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**DOG DEMOGRAPHY, RABIES AWARENESS AND DOG BITE CASES IN  
BISHOFTU, ETHIOPIA**

**MVSc**

**BY**

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BISHOFTU, ETHIOPIA  
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**BY  
HABLE WORKU KEBEDE**

**A thesis submitted to the College of Veterinary Medicine and Agriculture of  
Addis Ababa University in partial fulfillment of the requirements for the degree  
of Master of Veterinary Science (MVSc) in Veterinary Public Health**

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Addis Ababa University  
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## *Dedication*

*I am dedicating this thesis to my beloved late Brother Kumneger Worku who have meant and continue to mean so much to me. Although he is no longer of this world, his memories continue to regulate my life. I will never forget you.*

## STATEMENT OF AUTHOR

First, I declare that this thesis/dissertation is my *bona fide* work and that all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced (MVSc) degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University/College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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## **LIST OF ABBREVIATIONS**

ABLV	Australian bat lyssavirus
ALIPB	Aklilu lema institution of pathobiology
CDC	Central disease control
CNS	Central nervous system
CSF	Cerebral spinal fluid
dFAT	Direct florescent antibody test
DALYs	Disability Adjusted Life Years
DUVV	Duvenhage virus
EBLV	European bat lyssavirus
ELISA	Enzyme linked immunosorbent assay
FAT	Florescent antibody test
KAP	Knowledge attitude and practice
LBV	Lagos bat virus
MIT	Mouse inoculation test
MOKV	Mokola virus
NVI	National veterinary institution
OIE	World organization for animal health
PCR	Polymerase chain reaction
PEP	Post exposure prophylaxis
PET	Post exposure treatment
REID	Rabies enzyme immunodiagnostic
RNA	Ribonucleic acid
RTCIT	Rapid tissue culture test
WHO	World health organization

## ABSTRACT

Rabies is a zoonotic viral disease that affects humans and animals. Dogs are the primary source of infection and the majority of human rabies cases result from dog bites. Information on domestic dog populations is vitally important for rabies control but still rare in Africa, mainly in urban areas. Therefore, this study aimed to assess the demography of dogs, the incidence of dog bites, and the knowledge, attitude, and practice (KAP) of society concerning rabies in Bishoftu town, a typical urban environ. Cross-sectional household surveys were conducted from April to June 2021 involving a questionnaire survey and collection of retrospective patient records from healthcare facilities. A total of 244 respondents were interviewed using a structured questionnaire format to determine their KA and Practices.related Data on the incidence of dog bites and suspected cases of rabies from November 2019 to June 2021 were retrieved from the records of four health centers in Bishoftu. From the total respondents, more than half (51.2%) of households owned at least one dog with dog: human ratio of 1:9, and more than 70% of dogs had been vaccinated against rabies. Almost all, 99% of the respondents had heard of rabies and identified the mode of transmission of rabies. However, the majority of the study participants, 61.8%, had a moderate level of knowledge and 59.8% had an intermediate level of attitude, as well as 64.3%, had a satisfactory level of appropriate rabies prevention practices score. There was a statistically significant association between knowledge score and age, occupation, and source of information ( $P < 0.05$ ). However, a statically significant association was observed only with attitude score with age and source of information ( $P < 0.05$ ). In this study, respondents who attend higher education were more likely to have higher practice scores in the prevention of rabies ( $p < 0.05$ ). Also, there were significant correlations among the participants' knowledge, attitude, and practice ( $P < 0.01$ ). A total of 612 victims were registered and received post-exposure vaccine in Bishoftu over a period of three years (2019 to 2021). In conclusion, we identified critical knowledge gaps related to factors influencing rabies prevention and control. The veterinary and public health sectors should play an important role in educating and raising community awareness.

**Keywords:** *Knowledge, Attitude, Practice, Bishoftu, dog demography, Rabies*

## 1. INTRODUCTION

Dogs were the first animals to be domesticated in the world, and have a close relationship with humans with several useful functions, as a guide, guard, security, herding and for transport purposes (Rinzin *et al.*, 2016) and also their social behavior makes them good companions (Brian *et al.*, 2010). The dog population in the urban and peri-urban areas is classified as owned and ownerless free-roaming stray dogs. The owned dog includes both dogs that are restricted in their movement to a limited area (e.g., within a fenced yard or under human supervision on walks), and those that are free to roam unrestricted without human supervision (Smith *et al.*, 2019). Stray dogs are described by the World Organization for Animal Health (OIE) as dogs not under direct human control or not prohibited from freely roaming. They are classified into three categories: free-roaming dogs, free-roaming ownerless dogs that still live in human households, and wild dogs that have returned to a wild state and are no longer dependent on humans (OIE, 2009<sup>A</sup>).

Apart from their roles as a companion for humans, dogs also play a negative role in the transmission of disease to humans. They are the major reservoir and can transmit several zoonotic diseases to humans through infected saliva, aerosols, contaminated urine or feces, and direct contact with people (Acosta-jamett, 2009). The most common zoonotic infections transmitted to humans by dogs are viral infections such as *rabies* (Rinzin *et al.*, 2016) and *noroviruses* and bacterial infections such as *Pasteurella*, *Salmonella*, *Brucella*, *Yersinia enterocolitica*, *Campylobacter*, *Capnocytophaga*, *Bordetella bronchiseptica*, *Coxiella burnetii*, *Leptospira*, *Staphylococcus intermedius* and *Methicillin resistance staphylococcus aureus* (Ghasemzadeh and Sh, 2015).

Various studies have shown that the dog population has increased as the human population has increased globally, including in Africa (Reece, 2000). This tends to create favorable conditions for most important zoonotic infectious diseases transmitted from dogs to humans (Baneth *et al.*, 2016; Damborg *et al.*, 2016). Knowledge and information about the domestic dog population are relevant for dog-born zoonosis control and for planning effective vaccination programs (Gsell *et al.*, 2012; Rinzin *et al.*, 2016; Tiwari *et al.*, 2019). Estimates of the size of domestic and wild animal

populations have been used in several research areas, such as species monitoring and conservation or disease surveillance and control (Warembourg *et al.*, 2020). This can be helpful, particularly for developing and implementing vaccination programs and estimating the coverage of vaccination campaigns for infectious diseases (Rinzin *et al.*, 2016).

Rabies is among the dog-mediated deadliest zoonosis in the world, with an estimated case fatality rate of almost 100%. It is the top annual human death from all zoonoses and is likely the number one vaccine preventable disease that kills most (Hampson *et al.*, 2015). As in many African countries, the urbanization is rapidly increasing in Ethiopia in the form of slum cities and towns, which is closely related to the human and dog population (Gebremedhin *et al.*, 2020). Due to this, people in Ethiopia are among the worst affected by domestic dogs as the primary source of human infection (Beyene *et al.*, 2018). Rabies in Ethiopia is ranked as the first prioritized zoonosis (Pieracci *et al.*, 2016) and it has been estimated that Ethiopia is the second-largest number of rabies deaths in African next to (Coetzer *et al.*, 2016).

As WHO recommends, to ensure a successful vaccination coverage program and for effective control and prevention of rabies, local knowledge of dog population demography and ecology is critical (WHO, 2013). Knowledge of the dog demographic characteristics and factors associated with dog ownership is important for the planning and implementation of rabies awareness and dog vaccination programs and the promotion of responsible dog ownership (Darryn *et al.*, 2008). This knowledge would be essential for the implementation of more cost-effective rabies vaccination and the implementation of sustainable dog rabies management systems, and the evaluation of other risks or public health issues associated with the presence of dogs.

Dog ecology studies are directly linked to the epidemiology of dogs, thus a better understanding of this linkage is crucial to the design and planning of effective rabies control measures (Ratsitorahina *et al.*, 2009). In 2015, the world called for action by setting a goal of zero human dog-mediated rabies deaths by 2030, worldwide. This strategy is planned with 3 objectives; mass dog vaccination, public education, and awareness creation mentioned prior (WHO and OIE 2020).

Even though rabies is being reported endemically in Ethiopia, data on dog ecology, including their population densities, population structure, and characteristics, does not exist. So far, very little information has been published on the populations of domestic pets in Ethiopia (Menghistu *et al.*, 2012; Tschopp *et al.*, 2016; Gebremedhin *et al.*, 2020). Thus, identifying the status of dog demography, management, and impact of rabies on dogs, animals, and humans, as well as determining the knowledge, attitude, and practice levels of the community are found important for designing effective strategic options for prevention and control of rabies at the national level.

Therefore, the objective of this study was:

- To estimate owned dogs' demography in Bishoftu town, central Ethiopia,
- To assess the knowledge, attitude, and practice (KAPs) of the community toward prevention and control of rabies,
- To quantify, from (2019-2021) the retrospective occurrences of dog and animal bite cases in various health centers in Bishoftu town.

## 2. LITERATURE REVIEW

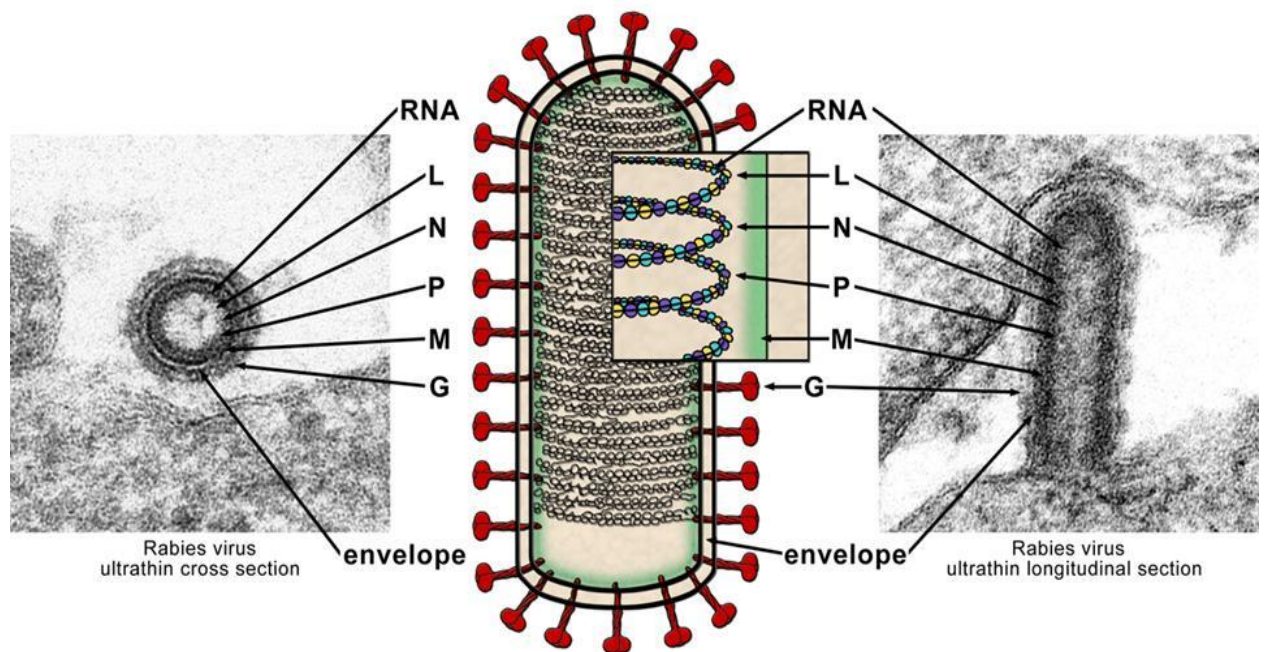
### 2.1. Taxonomy and Classification of rabies virus

The origin of rabies is RNA (ribonucleic acid) viruses belong to the genus *Lyssavirus* with the family Rhabdoviruses with order mononegavirales (Johnson *et al.*, 2010). *Lyssaviruses* are negative strands, rod- or bullet-shaped, negative-sense, unsegmented, single-stranded, enveloped RNA viruses that contain a single-surface glycoprotein and a ribonucleoprotein core (Brunker and Mollentze, 2018). The virus genome encodes five proteins it is rapidly inactivated by desiccation and sunlight. Infection requires contamination of infected saliva or neural tissue into a bite wound or broken skin or onto mucosa (Rodney and Willoughby, 2015).

The genus *Lyssavirus* comprises rabies virus and closely related viruses by antigenic cross-reactivity with sera and monoclonal antibodies at first it was divided into 4 serotypes, including serotype 1 rabies virus (RABV) (found in all continents except Antarctica and Australia), serotype 2 Lagos bat virus (LBV) (first isolated from bat found in Central and southern Africa), serotype 3 Mokola virus (MOKV) (first isolated from shrews found in Central Africa) (Robert *et al.*, 1970) and serotype 4 Duvenhage virus (DUVV) (first identified from bat found in South Africa).

Further, European bat viruses 1 and 2, and Australian bat lyssavirus have been isolated. The improvement of genetic characterization of several genes (N, P, and G) aided in the identification of seven genotypes, 1, RABV; 2, LBV; 3, MOKV; 4, DUVV; 5, European bat lyssavirus 1 (EBLV-1); 6, European bat lyssavirus 2 (EBLV-2); and 7, Australian bat lyssavirus (ABLV) (WHO, 2013).

The genotypes further segregate into two phylogroups, with genotypes 1, 4, 5, 6, and 7 (phylogroup I) and 2 and 3 (phylogroup II). Each of these viruses is considered capable of causing rabies like disease in animals and humans. Rabies virus and rabies like viruses, including European bat viruses 1 and 2, Lagos bat virus, Duvenhage virus, and Australian bat lyssavirus use bats as reservoir hosts; several other members of the family Rhabdoviridae have been isolated from bats (Picard-Meyer, *et al.*, 2004).



**Figure 1:** Structure of *Lyssaviruses*.

Source [https://www.who-rabies-bulletin.org/sites/default/files/rabv\\_particle.jpg](https://www.who-rabies-bulletin.org/sites/default/files/rabv_particle.jpg)

*Lyssaviruses* have a 12 kb long non-segmented RNA genome of negative polarity encoding five viral proteins (3' to 5'): nucleoprotein (N), phosphoprotein (P), matrix protein (M), glycoprotein (G), and polymerase (L) figure 1. The *Lyssavirus* particle has a bullet-shaped form, 100–300 nm in length and 75 nm in diameter (WHO, 2013; Gadd, 2013) M the matrix protein (formerly M2) that lies between the ribonucleocapsid and the envelope, and is responsible for virus budding and the bullet-shaped morphology (Dutta, 2014).

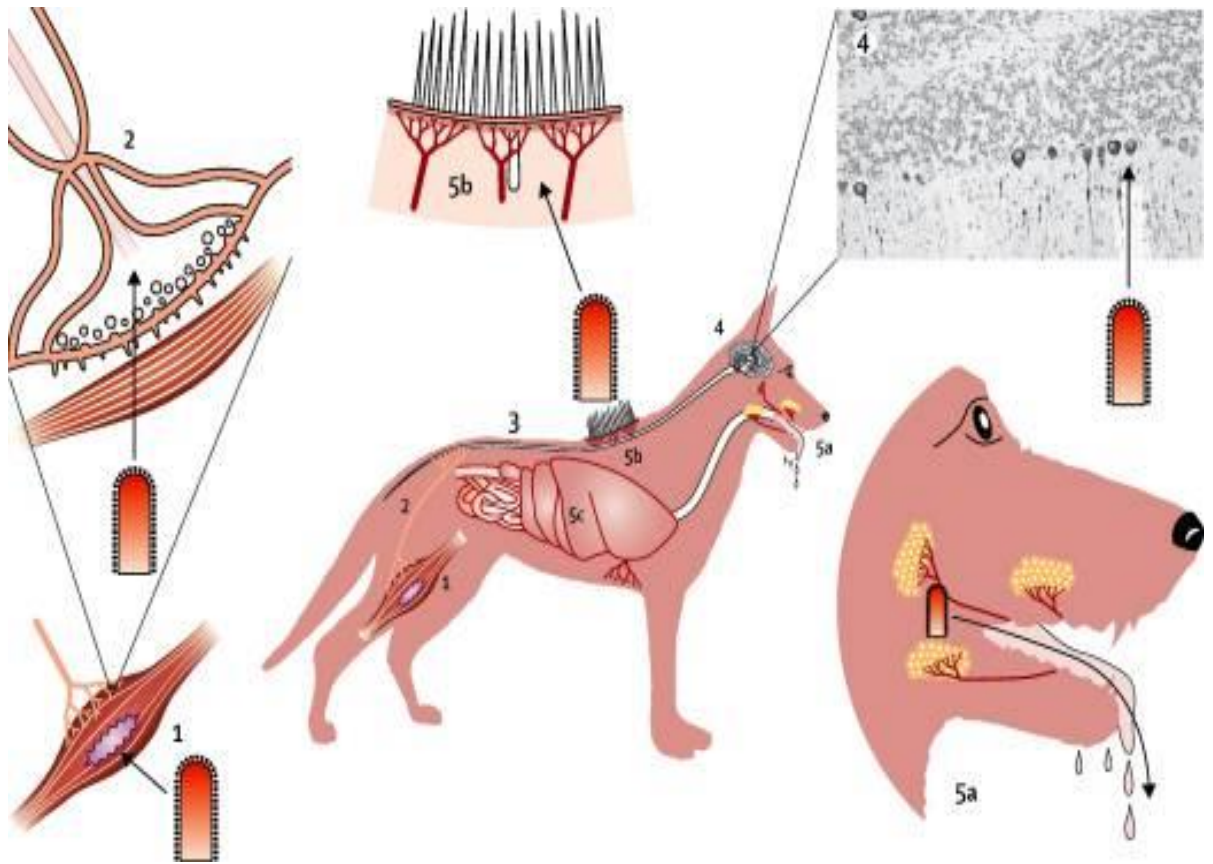
## 2.2. Pathogenesis

The rabies virus enters the body through a wound or by direct contact to the mucosal surface (eye, nose, mouse), it cannot cross intact skin (WHO, 2013). With the bite, the virus replicates in the bitten muscle and gain accesses to endplate and motor axons to reach the central nerves system (CNS) once the virus reached in CNS rapid virus replication take place. Because the nervous system is a privileged immunologic site

(Rodney and Willoughby , 2015). As soon as the virus reaches the brain it works its way into the salivary glands where it replicates in abundance and is shed in the saliva.

In the experimental study that has been done by Dietzschold *et al*, (2005), the virus spread from the site of an injection directly to the central nervous system to the salivary gland in various animal species. It proves the virus the typically transmitted from the site of exposure to CNS via the peripheral nerves system. After replication, the virus may return to the site of the bite by orthograde axonal transport or may travel along the corticospinal tract to the brain where it infects neurons in almost all brain regions (Fu, 1997).

Clinical signs develop from less than 91 weeks to a month and sometimes over a year the incubation period can range from 2 weeks to several months. The average incubation period for dogs and cats is about 2 months. Usually, the location of the bite wound will determine the length of incubation. If an animal is bitten on the neck, the virus would have a relatively short distance to travel to the brain, and would likely have a short incubation period. (Singha *et al.*, 2017)



**Figure 2:** Pathogenesis of Rabies Virus.

1) The virus enters into the muscle tissue of the host through a bite wound, then 2) enters the peripheral nervous system (PNS) via the neuromuscular junction, and then 3) from the PNS, travels to the spinal cord and brain. 4) A virus enters the brain and undergoes massive replication, leading to neuronal dysfunction. 5a) the virus replicates in salivary glands and is excreted in saliva, 5b) enters peripheral nerves of the skin and Purkinje cells, and 5c) spreads from the brain to infect many tissues and organs in the host ( Fooks and Jackson 2020).

### 2.3. Epidemiology of Rabies

Apart from Australia and Antarctica, a few island nations such as Great Britain, Ireland, New Zealand, Hawaii, and many Western European countries are endemic for rabies (Cifuentes *et al.*, 2017). In developing countries central and South America, Africa, and Asia, Canine rabies is predominant. These regions also account for the majority of global human rabies cases. Africa and Asia account for more than 95% of global

human deaths. In Asia and Africa over 24,000-30,000 people die due to rabies every year, the high death rates reported in poor rural communities and children. Although in Europe rabies is still present but due to the enforced animal vaccination, human rabies has been eradicated from many European nations (Yousaf *et al.*, 2012).

Carnivora and Chiroptera, are the primary hosts of the rabies virus. Chiroptera species are the primary hosts of almost all other *lyssaviruses* ( Cifuentes *et al.*, 2017). The *lyssaviruses* have a common host range which includes dogs, cats, men, bats, and wild carnivores like foxes, bobcats, mongoose skunks, and jackals, and 99% of human death is caused by Canine rabies (Warrell<sup>A</sup> and Warrell<sup>B</sup>, 2015).

The virus is enzootic in Africa with domestic dogs being the main vector for transmission (Sambo, 2012). Spillover rabies virus from dogs is threatening endangered wild African canids such as the Ethiopian wolf (*C. simensis*) and the African wild dog (*Lycaonpictus*) (Woodroffe *et al.*, 2012), also bats are important vectors of the disease by causing hundreds of cattle death every year in central and in south America (Cifuentes *et al.*, 2017).

#### **2.4.Host Susceptibility**

All mammals are susceptible to infection, however, the degree of susceptibility can be influenced by host factors such as age, health, and nutrition, (Rodney and Willoughby , 2015). Even though all warm-blooded animals are susceptible to rabies, the most resistant species are birds. Skunks, wild canids/foxes, raccoons, bats, and cattle are the most vulnerable, followed by dogs, cats, horses, sheep, goats, non-human primates, and humans (Muriuki, 2016).

#### **2.5. Transmission**

The rabies virus is usually transmitted when infected saliva from a host is passed on to an uninfected animal. Several routes of transmission have been identified, including contamination of mucous membranes (e.g., eyes, nose, and mouth), and corneal transplants (Depani, 2012). The most common mode of rabies virus transmission is through an infected host's bite and/or virus-containing saliva. Transmission occurs

when infected saliva in bites, scratches, and through licks from infected animals in open wounds or on mucosal membranes. The rabies virus cannot penetrate through normal skin. Human-to-human viral transmission by bite is theoretically possible but has never been confirmed (Ojo *et al.*, 2016).

## **2.6. Incubation period**

When compared to other infectious diseases, rabies has a unique incubation period. The incubation period after exposure is determined by the site of the bite, the severity of the bite, the species of animals involved, the age of the bitten individual, the strain and amount of virus, post-exposure treatment, and the ease with which the virus reaches nerve endings. 30–90 days long but may last from a few days to several years (Mani and Madhusudana, 2013).

The incubation period lasts 30 to 90 days on average, but it can last from a few days to several years. For instance, three to eight weeks for dogs, two to six weeks for cats, and two weeks to 12 months for humans (average three to six weeks). Incubation times have been documented to range from ten days to six years. Typically, the first symptoms appear between 30 and 90 days after exposure. Older animals incubate for a longer period than younger animals (Meng *et al.*, 2020).

## **2.7. Clinical Sign**

Clinically, rabies is manifested into three stages: prodromal, furious, and paralytic or dumb stage (Muriuki, 2016). Both furious and paralytic forms of rabies occur in both humans and dogs approximately in a 2:1 ratio (Hemachdha *et al.*, 2002).

### *2.7.1. Symptom in Animal*

Initially, the symptom of rabies in animals are often nonspecific which may include anxiety, restlessness, anorexia vomiting, a milled fever, pupil dilation, hyperactivity to stimuli, and excessive salivation these signs last 2 to 5 days ( Shuangshoti *et al.*, 2016). As rabies affects the nervous system, it is often associated with behavioral changes that can be manifested in a variety of ways classically it is described as having prodromal

phases followed either by an excessive encephalitic (furious) or a paralytic (dumb) form (Bishop *et al.*, 2010).

Encephalitic (furious rabies) observed in the majority of rabies cases is the classic "mad dog" syndrome even though it might be seen in all species. In this stage, animals become easily active by external stimuli and the loss of fear of humans and animals (Abera *et al.*, 2015). Generally, furious rabies is characterized by aggressiveness, restlessness, extremely roaming, howling, polypnea, drooling, and attacks on other animals, people, or inanimate. Often affected animals swallow foreign objects such as sticks and stones (OIE, 2009; Muriuki, 2016).

Paralytic rabies is the last stage of the disease manifested by ataxia, paralysis of the jaw, tongue, and throat, often with profuse salivation as well as inability to swallow (Abera *et al.*, 2015). Laryngeal paralysis can result in a change in vocalization, such as an abnormal bellow in cattle or hoarse howling in dogs, as well as facial paralysis or the lower jaw-dropping. Ruminants separate from the herd may become depressed (Oyda and Megersa, 2017).

### 2.7.2. *Symptom in Human*

Rabies in humans manifested either encephalitic (furious) or paralytic (dumb) forms with a high rate of fatality, in both clinical forms the brainstem is preferentially involved (Hemachudha *et al.*, 2002). Nearly two-thirds of cases are caused by furious rabies. It is characterized by fever, pain or paresthesia at the site of bite, anxiety, and nervousness, agitation, aerophobia, and hydrophobia involving muscle spasm and swelling and a late sign of delirium, diminished consciousness level and occasionally convulsions (Depani, *et al.*, 2012).

Paralysis of the limbs and respiratory muscles is caused by paralytic rabies. Although aerophobia and hydrophobia can be noticed, consciousness is not depressed, respiratory and heart failure is the most common cause of death. The behavioral effects are first mild and continue to be sporadic until the patient falls into a coma within a week after being hospitalized (Rodney and Willoughby, 2015).

The virus replicates quietly and at a low level in local tissues such as muscle (dog rabies) and skin (bat rabies). Inefficient viral multiplication prevents immune detection, resulting in a highly varied and prolonged incubation period (up to 7 years). Hydrophobia and aero phobia provide a strong suspicion of rabies in humans (WHO, 2013). Hydrophobia is extremely distressing when the patient becomes extensively thirsty hence the use of intravenous fluids as prophylaxis is recommended for individual patients (Depani, 2012).

## **2.8. Diagnosis**

Timely and accurate human and canine laboratory diagnosis is necessary for the generation of reliable surveillance data and to aid decision-making for post-exposure prophylaxis (PEP) (Rodney and Willoughby , 2015). Human rabies is typically diagnosed based on clinical symptoms and signs, as well as a circumstantial history or evidence of an animal bite, animal death, and partial or no vaccination following exposure (Tiwari *et al.*, 2019). Hydrophobia and aerophobia only occur in humans with rabies but are neither sufficiently sensitive nor specific. (Rodney and Willoughby, 2015).

In animals, rabies diagnosis can be made by taking any part from the affected brain. However, to rule out rabies, the test has to include tissues from at least two locations in the brain, the brain stem, and the cerebellum (Yousaf *et al.*, 2012). WHO recommended many diagnostic tests for the detection of rabies in animals, including direct florescent anti-body, mouse inoculation technique, tissue culture infection technique, and polymerase chain reaction (WHO, 2004).

### *2.8.1. Sample Transportation and Laboratory Diagnostic Techniques*

The sample for rabies diagnosis is the head of the suspected animal. The brain is extracted for sampling. Prompt laboratory testing, submitted specimens should be stored and transported under refrigeration (Muriuki, 2016). Specimens for rabies diagnosis should be shipped according to national and international regulations to avoid

exposure hazards. Personnel working with the virus should receive pre-exposure prophylaxis (WHO, 2004).

In general, biosafety practices are adequate for routine laboratory activities such as handling animals, necropsy, collection preparation, and processing samples. The basic facility design should be adequate, and precautions should include personal protective equipment (e.g. clothing, gloves, and eye protection) and vaccination (Fook *et al.*, 2012). A diagnostic laboratory should determine confirmation of the result and the only way to undertake a reliable diagnosis of rabies is to identify the virus or some of its specific components using laboratory tests.

If possible, the animal that is suspected of having rabies should be captured. If it is not overtly rabid, it can be quarantined for 10 days and observed for signs of rabies. If the animal exhibits signs of rabies, it should be euthanized and its brain tissue should be submitted. Rabies lesions, virus, and virus antigen are reported to be particularly abundant in the thalamus, pons, and medulla (Duong *et al.*, 2016). Although the thalamus has been reported to be the most likely positive tissue, a pool of brain tissue including the brainstem should be used for laboratory examination. Occasionally, virus antigen or infectious virus can only be detected in the salivary glands. Examination of salivary glands can also provide valuable epidemiological information on the excretion of the virus by different vertebrate species (OIE, 2018).

### 2.8.2. *The direct florescent antibody test (FAT)*

Direct florescent antibody test (FAT) is the golden test for diagnosis of both human and dog rabies which is a highly sensitive and specific method (WHO, 2012). It has been used for more than 60 years (Rupprech *et. al* 2018). It is still the most widely used test for rabies diagnosis. Post mortem Fluorescent Antibody Test (FAT) is based on impression smears of fresh brain and brain stem tissues (Muriuki, 2016).

Brain smears or touch impressions are used for the detection of virus antigen with the fluorescent antibody test (FAT) for both human and animal samples. In animals; the direct fluorescent antibody test (DFAT) is the recommended diagnostic test. This test

detects the presence of rabies antigens in brain tissue (Abera *et al.*, 2015). For a high sensitivity test, the cerebellum is recommended, The hippocampi (Ammonhorns) may be included, although they are not needed for a definite diagnosis (Bishop *et al.*, 2010).

FAT provides a reliable diagnosis in 98–100% of cases for all rabies virus strains if a potent conjugate is used. It is normally positive after inoculation of brain tissue, saliva, or CSF in cell culture, or after intra-cerebral inoculation in mice or suckling mice (Wilde *et al.*, 2005). The FAT results can be available within two hours of submission of the specimen while results of mice inoculation can take up to 28 days (OIE, 2011).

### 2.8.3. *Mouse inoculation test (MIT)*

Mouse inoculation test is a sensitive and easily performed test used to amplify the viruses for identification and possibly for isolating infectious viruses (Abera *et al.*, 2015). In some countries, the mouse inoculation test is employed as the main test, but it is more commonly used as a confirmatory test to confirm negative results, particularly in the case of humans who were bitten or scratched. Following that, mice are infected with a suspension of the suspected tissue (brain or salivary gland) that has a history of human contact ( Bishop *et al.*, 2010). Only fresh samples are used in this test, which includes the brain, salivary glands, liver, spleen, pancreas, and nuchal skin.

The test has also advantages and disadvantages compared to conventional cell culture, mice allow for the accumulation of high virus titers at first inoculation since infection causes disease only after fairly significant virus replication in the mouse brain. Most traditional cell cultures used for the rapid tissue culture inoculation test (RTCIT) must be split every 3–5 days, not allowing enough time for viral accumulation until numerous passes (sometimes 10 or more) have been made. The disadvantage side of MIT is required a much longer time for test completion compared to RTCIT to ensure a negative result (Kuzmin, 2017). A positive result is detected by the death of the animal within 4 to 28 days after injection. The positive animal brain must be confirmed by positive DFAT or another post-inoculation test (Mani and Madhusudana, 2013).

#### 2.8.4. *Enzyme-Linked Immunosorbent Assay (ELISA)*

Enzyme-linked immunosorbent assays (ELISA) also called rapid rabies enzyme immunodiagnosics (REID) developed for the detection of *lyssavirus* antigens in brain tissue, such as have provided consistently reproducible results in several laboratories. it is a rapid technique that can be particularly useful for the epidemiological survey (WHO, 1992). The test involves screening for RABV neutralizing antibodies in serum or CSF from the suspected animal (Singh *et al.*, 2018). Detection of antibodies from cerebral spinal fluid CSF is definitive (OIE, 2012). The test reduces time, facilitates handling, and avoids the utilization of biosecurity level 2 or 3 laboratories. It doesn't require live RABV or cell culture, the test was developed for domestic carnivores and wildlife. and it is certified and recommended by the OIE for the detection of rabies (Cifuentes *et al.*, 2017). However, compared to FAT the ELISA test, although have high sensitivity and less specificity, due to this reason, the test should be combined with other tests such as FAT for confirmation (Duong *et al.*, 2016).

#### 2.8.5. *Polymerase Chain Reaction (PCR)*

By sequencing, the amplified products polymerase chain reaction (PCR) provides an interesting method for genetic characterization of the viral strain. Compared to prior rabies diagnostic techniques PCR is a rapid and more sensitive alternative diagnostic method ( Picard-Meyer *et al.*, 2004). Most widely PCR used to detect RABV RNA for intra-vital rabies diagnosis in humans on cerebrospinal fluid, saliva, respiratory secretions, tears, and skin biopsies as well as by immune fluorescent staining of skin sections and corneal impressions (Warrell<sup>A</sup> and Warrell<sup>B</sup>, 2015). It is also expensive and required trained laboratory technicians and accredited molecular techniques (Duong *et al.*, 2016).

### **2.9. Rabies Control and Eradication Strategies**

Rabies will remain to be a threat as long as its control is not addressed adequately at the animal source (Fooks *et al.*, 2012). Every year, approximately 59,000 individuals

worldwide die as a result of rabies. That's one person every nine minutes of every day half of them are children living in Asia and Africa (Jonasson, 2014).

Today rabies is considered the disease of poverty, The poorest and most marginalized people are most at risk, not only from the trauma of a dog bite and the possibility of death but also from the devastating economic consequences of rabies, which are estimated to be more than US\$ 8.6 billion each year. Many people die as a result of exorbitant treatment expenses or a lack of access to post-exposure prophylaxis (PEP) (WHO, 2020). Post-exposure treatment (PET) is not a permanent solution for preventing rabies in humans as it will not prevent transmission of the virus from rabid dogs to other humans or dogs (WHO, 2015).

Rabies control consists of the control of stray animals, Immunization, health education for the public, sterilization, animal management, and registration programs, canine rabies can be controlled and significantly decreased in rabies endemic regions (Gsell *et al.*, 2012). According to the WHO (2013), mass vaccination of dogs is the most effective and sustainable method of controlling and possibly eliminating dog-mediated human rabies. It has been used in the industrial country to successfully control the disease (WHO, 2005). In the absence of concerted efforts and investment in control, the burden of human mortality from rabies and the economic consequences will continue to rise as dog and human populations grow (WHO, 2013).

The WHO recommends vaccinating 70% of the dog population will eliminate dog rabies and hence human rabies (WHO and OIE, 2020). Human rabies prevention through domestic dog rabies control is a realistic goal in Africa and Asia, and it is financially justified by the future savings of terminating post-exposure prophylaxis for humans. (CDC, 2011; WHO, 2010). By vaccinating 70% of dog populations in areas where rabies exists, the number of human cases can rapidly drop to almost zero, and also it is the only real way to break the disease infection life cycle between animals and humans Moreover, vaccination programs that are well designed and adequately resourced will have a significant benefit on animal welfare (Fooks and Jackson, 2020).

Reduction of a wild animal population by trapping has been attempted in efforts to control rabies. As poor public awareness of rabies is one of the major obstacles in any

prevention and control scheme of rabies especially in rabies endemic countries like Ethiopia (Chernet and Nejash, 2016; Abdela and Teshome, 2017),

Community awareness about rabies has a significant role in rabies prevention and control. Knowledge, attitudes, and practices (KAP) studies have been used widely to enhance community knowledge and thus important step towards developing strategies aimed at disease prevention and control based on the principle that increasing knowledge will result in changing attitudes and practices to minimize disease burden (Sambo *et al.*, 2014; Tiembré *et al.*, 2014; Digafe *et al.*, 2015; Abdela and Teshome, 2017).

In 2015, the world called for action by setting a goal of zero human dog-mediated rabies deaths by 2030, worldwide. This strategy planned with 3 objectives the first one is to effectively use a vaccine, medicines tools, and technologies, second to generate, innovate and measure impact and third to sustain commitment and resources under this improved awareness and education, increased access to healthcare, medicines, and vaccines and dog vaccinations are included (WHO and OIE 2020).

If dog rabies is eliminated through mass dog vaccination, both the demand for PEP and the expense of health demand should decrease. National vaccination programs will require persistence and sustainable commitment, it will have widespread health benefits especially for the poorest community (WHO, 2013).

## **2.10. Dog Ecology and Rabies**

The natural epidemiological spread of canine rabies is determined by the history of human-dog interactions as well as the structure and density of the presence of the dog population. Stray dogs are known to play a crucial role in the spread of rabies. A better understanding of the human-dog relationship is a prerequisite for the implementation of more effective rabies control strategies. (Adedeji *et al.*, 2010)

In most countries, rabies was successfully controlled through mass dog vaccination (Perry *et al.*, 1995; Abera *et al.*, 2015). It is only practicable when a certain amount of information on the epidemiology and ecology of the host species is available. The

percentage of dogs accessible for vaccination is determined by the ratio of owned versus un-owned dogs, and by owner attitudes (Wandeler, 1995). Rabies-endemic countries, including the Philippines, India, Sri Lanka, Kenya, Madagascar, Mexico, and Tanzania, have done dog ecological studies (Arief, 2014).

Domestic dog ecology could be divided into confined and free-roaming populations based on the confinement property. The confined population is exclusively made up of owned dogs, whereas free-roaming populations are classified into three categories: owned dogs, strays, and feral dogs. (Slater, 2001). While in the different countries free-roaming dog population is found as an important reservoir for canine rabies and other zoonosis disease and many of those dogs are owned dogs that are allowed to freely roam by their owner (Dalla, 2010).

The natural epidemiological spread of canine rabies is determined by the history of human-dog interaction as well as the structure and density of the existing dog population. Unfortunately, our knowledge of dog ecology in urban and rural areas is poor. However, knowledge of dog ecology could be used to identify high-risk areas and allocate resources accordingly (Arif, 2014).

### **2.11. Rabies in Ethiopia**

Rabies is one of the significant public health concerns in Ethiopia, with many cases of the disease it is diagnosed in many parts of the country and dogs are the most common source for human exposure (Deressa *et al.*, 2010). It is primarily a disease of dogs in the country in 1884, the first major dog outbreaks were recorded in many parts of Ethiopia, especially in the former provinces of Tigre, Begemder, Gojjam, and Wollo. (Oyda and Megersa, 2017). Another outbreak of rabies in dogs was reported in Addis Ababa in August 1903 and the disease becomes well establish and endemic (Fekadu, 1982).

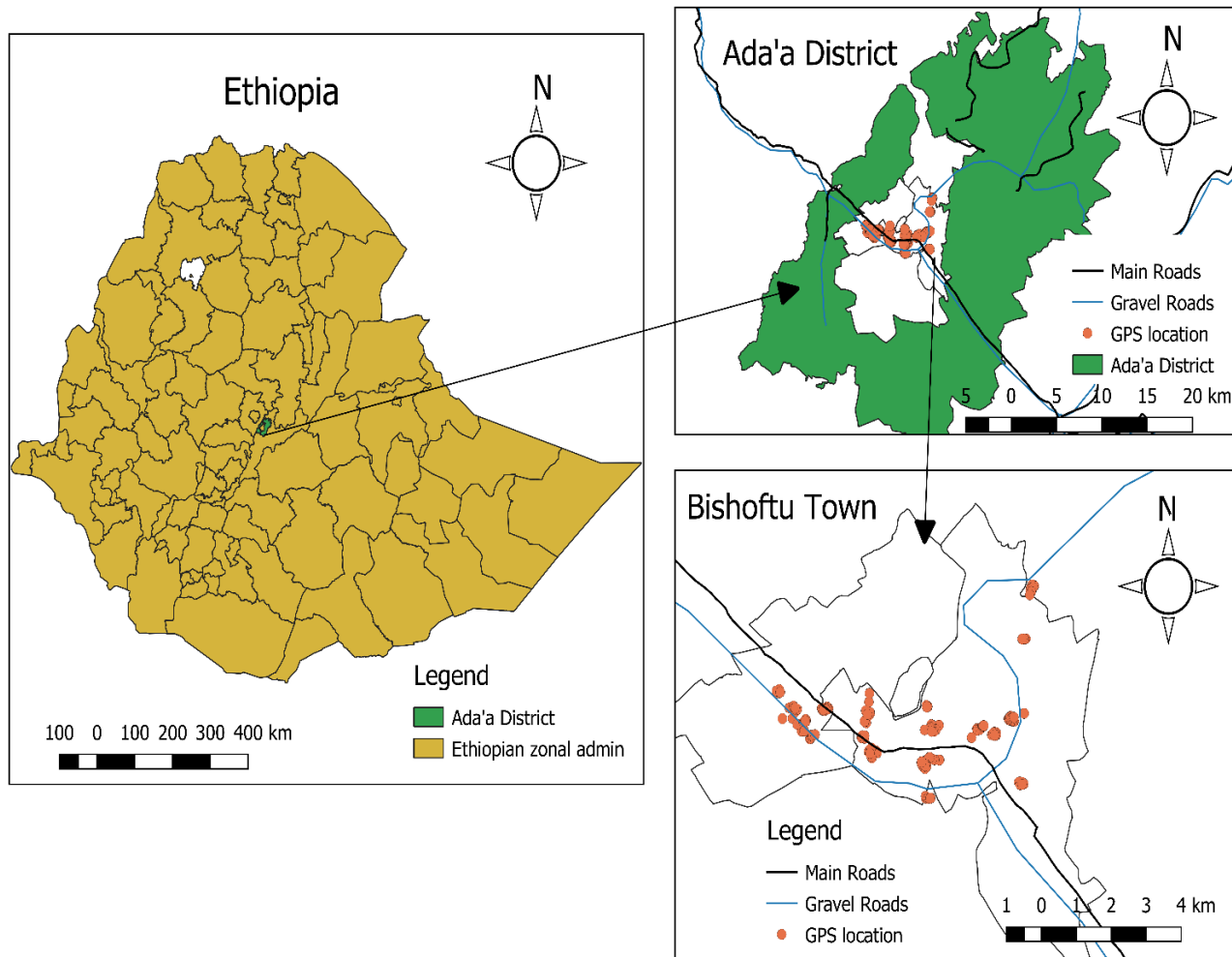
More than 98% of cases in humans and vaccinations are attributed to rabid or suspected rabid dogs. Due to the widespread nature of rabies in the country, approximately 77 individuals per million receive anti-rabies post-exposure treatment annually (Ramos *et al.*, 2015). The majority of the treatment is due to stray dogs bites. One retrospective

study in and around Addis Ababa from 2001- 2009 indicates that 386 fatal cases were reported with an annual range of 35 to 58 cases. (Deressa *et al.*, 2010). According to the annual reports of the EHNRI (Ethiopian Health and Nutrition Research Institute), a total of 488 human deaths occurred between 1964 and 1975. Between 1996 and 2000, a total of 9593 post-exposure cases and 153 fatal human rabies cases were documented in Addis Ababa and its surrounding (Oyda and Megersa, 2017).

### **3. MATERIALS AND METHODS**

#### **3.1. Study Area**

The study was conducted in Bishoftu town which is located at a distance of 45km southeast of Addis Ababa, Ethiopia (Figure 1). The town is located in the East Showa zone of Oromia Regional State and lays 9° North and 40° East in Ada'a district at an altitude of 1850 meters above sea level. A mixed farming system practiced in the rural area, with intensive and semi intensive livestock production in the town. It has an annual rainfall of 866 mm of which 84% is in the long rainy season (June to September) and the remaining in the short rainy season extending from March to May. The mean annual maximum and minimum temperatures of the area are 26°C and 14°C respectively, with a mean relative humidity of 61.3%. The town is divided into 14 administrative kebeles (Gebreegziabher *et al.*, 2017). In 2013 national census reported a total population for Bishoftu of 127,678 of whom 59,589 were men and 68,090 were women (CSA, 2013). Bishoftu is a resort town, known for its several lakes. As a result, it became known as the city of recreation and center of tourism. The town host a National Veterinary Institution (NVI), College of Veterinary Medicine and Agriculture Addis Ababa University (CVMA), and different export standard abattoirs and farms are located. Commercial livestock production is widely practiced in the town and its vicinity. As a result of urbanization, the total population in the town has increasing from time to time. Many people use dogs for guarding, and the human-dog relationship is increasing with urbanization in which many people tend to keep dogs, and also due to many abattoirs found in the town, waste disposals from abattoirs could attract stray dogs. As a consequence, there are a large number of free-roaming/stray dogs in town.

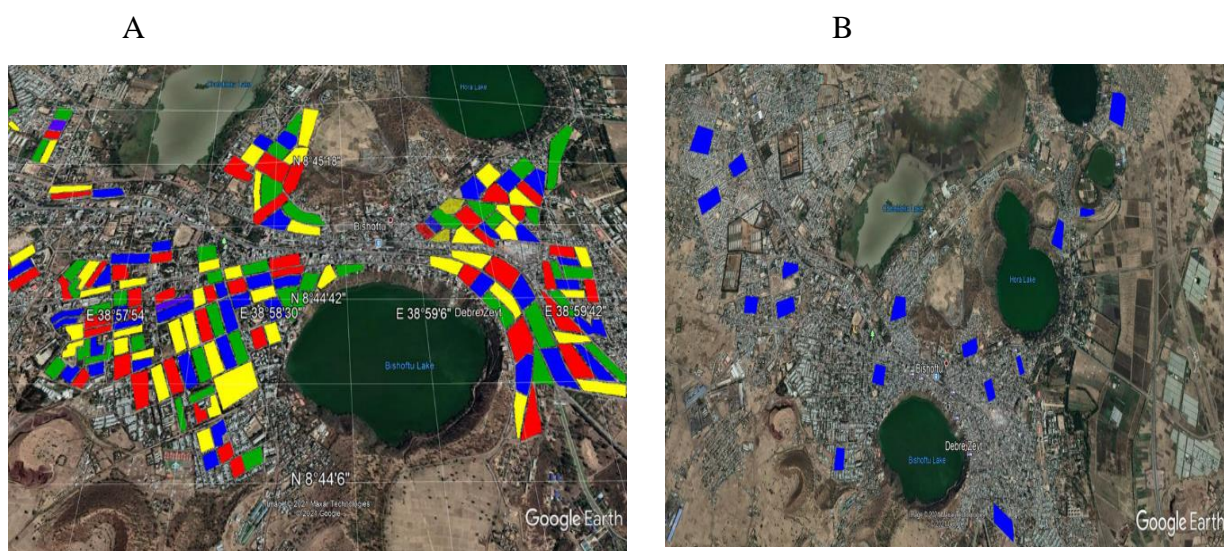


**Figure 3:** Map of the study area.

### 3.2. Study Design and Sampling Methods

Community-based cross-sectional study and healthcare facility-based retrospective study (from patient records) were conducted from April 2021- June 2021. The sampling method used in the present study was adopted from the previous study in the area (Tadesse *et al.*, 2020). A publicly available map of Bishoftu city was downloaded from Google Earth (<https://earth.google.com/web/>) and then the whole residential area of the town was divided into non-overlapping approximately equal-sized blocks surrounded by main roads (wide asphalt or cobblestone roads on the map). Then each equal-sized adjacent block was marked using four different colors: red, yellow, blue, and green (Figure 2A). As a result, the entire town of Bishoftu was divided into 80 blocks, each

adjacent area having an approximately equal size and marked with one of the four colors producing approximately 20 blocks marked by each color. The four colors were written on a sheet of paper and entered into a lottery system to be chosen. By a lottery system, the blue color was selected and included in the study. However, due to the limited capacity to cover all of the 20 blue marked blocks, we randomly reselected 16 blocks by the lottery system (Figure 2B). The selected areas were then visited to mark their boundaries on the ground using turning roads and fixed permanent land marks such as hotels, buildings, and long fences as markers. Then all the living compounds within the marked boundaries of the selected blocks were included in the survey.



**Figure 4:** Map of Bishoftu Town

**A)** Map divided into 80 approximately equal-sized non-overlapping blocks marked with four different colors, **B)** The randomly selected 16 Blue colored blocks and included in the study.

### 3.3. Data collection

In this study, two types of data collection approaches were used: questionnaire survey and retrieval of healthcare facility-based retrospective patient records. The focus of the questionnaire survey was to assess the number of owned dogs and dog-owning households, to estimate the dog to human ratio, and also the knowledge, attitude, and

practice of the people concerning rabies. The survey was implemented using pretested structured interview questions administered through face-to-face interviews. The other is retrospective data on dog bite cases reported in Bishoftu town healthcare facilities.

### *3.3.1. Questionnaire survey*

A structured questionnaire was prepared and finally populated to Epcollect5 mobile & web application data gathering platform. The types of questions were open and closed. The specific person interviewed from a household was head of the household or if the household head was not present, any household member +14 years old was interviewed based using the prepared format (Annex 1). The types of data collected included the socio-demographic characteristics of the interviewed person, also the households, dog ownership, confinement status of every dog owned by the household, dog anti rabies vaccine coverage and dog to human population ratio, factors related with rabies awareness, and dog-related zoonosis, community knowledge on rabies, rabies prevention measures, and animal bite management and health center seeking behavior. The questionnaire also encompassed the opinions about stray dogs that have been conducted. Further points asked were the clinical symptoms of rabies in humans and dogs, the reason for non-vaccination of dogs, and first aid treatment of dog bites. To avoid the biased response as much as possible, the interview started with open-ended questions. The interview was conducted in a language that respondents can understand, mainly Amharic and afaan Oromo. The respondents were interviewed after informed verbal consent was obtained.

### *3.3.2. Data collection for retrospective studies*

Reported data on dog bites and suspected rabies cases from November 2019 to Jun 2021 were collected from the records of four health stations that provide rabies vaccine in Bishoftu (namely Zqual, Cheleleka, Babugaya, and Keta Health Centers). Information on the date of bite, species of victim bitten, sex of the victim, and site of the victim bitten was retrieved from the hard copies of patient recording books.

### 3.3.3. KAP Assessment about rabies

To assess knowledge of rabies ten questions were used covering the cause of rabies, its mode of transmission and the consequence of disease, species affected and the symptom of the disease both in humans and animals. Six questions were used to evaluate rabies attitudes and practices, including first aid, prevention action as well as actions taken in response to suspicious rabid animals. (Table 6). Scores were given based on the completeness and validity of respondents' responses, ranging from zero to three depending on the nature of the question, with the right answers receiving the highest points. (Erfani *et al.*, 2020, Kaliyaperumal, 2004, Abbate *et al.*, 2006 and Xiang *et al.*, 2010).

The total knowledge score ranged from 0 to 15. Individuals scoring 7 and under were categorized as having low knowledge, 8 to 10 as having moderate knowledge, and above 10 as having a high knowledge of Rabies. If all questions were answered correctly the respondent would achieve an overall 15 score. The detailed scoring procedure is described in (Annex I). For example for the question clinical sign (symptom) rabies for participant mention two or more main symptoms assigned a score of 2, score 1 was assigned if the participant mentioned one symptom and zero for who answered wrongly or for those unable to answer the question. The scoring system and procedure were also used for the attitude and practice section

### 3.4. Data Analysis

After collecting the data using the Epcollect5 platform, the data was downloaded and converted into Microsoft Excel 2010 spreadsheet and coded. All the descriptive and analytical statistics analyses were performed by using a statistical package for social sciences (SPSS) version 25. Data obtained were presented using tables and charts. Pearson's chi-square test and fisher exact test was used for calculating association of all independent variables (gender, age, education level, occupation, dog ownership, and source of information on rabies) and each dependent variables (i.e. respondent knowledge, attitude, and practice level regarding the question). Descriptive statistics were used for calculating the frequency and percentage of both dependent and independent variables. The p-values were used to describe statistical significance

(judged as significant when the p-value is less than 0.05). The models were tested for correlations between each dependent variable.

### **3.5. Ethical Clearance**

This study was approved by the ethical review board of Addis Ababa University Akilu lema institution of pathobiology institutional review board (**Ref ALIPB IRB/16/2012/20, 09 March 2020**). Consent to be interviewed was verbal. Each participant was informed about the aim of the study and verbal informed consent was obtained from each respondent. Participation in the study was voluntary and respondents were free to withdraw from the study at any time.

## **4. RESULTS**

### **4.1. Respondent Demography and Household size**

A total of 247 urban households in Bishoftu were approached for the interview and 244 residents agreed to participate in the interview. It was only three households refuse to participate in the interview. On average there are 5 households in one living compound and one representative household was interviewed. The result indicated that (59%) of the respondents were female. The average age of the respondents was 37 (range from 14-80 years). In this study, we intentionally included an age group (<18 years of age) because this age group is the most common victim of a dog bite. The majority of the respondents were above 36 years of age and 40.2% of the respondents attended secondary school and 41.8 % attended college or university. The majority of the head of the household was female (Table 1). The households cover a total population of 1711 people with (range: 1 to 30 person per living compound) with an average household size was of 7 (see Table 2) and 287 (16.7%) was children under ten years old. Out of the total interviewed, 168 (68%) of the participants were heads of a household.

### **4.2. Dog demography**

In the survey, out of 244 households more than half (51.2%) of households owned at least one dog with a total number of 192 dogs (range: 1 to 4 dogs per household); the mean number of dogs per household was 1.54 (SE 0.713). The estimated overall dog to human ratio was 1:9. The recorded male: female ratio of dogs in the present study was 1 to 3.5 and age-wise majority was adult with adult: puppy ratio of 1:15. A total of 6 % of the dogs were within the one-week to one-year age range and (94 %) greater than 1 year of age. In terms of breed, (71.2%), (16.8%), and (12%) were local, cross, and exotic, respectively. The most common reason for keeping dog 88% was for security while 12% of dogs were kept as a pet. About 46% of dogs are the confined never allowed to leave their premises, while 53% never restricted their dogs and allow to roam freely in the neighborhood outside of their residential compounds and mixes with other dogs (Table 3). Almost all (99%) of a dog fed by the household members only 1% of dogs are either fed by neighbors or find their feed.

**Table 1: Socio-Demographic Characteristics of Respondent**

<b>Characteristics</b>	<b>Category</b>	<b>N</b>	<b>%</b>
<b>Gender</b>			
	Male	100	41
	Female	144	59
<b>Age group</b>			
	Range (Min,-Max)	14-80	
	Median age	35	
	<18	18	7.4
	19-35	73	29.9
	>36	153	62.7
<b>Educational statuses</b>			
	No formal educations	15	6.1
	Primary education (1-8 grades)	29	11.9
	Secondary education (9-12 grades)	98	40.2
	Technical / Higher education	102	41.8
<b>Occupations</b>			
	Employed/ Professional	76	31.1
	Privet business	58	23.8
	Housewife/ Unemployed	74	30.3
	Student	36	15.2
<b>Head of household</b>			
	Yes	163	66.8

**Table 2:** Structure of dogs owned household and human population

<b>Characteristics</b>	<b>value</b>
Total number of households interviewed	244
Total population in the HH	1711
Total number of Children $\leq$ 10	283
Number of HH with a dog (s)	125
Number of dogs	190
Dog to Human ratio	1:9

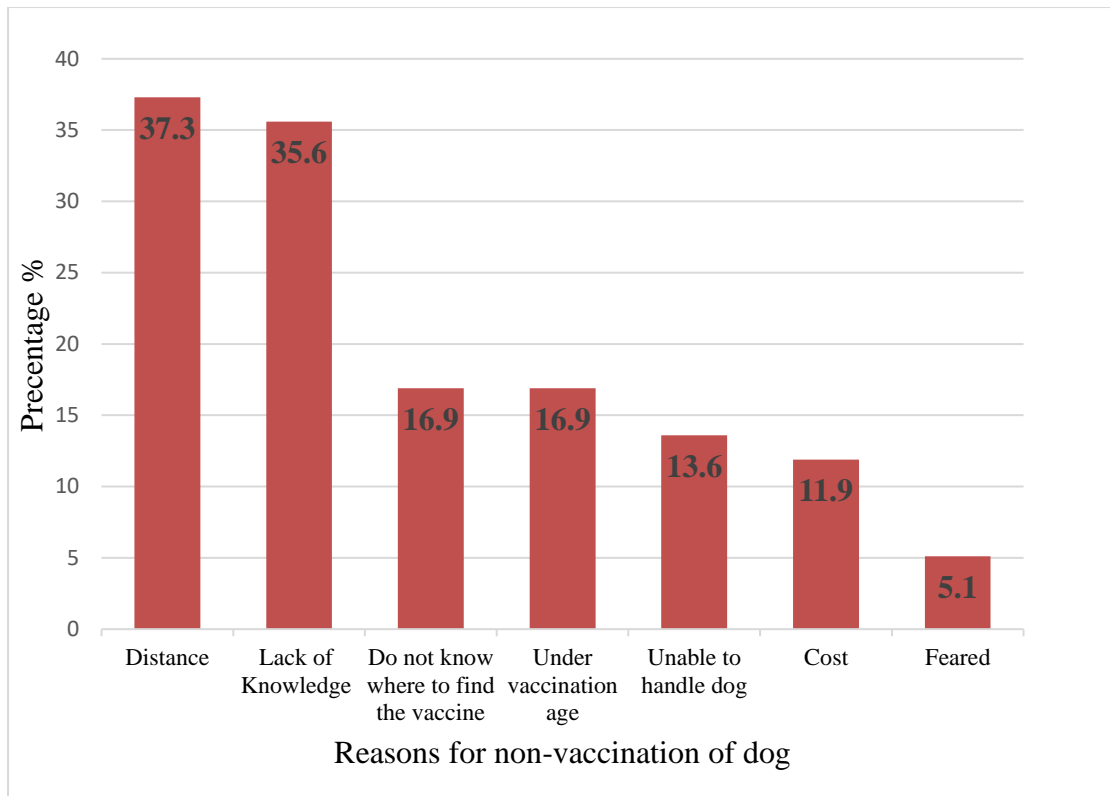
*Note.* HH= households

#### **4.3. Dog vaccination coverage for rabies**

Out of a total number of 190 dogs in the interviewed households, 135 (71%) dogs had been vaccinated against rabies (Table 3). However, only 15 owners could prove that vaccination by providing a vaccination certificate. Meanwhile, 29% of dogs were not vaccinated. The most common reason why a dog did not have a vaccination was the distance to a veterinary clinic (37%). However, 35% due to lack of enough knowledge about the rabies vaccine, and 16.9% of the respondents did not know where to find the vaccine (Figure 5) Also, 13.6% of the respondents reported that they would not be able to handle their dog to bring them for vaccination and 5% feared that the dog might change its behavior after being vaccinated.

**Table 3:** The demographic structure of 190 dogs kept by the 125 households

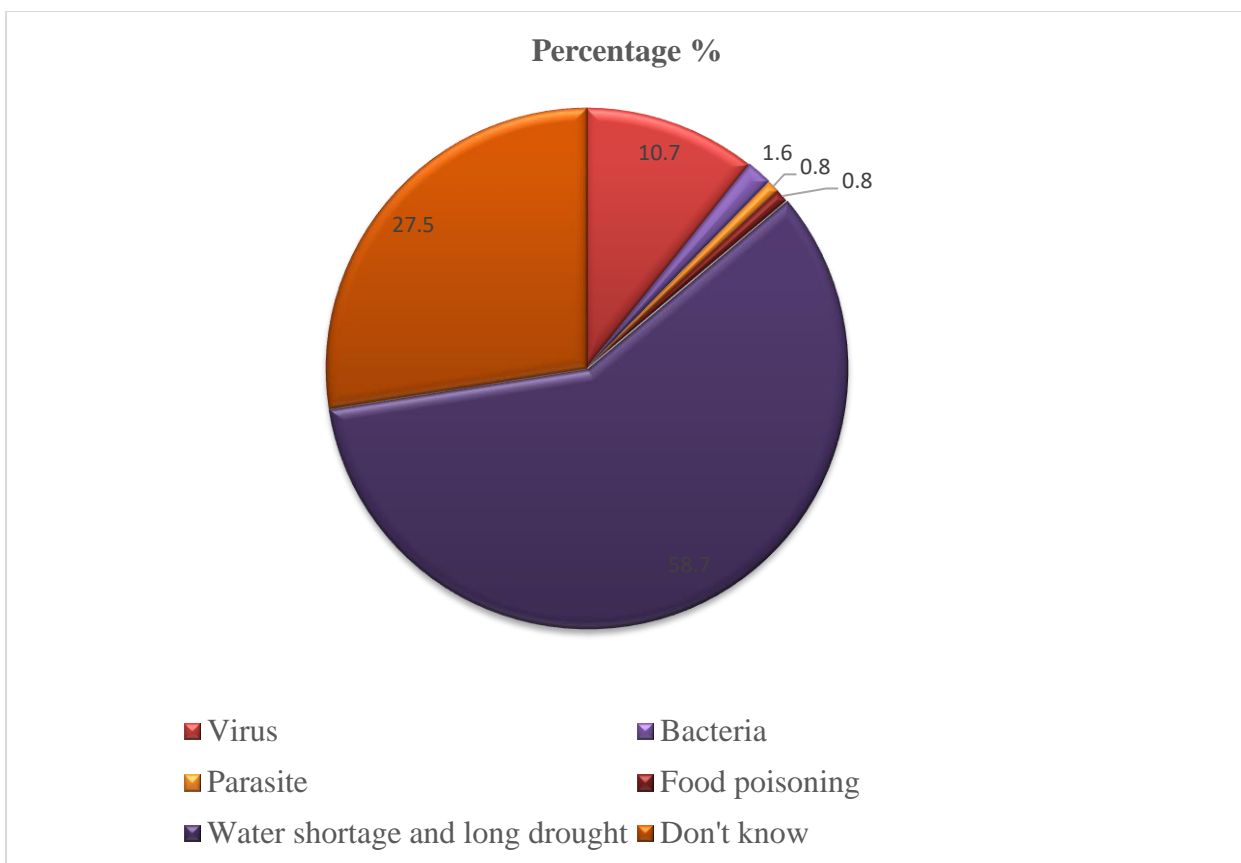
<b>Variable</b>	<b>Category</b>	<b>N</b>	<b>(%)</b>
<b>Sex of dog</b>	Male	150	79
	Female	40	21
<b>Age of dog</b>	Adult >1year	180	95
	Puppy <1year	10	5
<b>Breed</b>	Local	136	72
	Cross	36	18
	Exotic	18	10
<b>Source of dog</b>	Received as gift	144	75.8
	Bought	30	15.8
	From own bitch	16	8.4
<b>Reason for dog ownership</b>	Guard dogs/protection	158	83.2
	Love and affection/pet	32	16.8
<b>Confinement of dog</b>	Allow to roaming	102	53.7
	Never allowed to leave the premises	88	46.3
<b>Feeding of dog</b>	Household member	169	64.8
	Neighbors /household	15	0.5
	Find its own food/household	16	0.5
<b>Rabies vaccination status</b>	Vaccinated	136	71
	Not vaccinated	54	29
<b>Housing system</b>	Specially constructed house/cage	76	40
	Anywhere on the premises	66	34.8
	On house passageway/corridor	48	25.2



**Figure 5:** Reasons for non-vaccination of dog

#### 4.4. Community rabies awareness and Skill on rabies symptoms

Up on assessment of about zoonosis disease transmission by dogs to humans, the majority (83.6%) of respondents mentioned rabies followed by Covid 19 (13.9%), Echinococcosis, or hydatid disease 11.1%, and unspecific bacterial diseases often mentioned as skin disease. About 58.6% of respondents, perceived that water shortage and long drought cause rabies in dogs. Perceived causes of rabies of dogs are shown in (Figure 6).



**Figure 6:** Source /causes of Rabies perceived by 244 Respondents

All 100 % of the respondents, had heard about rabies. When respondents asked about species affected by rabies other than dogs, 74% mentioned humans followed by (cat, cattle, equine and wild). Detailed response on animal species transmit rabies to humans and means of rabies transmission to humans are described in (Table 4).

Regarding the symptoms of rabies in dogs, the most frequently mentioned were: salivation 77.9%, tail paralysis 53.3%, aggressiveness and biting objects 43.4%, restlessness/disorientation 35.2%, and behavior change 28.7%. About half (50.2%) of the respondents came across have seen rabid animals at least once in their lifetime. About 55.3% of the respondents believe that rabies can be cured after the onset of the symptoms in human and 30 % in humans. Regarding the symptom of rabies in humans, acts like a dog 47.1%, mad 20.9% and abnormal behavior 9% were frequently mentioned symptoms (Table 5) and 26.6% of respondents knew someone who had died of rabies.

**Table 4:** Species affected and transmission route of rabies to people described by 244 respondents

<b>Variable</b>	<b>Response</b>	<b>(%)</b>
<b>Heard rabies</b>		
Yes	244	100
<b>Species affected by rabies other than dog</b>		
Human	182	74
Cat	85	34.8
Cattle	78	32
Equine	51	21
Wild animal	22	9
Don't know	51	21
<b>Means of rabies transmission to human</b>		
Dog bite	230	94.3
Saliva through broken skin	36	14.8
Saliva contact with skin	107	44
Saliva contaminated objects	44	18
Wind/air	50	21
Dog fur	2	0.8
Contact unspecific with dog	7	2.9
Eating raw meat	4	1.6
Blood contact	5	2
Don't know	8	3.3
<b>Species Transmit rabies to human</b>		
Dogs	237	97.1
Human	7	2.9
Cats	61	61
Cattle	50	20.5
Equine	46	18.9
Wild animal	16	6.6
Don't know	43	17.6

**Table 5:** Respondents thought about the symptoms of rabies in dogs and humans (shown in frequency and percentage) perceived by 244 respondent

<b>Characteristics</b>	<b>n</b>	<b>%</b>
<b>Symptom in Dog</b>		
Change of behavior	70	28.7
Restlessness/disorientation	86	35.2
Aggressively, biting objects, and people	106	43.4
Roaming, uncontrollable	19	7.8
Salivation	190	77.9
Stop drinking and eating	14	5.7
Paralyzed tongue (hanging out of mouth)	24	9.8
Non-stop barking/crying	6	2.5
Tail paralysis	130	53.3
Don't know	18	7.4
<b>The curability of rabies in dogs</b>		
Curable	72	30
Incurable	124	51
Don't know	48	19.2
<b>Symptom in Human</b>		
The dog bark inside the abdomen	15	6.1
Fever	4	1.6
Mad	51	20.9
Act like a dog	115	47.1
Hydrophobia (fear of water)	7	2.9
Muscle paralysis	7	2.9
Headache	8	3.3
Confusion/agitation	18	7.4
Abnormal behavior	22	9.1
Don't know the symptoms	89	36.5
<b>The curability of rabies in human</b>		
Curable	135	55.3
Incurable	72	29.5
Don't know	37	14.3

#### 4.5. Source of Information

Only 21% received information from media (Television, Radio, and Newspapers), the majority of respondents (90.2%) get information about rabies from informal personal contacts (community, parents, and friends), while, 0.3% get information from mixed source (Figure 7)

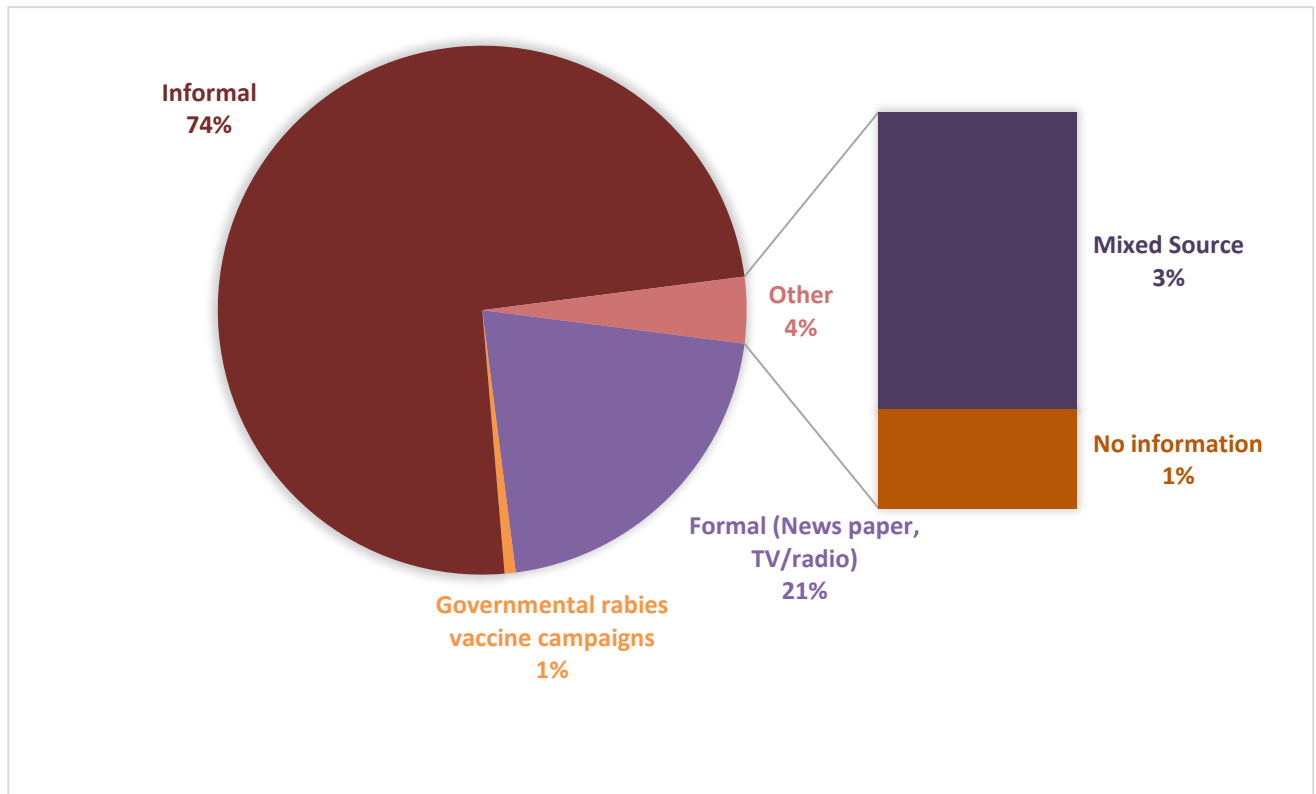
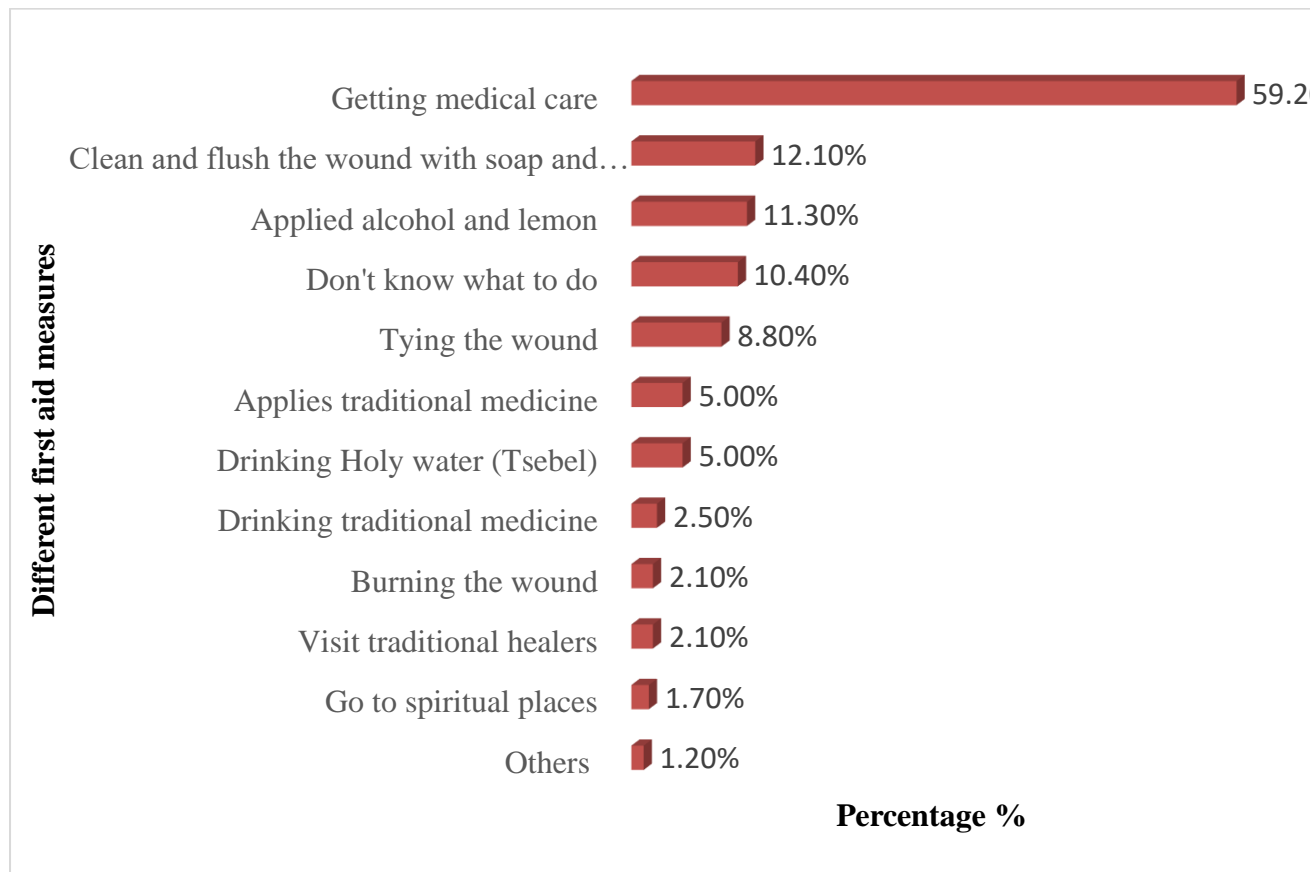


Figure 7: Sources of information on rabies

#### 4.6. Bite Wound Management and Bite history in the family

As a first-aid measure following an animal bite, only 12.1% reported that they would wash the wound with water and soap before going to the hospital (Figure 8). About 59% of respondents claimed that they would seek medical care immediately after a bite without cleaning the wound, 5% of the respondents would apply a traditional medicine to the wound, and 5% claimed either they drink claimed drink holy water (*Tsebel*) or visit a traditional healer. While 10% don't know what to do. Other spontaneous

responses also include burning the wound or consulting a veterinarian. While others reported they would do nothing.



\*Other include visit a veterinarian

**Figure 8:** Different first aid measures and health-seeking behavior.

Out of 244 respondents, 23 (9.4%) reported that one of their family members had been bitten by a dog in the last five years, of which 13 (5.3%) were male 10 (4.1%) of them were females. The majority of the victims were adults the average age was 20.6 with (a range from 3 to 60). Out of 23 bitten people, 14(5.7%) people were bitten by other person dogs, eight (3.3%) were bitten by stray/free-roaming dogs, and 1 person was by their own dog. The vaccination status of the bitten 15 dogs was unknown, the four were vaccinated against rabies, and 4 were not vaccinated. Twenty-one of the victims went to a medical center and take post exposure prophylaxis (PEP), and one person went to traditional healers and one victim did not take any action. Five (21.7%) victims have died as a result of rabies.

#### **4.7. Level of Knowledge, Attitude, and Practice concerning Rabies**

As shown in Table 6 on the respondent's knowledge, attitude, and practice of rabies. Only 10.7% of respondents correctly identify the feature of rabies as an infectious disease caused by a virus, and 96.3% of respondents were aware the transmission of the infection to humans. Overall, only 8.1% respondents correctly describe the symptoms of rabies in humans and 60% describe rabies symptoms in animals. Almost 96% of respondents correctly identify the different modes of transmission of rabies. Only 5.3% respondents aware about the rabies vaccine for humans that works before a dog bite and 76.6% of participants agreed with the statement that stray dogs can cause a problem for humans. Only 12.1% respondents describe wound washing as the first-aid measure that would be taken after a dog bite. About 67.6% of respondents correctly answer to the questions related rabies prevention measures, and 34% respondents correctly responded to the question regarding action to be taken against rabies suspected animals. Detailed questions and the number of respondents proportionate to each question are described in Table 6.

**Table 6:** Knowledge, attitude, and practice of the 244 respondents about rabies

Code	Knowledge question	Correct answer		Partially correct answer		In correctly answered	
		n	%	n	%	n	%
<b>K1</b>	What causes rabies in a dog?	26	10.7	-	-	281	89.3
<b>K2</b>	Is rabies a transmissible disease to humane?	235	96.3	-	-	9	3.7
<b>K3</b>	Dose rabies fatal disease in humans and animals?	184	73.4			60	24.6
<b>K4</b>	Which animals can be affected by rabies?	63	26	131	53.7	50	20.5
<b>K5</b>	Which species of animals are a source of rabies to a human?	112	46	91	37	41	16.8
<b>K6</b>	What are the symptoms of rabies in the animal?	148	60.7	79	32.4	17	7
<b>K7</b>	What are the symptoms of rabies in humans?	20	8.1	132	54.1	92	37.7
<b>K8</b>	How rabies can be transmitted to humans?	234	96	1	0.4	9	3.7
<b>K9</b>	Do you know the rabies vaccine for humans that work before a dog bite?	13	5.3	-	-	231	94.7
<b>Attitude question</b>							
<b>A1</b>	Do you think rabies can be cured once the animal show the symptoms	135	54.1	-	-	109	44.7
<b>A2</b>	Do you think rabies can be cured once a person shows the symptoms	74	30.3	-	-	170	69.7
<b>A3</b>	Do you agree with the statement that stray dogs can cause a problem for human	192	76.6	-	-	52	21.3
<b>Practice question</b>							
<b>P1</b>	How can rabies be prevented in dogs?	165	67.6	36	14.8	43	17.6
<b>P2</b>	As a first-aid measure, what would you do after a bite?	29	12.1	148	60.7	67	27.4
<b>P3</b>	What action do you take on rabies suspected animals?	83	34.1	152	62.3	9	3.7

*Where n= number of the respondent with correct answers and partially correct and wrongly answers to each question, %= percentage*

#### 4.8. The Proportion of respondents according to KAP levels of Rabies

The levels of KAP concerning rabies are presented in Table 7. The data showed that 61.8% of the respondents had a moderate level of knowledge, with a range of 0-14 (mean = 9.4, SD =2.5). Regarding the attitude scores, 59.8% of respondents had an intermediate attitude towards rabies that ranged from 0 to 3 (mean = 2.5, SD = 1.2). Similarly, 64.3% of respondents were in the intermediate level of appropriate practices, ranging between 0 and 8 (mean = 5.5, SD = 2).

**Table 7:** Number of questions, range, scores, and levels of knowledge, attitude, and practice regarding Rabies

variable	Number of question	Range score	Total score (mean ±SD)	Level (%) N=244		
				Low	Moderate	High
Knowledge	10	0-15	10.4±2.5	19.3	61.8	18.9
Attitude	3	0-3	2.5±1.2	17.2	59.8	23
Practice	3	0-8	5.5 ±2	17.2	64.3	18.4

##### 4.8.1. Determinants of rabies knowledge

The knowledge scores in this study were considerably variable among age groups, genders, occupations, and education levels. The association between independent variables and knowledge scores on rabies was calculated using Pearson's Chi-square and Fisher's Exact Test (Table 8). There was a significant association between knowledge scores and age ( $\chi^2 = 14.683$   $p < 0.094$ ). Knowledge scores were higher in the age group above 36 (23.5%). The majority of respondents from all groups had a moderate level of knowledge. Compared to others respondents who attended technical /higher education 22.5% had higher percentages of good rabies knowledge. The highest

knowledge score was observed in Employed/ Professional, 22.4%, while the lowest knowledge score was observed in students, 13.5%. Additionally, a statistically significant association was observed between the sources of information on rabies ( $\chi^2 = 15.789$ ,  $P < 0.015$ ). A higher knowledge level was observed in respondents who had a mixed source of information about rabies.

#### 4.8.2. *Attitude towards rabies*

In this study, the majority 59.8% of respondents (Table 7), had a satisfactory attitude towards rabies. It found that there was no statistical association occurs between attitude scores and heads of household, sex, education level, occupation, and dog ownership. A statistically significant association was observed only among with age ( $\chi^2 = 9.133$ ,  $P < 0.0721$ ), Education ( $\chi^2 = 12.333$ ,  $P < 0.060$ ) and source of information ( $\chi^2 = 17.697$ ,  $P < 0.003$ ). The relationship between attitude scores and selected independent variables is summarized in (Table 9).

**Table 8:** Relationships among knowledge scores on rabies and some key independent Variables between study respondents.

Variables	High	Moderate	Low	$\chi^2$	Df	P-value
	No (%)	No (%)	No (%)			
<b>Head of households</b>				4.225	2	0.121
Yes	36 (22.1)	101 (62)	26 (16)			
No	11 (13.6)	50 (61.7)	20 (24.7)			
<b>Sex</b>				0.071	2	0.965
Male	20 (20)	61 (61)	19 (19)			
Female	27 (18.8)	90 (62.5)	27 (18.8)			
<b>Age (year)</b>				15.027	4	0.003
<18	4 (22.2)	9 (50)	5 (27.8)			
19-35	7 (9.6)	44 (60.3)	22 (30.1)			
>36	36 (23.5)	98 (64.1)	19 (12.4)			
<b>Education status</b>				11.598	12	0.479
No formal educations	2 (13.3)	11 (73.3)	2 (13.3)			
Primary education (1-8 grades)	4 (13.8)	19 (65.5)	6 (20.7)			
Secondary education (9-12 grades)	18 (18.4)	65 (66.3)	15 (15.3)			
Technical / University	23 (22.5)	56 (54.9)	23 (22.5)			
<b>Occupation</b>				9.721	6	0.137
Employed/ Professional	17 (22.4)	50 (65.8)	9 (11.8)			
Privet business	11 (19)	37 (63.8)	10 (17.2)			
House wife /Do not have work	14 (18.9)	46 (62.2)	14 (18.9)			
Student	5 (13.5)	18 (48.6)	14 (37.8)			
<b>Dog ownership</b>				2.250	2	0.325
Yes	28 (22.4)	72 (57.6)	25 (20)			
No	19 (16)	79 (66.4)	21 (17.6)			
<b>Source of information</b>				15.007	6	0.009
Formal	11 (29.7)	24 (65)	2 (5.4)			
Informal	31 (16.2)	118 (61.8)	42 (22)			
Mixed source	4 (33.3)	8 (66.7)	0			

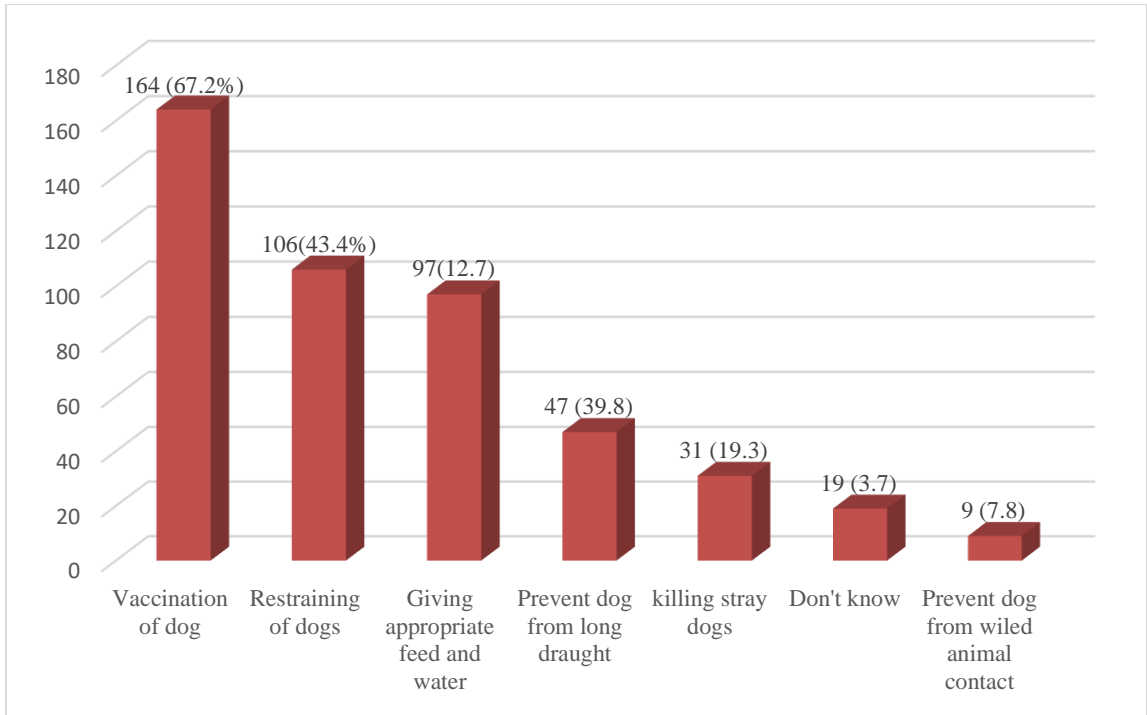
**Table 9:** Relationship between rabies attitudes score and some significant independent variables among study participants

Variables	High	Moderate	Low	$\chi^2$	Df	P-value
	No (%)	No (%)	No (%)			
<b>Head of households</b>				4.162	2	0.125
Yes	27 (16.6)	112 (68.7)	24 (14.7)			
No	18 (27.2)	45 (55.6)	18 (22.2)			
<b>Sex</b>				0.827	2	0.830
Male	18 (18)	63 (63)	19 (19)			
Female	27 (18.8)	94 (65.5)	23 (16)			
<b>Age (year)</b>				9.133	4	0.072
<18	5 (27.8)	9 (50)	4 (22.2)			
19-35	17 (23.3)	39 (53.4)	17 (23.3)			
>36	23 (15)	109 (71.2)	21 (13.7)			
<b>Education status</b>				12.333	6	0.060
No formal educations	1 (6.7)	6 (40)	8 (53.3)			
Primary education (1-8 grades)	6 (20.7)	17 (58.6)	6 (20.7)			
Secondary education (9-12 grades)	18 (18.4)	65 (66.3)	15 (15.3)			
Technical / University	20 (29.6)	67 (65.7)	15 (14.7)			
<b>Occupation</b>				4.175	6	0.678
Employed non-health Professional	17 (22.4)	48 (63.2)	11 (14.5)			
Privet business	12 (20.7)	37 (63.8)	9 (15.5)			
House wife /Do not have work	8 (12.2)	51 (68.9)	14 (18.9)			
Student	7 (19.4)	21 (53.3)	8 (22.2)			
<b>Dog ownership</b>				4.099	2	0.129
Yes	22 (17.6)	87 (69.6)	16 (12.8)			
No	23 (19.3)	70 (58.8)	26 (21.8)			
<b>Source of information</b>				17.697	6	0.003
Formal	5 (13.5)	30 (81.1)	()			
Informal	35 (18.3)	120 (62.8)	36 (18.8)			
Mixed source	5 (41.7)	6 (50)	1 (8)			

#### 4.8.3. *Practice towards Rabies*

Prevention measures they would take toward the prevention of rabies, about 7.8% didn't know how rabies could be prevented. More than half, 67.2 % of respondents, mentioned dog vaccination as an effective measure to prevent rabies infection in humans and animals, then restringing the dogs 43.4%. Among respondents, 39.8% believe that giving appropriate feed and water and 19.3% believe that prevent dogs from drought could prevent dogs from getting rabies infection. Killing stray dogs and prevention of dogs from willed animal contact were also mentioned (Figure 9). Regarding action to be taken against rabies suspected animals, 53% of the respondents suggest they would kill the suspected animal. Whereas, 14% would kill the animal and burning the carcass and 34.7% of the respondent would report to the veterinary service of the suspected animal.

Practice scores toward rabies were classified as “low”, “satisfactory”, and “good” (Table 9). Practice scores were significantly associated with age ( $\chi^2 = 9.133$ ,  $p < 0.051$ ), education ( $\chi^2 = 12.333$   $p < 0.046$ ) and the source of information ( $\chi^2 = 17.697$ ,  $p < 0.003$ ). This study revealed that respondents who attended higher education were more likely to have higher practice scores (19.6%) compared with others. The respondents who had information about rabies through mixed sources were more likely to have a higher percent of practice scores (41.7%) as compared with others.



**Figure 9:** Rabies prevention measures suggested by respondents.

**Table 10:** Relationship between rabies preventive practice scores and some significant independent variables among study participants

Variables	Good	Satisfactory	Low	$\chi^2$	Df	P-value
	No (%)	No (%)	No (%)			
<b>Head of households</b>				4.162	2	0.125
Yes	27 (16.6)	112 (68.7)	24 (14.7)			
No	18 (22.2)	45 (55.6)	18 (22.2)			
<b>Sex</b>				0.380	2	0.827
Male	18(18)	63(63)	19 (19)			
Female	27(18.8)	94 (65.3)	23 (16)			
<b>Age (year)</b>				9.133	8	0.051
<18	5 (27.8)	9 (50)	4 (22.2)			
19-35	17 (23.3)	39 (53.4)	17 (23.3)			
>36	23 (15)	109 (71.2)	21 (13.7)			
<b>Education status</b>				12.333	6	0.046
No formal educations	1 (20.7)	6 (40)	8 (53.3)			
Primary education (1-8 grades)	6 (20.7)	17 (58.6)	6 (20.7)			
Secondary education (9-12 grades)	18 (18.4)	67 (68.4)	13 (13.3)			
Technical / University	20 (19.6)	67 (62.7)	15 (14.7)			
<b>Occupation</b>				3.936	6	0.691
Employed/ Professional	17 (22.4)	48 (63.2)	11 (11.5)			
Privet business	12 (20.7)	37 (63.8)	9 (15.5)			
House wife /Do not have work	9 (12.2)	51 (68.9)	14 (19.9)			
Student	5 (13.5)	18 (48.6)	14 (37.8)			
<b>Dog ownership</b>				4.099	2	0.129
Yes	22(17.6)	87(69.6)	16(12.8)			
No	23(19.3)	70(58.3)	26(21.8)			
<b>Source of information</b>				17.697	6	0.003
Formal	5 (13.5)	30 (81.1)	2 (5.4)			
Informal	35 (18.3)	120 (62.8)	36 (18.8)			
Mixed source	5 (41.7)	6 (50)	1 (8.3)			

#### 4.9. KAP correlation

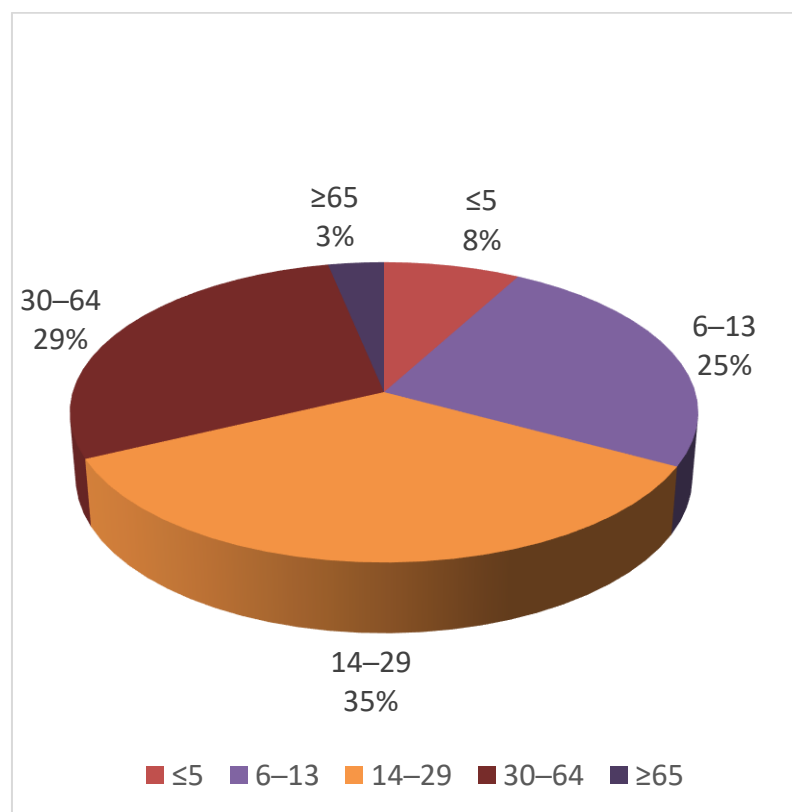
Depending upon our data, the correlation between the scores of the participants' Knowledge with attitude and Practice and the score of attitude with practice, there was a positive correlation between knowledge and attitude ( $P < 0.01$ ), knowledge and practice ( $P < 0.05$ ).

**Table 11:** Correlation among knowledge, attitude, and practice in a general population: Knowledge vs attitude, Knowledge vs Practice, and Attitude vs Practice

Knowledge	1		
Attitude	0.565**	1	
Practice	0.132*	.007	1
<b>Variables</b>	<b>Knowledge</b>	<b>Attitude</b>	<b>Practice</b>
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).			

#### 4.10. Animal bites cases on humans from 2019-2021

During the period from November 2019 to Jun 2021, a total of 612 injuries by rabies suspected animals were recorded in Bishoftu city, giving a mean annual incidence of ~204 cases annually. A total of 355 (58%) of the victims were males and 257 (47%) were females. This study shows those age group 14-29 (35%) were the most common victims of a dog bite, followed by the age group 30-64 (29%), and the minimum number of dog bite cases reported within the age group 65 and above, which account for 3% of the cases (figure 10).



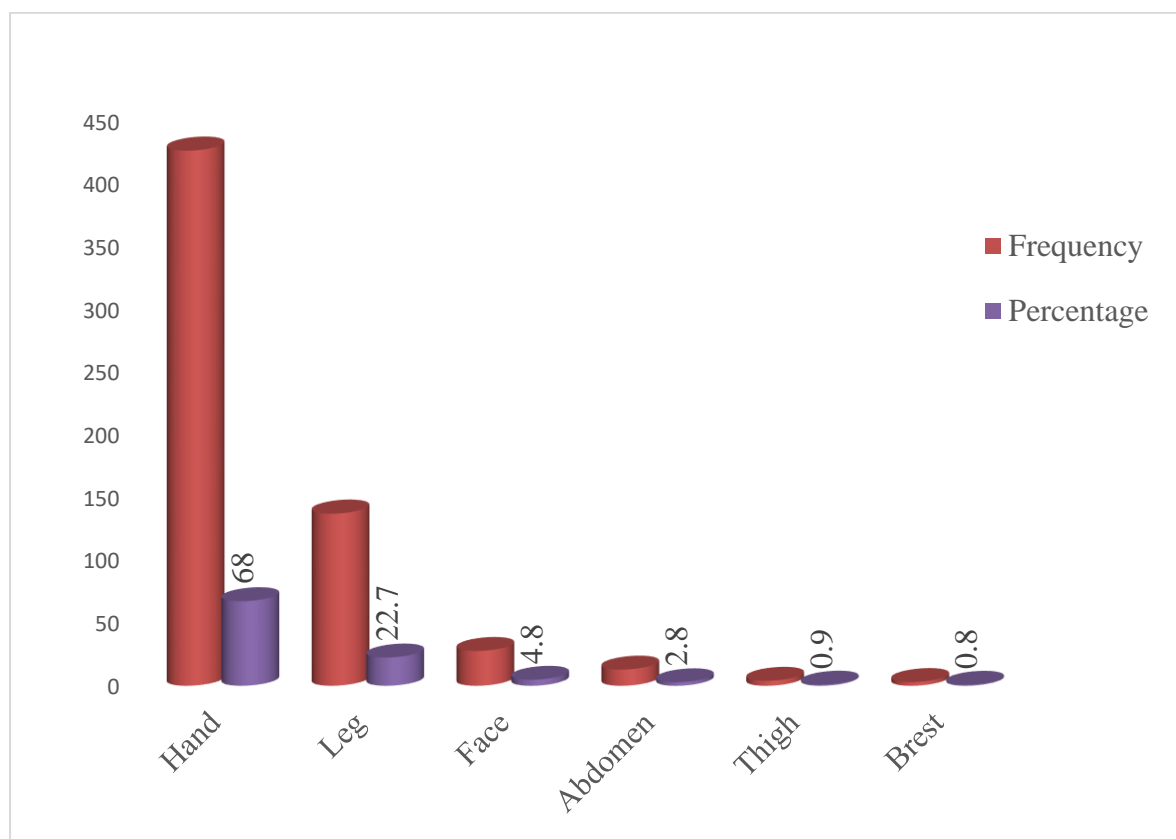
**Figure 10:** Age distribution of the victims.

The result of this study shows that in all 21 months of human rabies exposure, males comprised 58% of the cases across all age groups (Table 10). There was a significantly higher bite rate in males than females.

**Table 12:** Gender and age-wise distribution rabies cases in human beings (2019-2021)

Age in year	Gender		Total (%)
	Number of Male (%)	Number of Females (%)	
≤5	31(5.1)	18(3)	49 (8.1)
6-13	88(14.3)	64(10.4)	152 (24.8)
14-29	128(21)	87(14.2)	215 (35.2)
30-64	97(15.8)	79(13)	176 (28.8)
≥65	11(1.8)	9(1.4)	20 (3.2)
<b>Total</b>	<b>355(58)</b>	<b>257(42)</b>	<b>612(100%)</b>

The result of this study also showed that the leg (68%) was the most common bitten body part, followed by the hand (22.7%), face (4.8%), thigh (2.8%), abdomen (0.9%), and breast (0.8%) (Figure 11). Most of the bites on the face have happened to children.



**Figure 11:** Anatomical site of a dog bite of the victim.

Among different animal bites, dog bites (99.4%) are the most common cause of human injury (Table 14). Other than dogs, human bites have also been reported by other species including cats, donkeys, and horses.

**Table 13:** Biting animal species

<b>Species of animal</b>	<b>Frequency</b>	<b>Percentage (%)</b>
Cat	2	0.4
Dog	608	99.4
Donkey	1	0.1
Horse	1	0.1
<b>Total</b>	<b>612</b>	<b>100</b>

#### **4.11. Post-exposure prophylaxis administration in human**

According to retrospective data, 612 people received rabies post-exposure prophylaxis in 2019/2021 as a result of exposure and being bitten by various species of animals (Table 14), whereas rabid or rabies-suspect animals. However, most of the post-exposure prophylaxis was provided to people bitten by animals with unknown rabies status.

## 5. DISCUSSION

### 5.1. Dog population and vaccination coverage

Knowledge of dog populations and demography are essential for planning an effective dog-borne zoonosis control and for the population management. One of the aims of this study was to determine dog demography and population structure for management strategies of rabies. More than 192 dogs were recorded (51.2%) pre-selected households where the surveyed households owned at least one dog.

In Ethiopia, data on dog population numbers and structure is limited. This finding differs slightly from earlier reports that in the West Shoa zone, Oromia Region of Ethiopia where, 65.1% of households own dogs (Gebremedhin *et al.* 2020). In other studies in Eastern Ethiopia, 33% of the urban and 75% of pastoral households own dogs (Tschopp *et al.* 2016), 79.6% in Côte d'Ivoire (Kallo, *et al.* 2020), and 63% in Kenya (Kital *et al.* 2001). It is also greater compared to the reports of other African countries such as; 14% in Tanzania (Gsell, *et al.* 2012), 17% in South Africa (Conan *et al.* 2015), and 35% in Ghana (Tasiame, *et al.* 2019). There are also reports of, 17% in the United States (Shepherd 2008), 35% in Ireland (Downes *et al.* 2009), and 47% in Italy (Carvelli *et al.* 2020). The ownership was lower than that shown in developing countries' reports. Like in other developing countries, dogs are mainly kept for home guarding purposes (Mbile *et al.* 2019, Gasll, 2012).

The average number of dogs per household was (1.54) is low, with a higher proportion of dog-owning households keeping one dog (57.6%). Corresponding estimations were reported elsewhere, in Ethiopia 1.1 and 78%, in Tanzania 2.2 and 40% in the United States 1.7 and 63%, in Taiwan 1.6 and 69.5%, and in Sweden 1.4 and 77.9%. This variation may reflect socio-cultural and geographic variations in the distribution of factors that influence the household level in various parts of the world. In this study, the dog: human was 1:9, consistent with the findings in Nigeria of 1:7.8 (Otolorin *et al.*, 2014) and Chad of 1:7.8 (Mbilo *et al.*, 2017). Although most studies were done in different urban and rural settings, 1:4.3 in Mexico (Flores and Estrella, 2003), 1:6 in São Paulo (Alves, 2005), and 1:9.4 in urban Asian countries. Whereas 1:6-1:10 reported in North America and Europe (Wandeler, 1995). Almost all 94% of the dog populations

that were studied appeared to be adults greater than one year, which is 78% male and 22% female, similar studies were also reported on the urban dog populations in sub-Saharan Africa (Mbilo *et al.*, 2019; Mauti *et al.*, 2017; Conan *et al.*, 2015; Ratsitorahina, 2009; Sambo, 2018). According to the results, the majority of the community prefers to own a male dog over a female dog, which is thought to be more effective as a guard dog, and we observed the predominance of a male dog in our study. Some studies explain the predominance of male dogs in Tanzania and South Africa (Conan *et al.*, 2015, Knobel *et al.*, 2008).

The survey shows 71% of the dog population has taken the anti-rabies vaccine for the last 12 months, which is in the range of the World Health Organization's recommended vaccine coverage for canine rabies control. But The figure of this study is higher than reported 24% in Congo, 59% in Malawi, 47.9% in Nigeria and 0.5% in Chad, 56% in South Africa, 22% in Madagascar, 29% in Kenya, 20% in Zambia, (Mbilo *et al.*, 2017; Mbilo *et al.*, 2019; Jonasson, 2014; Van Sittert, *et al.*, 2010; Ratsitorahina *et al.*, 2009; Kitala *et al.*, 200; De Balogh *et al.*, 1993). One of the reasons this is possible is that the majority of dog owners are willing to pay for door-to-door vaccination fees for the private sector. Based on the exchange rate at the time of the study, on average, the vaccination fee was 100-150 ETB (2.2-3.5 USD) per vaccinated dog. But, the habit of vaccinating their dogs at the clinic is low. In most African countries where dog vaccination is not free, dog owners are generally unwilling to pay for dog rabies vaccination because they see no direct economic and/or health benefits. This is supported by the fact that the vast majority of humans who have been bitten were not bitten by their dogs (Jibat *et al* 2015).

## **5.2. Community Knowledge Attitude and Practice (KAPs) on rabies**

Implementing the KAP survey help to identify a knowledge gap, behavioral pattern, and cultural beliefs, thereby improvising the generation of information to control and prevent certain problems. It is also widely used to increase community knowledge, change attitudes and improve practice (Fabienne, 2009). In some ways, this survey can illustrate factors that influence "bad" behavior, such as the reasons for certain attitudes and the reasons for certain rabies-related practices. Over 52% of respondents in this study had attained primary and secondary school education, which is in line with similar

studies done in Rwanda 59%, Kenya 67%, Tanzanian 74%, and India 77% (Ntampaka *et al.*, 2019; Sambo *et al.*, 2014; Muriuki, 2016; Sivagurunathan *et al.*, 2021). The fact that the majority of people attend school has a positive impact on rabies control.

Rabies is still a significant public health issue in Ethiopia. The study's findings revealed the significance of rabies in the study area. The survey indicates that the community is significantly aware of the diseases. Almost all 99% of respondents have heard of a disease with the local name “*Ebdwusha*”. A similar result has been reported in Ethiopia and elsewhere. For instance, 96.4% of the study participants in Dessie (Gebeyaw and Teshome, 2019), 98% in Gonder (Jemberu *et al.*, 2013), and 95% in Tanzania (Sambo *et al.*, 2014) had heard of rabies. A higher level of awareness has also been observed in studies conducted in Asia; 94% in the Philippines (Davlin *et al.*, 2014), and 93% in Thailand (Kongkaew *et al.*, 2004), 93% in Cambodia (Lunney *et al.*, 2012). Even though the community is aware of the disease, they lack a comprehensive understanding of rabies. Many fallacies concerning the cause, means, and source of transmission was observed in the study.

The majority of respondents identified bite as a means of disease transmission and also many participants, (44%), also believed that any direct or indirect saliva contact could act as a means of transmission. But, simple saliva contact with intact or unbroken skin does not pose a risk of rabies virus exposure. More than half 50.4% of respondents, mentioned water and feed shortages and being exposed to a long drought as causes of disease. This idea is most likely explained by the belief of asymptomatic rabies carrier dogs that stress such as hunger and thirst may induce the development of clinical rabies in carrier dogs (Wilde *et al.*, 2007). But, the idea of clinical rabies development is a controversial issue (Jemberu *et al.*, 2013).

In many parts of the world, dogs are the primary cause of human rabies deaths, particularly in Africa and Asia, where 85-95 % of human rabies deaths are caused by dog bites (Fitzpatrick *et al.*, 2012, Assefa *et al.*, 2010). In this study, dogs were mentioned as the primary source of infection in the majority of fatal human rabies cases, followed by cats as the second most common source of human infection. Furthermore, rabies in other domestic animals, such as cattle, sheep, goats, and equines, was

mentioned as a risk for humans. Similar findings were also reported (Eshetu *et al.*, 2002, Gebeyaw and Teshome, 2019).

The public must be aware of the signs of rabies to detect suspected rabid animals in the community and take appropriate measures, such as informing the veterinary service. Most of the study participants correctly described the symptoms of rabies in animals. An accurate description of rabies symptoms in the cases reported by the study population strongly indicates that the disease is predominant in the study area. The majority of respondents mentioned paralysis as a possible sign of rabies, which is typical of the “dumb” or paralytic form of rabies. This may result in cases of paralytic rabies being detected. However, only 8.1% of respondents correctly mentioned symptoms of rabies in humans. Human rabies has a non-specific clinical manifestation, which can lead to a misdiagnosis of the disease (Mbilo *et al.*, 2017).

The fatality rate for rabies is almost 100% once clinical signs develop, in both domestic animals and humans (Digafe *et al.*, 2015). A lower level of case fatality rate in humans was reported by the respondents in this study. It is particularly concerning that 70% of respondents were unaware that rabies is fatal after the onset of symptoms and exacerbates the disease. This information will serve as baseline data for planning, implementing, and evaluating public awareness and rabies control programs (Muriuki, 2016).

Many of the respondents exhibited a lack of detailed knowledge about disease prevention and the risks associated with rabies. According to WHO guidelines, wounds must be washed with water and soap for 15 minutes and disinfected immediately before being admitted to the hospital. It helps to remove animal saliva from bite sites and reduce viral load (WHO, 2013). We found that the majority of respondents had low awareness of the importance of immediately washing the injury with water and soap. Only 12% of respondents are aware of first aid measures that should be taken after an animal bite. Studies in Tanzania, Uganda, Chad, South Africa, India, and Pakistan. Where rabies is endemic, it also showed that a low proportion of people practice wound washing with soap and water (Mbilo *et al.*, 2017; Sambo, 2012; Hergert and Nel, 2013; Ichhpujani *et al.*, 2008; Fevre *et al.*, 2005; Chhabra *et al.*, 2004). In this study, more than half, 67.6% of participants knew that dog vaccination is an effective measure to

prevent rabies infection from humans and animals. Restraining dogs, killing stray dogs, and preventing dogs from starving, hunger and drought are also mentioned as rabies prevention measures. The level of practice toward rabies prevention measures among the study's participants was satisfactory.

School, friends, family, neighbors have significant roles in disseminating information rather than mass media, health centers, and veterinary services. In these findings, the majority of the respondents have gained some knowledge about rabies from informal sources. A study was done in Côte d'Ivoire (Tiembre, *et al.* 2008) showed 82.9% of participants knew about rabies and 88.6% of them the source of information was from schools. This demonstrates the important role that schools play in creating awareness about Rabies. The medical and veterinary services did not play an important role in disseminating information. For rabies suspected animals, a large proportion of respondents would kill the animal without informing a veterinarian, while only a few would report a veterinarian. Similar findings were also reported in Dessie (Gebeyaw and Teshome, 2019), in Kenya (Muriuki, 2016), and in Congo (Mbilo *et al.*, 2019).

The results of the correlation analysis revealed a positive correlation between knowledge and attitude, knowledge and practice scores. This suggests that having good knowledge of rabies leads to a positive attitude and practice in rabies prevention.

### **5.3. Animal bite incidence and management**

According to the current findings, 612 animal bite cases reported were in four Bishftu health centers. An average of 204 people received post-exposure anti-rabies treatments each year from 2019 to 2021. This finding is similar to that recorded in the period between September 2013 and August 2014 by Tariku *et al.*, (2018). In contrast, it is lower than reported in Addis Ababa (Deressa *et al.*, 2010; Aklilu *et al.*, 2021). In this study, the bite victims were almost 99.4% bitten by dogs. Sex and age are two demographic characteristics that are frequently identified as risk factors for dog bites.

Male were most frequently bitten than males. The same finding was also reported in other parts of Ethiopia (Aklilu *et al.*, 2021), in Nigeria (Ikye-Tor *et al.*, 2020), in Tanzania (De Nardo *et al.*, 2018), and the USA (Tuckel and Milczarski, 2020). This

could be related to male activities, in that, they are more likely to engage in outdoor activities, whereas females are more likely to remain indoors for sociocultural and religious reasons. Another reason could be that males are more aggressive than females. Most bites occurred at age 14 and above. We also observed that most of the dog bites were on the legs and hands. It is a fact that these body regions are most likely used by people to protect themselves from dog attacks (Guy *et al.*, 2001).

In addition, post-exposure prophylaxis was given to victims bitten, without confirmation of the rabies status of the animal. Three types of rabies vaccines are available; outdated nerve tissue vaccines, cell culture vaccines, and embryotic egg vaccines. The cell culture and embryonated egg vaccines are the ones recommended for use by WHO. They are considerably safer and well-tolerated. In developed countries, nerve tissue vaccines have been replaced by cell culture and embryonated egg vaccines (WHO, 2012). In contrast, nerve tissue vaccines can cause severe adverse reactions that can last for 4–7 months in 0.03–0.08% of cases, including the risk of rabies due to incomplete virus inactivation, are less immunogenic and also contribute to vaccine failure. The World Health Organization has banned this vaccine since 1980 (WHO, 2018). However, in developing countries, including Ethiopia, the mammalian neural tissue vaccine is still widely used. While cell culture is effective and immunogenic, however, it is also expensive (Birhanu, 2015, Tariku *et al.*, 2018).

A limitation of this study is that the method used to estimate the dog population did not take into account the population of stray dogs. A common sensitivity issue for the majority of respondents was a large number of stray dogs and freely roaming owned dogs. The number of stray dogs in the town was not investigated in this study. However, the vast majority of owned dogs in this study were free-roaming. Further, they were not wearing collars, making them easily mistaken for stray dogs. This finding is supported by a study conducted in Kinshasa, which discovered that ownerless dogs accounted for less than 2% of the total dog population. Since dogs have owners, this offers the opportunity for health intervention campaigns, as regular vaccination programs would be made possible. 12.7% of respondents suggest killing stray dogs as a means of eliminating rabies. Mass stray dog elimination is unethical and hazardous to the environment. On the other hand, it has no effect on dog population growth and will not

stop the spread of rabies, because dogs will participate in compensatory breeding and relocate into newly vacated regions, facilitating disease transmission (Tschopp, 2016).

## 6. CONCLUSION AND RECOMMENDATION

The study revealed that there is a relatively high dog-to-household and dog-to-human of ratio prevalence, rabies and other dog-related zoonoses concerned of the close interaction between dogs and humans. The majority of owned dogs in these studies are free-roaming and during the study period, but over 70% of the total population was vaccinated against rabies. Rabies is a well-known disease in the area and is recognized as a critical public health issue. Although the findings of this study show that the owned dog population is accessible for vaccination, a lack of disease awareness may have a negative impact on the community. The aim of studying knowledge attitude and practice (KAPs) was to generate data that will assist in identifying knowledge gaps, behavioral patterns, and cultural practices that impede rabies. According to the findings of this study, the majority of respondents had a moderate level of knowledge and attitude toward rabies, as well as a satisfactory level of knowledge of rabies and prevention practices. Even though the vaccine coverage reached the WHO recommended standard, the incidence of dog bite cases is still increasing. In comparison to the previous study, no improvement has been seen. Based on the current study, the majority of the community can recognize rabies symptoms in a dog, which indicates that the disease is prevalent in the area. However, still, there is a lack of knowledge of the clinical signs and the deadly nature of the disease in humans, as well as the first aid measures that should be taken after exposure, like wound washing. This could be due to a lack of education about the diseases.

Therefore, the following recommendations are forwarded:

- There is a need for a strategic and consistent community awareness program for preventing rabies in human cases. The need to promote appropriate prevention measures (immediate washing bite wounds),
- Information sources such as radio, television programs, and newspapers should play an important role in increasing community awareness of the deadly nature of rabies and the availability of preventive measures such as vaccinations for both humans and dogs.
- It is necessary to introduce rabies into the education curricula. In addition, school-based interventions would be necessary to encourage children and young people to increase their knowledge of appropriate prevention measures.

- Veterinary services and public health officers should play an important role in educating and raising individual and community awareness,
- A stray dog control program should be facilitated by the government and other stakeholders,
- Further studies needed to be done on stray dog population and demography,
- Concerned stakeholders should raise public awareness about proper dog management to reduce the number of free-roaming dogs. Initiating dog registration, and punitive actions for those who leave their dogs unattended.

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## **8. ANNEXES**

## Annex I: KAP scoring procedures

Questions	Answer	score	Overall score
K1. What causes rabies in a dog?	Correctly answered rabies caused by a virus	1	1
	Don't know /wrong answer	0	
K2. Is rabies a transmissible disease to humane?	Yes	1	1
	No,/don't know the answer	0	
K3. Dose rabies fatal disease in humans and animals?	Yes	1	1
	No/don't know	0	
K4. Which animals can be affected by rabies?	Who mentioned 3 and more	2	2
	Who mentioned 1 or 2	1	
	Don't know /wrong answer	0	
K5. Which species of animals are a source of rabies to a human?	Who mentioned 3 and more animals	2	2
	Who mentioned 1 or 2 animal	1	
	Don't know /wrong answer	0	
K6. What are the symptoms of rabies in the animal?	Who mentioned 3 and more symptoms	2	2
	Who mentioned 1 or 2 symptoms	1	
	Don't know /wrong answer	0	
K7. What are the symptoms of rabies in humans?	Who mentioned 3 and more symptoms	2	2
	Who mentioned 1 or 2 symptoms	1	
	Don't know /wrong answer	0	
K8. How rabies can be transmitted to humans?	Through bite	2	2
	Saliva contact	1	
	Don't know /wrong answer	0	
K9. Do you know the rabies vaccine for human work before a dog bite?	Yes	1	1
	No	0	
<b>Overall knowledge score</b>			<b>14</b>

A1. Do you think rabies can be cured once the animal show the symptoms	Yes	0	1
	No	1	
A2. Do you think rabies can be cured once a person shows the symptoms	Yes	0	1
	No	1	
A3. Do you agree with the statement that stray dogs can cause a problem for human	Agree	1	1
	Disagree	0	
	Neutral	0	
<b>Overall attitude score</b>			3
P1. How can rabies be prevented in a dogs?	Who mentioned the dog vaccination restrain dogs and killing stray dogs,	3	3
	Restrain dogs and killing a stray dog	2	
	Restrain dogs	1	
	Don't know / wrong answer	0	
P2. As a first-aid measure what would you do after a bite?	Who claimed cleaning the wound with soap and water the seek medical care	3	3
	Who claimed to seek medical	2	
	Who claimed applies alcohol	1	
	Who claimed to to do noting	0	
P3. What action do you take on rabies suspected animals?	Who claimed Reported to a veterinarian	2	2
	Who claimed to kill the animal	1	
	Who claimed to do noting	0	
<b>Overall practice score</b>			8

**Annex II: Ethical clearance certificate**

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**Aklilu Lemma Institute of Pathobiology Institutional Review Board**  
***Ethical Clearance Certificate***

Ref. No.: ALIPB IRB/16/2012/20  
Date: Friday, 09 March. 2020

**Title of the Project: ‘Studies towards prevention and control of selected zoonotic diseases of veterinary and public health importance in Ethiopia’**

**PI: Tesfu Kassa, Professor**

**Recommendation of the ALIPB Institutional Review Board**

*Dear Professor Tesfu,*

The ALIPB IRB has reviewed your above mentioned Research proposal and noted its merit. The IRB would like to remind the PI to submit progress reports of the work every 6 months and the final report upon completion of the study. Furthermore, the PI is expected to notify the ALIPB/IRB ahead of time any amendments or modifications in the protocol or premature suspension or termination of the study.

**STATUS: APPROVED**

*Needs NRERC clearance:*

Yes: \_\_\_ No: x

IRB Chairperson: **Tilahun Tekelehaymanot, Prof.**

Signature: [Handwritten Signature]  
09/03/2020

IRB Secretary: **Lemu Golassa, PhD**

Signature: [Handwritten Signature]  
09/03/2020

**Approval**

Name: **Dr. Mengistu Legesse, Director**

Signature: [Handwritten Signature]

Date: 11/03/2020



Cc// IRB office

**Annex III: Some photographs of freely roaming owned dog**



**Annex IV: Questioners**

7/4/2021 Epicollect5 - Form builder

Dog demography and zoonosis Urban dog demography

General characteristics

Enumerator code

- Enum1
- Enum2
- Enum3
- Enum4
- Enum5
- Enum6

Instruction for the interviewer (read before starting and explain the objective of the study to your respondent) and get informed consent. If the respondent is not giving full consent, select the next household (by indicating this form as finished and record it).

What is the date of today?

Time of interview start

Name of Kebele

Block number (record from list)

Record GPS location of the household (try to get less than 10m accuracy by updating)

Do you consent to get involved in this survey?

- Yes  
 No

### **Demographic Data**

1. Respondent name

2. Residence respondents

- Urban  
 Rural

3. Are you head of the household?

- Yes  
 No

7/4/2021 Epicollect5 – Form builder

4. Sex of the respondent

Male

Female

5. Age of the respondent

6. Education status of the respondent

Illiterate

Do write and read

No formal education

Some level of primary education (1-8 grades)

Some level of secondary education (9-12 grades)

Technical and vocational

University

7. Religion?

Orthodox Christian

Muslim

Protestant

Catholic

No religion

8. Occupation?

- Employed non health Professional
- Heath Profession
  
- Veterinarian
- Farmer
- Privet business
- House wife
- Pensioner
- Student
- Do not have work

9. How many people are living in the same house and sharing meal in your household?

10. How many children (Less than 10years) have?

11. Do you own Dog?

- Yes
- No

7/4/2021 Epicollect5 – Form builder

**Interview questions for households with dog**

1. Do you own Dog?

Yes

No

2. How many dog/-s belong to the household?

3. Number of Male dog

4. Number of female dog

5. Housing system of the dog?

Specially constructed house/cage

On house passage way/corridor

Anywhere on the premises

6. How many are adult dogs greater than 6 months?

7. How many are puppies (younger than six months)?

8. What is the breed of your dog?

- Local
- Exotic
- Cross

9. From where did you get the Dog/-s?

- From own bitch
- Brought
- Received as a gift

10. What is the purpose of keeping dog?

- Protection/Guard purpose dogs
- Love and affection/pet
- Sale/breeding
- Hobby

11. Where does your dog spend majority of the day?

- All the time in the house
- Mostly in the house
- Half inside
- Mostly outside

12. Do you massage/ wash your dog?

Yes

No

13. Do you touching or have any contact with the dog's faces?

Yes

No

14. Who feed the dog/-s?

Household members

Neighbors

Neighbors/household

Find its own food

15. Does the dog allowed to leave the premises in day?

Never allow to leave the premises

Allow to freely roaming

16. Was any vaccine campaign in your area in the last 3 years?

Yes

No

<https://five.epicollect.net/myprojects/dog-demograohy-and-zoonoses> /form builder 7/17

7/4/2021 Epicollect5 – Form builder

17. Is your Dog vaccinated against rabies?

Yes

No

18. If the answer is No for the above question what is the reason the dog has not vaccinated?

The dog not up to vaccinated age

Didn't know where to find the vaccine

Lack of information

Distance to veterinary clinic/ no near vet clinic

Cost of the vaccination

Unable to handle the dog

Feared that the dog might change its behavior after  
vaccination

19. Why you vaccinate your dog?

Specifically for prevention of rabies

UN specifically for prevention of other disease

Don't know

20. Can we see the certificate?

Observed

Not observed

21. If the answer is yes for the above question please take a picture of the certificate

22. Which year did the dogs get the last vaccination?

23. Do you observe high number of stray dogs on your street?

Yes

No

24. Dose the presence of stray dogs affects you and / or your family in the area you live in?

Yes

No

25. Do you agree the statement that stray dogs are causing a problem?

Agree

Disagree

Neutral

### **Rabies general awareness**

1. Can you tell us a disease that can transmit between dogs and humans?

- Rabies
- Echinococcosis or Hydatid Disease
- Leishmaniosis
- Covid 19
- Don't know
- unspecific bacterial diseases

2. Have you heard of rabies?

- Yes
- No

3. What is your source of information about rabies?

- Formal (Newspaper, TV/radio)
- Informal
- Mixed Source
- Governmental rabies vaccine campaigns
- No information about rabies

4. Have you ever get training about rabies?

- Yes
- No

5. What cause rabies?

- Virus
- Bacteria
- Parasite
- Magic
- Feed shortage
- Bate
- Water shortage and long drought
- Food poisoning
- Don't know

6. Is rabies transmissible disease to human?

- Yes
- No
- Don't know

7. Do you think rabies is fatal Disease?

- Yes
- No

8. Which species of animal are source of rabies for human?

- Dogs
- Human
- Cats
- Cattle
- Equine

Wild animal

Don't know

9. Other than dog who can be affected by rabies?

Human

Cat

Cattle

Equine

Wild animal

Don't know

10. How rabies can be transmit to dog?

Bite

From bats

From other dog

From wild animal

Water and food shortage/long drought

Food contamination

Wind/Air

Don't know

11. Have you seen rabid animal?

Yes

No

12. Do you know the clinical signs associated with rabies?

Yes

No

13. Can you tell us symptoms of rabies in dogs?

Change of behavior

Restlessness/disorientation

Aggressively, biting objects and people

Roaming, uncontrollable

Salivation

Stop drinking and eating

Paralyzed tongue (hanging out of mouth)

Non-stop barking/crying

tail paralysis

Don't know

14. Dose rabies can be cure once the dog show symptom?

Yes

No

Don't know

15. What do you do if the dog shows the symptoms?

Killing the animal

- Killing the animal and burn
- Feeding an appropriate diet to dog
- Report to veterinarian
- Don't know

16. How Rabies can be transmit to human?

- Dog bite
- Saliva through broken skin
- Saliva contact with skin
- Saliva contaminated objects
- wind/air
- Dog fur
- contact unspecific with dog
- Eating raw meat
- Drinking raw milk
- Blood contact
- Don't know

17. Have you seen rabid Human?

- Yes
- No

18. Can you tell us the symptoms of rabies in humans?

- The dog bark inside the abdomen
- Fever
- Mad

- Act like a dog
- Hydrophobia (fear of water)
- Muscle paralysis
- Headache
- Confusion/agitation
- Abnormal behavior
- Paralysis
- Insomnia
- Don't know the symptoms

19. Can a person already show rabies symptoms be cured?

- Yes
- No
- Don't know

20. How can rabies be prevented in dog?

- Vaccination of dog
- Restraining of dogs
- Killing stray dogs
- Giving appropriate feed and water
- Prevent dog from long draught
- Prevent dog from wild animal contact
- Don't know

21. At what age should dogs receive first dose of rabies vaccine?

- 3 Months
- 6 Months
- 9 Months
- 1 Year
- Don't know

22. Do you know rabies vaccine for human work before dog bite?

- Know
- Don't know

23. As first aid measure what would you do after bite?

- Clean and flush the wound with soap and water for 15 minute
- Applies traditional medicine
- Getting medical care
- Applied alcohol and lemon
- Visit traditional healers
- Drinking traditional medicine
- Go to spiritual places
- Burning the wound
- Visit a veterinarian
- Tying the wound
- Drinking Holy water (tsebel)
- Don't know what to do

24. Do you know a person that died of rabies?

- I know
- Don't know

25. Has any member of the household been bitten by dog the last 5 years??

- Yes
- No

26. How many case that has happened?

27. If the answer for the above question is yes how old was the person?

28. Gender of the victim?

- Male
- Female

29. Sit of bite?

- Leg
- Hand/Arm
- Hip
- Shoulder/Neck

30. Was the bite caused skin penetration?

Yes

No

31. Types of dog bite the victim?

Own dog

Another person dog

Free roaming/Stray Dog

32. Was the dog that bite vaccinated against rabies before the incident?

Yes

No

Unknown

33. What action was taken after bite?

Seek medical care

Went to traditional healer

Went to spiritual place

Went to holy water

No action was taken

34. What happened to the person that was bitten afterwards?

Death

Survived

Thank you for your cooperation and this is the end of my questions. I can answer some of the questions in case you have.