



MEKELLE UNIVERSITY

COLLEGE OF VETERINARY SCIENCES



**ASSESSMENT OF KNOWLEDGE, ATTITUDE, AND PRACTICES OF THE
COMMUNITY TOWARDS DOG-MEDIATED RABIES IN ENDERTA DISTRICT,
TIGRAY, ETHIOPIA: A MIXED METHODS APPROACH**

By

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Sciences, Mekelle University in Partial Fulfillment of The Requirements for The Masters of
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Statutory Declaration

I declare that this thesis entitled “**Assessment of Knowledge, Attitude, and Practices of The Community Towards Dog-Mediated Rabies in Enderta District, Tigray, Ethiopia: A Mixed Methods Approach** ” presents the work carried out by myself and does not incorporate without the acknowledgement of 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.

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LIST OF ABBREVIATIONS

AOR	Adjusted Odds Ratio
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CNS	Central Nervous System
COR	Crude Odds Ratio
CSA	Central Statistical Agency
DALY	Disability-Adjusted Life Year
FAT	Fluorescent Antibody Test
FDRE	Federal Democratic Republic of Ethiopia
FGDs	Focus Group Discussion
KAP	Knowledge Attitude and Practices
KIIs	Key Informant Interview
OR	Odds Ratio
PEP	Post Exposure Prophylaxis
RNA	Ribonucleic Acid
WHO	World Health Organization
WOAH	World Organization for Animal Health

ABSTRACT

Rabies is a neglected viral zoonotic disease prevalent in the tropics that significantly impacts developing countries like Ethiopia, primarily transmitted by domestic dogs, causing severe health risks and death to both humans and animals. A cross-sectional study was conducted to assess knowledge, attitude, and practices of the community towards dog-mediated rabies in the Enderta district, Tigray, Ethiopia, from January 2024 to December 2024. Villages were selected purposively, and a systematic random sampling technique was employed for the selection of sample units. Data were collected from 437 households through face-to-face interviews using a pretested and structured questionnaire. In addition to this, six focus group discussions (FGDs) and 12 key informant interviews (KIIs) were performed to collect qualitative data. The data were then analyzed using STATA statistical software version 13 for the quantitative data and thematic analysis for the qualitative data. Descriptive statistical techniques, Pearson's chi-squares analysis, and univariate and multivariate logistic regression analysis were used to analyze the data. The findings revealed that the respondent had good knowledge (63.1%), good attitude (51.4%), and poor practice (43%). However, only 6.6% of respondents were aware of the causative agent of rabies disease. Although 88.3% of the respondents knew about vaccination as a means of rabies prevention, only 23.1% of the respondents practiced dog vaccination. Educated respondents were 8.91 times (AOR = 8.91; 95% CI: 1.070, 74.302) and 36.68 times (AOR = 36.68; 95% CI: 4.477, 300.485) more likely to have good knowledge and practices against rabies compared to respondents with non-formal education. Respondents who had dogs were 2.69 times (AOR = 2.69; 95% CI: 1.703, 4.274) more likely to have a favorable attitude about rabies compared to respondents who had no dogs. Generally, these findings indicate that the Enderta district community has good knowledge and attitude and poor practice about rabies; however, there are gaps in the community's knowledge and attitudes regarding rabies. Therefore, educational outreach should be conducted to ensure accurate knowledge and attitudes and improve practices about rabies in the study area.

Key words: *Attitude; Dog; Enderta; Knowledge; Practice; Rabies*

1. CHAPTER I

1.1. Introduction

Rabies is a zoonotic disease caused by the rabies virus, which belongs to the Rhabdoviridae family and the Lyssavirus genus. This disease is primarily transmitted to humans through close contact with the saliva of infected animals via bites or scratches (Adesina *et al.*, 2020). While various carnivorous animals such as cats, foxes, and bats can act as reservoirs for the virus, dogs account for over 95% of rabies transmission to humans in developing countries (Hampson *et al.*, 2015).

Globally, rabies causes approximately 60,000 human deaths annually, with over 95% of these fatalities occurring in Asia and Africa; notably, Africa alone accounts for 44% of these deaths (Woldegeorgis *et al.*, 2023). In Ethiopia, it was estimated that over 2,700 human lives were lost due to rabies in 2015 (Hampson *et al.*, 2015). Despite vaccination efforts, such as the vaccination of 4,734 dogs between 2010 and 2013 in Mekelle and its surroundings. Rabies remains prevalent in Ethiopia, particularly in the Tigray region, where surveillance data indicated 1,439 cases of exposure to suspected rabid dogs (Haile *et al.*, 2017).

National surveillance data reported by the Ethiopian Public Health Institute in 2016 revealed a total of 2,928 cases exposed to suspected rabid dogs and 31 rabies-related deaths across the country. Of these cases, Tigray accounted for 1,439 (49.1%), ranking first among other regions (Haile *et al.*, 2017). Although rabies is a disease that is nearly 100% preventable through timely intervention, it remains almost universally fatal once clinical symptoms appear. Globally, rabies leads to over 3.7 million disability-adjusted life years (DALY) lost and an estimated economic loss of \$8.6 billion annually due to premature death (55%) and direct costs associated with post-exposure prophylaxis (Beyene *et al.*, 2020).

All forms of bites, scratches, or other situations where saliva, cerebral or spinal fluid, tears, or nervous tissues from a suspected or confirmed rabid animal or person enter an open wound, are transplanted into, or come into contact with the mucous membrane of another

animal or person are the most common ways that rabies is spread. Infection with the rabies virus usually happens when a rabid animal bites another animal or a human. The virus then invades the central nervous system, resulting in acute and fatal encephalomyelitis (Oyda and Megersa, 2017). In Ethiopia, dogs are responsible for 97% of rabies-related human deaths. Despite the availability of vaccines for both human and dogs in the country, only 3.9% of dogs were found vaccinated in the study done from 2009-2012 in Addis Ababa (Kidane *et al.*, 2016). Rabies victim individuals, especially from rural areas, usually come to health institutions after failing traditional intervention and losing from family members (Beasley *et al.*, 2022).

Preventive measures against rabies include vaccination, wound care, and rabies immunoglobulin injection; however, many developing countries face high mortality rates due to limited access to affordable post-exposure prophylaxis (PEP). Eliminating canine rabies is crucial for reducing human deaths; this requires addressing past failures in rabies control across Africa (Hampson *et al.*, 2015).

The World Health Organization recommends vaccinating at least 70% of dogs in rabies-endemic areas to significantly lower transmission risks; however, vaccination coverage remains alarmingly low, often around 9% in many African nations compounded by socio-economic barriers. Effective control measures are vital since rabies is preventable but nearly always fatal once symptoms appear (Iddi *et al.*, 2023).

To combat this issue on a global scale, the WHO has established the "Zero by 30" strategy plan aimed at eradicating endemic rabies globally by 2030 through preventing human deaths caused by dog-mediated rabies. While widespread vaccination is recognized as the most effective strategy, addressing economic, cultural, social, educational, and technological issues is essential, particularly in regions like Asia and Africa where the burden of rabies is significant (WHO, 2018).

In Ethiopia specifically, community efforts involving both veterinary and public health officials are crucial for effective prevention of human rabies. Additionally, establishing baseline information on coverage rates for practices such as dog vaccination, proper care of bite wounds, seeking Post-Exposure Prophylaxis treatment, and managing rabid dogs is

important for predicting successful rabies control and elimination strategies (Gebrezgiher *et al.*, 2018).

1.1.1. Statement of the Problem

Rabies, a highly significant public health challenge, continues to pose a major threat in many developing countries, like Ethiopia. The country has long recognized rabies as an important disease with widespread implications for public health. In particular, the rural areas of Tigray, where many households' own dogs primarily for security purposes, have emerged as a hotspot for rabies transmission. National surveillance data from the Ethiopian Public Health Institute in 2016 revealed that Tigray ranked first among regions in terms of rabies cases. Despite this recognition, prevention and control practices face numerous challenges (Haile *et al.*, 2017).

Compounding the existing challenges, the destructive war in Tigray has further exacerbated the situation. The war has resulted in the destruction of crucial veterinary clinics and public health centers, effectively crippling the infrastructure necessary for effective control and prevention of dog-mediated rabies. Moreover, during this war period, essential measures such as the elimination of stray dogs, dog vaccination campaigns, and post-exposure treatments were absent. Consequently, the prevalence of rabies disease has witnessed an alarming increase within the study area. This urgent situation demands urgent attention and underscores the critical need to assess the knowledge, attitudes, and practices towards dog-mediated rabies in the community of the Enderta district.

The junction of these factors, like persistent rabies challenges, the lack of information on knowledge, attitude, and practices, and the devastating impact of the war, has created a pressing need to conduct a comprehensive assessment.

1.1.2. Objectives of the Study

1.1.2.1. General Objective

❖ To assess knowledge, attitude and practices towards dog-mediated rabies in the community of Enderta district, Tigray, Ethiopia.

1.1.2.2. Specific Objectives

- To assess knowledge towards dog-mediated rabies in the community of Enderta District.
- To assess attitude towards dog-mediated rabies in the community of Enderta District.
- To assess practice towards dog-mediated rabies in the community of Enderta District.

1.1.3. Significance of the Study

Rabies is a deadly viral disease that has a substantial influence on both human and animal health. It is typically spread via bites or scratches from infected animals, particularly dogs. Understanding the community's knowledge, attitudes, and practices (KAP) on dog-mediated rabies is critical for identifying activities that may contribute to the disease's spread or control.

The purpose of this study is to investigate Knowledge, Attitudes, and Practices for dog-mediated rabies in the Enderta District of Tigray, Ethiopia. The findings, which indicate gaps in knowledge and behavioral patterns, will help to guide targeted interventions and educational initiatives aimed at raising awareness and enhancing preventive measures.

Conducting this research locally enables the development of tailored strategies and policies that consider regional cultures, socioeconomic factors, and healthcare infrastructure. As a zoonotic disease, rabies underscores the importance of a One Health approach, which recognizes the interconnectedness of human, animal, and environmental health. By studying knowledge, attitudes, and practices related to dog-mediated rabies, this research aligns with the One Health framework, addressing factors influencing rabies transmission and supporting collaborative efforts across health sectors. Ultimately, this study will enhance understanding of rabies dynamics and contribute to effective control and prevention strategies.

Ultimately, understanding community knowledge, attitudes and practices is vital for designing effective prevention and control strategies. The insights gained will guide

evidence-based policies to mitigate the burden of dog-mediated rabies, safeguarding the health and well-being of both humans and animals in the region.

1.2. Literature Review

The word rabies is derived from the Latin word “rabere,” which means “to be mad.” The disease has been identified since the beginning of civilization as a significant zoonotic viral disease. Rabid animals serve as the primary source of the rabies virus, leading to human infections. Rabies is a dangerous disease with a global presence, primarily transmitted to humans and livestock by carnivorous animals. Despite its severity, rabies is often considered a neglected disease, particularly in many developing countries across Asia and Africa (Bilal, 2021)

1.2.1. Etiology

The virus that causes rabies is a non-segmented, negative-sense, single-stranded RNA virus that is a member of the Lyssavirus genus in the Rhabdoviridae family. Rabies, an acute encephalitis that can be fatal if clinical symptoms appear, can affect almost all mammals. This viral zoonosis, which causes severe neurological disease in both humans and warm-blooded animals, always results in the death of the infected person. The rabies virus, the prototype species of the Lyssavirus genus, is responsible for the widespread transmission of the disease through animal bites or scratches (Fisher *et al.*, 2018).

1.2.2. Epidemiology

1.2.2.1. Geographic distribution

Rabies is a neglected zoonotic viral disease that has a widespread geographic distribution, predominantly affecting developing countries in Asia and Africa, where it poses significant public health challenges. Globally, it is estimated that around 59,000 human deaths occur annually due to rabies, with a staggering 95% of these fatalities occurring in Asia and Africa, primarily as a result of bites from infected dogs. The disease is endemic in many regions where dog populations are poorly managed and vaccination efforts are inadequate. In contrast, rabies has been largely eliminated in parts of Western Europe, North America, and Japan through effective vaccination programs and stringent animal control measures.

However, the threat of reintroduction remains in these areas due to potential exposure from travel to endemic regions or through wildlife reservoirs (Ertl, 2020).

The persistence of rabies in many low-income countries can be attributed to factors such as limited access to post-exposure prophylaxis (PEP), lack of public awareness, and ineffective management of free-roaming dog populations. Thus, while rabies is a preventable disease, its geographic distribution reflects significant disparities in health infrastructure and community engagement across different regions of the world (Hampson *et al.*, 2015).

In Africa, approximately 24,000 human deaths occur annually, making it the continent with the second-highest rabies prevalence after Asia; the disease is primarily transmitted through domestic dogs, which are often unvaccinated and free-roaming. Asia accounts for the highest incidence, with an estimated 31,000 deaths each year, particularly in countries like India, where stray dog populations contribute to widespread transmission. In North America, rabies has been largely controlled through effective vaccination campaigns and public health measures, resulting in fewer than 100 cases annually, primarily from wildlife reservoirs like bats and raccoons (CDC, 2023).

South America sees sporadic cases of rabies, especially in rural areas with limited access to vaccination; however, some countries have made significant progress in controlling the disease through vaccination programs (Rocha, 2020). In Europe, rabies has been eliminated in many regions due to comprehensive vaccination efforts for domestic animals and wildlife management strategies; however, occasional cases still arise from wildlife (Freuling *et al.*, 2013). Australia is considered rabies-free, with strict biosecurity measures preventing its introduction, while Antarctica remains free from rabies due to its isolated environment and lack of susceptible wildlife (WHO, 2024).

Dog-mediated rabies is a significant public health concern in Ethiopia, with varying prevalence rates across different regions. A systematic review and meta-analysis conducted from 2010 to 2020 revealed a pooled prevalence of 32% for rabies in the country, with regional disparities highlighting a 78% prevalence in Addis Ababa, 46% in Oromia, and 40% in Tigray (Belete *et al.*, 2021).

In Tigray specifically, the prevalence of rabies was reported to be around 55%, indicating a high burden of the disease in this region. The high incidence is attributed to several factors, including poor dog management practices, low vaccination coverage among domestic dogs, and a lack of public awareness about rabies transmission and prevention. Many communities lack adequate access to veterinary services, which exacerbates the risk of rabies transmission from dogs to humans. Furthermore, cultural practices often lead individuals to seek treatment from traditional healers rather than formal healthcare facilities after potential rabies exposure. Notably, human rabies exposure cases have been frequently recorded, particularly in Northwestern Tigray, where studies indicate a rising trend in reported cases over recent years (Gebreyohans *et al.*, 2017).

1.2.2.2. Host range

The rabies virus can infect any mammal, but only a few species serve as reservoir hosts. The families they belong to are Canidae (dogs, jackals, coyotes, wolves, foxes, and raccoon dogs), Mustelidae (skunks), Viverridae (mongooses), and Procyonidae (raccoons), as well as the order Chiroptera (bats). Rabies reservoirs are generally grouped into terrestrial (i.e., land-dwelling) species and bat species (CDC, 2024).

In Africa, south America, and Asia, domestic dogs are the main reservoir for rabies, responsible for the majority of human cases. Other reservoirs include wildlife such as bats, jackals, and hyenas. In Europe, rabies is primarily maintained in wildlife populations, particularly in bats and foxes. Domestic dogs have been largely controlled through vaccination. In North America, the primary reservoirs include bats, raccoons, skunks, and foxes. Domestic dogs are less of a concern due to widespread vaccination (WHO, 2018).

The host range of rabies in Ethiopia primarily includes domestic animals, particularly dogs, as well as various wildlife species. The disease is predominantly transmitted through bites from infected animals, with domestic dogs serving as the main reservoir and responsible for the majority of human rabies cases (Gelgie *et al.*, 2022). Wildlife species are implicated in the maintenance and transmission of rabies. Notably, studies have identified urban carnivores such as hyenas and cats as significant contributors to rabies maintenance through both intra-and inter-species transmission. Hyenas, in particular, exhibit high contact rates that facilitate rabies transmission. Other wildlife species,

including jackals and mongooses, are also considered potential reservoirs for rabies, especially in areas where they interact with domestic animals (Binkley *et al.*, 2022).

1.2.2.3. *Transmission*

Rabies is primarily transmitted through bites or scratches from infected animals, with saliva being the main vector for the virus. When a rabid animal bites another animal or a human, the rabies virus is introduced into the body through the wound (Akinsulie *et al.*, 2024). The virus can also enter through mucous membranes if saliva comes into contact with open wounds, the eyes, mouth, or nose. Once inside, the rabies virus travels along peripheral nerves to the central nervous system (CNS), where it replicates and spreads. This neurotropic behavior of the virus means that exposure to highly innervated areas, such as the face and hands, can increase the likelihood of infection and potentially shorten the incubation period before symptoms appear (CDC, 2024).

In Ethiopia, domestic dogs are responsible for approximately 99% of rabies cases in humans, underscoring the critical need for effective control measures targeting dog populations (Belay *et al.*, 2024). The epidemiology of rabies is particularly concerning due to the high population of unvaccinated dogs and limited access to post-exposure prophylaxis (PEP). The interaction between domestic dogs and wildlife, such as jackals and hyenas, further complicates control efforts, as these species can also serve as reservoirs for rabies transmission (Aklilu *et al.*, 2021).

The World Health Organization (WHO) strongly advises against the consumption of raw meat from rabies-infected animals. While there are no documented cases of rabies transmission through the consumption of cooked meat, eating raw meat from an infected animal requires post-exposure prophylaxis (PEP). The WHO emphasizes that butchering or consuming meat from a rabid animal poses potential risks, and proper disposal methods for the carcass should be employed to prevent exposure to the virus (WHO, 2018).

1.2.3. *Pathogenesis*

The rabies virus enters the body through cuts or by coming into close contact with mucous membranes. It can't pass through healthy skin. In order for the rabies virus to reach the central nervous system, it must first replicate in the bitten muscle (local viral proliferation

in non-neural tissue) and then attach itself to motor endplates and motor axons. Virions are carried in transport vesicles and travel to the central nervous system (CNS) exclusively by fast retrograde transport along motor axons, with no uptake by sensory or sympathetic endings. The salivary glands become infected and release virus particles into the saliva after centrifugal transport along efferent cranial neurons. Infection of the brain commonly leads to behavioral changes that induce the host to bite other animals, thereby transmitting the virus (Tiwari *et al.*, 2021).

Widespread infections of the central nervous system nearly always result in death, mostly from respiratory paralysis but also from secondary viral, metabolic, or circulatory processes. During a penetrating injury, viruses can potentially directly infect peripheral nerve motor axons. Rabies virus has a variable incubation period in humans that ranges from 5 days to several years. The incubation period is influenced by the distance of the virus entry to the central nervous system, the density of nerve motor endplates at the wound site, and the quantity of virus in the inoculum. If a strong inoculum is transferred through several bites, deep wounds, or huge wounds, or if the patient is bitten on the head or neck, the incubation period is fewer than 50 days. A person who gets a scratch on their hand might not have rabies symptoms as quickly as someone who gets bitten in the head. The incubation period for dogs and cats ranges from 10 days to 6 months, with the majority of cases showing up between 2 weeks and 3 months (Ghosh *et al.*, 2020).

1.2.4. Clinical signs

The clinical picture might vary greatly between species, within individuals of the same species, and even within a single individual's disease history. Animals suffering from rabies may exhibit odd behavior as the illness worsens. Laboratory testing is required to confirm any clinical suspicion of rabies. Fear, restlessness, anorexia or increased hunger, vomiting, diarrhea, a mild fever, pupil dilatation, hyperreactivity to stimuli, and excessive salivation are some of the earliest clinical indications, which are frequently non-specific. Lameness in the vaccinated leg is typically the first indication of post-vaccinal rabies. Animals frequently experience behavioral and temperamental changes; they may exhibit exceptional levels of aggression or tenderness (CDC, 2024).

In the prodromal stage, after a certain incubation period, the onset of clinical symptoms follows. This initial phase, which typically lasts one to three days, may involve slight behavioral changes, such as aggression in domesticated animals, daytime activity in nocturnal animals, lack of fear of people in wild animals, or irregularities in appetite (Warrell and Warrell, 2015).

During the furious phase, after the prodromal stage, there occurs a time of extreme agitation and aggression. Any material is frequently bitten by the animal. Furious rabies, for instance, can cause a characteristic high barking sound in rabies-infected canines. Even if the condition does not progress to the paralytic stage, convulsions may still result in death. Symptoms of the furious variety include drooling, howling, polypnea, restlessness, wandering, and attacks on inanimate things, people, or other animals. Animals with the condition frequently ingest foreign things like sticks and stones. creatures in the wild often lose their fear of people and may attack people or other creatures they would ordinarily avoid (such as porcupines). It is possible to see nocturnal animals during the day. In cattle, this type may also manifest as extraordinary attentiveness (Merck and Dohme, 2024).

Progressive paralysis is a hallmark of the dumb or paralytic type of rabies. The masseter and neck muscles are paralyzed in this kind, causing the animal to salivate excessively and perhaps be unable to swallow. A change in vocalization, such as an aberrant bellow in cattle or a hoarse howling in dogs, can result from laryngeal paralysis. In addition, there may be facial paralysis or a dip in the lower jaw. Ruminants may become lethargic or despondent and split off from the herd. Rumination might end. Additionally observed are ataxia, incoordination, and progressive spinal paresis or paralysis. The difficulty to swallow, which results in the characteristic appearance of foamy saliva around the mouth, is what defines this stage. The hind extremities may be the first to become paralyzed in certain animals. Eventually, complete paralysis is followed by death (CDC, 2024).

1.2.5. Diagnosis

Laboratory diagnosis of rabies in humans and animals is essential for timely post-exposure prophylaxis, and it may be carried out either in vivo or postmortem. Diagnosing rabies ante-mortem can be challenging, as no clinical signs are pathognomonic for the disease, although hydrophobia is highly suggestive. The historical reliance on detecting

Negribodies is no longer considered suitable due to low sensitivity, leading to the development of alternative laboratory-based tests that conclusively confirm infection (Ali, 2022).

Most diagnostic tests for the rabies virus in animals require brain material, making them primarily postmortem procedures. Diagnosis can be achieved by sampling any part of the affected brain; however, to rule out rabies, tissues from at least two locations, including the brain stem and cerebellum, must be tested. Brain smears or touch impressions are utilized for detecting viral antigens using the Fluorescent Antibody Test (FAT), which is regarded as the gold standard for identifying rabies virus antigens in brain tissue for both human and animal samples (WHO, 2024).

1.2.6. Prevention and Control

1.2.6.1. Public health education

Regular veterinary care and immunization, responsible pet ownership, professional continuing education, and continuous public education are all crucial elements of rabies prevention and control (Asfaw *et al.*, 2024). Raising awareness about rabies transmission routes and avoiding interaction with wildlife will help prevent most animal and human exposures to the disease. It is essential to promptly identify and notify local public health authorities and medical professionals of any potential exposures (Hasanov *et al.*, 2018).

1.2.6.2. Human rabies prevention

Human rabies can be prevented by eliminating exposure to the rabies virus and providing appropriate rabies pre-exposure prophylaxis and prompt local treatment of bite wounds combined with appropriate rabies post-exposure prophylaxis. Inactivated human vaccines are available for at-risk veterinary staff, other animal handlers, wildlife officers, laboratory workers, and others at high risk of exposure (FDRE, 2018).

1.2.6.3. Animal rabies control

The main elements of a companion animal rabies control program include licensing and vaccination; controlling stray animals; reporting, looking into, and isolating animals involved in bite events; and educating the public. A number of vaccines are approved for use in domestic animals. Among the vaccines that are available are those that are vectored

by inactivated or modified live viruses, those that may be administered intramuscularly or subcutaneously, those that have immunity durations ranging from one to four years, and those with different minimum vaccination ages (WHO, 2024).

1.2.6.4. Animal bites reporting

Any person or animal bitten by or possibly exposed to a rabid or suspected rabid animal must be reported right away to the local health officer or designee. Additionally, whenever a person is bitten by an animal, the local health officer or designee must be informed. Potential human rabies exposures are then evaluated, and rabies post-exposure prophylaxis (PEP) recommendations are made (Adesina *et al.*, 2020).

1.2.6.5. Stray animal control

Effective control of stray animal populations is crucial for public health and animal welfare, requiring a multifaceted approach that includes sterilization, vaccination, and community education. Additionally, responsible pet ownership initiatives, including licensing and identification, play a vital role in preventing abandonment and overpopulation. Public health agencies must collaborate with local governments, veterinary services, and non-governmental organizations to implement comprehensive strategies that address the root causes of stray populations while ensuring the welfare of both animals and humans. By integrating education, legislation, and community engagement into stray animal management programs, communities can achieve sustainable solutions that promote harmony between people and animals (Abdulkarim *et al.*, 2021).

1.2.6.6. Isolation of animals exposed to rabies

Isolation of animals exposed to rabies is a critical public health measure aimed at preventing the spread of this deadly virus. When an animal is suspected of being exposed to rabies, particularly if it has bitten a human, it must be quarantined for a specified observation period to monitor for any signs of the disease. For example, unvaccinated dogs and cats are typically required to undergo a four-month quarantine, while vaccinated animals may only need to be observed for 10 days if they appear healthy (Ali, 2022).

This isolation allows health officials to assess the animal's health status and determine whether rabies symptoms develop, which is crucial since rabies is almost always fatal once

clinical signs appear. The isolation process also involves strict guidelines regarding the animal's confinement, ensuring that it cannot come into contact with humans or other animals during the observation period. Effective communication between pet owners and local health authorities is essential throughout this process to ensure compliance and timely reporting of any changes in the animal's condition (Hampson *et al.*, 2015).

1.2.6.7. Vaccination in animals

Vaccination plays a critical role in controlling rabies, particularly in domestic animals such as dogs and cats, which are the primary vectors for transmitting the virus to humans (Menghistu *et al.*, 2018). In regions like Ethiopia, implementing effective vaccination programs is essential for preventing rabies outbreaks. Vaccines licensed for use in animals are designed to induce immunity against the rabies virus, thereby reducing the incidence of the disease (Beyene *et al.*, 2020).

The World Organization for Animal Health (WOAH) emphasizes that systematic vaccination campaigns should be tailored to the epidemiological characteristics of rabies in specific areas, ensuring that a significant proportion of the susceptible animal population is immunized within a defined timeframe. This approach not only protects individual animals but also contributes to herd immunity, thereby reducing the overall risk of rabies transmission within communities. In addition to routine vaccinations, public awareness and community engagement are vital components of successful rabies control strategies. Educating pet owners about the importance of vaccinating their animals against rabies can lead to higher vaccination rates and improved community health outcomes. Vaccination programs should be supported by local veterinary services and public health authorities to ensure accessibility and compliance. Furthermore, monitoring and reporting systems are essential for tracking vaccination coverage and identifying areas with low immunization rates (WOAH, 2023).

2. CHAPTER II: MATERIALS AND METHODS

2.1. Study Area

The present study was conducted in the Enderta district from January 2024 to December 2024. Enderta is found in the southeast zone of the Tigray Region of Ethiopia, located approximately 783 km away from Addis Ababa. According to population projections by the Central Statistical Agency (CSA) of Ethiopia, the total population of Enderta district is 130,020. Of these, males account for 64,913, and females account for 65,107 (CSA, 2022). According to evidence from the district's agricultural bureau, there are 24 tabias and 43,008 household heads.

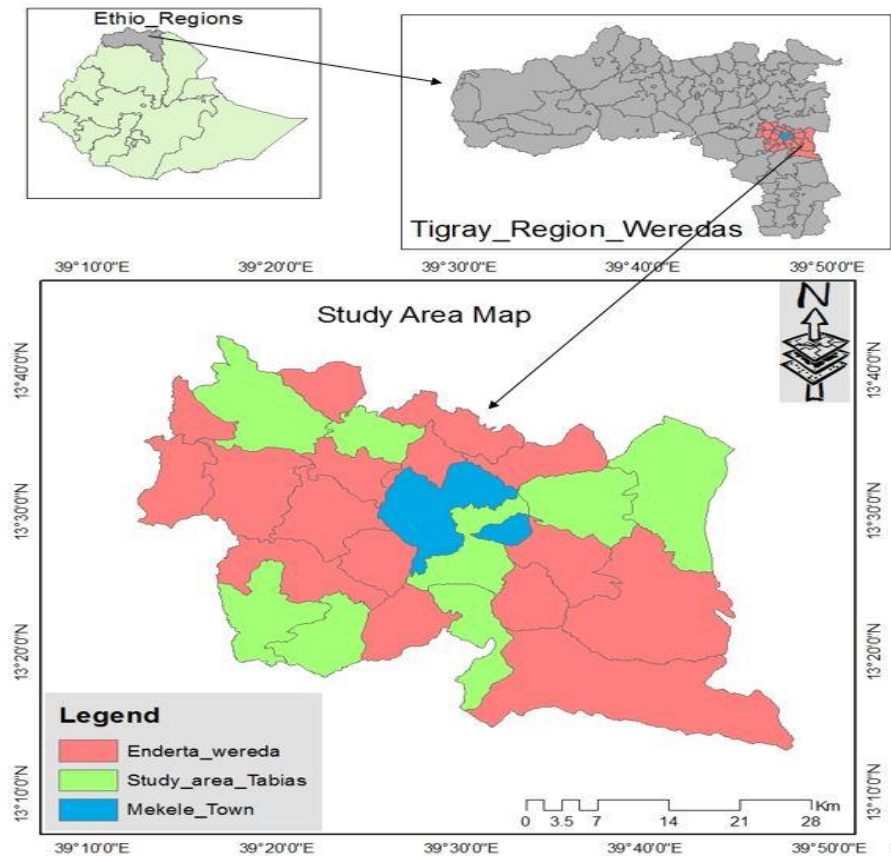


Figure 1: Map of the Enderta district, Tigray, Ethiopia

Source (CSA, 2020)

2.2. Study Population

The study population for the present research work includes household heads who reside in the selected tabias of the Enderta District in the Tigray regional state of Ethiopia. Individuals who have been at least six months as permanent residents and are age of eighteen years and above were included in the study.

2.3. Study Design

The present research employed a mixed-method design, utilizing both quantitative and qualitative methods, to comprehensively assess knowledge, attitude, and practices of the towards dog-mediated rabies in the community of the Enderta district, Tigray regional state of Ethiopia. The study encompassed a range of data collection techniques, including a cross-sectional survey, focus group discussions (FGDs), and key informant interviews (KIIs).

2.4. Sampling Technique

The study tabias were selected purposefully based on the number of household heads that have more than 2000 household heads. Accordingly, eight tabias namely Arato, Metkel, Mahbere genet, Didiba, Dejen, Adi azmera, Derga ajen and Kedamay weyane were selected. Systematic random sampling was employed to select the households. The household heads list of the tabiya administration was used as a sampling frame. Participants for FGDs and KIIs were selected purposefully.

2.5. Sample Size Determination

Based on the data obtained from the Enderta district database, there are approximately 43,008 household heads. Sample size was determined using a simplified proportion suggested by Yamane's formula (1973), considering a 95% confidence level and a 5% precision level.

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

$$n = \frac{43,008}{1 + 43,008 * 0.05 * 0.05} = 393$$

Where; n = required sample size,

$$N = \text{Total population on the study} = 43,008$$

$$e^2 = \text{the margin error in the calculation (level of precision)} = 0.05$$

The calculated sample size for this study was 397 i.e. the necessary sample size. In order to reduce the possibility of random errors and increase accuracy, the sample size was increased by 10% (to account for the non-response rate), 40 respondents were added. Accordingly, a total of 437 household heads were selected and interviewed in the present study. Due to the difference in the number of household heads within the selected tabias, the sample size was allocated proportionally based on their number of household size in the selected tabias.

The combined number of household heads in the selected eight Tabiyas, namely Arato (2866), Metkel (2567), Mahbere Genet (2547), Didiba (2441), Dejen (2417), Adi azmera (2410), Derga ajen (2170) and Kedamay weyane (2040), was 19,458. The distribution of individuals in each selected tabiya for the study was determined using the probability proportion equation ($n_i = N_i * n / N$), where n_i represents the total number of study subjects in each tabiya, N_i is the overall population in each tabiya, n indicates the total number of study subjects acquired, and N is the total population in the selected tabias. Consequently, the number of participants from Arato, Metkel, Mahbere Genet, Didiba, Dejen, Adi azmera, Derga ajen and Kedamay weyane were 64,58,57,55,54,54,49 and 46, respectively. Furthermore, six focus group discussions, each involving 6-12 participants, and twelve key informant interviews, as outlined by Hennink *et al.* (2019) and Muellmann *et al.* (2021), respectively, were conducted throughout the study duration.

2.6. Data collection procedures

2.6.1. Quantitative

A structured questionnaire was prepared and translated into Tigrigna and then translated back into English to maintain consistency. The questionnaires were pretested in the surrounding Enderta districts. Some questions were modified following the pretest based on the specific needs and understanding of the target population. The interview was held face to face with the interviewer.

The questionnaire addresses socio-demographic information of the respondent, such as age, educational status, occupation, dog ownership, and family exposure to dog bites, and questions related to knowledge, attitude, and practices of respondents towards rabies.

2.6.2. Qualitative

Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were employed to gather in-depth insights and perspectives on the subject matter, conducted in the local language, Tigrigna. These qualitative data collection methods provided an opportunity for participants to freely express their thoughts and experiences related to rabies.

The interviews and discussions were guided by interview guides consisting of open-ended questions. This approach allowed participants to share their perspectives in their own words, providing rich and detailed information. The researcher seeks verbal consent from participants before initiating the discussions, ensuring that their participation is voluntary and based on informed consent. Six FGDs, consisting of 7 to 12 participants each, were formed. Focus Group Discussion meetings were moderated by the researcher and each discussion was held until it reaches a saturation point. twelve KIIs were also conducted.

To ensure accuracy and capture the nuances of the conversations, the discussions was recorded. These records allow for later transcription and analysis of the data, ensuring that no valuable information is missed during the interviews. Throughout the interview process, the interviewer was also played an important role in maintaining focus on the topic at hand, guiding the conversation, and ensuring that relevant aspects of the rabies in the community are explored in depth.

2.7. Operational Definition

I. Knowledge assessment

Fifteen questions were prepared using a set of structured questions to assess the level of knowledge of the respondents towards the rabies disease. Each correct response was given a score of 1 for yes and 0 for no. The assessment method was modified Bloom's cutoff points from the 2007 KAP (knowledge, attitude, and practice) Study by Ms. Nahida. Out of fifteen available points, a score of eight or above (53.3–100% of correct answers) indicated good knowledge, while a score of seven or lower (46.6%) showed poor knowledge.

II. Attitude Assessment

Attitude was assessed by a list of thirteen questions put on Likert's scale. The questions on Likert's scale of have 5 options (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). After adding together all of the responses, each respondent's overall score was determined. After calculating the average score from the thirteen questionnaires, it was decided that respondents with scores above the average (7 and above, or 53.8-100%) had a favorable attitude, while scores below the average (6, or 46.1%) showed an unfavorable attitude towards dog-mediated rabies.

III. Practice assessment

Thirteen questions were prepared to assess participants to evaluate their activity of practice; a good practice was defined as providing seven or more accurate responses (53.8%), whereas a poor practice was defined as providing fewer than seven correct answers (46.6%).

2.8. Data Analysis

The collected data was entered into a Microsoft Excel spreadsheet and analyzed by using STATA statistical software version 13. The data was cleaned, coded, recoded, and checked for statistical assumptions. Descriptive statistics was employed to summarize the data and reported as frequency and percent in table form. Additionally, univariate logistic regression analysis was carried out to quantify the degree of association between knowledge, attitude, and practice levels of the participants with the socio-demographic factors and expressed in terms of crud odds ratio (COR) and 95% Confidence level (CI). Those variables significant at the univariant analysis were further included in the multivariate logistic regression analysis and expressed as adjusted odds ratios (AOR) and 95% CI. A step-wise method of model development was used and the goodness-of-fit of the developed model was tested by using the Hosmer and Lemeshow test. Moreover, the model prediction power was checked by using ROC curve. For all analysis a cutoff value ($P < 0.05$) was used for statistically significant difference. For the qualitative data thematic analysis was employed.

2.9. Ethical Consideration

Ethical approval was obtained from Mekelle University, College of Veterinary Sciences. Additionally, all interviewees provided their spoken informed permission. Although a separate written consent was not provided, the consent statement was already written in the questionnaires and submitted as additional files (Annex I). The phrase that clarifies the participants' consent to participate is provided in the questionnaire.

3. CHAPTER III: RESULTS

3.1. Quantitative Results

3.1.1. Socio-Demographic Information of the Respondents

A total of 437 household heads were interviewed during the study period of this research with a 100% response rate. The majority of the respondents were males (302), which accounts for 69.1%. Regarding age group, the majority (203 [46.4%]) of participants were between 30 and 45 years old. Among the participants, more than half (283 [64.5%]) were with non-formal education, and (187 [42.7%]) of the respondents had family size between 4 and 6. Regarding religion, most of the respondents (403 [92.2%]), were Orthodox Christians. Moreover, 86.2% (377/437) of the respondents were farmers and 56% (245/437) owned dogs (Table 1).

Table 1: Socio-demographic information of the study participants

Characteristics	Frequency	Percentage (%)
Tabia		
Arato	64	14.65
Metkel	58	13.27
Mahbere genet	57	13.04
Didiba	55	12.59
Dejen	54	12.36
Adi azmera	54	12.36
Derga ajen	49	11.21
Kedamay weyane	46	10.53
Sex of the respondents		
Male	302	69.11
Female	135	30.89
Marital status		
Married	372	85.13
Single	32	7.32
Divorced	15	3.43

Widowed	18	4.12
Age of the respondents (in years)		
18-29	56	12.81
30-45	203	46.45
>45	178	40.73
Total	437	100
Household size		
1-3	106	24.26
4-6	187	42.79
>6	144	32.95
Level of education		
Non-formal education	282	64.53
Primary school	106	24.26
Secondary school	36	8.24
Higher education (diploma and above)	13	2.97
Occupation		
Farmer	377	86.27
Merchandiser	26	5.95
Governmental or non-governmental employed	22	5.03
Skilled private worker	12	2.75
Religion		
Orthodox	403	92.22
Muslim	34	7.78
Are you a health professional?		
Yes	6	1.37
No	431	98.63
Dog ownership		
Yes	245	56.06
No	192	43.94

Family exposure to dog bite		
Yes	13	2.97
No	424	97.03

3.1.2. Knowledge of Participants Towards Dog-Mediated Rabies

This study revealed that the majority of the study participants of the current study had good knowledge about rabies (276 [63.1%]). In the study, 81% of those surveyed were aware that rabies can affect all warm-blooded animals, including human beings. About 75.7% of the respondents knew that bite or scratching by a rabid animal or contact with saliva on the mucus membrane is the mode of transmission from rabid animals to humans. In this study, 98.1% of the survey participants said that sudden change in behavior, paralysis, and excessive salivation is the main clinical sign of rabies in animals. In addition, 92.2% of the study participants revealed that rabies is a fatal disease in non-vaccinated humans, if left untreated. 88.5% of the respondents knew rabies had a vaccine (Table 2).

Table 2: Knowledge of study participants towards dog-mediated rabies

Characteristics	Frequency	Percentage (%)
Knowledge		
Good knowledge	276	63.16
Poor knowledge	161	36.84
Do you know about rabies disease?		
Yes	302	69.11
No	135	30.89
Have you ever got a training education program regarding rabies disease?		
Yes	62	14.19
No	375	85.81
Do you know that rabies can affect all warm-blooded animals, including humans?		
Yes	354	81.01
No	83	18.99

What is the cause of the rabies disease?		
Germs	29	6.64
Shortage of food and water (starvation)	151	34.55
anger of God	169	38.67
Unknown	88	20.14
What is the most common source of rabies disease in your locality?		
Pet animals (dog and cat)	244	55.84
Other domestic animals (cattle, sheep, and goat)	174	39.82
Insects	19	4.35
Does rabies transmit from animals to humans?		
Yes	433	99.08
No	4	0.92
Does rabies transmit among animals?		
Yes	227	51.95
No	210	48.05
What is the mode of transmission of rabies from rabid animals to humans?		
Bite by a rabid animal or contact with saliva on the mucus membrane	331	75.74
Insect bite	104	23.80
Wind	2	0.46
What are the main signs and symptoms of rabies in animals?		
Change in behavior and paralysis, excessive salivation.	429	98.17
Excessive thirst, rolling on the ground	8	1.83
What are the main signs and symptoms of rabies in humans?		
Hydrophobia, muscle weakness, and paralysis.	114	26.09
Excessive thirst, coughing, rash, and skin lesions	323	73.91
Do you know that rabies is fatal once clinical signs develop in animals?		
Yes	94	21.51
No	343	78.49
Is rabies a fatal disease in humans if left untreated?		

Yes	403	92.22
No	34	7.78
Can rabies be transmitted through the consumption of meat from a rabid food animal?		
Yes	124	28.38
No	313	71.62
Can wild animals like hyenas transmit rabies to humans or animals by biting?		
Yes	127	29.06
No	310	70.94
Does rabies disease have a vaccine?		
Yes	387	88.56
No	50	11.44

Univariate and multivariate logistic regression results on knowledge

Males were 2.60 times (AOR=2.60; 95% CI: 1.590, 4.270) more likely to have good knowledge about rabies compared to females, and it was found to be statistically significant. Respondents who had dogs were 2.36 times (AOR = 2.36; 95% CI: 1.509, 3.705) more likely to have good knowledge towards rabies compared to respondents who had no dogs, and the association was found to be statistically significant. The Crude Odds Ratio (COR) and Adjusted Odds Ratio (AOR) results are presented in table 3.

Table 3: Factors associated with knowledge towards dog-mediated rabies

Characteristics	Total	knowledge N (%)	COR 95% CI	P- value	AOR 95% CI	P- value
Sex						
Male	302	209 (69.2)	2.28 (1.503,3.459)	0.000	2.60 (1.590,4.270)	0.000
Female	135	67 (49.6)	Reference	-	Reference	-
Marital status						
Married	372	232 (62.3)	2.48 (0.866,7.132)	0.090		

Single	32	27 (84.3)	8.1 (1.984,33.054)	0.004		
Divorced	15	6 (40.0)	Reference	-		
Widowed	18	11 (61.1)	2.35 (0.580,9.576)	0.231		
Age in years						
18-29	56	47 (83.9)	3.46 (1.611,7.461)	0.001	3.12 (1.262,7.735)	0.014
30-45	203	122 (60.1)	Reference	-	Reference	-
>45	178	107 (60.1)	1.00 (0.663, 1.509)	0.998	0.64 (0.372,1.099)	0.106
Household size						
1-3	106	79 (74.5)	2.71 (1.609,4.578)	0.000	1.94 (1.015,3.736)	0.045
4-6	187	97 (51.8)	Reference	-	Reference	-
>6	144	100 (69.4)	2.10 (1.336,3.327)	0.001	2.01 (1.165,3.494)	0.012
Level of education						
Non-formal education	282	153 (54.2)	Reference	-	Reference	-
Primary school	106	81 (76.4)	2.73 (1.647, 4.530)	0.000	2.26 (1.316,3.895)	0.003
Secondary school	36	30 (83.3)	4.21 (1.701,10.444)	0.002	2.89 (1.118,7.505)	0.029
Higher education	13	12 (92.3)	10.11 (1.298,78.860)	0.027	8.91 (1.070,74.302)	0.043
Occupation						
Farmer	377	227 (60.2)	Reference	-		
Merchandiser	26	18 (69.2)	1.48 (0.630,3.506)	0.365		

Governmental or non- governmental employed	22	21 (95.4)	13.87 (1.846,104.257)	0.011		
Skilled private worker	12	10 (83.3)	3.30 (0.713,15.290)	0.126		
Dog ownership						
Yes	245	167 (68.1)	1.63 (1.101,2.413)	0.015	2.36 (1.509,3.705)	0.000
No	192	109 (56.7)	Reference	-	Reference	-
Exposure to dog bite						
Yes	13	12 (92.3)	7.27 (0.936,56.461)	0.058	9.56 (1.139,80.318)	0.037
No	424	264 (62.2)	Reference	-	Reference	-
Hosmer-Lemeshow chi 2 (8) = 10.31, Prob > chi 2 = 0.2440						
Area under ROC curve = 0.7452						

3.1.3. Attitude Assessment Results

This study revealed that the study participants of the current study have favorable attitude about rabies 225 (51.4%). About 51.2% of the respondents disagreed that dogs should be kept free to roam around while 50.57% of the respondents agreed stay dogs are dangerous for the transmission of rabies disease. In addition to this, 52.4% of the participants of the study believed that rabies poses a significant threat to public health in their locality. Majority (86.7%) of the participants agreed that vaccination of animals (pet animals) can help to prevent rabies disease in animals. About 81.2% and 79.4% of the respondents disagreed that holy water cannot treat rabies disease in humans and traditional healers could not potentially provide a viable solution for the treatment of rabies respectively (Table 4).

Table 4: Attitudes of study participants towards dog-mediated rabies

Characteristics	Frequency	Percentage (%)
Attitude		
Favorable attitude	225	51.49
Unfavorable attitude	212	48.51
Do you think dogs should be kept free to roam around?		
Strongly disagree	17	3.89
Disagree	207	47.37
Neutral	8	1.83
Agree	202	46.22
Strongly agree	3	0.69
Do you think that stray dogs are dangerous for the transmission of rabies disease?		
Strongly disagree	4	0.92
Disagree	186	42.56
Neutral	26	5.95
Agree	147	33.64
Strongly agree	74	16.93
Do you believe that rabies poses a significant threat to public health in your locality?		
Strongly disagree	2	0.46
Disagree	131	29.98
Neutral	75	17.16
Agree	197	45.08
Strongly agree	32	7.32
Do you believe holy water cannot treat rabies disease in humans?		
Strongly disagree	39	8.92
Disagree	316	72.31
Neutral	50	11.44
Agree	28	6.41
Strongly agree	4	0.92

Do you think that an exposed human to rabies can recover if treated with post-exposure vaccine?

Strongly disagree	10	2.29
Disagree	83	18.99
Neutral	90	20.59
Agree	201	46.00
Strongly agree	53	12.13

Do you think that the consumption of rabid food animals is safe?

Strongly disagree	30	6.86
Disagree	147	33.64
Neutral	176	40.27
Agree	84	19.22
Strongly agree	0	0

Do you think that vaccination of pet animals can help to prevent rabies in animals?

Strongly disagree	2	0.46
Disagree	17	3.89
Neutral	39	8.92
Agree	326	74.60
Strongly agree	53	12.13

Do you think that vaccination of pet animals can help to prevent rabies in humans?

Strongly disagree	0	0
Disagree	197	45.08
Neutral	74	16.93
Agree	127	29.06
Strongly agree	39	8.92

Do you think that coordination between different stakeholders is important?

Strongly disagree	2	0.46
Disagree	1	0.23
Neutral	10	2.29
Agree	320	73.23
Strongly agree	104	23.80

Do you think that Traditional healers could not provide a solution for the treatment of rabies?

Strongly disagree	27	6.18
Disagree	320	73.23
C) Neutral	76	17.39
Agree	12	2.75
Strongly agree	2	0.46

Do you think immediate medical attention or care is necessary after a dog bite?

Strongly disagree	0	0
Disagree	3	0.69
Neutral	2	0.46
Agree	350	80.09
Strongly agree	82	18.76

Do you believe that burning a rabid could be an effective treatment for rabies?

Strongly disagree	12	2.75
Disagree	93	21.28
Neutral	130	29.75
Agree	198	45.31
Strongly agree	4	0.92

Do you think crossing a river before 40 days could prevent rabies development?

Strongly disagree	16	3.66
Disagree	137	31.35
Neutral	168	38.44
Agree	110	25.17
Strongly agree	6	1.37

Univariate and multivariate logistic regression results on attitude

In the present study higher proportion of males were found to have favorable attitude towards rabies (55.6%). Male respondents were known to have 93% (AOR = 1.93; 95% CI: 1.174, 3.194) higher favorable attitude towards rabies compared to female respondents, and the difference was found to be statistically significant. Likewise, respondents in the age group of 18-29 years old were 2.90 (AOR = 2.90; 95% CI: 1.322, 6.394) times higher to have favorable attitude towards rabies compared to respondents of greater than 45 years old and the difference was found to be statistically significant (P<0.05). Respondents who had dogs were 2.69 times (AOR = 2.69; 95% CI: 1.703, 4.274) more likely to have a favorable attitude about rabies compared to respondents who had no dogs, and the association was found to be statistically significant (P<0.05). The crude odds ratio and adjusted odds ratio results on attitude are presented in table 5.

Table 5: Factors associated with attitude towards dog- mediated rabies

Characteristics	Total	Attitude	COR	P-	AOR	P-
		N (%)	95% CI	value	95% CI	value
Sex						
Male	302	168 (55.6)	1.71 (1.138,2.585)	0.010	1.93 (1.174,3.194)	0.010
Female	135	57 (42.2)	Reference	-	Reference	-
Marital status						
Married	372	187 (50.2)	2.77 (0.869,8.887)	0.085	-	-
Single	32	25 (78.1)	9.82 (2.377,40.569)	0.002	-	-
Divorced	15	4 (26.6)	Reference	-	-	-
Widowed	18	9 (50.0)	2.75 (0.631,11.969)	0.178	-	-
Age in years						

18-29	56	37	2.33	0.008	2.90	0.008
		(66.0)	(1.245,4.365)		(1.322,6.394)	
30-45	203	107	1.33	0.161	1.90 (1.165,	0.010
		(52.7)	(0.891,1.998)		3.108)	
>45	178	81	Reference	-	Reference	-
		(45.5)				
Household size						
1-3	106	60	1.49	0.116	-	-
		(56.6)	(0.904,2.483)			
4-6	187	98	1.26	0.289	-	-
		(52.4)	(0.818,1.955)			
>6	144	67	Reference	-	-	-
		(46.5)				
Level of education						
Non-formal education	282	103	Reference	-	Reference	-
		(36.5)				
Primary school	106	80	5.34	0.000	5.57	0.000
		(75.4)	(3.228,8.855)		(3.260,9.549)	
Secondary school	36	30	8.68	0.000	8.89	0.000
		(83.3)	(3.499,21.574)		(3.408,23.187)	
Higher education	13	12	20.85 (2.673,	0.004	26.58	0.002
		(92.3)	162.7)		(3.265,216.467)	
Occupation						
Farmer	377	181	Reference	-	-	-
		(48.0)				
Merchandiser	26	16	1.73	0.187	-	-
		(61.5)	(0.766,3.916)			
Governmental or non-	22	19	6.85 (1.996,	0.002	-	-
		(86.3)	23.564)			

governmental employed Skilled private worker	12	9 (75.0)	3.24 (0.865,12.187)	0.081	-	-
Dog ownership						
Yes	245	142 (57.9)	1.81 (1.235,2.652)	0.002	2.69 (1.703,4.274)	0.000
No	192	83 (43.2)	Reference	-	Reference	-
Exposure to dog bite						
Yes	13	12 (92.3)	11.88 (1.532,92.234)	0.018	18.83 (2.161,164.184)	0.008
No	424	213 (50.2)	Reference	-	Reference	-

Hosmer-Lemeshow chi 2 (8) = 10.07, Prob > chi 2 = 0.2605

Area under ROC curve = 0.7909

3.1.4. Practice Assessment Results

The total average result of practice in the present study was 249 (56.9%) which revealed that poor practice of the participants towards rabies. Out of the 437 respondents, (76.8%) did not vaccinate against rabies this year. Additionally, 66.8% of the study participants family members do not wash their hands after close contact with a dog (Table 6).

Table 6: Practice of study participants towards dog-mediated rabies

Characteristics	Frequency	Percentage (%)
Practice		
Good practice	188	43.02
Poor practice	249	56.98

Do you vaccinate dogs against rabies this year?		
Yes	101	23.11
No	336	76.89
Does any member of your family have close contact with dog(s), or cat(s)?		
Yes	292	66.82
No	145	33.14
Do any of your family members wash their hands after close contact with dog(s), or cat(s)?		
Yes	244	55.84
No	193	44.16
Do you keep your distance from dogs that are roaming freely?		
Yes	391	89.47
No	46	10.53
What action do you take in controlling stray dogs in your kebele or village?		
Kill, inform the owner, or report to authorities	204	46.68
Only repelling stray dogs	203	46.45
Ignoring the presence of stray dogs	30	6.86
Do you wash the wound with soap and water as a first aid if you are bitten by a rabid dog?		
Yes	243	55.61
No	194	44.39
Do you use traditional healers for treating suspected rabid dog bites?		
Yes	385	88.10
No	52	11.90
What actions do you take if a pet animal is bitten by a rabid dog?		
Isolate the pet, prevent contact with other animals	344	78.72
Release the bitten pet outside	93	21.28
What action do you take on the carcass of a food animal that died of rabies?		
Eat the meat after making it into dried meat.	223	51.03
Discard the carcass either by burial or burning.	214	48.97

Do you use Personal Protective Equipment (PPE) when handling animals that may carry rabies?		
Yes	109	24.94
No	328	75.06
How do you dispose of food waste to prevent attracting stray dogs or wild animals?		
Secure in trash bins	126	28.83
Leave them outside	311	71.17
Do you eat meat from an animal that died of rabies as a treatment for rabies?		
Yes	26	5.95
No	411	94.05
Do you visit immediately a health center if you are bitten by a dog?		
Yes	423	96.80
No	14	3.20

Univariate and multivariate logistic regression results on practices

The current study revealed that higher proportion of the respondents who attained higher education (92.3%) and secondary school (72.2%) were known to have good practice towards rabies. Participants who attained higher education and secondary school were found to be 36.68 (AOR = 36.68 95% CI: 4.477,300.485) and 7.41 (AOR = 7.41; 95% CI: 3.209,17.116) times more likely to do good practice towards rabies prevention and control as compared to respondents with non-formal education, respectively. The difference in practice among the education levels were found to be statistically significant ($P < 0.05$) (Tables 7).

Table 7: Factors associated with practice towards dog-mediated rabies

Characteristics	Total	Practice	COR	P-value	AOR	P-value
		N (%)	95% CI		95% CI	
Sex						

Male	302	141 (46.6)	1.63 (1.077,2.495)	0.021	2.09 (1.255,3.487)	0.005
Female	135	47 (34.8)	Reference	-	Reference	-
Marital status						
Married	372	156 (41.9)	1.98 (0.620,6.353)	0.247		
Single	32	22 (68.7)	6.04 (1.542,23.734)	0.010		
Divorced	15	4 (26.6)	Reference	-		
Widowed	18	6 (33.3)	1.37 (0.304,6.203)	0.679		
Age in years						
18-29	56	29 (51.7)	1.82 (0.994,3.341)	0.052		
30-45	203	93 (45.8)	1.43 (0.951,2.163)	0.085		
>45	178	66 (37.0)	Reference	-		
Household size						
1-3	106	56 (52.8)	2.04 (1.224,3.407)	0.006	3.62 (1.908,6.885)	0.000
4-6	187	81 (43.3)	1.39 (0.890,2.180)	0.146	2.31 (1.347,3.993)	0.002
>6	144	51 (35.4)	Reference	-	Reference	-
Level of education						
Non-formal education	282	90 (31.9)	Reference	-	Reference	-

Primary school	106	60 (56.6)	2.78 (1.759,4.401)	0.000	3.23 (1.926,5.438)	0.000
Secondary school	36	26 (72.2)	5.54 (2.565,11.992)	0.000	7.41 (3.209,17.116)	0.000
Higher education	13	12 (92.3)	25.6 (3.278,199.915)	0.002	36.68 (4.477,300.485)	0.001
Occupation						
Farmer	377	148 (39.2)	Reference	-		
Merchandiser	26	16 (61.5)	2.47 (1.093,5.602)	0.030		
Governmental or non-governmental employed	22	17 (77.2)	5.26 (1.900,14.564)	0.001		
Skilled private worker	12	7 (58.3)	2.16 (0.674,6.952)	0.194		
Dog ownership						
Yes	245	126 (51.4)	2.22 (1.498,3.288)	0.000	3.40 (2.131,5.441)	0.000
No	192	62 (32.2)	Reference	-	Reference	-
Exposure to dog bite						
Yes	13	12 (92.31)	16.90 (2.178, 131.232)	0.007	36.63 (4.097,327.540)	0.001
No	424	176 (41.5)	Reference	-	Reference	-

Hosmer-Lemeshow chi 2 (8) = 10.63, Prob > chi 2 = 0.2237

Area under ROC curve = 0.7717

3.2. Qualitative Results

Rabies has long been a critical public health issue in Tigray, Ethiopia, affecting both animals and humans. The recent conflict in Tigray has exacerbated the situation, leading to a significant deterioration of health services and complicating rabies management in Enderta woreda. The destruction of healthcare infrastructure, along with the displacement of veterinary professionals, has severely limited access to vaccinations and treatment options. The lack of effective rabies management not only poses a threat to animal health but also increases the risk of human exposure, particularly among those who work closely with animals.

Table 8: Composition and characteristics of FGDs and KIIs participants in exploring knowledge, attitude and practices in Enderta district

Type of respondents	FGDs	KII	Total
Dog owners	6	-	6
Livestock farmers	6	-	6
Non-dog owners	6	-	6
Veterinary health workers	6	2	8
Veterinary clinic coordinators	5	4	9
Public health workers	4	3	7
Teachers	4	-	4
Tabia administrator	3	-	3
Agricultural extension workers	2	-	3
Community leaders	6	-	6
Private veterinary pharmacy workers	1	3	3
Total	49	12	61

3.2.1. Focus Group Discussion Results

Sources of rabies awareness

All participants of this study revealed that they had all heard about rabies from various sources. The majority of the respondents (71.4%) reported that they heard about rabies from non-mass media, including family, community members, friends, and elders.

One participant from Metkel explained that *"he had heard about rabies, from the radio which is called 'himam ebud kelbi' in Tigrigna"* which to mean rabies.

Cause of the disease

Majority (53%) of the participants in the focus group discussion recognized that the cause of rabies is virus. However, 28.57% of the respondents attributed the disease to starvation and thirst, while 12.2% believed that it was due to God given and 6.12% did not know the cause of the disease.

One participant from Dejen elaborated on these beliefs, stating that *" himam ebud kelbi arises when there is starvation and thirst. When there is a shortage of food, something called 'hasaku' develops inside the dog's intestines. These hasaku attack the dog's body, and as a result, the dog becomes mad, stops eating and drinking, and finally dies as a result of emaciation."*

Signs and symptoms of rabies in animals and humans

In animals, the majority of participants (89.7%) were aware of the signs of rabies, such as behavioral changes (aggression and restlessness), a tendency to attack animals or humans, difficulty swallowing, salivation, and paralysis. Participant from Derga ajen noted that *"dogs with rabies show signs like excessive salivation, a sticking tail, difficulty walking, and decreased appetite."*

In the case of humans, the majority of participants (71.4%) did not recognize the symptoms and signs of rabies. One participant from Adi azmera shared that *"when a human gets bitten by a rabid animal, 'hasaku' develops in the intestine, and a sound can be heard from the intestine."* Another participant stated, *"I'm not sure what humans look like when they have rabies."*

Additionally, a participant from Adi azmera mentioned that *"the early symptoms of rabies in humans, such as fever, headache, and malaise, are non-specific and resemble flu-like conditions. As the disease progresses, neurological symptoms like delirium, hallucinations, and paralysis emerge."* The participant also added that *"hydrophobia (fear of water) and excessive salivation are among the symptoms seen in humans."*

Transmission of the disease

Regarding the transmission of rabies, the majority of participants (89.7%) responded that rabies is usually transmitted from animal to animal through bites, and transmission to humans occurs via the bite of a rabid animal. A participant from Mahbere genet explained, *"In 2015, I encountered rabies in my home while serving my guests during the November Saint Michael holiday. A rabid donkey came straight to my house. I tried to defend myself, but it bit me on my leg. My brother came and separated us. I immediately went to the clinic, where they washed the bite with soap, water, and alcohol. There was no medication or vaccine available at the clinic, so they referred me to Ayder Hospital, which then referred me to Mekelle Hospital. They ordered me to undergo post-exposure treatment for 27 days.*

The participant added, *"The post-exposure vaccine was administered by my navel in the morning before meals. During the treatment process, after 23 days, the post-exposure vaccine ran out, so I was sent to Abiy Adi to complete the remaining four-day treatment and finally recovered from the disease. The rabid donkey had bitten another woman (on her leg) and her daughter (on her knee) before it came to me. Both of them received treatment and eventually recovered. After biting me, the rabid donkey was found dead; my neighbor informed us that it was lost. The donkey had also bitten another animal (a cow) and had thrown its saliva at two oxen. At that time, there was no treatment available for these animals. The owners applied holy water from Aba Hadera to their bodies; ultimately, the cow died, but the two oxen survived. "*

In addition, another participant from Mahbere genet explained, *"In 2013, our neighbor's dog was freely roaming around all the time. Then the dog became ill; they did not follow up on it. The diseased dog started biting my dogs (I had two at that time). It bit one of my dogs and then disappeared. The bitten dog subsequently bit my other animals (one donkey, two oxen, and one cow with her calf). I immediately killed the dog and reported it to the*

Tabia administration, which informed me to report it to the Woreda administration. Regional and Woreda veterinarians came and took the head of the donkey for investigation purposes. They informed me that it had rabies. When I asked what to do about my bitten livestock, they told me there were no medications for them and advised me not to eat them if they died but to bury them instead. Unfortunately, three of my livestock died, and I buried them. Afterward, I asked both the Tabia and Woreda for assistance because I had lost almost all my animals, but they did not help me."

Another participant from Kedamay weyane described that *"rabies transmits from animal to animal and to human through air transmission and close contact "* and another participant from Dejen mentioned that *"rabies is transmitted through ingesting contaminated food or water."*

Prevention and control methods of the disease

More than half of the participants, (59.1%) explained that vaccination is the primary method for preventing rabies and creating public awareness and education regarding its causes, signs and symptoms, transmission methods, vaccination in animals, and post-exposure prophylaxis in humans. 30.6% described rabies as prevented by removing or eliminating stray dogs. Regarding control, the majority of the participants (85.7%) described that killing the rabid animal is the best way to control the disease in animals, and (71.4%) described post-exposure vaccination to control in humans.

A participant from Metkel noted, *"We can prevent rabies by avoiding contact with stray animals and vaccinating our livestock. However, since there is no vaccine available for some animals, we are forced to go to traditional healers to save our livestock. Unfortunately, traditional healers often cannot provide effective solutions, leading to the loss of our animals and worsening our cost of living because we are highly dependent on livestock for our economy."*

Another participant from Metkel explained that *"rabies is common in the months of April and May when there is high sun exposure. During these months, we can prevent our dogs from contracting rabies by providing sufficient food and water."*

A participant from Kedamay Weyane stated, *"Dogs breed in months like September and October. During these months, we can prevent rabies by keeping the dogs tied up in their houses."* The participant added, *"We can control rabies by killing rabid animals and burying them."*

Challenges

All participants cited difficulties in accessing vaccination services due to limited availability of vaccines. In addition, the majority (53%) expressed that the high stray dog population is a significant challenge in the prevention and control of rabies.

A participant from Kedamay Weyane described that *"before the war, there was regular vaccination against rabies, but after the war, there has been a lack of vaccines. As a result, we are not vaccinating our dogs."* The participant added that *"while rabies vaccines are available at private veterinary clinics, they cost up to 150 birr, which is unaffordable for many of us."*

A participant from Dejen stated, *"There is no vaccination in our tabya; as a result, we are losing our animals. In our tabya, there are many stray dogs that are transmitting the disease."* The participant also mentioned the *"lack of intersectoral collaboration."*

3.2.2. Key Informant Interview Results

In the present study, key informant interviews (KIIs) were conducted with selected tabias. A total of 12 key informants were interviewed, including public health professionals, veterinary health workers, private veterinary pharmacy workers, and veterinary clinic coordinators. The purpose of these interviews was to gather insights on dog-mediated rabies in the study area. Specifically, the interviews aimed to explore the informants' experiences with rabies cases, assess the effectiveness of existing prevention strategies, and identify the challenges faced in controlling this disease.

Experiences and insights on rabies

The majority of the key informants, 75%, reported encountering rabies in the study area. An informant from Mahbere Genet stated, *"There was an outbreak in Tabia Mahbere Genet. The disease was observed many times in the year 2014, resulting in the deaths of a woman, a child, and a total of eight animals (three dogs, two donkeys, and three bovines)."*

The woman and the child were bitten on the same day and developed symptoms of rabies before they died. The informant added that "At that time, we washed their wounds with soap and water but did nothing more. The woman died after 72 days, while the child died after 48 days. Unfortunately, we could not save them because we did not have access to post-exposure vaccines at that time. It was a challenging period due to the bloody war, and everything was mixed up."

Prevention and control measures for rabies

All the key informants noted that public awareness creation activities, such as killing stray dogs, tying up their own dogs, and emphasizing the importance of vaccinating animals and providing post-exposure vaccinations for humans, are among the prevention methods implemented in the study areas. They also mentioned that there is a limited supply of vaccines for both animals and humans. As a result, there is very low vaccination coverage in animals. An informant from Didiba stated, *"Even after the Pretoria agreement, there are still instances of animal bites to humans. We dress the wounds until they dry and prescribe antibiotics such as cotrimoxazole or Augmentin. Still, there is a shortage of post-exposure vaccines."*

Challenges in rabies prevention and control

The key informants described prevention and control measures being implemented, including community awareness activities, dog vaccination, and post-exposure prophylaxis (PEP) for bite victims. However, they noted that these efforts are often limited by resource constraints and insufficient public engagement.

All key informants noted that there is only a small number of vaccines available for animals, resulting in limited vaccination coverage. One informant from Mahbere genet expressed concern about the insufficient availability of rabies vaccines, stating, *"The lack of vaccines for animals is a critical issue here. With only a limited number of doses available, many pets remain unvaccinated, leaving them vulnerable to rabies. This not only puts the animals at risk but also endangers the health of our community. As a result, we are facing a serious public health threat."*

Seventy-five percent of key informants stated that when food animals are bitten by a rabid dog or another rabid animal, they do not kill and bury the bitten animal; instead, they slaughter and consume it. An informant from Adi azmera noted, *"Animals like dogs and donkeys are often killed or removed when they exhibit symptoms of rabies. However, for food animals, people do not kill and bury them. Instead, they slaughter the animal and eat it, removing only the head region while consuming the rest of the carcass."*

The majority of the key informants (58.3%) noted that there is no immediate reporting when there is a bite from a suspected rabid animal in a human and in animals. An informant from Metkel emphasized the issue of delayed reporting of bites from suspected rabies, stating, *"In our community, many people do not report bites immediately, often due to a lack of awareness about the severity of rabies. This delay can be fatal, as rabies is a preventable disease if addressed promptly. When someone is bitten, they might think it's not urgent and wait too long to seek medical attention. This not only jeopardizes their health but also increases the risk of rabies spreading among animals in the area."*

Barriers to effective coordination and collaboration in rabies

The majority of the key informants (83.3%) noted that there is low coordination and collaboration between veterinarians, public health authorities, and other relevant agencies in responding to rabies. They identified primarily resource constraints, such as funding limitations, and a lack of communication channels, including insufficient networking and limited information sharing, as contributing factors. One informant from Arato stated that *"the aftermath of the conflict severely impacted resource availability, leading to limited access to vaccines, medical supplies, and funding for public health initiatives. Before the war, there was good coordination and collaboration among the concerned bodies in the prevention and control of rabies, with activities like regular meetings, collaborative protocols, data sharing, and joint training sessions for community engagement and education. However, at this time, we only meet when there is a rabies case."*

4. CHAPTER IV: DISCUSSION

Rabies is a severe public health concern because of the disease's rapid mortality rate, particularly in tropical nations like Ethiopia. Few awareness-raising and public education initiatives are conducted globally because rabies is regarded as a neglected tropical disease. Rabies in Ethiopia is a neglected zoonotic disease but a serious public health burden, especially in locations where stray dogs are ineffectively managed (Abdela and Teshome, 2017).

In this study, more than half of the respondents (63.1%) had good knowledge regarding rabies, which was in line with reports from the community of the Amhara region (61.3%) (Bahiru *et al.*, 2022) and Mekdella district 60% (Belay *et al.*, 2024), while slightly lower (51.9%) were reported from Dedo district of the Jimma zone (Abdela *et al.*, 2017). In contrast, slightly higher knowledge level was reported from Adiss ababa, 75.2% (Ali *et al.*, 2013). This difference in level of knowledge is due to the reason that the majority of the study participants were farmers, many of whom were with no formal education. In contrast, Addis Ababa, being the capital city, has a more educated population with better access to information and educational resources. Studies have shown that higher education levels correlate with better knowledge regarding rabies (Bahiru *et al.*, 2022).

The current study revealed that 92.2% of respondents recognize rabies as a dangerous and fatal disease, which is consistent with a study conducted in Nigeria (99%) (Al-Mustapha *et al.*, 2021), in Ethiopia, where over 90% of respondents shared this recognition (Woldegeorgis *et al.*, 2023), and in Nekemte (88.5%) (Tolessa and Mengistu, 2017).

Regarding the perceived causes of rabies, the majority of respondents in the current study held misconceptions, attributing the disease to the anger of God (38.6%) and to starvation and thirst (34.5%). This finding aligns with a similar study in Bahir Dar town, where 24.1% of respondents cited food and water shortages as causes of rabies disease (Guadu *et al.*, 2014). However, this result is lower compared to studies conducted in and around Dessie town, Ethiopia (49.6%) (Serebe *et al.*, 2014), in and nearby Gondar town, Ethiopia (63.5%) (Yalemebrat *et al.*, 2016), and in Shone Town, Hadiya Zone, Southern Ethiopia (68.3%) (Beresu *et al.*, 2023). This could be due to low awareness creation activities of the study area and another reason could be dog-mediated rabies-related lessons

given only to human and animal health students at higher levels, and there may be low awareness creation programs about the disease for the community at large.

Regarding the public health importance of rabies, approximately 98% of respondents indicated that the disease is transmitted from animals to humans. Similar findings were reported in Chiro, West Hararghe, Ethiopia (Ahmed *et al.*, 2022), where 99.4% of respondents recognized this transmission of rabies from animals to humans, and in the Gomma district of Jimma Zone, southwestern Ethiopia, 94% (Kebede *et al.*, 2024). 75.7% of respondents identified that the mode of transmission of rabies is through bites from rabid animals. This finding is supported by reports from Nigeria, where 84.2% of respondents were aware of this transmission mode (Ibrahim *et al.*, 2024), and in Uganda, where 72.3% recognized it (Atuheire *et al.*, 2024).

Among the household heads in this study, 51.4% had a favorable attitude toward rabies. This finding is in agreement with reports from Mekelle, where 56.2% of respondents had a favorable attitude (Hagos *et al.*, 2020), but is lower than a study conducted in Indonesia, which reported a favorable attitude of 74.2% (Rehman *et al.*, 2021). This difference may be explained by the lack of health education about rabies in the study area. About 86.7% of respondents believe that rabies is preventable through regular vaccination of dogs. This finding aligns with research conducted in Tanzania (Iddi *et al.*, 2023) and in South Gondar (Bihon *et al.*, 2020). According to the World Health Organization, successive annual mass dog vaccination campaigns that achieve 70% vaccination coverage can bring rabies under control in reservoir populations (WHO, 2018).

Most respondents (79.4%) in this study believe in traditional healers. This finding is consistent with reports from South Gondar (81.5%) (Bihon *et al.*, 2020) and North Gondar (84%) (Jemberu *et al.*, 2013). In contrast, studies conducted in Addis Ababa, Dessie City, and Arba Minch reported lower beliefs in traditional healers, with percentages of 58.3%, 46%, and 42.45%, respectively (Ali *et al.*, 2014; Gebeyaw and Teshome, 2016; Tamirat *et al.*, 2016). The preference for traditional practices may arise from several factors, including easy access to medicinal plants, limited availability of health centers, and lower treatment costs in the study area.

The current findings revealed that 43% of respondents exhibited good practices against rabies. Similar reports have been documented from the Amhara region (45%) (Bahiru *et al.*, 2022), Jimma Zone (45%) (Abdella *et al.*, 2017) and Enderta district (47.5%) (Abdelkadir *et al.*, 2024). Higher percentages were reported from Mekelle (61.3%) (Hagos *et al.*, 2020) and Mekdella District (57%) (Belay *et al.*, 2024). The results of the current study indicate poor practices, which may be attributed to limited access to veterinary services, insufficient health education, and the respondents' levels of education. Additionally, the siege and violent conflict in Tigray have severely disrupted health services and community outreach programs. Access to healthcare facilities for vaccinations and post-exposure prophylaxis has been restricted, leading to decreased community engagement in preventive and control measures against rabies.

The current study revealed that 88.1% of respondents use traditional healers for treating suspected rabid dog bites. A similar reliance on traditional treatment (84%) was reported from Dabat, Gondar (Jemberu *et al.*, 2013). In contrast, almost all respondents in Addis Ababa agreed to consult health professionals in the case of suspected animal bite (Ali *et al.*, 2013). The preference for traditional practices may arise from several factors, including easy access to traditional medicine, lack of awareness, prolonged treatment durations, and shortages of post-exposure vaccines. Reliance on traditional medicines with unproven efficacy is very risky; once the first symptoms of the disease occur, little can be done to save one's life. After suspected or proven exposure to the rabies virus, immediate use of effective anti-rabies vaccines, along with proper wound management and simultaneous administration of rabies immunoglobulin, is almost invariably effective in preventing rabies (WHO, 2018).

(55.6%) of the respondents reported that they would wash the wound with water and soap if bitten by suspected rabid animals. A higher percentage of respondents practiced washing wounds with water and soap in Kombolcha town (92.4%) (Gebremeskel *et al.*, 2019). This relatively poor practices observed in the current study may be associated with the characteristics of the respondents, including the fact that most lived in rural areas, their educational status, and low community awareness. The World Health Organization (WHO) recommends washing wounds and vaccination immediately for at least fifteen minutes after

contact with a suspected rabid animal, which can prevent almost 100% of rabies deaths when combined with other preventive measures, including post-exposure prophylaxis (WHO, 2018).

In the present study, although more than 86.7% of the respondents knew that rabies could be prevented by vaccinating dogs, only 23.1% practiced dog vaccination. In contrast, higher percentages of dog vaccination were reported in different studies: 79% in Mekelle City (Hagos *et al.*, 2020), 71.1% in Adigrat Town (Ahmed *et al.*, 2021), and 85.3% in Chiro Town (Ahmed *et al.*, 2022). This indicates that dog vaccination practices are very poor in the Enderta district. The reasons for this low vaccination rate may include lower coverage of rabies vaccines, low community awareness, economic barriers, and cultural beliefs and practices.

51% of the respondents indicated that the meat of rabid food animals is safe for consumption. These results are consistent with those reported in the Gondar Zuria district by Digafe *et al.* (2015), which revealed that 67% of respondents considered meat from rabid animals to be safe. According to the World Health Organization (WHO, 2018), the consumption or preparation of meat from rabid animals poses a risk and is strongly discouraged. The consumption of raw meat from an infected animal requires post-exposure prophylaxis (PEP). Although the extent of transmission varies, all possible modes of transmission, including bites, contact with saliva, and consumption of animal products from infected animals, should be avoided. Proper disposal methods for the carcasses of infected animals are also essential.

Males were 2.60 times (AOR = 2.60 (1.590, 4.270)) more likely to have good knowledge compared to females. This finding is consistent with studies conducted in Mekelle City (Hagos *et al.*, 2020), South Gondar (Alie *et al.*, 2015), and Bahirdar Town (Guadu *et al.*, 2014). This statistically significant variation in knowledge between male and female respondents may result from the greater opportunities for males to acquire knowledge about rabies from various sources, such as exposure to meetings, idea exchanges within the community, and workplace interactions, which enhance their chances of obtaining accurate information about rabies.

The association between education level and knowledge about rabies revealed a statistically significant difference. Respondents with higher education (diploma and above) were found to be 8.91 times (AOR=8.91 (1.070,74.302)) more likely to have good knowledge than those with no formal education. This finding is supported by studies conducted in Mekdella district (Belay *et al.*, 2024), in and around South Gondar, North West Ethiopia (Bihon *et al.*, 2020), and in Chiro, West Hararghe, Ethiopia (Ahmed *et al.*, 2022). A possible explanation for this disparity is that educated individuals have better access to information and can more easily understand the disease.

Household heads who owned dogs were 2.36 times (AOR = 2.36 (1.509, 3.705)) more likely to have good knowledge about rabies compared to their counterparts. This finding is consistent with a study conducted in Tanzania (Belay *et al.*, 2024). A possible explanation for this finding is that dog owners often have firsthand experience with their dogs, leading to greater awareness of the health issues associated with rabies.

Participants with a high level of education are associated with a favorable attitude towards rabies; those with higher education are 26.58 times (AOR = 26.58 (3.265, 216.467)) more likely to have a favorable attitude than those with no formal education. This finding is in agreement with a study conducted in Egypt (Sharaa and Ali, 2020). Higher education levels often correlate with increased awareness and understanding of health issues, including rabies. Educated individuals are more likely to have access to information about disease prevention, transmission, and management, which can lead to more favorable attitudes towards health behaviors. A study conducted in Myanmar (Aung *et al.*, 2021) showed that educational interventions significantly improve knowledge about rabies, which in turn influences attitudes toward vaccination and preventive measures.

Those who own dogs are 3.40 times (AOR = 3.40 (2.131, 5.441)) more likely to have good practices toward rabies prevention compared to those who do not own dogs. This finding is consistent with a study conducted in the West Shewa Zone, Oromia, Ethiopia (Dinbiso *et al.*, 2024). Communities with dogs tend to have better awareness of rabies during vaccination and dog care, which may contribute to improved practices regarding rabies prevention and control.

All participants in the focus group discussion cited difficulties in accessing vaccination services due to limited availability of vaccines. In addition, the majority (53%) expressed that the high stray dog population is a significant challenge in the prevention and control of rabies in the study area. The reason for the presence of this high stray dog population is attributed to irresponsible dog ownership and the war conflict in Tigray, which disrupted local infrastructure and led to an increase in stray dog populations.

The key informant interviews revealed significant barriers to effective coordination and collaboration among veterinarians, public health authorities, and relevant agencies in addressing rabies. A notable 83.3% of informants reported low levels of collaboration, primarily attributed to resource constraints such as funding limitations and a lack of efficient communication channels. This is due to the reason that the aftermath of conflict has severely impacted resource availability, resulting in limited access to vaccines and medical supplies. Consequently, there are no regular meetings or joint training sessions, making it difficult to prevent and control rabies in both animals and humans in the study area.

5. CONCLUSION AND RECOMMENDATIONS

The current study revealed that rabies is a significant disease in both animals and humans in the study area. The level of knowledge about the modes of transmission from animals to humans, as well as the clinical signs of rabies in animals, is good. However, there are knowledge gaps regarding the cause of rabies and the signs and symptoms in humans. Participants exhibited favorable attitude towards the dangers posed by stray dogs. Conversely, the majority believe in traditional medicine. In terms of practices, there is a significant gap; many participants are unable to vaccinate their animals and rely on traditional medicine. Factors such as sex, educational status, dog ownership, and exposure to dog bites were found to be significantly associated with knowledge, attitudes, and practices regarding rabies. The focus group discussions revealed key barriers to effective rabies prevention, including limited access to vaccination services due to shortages and the presence of a high stray dog population. The majority of key informants indicated low collaboration levels due to resource constraints and ineffective communication channels.

Therefore, based on the above conclusion, the following recommendations are forwarded:

- Veterinarians and health professionals should prepare and deliver continuous and strategic community awareness programs focusing on the causes of rabies and the signs and symptoms of rabies in humans.
- There must be a sufficient supply and distribution of vaccines at animal clinics and post-exposure vaccines at health centers to enhance vaccination coverage in animals and control rabies in humans.
- A one-health approach should be implemented to prevent and control the public health and economic impact of rabies.
- Comprehensive strategies should be developed to manage stray dog populations, including vaccination programs, community education on responsible dog ownership, and collaboration with local authorities to reduce rabies transmission risks.

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7. ANNEXES

Annex I: A Questionnaire for the Assessment of Knowledge, Attitudes, and Practices Towards Dog-Mediated Rabies in the Community of Enderta District, Tigray, Ethiopia.

My name is Mebrahtu Gebreselassie. I am a master's degree student at Mekelle University in the Department of Veterinary Public Health and Food Safety. The study aims to assess knowledge, attitudes, and practices related to dog-mediated rabies among community members in Enderta district. As a local resident, you are being invited to participate in this study. I would appreciate it if you could complete the questionnaire and provide your answers. I guarantee that every piece of information I gather from you will be kept confidential.

Are you willing to take part in this study and respond to the questions? Yes, [] No []

1) Personal information

1. Name of participant: _____ Tel. No. _____

Woreda/District: _____ Tabia/Kebelle: _____ Kushet/village:

Date of interview: dd/mm/yyyy _____

2) Socio-demographic information

1. Sex of the respondent A) Male B) Female

2. Marital status A) Married B) Single C) Divorced D) Widowed

3. Age of the respondent A) 18-29 B) 30-45 C) >45

4. Household size A) 1-3 B) 4-6 C) >6

5. Level of education:

A) No formal education B) Primary school C) Secondary school D) Higher education (diploma and above).

6. Occupation

A) Farmer B) Merchandiser C) Government or non-governmental employed D) Skilled private worker

7. Religion

A) Orthodox B) Muslim C) Catholic D) Protestant

8. Are you a health professional? A) Yes B) No

9. Dog ownership A) Yes B) No

10. Family exposure to dog bite A) Yes B) No

3) Knowledge of the community towards dog mediated rabies

1. Do you know about rabies disease? A) Yes B) No

2. Have you ever got a training education program regarding rabies disease? A) Yes B) No

3. Do you know that rabies can affect all warm-blooded animals, including human beings?
A) Yes B) No

4. What is the cause of the rabies disease?

A) Germs B) Shortage of food and water (starvation) C) anger of God D) unknown

5. What is the most common source of rabies disease in your locality?

A) Pet animals (dog and cat) B) Other domestic animals (cattle, sheep, and goat) C) insects

6. Does rabies transmit from animals to humans? A) Yes B) No

7. Does rabies transmit among animals? A) Yes B) No

8. What is the mode of transmission of rabies from rabid animals to humans?

A) Bite or scratching by a rabid animal or contact with saliva on the mucus membrane

B) Insect bite

C) Wind

9. What are the main signs and symptoms of rabies in animals?

A) Biting and sudden change in behavior and paralysis, and excessive salivation.

B) Excessive thirst, rolling on the ground, and docile behavior.

10. What are the main signs and symptoms of rabies in humans?

A) Fever, hydrophobia (fear of water), hallucination, muscle weakness, and paralysis.

B) Excessive thirst, coughing, rash, and skin lesions.

11. Do you know about the almost fatal nature of rabies once the clinical signs develop in animals? A) Yes B) No

12. Is rabies a fatal disease in humans if left untreated? A) Yes B) No

13. Can rabies be transmitted through the consumption of meat from a rabid food animal?

A) Yes B) No

14. Can wild animals like hyenas, and foxes transmit rabies disease to humans or animals by biting? A) Yes B) No

15. Does rabies disease have a vaccine? A) Yes B) No

4) Community attitude towards dog-mediated rabies

All Attitude questions are five Likert questions

A) Strongly disagree

B) Disagree

C) Neutral

D) Agree

E) Strongly agree

1. Do you think dogs should be kept free to roam around?

2. Do you think that stray dogs are dangerous for the transmission of rabies disease?

3. Do you believe that rabies poses a significant threat to public health in your locality?

4. Do you believe holy water cannot treat rabies disease in humans?

5. Do you think that an exposed human to a rabid animal can recover if immediate post-exposure treatment is given?

6. Do you think that the consumption of rabid food animals is safe?

7. Do you think that vaccination of animals (pet animals) can help to prevent rabies in animals?

8. Do you think that vaccination of animals (pet animals) can help to prevent rabies in humans?

9. Do you think that coordination and collaboration between different stakeholders (e.g., healthcare providers, veterinarians, and community leaders) could enhance rabies prevention and control efforts?

10. Do you think that Traditional healers could not potentially provide a viable solution for the treatment of rabies?

11. Do you think immediate medical attention or care is necessary after a dog bite?

12. Do you believe that burning a rabid animal and inhaling the smoke could be an effective treatment for rabies?

13. Do you think crossing a river before 40 days could prevent rabies disease development?

5) Community practice towards dog-mediated rabies

1. Do you vaccinate your dogs against rabies regularly (within the last 12 months)?

A) Yes B) No

2. Does any member of your family have close contact with dog(s), or cat(s)? A) Yes B)

No

3. Do any of your family members wash their hands after close contact with dog(s), or cat(s)? A) Yes B) No

4. Do you keep your distance from dogs that are roaming freely A) Yes B) No?

5. What action do you take in controlling stray dogs in your kebele or village?

A) Killing, informing the owner, or reporting to the local authorities or animal control services for proper handling and management.

B) Only repelling stray dogs

C) Ignoring the presence of stray dogs and not taking any action to address the issue in the community.

6. Do you wash the wound with soap and water as a first aid if you are bitten by a dog that may be rabid? A) Yes B) No

7. Do you use traditional healers for treating suspected rabid dog bites? A) Yes B) No

8. What actions do you take if a pet animal is bitten by a rabid dog?

A) Isolate the pet, prevent any contact with other animals or people, and inform an animal health worker.

B) Release the bitten pet into the community without proper evaluation and treatment.

9. What action do you take on the carcass of a food animal that died of rabies?

A) Eat the meat after making it into dried meat.

B) Discard the carcass either by burial or burning.

10. Do you use protective clothes or Personal Protective Equipment (PPE) when handling animals that may carry rabies? A) Yes B) No.

11. How do you dispose of food waste to prevent attracting stray dogs or wild animals?

A) Secure in trash bins B) Leave them outside

12. Do you eat meat from an animal that died of rabies as a treatment for rabies?

A) Yes B) No

13. Do you visit immediately a health center if you are bitten by a dog? A) Yes B) No



Figure 2: Photos of participants from different tabias of the Enderta district while filling out the questionnaire

Annex II: Focus Group Discussions (FGDs) Questions

1. Do you know the disease rabies? Or have you ever heard about the disease rabies?
2. What is the cause of the disease?
3. what are the signs and symptoms of rabies in animals and humans?
4. What are the transmission methods? How do animals acquire rabies disease? How do humans acquire the disease?
5. What are the prevention and control methods of the disease, and what challenges do you face in implementing these methods?



Focus group discussion with participants from kedamay weyane tabia



Focus group discussion with participants from mahbere genet tabia



Focus group discussion with participants from metkel tabia

Figure 3: Focus group discussion with participants

Annex III: Key Informant Interviews (KIIs) Questions

1. Have you ever encountered any cases or outbreaks of rabies in animals or humans in this area?
2. What are the prevention and control measures being taken to address rabies in this area?
3. What are the challenges that you are facing during the application of prevention and control methods?
4. How do you typically coordinate and collaborate with local veterinary services, public health authorities, and other relevant agencies when responding to rabies threats?



Key informants from Mahbere genet and Adi-azmea tabia

Figure 4: Key informant interviews with participants from different tabias in the study area

Annex IV: Goodness-of-fit test using the hosmer-lemeshow test and ROC curve to evaluate model regarding knowledge.

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. estat gof, group(10) table
```

Logistic model for K result, goodness-of-fit test

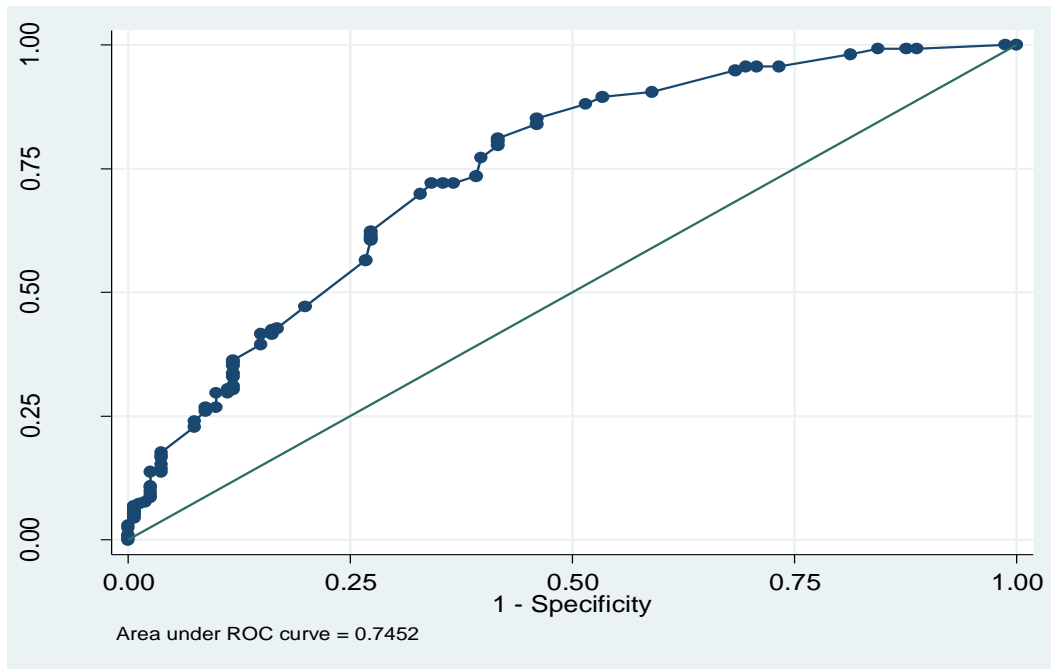
(Table collapsed on quantiles of estimated probabilities)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.3272	12	15.3	43	39.7	55
2	0.4080	14	14.8	23	22.2	37
3	0.5349	26	26.5	28	27.5	54
4	0.6052	25	19.4	8	13.6	33
5	0.6424	27	26.9	15	15.1	42
6	0.6989	42	37.5	12	16.5	54
7	0.7778	30	32.4	13	10.6	43
8	0.8351	28	26.7	5	6.3	33
9	0.8880	34	37.3	10	6.7	44
10	0.9959	38	39.2	4	2.8	42

```

number of observations =      437
number of groups      =       10
Hosmer-Lemeshow chi2(8) =     10.31
Prob > chi2          =     0.2440

```



Annex V: Goodness-of-fit test using the hosmer-lemeshow test and ROC curve to evaluate model regarding attitudes.

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. estat gof, group(10) table
```

Logistic model for A result, goodness-of-fit test

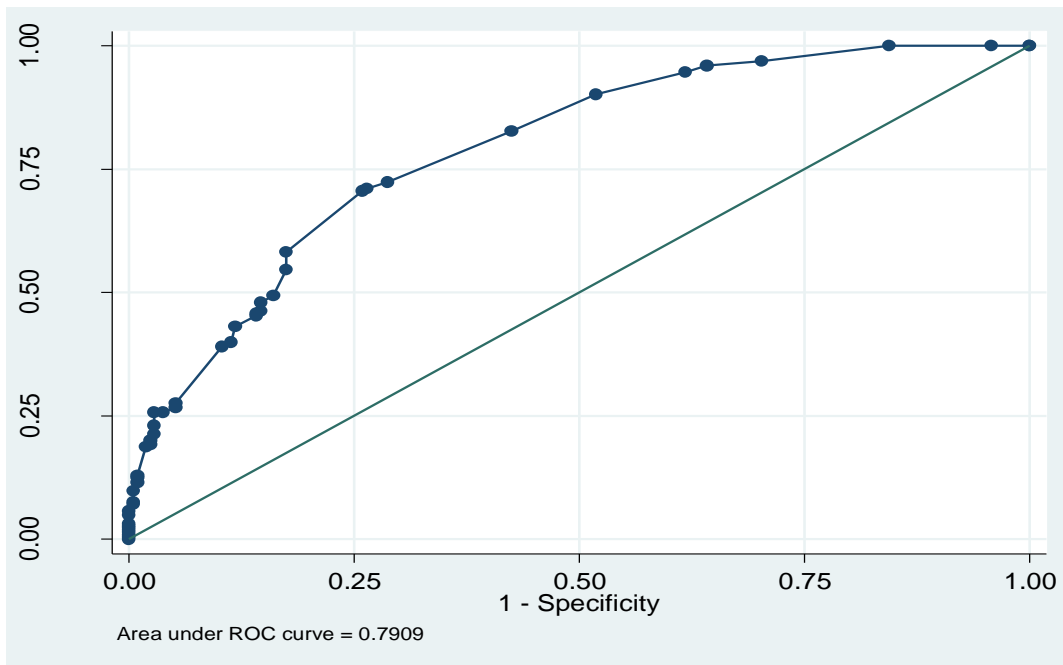
(Table collapsed on quantiles of estimated probabilities)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.1940	7	12.8	63	57.2	70
2	0.2655	5	5.9	18	17.1	23
3	0.3895	27	24.2	41	43.8	68
4	0.3937	23	20.5	29	31.5	52
5	0.4118	3	3.3	5	4.7	8
6	0.5527	29	26.4	19	21.6	48
7	0.7188	34	29.0	12	17.0	46
8	0.7837	35	38.2	14	10.8	49
9	0.8733	33	35.8	9	6.2	42
10	0.9952	29	29.0	2	2.0	31

```

number of observations =      437
number of groups      =      10
Hosmer-Lemeshow chi2(8) =      10.07
Prob > chi2           =      0.2605

```



Annex VI: Goodness-of-fit test using the hosmer-lemeshow test and roc curve to evaluate model regarding practices.

```
. estat gof, group (10) table
```

Logistic model for P result, goodness-of-fit test

(Table collapsed on quantiles of estimated probabilities)

Group	Prob	Obs_1	Exp_1	Obs_0	Exp_0	Total
1	0.1201	5	5.5	47	46.5	52
2	0.2222	9	11.1	46	43.9	55
3	0.2955	17	16.7	40	40.3	57
4	0.3087	11	7.7	14	17.3	25
5	0.3173	10	11.1	25	23.9	35
6	0.4931	40	34.2	32	37.8	72
7	0.5758	12	16.1	16	11.9	28
8	0.6032	12	15.6	14	10.4	26
9	0.7679	33	33.3	13	12.7	46
10	0.9962	39	36.7	2	4.3	41

```

number of observations =      437
number of groups      =       10
Hosmer-Lemeshow chi2(8) =     10.63
Prob > chi2          =     0.2237

```

