MEKELLE UNIVERSITY

COLLEGE OF VETERINARY SCIENCE

DEPARTMENT OF PUBLIC HEALTH AND FOOD SAFETY

Prevalence and Associated Risk Factors of Hydatidosis in Sheep and Goats Slaughtered at Maandeeq Abattoir, Hargeisa, Somaliland

By

Yousuf Ahmed Farah

(ID No. CVS/pr026/12)

OCTOBER 2023

MEKELLE-TIGRAY-ETHIOPIA

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Advisor

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A Thesis Presented in Partial Fulfilment for the Requirements of the Master of Science in Zoonoses and Food Safety

Department of Public Health and Food Safety

College of Veterinary Science

Mekelle University

Declaration

Declaration A

I hereby declare that this thesis is a presentation of our original research work. Whenever contributions of others are involved, every effort has been made to indicate this clearly, providing due references to the literature and acknowledging collaborative research and discussions.

Candidate:

Name Signature

Yousuf Ahmed Farah _____

Declaration B

I confirm that the work reported in this thesis was conducted by the candidate under my supervision.

Name: Endale Balcha (DVM, MSc., Associate professor)

Date: …October 26, 2023

Signature: …  ……

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ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to the Almighty ALLAH, the gracious and benevolent, for His countless blessings and for granting me the opportunity to exist and thrive.

I am deeply thankful to my advisor, Endale Balcha, for his unwavering support, technical guidance, and professional advice throughout this thesis. His insightful feedback, critical review, and editing have greatly contributed to the refinement of this manuscript. I am also grateful for his provision of valuable reference materials, which have been instrumental in the completion of this work.

Furthermore, I would like to acknowledge and extend my heartfelt appreciation to my mother, Basra Hussein. Her selflessness, constant support, and unwavering dedication have been invaluable throughout my research journey. Her presence and assistance in every aspect of my proposal work have been immeasurable, and I am forever grateful for her sacrifices.

I would also like to express my profound love and respect to my entire family. It is difficult to put into words the extent of their support and the impact they have had on my life, from my upbringing until this very moment. I am especially grateful to my mother, my brothers, and sisters, as well as my relatives and my closest friends, whose unwavering support and encouragement have been a constant source of strength and inspiration.

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ABSTRACT

Hydatidosis, caused by the parasitic cestode Echinococcus granulosus, poses a significant public health concern in many regions. This study aims to determine the prevalence of hydatid cysts in sheep and goats slaughtered at Maandeeq Abattoir in Hargeisa, Somaliland, as well as to identify associated risk factors. A cross-sectional study was conducted for a period of one month with random selection of 400 slaughtered shoats (200 sheep and 200 goats). Post-mortem examinations were performed on visceral organs, including the liver, lung, kidney, heart, and spleen, following recommended procedures. Animals were categorized as either positive or negative for the presence of hydatid cysts based on a comprehensive assessment involving visual inspection, palpation, and systematic organ incision. Data from ante-mortem and post-mortem findings were recorded in MS Excel and analyzed using SPSS statistical software (version 20). The Chi-Square ($\chi 2$) test was employed to assess the association between risk factors and the prevalence of Hydatidosis. A p-value < 0.05 indicated statistical significance. Out of 200 slaughtered sheep, 16 (8.0%) were infected with hydatid cysts. The prevalence among slaughtered goats was 3.5%, with 7 out of 200 goats infected. Overall, of the 400 animals examined (sheep and goats), 23 were infected, resulting in a prevalence of 5.8%. Age class showed a strong association ($p < 0.0001$), with 13 out of 335 adult animals (2-5 years) and 10 out of 45 old animals (> 5 years) infected. Sex also exhibited a moderate association ($p = 0.01$), with 8 out of 241 males and 15 out of 159 females infected. Although animal origin displayed a moderate association, it was not statistically significant ($p = 0.074$). In conclusion, this study determined the prevalence of hydatid cysts in sheep and goats slaughtered at Maandeeq Abattoir in Hargeisa, Somaliland. The results highlight the importance of considering age and sex as potential risk factors for Hydatidosis. Further interventions and control measures are necessary to reduce the prevalence and associated risks of this zoonotic disease.

Keywords: Hydatidosis; Prevalence; Risk factors; Sheep and goats

Definition of Terms:

Echinococcus granulosus: also known as the hydatid worm, hyper-type worm, or dog *tapeworm*, is a *cyclophyllid* cestode that primarily resides in the small intestine of canids as an adult. However, it also relies on important intermediate hosts such as livestock and humans, where it causes a condition known as cystic e*chinococcosis*.

Definitive host: refers to the biological organism in which the parasite undergoes sexual reproduction. In the case of *Echinococcus granulosus*, canids serve as the *definitive host.*

Echinococcosis: is a parasitic disease caused by infection with tiny tapeworms belonging to the *genus Echinococcus.*

Hydatidosis: is a parasitic infection specifically caused by the type of *tapeworm* known as *Echinococcus granulosus*.

Hydatid worm: refers to the larval cyst of the tapeworm *Echinococcus granulosus*. It typically appears as a fluid-filled sac containing daughter cysts.

Intermediate host: is an organism that harbors the immature or non-reproductive forms of a parasite. In the case of *Echinococcus granulosus*, livestock and humans can act as *intermediate hosts.*

Small ruminants: are grazing mammals such as goats and sheep.

Zoonotic diseases: are infections that can be transmitted between people and animals.

CHAPTER ONE

1.1. Introduction

Livestock production and marketing have traditionally been central to Somaliland's culture and economy (Mugunieri et al., 2016). Recent literature highlights the significant role of livestock exports in terms of income generation, food security, employment opportunities, foreign exchange earnings, and government revenue (Nadhem et al., 2021). Livestock exports not only drive export growth but also shape the socio-economic landscape of the Horn of Africa (Ibrahim, 2010). An illustrative example is the remarkable export numbers from Berbera port in 1997, where 2.8 million heads of livestock were exported. This impressive figure represents the highest number of animals exported from a single port worldwide that year (Holleman, 2003).

Despite the numerous economic benefits associated with livestock in Somaliland, recent literature highlights the substandard health management practices in the livestock sector, leading to the intermittent ban on livestock exports to the Middle East (Ibrahim et al., 2021). Moreover, the livestock industry poses a significant risk of zoonotic diseases in the country, although there is a general lack of awareness among local communities about such diseases (Nadhem et al., 2021). It is crucial to address these gaps in knowledge and improve information dissemination regarding zoonotic diseases in Somaliland.

Amongst zoonotic diseases, *echinococcosis* is an emerging and re-emerging *cyclozoonosis* that been reported from many countries (Nasr and Pal, 2016). Generally, the two most abundant types of hydatid diseases are caused as a result of *E. granulosus* and *E. multilocularis*. *Cystic echinococcosis* (CE) is the most commonly occurring form that is caused by the larval stage of *E. granulosus* (Sarkar et al., 2016). Echinococcosis, which mainly affect poor communities, attract much less attention, and are considered neglected by the World Health Organization (WHO). In the Horn of Africa, many people live in close proximity to livestock and depend on them for food and income. Their frequent interaction with animals increases the risk of contracting zoonoses (Cavalerie et al., 2021).

Small ruminants serve as intermediate hosts for the parasite, and their role in the transmission and life cycle of the parasite is significant. Given the large population of sheep and goats (shoats) in the country, the presence of hydatid cysts is inevitable, and the prevalence of the disease may be high, although comprehensive studies have not been conducted in the country. The utilization of older, uninspected female animals (Daabax) for local consumption may contribute to the incidence of the disease, as there is a possibility of the animal acquiring the parasite as it ages (Tilahun, 2008).

At Maandeeq slaughterhouse, there have been reports of a disease resembling *hydatidosis* in shoats, as indicated by the slaughterhouse staff. Currently, the occurrence of the disease and associated risk factors are being assessed. Therefore, this study intends to establish baseline data that can contribute to the control of the disease.

1.2. Objectives of the study

2.3.1. General Objectives

To determine the overall prevalence and associated risk factors of hydatid cyst in small ruminants slaughtered in Maandeeq abattoir.

2.3.2. Specific Objectives

- To determine the prevalence of Hydatidosis in slaughtered sheep and goats.
- To explore association of hydatid cyst with risk factors.

1.3. Research questions

To establish the above objectives, the following guiding questions were set:

- Does animal origin affect infection of Hydatidosis?
- Do all animal age groups have equal chance to get infected?
- What is the sex ratio between male and female animals for disease hosting?

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

The understanding of hydatid cyst infection in animals and humans dates back to ancient times. In the 4th century AD, Hippocrates described this infection, followed by Galen and Arataeus in the 1st and 2nd centuries AD, respectively. Francisco Redi recognized the parasitic nature of the cyst in the 17th century, and in 1766, Pierre Simon Pallas proposed that hydatid cysts were larval stages of tapeworms. Carl von Siebold demonstrated in 1853 that dogs acquire adult tapeworms from cysts in sheep. The complete understanding of the disease's clinical features was achieved in the late 1800s, and immunological diagnostics were developed in the 1900s. Surgical operations to remove cysts were first attempted in the 1600s (Eckert and Thompson, 2017).

Echinococcosis, or Hydatid disease, is a zoonotic disease caused by tapeworms of the genus Echinococcus. There are five identified species of Echinococcus that infect a wide range of domestic and wild animals (J Eckert 2002). Hydatidosis is primarily caused by the larval stage of Echinococcus granulosus and is recognized as a major zoonosis worldwide. It is more prevalent in developing countries, particularly in rural communities where there is close contact between the definitive host and various domestic animals acting as intermediate hosts (Tilahun, 2008).

The infection in food animals such as goats, cattle, sheep, and pigs occur through the ingestion of parasite eggs passed in the feces of the definitive host, which contaminate grass and water sources. The oncospheres released from the eggs penetrate the intestinal wall and reach visceral organs such as the liver, lung, heart, and kidney of humans and animals (Erbeto et al., 2010).

Cystic echinococcosis (CE) has a significant negative impact on public health and the economy in many parts of the world. It is an important zoonotic disease with great social

importance (Benito et al., 2006; Daryani et al., 2007; Garippa et al., 2004) and has been reported in many countries in Sub-Saharan Africa (Ibrahim, 2010).

The genus Echinococcus, specifically tapeworms within it, is responsible for causing hydatidosis, a zoonotic disease that transmits from animals to humans. Currently, four species are recognized in the Genus Echinococcus: *E. multilocularis*, *E. granulosus*, *E. oligarthrus*, and *E. vogeli* (Thompson et al., 1995). Echinococcosis is an emerging and re-emerging cyclozoonosis reported in many countries in both humans and animals. *E. granulosus* and *E. multilocularis* are the most abundant species causing hydatid diseases. Cystic echinococcosis (CE), caused by the larval stage of *E. granulosus*, is the most commonly encountered form of the disease. It is prevalent in Africa and Mediterranean areas, affecting many people (Pal et al., 2020).

Echinococcus granulosus, a cestode, is responsible for causing cystic hydatid disease *(echinococcosis*). It is transmitted from carnivores (foxes, dogs, leopards, lions, and hyenas), which serve as the definitive hosts harboring the adult stages of *E. granulosus* in their intestines, to herbivores (sheep, camels, goats, buffaloes, cows, horses, donkeys, rabbits, pigs, and humans), which act as intermediate hosts harboring the larvae (hydatid cysts) of the *Echinococcu*s parasite (Buttenschoen and Buttenschoen, 2003). The causative agent of cystic hydatid disease (CHD) is the cestode Echinococcus granulosus, which possesses various genetic variants or strains based on a wide variety of criteria (Rosenzvit et al., 1999).

Hydatidosis is an important parasitic disease in ruminants, with both economic significance and public health implications. It is associated with severe disability and morbidity and is one of the most widespread zoonotic diseases geographically. The pathogenicity of the disease depends on the severity and extent of infection, as well as the affected organ where the cyst is located. Rupture of hydatid cysts can lead to sudden death due to severe immunological reaction, metastasis, and hemorrhage (Kebede et al., 2009).

2.2. Worldwide distribution of *Echinococcus granulosus*

2.2.1. Human distribution

The global burden of *Echinococcus granulosus* is primarily attributed to E. granulosus s. s. (G1), followed by E. canadensis (G6 and G7), particularly in South America (Asmare et al., 2016). The highest prevalence of cystic echinococcosis in both human and animal hosts is found in countries within temperate zones. These regions include southern and central parts of Russia, Mediterranean regions, China, central Asia, South America, Australia, and east and north Africa (Grosso et al., 2012). *Echinococcosis*, specifically cystic *echinococcosis* (CE) and alveolar *echinococcosis* (AE), are the most common clinical forms and pose a significant economic and health burden, particularly in low-income societies (Otero-Abad and Torgerson, 2013).

An investigation was conducted to predict the prevalence of *hydatid* disease among nomadic pastoralists residing in eastern Africa, as well as to identify cultural, environmental, and behavioral factors contributing to *Echinococcus* transmission. A total of 18,565 individuals from 12 different nomadic pastoralist groups living in vast semi-desert regions of Ethiopia, Kenya, Sudan, and Tanzania were examined for cystic echinococcosis using a mobile ultrasound scanner. The study found high prevalence rates of Echinococcosis among the north-western (5.6%) and north-eastern (2.1%) Turkana of north-west Kenya, the Toposa (3.2%) of southern Sudan, the Nyangatom (2.2%), Hamar (0.5%), and Boran (1.8%) of southwest Ethiopia and northern Kenya, and the Maasai (1.0%) of Tanzania. Lower prevalence rates were recorded among the lake-dwelling (0.3%) and southern (0.3%) Turkana and the Pokot (0.1%) of Kenya. No cases of the disease were found in the Samburu, Gabbra, Dassanetch, Turkana, Somali, or Rendille populations screened from the east side of Lake Turkana (Macpherson et al., 1989).

2.2.2. Animal distribution

The *metacestodes* and larval stages of canid cestode parasites are the main causes of morbidity, mortality, and financial losses in small ruminants. These parasites lead to organ and carcass condemnation at slaughter (Asmare et al., 2016). A cross-sectional study was

conducted in Jigjiga, the capital of the Somali region in Eastern Ethiopia, where 400 camels were examined during slaughter. Among them, 92 (23%) were found to be positive for cystic disease (Debela et al., 2015).

2.3. *Echinococcus granulosus*

The identification and classification of Echinococcus species have long been challenging due to a lack of distinct phenotypic traits, limited evidence for geographical or ecological segregation, and inadequate taxonomic descriptors. Originally, numerous subspecies and species of Echinococcus were categorized based on host-parasite specificity. However, most of these classifications were later considered synonyms for Echinococcus granulosus. Subsequent taxonomic revisions recognized four confirmed species: *E. granulosus, E. oligarthrus, E. multilocularis*, and *E. vogeli*. The taxonomy of *Echinococcus* has been further complicated by conflicting views on population genetics and reproductive systems. Nevertheless, field and laboratory observations over the past 50 years have identified significant phenotypic variability among *Echinococcus* isolates. This variability has been predominantly observed in *E. granulosus*, particularly among isolates from different species of intermediate hosts. Studies based on mitochondrial DNA have concluded that *E. granulosus* encompasses 10 *genotypes* (G1 to G10), and certain genotypes have been elevated to distinct species. This includes *E. granulosus* sensu stricto (G1, G2, and G3), *E. equinus* (G4), *E. ortleppi* (G5), and its sister species, E. *canadensis* (G6, G7, G8, G9, G10). Recently, a new species has been identified, named the lion strain, which is positioned as a sister taxon to E. felidis. Additionally, E. *multilocularis*, a sister species to *Echinococcus shiquicus*, has been found in Tibet (McManus et al., 2013). *Echinococcus granulosu*s (sensu lato) is responsible for cystic *echinococcosis,* the most commonly examined form, while *E. multilocularis* causes alveolar *echinococcosis*, which is becoming increasingly common.

2.3.1. Definitive Host

In 1786, Batsch discovered the adult tapeworm in the dog's intestine and named it "granulosus." The link between these hydatid cysts and the adult tapeworm was established later (Bourée, 2001). Several species of wild canids, such as grey wolves (Canis lupus), act as hosts for E. granulosus, while the red fox (Vulpes vulpes) serves as a host for *E.*

multilocularis. However, infected domestic dogs (Canis familiaris) pose the greatest risk of human infection (Van Kesteren et al., 2013). In most countries, there is generally no direct contact between humans and foxes, making the foxes less likely to be directly responsible for many *echinococcal* infections in humans. However, foxes may act as definitive hosts for one or more species of *Echinococcus* and play a role in maintaining the transmission cycle involving wild or domestic animals. The significance of foxes in the epidemiology of *echinococcal* disease in humans needs to be defined, especially considering that domestic carnivores can become infested (Gemmell, 1959).

2.3.2. Intermediate host

The intermediate hosts of *Echinococcus granulosus* are typically nomadic or semi-nomadic sheep and goat flocks. The geographic distribution of these hosts varies from country to country, and their close contact with the final host, the dog, is crucial for completing the transmission cycle of infection to humans (Grosso et al., 2012).

A study conducted in Lahore, Pakistan, indicated that the overall prevalence of *hydatidosis* in sheep and goats was 8.25% and 6.21%, respectively. The prevalence was significantly higher in sheep compared to goats (Iqbal et al., 2012).

2.4. Clinical symptoms

Respiratory *hydatidosis* presents with prominent symptoms such as fever, cough, dyspnea (difficulty breathing), and chest pain. *Eosinophilia*, an increase in eosinophil white blood cells, is also observed (Aytaç et al., 1977). If cysts form in the liver, additional symptoms may include yellowing of the skin, abdominal pain, and jaundice (yellowing of the whites of the eyes). In cases where cysts form in the air sacs (lungs), patients may experience coughing up blood or the contents of the cysts, as well as chest pain. In severe cases, life-threatening symptoms such as anaphylaxis (severe allergic reaction) or hives may occur. These clinical signs and symptoms of e*chinococcosis* may be attributed to the mass effect of the hydatid cyst, while anaphylactic or superinfection reactions can result from cyst rupture (Arminanzas et al., 2015).

2.5. Transmission Dynamics of Echinococcus

The distribution order refers to the number and pattern of parasites within a specific host population during a given period. It serves as a measure of the success or failure of parasite transmission and is influenced by the interaction between the availability of infective stages (infection pressure) and the host's response. The host's response is primarily determined by its physiological state, level of acquired and innate resistance, as well as feeding behavior patterns. In the case of *Echinococcus,* parasite-related factors encompass all events that impact the density, infectivity, and distribution of eggs in the environment.

Association between Animal Age Group and *Hydatidosis*: A study investigating hydatid disease examined 704 sheep, 391 goats, 280 cattle, and 68 camels slaughtered in two abattoirs in North Jordan. The infection rates for these animals were found to be 4.0%, 3.6%, 11.4%, and 8.8%, respectively. Notably, older camels exhibited a higher prevalence rate of *hydatidosis* (Gusbi et al., 1990). Generally, older animals tend to have higher rates of infection compared to younger ones (Al-Yaman et al., 1985).

2.6. Transmission

The asexual multiplication of the *metacestode* stage produces *protoscoleces,* which are then ingested by definitive hosts, leading to infection. A single cyst may contain several thousand *protoscoleces,* each capable of developing into sexually mature adult worms (Wen et al., 1993). The most common mode of *Echinococcus* transmission to humans is through accidental consumption of soil, water, or food contaminated with fecal matter from infected dogs. Eggs deposited in soil can remain viable for up to a year.

2.6.1. Morphology and Molecular characterization

Key characteristics used for differentiation include total worm length, position of the genital pore, number of testes, and the anatomy of the female reproductive duct system. In domestic and sylvatic strains, differences in rostellar hook morphology have been considered the fastest and most reliable means of differentiation (Hobbs et al., 1990). Modern molecular techniques have provided greater sensitivity in distinguishing complex intra-specific strains of *E. granulosus*. Sequence comparison of mitochondrial DNA, such

as CO1 and ND1, has proven reliable in identifying genetic diversity and *polymorphism* in *genes* of both intermediate and definitive hosts (Arbabi et al., 2017).

2.6.2. Life cycle

The adult tapeworm resides in the small intestine of definitive animal hosts, such as domestic and wild carnivores (e.g., dogs, dingoes, and foxes), and eggs are excreted with the feces. Intermediate hosts, such as sheep and cattle, become infected by accidentally ingesting eggs while grazing on contaminated pasture or licking their muzzle or coat where flies carrying eggs have deposited them. Once inside the stomach of the intermediate host, the eggs hatch, releasing larvae (oncospheres) that penetrate the gut wall. The *oncospheres* are then passively transported through the bloodstream to various organs, including the liver or lungs, where they develop into fluid-filled hydatid cysts over several years (Wilson et al., 2020).

2.7. Public health effect

Echinococcosis poses a significant public health challenge in certain countries and may be emerging or re-emerging in some areas. The most common form of the disease, *cystic echinococcosis*, is caused by members of the *Echinococcus granulosus sensu lato* complex. This form is generally less severe and more treatable, as the larvae of these organisms typically develop as discrete single cysts. However, *E. multilocularis* (causing *alveolar echinococcosis*) and E. vogeli (causing polycystic echinococcosis) are more serious and difficult to treat. These organisms can proliferate in intermediate hosts, forming masses that infiltrate entire organs and may even spread to distant sites, including the brain (J Eckert 2002).

2.8. Economic importance

Developing countries, despite having nearly two-thirds of the world's livestock population, produce less than a third of the world's meat and only a fifth of its milk (Kebede et al., 2009). *Hydatidosis* in farm animals leads to significant economic losses, primarily due to the condemnation of edible organs, decreased meat and milk production, reduced value of hide and fleece, and a decline in fecundity. The lungs and livers are organs heavily affected by *Hydatidosis*, resulting in reduced livestock productivity and the condemnation of offal containing cysts during meat inspection (Shiferaw et al., 2018)

CHAPTER THREE: MATERIALS AND METHODS

3.1. Study Area

This cross-sectional study was conducted in September-October 2023 in Hargeisa, the second largest city in Somalia. Hargeisa is located in the Woqooyi Galbeed region and serves as the capital city of Somaliland, a self-declared unrecognized country in northern Somalia. The city is situated in a valley in the northwestern part of the country and is characterized by a mountainous terrain. It experiences a semi-arid climate, with temperatures ranging from 13°C to 32°C (55°F to 89°F). Winters are warm, while summers are hot. The city receives the majority of its rainfall between April and September, with an average annual precipitation of just under 400 mm.

Hargeisa has a high population density of livestock and is home to the second largest livestock market in Somalia. The city also houses two government-owned abattoirs where more than 1200 shoats, 150 camels, and 100 cattle are slaughtered daily, using the Halal method. The meat from these animals is primarily consumed locally (Omar and Ali Fara, 2018).

3.2. Study animals and sampling method

The study focused on small ruminants at Maandeeq slaughterhouse. The shoats were grouped based on species, sex, age, and origin. The sample size was determined according to the methodology described by Thrusfield (2005), considering time constraints, and a total of 400 animals were selected, with 200 each for sheep and goats.

To gather data on the place of origin, animal farms were traced back, and the owners were interviewed. Visual observation of hooves and wool was also used to assess the effect of geo-zone soil type. The age of the animals was determined through dentition analysis, while sex and species were identified through visual observation.

3.3. Study Design

A cross-sectional study was a carried out using simple random sampling method.

3.4. Examination of slaughtered animals

During the post-mortem examination, a comprehensive assessment of the visceral organs, including the liver, lung, kidney, heart, and spleen, was conducted. This involved a meticulous visual inspection, palpation, and systematic incision of each organ, following the procedures recommended by FAO/UNEP/WHO (1994). While data generation on the specific infection status of these visceral organs was not considered, the overall assessment categorized the animal as either positive or negative for the presence of the disease.

3.5. Analysis

The data obtained from both ante-mortem and post-mortem findings were recorded in an MS Excel spreadsheet and subsequently exported to the SPSS statistical software package, version 20, for analysis. To assess the association between various risk factors contributing to the prevalence of Hydatidosis, the Chi-Square ($\chi 2$) test was employed. A p-value of less than 0.05 was considered indicative of a statistically significant difference.

CHAPTER FOUR: RESULTS

4.1. Prevalence of Hydatidosis

Table 1 provides information on the prevalence of hydatid cyst in slaughtered sheep and goats. It presents data on the number of animals examined, the number infected, and the prevalence percentage for each category. Out of 200 sheep slaughtered, 16 were found to be infected with hydatid cysts. This represents a prevalence of 8.0%, indicating that approximately 8% of the slaughtered sheep had hydatid cysts. 7 out of 200 which is 3.5% of the slaughtered goats had hydatid cysts. In total, 400 animals were examined, and 23 of them were infected with hydatid cysts. The prevalence for all examined animals is calculated as 5.8%, indicating that approximately 5.8% of all examined animals (sheep and goats) had hydatid cysts.

Table 1: Prevalence of Hydatid cyst in slaughtered sheep and goats

Animals slaughtered	Total number examined	Total number infected	Prevalence (%)
Sheep	200	16	8.0
Goats	200	7	3.5
Both	400	23	5.8

4.2. Risk factors of Hydatidosis

Table 2 examines the association of Hydatidosis (infection with hydatid cysts) with proposed risk factors. It presents data on the number of individuals infected and not infected, as well as the results of chi-square tests and p-values indicating the significance of the associations. The table indicates a strong association between age class and Hydatidosis. The p-value is reported as <0.0001, suggesting a highly significant association. The chi-square value is reported as 6.6 for the association of sex with Hydatidosis, indicating a significant moderate association (p=0.01). The result also showed moderate association between animal origin and Hydatidosis, but the association was not significant (p=0.074).

Table 2: Association of Hydatidosis with proposed risk factors

Risk factors	Number infected	Number not infected	Chi-square	*P-value*
Age class				
Young (≤ 2 years)	-	20	25.9	<0.0001*
Adult (2-5 years)	13	322		
Old (> 5 years)	10	35		
Sex				
Male	8	233	6.6	0.01*
Female	15	144		
Origin				
Coastal	11	111	5.2	0.074
Mountainous	5	148		
Plateaus	7	140		

* Significant at 5% level of significance

CHAPTER FIVE: DISCUSSION

In current cross-sectional study, the overall prevalence of small ruminants Hydatidosis in Hargeisa city of north western province of Somalia (Somaliland), was found to be 5.8%. This finding is lower than the prevalence reported in some studies: 11.6% in Mekelle (Yitbarek 2011), 8.6% in Addis-Ababa Getachew (2012) and 10.6% of slaughtered animals in Bahir Dar Abattoir, Northwestern Ethiopia Nigatu (2009). It is also significantly lower than the prevalence rate of 27.6% reported in Ambo Municipal abattoir western Oromia regional state, Ethiopia by Zewdu (2012) and 19.9% in Addis Ababa abattoir Kebede (2010). These variations in prevalence rates could be due to differences in study populations, sample sizes, sampling techniques, diagnostic methods, and geographical variations.

The finding revealed a lower occurrence of Hydatidosis compared to similar studies conducted in Ethiopia. This discrepancy may be attributed to certain factors specific to the Somali herders' practices in pastoral areas. One possible explanation is the limited presence of stray dogs, which are known to contribute to the transmission of the disease. Somali herders may have effective measures in place to control the population of stray dogs, thereby reducing the risk of infection. Furthermore, the herders' cultural norms and practices regarding the proper disposal of dead animal carcasses, offal, and soft organs play a significant role in minimizing the spread of the disease. The herders often choose to burn, bury, or throw these remains onto dense high trees, preventing scavenging by carnivores such as foxes. This practice not only prevents the transmission of the disease but also adds an extra layer of safety through the additional cooking of animal meat. These unique customs and practices followed by Somali herders contribute to the lower prevalence of Hydatidosis observed in the study area compared to other similar studies conducted in the region. However, it is essential to acknowledge that further research and larger-scale studies are necessary to validate and expand upon these claims.

Animals originating from coastal areas showed a higher infection rate, which can be attributed to the presence of permanent water streams that support a diverse range of wild intermediate ungulates and carnivores. This creates a robust wildlife infection cycle, increasing the risk of transmission.

Within the studied species, the prevalence of infection was 8% for sheep (23 out of 400) and 3.4% for goats. These findings are comparable to the results reported in Lahore, Pakistan, where Iqbal et al. (2012) found a prevalence of 8.25% in goats and 6.21% in sheep. Notably, sheep exhibited a higher infection rate, which can be attributed to their grazing behavior, as they are more likely to come into contact with contaminated areas.

When examining the infection rates within different age groups, the prevalence was 0% in young animals, 3.9% in adult and 22.2% in older animals. This pattern suggests that the risk of infection increases with age, which aligns with the findings of Tahir (2015). Tahir (2015) reported a prevalence of 10.8% in ovine and 0% in caprine, 12.9% in females and 2.9% in males, and 0% in young and 11.1% in adult animals. These similarities highlight the consistency of the prevalence patterns across different regions and reinforce the importance of considering these factors when assessing the risk and transmission of Hydatidosis.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

The study examined the prevalence and associated risk factors of Hydatidosis in sheep and goats slaughtered at Maandeeq Abattoir in Hargeisa, Somaliland. The post-mortem examination of slaughtered animals revealed an overall prevalence of 5.8% for hydatid cysts. Specifically, 8.0% of the examined sheep and 3.5% of the examined goats were found to be infected. The results indicate that Hydatidosis is present in the study area, highlighting the importance of addressing this zoonotic disease.

Furthermore, the analysis of risk factors demonstrated significant associations between Hydatidosis and age class as well as sex. The association between age class and Hydatidosis was highly significant ($p<0.0001$), with a higher prevalence observed in adult animals (2-5 years) compared to young (≤2 years) and old (>5 years) animals. The association between sex and Hydatidosis was moderately significant ($p=0.01$), indicating a higher prevalence in females compared to males. Additionally, although the association between animal origin and Hydatidosis was not statistically significant ($p=0.074$), there was a moderate association observed.

Based on the findings of this study, the following recommendations can be made:

- Implementation of control measures: Given the prevalence of Hydatidosis in the studied population, it is crucial to implement effective control measures. This may include regular deworming programs, proper disposal of infected organs, and public health education on the importance of hygienic practices and the risks associated with hydatid cysts.
- Focus on high-risk groups: The study identified age and sex as significant risk factors for Hydatidosis. Therefore, control efforts should prioritize adult animals and females, considering their higher prevalence. Targeted interventions such as strategic deworming and health education campaigns can be developed to address these high-risk groups effectively.
- Improved surveillance and monitoring: Regular monitoring of the prevalence and distribution of Hydatidosis should be conducted in slaughterhouses and livestock

markets to assess the effectiveness of control measures. This will help in evaluating the impact of interventions and modifying strategies accordingly.

- Collaboration and interdisciplinary approach: Addressing Hydatidosis requires collaboration between veterinary services, public health authorities, and relevant stakeholders.
- A multidisciplinary approach involving veterinarians, physicians, epidemiologists, and policymakers can help develop comprehensive control programs, enhance surveillance systems, and promote awareness about the disease.
- Further research: To gain a deeper understanding of Hydatidosis in the study area, further research can be conducted to investigate additional risk factors and explore the economic impact of the disease. Moreover, studies focusing on the molecular characterization of the parasite and its transmission dynamics would contribute to the development of targeted control strategies.

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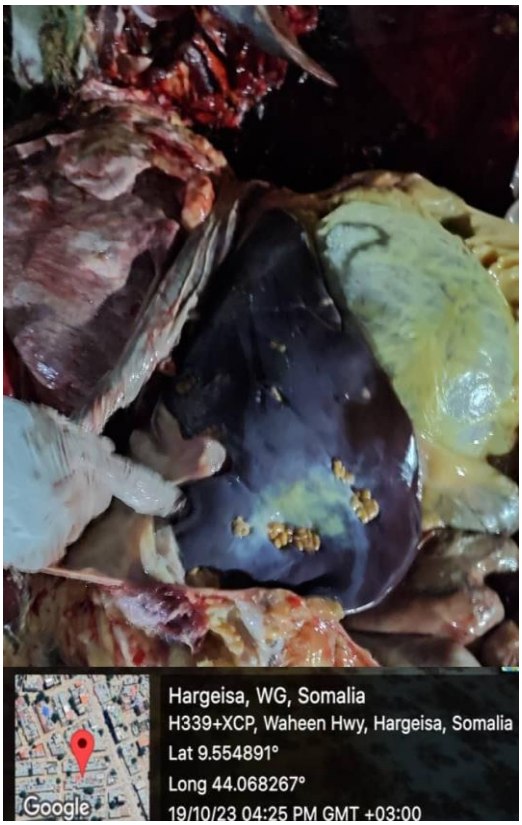
ANNEXES


Hargeisa, WG, Somalia
H339+XCP, Waheen Hwy, Hargeisa, Somalia
Lat 9.554891°
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Hargeisa, WG, Somalia
H339+XCP, Waheen Hwy, Hargeisa, Somalia
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Small ruminant Hydatid cyst survey in Maandeeq slaughter house Hargeisa

NO	Condition (Infection)	Species	Age	Sex	Origin
1	-	1	2	1	3
2	-	1	2	1	3
3	-	1	2	1	3
4	-	1	2	1	2
5	-	1	2	1	2
6	-	1	2	1	2
7	-	2	2	1	2
8	-	2	1	2	2
9	+	2	2	2	2
10	-	2	2	2	2
11	-	2	2	1	1
12	-	2	2	2	2
13	-	2	2	2	2
14	-	1	3	2	2
15	-	2	2	2	1
16	-	2	2	2	2
17	-	1	3	1	1
18	-	2	2	1	3
19	-	2	3	2	2
20	-	2	3	2	2

Index:- condition(-,+), Species (sheep=1, Goat=2), Age(Young=<_ 2 yrs , Adult 3-5 yrs, Old ≥ 5 yrs) Sex (Male=1, Female=2) Origin (Guban=1, Oogo=2, Hawd=3)

(1) (2) (3)

Statutory Declaration

I declare that this thesis presents the work carried out by my self and does not in corporate without the acknowledgement any material previously submitted for a degree or diploma in any university ; and to the best of my understanding , it does not contain any materials previously published or written by another person except where due reference is made in the text; all substantive contributions by others to the work presented including jointly authored publications, is clearly acknowledged.

Name of the candidate:---------- Signature: ----------