**PREVALENCE, DETERMINANTS AND ECONOMIC LOSSES DUE TO ECHINOCOCCOSIS IN CATTLE, SHEEP AND GOATS SLAUGHTERED IN WEBUYE ABATTOIR, BUNGOMA COUNTY, KENYA.**

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**A THESIS SUBMITTED TO SCHOOL OF PUBLIC HEALTH, DEPARTMENT OF EPIDEMIOLOGY AND BIOSTATISTICS IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH.**

**MOI UNIVERSITY.**

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# **DECLARATION**

**Declaration by the candidate:**

I hereby declare that this thesis is my original work and has not been submitted in any other University.

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

**Declaration by the Supervisors**

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

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# **DEDICATION**

This Thesis is dedicated to my late mother Phoebe Khasoa and my late father Harun Mupalia who together laid a firm academic foundation for me, which, throughout their early mentorship and guidance, led to my high academic achievements.

# **ABSTRACT**

**Title:** Prevalence, determinants and economic losses due to Echinococcosis in cattle, sheep and goats slaughtered in Webuye abattoir, Bungoma County, Kenya

**Background:** Cystic Echinococcosis is a neglected zoonosis, but is of great veterinary, Public health and economic importance. An account of Echinococcosis in cattle, sheep and goats slaughtered in Webuye abattoir, presence of roaming dogs in Webuye town, practices, minimal knowledge by people on Echinococcosis and economic loss from organ condemnation due to Echinococcosis justified carrying out the study.

**Objective:** To determine the prevalence, determinants and economic losses due to Echinococcosis in cattle, sheep and goats slaughtered at Webuye abattoir.

**Methods:** Study area was Webuye abattoir and Cross sectional study was used in March 15th to 15th April 2015. All cattle, sheep and goats slaughtered were inspected for the presence of Echinococcus cysts. Cysts encountered were recorded and further subjected to fertility and viability tests. A questionnaire whose purpose was to determine risk factors was administered to 15 butchers and 9 flayers. Percentages of Echinococcosis cases were calculated. Economic loss due to organ condemnation was calculated by taking the weight of individual organ and multiplying by its prevailing market value. Statistical package for Social Scientists version 20 and MS Excel were used in data analysis where frequencies and percentages were the outputs. Data was presented using tables, narratives, frequencies, percentages and charts.

**Results:** A total of 134 head of cattle, 126 sheep and 49 goats were slaughtered and inspected. Hydatid cysts were detected in 31 (23.1%) cattle, 4 (3.2%) sheep and none in goats. A total of 111, 9 and 0 cysts were detected in cattle, sheep and goats respectively. In cattle 89 cysts were fertile and 38 were viable. In sheep 9 cysts were fertile and viable, that indicates risk of transmission. On risk factors, 29.5% of respondents fed dogs on condemned offal, 33% did not confine their dogs, and 37.5% did not deworm their dogs and 54% admitted that no inspection was carried out to meat of livestock slaughtered at home. The total annual economic loss from organs condemnation was estimated to be Ksh. 195, 300 (1,884.2 US Dollars). That was substantial amount.

**Conclusion:** Prevalence of Echinococcosis in cattle was moderate and low in sheep. Public knowledge on Echinococcosis and its control was low. Annual Economic loss from organ condemnation was substantial.

**Recommendation:** Based on these study findings, abattoir public health measures should be tightened. Regular Public health education awareness programs on Echinococcosis and its control should be conducted. Further research is needed to assess the prevalence of Echinococcosis in humans.

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# **LIST OF ABBREVIATIONS AND ACRONYMS**

AE Alveolar echinococcosis

AMREF African medical research foundation

CE Cystic echinococcosis

DALYs Disability adjusted life years

DDO District development officer

G.O.K Government of Kenya

IREC Institutional Research and Ethics Committee

Ksh Kenyan shillings

Kg Kilogram

MI Meat inspector

MTRH Moi Teaching and Referral Hospital

PE Polycystic echinococcosis

S/NO Serial number

SPP Species

WHO World Health Organization

IEBC Independent electoral and boundary commission

OIE Office of International des Epizootics

**OPERATIONAL DEFINITION OF TERMS USED**

**Echinococcosis/ Hydatid disease/ Hydatidosis or Echinococcal disease** – Is a parasitic disease of tapeworms of the Echinococcus species.

**Alveolar Echinococcosis**- Is a parasitic disease caused by *Echinococcus multilocularis*

**Polycystic Echinococcosis-** Is a parasitic disease caused by *Echinococcus vogeli* and *Echinococcus* *Oligarthrus*

**Cystic Echinococcosis** - Is a parasitic disease caused by *Echinococcus granulosus*

**Protoscolesces** – Juvenile scolesces formed from the germinal layer of a hydatid metacestode.

**Zoonoses** – Diseases that are transmitted naturally between vertebrate animals and human.

**Fertile cysts** – Cysts that harbor protoscolesces.

**Viable cysts**- Cysts whose protoscolesces are alive and able perpetuate the life cycle

**Calcified cysts** – Cysts whose protoscolesces has died and dried.

# **CHAPTER ONE: INTRODUCTION**

## **1.1 Background Information**

Echinococcosis is a major public health concern, particularly in developing regions with limited economic resources. Furthermore, there are indications of an increasing number of cases in certain areas like Bulgaria, Kazakhstan and the people’s republic of China, so it is becoming an emerging or re-emerging disease (Torgerson *et al*., 2011).

Despite these challenges World Health Organization has classified Echinococcosis among neglected zoonoses (WHO., 2018).

Echinococcosis is of Veterinary, public Health as well as economic importance. The economic loss due to its infestation is measured in terms of lowered milk, meat and wool production in addition to condemnation of infested organs (Koskei *et al*., 2011).

*Echinococcus spp*. are found throughout the world, although some species have restrictive distributions. There are four species of this tapeworm, namely *E. granulosus*, *E. multilocularis*, *E. vogeli* and *E. oligarthrus*. *E. granulosus* is the most prevalent of the four species and can be found in Africa, Europe, Asia, the Middle East, Central and South America. *E. multilocularis* is rare and only found in northern latitudes including Europe, Asia and North America. *E. multilocularis* is endemic in foxes in large areas over the northern hemisphere where rodents act as intermediate hosts (Eckert *et al*., 2017).

In humans the larval stage of *E. multilocularis* causes alveolar echinococcosis (AE), a space-occupying lesion, which is lethal if untreated. *E. vogeli* is confined to central and South America. Infection with *E. vogeli* and *E. oligarthrus* are usually known as Polycystic Echinococcosis (PE). Infestation with *E. granulosus*, which is the most common species, leads to cystic Echinococcosis (CE) (Mohammad *et al*., 2011).

A minimum of 11 strains denoted G1 to G10 and a “lion” strain, *E. felidis* have been recognized globally (Eckert *et al.,* 2017). G1 is the common sheep strain and is cosmopolitan. G2 is the Tasmanian sheep strain. G4 strain has been found not to be zoonotic; G5 is known to be a cattle strain while G6 is a camel strain. G7 has been recovered mostly in pigs. G9 strain has been reported only from Poland. The G8 and G10 strains have been reported in North America, mainly in Canada and Northern US States as well as in Europe and Asia. *E. felidis*, the “lion strain”, is thought to occur only in Africa (Eckert *et al*., 2017).

Cystic Echinococcosis is a widespread chronic zoonosis, and domestic dogs have long been identified as the main source of infection to livestock and humans (Budke *et al*., 2010). Dogs acquire *E. granulosus* larvae through the ingestion of viscera and other tissues from infested intermediate hosts. Factors facilitating the contact of dogs with raw offal are potential determinants for canine infestation (Eckert *et al*., 2017).

Dogs from a semi-nomadic pastoral community show a higher infection levels in winter when higher numbers of livestock are slaughtered for the winter provisions (Eckert *et al*., 2017).

Roaming dogs together with their pastoral owners has been identified to be a determinant for *E. granulosus* infection since such dogs has higher contact with livestock, which can be seen as a proxy for scavenging on infested carcasses (Mutwiri *et al*., 2013). The risk of *E. granulosus* infestation in dogs is commonly higher in rural areas (Mutwiri *et al*., 2013).

High infestation rates have also been recorded in dogs from the borders of urban areas and the continuation of the practice of home slaughtering in the periphery of some cities might explain these findings (Adediran *et al*., 2014).

Dogs that are allowed to roam freely or stray dogs have been identified as presenting higher risk as they have increased chance of finding and ingesting on offal of cadavers (Inangolet *et al*., 2010). Dogs that are confined including guard-dogs or household pets commonly have lower infestation rates. This may be due to the fact that such dogs are fed on cooked food that is unlikely to contain viable hydatid cysts (Buishi *et al*., 2016).

Differences in relative infection rates among dogs that are allowed to roam and household pets may also be explained by the fact that dogs which are allowed to roam freely are unlikely to be given regular anthelmintic treatment as compared to pet or guard dogs (Buishi *et al*., 2016). Wild carnivores including jackals, hyenas and foxes are definitive hosts for E. granulosus. (Buishi *et al*., 2013).

Intermediate hosts are cattle, sheep and goats. Other domestic animals that serve as intermediate hosts include horses, pigs and camels (Buishi *et al*., 2013).

In North America for example, Echinococcus species have been recovered in elk, Caribou, and various species of red deer (Massolo *et al*., 2014). In Australia Echinococcosis has been reported in the native mammals such as kangaroos and wallabies (Keong *et al*., 2017). In Africa herbivores such as giraffes, warthogs, impalas and many others have been recorded to be susceptible to Echinococcus species (WHO., 2014).

Man is infested by ingestion of tape worm eggs in contaminated water, soil, food such as vegetable salad (Wang *et al*., 2014).

The practice of feeding the viscera of slaughtered animals to dogs in endemic areas is responsible for the high incidence and spread of the *E. granulosus*. (Vuitton *et* *al*., 2018).

Hygiene practice of hand washing after handling dogs, stringent meat inspection and avoiding feeding dogs on cystic animal organs can greatly reduce the life cycle of echinococcosis (CDC., 2017).

A thorough epidemiological data is needed in order to design an effective and a practical control program of hydatidosis. This study therefore sought to determine the prevalence, determinants and economic loss due to hydatidosis in cattle, sheep and goats presented for slaughter at Webuye abattoir, Webuye East Sub County of Bungoma County.

## **1.2 Statement of the Problem**

Hydatidosis is one of the zoonotic diseases that is considered neglected, but is of great public health concern, affecting domestic animals and people world over (WHO., 2018).

Currently there are an increasing number of Hydatid cysts in animals slaughtered in Webuye East Sub County. This leads to condemnation of the infested organs. In this Sub County dog owners do not confine their dogs neither do they deworm them regularly. This is evident by the presence of increasing number of roaming dogs seen at the dump sites and near abattoirs. In 2010 veterinary department conducted a dog baiting exercise and a total of 23 dogs and one cat were netted. Livestock owners practice free range grazing system where pasture is more likely to be contaminated with dogs’ feces. Communities in Webuye East Sub County slaughter livestock at home during ceremonies and the meat is rarely inspected by qualified personnel. Also people in this Sub County have minimal knowledge regarding Echinococcosis disease. Meat inspectors have more than one abattoir to which they inspect meat and supervise disposal of condemned organs. Records at Webuye District Hospital show that one man was suspected to harbor Hydatid cyst in 1998 and was referred to Kakamega Provincial general Hospital for confirmatory diagnosis and further management.

Ideally dogs are supposed to be confined within owner’s compound and be well fed so that they don’t roam around. They should also be dewormed regularly, at least after every three months as per veterinary guidelines. Livestock owners should practice zero grazing system and ovoid grazing on open fields where pasture is more likely to be contaminated with dog feces. People should also be equipped with knowledge on Echinococcosis so that they are made aware of its transmission modes. Ideally each abattoir should be manned by one or more meat inspectors to improve on efficiency and supervise disposal of condemned organs. Livestock that are slaughtered at home should have their carcasses inspected by qualified personnel.

If disposal of condemned cystic organs at abattoirs is not well supervised by meat inspectors and such organs getting their way out of the abattoir illegally and then fed to dogs, then life cycle of Echinococcus will be sustained. If dogs are not confined and also not dewormed regularly, they will contaminate pasture and vegetable fields with Echinococcus eggs by defecating on them. Man and livestock will be infested by ingestion of those eggs through contaminated vegetable salad and pasture respectively, and this is of great public health concern. If man is infested with Echinococcosis, it will lead to negative impact on health. In animals there will be economic loss due to condemnation of infested organs. Highly nutritive organs will be condemned leading to loss of proteins that compromises on food security.

## **1.3 Justification**

Echinococcosis is a neglected zoonotic disease that presents enormous economic and health problems to animals and man (WHO., 2018). Prevalence of Echinococcosis in livestock seems to be on the increase within the last few years (Mbaya *et al*., 2014).

No known study on Echinococcosis has been carried out in Webuye East Sub County. This formed the basis for carrying out the study in the area.

Echinococcosis is endemic in Turkana, West Pokot and Marakwet Counties (Solomon *et al*., 2017). These counties are the main exporters of livestock into Webuye east Sub County as evident by accompanying movement permits held in Webuye east sub county veterinary office. Cases of Echinococcosis are increasing among animals slaughtered in Webuye due to imports from the above Counties (Veterinary annual report for the year 2016, Webuye East, Compiled by Wandabwa). Being a zoonotic disease, spread in Webuye from those Counties may equally affect man leading to an increase in Hydatid disease burden. This is of public health importance. So far no confirmed human case has been recorded in Webuye East apart from one suspected case at Webuye District Hospital in 1998, according to medical records at the Hospital.

In Webuye East, domestic animals are at a high risk of being infested by hydatid cyst by virtue of having minimal meat inspection carried out during home slaughter, poorly supervised disposal of condemned cystic organs at meat inspection, presence of stray dogs, minimal knowledge by dog owners to confine and deworm their dogs regularly and free range grazing systems practiced by livestock farmers (Veterinary annual report for the year 2016, Webuye East Sub County).

Hydatid cyst infested offal are condemned during meat inspection and this leads to loss of protein and income (Veterinary annual report for the year 2016, Webuye East Sub County). This compromises on food security status in the Sub County.

The purpose of this study was to determine the prevalence of hydatid cyst in cattle, sheep and goats slaughtered at Webuye Municipal abattoir in Webuye east Sub County, evaluate determinants which contributes to its transmission in animals and subsequently assess economic loss due to organ condemnation. Result from this study will assist in prioritizing the need for control and preventive measures of livestock Echinococcosis.

## **1.4. Research questions**

1. What is the prevalence of Hydatid cysts in cattle, sheep and goats?

2. What are the factors contributing to the transmission of Echinococcosis in cattle, sheep and goats?

3. What are the economic losses associated with organ condemnation resulting from Echinococcosis?

## **1.5 OBJECTIVES**

## **1.5.1: Broad objective:**

To determine the prevalence, determinants and economic losses due to Echinococcosis in cattle, sheep and goats slaughtered in Webuye abattoir.

## **1.5.1.1: Specific Objectives**

1. To determine the prevalence of hydatid cysts in offal of Cattle, Sheep and Goats.
2. To determine the risk factors contributing to the transmission of Echinococcosis to cattle, sheep and goats, using a questionnaire as a tool.
3. To determine the annual economic losses associated with organ condemnation due to hydatid cysts.

# **CHAPTER TWO: LITERATURE REVIEW**

## **2.1. Hydatidosis as a Zoonotic Condition**

Echinococcosis is a zoonotic disease that is of great public health importance and is found in many parts of the world, especially in sheep and cattle rearing areas (OIE., 2018). The burden of endemic neglected zoonoses falls heavily on rural settings with limited resources (Shyamapada *et al*., 2012). Livestock-rearing communities with subsistence-farming practices are high-risk areas for acquiring Echinococcosis (Torgerson *et al*., 2010). Echinococcosis infestation constitutes a significant financial constraint derived from human healthcare costs and livestock production losses (Timketa *et al*., 2012).

The global burden of CE and AE has been calculated to be of approximately 1 million and 600,000 DALYs (Disability Adjusted Life Years) respectively (Budke *et al*., 2010, Torgerson *et al*., 2017). In addition the economic burden of CE on the global livestock industry has been estimated at over $2 billion per annum (Budke *et al*., 2010). Despite this substantial socioeconomic impact, CE and AE remain neglected zoonoses (WHO., 2018). Echinococcosis disease due *E. granulosus* is classified as cystic Echinococcosis (CE) (Jacquier *et al*., 2018).

*E. granulosus* is commonly seen in great grazing regions of the world, which includes Mediterranean region, Africa, South America, the Middle East, Australia and New Zealand. CE causes harmful, slowly enlarging cysts in the affected body organs that grow un- noticed and neglected for years. Most cases occur where livestock and dogs are raised together (Shymapada *et al*., 2012).

In East Africa several species/ strains are known to occur in livestock and humans, but host preference, relative frequencies and spatial distribution is poorly known (Addy *et al*., 2012). A study conducted in Modjolume Export slaughter house in Ethiopia in 2008- 2009, results showed the prevalence of hydatid cyst in sheep and goats to be 7.7 % and 6.13 % respectively (Fromsa *et al*., 2011).

In a study by Koskei *et al*., (2011) in some selected sites in Ethiopia, results showed high prevalence of *E. granulosus* in cattle, sheep, goats and dog. In southern Sudan a study was carried out to find out the distribution of cystic Echinococcosis (CE) among Mundary tribe members and results showed a high prevalence of CE (Bames *et al.,* 2017). In Tanzania, Uganda and South Africa several similar studies have been carried out for prevalence of CE in domestic animals (Luke *et al*., 2012, Benjamin *et al*., 2013 and Erick *et al*., 2013).

Kenya has the highest reported incidence of human hydatid disease in the world (WHO.,2014). In domestic animals, up to about 50.4% of cattle, 34.3% of goats, 48.8% of sheep and 2.4% of pigs harbor the infection as reported by Ndirangu *et al*., (2004). The causative agent of Echinococcosis in Kenya is *E. granulosus* and a complex strain picture of this parasite has been postulated to occur. The domestic dog is the main definitive host of *E. granulosus* in Kenya but infection in wild carnivores has also been reported. Hydatid cysts have also been found in wild herbivores (Mbaya *et al*., 2014).

In Kenya, studies have been carried out in animals but majorly concentrated in pastoral region of the country, especially Maasailand and Turkana region of North West Kenya (Mbaya *et al*., 2014). The reason could be due to social cultural interaction between people, dogs and other domestic animals kept by these communities.

## **2.2 Life Cycle and transmission of Echinococcus granulosus**

Although the domestic cycle has been shown to be the most important mode of transmission of the Echinococcosis, a sylvatic cycle is also known to exist (CDC., 2017).

Understanding of the etiological agents of diseases demands appreciation of the life cycle of the agent and their transmission modes. Comprehensive understanding of these two cycles is crucial in the diagnosis, control and treatment of the parasite and the disease they cause. Studying the life cycle of parasites that present in different forms of manifestation in different classes of hosts and whose life cycles are enhanced by transmission cycle is of scientific importance (WHO., 2016).

*Echinococcus spp*. is perpetuated in a life-cycle requiring two groups of mammals of predator-prey relationship to complete a cycle as shown in Figure 2.1 (inner cycle)(Arsalan., 2015).

Carnivores such as the domestic dog serve as definitive hosts that harbor the hermaphroditic adult in the proximal part of the small intestine, (stage 1 of outer cycle in (Figure 2.1), while herbivorous and omnivorous animals play the intermediate host role. The definitive host pass on the parasites to the intermediate host by releasing, through their feces, gravid proglottids containing embryonated eggs (stage 2), into the environment. Intermediate hosts such as livestock get infected with the released eggs via oral route during grazing, watering or accidentally as in human (aberrant host) when living in close contact with the definite host. After ingestion by a suitable intermediate host, the eggs hatches in the intestine and releases oncospheres that gets attached to the intestinal mucosa (stage 3). The oncospheres penetrates the intestinal wall and enters the portal blood/lymph where they are transported passively throughout the body to major filtering organs mainly, liver and/or lungs. Many body organs become predilection sites. They include (70%) in liver, 20% get to the lungs and10% to other body organs (Ulular., 2012).

After localizing in an organ, the parasite develops into larval hydatid cyst (stage 4) as unilocular fluid-filled bladder (Zhang *et al.,* 2011).

These consist of two parasite-derived layers; an inner nucleated multi-potential germinal layer and an outer acellular laminated layer surrounded by a host-produced fibrous capsule. The hydatid cyst at this stage may contain numerous tiny tapeworm heads (called protoscolesces) or brood capsules filling the cyst interior. Brood capsules and protoscolesces evaginate from the germinal membrane. They increase in number over time via asexual or clonal reproduction. In addition, daughter cysts of variable sizes are often detected within the mother cyst. The growth rate of cysts is highly variable and may depend on strain differences (Abdel-Azeem *et al*., 2018). However they all share the unique hermaphroditic and clonal reproduction systems (Casulli *et al*., 2012).

The larvae of *Echinococcus granulosus* enlarge in size in connection with the asexual reproduction of scolices in the bladder-like cyst. Despite the primary infection route, a secondary Echinococcosis can occur within an intermediate host. Secondary infection is caused by spontaneous trauma or during medical interventions where the larval tissue proliferates after being spread from the primary site of the metacestode (Arsalan., 2015).

The life cycle is completed when infected intermediate hosts are ingested by definitive host(s). The ingested scolices (stage 5 and 6) attach to the intestinal mucosa and develop into egg-producing adult tapeworms consisting of a chain of proglottids with genital organs (Arsalan., 2015).

Proglottids and/or eggs released from the adult worm initiate new life and transmission cycles (Siracusano *et al*., 2012).



Figure 2.1: Life cycle and cycle of transmission of Echinococcus species. Source: www.dpd.cdc.gov/dpdx [Last updated: 20.07.2009] [Date accessed: 19.03.2015]

1. Adult Echinococcus in small intestine of dogs
2. Embryonated eggs in feces of dogs eaten by intermediate host that includes man as aberrant (dead end host)
3. Oncospheres hatches in intestines of intermediate host and penetrates intestinal wall
4. Hydatid cysts form in liver, lungs etc. of intermediate host
5. protoscolesces from hydatid cyst eaten by dogs

6. Scolex attaches to small intestines of dogs and develops to adult worm (1)

## **2.3 Epidemiology**

A sound understanding of the epidemiology of infection in animals is a key factor in limiting the transmission to humans. Controlling the parasitic infection in animals is crucial to reduce the incidence of human disease. The study of *Echinococcus* transmission in animal hosts draws heavily on statistical and epidemiological models. Modeling enhances our epidemiological understanding of parasite transmission allowing predictions to be made and thus, the evaluation of potential control strategies in a cost-effective way (Graig *et al*., 2017).

The World Health Organization has recently included human Echinococcosis within the group of neglected tropical diseases, and recommends a veterinary public health strategy as part of an effective control approach (WHO., 2014).

*Echinococcus granulosus* is present virtually worldwide since there are very few countries, such as Iceland and Greenland, which are considered to be completely free o f *Echinococcus granulosus* (Macpherson *et al*., 2013). This global distribution is partly attributed to the fact that the parasite has the ability to adapt to a wide variety of domestic and wild intermediate and definitive hosts. This fact is very well demonstrated by a wide range of hosts affected by the parasite (Mbaya *et al*., 2014). Areas of the world with high incidence of *Echinococcus granulosus* coincide with rural, grazing areas where dogs are able to find and ingest organs from infected animals (Macpherson *et al*., 2013).

Worldwide prevalence of CE is 1-500/100,000 individuals and the incidence is 5-20/100,000 (WHO., 2018). Supervision of disposal of condemned animal organs due to CE is not well supervised by meat inspectors. A study carried out in Uganda, Kasese District found out that some infested cystic organs found their way out of public slaughter houses illegally (Luke *et al*., 2012).

Man becomes infected accidentally (Aberrant host), by ingestion of contaminated water, soil, and food. Eggs released by infected dog can end up in its fur and man gets infected by petting, handling or playing with such dog (Addy *et al*., 2012).

The percentage of dogs infested with *Echinococcus granulosus* is 6% in Melbourne and 63% in Kenya. Turkana, a remote area of north- west Kenya has the highest incidence of hydatidosis in the world. In this tribe of about 200,000 people, approximately 200-300 new cases of hydatid disease are reported each year (Macpherson *et al*., 2013). Data on prevalence and fertility of hydatid cysts in different domestic animal reservoirs are very necessary to be determined in surveys of Hydatidosis, because they provide reliable indicators of the importance of each type of animal as a potential source of infection to dog. Fertile cyst is one that contains protoscolesces. Unfertile cyst is one that contains no protoscolesces as well as one that is suppurative or calcified. Viable protoscolesces are responsible for infecting definitive host when ingested (Auther *et al*., 2011).

A survey conducted in Iran for prevalence of hydatid cyst among domestic animals did not record hydatid cyst of goats. This was attributed to the fact that goats mainly feed by browsing, rather than grazing, and thus showed lower level of infection (Dalimi *et al*., 2010). Studies in other regions have also reported less prevalence of Echinococcosis in goats compared to the prevalence in cattle and sheep (Ibrahim., 2010).

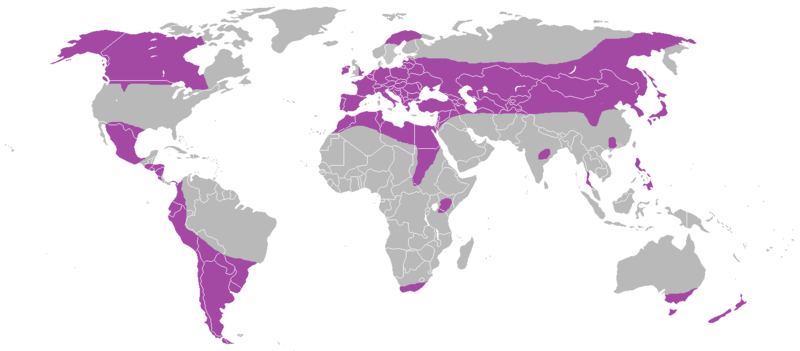


Figure 2.2: World distribution of Echinococcus granulosus (purple color)

## 

## **2.3.1: Risk Factors for cystic Echinococcosis**

It is important that risk factors be understood properly, especially in endemic areas and appropriate measures taken to reduce transmission to domestic animals and human.

The risk factors that contribute to hydatid transmission to domestic animals include: Feeding dogs with raw offal, allowing dogs to roam, lack of knowledge by dog owners to deworm their pets regularly. These are the cultural and economic factors that contribute to infection in dogs. Free range as well as road side grazing of livestock where pasture and animal watering points are likely to be contaminated with dogs’ feces is a risk factor for infection in livestock (Cadavid *et al*., 2016).

Poor supervision of condemned cystic organs at meat inspection will also enhance life cycle of the disease (Mbaya *et al*., 2014).

The gender of the intermediate host has also been identified as a possible determinant of CE infection. In a large slaughterhouse survey in Saudi Arabia, females were found significantly more likely to be infested than males (Ibrahim., 2010).

Females were reported by Elmajdoub *et al* (2015) as showing a higher prevalence than males in Eastern Libya. Contrarily, a study carried out in Ethiopia revealed that small male ruminants were significantly more susceptible to infestation compared to the females (Erbeto *et al*., 2010). The age of the host has also been recognized as an infection determinant for many farm species. Numerous studies have recorded higher hydatidosis prevalence in old animals compared to young ones (Yang *et al*., 2016).

Small ruminants (sheep and goats) equal or older than 3 years old were also found to be 1.6 times more at risk compared to the younger groups (Marshet *et al*., 2011). Additionally, an increase of cyst load has been recorded in older age groups of farm animals (Ibrahim., 2010). Experimental studies have suggested that parasite survival may be longer in females due to the potential linkage between reproductive hormones and the response of the host’s immune system as reported by Romano *et al*., (2015).

An alternative explanation may be that females are slaughtered at older age as they are retained on the farm for reproductive and production purposes (Ibrahim., 2010). Increased life expectancy also increases the chance of exposure and infection with *E. granulosus*. As such higher prevalence is usually found in older animals (Amer *et al*., 2015).

Multiple studies have found that *E. granulosus* prevalence and/or abundance are higher in young dogs compared to adults (Amer *et al*., 2015). This supports the hypothesis that protective immune responses increase with the age of the host as reported by Romano *et al*., (2015). Changes in infection pressure due to behavioral differences related to dog's age is a factor to consider (Togerson *et al*., 2011). Prevalence studies have observed higher numbers of infected male dogs compared to females (Acosta *et al*., 2010). A plausible reason might be that male dogs tend to break away from the pack and explore larger areas than females, due to their tendency towards territorial behavior and to go hunting (Budke *et al*., 2010).

Human behavior has also been recognized as playing a key role in the perpetuation of Echinococcosis transmission (WHO., 2014). This behavior is closely related to human cultural and economic backgrounds (WHO., 2014). Studies have reported dog owners' ethnicity as being related with canine infection rates, also found a higher number of dogs per owner, lower levels of education and lower standards of animal care as a determinant of EC transmission. Thus, this variable, ethnicity, may act as a confounder for other risk practices (Otero - Abad *et al*., 2013). Changes in agricultural practices following the collapse of the Soviet Union may partly explain the increase in Echinococcosis in Central Asia (Torgerson *et al*., 2017). The social and economic changes brought after the collapse of socialist administration, such as the return to small private farms, the proliferation of the clandestine slaughter or the lack of anthelmintic dog treatment, are associated with a substantial increase in echinococcosis (Shaikenov *et al*., 2013).

Environmental temperature and humidity are risk factors for livestock infection (Torgerson *et al*., 2017). Low temperatures and high rainfall allows for longer viability of eggs in the environment and this ensures the perpetuation of the parasite life cycle. Several studies have reported higher levels of CE in domestic livestock in areas presenting these environmental conditions when compared with warmer and drier sites (Ibrahim., 2010).

Species difference is also responsible for varied infection rate among susceptible hosts. Sheep frequently present the highest infection rate, (Almalki *et al*., 2017). As such they are often the most important intermediate hosts for *E. granulosus* (Yang *et al*., 2016). Cattle and camels are normally sent to the abattoir at an older age than other ruminants, and hence have an increased probability of exposure to *E. granulosus'* eggs during their lifetime (Torgerson *et al*., 2011).

Goats show lower infection rates, possibly because they are browsers and eat the most distal parts of plants where there are fewer Echinococcus eggs. Moreover, these eggs commonly have a greater exposure to hostile environmental conditions, and thus show a reduced infective capacity (Torgerson *et al*., 2011). The difference in prevalence between host species could also be as a result of the existence of different strains of *E. granulosus* morphologically and biochemically adapted to each farm species (Fromsa *et al*., 2011).

Human activities can play a critical role in the persistence of *E. granulosus* in farm species. Different management practices might be behind the infection differences showed between family and industrial pig farms (Yang *et al*., 2012). Family pigs are both raised on semi or total free range while industrial pigs are raised in total confinement and are fed solely on industrial feeds. Similarly, the local cattle breed presents a higher infection rates than the crossbreeds presumably because crossbreeds are frequently kept indoors whereas local breeds are pasture-grazing animals (Bekele *et al*., 2011).

A study carried out in Sardinia found out that the highest sheep prevalence was associated with farms whose owners admitted throwing the viscera into the trash/garbage and fed their dogs with offal (Varcasia *et al*., 2011). Some recommended measures to interrupt parasite transmission encompass controlled slaughtering of livestock and proper disposal of condemned cystic offal, regular treatment of dogs with praziquantel, vaccination of intermediate hosts and an improvement to the level of health education in poor rural livelihoods (WHO., 2018).

## **2.4 Diagnosis of Cystic Echinococcosis**

Correct diagnosis of a disease is a significant step in its treatment and/or control efforts. However, this depends on understanding of the etiological agent and the manifestation of the disease. Complex epidemiology of some disease conditions is a challenge that has befallen the effort to control diseases in animals and human (OIE., 2016).

Diagnoses of CE in living definitive hosts involve purgation, immunodiagnostics as well as necropsy approaches (Stojkovic *et al.,* 2012). The definitive host (dog) can be purged with arecolinehydrobromide (parasympathomimetic drug) that induces purgation which carries the worm with the feces. There are two immunodiagnostic methods, namely; coproantigen which involves detection of parasite antigen in feces using enzyme-linked immunosorbent assay (ELISA) and serum antibody detection using *E. granulosus* antigen preparations in ELISA. These methods have variable sensitivity and specificity. However, detection of specific antigen(s) in fecal samples from definitive hosts has the advantage over serum antibody detection in the high probability of correlation with current infection (Brunetti *et al.,* 2012).

At necropsy, the main focus is the detection of the adult worm or the eggs in the proximal small intestine of the definitive host. For differential diagnosis the parasite is observed under microscope. It is about 2 mm-6 mm long, typically with 3 proglottids (up to 6). It has a genital pore usually posterior to the middle of the proglottids and a uterus with lateral sacculations. Alternatively DNA from small parasite materials obtained by the above methods can be amplified to molecularly differentiate the etiological agent (Amer *et al.,* 2015).

The diagnosis of CE in intermediate hosts has been based mainly on necropsy findings (WHO*.,* 2014). Ultrasound examination for cystic structures in organs may be used for the diagnosis in smaller animals, such as sheep and goats (WHO*.,* 2014). Immunological tests such as serum antibody detection and detection of circulating antigens for the diagnosis of *E. granulosus* metacestodes in animal intermediate hosts have been used. These diagnostic techniques are less sensitive and specific in animals than in human. Variation in the pathogenicity of strains/species of *Echinococcus* also influences the prognosis in animals (OIE2018).

To overcome the influence of strain and host animal factors on the diagnosis of cystic echinococcosis, recent approaches have been based on molecular analyses of genomic segments of the parasite (OIE., 2018).

## **2.5 Control of Cystic Echinococcosis**

Surveillance in animals is difficult because the infestation is asymptomatic in livestock, and is not recognized or prioritized by communities or local veterinary services (WHO., 2014). If the disease is controlled in animals, then transmission to man will significantly be lowered.

Control of Echinococcosis currently relies on the interruption of parasite transmission in animal hosts and, in consequence, a sound understanding of infection risk factors in animals can effectively assist the drawing of a prevention plan (Mateus *et al*., 2016).

Prevention and control of zoonoses such as Echinococcosis, Rabies, Tuberculosis, Brucellosis and Anthrax remain an area of major concern in most developing countries. Expenses related to prevention of zoonotic diseases are likely to increase dramatically in the near future and therefore, programs for their control and eventual eradication in animal reservoirs are highly desirable in these countries (WHO., 2014).

Control of CE in populations requires multiple strategies including chemotherapy, immunization, surgery (in humans) and population control of dogs, sanitation and education (Eckert *et al*., 2017). In most communities, control policies employ more than one strategy for maximal effect but the core has been chemotherapy (Samia *et al.,* 2011).

## **2.6 Economic Importance of Cystic Echinococcosis**

Global disease burden of CE in terms of disability adjusted life years (DALYs) of approximately one million in human compares favorably with other disease conditions such as Onchocerciasis and the Chagas disease and close to the African Trypanosomosis (Budke *et al*., 2010).

After infection of the intermediate host(s), resultant cysts develop slowly but gradually get bigger causing considerable pressure and pain at affected part(s) (Shyamapada., 2012).

In human, CE is manifested in systemic immunological reactions like urticaria, asthma, or anaphylaxis. Asymptomatic CE is quite common and may remain symptom-free for many years (Dakkak., 2010).

Effect of Echinococcosis in livestock is shown in retarded growth rate, weight loss, decreased milk and wool production and declined resistance to harsh environmental conditions and consequent loss in market value of infested animal (Torgeson *et al*., 2011).

Estimated global annual livestock production loss is estimated to be about US$ 2 billion. This high value stems from losses associated with carcasses and visceral condemnations, market value and reduced productivity. *Echinococcus* is known to infect all internal organs but with particular preference for liver and lungs (Varcasia *et al*., 2011).

An extreme case was reported of the parasite found in the eyeball of human patient in Turkana, Kenya (WHO., 2014).

Cystic Echinococcosis is considered an emerging/ re- emerging zoonotic disease in various regions including the Middle East, Central Asia, and Northern and Eastern Africa (Eckert *et al.,* 2017).

In these areas, CE in humans is a significant public health problem among pastoralists; the Turkana, Samburu and Maasai communities in Kenya are such examples.

Four decades ago French and Nelson., (1982) reported a prevalence of the disease in human in the Turkana district in Kenya as 220/100,000. It has been shown to be one of the places with highest incidences of CE in the world. Despite considerable management of the epidemic, hydatid disease has been persistent in this region (WHO., 2017).

The disease burden had not been the focus of most studies done in Kenya in the past but it is obvious from reported prevalence that infected populations could not evade the burden of the disease. Hydatidosis poses substantial human health problem and significant negative economic effect on the livestock sub- sector in some of the most socioeconomically fragile countries (Budke *et al.*, 2010).

## **2.7 Conceptual Framework**

The conceptual framework (Figure 2.2) illustrates the interplay among factors influencing transmission of echinococcosis in cattle, sheep and goats. The direction of the arrows shows factors influenced in each case. According to the model, farmers’ level factors (independent variable) influenced transmission of Echinococcosis to intermediate hosts (intervening variable) which eventually influences infestation in cattle sheep and goats (Dependent variable).

**Independent variables Intervening**

**variable Dependent variable**

|  |
| --- |
| Knowledge on Echinococcosis  -Recognition of Hydatid cyst  - condemnation of infested organs  - Reason for condemnation |

|  |
| --- |
| Practices enhancing transmission  - Improper disposal of condemned cystic organs  - Confining of dogs  - Deworming of dogs  - Grazing practices  - Meat inspection at home slaughter |

|  |
| --- |
| Proper disposal of hydatid cyst organs of cattle, sheep and goats |

|  |
| --- |
| - Infestation of cattle, sheep and goats with hydatid cysts |

|  |
| --- |
| Figure 2.3 Conceptual Framework |

# **CHAPTER THREE: 3.0 METHODOLOGY**

## **3.1 The Study Area**

The study was carried out at Webuye Municipal abattoir in Webuye East Sub County, Bungoma County. The Sub County is cosmopolitan and covers an area of 401.4 square kilometers. It has Webuye, Lugulu and Misikhu as the main towns and it lies at an altitude of 1370- 2000 meters above sea level with three (3) administrative wards namely, Maraka, Mihuu and Ndivisi as shown in the Sub the Sub County map (Figure 3.1). The Sub- County is one of the 9 Sub- Counties that form Bungoma County. It borders Bungoma North to the North, Lugari Sub- County to the East, Matete Sub- County to the South, Kanduyi to the South and Webuye West to the North West. The main land use activity is agriculture and the rural communities practice crop and livestock farming of which 65% of farmers keep indigenous breeds for milk and meat production.

Livestock kept includes, cattle, goats, sheep, pigs, dogs and chicken among others. Human population stood at 234,747 persons as projected by 1999 population census. Livestock population was 52,260 cattle, 11,325 sheep, 8,730 goats and355 pigs. Population of dogs had not been documented (Sambili., 2010). Licensed slaughter points were 9, with 8 being slaughter slabs and one abattoir, Webuye Municipal slaughter house. There were 15 butchers and 9 licensed flayers at Webuye Municipal abattoir (Veterinary monthly report for Webuye East, September., 2013).Tachonis and Bukusus are the dominant ethnic communities. These two communities carry out circumcision ceremonies in the month of August of every even year. Two bulls are usually slaughtered for every initiate. One bull comes from the uncle’s side and another one from the parents’ side. During the months of December of every odd year, houses of deceased male households are brought down, usually done at night. Usually an old cow is slaughtered in each case. In both ceremonies, the slaughtered animals’ meat is never inspected by a qualified personnel`. Old men from these communities usually ‘inspect’ the internal organs of the animal for any sign of bad omen. The slaughtered animals in this study were purchased from local and neighboring markets. Others were bought from individual farmers. Neighboring markets included Matete in Kakamega County, Kipkaren in Uasin Gishu County. Local markets were Webuye and Misikhu auction yard. The area was purposely selected because of many imports of animals from Echinococcus high risk areas of west Pokot and parts of Marakwet counties. This is evident from much organ condemnation of cystic organs reported by the veterinary department in the sub- County.

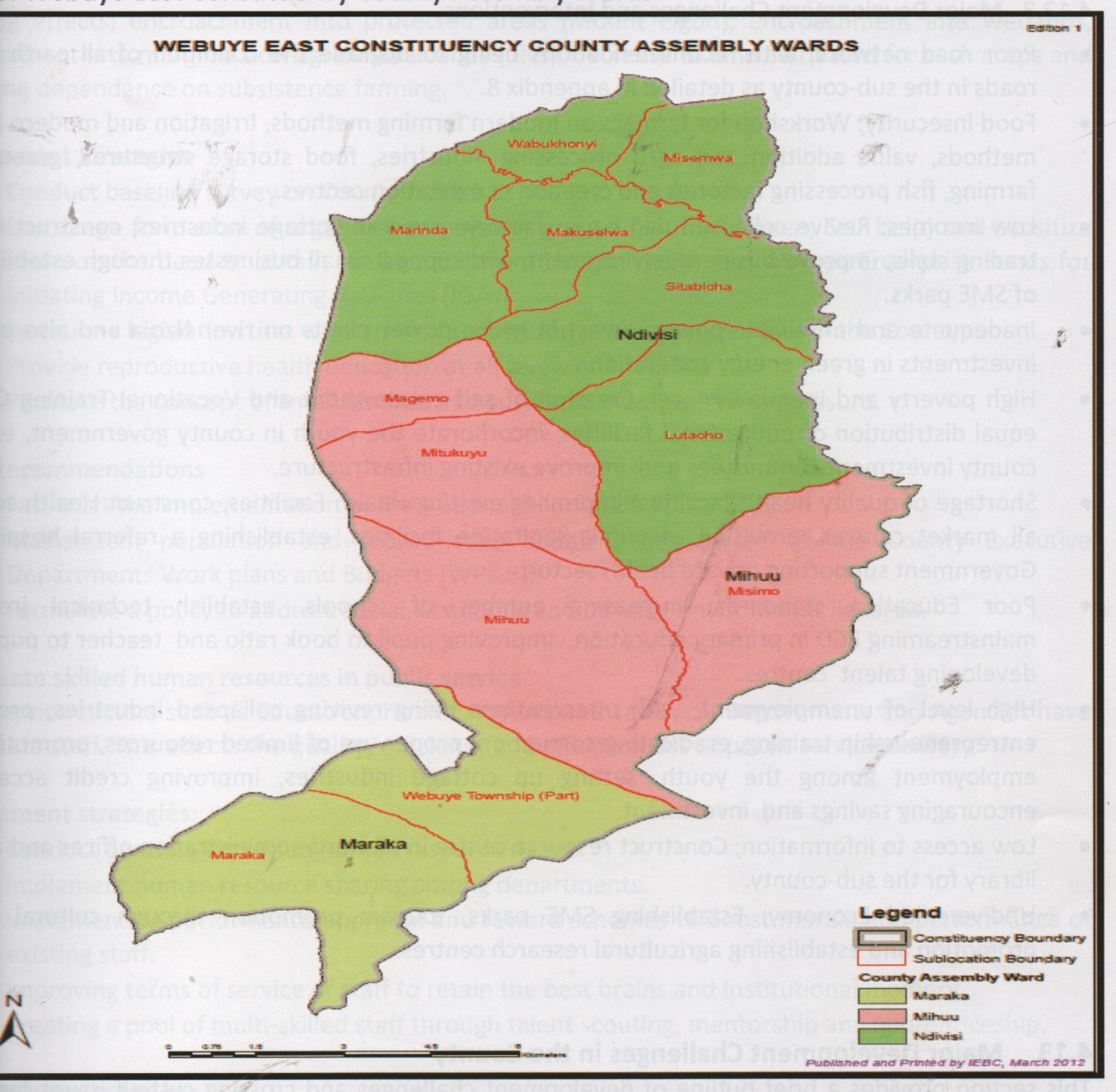


Figure 3.1: Webuye East Sub County Map that is part Bungoma County. The black triangle in Maraka ward as pointed by the arrow is where the Webuye Abattoir is situated.

Source: IEBC, March, 2012

## **3.2 Study Population**

All slaughtered and inspected carcasses of cattle, sheep and goats presented at Webuye abattoir during the study period from 15th March to 15th April 2015. All Butchers and flayers that operate at the abattoir also formed part of the study population. Webuye abattoir is the only facility that has higher slaughter figures in Webuye East Sub County. Other laughter facilities are gallantries with an average of one (1) animal slaughtered per day. For this reason Webuye abattoir was selected as a study site.

**3.3 Study Design**

Was a cross sectional study.

## **3.4 Sample size Determination.**

A census method was used in the study. All 15 butchers and 9 flayers, who operate at the abattoir, and 134 cattle, 126 sheep and 49 goats slaughtered and inspected at Webuye Municipal abattoir from 15th March 2015 to 15th April 2015 was used in the study as my samples.

**3.5 DATA COLLECTION**

## **3.5.1 Data collection tools**

My two assistant researchers administered the Questionnaire to the respondents (Appendix I). Questionnaire assisted to collect information on determinants that influence transmission of Echinococcosis to cattle, sheep and goats. The respondents were all 15 butchers and 9 flayers. The assistant researchers had worked at the Abattoir for more than ten years and were from the local community. They therefore helped to interpret questions that were not well understood and also helped those whose literacy level was low.

## **3.5.2 Pre- test**

The questionnaire was pre tested at Misikhu abattoir, Bungoma County. The pre test of questionnaire was carried out on 50% of the total questionnaires. The purpose of the pre test was to clarify any ambiguities, answers or any other related questions in the questionnaire. Comments from the respondents were used to revise questions that were not clear.

## **3.5.3 Data collection procedure**

The source of animals slaughtered was determined by the accompanying movement permits prior to slaughter and the animals were examined for age and sex. The age of the animals was estimated using their dental formulae as described by De Lahunta and Habel (1986). The age and sex of the animals was then recorded.

After animal slaughter, meat inspection was carried out by the researcher and two assistant researchers who were the veterinary public health officers at the abattoir. This was done by visual inspection, palpation and incisions where necessary of livers, spleen, lungs, hearts, and kidneys. Those whose organs were found to harbor Echinococcus cysts were recorded on a daily basis. The cysts of individual organ per species was counted and recorded daily. Individual cysts were grossly examined for evidence of degeneration or calcification. None calcified hydatid cysts were selected for fertility and viability tests. The surface of each cyst was sterilized with alcoholic iodine solution. The cyst wall was then penetrated using a large size needle, Gauge 14 of 1.5 inch long, and a cut given with scalpel and scissors. The contents were then transferred into sterile plastic containers clearly labeled for each animal species, its age, sex and the affected organ and transported to the laboratory at Compell Medical Centre in Webuye. The contents were examined microscopically for the presence of protoscolesces. Cysts which contained no protoscolesces were considered as unfertile cysts. Viability of the protoscolesces was assessed by observing motility of flame cells as well as the ease of staining with 0.1% aqueous eosin solution and examining under a light microscope as described by Smith and Barett (1980). Viable protoscolesces did not take the dye whereas the dead ones took the dye and stained red.

The weight of each infested organ was measured using electronic weighing scale, which assisted in calculating the economic loss due organ condemnation at the abattoir.

All 15 butchers and 9 flayers at the abattoir filled the questionnaire that sought to identify risk factors that contribute to transmission of Echinococcosis to cattle, sheep and goats. The two assistant researchers were people who had worked at the abattoir for a long time and therefore had an excellent knowledge of the respondents’ level of education and assisted those who could fill the questionnaire.

## **3.6 Data Management, Analysis and Presentation.**

Data collected was stored in a flash disk, external and internal hard drive. A password was created to protect the data from access by un- authorized persons. This ensured data privacy, security and integrity. Storage in these media enabled regular modification whenever need arose. Data was also stored as a hard copy for back- up measure incase storage in hard and flash disk was lost.

Data collected was processed by cleaning, coding, entry into the computer and then analyzed. Descriptive statistics was used to summarize the data where prevalence of Echinococcosis in individual host species was calculated. The questionnaire on risk factors associated with transmission of Hydatid cyst in domestic animals was processed using the statistical package for social scientists (SPSS) version 20 and excel. The package produced statistical parameters appropriate to the input information where frequencies and percentages were the main outputs. In some cases, Microsoft supplemented SPSS in data analysis when it was considered to work faster. In some cases simple calculators were used for simple calculations like additions and subtractions.

The resultant data was presented using tables, narratives, charts, frequencies and percentages.

## **3.7 Ethical Considerations**

The smooth running of this work required the consent of various authorities that included; Institutional Research and Ethics Committee (IREC) of Moi University, The county veterinary officer, Bungoma County. IREC approval for the study was sought. A consent letters from County Director of Veterinary Services was also sought to facilitate in taking statistics at the municipal slaughter house using his serving meat inspectors who were also my assistant researchers. A baraza was held at the abattoir to inform all butchers and flayers about the purpose of the research and seek their consent and voluntary participation without monetary gain.

# **CHAPTER FOUR**

# **4.0 RESULTS**

## **4.1 Introduction**

The study was conducted from 15th March 2015 to 15th April 2015.Questionnair return rate was 100%. A total of 134 heads of cattle, 126 sheep and 49 goats were slaughtered and examined for prevalence of Echinococcosis during the study period as shown in table 4.2. In cattle, 55 were male while 79 were female were inspected. In sheep, 53 males and 73 females were inspected. In goat, 21 male and 28 female carcasses were inspected (Table4. 2)

**Table 4.2: Inspected carcasses for each species, sex and source of origin of animals.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Source of origin | CATTLE | | SHEEP | | GOAT | |
|  | M | F | M | F | M | F |
| Matete market | 15 | 27 | 16 | 26 | - | - |
| Kipkaren market | 9 | 11 | 4 | 6 | - | - |
| Webuye market | 12 | 19 | 15 | 17 | 8 | 10 |
| Misikhu market | 9 | 11 | 9 | 17 | 5 | 6 |
| Individual farms | 10 | 11 | 9 | 6 | 8 | 12 |
| Total per sex | 55 | 79 | 53 | 73 | 21 | 28 |
| TOTAL | 134 | | 126 | | 49 | |

## **4.2 Number and age (range, mean, mode and median) of animals examined.**

The age of male cattle slaughtered ranged between 2- 10 years and their total number was 55. Females’ age ranged between 2-13 years and they were 79 in number. Mean and mode for both sexes was 6 years. Median for both sexes was 6 years. The age of females ranged higher than males. Sheep and goats presented for slaughter aged between 2 and 4 years. (Table 4.3)

**Table 4.3: Number, Sex and Age of Livestock Species inspected at Webuye Abattoir.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Livestock Species | Sex (number) | Age (Years) | | | |
|  |  | Range | Mean | Mode | Median |
| Cattle ( n= 134) | M (55)  F (79) | 2-10  2-13 | 6.25  6.5 | 6  6 | 6  6 |
| Sheep (n= 126) | M (53)  F (73) | 2-4  2-4 | 3.5  2.5 | 3  2 | 3  2 |
| Goats (n=49) | M (21)  F (28) | 2-4  2-4 | 2.3  2.4 | 2  2 | 2  2 |

## **4.3 Prevalence of Echinococcosis in cattle, sheep and goats inspected during the study period.**

### **4.3.1 Overall prevalence.**

Overall prevalence of hydatid cyst in cattle was 31 out of 134 (23.1%) carcasses, 4 out of 126 (3.2%) sheep slaughtered harbored hydatid cysts as shown in table 4.4. Out of the 31 cattle carcasses infested with hydatid cysts, 7 (5.2%) came from Kipkaren, 11 (8.2%) from Matete, 7 (5.2%) from Misikhu 5 (3.7%) from Webuye market and 1 from an individual farm in Webuye East. Of those sheep that harbored hydatid cysts, 3 (2.3%) were obtained from Misikhu market and 1(0.8%) from Webuye market. While goats presented at the abattoir harbored no hydatid cysts.

In cattle, liver, lung, spleen, kidney, mixed infestation of liver and lungs were echinococcus cyst predilection sites in sheep it was liver and lung that were infested (table 4.4).

**Table 4. 4: Overall prevalence of echinococcosis in cattle, sheep, goats and the affected organs.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ORGANS INSPECTED | SPECIES | | | | | |
|  | CATTLE (n = 134) | | SHEEP (n = 126) | | GOATS n = 49) | |
|  | Males | Females | Males | Females | Males | Females |
| Liver | 3(9.7%) | 7(22.6%) | 1(25%) | 2(50%) | - | - |
| Lung | 2(6.5%) | 6(19.4%) | 1(25%) | - | - | - |
| Lung & Liver | 4(13%) | 6(19.4%) | - | - | - | - |
| Spleen | 0 | 2(6.5%) | - | - | - | - |
| Kidney | 0 | 1(3.2%) | - | - | - | - |
| Sub- total | 9(29%) | 22(71%) | 2(50%) | 2(50%) | - | - |
| TOTAL | 31(23.1%) | | 4(3.2%) | | - | |

### **4.3.2 Age specific prevalence**

In cattle the prevalence was 4.5%, 7.5% and 11.2% in animals aged 4 years, 5 years and those above 6years respectively. Cattle aged less than 4 years harbored no hydatid cysts. In sheep the prevalence of 3.2% was recorded in those aged 4 years and above. No case of Echinococcosis was recorded among goats (table 4. 5).

**Table 4. 5: Age specific prevalence**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Livestock Species | General Prevalence  (95% CI) | Age specific Prevalence | | |
|  |  | Age (Years) | Number | Prevalence (%) |
| Cattle (n= 134) | 23.1% | 2  3  4  5  Above 6 | -  -  6  10  15 | -  -  4.5  7.5  11.2 |
| Sheep (n= 126) | 3.2% | 2  3  Above 4 | -  -  4 | -  -  3.2 |
| Goat (n= 49) | 0 | 2  3  Above 4 | -  -  - | -  -  - |

## **4.4 Echinococcus cyst count in inspected cattle, sheep and goats.**

A total of 111 cysts were counted amongst cattle while a total of 9 cysts were counted in sheep as shown in table 4. 6. In cattle, one cyst was recorded in one animal. Cattle with 2-5 cyst count were 25 with an average of 3 cysts. While 5 heads of cattle had between 6- 10 cysts counted. Sheep with cyst count between 2-5 cysts were 3. These cyst counts were from various body organs for both cattle and sheep.

**Table 4. 6: Echinococcus cyst count in inspected cattle, sheep and goats.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Livestock Species | Number of Echinococcus Cyst Count per Animal species | | | |
| NO. OF CYST COUNT | **1** | **2-5** | **6-10** | **TOTAL** |
| Cattle ( n = 134) | 1 | 25 | 5 | **111** |
| Sheep ( n = 126 ) | 1 | 3 | - | **9** |
| Goats ( n = 49 ) | - | - | - | - |



Figure 4.1: Lung of a bovine infested with Hydatid cysts as shown by the arrows



Figure 4.2: Liver of a bovine infested with Hydatid cysts as shown by the arrow

**4.5 Fertility and Viability of Echinococcus cysts**

In cattle, a total cyst count was 111 while in sheep they were 9 as shown in table 4.7. In cattle 20 cysts from animals older than 6 years were found to be calcified while 2 had degenerated. A total of 89 and 9 cysts from organs of cattle and sheep respectively were subjected to fertility and viability test. In cattle, 64 cysts came from Liver 69 cysts were from lungs as these were the two organs mainly found to be infested. In sheep all the cysts came from animals older than 4 years.

It was observed that out of 89 fertile cysts from cattle, 38 of them were from the liver while 51 cysts were from the lungs. Of the 89 fertile cysts, when subjected to viability test, 38 of them were found to be viable. Lungs had 21 viable cysts and liver had 17 cysts being viable. Non viable cysts were 51 in total. Most of the non viable cysts were recorded in animals older than 6 years. In sheep 9 cysts were all fertile and viable. They were from sheep older than 4 years.

**Table 4.7: Status of Echinococcus cyst isolates of cattle and sheep inspected at Webuye abattoir.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Livestock species | Cyst State | Organ Predilection Site | | | | |
| Liver | Lung | Kidney | Spleen | TOTAL |
| Cattle | Fertile | 38 | 51 | 0 | 0 | 89 |
| Viable | 17 | 21 | 0 | 0 | 38 |
| Non viable | 26 | 18 | 4 | 3 | 51 |
| Sheep | Fertile | 6 | 3 | - | - | 9 |
| Viable | 6 | 3 | - | - | 9 |
| Non viable | - | - | - | - | - |
| Goats | Fertile | - | - | - | - | - |
| Viable | - | - | - | - | - |
| Non viable | - | - | - | - | - |

## **4.6 Risk Factors contributing to the Transmission of Echinococcus in Domestic Animals**

The questionnaire that was used to determine risk factors that contribute to transmission of Echinococcosis in cattle, sheep and goats had 100% return rate.

## **4.6.1 Knowledge on Echinococcosis**

For the 24 responders 13 (54%) had seen hydatid cyst while 4 (16.7%) had not seen hydatid cyst. Other respondents, 7 (29.2%), had no idea of hydatid cyst disease. Only a few, 8 (33.3%), respondents knew that cystic organs were condemned due to public health reason. Equal percentage of 33.3% (8 respondents) did not know the reason for condemnation. Some respondents, 33.3%, even had no input on the reason for condemnation.

## **4.6.2 Practices that enhance transmission in domestic animals**

Among the respondents, 83.3% kept dogs. Condemned offal was reported to have been fed to dogs by 29.2% of the respondents. This condemned offal was obtained from the abattoir illegally.

Of the 24 respondents 16 (67%) confined their dogs while 33% did not. Among the respondents, 15 (63%) dewormed their dogs while 37% did not. Those respondents who dewormed their dogs, 75% used a veterinarian while 25% dewormed the dogs on their own. On livestock keeping practice, 25% of the respondents kept cattle, 21% kept sheep, 25% kept goats while 29% kept more than one animal species. Roadside grazing was practiced by 4% of the respondents, 8.3% practiced zero grazing while 87.7% practiced free range grazing in open fields.

Out of the 24 respondents, 63% had witnessed livestock home slaughter while 37% had not witnessed. Among the respondents 46% said carcass slaughtered at home was inspected by qualified meat inspector while 54% said no inspection was carried out.

## **4.7 Economic Losses due to Organ Condemnation.**

Figure 3 below shows the weight of specific organ per species condemned due to hydatid cyst at Webuye abattoir during the study.

Kg

Animal Species

## **Figure 4.3: Total weight of individual organs condemned.**

Figure 4.1 above depicts specific organ per species that was condemned during the study period and its resultant total weight in kilograms (Kg).

Condemned livers, lungs and spleen from inspected bovine carcasses weighed 23 kg, 19 kg and 2 kg respectively. Market price for bovine liver, lung and spleen was Kshs. 350.00, Kshs. 200.00 and Kshs. 200.00 respectively. Condemned liver and lung from inspected sheep carcasses weighed 2 kg and 0.5 kg respectively and the market value was Ksh. 350.00 for sheep liver and Kshs. 200.00 for sheep lung.

Therefore economic losses resulting from organ condemnation was calculated based on the prevailing market prices and gave a total of Ksh. 13,050 (US $ 129.195). This was then the average monthly loss that traders incurred at the abattoir. Projected annual loss was estimated to be Ksh. 13,050.00 x 12 months = Ksh. 156,600 (US $1,550.34). Economic loss also results from gross carcass weight loss. Carcass with heavy infestation had poor body condition. Economic loss due to poor body condition was not dealt with in this study.

# **CHAPTER FIVE**

# **DISCUSSION**

Current control strategies mainly focuses on decreasing prevalence of Hydatidosis in definitive hosts through baiting of stray dogs or regular deworming of domestic dogs and preventing infection to intermediate hosts through education campaigns (Vuitton *et al*., 2018). Prevalence of Echinococcosis in intermediate hosts, cattle, sheep and goats will determine the level of dog infestation if stringent meat inspection procedures are not followed and infested organs from those intermediate hosts are fed to dogs.

## **5.1 Prevalence** **of Echinococcosis in cattle, sheep and goats examined**

## **5.1.1 Overall prevalence**

In animals examined, 31 out 134 (23.1%) cattle, and 4 out of 126 (3.2%) sheep harbored hydatid cysts. There was no case of Hydatidosis recorded among goats presented for slaughter. Of the 31 cattle with hydatid cysts, 35.4% originated from Matete, 22.6% from Kipkaren, 22.6%from Misikhu, 16.1% from Webuye market and 3% from a farm in Webuye east. For sheep with hydatid cysts, 75% sheep with hydatid cyst originated from Misikhu market while 25% sheep came from Webuye Market.

The burden of Hydatidosis was moderate considering 23.1%cattle carcass inspected harbored the cysts. In sheep the infestation was mild given that only 3.2% sheep carcasses harbored hydatid cyst. In cattle 29% males harbored the cysts compared to 71% females. Possible reason could be that females are kept longer by farmers for production and reproduction therefore they had an increased exposure risk compared to males. Liver and lungs were the organs mainly affected. In cattle, 32.2% carcasses had their liver infested and 26% carcasses had their lungs harbored. Mixed infestation of liver and lung was recorded in 32.2% cattle. The finding of Echinococcus cyst in liver, lung, kidney and spleen of cattle and sheep in this study validates previous findings by Jabbar *et al*., (2011).

Liver and lung are the most Echinococcus infested organ before any other peripheral organs and the possible reason could be due to the fact that the liver and lung are the first capillary beds encountered by migrating Echinococcus oncospheres via the portal vein route before any other peripheral organ (Getaw *et al*., 2010).However the finding of the liver to be the main predilection site in this study was in contrast to previous studies that identified the lungs as being the main predilection site in livestock (Ibrahim *et al*., 2011). Also the study was in contrast to what was reported by Getaw *et al*., (2010) who observed the prevalence of 55.5% in lung and 37.1% in liver. But the study was in agreement with other studies that found liver having higher prevalence than the lung, Tural- Kara *et al*., (2018).

The findings of 0.32% infestation of the kidney and recorded as the least affected organ in this study is in agreement with observation by Getaw *et al.,*  (2010) who found the kidney as the least affected organ.

The absence of hydatid cyst in goats in this study agrees with other studies done elsewhere (Osman *et al*., 2014). Goats show lower infestation rate possibly because they are browsers and feed on the most distal parts of the plants where there are fewer eggs of Echinococcus. Moreover the eggs have a greater exposure to hostile environmental condition, and thus show a reduced infective capacity (Balbir *et al*., 2014).

## **5.1.2 Age specific prevalence**

Age of cattle slaughtered ranged from 2-10 in males while the range in females was 2- 13 years. Median age for both sexes was 6 years.

Cattle aged 2-3 years harbored no cysts. Hydatid cysts were recorded in 6 cattle aged 4 years. Most cysts were recorded in cattle older than 5 years. The reason could probably be that older animals had increased risk of exposure to infestation over years. For the same reason hydatid cysts were recorded only in sheep older than 4 years. The observation of high infestation in older cattle and sheep validates the observation by Tamarozzi *et al*., (2016) that intermediate hosts do not develop strong immunity under natural conditions. These older cattle and sheep might have had continuous infection of Echinococcus species from the environment. Alternatively, hosted parasites were only gradually reaching detectable stage (cyst) as host animal advanced in age.

Occurrence of Echinococcosis at different ages in cattle and sheep shows that the parasite is in endemic steady equilibrium which makes it amiable to control (Samia., 2011).

## **5.1.3 Sex specific prevalence**

In this study, cattle that harbored Echinococcus cysts were 71% female and 29% male. Possible reason is that female cattle are sent latter for slaughter as they are retained on farm for production and reproduction therefore they had increased risk of exposure to echinococcus eggs from contaminated environment (Ibrahim.,*et al* 2010) Consequently, higher prevalence of Echinococcosis is usually reported in older animals as reported by Otero - Abad *et al*., (2013)

Experimental studies have also suggested that Echinococcus parasite survival may be longer in females due to the potential linkage between reproductive hormones and the response of the immune system (Romano *et al*., 2015).

## **5.2 Echinococcus cyst count in cattle and sheep**

Cattle that harbored Echinococcus cysts of between 2- 5 cysts was 81%. Cysts count of between 6- 10 was recorded in 19.3% cattle. Only one cattle had one cyst counted. The total cyst count in 31 cattle that harbored hydatid cyst was 111. Though this appeared to be moderate but it was of great veterinary as well as public health importance. The 3.2% of sheep that harbored hydatid cyst, they had a total load of 9 cysts. This appeared to be mild but can contribute to transmission of Echinococcosis to definitive host, dog.

**5.3 Fertility and viability of Echinococcus cysts from cattle and sheep examined**

In this study, 111 cyst counts were recorded in cattle and 9 in sheep. In cattle 46% fertile cysts were recovered from lungs while 34.2% were from the liver among the 111 cyst counted. This is in agreement with findings by Tigre *et al* (2016) who reported higher fertility rate of pulmonary and lower fertility rate in cyst obtained from the liver. Possible reason could be due various metabolic reactions that take place in the liver as compared to lungs. However the finding of pulmonary hydatid cysts being more fertile than the hepatic hydatid cyst is in contrast to observation made by Ibrahim (2010) who found a higher fertility rate in liver than in lung, at 38.8% in liver and 25.1% in lung in cattle.

The moderate percentage of viable cysts (32.2%) in cattle and higher percentage of viable cyst (100%) in sheep recorded in this study indicates that there is a high risk of dog exposure as 29.2% of the respondents to the questionnaire in this study admitted feeding dogs to condemned offal. Finding of 100% viable cysts is in agreement with other studies which identified sheep as the main source of infection to dogs, hence man. The genotype causing the great majority of cystic echinococcosis is principally maintained in dog – sheep dog cycle. Goats, cattle, camels swine and many other domestic animals may be involved (WHO., 2018). This study is in contrast to studies done by Rinaldi in 2008 as reported by The Center for Food Security and Public Health (2011). Rinaldi did not observe any viable cyst from their survey. The plausible reason why no viable cyst was observed by Rinaldi could be due the difference in immunological response by different individual hosts or deworming of the intermediate hosts by use of anti – helmintics as reported by Daryani *et al*., ( 2009).

Finding of 100% viable cyst recorded in sheep in this study also validates observation by Torgerson *et al*., (2010) that sheep is the main source of infection to man.

**5.4 Risk factors that contribute to Hydatid cyst transmission in domestic animals**

## **5.4.1 Practices that enhance transmission of Echinococcus species**

Cattle, sheep and goats acquire CE infection by ingestion of fertile and viable *E. granulosus* eggs excreted by infested dogs. Therefore for sustainability of infection by CE in a given population, both definitive (dog) and intermediate hosts (herbivores) should be present.

Owning a dog is a known risk factor in Echinococcus transmission to man and livestock. In this study 95% of the respondents to the questionnaire owned dogs while 94% owned cattle, sheep and goats. It can be postulated that ownership of these species, dogs, cattle, sheep and goats pose a high risk of exposure to CE in man, dog, cattle, sheep, goats (Yuan *et al*., 2017).

Home slaughter without inspection as reported by 54% of the respondents to the questionnaire in this study is a risk factor in the transmission cycle of Echinococcosis. This study is in agreement with other studies where animals are slaughtered at home with no meat inspection being carried out and this can easily pass on cysts to dogs (Romig *et al*., 2011)

In this study 33.3% respondents did not confine their dogs. This led dogs roaming about and is supported by the fact that sub count veterinary office, Webuye East, records 4 dog bite cases per month. Of the respondents to the questionnaire in this study, 37% did not deworm their dogs and it was noted that dogs defecated in the immediate environment and this implied increased risk of exposure to CE in cattle, sheep, goats and man. Offal that left the abattoir illegally was also fed to dogs. In this study it was noted that 29.2% of the respondents fed dogs to condemned offal obtained illegally from the abattoir. If such offal were condemned as a result of hydatid cysts, then the danger of enhancing life cycle of hydatid cyst with public health implication is clear.

Free range grazing system practiced by communities in Webuye East Sub County can greatly expose livestock to Echinococcus eggs in pasture as 87.7% of respondents admitted to free range grazing system.

## **5.4.2 Knowledge on Echinococcosis**

It was noted from the questionnaire in this study that some respondents lacked knowledge on hydatid cyst. This posses a major challenge in breaking the life cycle of this disease. It was recorded that 17% of the respondents had not seen hydatid cyst, while 33.3% had no input. There is need for public health education campaign to communities in the Sub Count on Echinococcus transmission modes and its control.

Practices and lack of knowledge about Echinococcosis in this study points out that more effort is required to control this disease.

## **5.5 Economic loss due to cystic organ condemnation**

Infestation of multiple organs by CE encountered in this study coupled with moderate cyst load points to a moderate economic loss as a result of condemnation of cystic organs during meat inspection. This therefore calls for meat inspectors to concentrate more on these internal organs during routine meat inspection.

Also meat inspectors should be vigilant as some Echinococcus spp. Present as hard calcified solid appearance and not as the usual bladder like fluid filled structures (Torgerson *et al*., 2013).

Global economic loss due to Echinococcosis in livestock industry is estimated to be over US $2 billion per annum. In this study the annual economic loss of Kshs. 156,600 (US $ 1,550.34) as a result of organ condemnation was moderate. This figure of annual economic loss compares favorably to that which was recently calculated by Getaw in Ethiopia and found an annual economic loss US $ 5,059 as a result of condemnation of cystic organs (Getaw *et al*., 2010).

Putting into account the low income level coupled with poor nutrition experienced by most rural households, the annual economic loss from organ condemnation in Webuye East could be considered significant.

In this study 46% of the respondents to the questionnaire admitted having witnessed livestock home slaughter and this could imply that the actual economic loss due to CE is higher than what is recorded during routine meat inspection.

In this study indirect economic loss such a loss of carcass weight, reproduction and production related losses were not dealt with and thus it implies that the annual economic impact as a result of Echinococcosis could be higher than the calculated figure in this study. It is also generally accepted that there is an estimated reduction in carcass weight loss of about 5% associated with CE in infested cattle (WHO., 2018). This trend if not corrected by breaking the life cycle of *E. granulosus*, then there will be a continued negative impact on the economy and a threat to food security as highly nutritive animal organs are condemned at meat inspection.

# 

# **CHAPTER SIX**

# **6.0 CONCLUSION AND RECOMMENDATIONS**

## **6.1 Conclusion**

This study has shown that Echinococcosis is of veterinary, public health as well as economic importance in Webuye East sub County.

1. Echinococcosis is endemic among cattle and sheep slaughtered in Webuye east sub County. However, its prevalence was moderate in cattle (23.1%) and significantly low in sheep (3.2%).There was no prevalence of Echinococcosis recorded in goat. An account of Echinococcosis in this study poses a risk of transmission to human especially children who are in constant contact with dogs. The liver appeared to be the most affected organ in this study as most of the oncospheres are filtered there.

On age specific prevalence, cattle and sheep were affected from the age of 4 years. Most viable cysts were found in young cattle and sheep.

1. In this study knowledge on Echinococcosis and its control was found to be low. This was why a considerable number of the respondents (29.2%) fed dogs to Echinococcus infested organs. There was also inadequate deworming of dogs. Most dog owners did not confine their pets. Open field grazing was evident in the study. There was lack of Veterinary public health in home slaughters.

All the above factors increased the risk of the disease both in human and animals.

1. Economic losses due to infested organ condemnation was significant (Kshs. 13,050.00 monthly), and this impacts negatively on socio- economic status and food security in the study area as highly nutritive organs are disposed off.

## **6.2 Recommendations**

Based on the study findings, the following recommendations are made to the Veterinary department, Public Health officials and policy makers.

1. Condemned cystic organs should be put in a deep condemnation pit with a lockable lid by meat inspecting officers so that dogs do not access and ingest on them. Tight measures should be put in place so that no condemned Echinococcus cystic organs leave the abattoir illegally.
2. There is need for policy consideration to have all animals slaughtered at a licensed abattoir even if the carcass is to be used during ceremonies. Those found violating the policy be prosecuted. If this is made compulsory then there will be a reduced chance of transmission to human and domestic animals.
3. There is need for regular public health education awareness programs on all aspect of Echinococcus and its control to reduce the risk of animals and human infection and improve social economic status and food security in the study area.

## **6.2.1 Recommendation for further research**

Further research is required to assess prevalence of Echinococcus tapeworm in dog population in Webuye east sub County. Also further research is required to determine prevalence of Echinococcosis among human population of this sub County.

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# **APPENDICES**

1: Questionnaire for collecting data on risk factors that contributes to hydatidosis transmission in domestic animals.

2: Consent to participate in the research.

3: Approval letter for the research from IREC.

4: Consent letter from County Director of Veterinary Services.

**Appendix 1. Questionnaire to Butchers and flayers for evaluating risk factors contributing to transmission of Echinococcosis.**

Tick where appropriate.

**Knowledge on the disease**

1. Do you keep dog(s)? (a) YES……. (b) NO……..
2. If the answer in 1 above is yes, How many? ........... Do you confine them? (a)YES…… (b) NO……..
3. Do you deworm your dog(s)? (a) YES….. (b)NO……If the answer is YES who deworm? (a) SELF……….. (b) A VET………..
4. Do you wash your hands after handling dog(s)? (a) YES … (b) NO………
5. Do you sometimes feed your dog(s) with meat parts from the abattoir? (a)YES….. (b) NO…….. If answer is YES, which meat? (a)CONDEMNED ……… (b) CERTIFIED AS GOOD FOR CONSUMPTION………
6. Have you heard or seen hydatid cyst that affect Liver, Lungs Spleen and it presents as water filled swellings in slaughtered animals? (a) YES….. (b) NO…..
7. If the answer in 6 above is YES, Have you known why such meat is condemned by meat inspectors? (a) YES…… (b) NO….. If the answer is YES, briefly what is reason? .…………..………………………………………
8. Have you witnessed livestock home slaughter? (a) YES…. (b) (NO) ……. If answer is yes, who inspects the meat? (a) Meat inspector….. (b) None….. (c) Others……………Specify………….
9. **Risk factors that contribute to the disease transmission to livestock**
10. Do you keep, cattle (A) YES…….. (B) NO……. Sheep (A) YES …… (B) (NO)….

Goats (A) YES…… (B) NO……

1. How you do feed the livestock you keep (A) Roadside grazing….. (B) Open field grazing….. (C) Zero grazing……..

# **APPENDIX 2; Consent to participate in the study**

**Investigator:** Wasike Jairus Wanga, School of Public Health, Moi University.

Study title: PREVALENCE, DETERMINANTS AND ECONOMIC LOSS OF ECHINOCOCCOSIS IN CATTLE, SHEEP AND GOATS SLAUGHTERED AT WEBUYE ABATTOIR, BUNGOMA COUNTY, KENYA.

**Purpose and Background:** The purpose of the study is to fill gaps in knowledge regarding prevalence, risk factors and economic loss due to Echinococcosis in domestic animals presented at Webuye Municipal abattoir in Webuye East Sub County and the translation of outcomes into recommendations for policy makers, public health officials, veterinary department and other stakeholders involved in Echinococcosis control.

**Procedure:** Two field meat inspectors who are my assistant researchers, at Webuye Municipal abattoir and the researcher will record cases of Echinococcosis for all animals presented for slaughter; result will assist in finding the prevalence and calculating economic loss. Questionnaire will be administered to all butchers and flayers by the researcher and his two assistants to establish risk factors that contribute to its transmission to domestic animals.

**Benefits and Risks:** There will be no direct benefit or risks for those participating in the study.

**Confidentiality:** All information given in this study will be confidential and will be used only for the purpose of the study.

**Voluntary participation:** The participation in the study is entirely voluntary and participants are free to accept, refuse to take part in the study or withdraw at any time.

**Contact**

1. The proposal has been reviewed by Institutional Research and Ethics Committee (IREC) of Moi Teaching and Referral Hospital (MTRH) and Moi University. The committee ensures that research participants are protected from harm. If you want to find more information from the committee you may contact:

The Administrator,

IREC,

P.O BOX 4606- 30100,

**ELDORET.**

Tel 3371/2/3

1. You may also address your questions or any issues requiring clarification now or at any time of the study to the investigator through the following contact:

Wasike Jairus Wanga,

School of Public Health,

Moi University,

P.O BOX 4606- 30100,

ELDORET

MOBILE: 0733571535/0710152435

Email: wasikejairus @yahoo.com

**CONSENT**

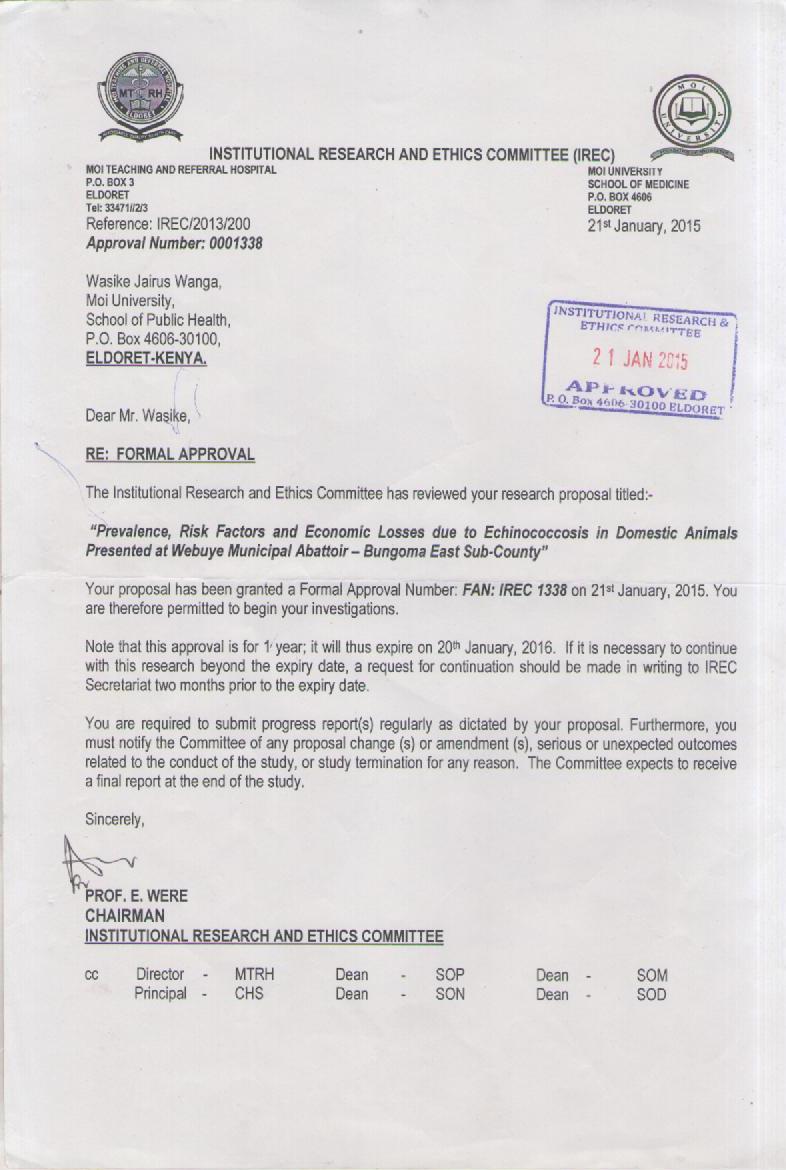
I have understood the nature of the study and voluntarily agree to participate in the study.

Signature of participant …………………………………………..

Date …………………………………………….

Signature of researcher ………………………….

## **Appendix 3: Formal IREC Approval**



## **Appendix 4: Approval from County Director of Veterinary Services Bungoma County.**

