	3 Pneumonia	514
4	Pheumogystic carina pneumonia	1	4 Skin diseases	415
5	Pneumonia	1	5 Intestinal worms	299
6	Severe intracarina haemorrage	1	6 Accidents	255
7	Aspiration of gastric content/Severe pneumonia	1	7 Urinary Tract Infection	246
			8 Malnutrition	206
			9 Burns	205
			10 Chicken pox	150

Upper respiratory pneumonia was the leading cause of mortality while chicken pox was tenth cause of morbidity among children in age group 5-14 years. Intestinal worms which would include such food borne and soil transmitted helminthes ranked 5th cause of morbidity. Mortality among children aged 5-14 years was nine cases resulting from seven causes and zero deaths were caused by Tungiasis. Morbidity in this age group was high compared with mortality. Upper respiratory pneumonia caused the greatest morbidity indicated by 3391 cases. Tungiasis had only one inpatient case from level 4 hospital but from outpatient data an average of 204 school age children were suffering from Tungiasis.

4.6 Disability Adjusted Life Years resulting from Tungiasis among the children.

Among children aged 5-14 years Tungiasis had not caused any deaths. Thus DALYs were contributed by morbidity (YLDs) component. DALYs among the children aged 5-14 years resulting from symptomatic Tungiasis were therefore equivalent to YLDs. This could mean that DALYs lost due to Tungiasis among the children aged 5-14 years are attributed 100% to YLDs .Therefore more DALYs were lost by 78.6% due to severe Tungiasis 2.51 DALYs compared to mild Tungiasis 0.3.DALYs as shown in table 4.11.

Table 4.11:DALYs caused by Tungiasis among the children aged 5-14 years

Tungiasis	DALYs 5-14yrs both male and female	DALYs Male	DALYs Female	DALYs 5-9yrs	DALYs 10-14yrs
Mild Tungiasis	0.3	0.21	0.09	0.11	0.19
Severe Tungiasis	2.51	1.28	1.24	1.395	1.12

Mild Tungiasis caused 0.3 DALYs in all the children which is equivalent to 0.3 of a year lost due to premature death. A total of 2.51 DALYs were lost due to severe Tungiasis with male children and children aged 5-9 years bearing highest burden. Therefore severe Tungiasis caused loss of 2.51 years equivalent two and half years lost due to premature death.

4.7 Impact of Tungiasis on School attendance among the children

Majority of the pupils with severe Tungiasis (65.4%) indicated that they had failed to attend their classes due to Tungiasis as they could not walk to school due to pain. Some of the children, 34.6% had not been absent from school although a number of them had been diagnosed with mild Tungiasis. It was observed during data collection that some of children suffering from

Tungiasis were in one or two classes lower than their age mates although others had retained their good performance.

The number of school days lost due to Tungiasis differed with Tungiasis status. The school absenteeism was found to be less among those with mild Tungiasis of them 2.4 days per term and 7.2 days per year. Children suffering from severe Tungiasis lost five times more school days compared to those diagnosed with mild Tungiasis. In total 633 days were lost per term due to Tungiasis and 1899 days per every academic year. This was likely because the average duration of Tungiasis was 1.0209 years. Although it was reported that the number of days missed was mainly contributed by the children who had dropped out of the school for a school term due severe Tungiasis. Male children missed to attend school regularly due to Tungiasis compared to female children. The number of days is summarized in table 4.12 in terms of Tungiasis status and gender.

Table 4.12; Number of days children aged 5-14 years missed school due to Tungiasis per term.

	No. of respondents		Gender				Tungiasis Status			
Number of days	Frequency	Percent	Male	Female	Male Percent	Female Percent	Mild	Severe	Mild Percent	Severe Percent
0	305	87.9%	159	146	86.9%	89.0%	103	8	84.4%	25.8%
5	17	4.9%	10	7	5.5%	4.3%	9	8	7.4%	25.8%
10	10	2.9%	6	4	3.3%	2.4%	4	6	3.3%	19.4%
15	6	1.7%	4	2	2.2%	1.2%	2	4	1.6%	12.9%
20	1	0.3%	0	1	0.0%	0.6%	0	1	0.0%	3.2%
40	4	1.2%	2	2	1.1%	1.2%	2	2	1.6%	6.5%
60	2	0.6%	1	1	0.5%	0.6%	0	2	0.0%	6.5%
65	2	0.6%	1	1	0.5%	0.6%	0	2	0.0%	1.6%
Total	**347**	**100.0%**	**183**	**164**	**100.0%**	**100.0%**	**122**	**31**	**100.0%**	**100.0%**

During the examination of the registers the days the children missed to attend school was taken into account. Data from class register revealed that missing classes and other school activities was a trend for pupils during the dry seasons. Among the children suffering from severe Tungiasis 23.2% had difficulty in walk as results of pain and wounds on sole of the feet, between the toes and heel. They also suffered from stigma and harassment from their peers. Lack of school uniform was cited by 6.1% pupils while 4.8% indicated other reasons. However, majority of them (65.9%) indicated that they failed to attend classes due to sickness.

In one of the household with three female siblings aged 24 years, 13 years and 10 years the mother was suffering from Tungiasis and epilepsy. The 24 year old was mentally retarded and the 13 years was the one who was taking care of them "I miss school to take my mother to the health center for her regular clinics and also when I am sick I go to hospital the back to school".

Other reasons cited for missing school due to Tungiasis; parents asked the child not to go because they were experiencing persistent pain and had difficulty in walking for instance a parent in Kagira during an interview said" I tell him not to go to school when he has those wounds, feeling pain and have difficulty in walking, he cannot understand what is taught, he was thus to repeat class. Table 4.13 summarizes the findings.

Table 4.13: Reasons for missing to attend school.

		Frequency	Valid Percent
A	Sickness	54	65.9
B	Tungiasis	19	23.2
C	Lack of school uniforms	5	6.1
D	Lack of sanitary pads and Others	4	4.8
	Total	82	100.0

4.8 Influence of Tungiasis on class Repetition among the children

It is imperative to note that teachers and head teachers in the schools in the study area were generally reluctant to talk about repetition in their schools. This is because the Ministry of Education did not allow schools to force children to repeat classes. Besides, most parents did not support the exercise. However the data on the number of pupils who had repeated a class was obtained in three complementary ways. The first one was by asking the class teacher who the repeaters were in each stream or class. The second one was by checking the current and previous class registers of two consecutive grades and lastly through the use of questionnaire filled by pupils. If the name of a pupil appeared in a class registers of say primary one in two consecutive years, then such a pupil was considered to have en a repeater. In some schools, pupils were forced to repeat several times to improve their performance. About 54.3% of the sampled pupils who participated in this study indicated that they had repeated at least once since they began going to school.

Children who had repeated at least once were the majority (70.0%), 23.3% had repeated twice while 6.7% had repeated three times in the course of their study. Repetition may be one aspect that may promote school dropout among the children who felt left out.

Various reasons were cited for repetition. In normal circumstances, parents would prefer their children to continue with their learning without interruptions or even repeating classes. This has not been the case as some children were forced to repeat classes due to diverse reasons. When the respondents were asked why their children repeated classes, 39.5% of the respondents indicated poor performance of the pupil as the main reason. Likewise, those who indicated sickness as the reason that made children repeat classes represented 39.5% of the respondents while 11.6% respondents indicated disabilities associated with Tungiasis. A small fraction 7.0% indicated lack of school uniform as a reason. Some children are sent home due to indiscipline and are forced to repeat classes when they are accepted back. As can be observed most of the reasons cited were implications brought about by Tungiasis infestation as shown in table 4.14.

Table 4.14: Causes of repetition among children

		Frequency	Percent
A	Poor performance	17	39.5
B	All causes of ill health	17	39.5
C	Lack of school uniforms	3	7.0
D	Tungiasis	6	14
	Total	43	100.0

This study found that, there was a significant relationship between Tungiasis and class repetition ($p = 0.007$). The assumption for this was that since most pupils failed to proceed to the next grade due to poor performance resulting from irregular class attendance and low class concentration during lessons as a result of Tungiasis. This findings show that Tungiasis infestation has an impact on class repetition.

4.9 Influence of Tungiasis on school drop out

Tungiasis contributed to stigmatization among children and parents from their peers and local communities leading to low enrolment in schools. Drop-out just like repetition figures were not easy to collect. This is cause at primary school level there is no systematic monitoring of who drop-out and why. There is a general assumption among school heads and teachers that most children who fail to come to school after sometimes generally transfer to other schools. The record keeping in about 90 per cent of the primary schools visited is non-existence or is very poor. It became necessary therefore to visit each class and enquire from the class teacher and the pupils which of the pupils could have dropped out of the stream or class during the course of the year. About 20.5% pupils indicated that there are pupils at their homes who had dropped out of school.

Male children were found to be more likely to drop out of schools than their female counterparts. Teachers were asked to indicate reasons that had caused drop out of school as well as their proposed remedies to the problem. About 80.4% students indicated that it was due to Tungiasis related implications and child labour. However, there are indication of cases where pupils, especially girls who drop-out cause of pregnancy or early marriages. Some school dropout who were still of tender age were staying with their parents while the older ones could traced in shopping centers where they were engaged in income generating activities. The drop out among male and female children is shown in table 4.15.

Table 4.15: Drop out due to Tungiasis among male and female children

		Male		**Female**	
		Frequency	Percent	Frequency	Percent
A	1	9	42.9	8	57.1
B	2	9	42.9	3	21.4
C	3	3	14.3	2	14.3
D	More than 4	0	0.0	1	7.1
	Total	21	100.0	14	100.0

4.11 Academic performance among children suffering from Tungiasis

Academic performance among children suffering from Tungiasis was rated by the individual child, class teacher and the parent in relation to the perceived academic ability of the child or performance before suffering from Tungiasis. The average of performance rate was 28.9% with average performance (annual average score in all subjects 40-50%), 26.4% rated as poor performance (annual average score in all subjects 30-40%) and 21.5% very poor (annual average score in all subjects of low 30%). The results showed most of the children, teachers and parents were dissatisfied with the performance and had no confidence they would attain good scores to join admission in public secondary schools. The low expected performance can be attributed to chronic Tungiasis which was common among the children meaning that some children had suffered from Tungiasis for more than one year. This can be attributed to reduced low school attendance due to Tungiasis which can be used as an indicator of performance.

This study found that, children suffering from Tungiasis were likely to repeat same class even more than one time (p= 0.007). Hence the children were in primary school for more than eight years which encouraged dropout and low transition to secondary schools. School attendance was reduced at 1.83 days per term among all the children due to Tungiasis. However children suffering from severe Tungiasis lost five times school days, 12.74 days than those suffering from mild Tungiasis who lost 2.4 school days per term. Regression coefficient for Age (Years) was been found to be statistically different from zero in estimating Tungiasis Status given family size, number of school days missed, gender and head of household at p= 0.048.Also the regression coefficient for number of school days missed has been found to be statistically different from zero in estimating Tungiasis Status given family size, number of school days missed, gender and head of household at p= 0.001.

4.10 Descriptions of the schools/classrooms and pupils homes

A number of schools in Murang'a use incomplete and semi-permanent structures as classrooms. About 6.5% of them had wooden walls while 93.5% had stone/bricks walls. About 37.7% had earthen dusty floors, 5.7% were partly cemented while 56.6% were cemented. *T.penetrans* flea that causes Tungiasis breed and camouflage in dusty classroom floors, dirt, rubbish, cracks in floors and walls. All the classes had iron sheets roofs. However, some parts of the schools open play field were found to be dusty. Going barefoot, as many young children are, is a risk factor that can be attributed to suffer from Tungiasis.

The environment where most pupils come from were favorable grounds for breeding of *T.penetrans* as over 90.0% homes had mud/earthen walls and dusty earthen floors. Exposed dusty floors, walls and compounds common among many village homes in Murang'a mean that *T.penetrans* can breed inside the houses. The mud walls and earthen floors create favorable ground for the breeding of *T.penetrans* and triggers emerging of adult stage from pupae cocoon thus increasing parasite load to humans in the dwelling who are preferred hosts.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the findings

Tungiasis is likely to be prevalent among the children aged between 5-14 years with average of 16 children (3%) in 17 (78%) schools included in this study. Test results showed that the age of the children had a relation to vulnerability to suffer from Tungiasis at (P=0.048). Among children aged 5-14 years Tungiasis had caused zero mortality (YLLs). Thus DALYs were mainly contributed by morbidity (YLDs) component. DALYs among the children aged 5-14 years resulting from symptomatic Tungiasis were equivalent to total YLDs. Mild Tungiasis YLDs were 10.7% compared to severe Tungiasis YLDs 89.3% hence high burden by 78.6% than mild Tungiasis. There was no statistical difference in YLDs between gender and age group both at P =0.199. The total YLDs caused by Tungiasis were 3.06 years for all the children aged 5-14 years in the population of 347 children. This study found in some cases the children had lived with two health states open wound and disfigurement with itching and pain for a duration of 2.38 and 2.4 years compared with infectious disease post-acute consequences health state that had lasted 2.02 years.

Regression coefficient for Age (Years) has been found to be statistically different from zero in estimating Tungiasis Status given family size, number of school days missed, gender and head of household at P= 0.048. Also the regression coefficient for number of school days missed was found to be statistically different from zero in estimating Tungiasis Status given family size, number of school days missed, gender and head of household at P= 0.001. The school absenteeism was found to be less among those with mild Tungiasis who lost an average of 2.4 days per term and 7.2 days per year. The level school absenteeism was high among the children diagnosed with severe Tungiasis who lost an average 12.74 days per term and 38.22 days per school year. This study found that, children suffering from Tungiasis were likely to repeat same class even more than one time (P=0.007). This study found that, there was a relationship between Tungiasis and class repetition (P=0.007).

5.2 Discussions

The findings have been discussed under four sub topics. The prevalence of Tungiasis and occurrence of its sequelae, morbidity, mortality and DALYs and impact of the disease on acquisition of basic education.

5.2.1 Prevalence of Tungiasis and occurrence of its sequelae.

In this study, the overall prevalence of Tungiasis was found to be at 44% among children aged 5-14 years slightly lower than 49% recorded by in the same area (Ngunjiri and Keiyoro, 2011). In other studies higher prevalence rates had been reported inclusive of other age groups during the dry season in poor rural communities and urban slums in Brazil, (Muehlen *et al.*, 2003, and Carvalho *et al.*, 2003). Njeumi *et al.*, 2002 reported a prevalence of about 50% among school children from different communities in the West Province of Cameroon neighboring Nigeria. In the year 2009, the prevalence was found to be the highest among children in the same country (Collins *et al.*, 2009). The most prevalent sequel was lesions which were observed among all the children diagnosed with the disease. Most of the lesions were localized on the feet thus making pupils to have difficulty in walking and deformation of the toenails. This has also been observed among children in Tanzania (Mazigo *et al.*, 2011).

School-aged children may have a longer duration of exposure to an environment contaminated with *T.penetrans* without adopting appropriate protective behavior. It was observed that most of the children walked barefooted or, at best, wore slippers or open shoes. The high prevalence among children is probably a result of their greater exposure. In endemic areas closed foot wear has been described to reduce *T.penetrans* infestations which may reduce severity of the disease (Ugbomoiko *et al.,* 2006).

Though the rate of Tungiasis prevalence varied across different age groups, results showed that age of the pupils influenced infestation of Tungiasis. The different prevalence may be influenced to large extent by the different exposure behavior and age. One possible reason why older children had a lesser prevalence of Tungiasis than younger ones was because most of them were able to take care of their personal hygiene. Ugbomoiko *et al.,* 2008 noted that older children above fifteen years were likely to observe their personal hygiene. Also skillful older children carry out flea extraction for their friends and younger children at school (Ugbomoiko, 2007).The pupils who were very young had high concentration of Tungiasis' infestation than older pupils. This may also be due to limited knowledge about the parasites, inability to care for themselves or playing in dirty, dusty environment where the parasite thrives best. Secondly they may have just been enrolled to school translating into less contact with the parent thus less physical examination. It was also noted that younger sibling competed for care with their older siblings or left to be taken care of by grandparents, aunts or even left on their own. Thirdly, their ability to remove embedded female *T.penetrans* is limited and they exhibited less tolerance of the pain experienced during the process of physical removal.

Parents and children suffering from severe Tungiasis were terrified of the removal process and even some never reported the infestation and only when compelled they were examined by which time the parasite load was high. Some the children suffering from Tungiasis chose to have the embedded female *T.penetrans* rather than bear the pain of the removal process. This is because removing embedded female *T.penetrans* with a sharp instrument has remained the main intervention even when the parasite load is high (Kimani *et al.*, 2012). Fourthly majority of these children suffering from Tungiasis are aged between 5years-11 years attending the preschool and lower classes in primary school which runs up to midday or 3.00PM. Therefore these children go home early from school, spending more hours in an environment with adult *T.penetrans*. The host and contaminated environment contact promotes new infestations. These findings is in agreement with Muehlen *et al.*(2003) and Ugbomoiko *et al.*(2008) who found out that S-shaped prevalence pattern has been reported previously from a rural community in Brazil and Nigeria. The highest prevalence being among the children aged 5–14-years and individuals above the age of 60 years.

The disease affected both gender (male and female) none discriminatively. Though the rate of Tungiasis varied among both sexes, the test results shows that there was no statistically significant relationship between gender and infestation (P= 0.064). Indeed, data on sex distribution are inconsistent and, similar to age, are probably related to different exposure and disease-related behavior. For example, in some studies it has been observed more females than males to be affected in south Brazil, whereas other studies from Brazil, and Nigeria found more males to be affected, or no significant difference between the sexes (Carvalho *et al.*, 2003; Ade-Serrano *et al.*, 1981; Arene FO, 1984; Muehlen *et al.*, 2003). In Cameroon, males were found have high prevalence than females in Cameroon (Mazigo *et al.*, 2011).

5.2.2 Morbidity resulting from Tungiasis.

The morbidity caused by Tungiasis was established from three health states which were derived from the sequelae identified from the children diagnosed with the disease. These health states were open wound short term, long term, with or without treatment, disfigurement level 1 with itching or pain and Infectious disease, post-acute consequences which are fatigue, emotional lability, and insomnia (Salomon *et al.*, 2012). In this study mild and severe Tungiasis were defined in relation to the number of health states and duration of individual health state. This differed from other definition in which severity scores had been used to describe morbidity (Kehr *et al.,* 2007). This study found that mild and severe Tungiasis among the children aged 5-14 years caused different level of morbidity.

Open wound health state increased the risk of secondary infections because the skin which is the primary defense against pathogens had been opened up. This health state also contributed to difficulty in walking as it was mainly on the feet that necessitated extra care while walking. Difficulty in walking has been described among children with high number of wounds on the feet, sole and heel (Mazigo *et al.*, 2011). Infectious disease, post-acute consequences health state which included fatigue, emotional lability, insomnia which had the greatest disability weight was prevalent among children aged 5-9 years. The health state had lasted for one (1) year among the female children and for more than one year among the male children. The health state is likely to be experienced during onset stages of chronic Tungiasis and with time the child can tolerate the Tungiasis heath states. Disfigurement with itching or pain health state though resulting from severe Tungiasis was likely to cause embarrassment, stigma and elicit mockery from peers reducing the child's self-esteem and consequently sense of longing among peers. These negative implications on the child may decrease their ability to socialize and become team players in future. Most of the children who suffered disfigurement wore shoes for cover up and thus they were also less likely to seek medical care.

The total number of Tungiasis cases recorded in eleven months was 2243. If this number of cases was considered for ranking Tungiasis in addition to one inpatient case, it would be ranked as second cause of morbidity among school children. However when mean is considered for the eleven months then Tungiasis with a total 205 cases would be ranked 9th cause of morbidity among the children aged 5-14 years. Hence Tungiasis can be perceived as an important cause of morbidity among children in the study area that should be addressed.

5.2.3 Mortality caused by Tungiasis.

Mortality data was from verbal autopsy and desktop review of medical records for both inpatient and outpatient. There was zero number of cases of mortality among the children aged 5-14 years related to Tungiasis during the period of study. In the study area, the burden of disease resulting from Tungiasis was caused by non-fatal outcomes as described under morbidity in terms of YLDs. However, the non-fatal outcomes such as open wounds are risk factors to potentially fatal secondary infections from *Clostridium tetani* and other pathogens such as *Staphylococcus aureus, Enteroccous faecalis, Streptococcus pyogenes, Pseudomona sp, Bacillus sp, .Bifermantaos sp., and Peptostreptococcus sp.* (Feldmeier *et al.*, 2002). The secondary infections as a result of Tungiasis may cause death. Although both in medical records and verbal autopsy secondary infections due to Tungiasis were associated with patients aged above 60 years.

5.2.4 DALYs due to Tungiasis.

DALY is an important metric of quantifying the Burden of Disease due to the YLD component that describes the non-fatal outcome of the disease (Murray *et al.*, 2012b). The DALYs lost due to Tungiasis was equivalent to the number of YLDs among the children aged 5-14 years because YLL was zero since no death had been caused by the disease. This is similar to other neglected diseases such as hook worm disease, trichuriasis, lymphatic filariasis, food trematodiasis, onchocerciasis and trachoma whose DALYs were contributed by YLDs only with zero YLLs in the year 2010 (Hotez *et al.*,2014). This metric was applied to estimate burden of disease caused by Tungiasis in a representative population of defined administrative region in Kenya. The estimated burden of disease resulting from Tungiasis was high among children who suffered chronic Tungiasis which had lasted for more than two years. This could imply that there were continued infestations by the female *T.penetrans* and minimum efforts were geared towards managing the disease.

These efforts included removal of embedded parasite, wearing of shoes, soaking feet in Potassium Permanganate solution and fumigation of households. The efforts were therefore limited and it is important to consider each intervention's accessibility, effectiveness and sustainability. Other interventions used were hazardous to the patients in whom agrichemicals were used to control embedded female *T.penetrans*. The burden of disease caused by Tungiasis was suffered by both male and female children aged 5-14 years. Although there was no statistical difference between the burden of disease in terms of DALYs lost by male children and female children, this study, found that male children were 8.9% more likely to be suffering from Tungiasis while female children would be 10% less likely to suffer from the same in endemic areas.

The burden of disease caused by Tungiasis can also be compared with the burden of disease caused by schistosomiasis with 252 million cases in the year 2010 and 100 times morbidity compared with its mortality in the year 2002 (Hotez *et al.*, 2014;WHO, 2008). Further, a total of 3.31 million DALYs were lost due schistosomiasis, <0.001 million DALYs due to yellow fever, rabies 1.46 million DALYs in GBD 2010 (Hotez *et al.*, 2014). Tungiasis caused in total a loss of 3.06 DALYs and zero deaths contrary to the 275 deaths that had been associated with Tungiasis in Kenya by AHADI cited in Ngunjiri and Keiyoro (2011). Mortality due to Tungiasis in Luanda general hospital in 19th century was ranked second to small pox cited in (Heukelbach and Ugbomoiko, 2007).Tungiasis with estimated 205 cases among children aged 5-14 years in Murang'a can be compared with other neglected diseases among all the age groups worldwide in the year 2010 such as Africa Trypansomiasis with 37,000 symptomatic cases, rabies 1,100 cases and 100 cases of yellow fever (Hotez *et al.*, 2014).

In most of health facilities a community health worker was in charge of activities related to Tungiasis. The community health workers had not kept formal records of cases diagnosed, treated, recovered and any death caused by Tungiasis. However, the data from Murang'a level 4 hospitals showed that efforts that had lasted for one financial year had been made to address Tungiasis in households and schools. Also the government's effort are commendable which includes putting in place National guidelines on prevention and control and putting funds towards the same (MOH,2014,MOH 2009). The medical records in hospitals ,health centers and by community health workers can be improved to indicate gender, age groups, treated cases, duration until remission, recovered cases, follow up cases, incidences and describe morbidity. This would improve the intervention strategies. The burden of disease caused by Tungiasis compared to malaria is that it causes high morbidity while malaria causes both mortality and morbidity.

Lack of motivation among Tungiasis patient to seek medical care may explained by individuals' skill and strength of intention which is a function of attitude and subjective norm as explained in Theory of Reasoned Action (Ajzen and Fishbein, 1980; Fishbein & Ajzen, 1975). Also perceived benefit and cost for engaging in a behavior determines if an action will be taken (Janz and Becker, 1984; Rosenstock, 1974). In this case Tungiasis patients are likely not to seek medical care due to their attitude and that of the people close to them who may perceive the disease as a negligible condition without a serious outcome. For instance, in Tanzania, the disease is perceived to be of the dirty people (Mazigo *et al.*, 2011).This would limit the strength of their intention to seek medical care and distort their cost-benefit analysis of seeking help from health facilities. This also may be the case for other stakeholders who are supposed to put intervention measures in place to prevent, control and manage Tungiasis.

In all the health facilities visited the health personnel considered Tungiasis that had total of 205 cases of morbidity a public health concern and not a disease that would be given much medical attention compared to other causes of morbidity. Other causes of morbidity such as intestinal worms (299 cases) and malnutrition (206 cases_) had not caused deaths among the children aged 5-14 years yet they were considered to be of greater medical concern than Tungiasis. This is factual even when the risk factors of food and soil transmitted intestinal worms could be similar to those of Tungiasis. Despite this, when children suffered from these other causes of morbidity medical care was sought from health facilities and were attended to. These factors could have made Tungiasis to remain a neglected disease although it is causing burden of disease in endemic areas (Feldmeier *et al.*, 2014). Tungiasis hence can be described as a disease that causes high morbidity among few individuals for an average duration of more than two years.

5.2.5 Impact of Tungiasis on acquisition of basic Education among children.

School attendance was found to be lower among the children suffering from Tungiasis, although this differed among those diagnosed with mild and severe disease. The school absenteeism was found to be less among the children suffering from mild Tungiasis compared to those suffering from the severe form. Among the children suffering from Tungiasis a total 633 days were lost per term due to Tungiasis and 1899 days per every academic year. This is a threat to formal education because missing to attend school even for a few days for any reason has been found to contribute to low scores in standardized tests and substantial school dropout rates (Chang and Romero, 2008). Subsequently the rate of school attendance at primary school has also been attributed to progressing and completion of secondary school education (McGiboney, 2012). Attending school has been suggested to promote socialization, playing and developing attitudes and physical abilities. The skills and attitudes to socialize, complete task, take responsibility motivates these children to pursue further education and become responsible citizens. Morkve (2013) also noted that Tungiasis is a threat to learning process among the children in endemic areas.

Children failed to attend their classes due to Tungiasis as they could not walk to school due to open wounds and pain. Discussions with teachers revealed that some pupils have been arriving to school late and some had drop out of school because they could not walk normally and even when they tried, the pain from their feet was unbearable. Worse still, they had to cope with the stigma attached to Tungiasis. It was noted that some pupils who were Tungiasis-free often shun them, called them names and mimicked their walking style. In other studies children suffering from Tungiasis experienced stigmatization and isolation in schools and community (Feldmeir *et al.*, 2013; Morkve, 2013; Sharma, 2010). This may deny the children suffering from Tungiasis fulfilling need for love and sense of belonging that would hinder the affected children from unleashing their potential. Their self-esteem would be lowered due to ridicule among their peers, stigma, isolation and inability to play when others are playing (Morkve, 2013). This according to Maslow's theory (1943), lower needs for love and sense of belonging must be fulfilled first before other needs such as achieving cognitive (thinking) which are likely facilitate learning, school attendance and retention .

Sequelae resulting from Tungiasis among children such as pain, itching lack of sleep, difficulty in walking and grasping destabilizes the psychological and physiological swell being of the children who were suffering from the disease (Morkve, 2013). Pain among children has been described to give them a sense of desperation and feeling of anything can happen to them. It can therefore be argued that children experiencing constant pain due to Tungiasis will be affected in the same way. The pain and lack of sleep among the children suffering from Tungiasis are likely to limit the fulfillment of biological and physiological needs. These needs are basic and must be fulfilled first to promote learning as well as motivate the child to fulfill higher physiological and social needs (Maslow, 1943).

In this study it was found that children suffering from severe Tungiasis lost five times more school days than those children suffering from mild Tungiasis. This could be attributed to the fact that they suffered from all the health states. Open wounds health state and disfigurement with itch or pain health state could lead to difficulty in walking. This in some cases forced the parent to keep the child at home or the child opted to remain at home especially if the child presented with infectious post-acute consequence health state. Attending school is important because it promotes learners to finding out things for themselves in a school setting facilitated by the teacher which should empower them to be thinking independently after formal schooling (Brunner, 1961). In other studies, parasitic infections have been cited to reduce learning ability among children, retard their growth and reduce their potential for future employability (Hotez *et al.*, 2006; Bleakley, 2003; WHO, 2003; Grantham-McGregor and Ani, 2001). Thus children suffering from Tungiasis who have reduced rate of school attendance may limit their performance considering that school attendance has been used as an indicator of performance (Grigorenko *et al.*, 2006, Partnership for Child Development, 2002). Poor performance in tests is likely to cause class repetition which may lead to dropout in some cases.

Acquisition of basic education among the children suffering from Tungiasis therefore may be hampered by reduced school attendance, repetition and dropout. This is in spite of major efforts made to increase literacy levels for example free compulsory education in Kenya (Ingubu and Wambua, 2011). This would then compromise the children future since formal education has been thought to be a tool in which the socio economic status can be improved (Ojiambo, 2009; Bogonko, 2006).

The children who acquire formal education are able to seek health care and even make independent decisions after school as explained by Constructivist Learning Theory (Brooks and Brooks, 1993). The children after they acquire education and become citizens they are likely to eliminate socio inequalities associated with Tungiasis patients which would limit access to quality health care, education, proper sanitation, clean water and basic needs (Helman, 2007). Therefore children suffering from Tungiasis must be enabled to obtain health care and formal education through mechanisms that enhance school attendance, promotion to the next class and completion of basic education cycle. This is because it has been found that one year in primary school would improve income by 10% and individuals who have been in school for more than six years are likely to seek health care especially women of child bearing age(Psacharopoulos and Patrinos ,2004).

Loss of health among the children as a result of disabilities caused by Tungiasis should thus be addressed to promote acquisition of basic education. This is because loss of health among children due to parasitic diseases have been shown to reduced memory, intellectual and physical growth (Grantham-McGregor and Ani, 2001; Bleakley, 2003). This may also be the case for among the children suffering from Tungiasis which would further compromise their capacity to learn.

5.3 Conclusions, Recommendations and Suggestion for Further Studies

Schools could be the most effective points of managing and controlling Tungiasis among the children in collaboration with community health workers who should do follow ups at household levels. Hence the teacher in charge of health and First Aid should be empowered to carry out the interventions. This could also help reduce stigmatization if integrated with other routines such as deworming and first aid.

5.3.1Conclusions

This study found that chronic Tungiasis that had persisted for more than 1 year is likely to be common among children aged 5-14 years. It was also noted that male children were more likely to suffer from Tungiasis compared to the female children and children aged between 5-9 years were also more likely to suffer from Tungiasis than the children aged 10-14 years.

Infectious disease: Post-acute consequences health states which include fatigue, emotional lability and insomnia and open wound: short term, with or without treatment were the health states that defined mild Tungiasis. Severe Tungiasis was defined by the two health states and the third health state which was disfigurement level 1 with itching or pain. However, severe Tungiasis health states had lasted for a longer time than mild Tungiasis health states. The study also found that more years lived with disability was lost among children who were diagnosed with severe Tungiasis than those suffering from mild Tungiasis. On the other hand, children aged 5-14 years had suffered from disabilities caused by severe Tungiasis for an average of more than two years. This was likely to cause high burden of disease in terms of morbidity among children.

Burden of disease caused by Tungiasis is neglected by health personnel in which case community health workers, who have minimum skills have been given the responsibility to manage, prevent and control the disease. The disease is also neglected among the patients who rarely sought health care from the health facilities.

This study found that acquisition of basic education could be improved by addressing and managing Tungiasis in endemic areas. This would improve school attendance, retention and dropout which were found to be low among children who were suffering from Tungiasis.

The study also found that severe Tungiasis among the children was likely to cause continued absenteeism from school. School absenteeism on the other hand in most cases may result in low performance in standardized score tests.

5. 3.2 Recommendations

i. In endemic areas Tungiasis should be demystified among health providers and communities to enable patients suffering from the disease to seek medical care from health facilities.

ii. At the same time all health care providers should made aware that Tungiasis is a disease that should not be left to the management of community health workers and teachers. The health providers should make an effort to also should provide treatment to Tungiasis patients as in all other diseases occurring in endemic areas.

iii. There is need to develop capacity to improve Tungiasis management by providing adequate training and infrastructure to community health workers and teachers in charge of health care and hygiene of children in schools to enable then focus on management and treatment of Tungiasis.
iv. It is also recommended that reliable data should be created by resources health personnel in health facilities, teacher in charge of health in schools and community health workers should be encouraged to keep formal records for all cases of Tungiasis diagnosed, treated, recovered, morbidity and mortality.
v. Finally, there should be continued and sustained research and surveillance on burden of disease caused by Tungiasis.

5.3.3 Suggestion for further studies

It is suggested that further studies can be carried out on:

i. Effect of effective intervention measures on school attendance among all the age groups.
ii. Influence of Tungiasis on other education activities among all the age groups.
iii. Longitudinal studies on Impact of chronic Tungiasis among children aged 5-14 years on their health and general wellbeing.
iv. Quantification of burden of disease caused by Tungiasis at national and global level among all the age groups using DALY metric.
v. Studies of other health states that require different methods to establish such as anemia which has been associated with Tungiasis.
vi. Systematic controlled studies assessing the impact of different community-based intervention measures.

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Appendices

Appendix 1; Questionnaire for the teachers
Please tick (√) in the appropriate space or fill in your short responses to all questions.

Name of the researcher………………………

Date…………….……. Sub-location……………………

Name of School……………………………

PART A: Prevalence of Tungiasis

1. **The total number of the children in the school is ………………….**
2. **Number of children aged 5-14 years who are suffering from Tungiasis (jigger infestation) per class?**

Class	Number of children in the class			Number of children suffering from Tungiasis			prevalence
	male	Female	Total	Male	Female	Total	
Pre primary							
Std I							
Std II							
Std III							
Std IV							
Std V							
Std VI							
Std VII							
Std VIII							

3. **Which diseases are common among the pupils?**

4. **How do you find out a pupil is suffering from Tungiasis?**

5. **Which symptoms do you observe among the children suffering from Tungiasis?**
6. **How many new cases of Tungiasis do you encounter per week?**

7. **What reason(s) can you give for the occurrence of the new incidences of jiggers among children?**

8. **How many children have died in this school for the last one year?**

9. **What were the causes of death?**

10. **Was the child(ren) who died suffering from Tungiasis?**

11. **How many people do you know who have died because of Tungiasis?**

Part B; School attendance

12. **How can you rate weekly attendance in your school?**
    a) 100-90% [ ] b). 80-90% [ ] c) 79-70% [ ]
    (d) 69-60% [ ] e).59-50% [ ] f) below 50% [ ]
13. **What reason(s) can you give for absenteeism?**

14. **If Tungiasis, why do the child miss school?**
15. **What measures do you put in place to reduce absenteeism caused by Tungiasis** (jigger infestations)?
16. **Describe absenteeism after the initiative to control Tungiasis?**
17. **How can you describe performance in tests among children who are suffering from Tungiasis?**
18. **How has the performance changed when the child started suffering from Tungiasis or after the child recovered from Tungiasis?**
19. **What reasons can you give for class repetition?**
20. **Which reasons can you give for school dropout in this school?**

21. **How many children aged 5-14 years dropped out of school in year 2014/2015 due to Tungiasis (jigger infestations)?**

Year	Male	Female
2014		
2015		

Appendix 2; Questionnaire for the parents
Please tick (√) in the appropriate space or fill in your short responses to all questions.

Name of the researcher………………………….……… Date ……………………… Sub-location……………………

A. Demographic Data

1. **How old are you (years)?** a) Below 30 [ ] b) 31-40 [ ] c) 41-50 [ ] d) 51 – 60 [ ] e) 61 and above [ ],
2. **Gender of the head of the household?** a) Female [ ] b) Male [ ]
3. **What is your marital status?** a) Married [ ] b) Single [ ] c) divorced [ ] d) widow [ ] e) widower [ ]
4. **How many children do you have (respondents own children)?**
5. **Number of other dependents?** a) 1-3 [ ] b) 4-6 [ ] c) 7-9 [ ] d) above 10 [ ]
6. **How many children are aged 5-14 years?**
7. **What is the main source of income for your family?**
   a) Formal employment [ ] b) casual [ ] c) self-employment [ ] (d) Funds for the elderly [ ] e) help from relative [ ] f)0ther (s) [ ]
8. **What is the average monthly income of the household?** A) Below Kshs.1,000 [ ]
   b) Kshs.1,000- 3,000[ ] c) Kshs. 4,000-6,000 [ ] d) Kshs.6, 000-10,000 [ ]
   e) Above Kshs. [ ]

PART B: Prevalence of Tungiasis

9. **How do you diagnose Tungiasis (jigger infestation) among children?**

10. Number of individuals suffering from Tungiasis per household?

Household	Age	Gender		Suffering from Tungiasis	Not suffering from Tungiasis
		male	Female		
Total No. of individuals present					
Number attending school aged 5-14 yrs					
School(s) attended					

Part C School attendance

11. How many children are attending preprimary and primary school?

12. What are the reasons that you can be given for cases of absenteeism among the children attending school?

13. Which reason(s) can you give for the absenteeism caused by Tungiasis?

14. How do absenteeism differ in the academic year, give the month and reason(s)?

15. What measures do you put in place to reduce absenteeism caused by Tungiasis?

16. If you have initiated measures to reduce absenteeism, which ones for control of Tungiasis?

17. How can you describe absenteeism after the initiative to control Tungiasis?

18. How many children aged 5-14 years dropped out of school in the year 2014 and 2015?

Year	Male	Female
2014		
2015		

19. Apart from school attendance which other child's activities are affected by Tungiasis?

20. What reason(s) can you give for the affected activity (s)

Appendix 3: Questionnaire for the children aged 5-14 years.
Administered by the researcher.

Age;

Gender;

Tungiasis status:

Duration lived with the disease:

	Experience	Explanation
A	Avoid playing with the other children	
B	Fail to attend school	
C	Feel pain	
D	Itching	
E	Lack sleep	
F	Limit physical contact with friends and family	
G	Avoid seeing doctors, even when you're sick from something unrelated to jiggers	

H	Stay indoors at all times	
I	Who helps you to treat Tungiasis	
J	How does the person help treat Tungiasis	
K	How do other children/teachers treat you	

Appendix 4; Physical Examination guide

Child's household	Age	Gender		Sequel(Kerh *et al.* 2007)	Duration with sequel	
		male	female			

Stages (1-penetrating *T. Penetrans,* 2—Red brown itching spot, 3---white area with central black area, 4 ----Black lesion with *T. Penetrans* dying) 5--- manipulated lesion.

Appendix 5; Questionnaire for health facilities

Please tick (√) in the appropriate space or fill in your short responses to all questions.

Name of the Researcher…………….…………….…..……..

Date ………….…….

Sub-location…………………………..…………………………………

Name of clinic / hospital …………………………………………………

PART A: Diagnosis and prevalence of Tungiasis

1. Which symptoms do you take into account when diagnosing Tungiasis among patients?

2. The total number of the patient in treated in the health facility per is day?
3. How many new cases of Tungiasis do you encounter per week?
4. What reason(s) can you give for the occurrence of the new incidences?
5. Prevalence of Tungiasis in this location (Tick the appropriate)

   a) 0 [ ] b). Below 10% [ ] 11-30% [ ] d) 40-50% [ ] e).51-100% [ ]
6. If the symptoms of the Tungiasis are ordered according to how often they occur, which ones are most prevalent?
7. What reason(s) that you can give for level of the prevalence in this area?

Part B: Disability due to Tungiasis

8. Which symptom(s) can be said to cause most suffering among patients aged 5-14 years?
9. How long do the patients take to recover from Tungiasis?
10. Which symptom (s) takes more than one week to cure, indicate recovery time against each symptom?
11. Which are the causes of death in this locality?
12. How often do Tungiasis cause death?
13. How many people have died due to Tungiasis related condition?

year	Male	Female
2014		
2015		

14. Which were these conditions?

15. Which other observations have you made among patients aged 5-14 years suffering from Tungiasis?

Appendix 6; Ethics consent form

Title: Impact of Tungiasis among school age children in Murang'a County.

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Introduction

I am a PhD student in the University of Nairobi. I was carrying out a research in Kandara Sub County. The purpose of the research is to understand impact Tungiasis (a disease resulting from jigger infestations) among children who are aged 5-14 years. The importance of this is to determine how Tungiasis is affecting children in terms of school attendance and burden caused by Tungiasis. The study was carried out by gathering information on Tungiasis among children. The information was collected using questionnaires, interviews and observation methods. The participants were selected from households sampled through systematic random sampling. The children aged recruited were followed to their schools to know how they attend school. Additional information on Tungiasis and resulting burden was sought from health officers and government officers in the area. The results from information gathered will help make conclusions and recommendations in policy making and management of the disease. These may assist in future to manage the disease, improve quality of life and school attendance. You have en recruited to participate in the study because this area is prone to Tungiasis. I request you to cooperate with me during the study and I respect your participation.

Objectives: to determine what are impacts on of Tungiasis among school age children. These impacts were measured in terms of ability to attend school and burden of disease caused by Tungiasis.

Benefits: The findings of this research have many indirect benefits to the children, schools and households in the area and other areas in which Tungiasis is prone. However, there is no monetary gain if you participate in the research. If you are suffering from Tungiasis you are requested to visit a health facility to see a health officer to help you and also get tetanus vaccination. The community health workers was informed about the disease status in your household and requested to help you put intervention measures into place.

Risks: the research was not exposing you to any harm before, during or after the study.

Voluntarism: Your participation in the study is voluntary and you can withdraw from the study at any time.

Confidentiality: All the information gathered from you was treated with privacy and for the purpose of this study as explained in introduction.

Study Procedure: Pretesting of data collection tools and selection of households through systematic random sampling was done during a preliminary study. The participants was recruited from selected the households. This was followed by data collection which was done through interviews, questionnaires, observation and desk review methods. The data collected was on Tungiasis, school attendance and burden of disease. The data collected was analyzed and interpreted from which conclusions and recommendations was made. Ethical issues was considered bebefore, during and after the research. This was done by seeking approval from relevant Kenyatta National Hospital-ethics and research committee and permit from National Council of Science and Technology. Also communication to the County government and local administration, seeking consent from participants and treating information with confidentiality.

Problems /questions: if you any questions about the study or the use of the results contact Principal investigator; Josephine Ngunjiri by calling 0723768653. Also if you have any questions regarding your rights as participants to contact Kenyatta National Hospital Ethics and Research Committee (KNH-ERSC) by calling (254-020)272630 Ext 44355.

I ……………………………………………..agree to participate in the above study. I confirm that I have read / en explained and understand the objectives of the study stated above and I have en given an opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason(s). I agree to the interview and consultation being audio recorded. I also agree to the interview and consultation being video recorded. I have also allowed children under my care aged 5-14 years to participate in the study.

Participant's Name …………………………………………………………

Signature…………………………………Date……………………………….

Witness for those whom cannot able to read and write

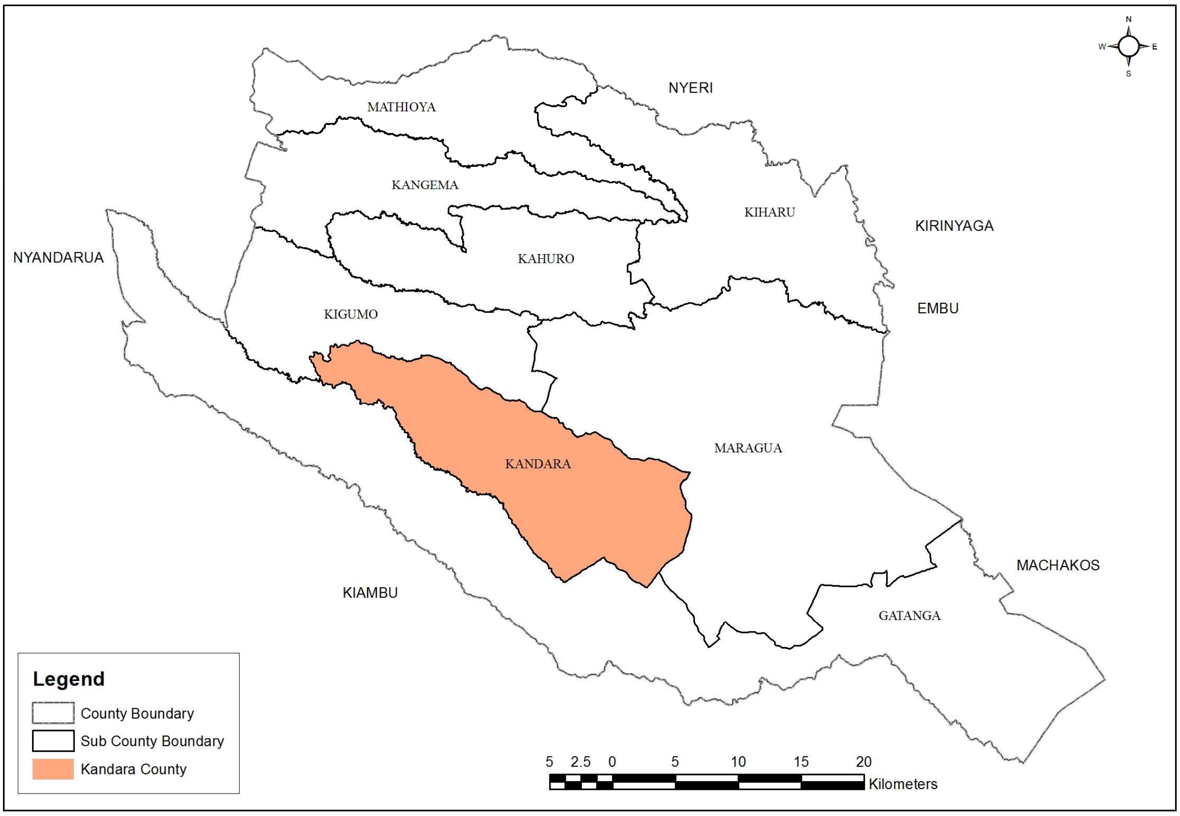
Witness's Name ……………………………………………………………

Signature…………………………………Date………………………………….

Researcher's Name ………………………………………………………….

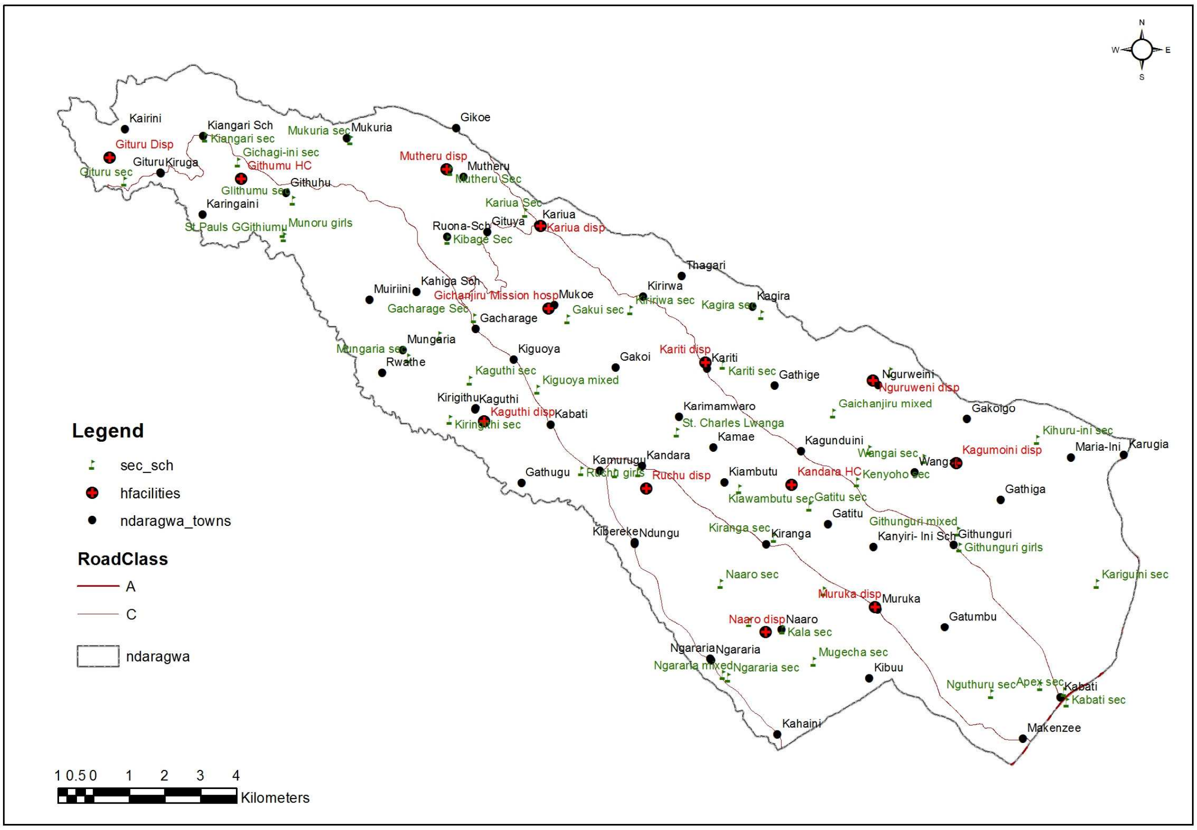
Signature…………………………………Date……………………………….

Appendix 7:Map of Kandara

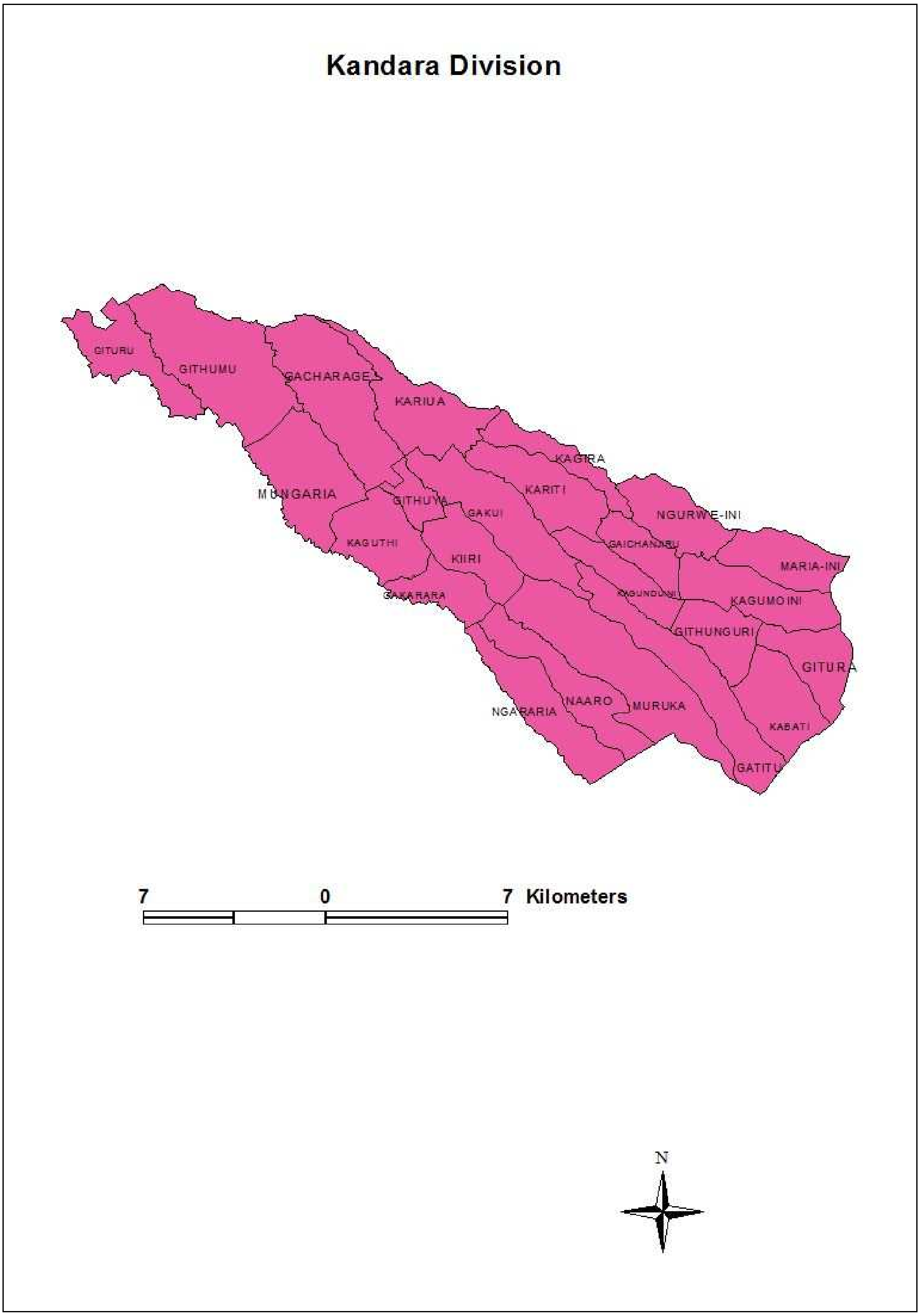


Source: Survey of Kenya 2011

Appendix 8: Health facilities in Kandara



Appendix 9: Distribution of clusters in Kandara Divisions.



Appendix 10: Primary schools sampled in Kandara sub county.

s/n	Name of the Primary school
1	Githumu
2	Kiawambutu
3	Mutitu
4	Karugu-ini
5	Matira-ini
6	Manjuu
7	Kihaaro
8	Rwathe
9	Gakui
10	Githunguri
11	Gituru
12	Karumu
13	Kawanjeru
14	Kariua
15	Kaguthi
16	Makindi
17	Gichagi-ini
18	Mahutia
19	Gaichanjiru
20	Mairungi
21	Nguthuru
22	Muruka