ADDIS ABABA UNIVERSITY COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE DEPARTMENT OF MICROBIOLOGY IMMUNOLOGY AND VETERINARY PUBLIC HEALTH

ASSESSMENT OF STRAY DOG COUNTING AND KNOWLEDGE, ATTITUDES, AND PRACTICE TO WARDS RABIES IN HOUSEHOLDS IN ADDIS ABABA CITY, ETHIOPIA

MSc

BY

TEWODROS LEGESSE

ADVISOR

OLANA MERERA (DVM, MSc, ASSIS. PROFESSOR)

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 Science (MSc) in Veterinary Public Health

JUNE, 2024

BISHOFTU, ETHIOPIA

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Department of Veterinary Microbiology, Immunology and Veterinary Public Health

As MSc research advisors, I hereby certify that I have read and evaluated this thesis prepared under my guidance by Tewodros Legesse Demeke

Entitled:

Assessment of stray dog counting and knowledge, attitudes, and practice to wards rabies in households in Addis Ababa city, Ethiopia

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As a member of examining board of the final MSc, open defense we certify that we have read and evaluate the thesis prepared by Tewodros Legesse Demeke

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LIST OF ABBREVIATIONS

ABC	Animal birth control
ABLV	Australian Bat Lyssavirus
CDC	Center for disease control
CNS	Central Nervous System
CSF	Cerebro- Spinal Fluid
dFAT	Direct Fluorescent Antibody Testing
dRIT	Direct Rapid Immunohistochemical Test
DUVV	Duvenhage Infection
EBLV	European Bat Lyssavirus
EHNRI	Ethiopian Health Andand Nutrition Research Institute
ELISA	Enzyme-Linked Immunosorbent Assay
EPHI	Ethiopian Public Health Institute
FAT	Fluorescent Antibody Testing
GnRH	Gonadotropin releasing hormone
HH	House Hold
IBM	International Business Machines
KAP	Knowledge, Attitude. Practice
LBV	Lagos Bat Virus
MIT	Mouse Inoculation Test
MOKV	Mokola Virus
MoLFR	Ministry of Livestock and Fishery Resources
MR	Mark Recapture
NY	New York
OIE	World Organization for Creature Wellbeing
PCR	Polymerase Chain Reaction
PEP	Post -Exposure Prophylaxis

PET	Post-Exposure Treatment
PMR	Photographic Mark Recapture
PNS	Peripheral Nervous System
RABV	Rabies Virus
RAT	Risk Assessment Tool
REID	Rapid Enzyme Immunodiagnostic
RNA	Ribonucleic Acid
RTCIT	Rapid Tissue Culture Inoculation Tests
RT-PCR	Reverse transcriptase polymerase chain reaction
STATA	Statistics And Data
UV	Ultraviolet
WHO	World Health Organization
WOAH	World Organization for Animal health

ABSTRACT

Rabies is a fatal viral disease of animals and people. Dogs are the primary source of infection and the majority of human rabies cases result from dog bites. Information on both domestic and stray dog populations along Knowledge Attitude Practice (KAP) assessment regarding rabies is vitally important for rabies control. However the situation of rabies is poorly known in Ethiopia, mainly in urban areas. Therefore, this study aimed to assess the demography of stray dogs, the incidence of dog bites, and the knowledge, attitude, and practice (KAP) of society concerning rabies. Questionnaire survey was collected from November, 2023 to May, 2024 using Kobo Collect toolbox in selected sub city Gulele, Yeka and Arada in order to assess KAP of the respondents towards rabies in households. In the survey, out of 384 households (96.35%) of households owned at least one dog with a total number of 463 dogs (range: 1 to 5 dogs per household); the mean number of dogs per household was 1.25 (SE 0.58). From this 96.35% of dog owning households 51.2% of respondents, owned only one dog with dog: human ratio of 1:9. 70% of dog owning households have vaccinated their dogs against rabies. Nearly all (99%) of the respondents recognized the right response regarding the route of rabies transmission and had heard of rabies. However, 64.3% of research participants had a satisfactory level of suitable rabies prevention practices score, whereas 61.8% of individuals had a moderate level of knowledge and 59.8% had an intermediate level of attitude. In this study, even though the study participants have moderate knowledge, attitude and practice towards rabies, the dog bite management and dog vaccination practice is unsatisfactory on the last three years. Age, occupation, and the source of rabies information were all significantly correlated with knowledge score ($P<0.05$). The counting method was by using photo capturing method and by observation. In this study, male dogs were higher than female dogs. The total dog estimation of Gulele, Arada and Yeka sub cities had estimate 1050,783, 1282 respectively. There is huge population of stray dog in the studied sites which may serve as a risk for maintaining and transmission of rabies. Along the set of study objectives, the RabiCare android app was developed to create awareness on transmission, prevention and control of rabies in three most spoken languages.

Keywords: *Addis Ababa, Attitude, Knowledge, Practice, Rabies, Stray dog demography*

1. INTRODUCTION

1.1 Background information

Rabies is among the deadliest zoonotic in the world, with an assessed case casualty rate of about 100%. It beats annual human passing from all zoonoses and is likely the number one immunization preventable disease (Hampson *et al.*, 2015). As in various African countries, the urbanization is quickly expanding in Ethiopia inside the outline of ghetto cities and towns, which is closely related to the human and dog populace (Gebremedhin *et al.*, 2020). Rabies is a neglected disease because rabies remains an ignored zoonotic disease in numerous developing countries such as Asia and Africa which needs unequivocal symptomatic and examination procedures. Rabies is one of the 17 chief marked down tropical diseases. Thus, it may be a reduced zoonotic ailment so its control is tougher and is widespread in most of the world (Bilal, 2021).

Dogs were the essential creatures to be restrained inside the world, and have a close relationship with individuals with a number of important capacities, as a coordinate, observe security, swarming and for transport purposes (Rinzin *et al.*, 2016) furthermore their social behavior makes them incredible companions (Brian *et al.*, 2010). The canine populations found in urban and peri-urban area is classified as owned and ownerless free-roaming stray dog. The possessed canine consolidates both dog that are restricted in their advancement to a limited zone (such as interior a fenced yard or underneath human supervision on walks), and those that are free to wind unhindered without human supervision (Smith *et al.*, 2019). Stray dog are depicted by the World Organization for Animal Health (WOAH) as dog not underneath facilitate human control or not blocked from transparently wandering. They are classified into three categories: free-roaming dog, free-roaming ownerless dog that still live in human family units, and wild dog that have returned to a wild state and are not subordinate on individuals (OIE, 2009).

As WHO proposes, to ensure a productive vaccination scope program and for practical control of rabies, adjacent data of dog populace demography and environment is essential (WHO, 2013). Information of the canine statistic characteristics and factors related with dog

proprietorship is imperative for the organizing and utilization of rabies mindfulness and dog immunization programs and the headway of able puppy proprietorship (Darryn *et al.*, 2008).

According to estimates, Ethiopia has the second-highest rate of rabies-related deaths in Africa (Coetzer *et al.,* 2016). Rabies is regarded as the most important and prioritized zoonotic disease in Ethiopia (Pieracci *et al.,* 2016). Like other major cities in poor nations, Addis Abeba has had the highest rate of rabies cases due to the disease's widespread recognition and endemic status (Girma *et al,* 2002; Paulos *et al,* 2003). According to Massei *et al.* (2013), while a significant percentage of dogs reside indoors and are restricted, a significant percentage of dogs are still walked on the streets all the time, forming several demographic groupings referred to as free roaming, stray, wandering, not domiciled, or unrestrained. (Alves *et al.,* 2013) state that stray dogs are thought to be the main victims of negligent owners who abandon their animals on the streets. Dogs that wander freely are thought to be a serious issue for both public health and animal welfare (Garcia *et al.,* 2012).

Sufficient approximations regarding the magnitude and attributes of the unrestrained dog population are vital for organizing and overseeing the efficacy of tactics implemented for population management and well-being (Fei *et al.*, 2012). Outstandingly little information has been conveyed on the populaces of owned and non-owned dogs in Ethiopia (Menghistu *et al.*, 2012; Tschopp *et al.,* 2016; Gebremedhin *et al.,* 2020). Consequently, recognizing the status of canine demography, organization, and impact of rabies on mutts, animals, and individuals, as well as choosing the data, mien, and sharpen levels of the community are found basic for arranging fruitful key options for expectation and control of rabies at the national level.

Therefore, the objective of this study was:

- To identify the public health impact and welfare of owned and stray dog population in the current study area.
- To assess the community knowledge, attitude and practice regarding dog management and rabies.
- To evaluate the dog population to enable devising realistic planes for dog population management, zoonosis control and monitoring the success of the future investigation.
- To assess the total street dog population in order to enable better planning of the control actions against diseases involving these animals.

- To develop a software app used to orient and teach the community about the Rabies disease in most three most spoken languages (Amharic, English and Afan Oromo)

2. LITERATURE REVIEW

2.1 Etiology

As a member of the family Rhabdoviridae (Rhabdos = "a rod") and genus Lyssavirus (Greek: Lyssa = "rage" or "madness"), rabies is characterized by a bullet-shaped RNA virus that is common among many viruses that infect fish, plants, animals, and insects (Quinn *et al.*, 2011). There are currently seven genotypes identified in this family. The two genera that infect animals are Rabies virus (RABV) and Vesiculovirus, which causes vesicular stomatitis in horses and cattle. However, several taxa within this family are limited to affecting plants and insects (Collier and Oxford, 2006). RABV is a negative sense, enclosed, unsegmented, single-stranded RNA virus with helical symmetry. Its length is around 180 nm, and its cross-sectional diameter is approximately 75 nm. Furthermore, they are readily susceptible to heat, formalin, phenol, UV light (sunlight), and desiccation and other organic solvents (Quinn *et al.*, 1994).

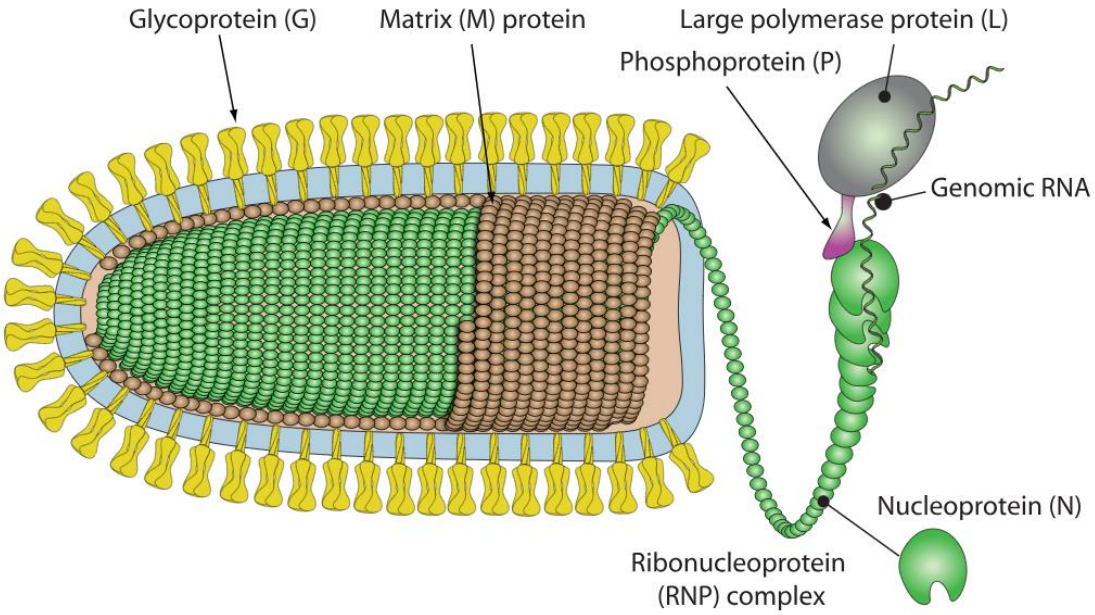

Figure 1: Structure of *Lyssaviruses.*

Source: https://www.who-rabies-bulletin.org/sites/default/files/rabv_particle.jpg or https://www.mdpi.com/2218-273X/12/10/1436

2.2 Pathogenesis

The rabies virus enters the body by direct contact with mucosal surfaces or through wounds. It can't pass through skin that is still intact. In order to enter the central nervous system, the rabies virus multiplies in the bitten muscle and enters through motor endplates and motor axons (Ugolini, 2008). There is no uptake by sensory or sympathetic ends during the fast retrograde transport of virions via motor axons to the central nervous system, where they are transported in transport vesicles (Ugolini, 2011).

Viral penetrations from penetrating injuries can also directly penetrate peripheral nerve motor axons. Because of skin tropism, certain bat variations may also experience viral propagation through sensory nerves. Depending on the amount of virus in the inoculum, the density of motor endplates at the wound site, and the proximity of virus entry to the central nervous system, the incubation period can range from five days to several years (typically two to three months; rarely more than a year) (Hemachudha *et al.,* 2013). This eclipse phase may be facilitated by muscle-specific micro-RNA, which inhibits viral transcription and replication in the muscle. Whether a virus spreads by centrifugal or centripetal retrograde axonal transport determines the predicted speed of its migration. Centripetal retrograde axonal transport involves rapid movement, reaching up to 100 mm/day or more, as a result of simultaneous infection of neuronal populations of the same synaptic order spread over different distances, such as 10 µm to 2 cm. In contrast, centrifugal spread is slow, probably mediated by passive diffusion rather than active transport (Ugolini, 2008).

Through their core connections with the originally infected motor neurons and spinal interneurons, the first rapid centripetal phase causes extensive trans neuronal transfer throughout the central nervous system and infection of the dorsal root ganglia (Hemachudha *et al.,* 2013). After infecting peripheral sensory axons of the infected dorsal root ganglia, muscle spindles, skin, hair follicles, and other non-nervous tissues like salivary glands, heart muscle, lung, and abdominal visceral organs through their sensory innervation are all infected by the virus, which then moves centrifugally from the central nervous system via slow anterograde axoplasmic flow in motor axons to the ventral roots and nerves and in motor axons to the ventral roots and nerves. The virus has likely spread to extra-neural organs and is extensively distributed throughout the central nervous system by the time clinical symptoms appear (Hemachudha *et al.,* 2006).

At the bite site, neuropathic pain is the initial distinct clinical manifestation. Cellular immunity-induced inflammation and virus replication in dorsal root ganglia are the causes of this. There is no correlation between the anatomical location of the rabies virus in the central nervous system and the manifestation of furious or paralytic types of human rabies (Mitrabhakdi *et al.*, 2005). The primary clinical symptoms most likely result from various site-specific reactions. Coma is also explained by impairment of functional neurons. Weakness in paralytic rabies is caused by peripheral nerve axonopathy or myelinopathy, according to electrophysiological studies with pathological correlations (Hemachudha *et al.*, 2005).

Dogs inoculated with different dosages of the canine street rabies virus will secrete the virus into their saliva as early as 14 days prior to the onset of symptoms (Fekadu, 1988). The dose of the inoculum mostly determines the extent of infection and, to some extent, the location of alterations. Even a tiny amount of the virus can cause more pathogenic alterations and prolonged incubation times. The duration of the incubation and morbidity phases is directly correlated with the level of inflammation in the brain and, less frequently, the spinal cord. In the central nervous system, there can be mild to severe neuronal degeneration. Early neuronal necrosis is indicated by satellitosis and neurophagia. The brain stem, pons, cerebral cortex, and cervical regions all contain Negribodies' part of the spinal cord. In general, the number of Negri bodies present is directly proportional to the severity of inflammation (Fekadu, 1988).

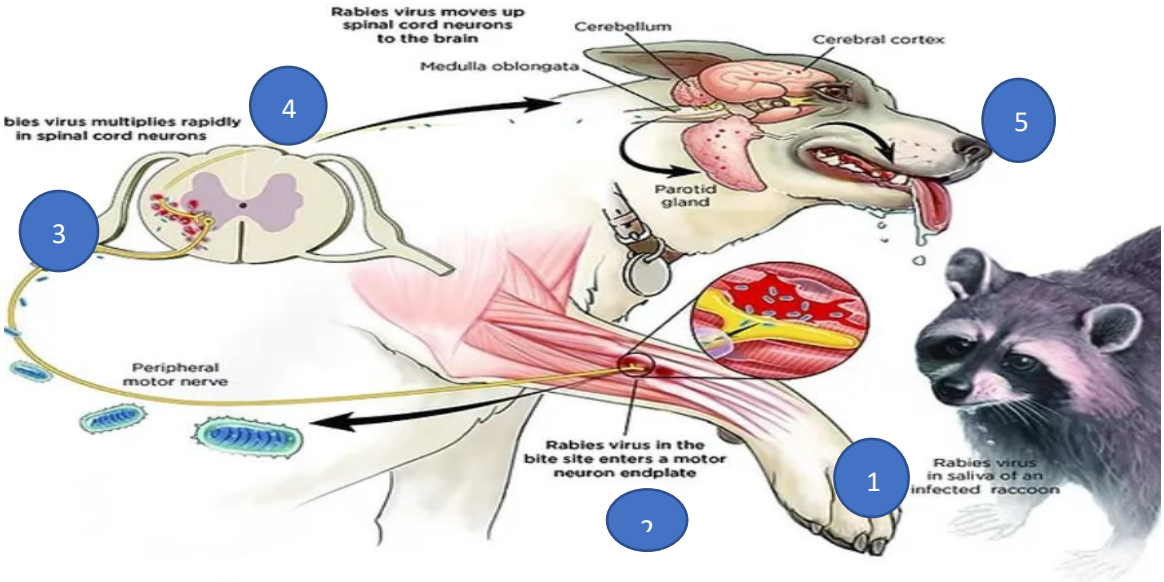

Figure 2: Pathogenesis of rabies virus

Source: https://todaysveterinarypractice.com/preventive-medicine/rabies-vaccination-in-dogs/

2.3 Epidemiology of Rabies

Rabies is eradicated in some island countries such as Australia and Antarctica the United Kingdom, Ireland, New Zealand, Hawaii, and many Western European countries (Cifuentes *et al.,* 2017). Rabies is prevalent in dogs in developing countries in Central and South America, Africa, and Asia. These regions account for the majority of human rabies cases worldwide. Africa and Asia account for more than 95% of the world's deaths. More than 24,000 to 30,000 people die from rabies each year in Asia and Africa, with higher mortality rates reported in poor rural areas and in children. Although rabies is still present in Europe, mandatory vaccination of animals has eliminated human rabies in many European countries (Yousaf *et al.,* 2012).

According to Sambo (2012), domestic dogs serve as the primary vector for the virus's propagation, making it enzootic across Africa. Dogs carrying the spillover rabies virus pose a threat to critically endangered wild African canids, including the African wild dog (Lycaonpictus) and the Ethiopian wolf (C. simensis) (Woodroffe *et al.,* 2012). Bats are also important disease vectors, as they are responsible for hundreds of cattle deaths annually in central and South America (Cifuentes *et al.,* 2017).

2.4 Host Susceptibility

All animals are prone to infection; however, host characteristics including age, health, and diet can affect the degree of sensitivity (Rodney and Willoughby, 2015). While all animals with warm blood can contract rabies, birds are the species most resilient to the disease. According to Muruki (2016), the most vulnerable animals include skunks, wild dogs and foxes, raccoons, bats, and livestock. Dogs, cats, horses, sheep, goats, non-human primates, and humans are next in line.

2.5 Transmission

Despite the involvement of other animal species, domestic carnivores were the primary animals responsible for the persistence and spread of rabies in the region (Reta *et al.,* 2014). A study carried out in Addis Ababa by (Mengistu *et al.,* 2011) revealed that the majority of dog bite instances on humans happened in the autumn (September, October, and November) rather than any other season, and that stray dogs were more likely to bite people during this time than owned dogs (Reta *et al.,* 2014) also discovered that September had the largest RABV transmission during their investigation, with diminishing numbers in November. This higher frequency most likely corresponds with the June to September dog breeding season. There's a chance that enormous devastation caused the November decrease. The widespread slaughter of confined dogs in reaction to increased movement during mating and a rise in rabies infections may have contributed to the November drop

2.5.1 Direct contact with an infected animal (bites)

According to (Fekadu *et al.,* 1982) and (Quinn *et al.*, 2011), people may contract the disease from domestic or wild animals mostly by biting. However, before any clinical symptoms appear, infected animals may continue to secrete the virus through their saliva (Fekadu *et al.*, 1982). While there is a possibility of virus transmission through licking and scratching, bites is typically the mode of infection (Quinn *et al.,* 2011). Even while fresh saliva can cause infection, the source of infection is always an infected animal, and the mechanism of transmission is usually always through the bite of an infected animal. Before symptoms appear, the virus may reside in the saliva for up to five days. Because the virus is not always in saliva, not every bite from a rabid animal will cause infection. If saliva is kept away from the teeth by clothing, the virus may not enter the wound (Moges, 2015; Constable *et al.*, 2017).

2.5.2 Air-Borne

A few human cases of RABV transmission through aerosol have been documented in bat caves; however, due to the alternate natural occurrence of rabies in animals living in caverns inhabited by infected insectivorous bats, inhalation as a mode of transmission became suspect. It is now acknowledged that bats can spread from one to the other and among themselves.

2.6 Incubation period

A distinct incubation time distinguishes rabies from other infectious illnesses. The site and intensity of the bite, the animal species involved, the biter's age, the kind and quantity of the virus, the post-exposure therapy, and the ease of transmission all affect how long the incubation period lasts after exposure. The nerve terminals are infected by the virus. It can endure anywhere from a few days to several years, with a duration ranging from thirty to ninety days (Mani and Madhusudana, 2013).

Incubation times can vary from days to years, but they often last 30 to 90 days. Dogs, for instance, require 3 to 8 weeks, cats, 2 to 6 weeks, and humans, 2 weeks to 12 months (on average), 3 to 6 weeks. The time for incubation has been range from 10 days to 6 years. The first symptoms usually appear 30 to 90 days after exposure. Older animals breed longer than young animals (Shengli *et al.*, 2021).

2.7 Clinical Sign

While there is significant individual diversity, most species share comparable clinical traits. The incubation period following the bite of a rabid animal, like a dog or bat, typically lasts between 14 and 90 days, although it can go much longer (Collier and Oxford, 2006). Where in the amount of virus inoculums, the path, the place, the degree of exposure, the distance (between the lesion and the brain or spinal cord), and the status of vaccinations all affect how long the incubation period takes. The majority of animals impacted include dogs, cats, and wild carnivores such foxes, raccoons, and coyotes (Kidane *et al.*, 2016).

The typical way that people contract rabies is through the bite of an infected animal, although the virus can also be spread by licking abraded skin; aerosols from bat caves have also been shown to carry the infection. Human incubation times can range from 10 days to a year or longer, although they often last between one and three months, depending on the previously listed incubation period parameters. Typically, the onset occurs gradually over a period of one to ten days (Collier and Oxford, 2006; WHO, 2018).

There are three stages of clinical manifestation, these are;

(i) The prodromal phase (one to two days): The following symptoms have appeared: headache, fever, malaise, and excessive salivation. Dogs can exhibit jitters, fear, anxiety, fever, behavioral shifts (becoming hostile or shy, and vice versa), intense biting at the bite site (itching), laryngeal spasms, and vocal changes may be initially observed (Collier and Oxford, 2006).

(ii) Furious rabies (lasting two to four days): The patient exhibits enthusiasm along with signs of anxiety and trepidation. The majority of observable symptoms include restlessness, aggressive conduct, and persistently elevated salivation (Moges, 2015). The most common classical indication is hydrophobia, which is extremely upsetting since the patient wants to drink, but any attempt to do so or even the sight of water causes severe muscular spasms in the respiratory system and other body parts, along with a profound sense of panic. According to (Constable *et al.,* 2017), the patient passes away in a coma from widespread paralysis and circulatory collapse.

(iii) Paralytic ('dumb') rabies (next to 4 days): Less drama exists throughout the course. Ascending paralysis is the hallmark of an illness that can last up to a month; hydrophobia is not a defining characteristic. When left untreated and unvaccinated, the disease causes painful convulsions of the pharynx and muscles, which can proceed to a paralytic phase, respiratory arrest, and death. In humans, this has long been thought to be lethal. Death is certain, just like in cases of furious rabies (Tortora *et al.,* 2010).

2.8 Diagnosis

Early post-exposure prophylactic treatment for both humans and animals require laboratory detection of rabies. Due to a lack of facilities, the majority of rabies diagnoses in underdeveloped nations are based on clinical signs, history of exposure, and epidemiological data (Fooks *et al.,* 2009; Hemachudha *et al.,* 2013).

Because rabies is a neurotropic illness, brain tissue samples are commonly employed in laboratory diagnosis; the cerebellum, hippocampal regions, and brain stem are indicated for diagnostic sampling (OIE, 2017; Gumi *et al.,* 2018). Compared to other animal species, the

rabies virus was found in brain samples from carnivores more frequently (94.5%) (Reta *et al.*, 2014).

2.8.1 Direct Fluorescent Antibody Test (dFAT)

The most popular and "gold-standard" test for diagnosing rabies, DFAT is endorsed by the WHO and OIE (Pal M *et al.*, 2013). The DFAT, which is almost 100% sensitive and highly specific, is typically used to identify the viral antigen in order to diagnose rabies in a laboratory setting. Saliva samples or biopsies of certain external tissues can be used for this test; post-mortem samples are typically collected from the brain (Fooks *et al.*, 2009).

2.8.2 Cell culture and Mouse inoculation test

The foundation of these tests is the detection of the infectivity of a tissue suspension of the rabies virus in laboratory animals (mouse) or cell cultures following injection. When FAT yields an unclear result or is negative in the event of known human exposure, these tests ought to be employed. According to (Hemachudha *et al.*, 2013), both tests require lengthier turnaround times than FAT (4 days for the cell culture test and 28 days for the mouse inoculation test).

2.8.3 Direct Rapid Immunohistochemical Test (dRIT)

Using anti-rabies monoclonal antibodies specific for the nucleoprotein a viral protein generated in large quantities during productive infection a direct quick immunohistochemical assay can identify rabies antigen by direct staining of fresh brain impressions in less than an hour (Fooks *et al.*, 2009). The CDC has created a Risk Assessment Tool (RAT) for less developed regions of the world. Its sensitivity and specificity are comparable to those of the usual dFAT, and all that is needed to utilize it is a regular light microscope (Tortora *et al.*, 2010).

2.8.4 Molecular techniques and Serological tests

For the quick and accurate diagnosis of rabies, a variety of molecular diagnostic procedures are employed, including as RT-PCR, PCR-ELISA, real-time PCR, hemi-nested PCR, and

nested PCR, which identify viral RNA (OIE, 2017; Pal M *et al.*, 2013). By evaluating antibodies in cerebral fluid or serum in suspected rabid cases, serological assays can identify the host response to rabies infection and quantify the quantity of virus neutralizing antibody in vaccinated persons. Unfortunately, these tests are too complicated for widespread field sera screening and necessitate a specialized laboratory and infrastructure to manage tissue culture and the virulent rabies virus (OIE, 2017).

2.9 Rabies in Ethiopia

One of the main health issues in Ethiopia is rabies, which is primarily transmitted to humans through dogs. Numerous rabies cases have been reported in various parts of the nation (Deressa *et al.*, 2010). It is mainly a dog sickness in this country. The first significant dog outbreak was documented in 1884 and affected several areas of Ethiopia, including the Gonder, Wollo, Gojam, and old Tigray provinces (Oyda and Megasa, 2017).

Another canine rabies outbreak was documented in Addis Ababa in August 1903; the illness subsequently spread and became endemic (Fekadu, 1982). Rabies or dogs suspected of having rabies are estimated to be the cause of more than 98% of human infections and vaccines. Because of how common rabies is in this country, approximately 77 people per million people receive rabies treatment after exposure to rabies each year (Ramos *et al.*, 2015).

2.10 Community Knowledge, Attitude and Practice about Rabies and Management of Dog.

Out of 106 participants in Thailand, the Rabies Knowledge and Practices Survey found that while the majority of respondents (10%) believed that bats are the primary carrier of rabies, overall awareness of the disease's severity and mode of transmission was quite high. In a similar vein, 80 (76%), 41 (39%), and 24 (23%), of the mammals mentioned were dogs, cats, and other mammals (including rodents and large domestic animals). According to (Robertson *et al.*, 2011), 14 individuals, or 13%, were unable to identify any animals as potential carriers of rabies.

The majority of respondents (87%) to a study poll on KAP conducted in Addis Ababa stated that there is a chance of contracting a zoonotic disease from dogs. Only 4.6% of respondents were aware of parasitic diseases, while the majority of them (95.4%) only knew about rabies (Kilfu *et al.,* 2016). Intestinal helminthosis is frequent in dogs of all ages, according to a study completed by (Muhairwa *et al.,* 2008) in Morogoro, Tanzania. It may be linked to poor dog husbandry techniques, which suggests that the community is at danger of contracting the illnesses.

According to a report by Asmare and Mekuria (2013) in Hawassa, there was no treatment for dogs against parasites, so there was low community awareness regarding dog care and zoonotic parasites and the dog keepers were all unaware that dogs can carry zoonotic infections. The majority of respondents (87%) to research on KAP conducted in Addis Ababa, Ethiopia, said there is a chance of contracting a zoonotic disease from dogs. However, just 4.6% of respondents were aware of parasitic diseases, and the majority of them (95.4%) only knew about rabies (Kilfu *et al.,* 2016).

According to a study on a cross-sectional survey examining community knowledge in addition to attitudes and practices regarding rabies in Kandy District, Sri Lanka, a high percentage of respondents (90%) knew that dogs are the most common reservoir for rabies and that vaccination is the best way to prevent rabies (88%). According to another survey conducted in Sri Lanka, 77.1% of people had sufficient knowledge about cleaning their wounds after being bitten by a dog, 0.2% knew about over-the-counter or home remedies, and 89.5% knew that rabies is a fatal disease. According to Indian research, every person knew about rabies, and 95% of them knew that it can spread by a dog bite or by being scratched by a rabid animal. 86.6% of respondents knew (Matibag *et al*., 2007).

2.11 Stray dog population

Accurate estimates of the number of dogs in urban regions are challenging due to low reported rates of dog ownership and diverse ownership patterns in metropolitan settings. Dog registries can provide valuable information, but using them exclusively will result in an underestimation of the overall dog population because they do not include unowned or unregistered dogs (Reece *et al.,* 2006; Hiby *et al.*, 2011).

A significant advancement would be research on humane techniques to lower dog fertility in countries where an excessive number of wandering animals impedes illness control (Meslin and Briggs, 2013). There are numerous strategies for managing the dog population, including the permanent method of controlling dog births through surgical removal of reproductive organs, known as "Animal Birth Control (ABC)" (neutering and spaying) or (castration, hysterectomy, ovariohysterectomy), is effective but expensive (though it might be more economical in the long run) (Bogel and Hoyte, 1990).

In the framework of the fight against canine rabies, improving and maintaining vaccination coverage as well as reducing dangerous behavior in dogs are the goals of dog population management. Although there is no proof that dog population density affects the spread of rabies, decreasing the number of dogs in the world through human population control may still be beneficial in other ways. For this reason, controlling dog populations may help in the fight against canine rabies. There isn't much research on how humane dog population control initiatives affect rabies and other related benefits (Hiby, 2013), therefore more research on this strategy would be beneficial.

However, "ABC" programs have been implemented with encouraging results in a number of nations, including Ethiopia, where "ABC" tactics were used to decrease or eliminate the number of ownerless dogs in Mekelle City (Taeme *et al.*, 2017). Additionally, progestins, androgens, or gonadotropin releasing hormone (GnRH) analogs are used in hormonal contraception. These drugs work by either directly blocking events mediated by reproductive hormone receptors or indirectly blocking conception through negative feedback mechanisms (Bogel and Hoyte, 1990).

On the other hand, the ownerless canines in Mekelle City, Ethiopia, were humanely removed using various anesthetic agents, formalin, magnesium sulphate, and other chemicals (Taeme *et al.*, 2017). Mass murder is ineffective, alienates the populace, and frequently leads to disputes with international organizations. It frequently leads dog owners to conceal their pets or relocate them, which could aid in the spread of rabies. Using "strychnine" to kill dogs is equally cruel. Poisoning not only results in needless agony and suffering but also presents a risk to people and other animals in areas where the poison is present. International recommendations for reducing dog numbers should be enforced via rabies control programs rather than resorting to mass extermination (Lembo *et al.*, 2012).

One way to lower dog turnover and establish a healthy, long-lasting population is through humane management of dog populations. No action will be effective in every case because dog populations differ from nation to nation in terms of their status and makeup. To better understand dog owners, demographics, and community attitudes toward dogs, authorities should collaborate with individuals who have firsthand knowledge of the local dog population. Based on this data, a humane dog population management toolkit appropriate for long-term sustainable management may be developed (Lembo *et al.,* 2012).

Both industrialized and developing nations continue to struggle with stray dog populations, which can lead to rabies and other issues such bites to humans (Rinzin *et al.,* 2008; Dalla Villa *et al.,* 2010). Official statistics indicate that there are 17.14 million India's stray dogs (BAHS, 2012). The percentage of stray (unowned) dogs varies greatly between nations; according to (Totton *et al.,* 2010), it is as low as 5% in Tanzania, as high as 19% in Sri Lanka, and as high as 60% in India.

Because they are frequently afraid of people, stray dogs cannot be confined. As a result, in order to vaccinate these dogs, they must be caught or given mouth baits (WHO 2013).In India, the overpopulation of stray dogs poses a major threat to public health and animal welfare (Amaku *et al.,* 2010).According to reports, rabies-related deaths in India claim the lives of 92–97% of people, with stray dogs responsible for 60% of these cases (Suraweera *et al.,* 2012).Numerous significant zoonotic pathogens are spread throughout India by stray dogs (Sharma *et al.,* 2017). In various regions of the nation, there are a lot of dogs that roam the streets (Hiby *et al.,* 2017).

The abundance of edible garbage that is available on the streets, the tolerance of stray dogs for their culture, and the absence of reliable and long-lasting birth control programs are the main causes of the high population of stray dogs (Butcher *et al.,* 1999). Reducing stray dog and cat populations is crucial for preventing zoonotic illnesses as well as other annoyances including dog bites, loud noises, and auto accidents. It is crucial for these creatures' health as well. The most prevalent and well-known zoonotic illness is rabies. All continents have rabies, and most African and Asian nations have an endemic case of the disease.

2.12 Prevention and Control

2.12.1 Prevention and control of rabies in dogs

Although rabies is a lethal disease that is incurable but avoidable, there is no specific cure for it (OIE, 2017). Children under the age of 15 account for almost 45–60% of dog bite injuries and human fatalities. They frequently lack knowledge on how to act around animals, particularly dogs that live in the same home or neighborhood, and they are also less likely to comprehend how rabies is spread (WHO, 2005). As a result, kids who have been bitten or scratched by suspected rabid dogs might not report the incident to their parents or guardians, particularly if they've been told not to approach strangers' animals (Cleaveland *et al.*, 2003).

Accordingly, the elderly, children, people with disabilities, the impoverished, and less developed third world countries are the primary targets of previous RABV prevention campaigns (Tenzin, 2012). About 99 percent of human rabies cases in Asia and Africa are in domestic dogs, who serve as the primary rabies reservoir in many developing nations (Knobel *et al.,* 2005). As outlined previously (WHO, 2018), the tenets of a canine rabies control program should include mass dog vaccination campaigns, one health approaches, rabies education for the general public, worldwide (global) collaboration, and partnerships (Tenzin, 2012). According to the case definition, an animal is deemed rabid following a qualified laboratory's diagnosis and confirmation through either a positive direct fluorescent antibody test (ideally conducted on tissue from the central nervous system) or isolation of rabies virus in cell culture or in a laboratory animal" (Pal *et al.,* 2013).

2.12.2 Public awareness

The degree of awareness among the public and the medical community is one of the most crucial aspects of rabies prevention. In many nations, innovative teaching approaches are starting to advance. For instance, by including rabies education into elementary school curricula, Filipino educators have made impressive progress (Lembo *et al.,* 2012). Additionally, (Taame *et al.,* 2017) state that Ethiopia elaborates on this innovative idea.

New methods that may reach a larger population in endemic areas would save lives, though, as many youngsters do not receive their education in a structured classroom setting. Governments must also take part in public education campaigns that promote safe pet ownership, regular veterinary care and vaccinations, and ongoing professional development. Unless otherwise: the absence of useful health education programs result in a low degree of awareness of the disease burden and the methods necessary to prevent and control rabies (Aga *et al.,* 2016).

Inadequate knowledge also results in low community involvement in rabies control initiatives and the failure to protect those exposed to rabid dogs (Meslin and Briggs, 2013). According to (Aga *et al.,* 2016), nearly all human rabies deaths have been caused by either disregarding the urgency of administering PEP or by not adhering to WHO guidelines regarding vaccination and wound cleaning. Political, religious, and cultural considerations must be made in all successful public education initiatives. Programs that make use of creative information highways, such as meetings, schools, and other local organizations, have significantly increased public awareness of the illness (Aga *et al.,* 2016).

2.12.3 'One Health' approach (operational activities)

Initiatives to start developing plans to eradicate canine rabies by uniting experts in veterinary and human care to collaborate under the 'One Health' paradigm (Lembo *et al.,* 2012). Eliminating the cause of a disease is the most economical way to lower exposure to it (Zinsstag *et al.,* 2009). This is only possible for canine-transmitted rabies when authorities tasked with both human and animal health collaborate on a "One Health" approach. Africa and Asia, which are now responsible for the majority of the world's rabies cases, should view this as a public health objective (Meslin and Briggs, 2013). In contrast to European and American countries, Ethiopia's veterinary, medical, and governmental authorities have not placed much attention on rabies (Reta *et al.,* 2014).

Experts from the human and animal health domains must be involved in canine rabies control programs on a daily basis (Kidane *et al.,* 2016). It is imperative that these departments collaborate, even though they are frequently located in different countries and lack connectivity. The primary aim is to prevent the spread of the rabies virus among dogs, but the

ultimate goal is to safeguard human health. This means that information on surveillance efforts and cases of rabies in both humans and animals needs to be communicated across departmental boundaries (Moges, 2015).

In order to assist with this, the attendees of a workshop on "One Health-focused Zoonotic Diseases" in Ethiopia proposed creating a "One Health-focused Zoonotic Disease Unit," which would include staff members from the Ministry of Livestock and Fishery Resources (MoLFR), EPHI (Ethiopian Public Health Institute), and other appropriate animal health organizations. The proposed unit would develop a national strategy for zoonotic disease and coordinate efforts across the human and animal health sectors in order to collaboratively treat the selected zoonotic illnesses and respond to outbreaks in both humans and animals (Pieracci *et al.*, 2016).

3. MATERIALS AND METHODS

3.1. Study area

The research was carried out in the city of Addis Ababa between November 2023 and May 2024. The Federal Democratic Republic of Ethiopia's administrative and capital cities are Addis Ababa. Its coordinates are 38° 44′ 24″ E longitude and 9° 1′ 48″ N latitude (AACG, 2013). It is situated at a height of 2,500 meters in Ethiopia's central highlands. There is 1800 mm of rain in a year. The average annual minimum temperature is 11°C, while the average annual highest temperature is 26°C. 18.7°C is the average temperature worldwide (NMSA, 2012). Based on factors including geographic location, population density, asset and service provider distribution, and administrative convenience, the city is subdivided into 11 sub-cities (Kifle Ketemas). The smallest administrative entities, known as woredas, are often used to partition lower within a city. The municipality has 116 Woredas (AACG, 2013).

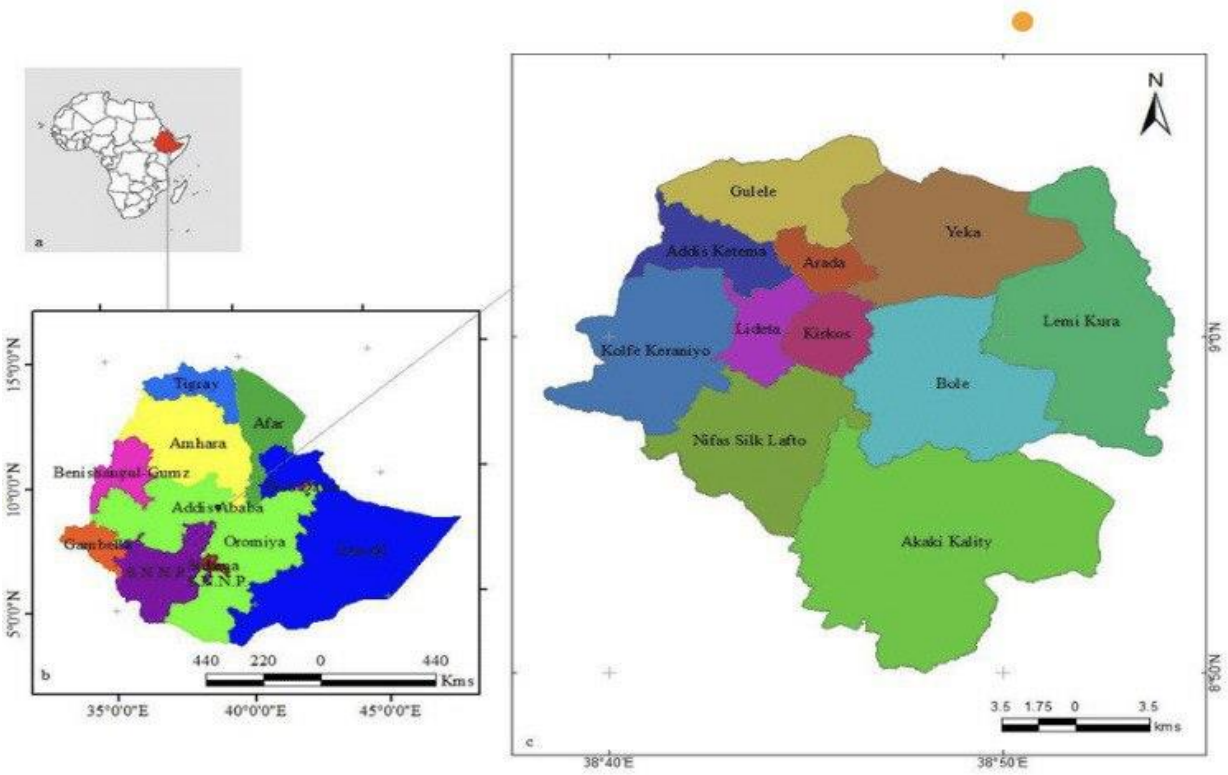

Figure 3: Map of the study area.

Source: Ayele *et al.*, 2022.

3.2. Study Design and Methodology

3.2.1. Questionnaire survey

A community-based cross-sectional survey will be conducted to study rabies knowledge and practices using interview survey collected using Kobo collect tool. The survey targeted selected households in three purposively selected sub-cities (Kifle Ketemas): Arada, Yeka and Gulele. The publicly available map of Addis Ababa city is downloaded from all residential properties located within the marked boundaries of the selected city block and containing at least one dog was included in the survey. The questions were only answered by people who are 18 years of age or older and belong to the specific household participating in the interview.

3.2.2. Retrospective data collection

Retrospective data was obtained from case files and registries of Addis Ababa City from January 2019 to June 2023. Registration data on dog bites and suspected rabies cases caused by domestic dogs were collected from the EPHI file book. Information about date of bite, type of animal bitten, gender of victim, and body part bitten is obtained from the patient record book.

3.3. Sample size

To survey respondents and estimate dog-owning households, the sample size was calculated based on the formula developed by Bennett (Bennett *et al.*, 1991). N=b*c: where N= total number of samples, b= number of respondent households per cluster, c= clusters, so the total number of samples is 384.

3.4. Methods of data collection

This study was conducted on two dog populations: domestic stray dogs and free-roaming stray dogs. Data was collected from November 2024 to May 2024. Methods for estimating the

number of owned and roaming dogs include questionnaires (door-to-door) (Menghistu *et al.*, 2012), surveys, and photo tagging and recapture in randomly selected cities. Includes a comprehensive number of dogs.

3.4.1. Door to Door Questionnaire survey

A survey of dogs owned was collected through their owners. Households with dogs identified by field teams. A structured questionnaire was developed. Open-ended and closed-ended questions were included in the questionnaire, which was sent to owners by door-to-door interview. In order to ensure appropriateness and clarity when addressing the study participants, the questionnaire was initially created in English and then translated into Amharic. They were informed of the goal of the study and requested for their consent prior to the interview starting. In this study, only willing volunteers were included. Every piece of information collected from research participants was kept private. A household representative was interviewed using a form. Every dog possessed by the household's sex, age group, immunization history, and state of confinement were among the information gathered. Additionally, the questionnaire included socio-demographic characteristics of the study population, dog owners and dog: population ratio, rabies awareness and factors associated with dog-related zoonosis, community knowledge, and rabies. Knowledge assessment survey results, dog vaccination rates, and rabies prevention. The same goes for animal bite management and search operations at health centers. Questionnaire surveys on owned dogs and to elicit opinions about ownerless dogs were conducted to determine dog population size (per person, per household, per surface area), demography, and dynamics.

3.4.2. Photographic capture-mark-recapture Method to count stray dog

After running MR for one day and counting the following consecutive days. Capturing took place on the first day from 6:00 a.m. to 8:00 p.m. Most stray dogs were present in public areas during this time, and visible dogs were counted while walking through the community. The location and number of dogs are also recorded. Similar activities were repeated simultaneously in the afternoon. Dogs were then identified based on characteristics such as the type of color in the photo and the color of the markings. At the most appropriate time in Yeka, Arada and Gulele districts. When traffic was minimal and natural light was sufficient for observation (there were no street lights in this location, so it was impossible to count dogs

at night. Counts were conducted on two consecutive days at each site. The dog count included homeless dogs that were free to roam and whose owners could not be identified.

3.5. Data analysis

Responses to KAP questions are scored by cutting 50% of the maximum achievable score and dichotomized to reflect desired and undesired KAP scores. Binary knowledge questions are worth 1 point if answered correctly and 0 points if answered incorrectly. Respondents with a score of 50% or higher are considered having sufficient knowledge, and respondents with a score below 50% are considered to have insufficient knowledge. Similarly, practice responses are rated as 1 (desired practice) and 0 (good practice). Respondents who achieve a score of 50% or above are classified as having good practice, and respondents with a score below her 50% are classified as having poor practice.

Attitude questions were asked on a Likert scale, with 1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, and 5 = completely Agree. The answer with the highest number is given in the desired direction. An individual's attitude is determined based on the sum of the values provided in the questions measuring attitude and transformed as a binary variable to identify desirable attitudes (if attitude score $\geq$ 50%) and undesirable attitudes (if attitude score < 50%).

Descriptive statistics are used to provide an overview of the participants' socio-demographic traits as well as their knowledge distribution, attitudes, and habits. To ascertain the relationship between variables pertaining to adequate knowledge, acceptable preventive behaviors, and desirable attitudes, Statistical analyses were performed using Stata version 14 (StataCorp LLC, College Station, Texas, USA). Both descriptive and inferential statistics were utilized to present data and the association between the predictor and dependent variables was assessed using odds ratio.

4. RESULTS

4.1.Household size and respondent demographics

A total of 384 urban households in the Addis Ababa sub-cities of Gulele, Arada, and Yeka were invited to participate in interviews, and 384 of the residents accepted (Table 1). Among the responses were 118 (30.73%) from Gulele, 77 (20.05%) from Arada, and 189 (49.22%) from Yeka. An apartment complex typically has five households, and the poll focused on one representative household. According to the data, there were (14.06%) female respondents and (85.94%) male respondents. The average age of respondents was 41 years (range 19 to 70 years). In this study, we intentionally included the age group (>18 years).

4.2.Dog population

With a total of 463 dogs (ranging from 1 to 5 dogs per family), 384 houses (96.35%) in the survey had at least one dog; the mean number of dogs per household was 1.25 (SE 0.58). According to Table 2, the estimated overall dog to human ratio was 1:4. In the current study, the ratio of male to female canines was reported at 1 to 19, with adults making up the bulk of the age group with an adult: puppy ratio of 1:7.6. Of the dogs, 12.1% were puppies and 87.9% were older than six months. Regarding breed, the percentages were local (57.29%), cross (36.72%), and exotic (5.21%), in that order. Security was the primary justification for owning a dog (95.57%), with 4.43% of dogs kept for as a pet. About 51.3% of dogs are the confined never allowed to leave their premises, while 48.7% never restricted their dogs and allow roaming freely in the neighborhood outside of their residential compounds and mixes with other dogs. Almost more than 80% are freely allowed to leave their premises on day time.

Table 1: Socio-Demographic Characteristics of Respondent

Characteristics	Category	N	%
Gender	Male	330	85.94
	Female	54	14.06
Age group	Range (Min, Max)	19-70	
	Median age	41	
	<18	0	0
	19-41	198	51.56
	>42	186	48.44
Educational statues	No formal educations	9	2.34
	Primary education (1-8 grades)	24	6.25
	Secondary education (9-12 grades)	107	27.86
	Technical / Higher education	244	63.54
Occupations	Employed/ Professional	172	44.79
	Privet business	153	39.84
	Pensioner	14	3.65
	Student	33	8.59
	House maid	12	3.12
Religion	Orthodox	215	55.99
	Protestant	142	36.98
	Catholic	12	3.12
	Muslim	2	0.52
	Don’t mention	13	3.39

Table 2: Structure of dogs owned household and human population

Characteristics	Value
Total number of households interviewed	384
Total population in the HH	1726
Total number of Children ≤ 10	224
Number of HH with a dog (s)	370
Number of dogs	463
Dog to Human ratio	1:4

Note. HH= households

4.3.Coverage of rabies vaccinations for dogs

Out of a total number of 463 dogs in the interviewed households, 280 (72.92%) dogs had been vaccinated against rabies. However, only 163 (42.45%) owners could prove that vaccination by providing a vaccination certificate. Meanwhile, 104 (27.08%) of dogs were not vaccinated. The most common reason why a dog did not have a vaccination was lack of information (72.4%). However, 49.48% households give response due to cost of rabies vaccine, 26.82% of the respondents unable to handle their dog. Also, 18.75% of the respondents reported that they didn't know where to find the vaccine while, 15.62% think their dog is not up to vaccination age. 12.76% respondent reported that the veterinary clinic is far from their home and 10.68% of the respondents feared their dog might change its behavior after vaccination as presented in table 3 and Figure 5 below.

Table 3: The demographic structure of 463 dogs kept by the 384 household**s**

Variable	Category	N	(%)
Sex of dog	Male	440	95.03
	Female	23	4.97
Age of dog	Adult >6month	407	87.9
	Puppy <6month	56	12.1
Breed	Local	220	57.29
	Cross	141	36.72
	Exotic	20	5.21
Source of dog	Received as gift	132	34.38
	Bought	180	46.88
	From own bitch	36	9.38
	Road side	58	15.1
Reason for dog ownership	Guard dogs/protection	367	95.57
	Love and affection/pet	56	14.58
	Sale /breeding	15	3.91
	Hobby	12	3.12
Confinement of dog	All time in house	197	51.3
	Mostly in house	145	37.76
	Half inside	27	7.03
	Mostly out side	7	1.82
Rabies vaccination status	Vaccinated	280	72.92
	Not vaccinated	104	27.08
Vaccination Certificate	Available	163	58.21%
	Non-available	117	42.79%
Housing system	Specially constructed house/cage	235	61.2
	Anywhere on the premises	50	13.02
	On house passageway/corridor	115	29.95

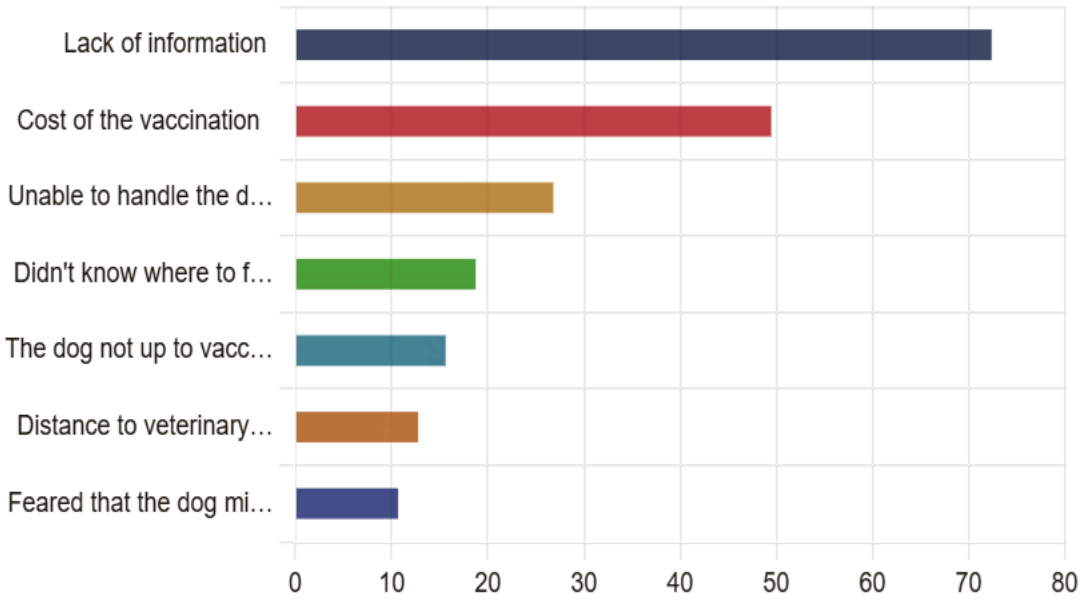

Figure 4: Reasons for non-vaccination of dogs

4.4. Knowledge of rabies symptoms and awareness in the community

Up on assessment of about rabies knowledge and its zoonotic characteristics 100% of them are aware about the virus. The majority 100% of respondents mentioned they as they have heard about rabies. About (94.7%) of respondent, perceived that from other dog. While (66.4%) said that it caused by dog bite, (27.3%) respondents responded caused by wild animal and (1.0 %) of respondent long drought causes rabies in dogs. When respondents asked about species source of transmission to human rabies other than dogs (22.4%) livestock, mentioned humans (18.75%) followed by wild animals (17.71%).

Regarding the symptoms of rabies in dogs, the most frequently mentioned were: salivation 63.17%, tail paralysis (tail locking) 42.15%, aggressiveness and biting objects 41.56%, hydrophobia 6.58%, and behavior change 1.82%. About (13.54%) of the respondents came across have seen rabid animals at least once in their lifetime. About 6.77% of the respondents believe that rabies can be cured after the onset of the symptoms in human and 3.65% in dogs. Regarding the symptom of rabies in humans, acts like a dog or mad 10.94 %, agitation 3.39% and abnormal behavior 3.39% were frequently mentioned symptoms and 72.66% of

respondents knew rabies can't be cured once the person showed symptom as presented in table 4 below.

Table 4: Species affected and transmission route of rabies to people described by 384 respondents

Variable	Category	Response	(%)
Heard rabies	Yes	384	100
Species transmitting rabies to dogs	From other dogs	365	95.05
	Bite from other animals	250	65.1
	Wild animal	105	27.34
	Water and food shortage/long drought	5	1.3
	Contaminated food	1	0.26
Species transmitting rabies to human	Dogs	384	100
	Livestock	86	22.4
	Human	72	18.75
	Wild animal	68	17.71

Table 5: Respondents thought about the symptoms of rabies in dogs and humans (shown in frequency and percentage) perceived by 384 respondents

Characteristics	Category	N	%
Symptom in Dog	Salivating, tail locking	28	7.29
	Salivating, aggressiveness	20	5.21
	Salivating, tail locking, aggressiveness	18	4.69
	Salivating	14	3.65
	Aggressiveness, salivating, tail locking	14	3.65
	Tail locking, salivating	12	3.12
	Aggressiveness, salivating	12	3.12
	Salivating, tail locking	9	2.34
	Salivating	7	1.82
	Salivating, aggressiveness	4	1.04
The curability of rabies in dogs	Curable	14	3.65
	Incurable	208	54.17

	Don’t know	162	42.1
Symptom in Human	The dog bark inside the abdomen	25	6.51
	Mad O Act like a dog	17	4.43
	Abnormal behavior	13	3.39
The curability of	Curable	26	6.77
rabies in human	Incurable	279	72.66
	Don’t know	79	20.57

4.5.Information Source

Only 3.65% of respondents got information about rabies from the media (television, radio, newspapers). The majority of respondents (49.48%) learned about the disease from unofficial personal contacts (friends, parents, and community members); 43.23% learned about it from mixed sources; and 3.39% learned about it from the government's rabies vaccination campaign.

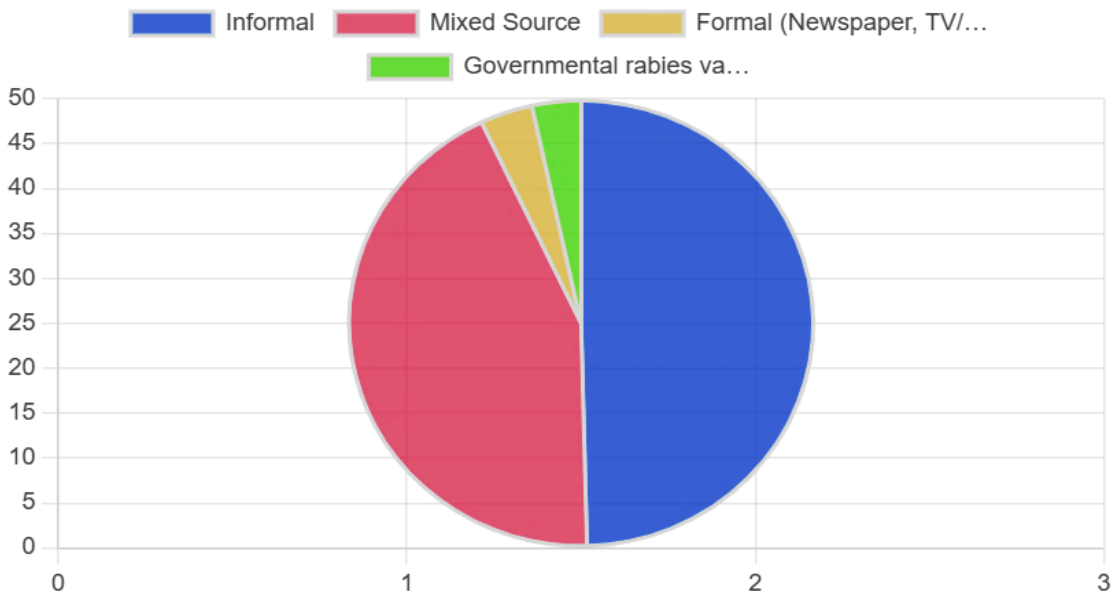

Figure 5: Sources of information on rabies

4.6.Treating bite wounds and bite history in the family

Just 23.7% of respondents said they would clean the lesion with soap and water as first aid after an animal bite before visiting the hospital (Figure 6). A little over 95.57% of respondents said they would get medical attention right away, 18.49% said they would

bandage the wound with traditional medicine, and 13.8% said they would drink holy water (Tsebel) or visit spiritual locations. 0.52% of other spontaneous reactions involve burning the wound.

Out of 384 respondents, 81 (21.09%) reported that one of their family members had been bitten by a dog in the last five years, of which 50 (13.02%) were male 31 (8.07%) of them were females. Out of 81 bitten people, 23 (5.99%) people were bitten by other person dogs, 19 (4.95%) were bitten by stray/free-roaming dogs, and 39(10.16%) person was by their own dog.

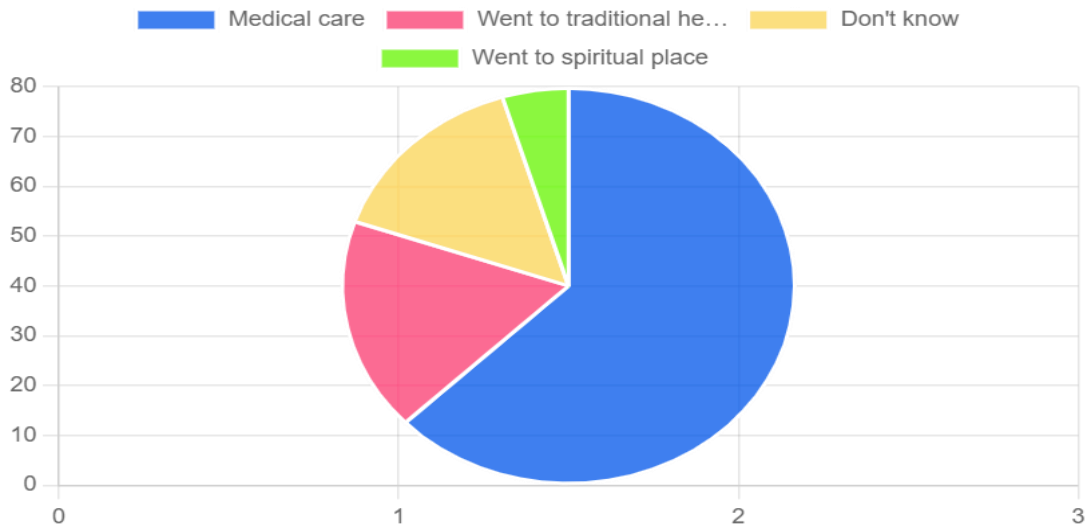

Figure 6: Different first aid measures and health-seeking behavior

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

As demonstrated by the respondent's knowledge, attitude, and practice about rabies in Table 6. 100% of respondents correctly identified rabies as a deadly illness, and 100% of respondents knew that the infection may spread to humans. 68 out of 384 respondents said they had experienced rabies signs in people. Out of 384 respondents, 287 indicated they were aware of the clinical sign in dogs, and almost 95% described the symptoms in animals. However, only 11.21% of respondents accurately described the symptoms of rabies in humans. Nearly 95.05% of participants accurately identified the various ways that rabies can

spread. Just 26.3% of participants knew of the human rabies vaccine that protects against dog bites, and 50.26% of respondents agreed with the statement that stray dogs can cause a problem for humans. Only 23.7% respondents describe wound washing as the first-aid measure that would be taken after a dog bite. About 90.62% of respondents correctly answer to the questions related rabies prevention measures, and 66.15% respondents responded to the question regarding action to be taken prevent rabies by restraining their dogs and 40.1% of the respondent believe that killing stray dogs will prevent rabies.

Table 6: Knowledge, attitude, and practice of the 384 respondents about rabies

Code	Knowledge question	Correct answer		Incorrect answer		Do not know	
		N	%	N	%	n	%
K1	Is rabies a transmissible disease to human?	384	100	-	-	-	-
K2	Dose rabies fatal disease in humans and animal?	384	100	-	-	-	-
K3	Which species of animals are a source of rabies to a human?	384	100	-	-	-	-
K4	What are the symptoms of rabies in the dog?	287	74.7	-	-	97	25.3
K5	What are the symptoms of rabies in humans?	68	17.7	-	-	-	-
K6	How rabies can be transmitted to humans?	384	100	-	-	-	-
K7	Do you know the rabies vaccine for humans that work Before a dog bite?	101	26.3	-	-	283	73.7
K8	At what age should dogs receive first dose of rabies vaccine?	75	19.53	194	50.52	115	29.95
	Attitude question						
A1	Do you think rabies can be cured once the animal shows the symptoms	208	54.17	14	3.65	162	42.19

A2	Do you think rabies can be cured once a person shows the symptoms	279	72.66	26	6.77	79	20.57
A3	Do you agree with the statement that stray dogs can cause a problem for human	193	50.26	191	49.74	-	-
	Practice question						
P1	How rabies can be prevented in dogs?	374	97.4	-	-	10	2.6
P2	As a first-aid measure, what would you do after a bite?	222	57.81	-	-	-	-
P3	Getting medical treatment after bite?	367	95.57	-	-	-	-

Where n= number of the respondent with correct answers and incorrect and do not know answers to each question, %= percentage.

4.8.The percentage of responders based on rabies KAP values

Table 7 displays the KAP levels related to rabies. On a scale of 0 to 9, the data indicated that 67.28% of the respondents had a moderate degree of knowledge (mean = 6.085, SD = 0.35). In terms of attitude ratings, the mean (3.672, standard deviation = 0.52) for 59.03% of respondents indicated an intermediate attitude toward rabies, which varied from 0 to 5. Comparably, 83.59% of participants fell into the middle category of suitable practices, which spans from 0 to 3 (mean = 2.51, SD = 0.27).

Variable	**Number of Question**	**Range Score**	**Total score (mean ±SD)**	**Level (%) *N*=384**		
				Don't know	**Incorrect**	**Correct**
Knowledge	8	0-9	6.085±0.35	16.12	16.6	67.28
Attitude	3	0-5	3.67±0.52	20.92	20.05	59.03
Practice	3	0-3	2.51±0.27	15.55	0.86	83.59

Table 7: The levels of KAP

4.8.1. Determinants of rabies knowledge

There was significant variation in the knowledge ratings among age groups, genders, jobs, and educational levels in this study. Using Pearson's Chi-square, the relationship between independent variables and rabies knowledge scores was determined. Age and knowledge scores had a strong correlation (x2= 5.3557 P= 0.021). The age group under 35 had higher knowledge scores (13.9%). Across all groups, the majority of responders possessed little expertise. In contrast to the other respondents, 21.7% of those who attended technical or higher school had greater percentages of proficient knowledge of rabies. With an 18.2% knowledge score, Employed/Professional received the highest rating. Furthermore, a statistically significant correlation (x2= 57.8564 P= 0.000) was found between the rabies information sources. Those that had a higher level of expertise were found to have mixed source of information about rabies as presented in table 8 below.

4.8.2. Attitude towards rabies

In this study, the majority 46.3% of respondents (Table 9), had a satisfactory attitude towards rabies. It found that there was no statistical association occurs between attitude scores and age, sex and occupation. A statistically significant association was observed among with Education status (x^2= 31.7199 P= 0.000), dog ownership (x^2= 14.0286, P= 0.001) and source of information (x^2= 91.5611 P= 0.000). The relationship between attitude scores and selected independent variables is summarized in (Table 9).

4.8.3. Practice towards Rabies

Practice scores toward rabies were classified as “low”, “moderate”, and “high” (Table 10). Practice scores were significantly associated with Occupation (x^2= 12.1737, P= 0.016), education (x^2=80.7554 P= 0.000) and the source of information (x^2= 23.6907, P= 0.000). This study revealed that respondents who attended higher education were more likely to have higher practice scores (40.6%) compared with others The respondents who had information about rabies through formal sources were more likely to have a higher percent of practice scores (59.3%) as compared with others as presented in table 8 below.

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

Variables	Category	No. (%)	χ^2	P-value
Sex	Male	269 (81.5%)	2.775	0.096
	Female	49 (90.7%)		
Age (year)	<35	251 (65.51%)	5.3557	0.021
	>35	133 (34.6%)		
Education status	No formal education	9 (2.34%)	10.9321	0.012
	Primary school	24 (6.25%)		
	Secondary school	107 (27.86%)		
	Technical/ university	244 (63.54%)		
Occupation	Student	33 (8.59%)	5.9850	0.050
	Unemployed	26 (6.77%)		
	Employed	325 (84.64%)		
Dog ownership	Yes	370 (96.35%)	3.0156	0.082
	No	14 (3.65%)		
Source of	Formal	27 (7.03%)		
information	Informal	190 (49.48%)	57.8564	0.000
	Mixed	167 (43.49%)		

Table 9: Relationship between rabies attitudes score among study participants

Variables	Category	Low No (%)	Moderate No (%)	High No (%)	χ^2	P-value
Sex	Male	121 (36.7%)	115 (34.8%)	94 (28.5%)	2.2397	0.326
	Female	25 (46.3%)	14 (25.9%)	15 (17.8%)		
Age (Year)	<35	101 (40.2%)	84 (33.5%)	66 (26.3%)	2.0572	0.358
	>35	45 (33.8%)	45 (33.8%)	43 (32.4%)		
Education Status	No formal Education	9 (100%)	-	-		
	Primary Education	17 (70.8%)	4 (16.7%)	3 (12.5%)	31.7199	0.000
	Secondary Education	44 (41.1%)	37 (34.6%)	26 (24.3%)		
	Technical / University	76 (31.1%)	88 (36.1%)	80 (32.8%)		
Occupation	Student	11 (33.3%)	12 (36.4%)	10 (30.3%)	4.1960	0.380
	Employed	12 (46.2%)	11 (42.3%)	3 (11.5%)		
	Un Employed	123 (37.8%)	106 (32.6%)	96 (29.6%)		
Dog Ownership	Yes	134 (36.2%)	128 (34.6%)	108 (29.2%)	14.0286	0.001
	No	12 (85.8%)	1 (7.1%)	1 (7.1%)		
Source of Information	Formal	5 (18.5%)	9 (33.3%)	13 (48.2%)	91.5611	0.000
	Informal	117 (61.6%)	44 (23.1%)	29 (15.3%)		
	Mixed	24 (14.4%)	76 (45.5%)	67 (40.1%)		

Table 10: Relationship between rabies preventive practice scores among study participants

Variables	Category	Low No (%)	Moderate No (%)	High No (%)	χ^2	P-value
Sex	Male	11 (3.3%)	195 (59.1%)	124(37.6%)	1.3524	0.509
	Female	3 (5.6%)	28 (51.8%)	23 (42.6%)		
Age (Year)	<35	12 (4.8%)	152 (60.5%)	87 (34.7%)	5.8120	0.055
	>35	2 (1.5%)	71 (53.4%)	60 (45.1%)		
Education Status	No formal Education	4 (44.5%)	3 (33.3%)	2 (22.2%)	80.7554	0.000
	Primary Education	6 (25%)	11 (45.8%)	7 (29.2%)		
	Secondary Education	2 (1.9%)	66 (61.7%)	39 (36.4%)		
	Technical / University	2 (0.8%)	143 (58.6%)	99 (40.6%)		
Occupation	Student	-	21 (63.6%)	12 (36.4%)	12.1737	0.016
	Unemployed	4 (15.4%)	12 (46.1%)	10 (38.5%)		
	Employed	10 (3.1%)	190 (58.5%)	125(38.4%)		
Dog Ownership	Yes	13 (3.5%)	214 (57.8%)	143(38.7%)	0.9418	0.624
	No	1 (7.1%)	9 (64.3%)	4 (28.6%)		
Source of Information	Formal	-	11 (40.7%)	16 (59.3%)	23.6907	0.000
	Informal	14 (7.4%)	118 (62.1%)	58 (30.5%)		
	Mixed	-	94 (56.3%)	73 (43.7%)		

4.9.KAP correlation

According to our data, there was a positive association between knowledge and practice ($P<0.05$) and knowledge and attitude ($P<0.01$) between the participant's knowledge and attitude scores and their practice scores.

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

Variables	**Knowledge**	**Attitude**	**Practice**
Knowledge	1		
Attitude	0.2931**	1	
Practice	0.1153*	0.1636	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.02 level (2-tailed).

4.10. Stray dog bites cases on humans from 2019-2023

A total of 2480 injuries caused by rabies-suspected animals were reported to EPHI between November 2019 and June 2023, translating to a mean yearly incidence of approximately 496 cases. According to this study, the age range of 5 to 55 was the most prevalent for dog bite victims. The age group of 55 and over had the fewest dog bite cases reported, and out of 2480 biting instances, 1140 were caused by stray dogs.

Figure 7: Stray dog biting case captured at EPHI

Table 12: Bites cases on humans from 2019-2023

Bite case	Year	Total	Stray
	2019	495	218
	2020	535	272
	2021	471	253
	2022	581	305
	2023	398	193
Bite case in	**sub city**	**Total Case**	**Selected case**
2021		471	
	Gulele		50
	Yeka		35
	Arada		28
2022		581	
	Gulele		79
	Yeka		42
	Arada		31
2023		398	
	Gulele		70
	Yeka		45
	Arada		33

4.11. Number of stray dog counting

This counting was done from January 10- April 8, 2024. The counting method was by using photo capturing method and by observation. In this study, male dogs were higher than female dogs. The total dog estimation of Gulele, Arada and Yeka sub cities had be estimate 1050,783, 1282 respectively.

Figure 8: *During estrus and rest time*

Table 13: The data that collect from deferent sub city

Sub city	Block	Number of stray dogs	Minimum Age	Maximum Age	Male	Female	Estimated number of dogs per each sub cities
Gulele	G1	63	3 months	10 years	887	163	1050
	G2	104	6 months	10 years			
	G3	107	2 months	12 years			
	G4	163	2 months	10 years			
	G5	53	1 year	10 years			
	G6	133	1 month	12 years			
	G7	155	1 year	12 years			
	G8	93	6 months	10 years			
	G9	53	1 month	7 years			
	G10	126	6 months	10 years			
Arada	A1	53	1 month	10 years	620	163	783
	A2	81	6 months	12 years			
	A3	84	6 months	10 years			
	A4	73	3 months	10 years			
	A5	88	1 year	12 years			
	A6	45	3 months	10 years			
	A7	103	1 month	12 years			
	A8	68	1 month	10 years			
	A9	86	3 months	10 years			
	A10	102	1 month	12 years			

Yeka	Y1	95	1 month	12 years	1023	259	1282
	Y2	103	6 months	7 years			
	Y3	105	3 months	10 years			
	Y4	108	6 months	12 years			
	Y5	111	1 month	10 years			
	Y6	121	3 months	10 years			
	Y7	102	1 month	12 years			
	Y8	116	6 months	10 years			
	Y9	110	1 month	10 years			
	Y10	113	6 months	11 years			
	Y11	105	3 months	12 years			
	Y12	93	3 months	12 years			

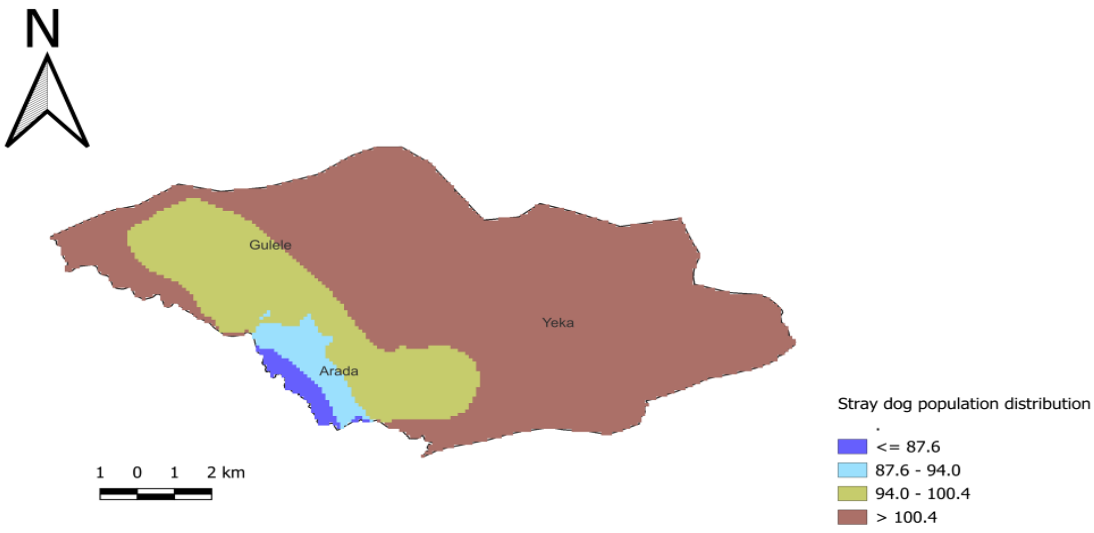

Figure 10:- Spatial distribution of stray dog at selected area

Table 14: Total dog count statistics (sum min max median mean SD se mean IQR) by (Area)

Area	Sum	Min	Max	p50	Mean	SD	Se (mean)	IQR
Arada	783	46	103	82	78.3	18.7738	5.936797	20
Gulele	1050	20	71	52.5	47.72727	14.40629	3.071431	27
Yeka	1282	76	97	85	85.25	6.770591	1.954501	11.5
Total	3115	20	103	63	64.90909	22.24997	3.35431	33.5

Table 14: Number of female doges, statistics (sum) by (Area)

Area	Number	n~fema~s
Arada	783	163
Gulele	1050	163
Yeka	1282	259
Total	3115	585

Arada ratio = 3.8:1, Gulele = 5.44:1 and Yeka = 3.94:1

Table 15: ANOVA test (one way)

	Summary of Total counted		
Area	**Mean**	**Std. dev.**	**Freq.**
Arada	78.3	18.7738	10
Gulele	47.727273	14.406288	22
Yeka	85.25	6.7705915	12
Total	64.909091	22.249973	44

Table 16: Analysis of variance

Source	SS	df	MS	F	Prob > F
Between groups	13252.9227	2	6626.46136	33.81	0.0000
Within groups	8034.71364	41	195.968625		
Total	21287.6364	43	495.061311		

Bartlett's equal-variances test: chi2 (2) = 9.1495 Prob>chi2 = 0.010

Table* 17*: *Tukey Multiple means comparison*

Total counted	Mean	Std. err.	Unadjusted [95% conf. interval]	
Arada	78.3	4.426834	69.35983	87.24017
Gulele	47.72727	2.984571	41.69981	53.75474
Yeka	85.25	4.041128	77.08878	93.41122

Total counted	Contrast	Std. err.	Tukey t	Tukey P>|t|	Tukey [95% conf. interval]	
Area						
Gulele vs Arada	-30.57273	5.338963	-5.73	0.000	-43.55522	-17.59023
Yeka vs Arada	6.95	5.993962	1.16	0.484	-7.625223	21.52522
Yeka vs Gulele	37.52273	5.023782	7.47	0.000	25.30664	49.73881

4.12. Stay dog Abnormality

In this study stray dog populations identified from the counted survey in study towns where different types of abnormality are acquired. As we seen in the figure 10 some are wounded, lameness, skin disease and eye disease.

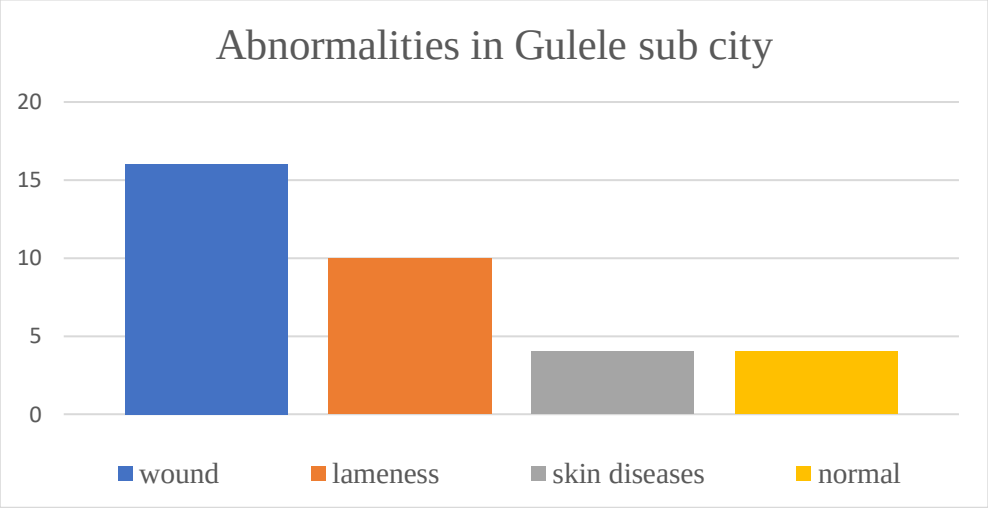

Figure 11: Stray dog abnormality at Gulele Sub city

Figure 12*: Skin and lameness abnormality*

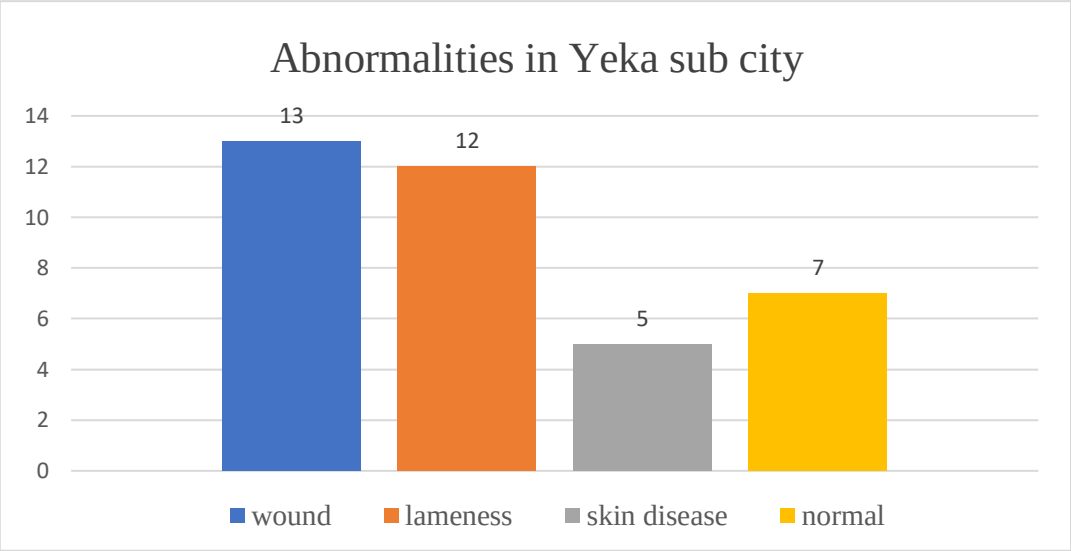

Figure 13: Abnormality in Yeka Sub city

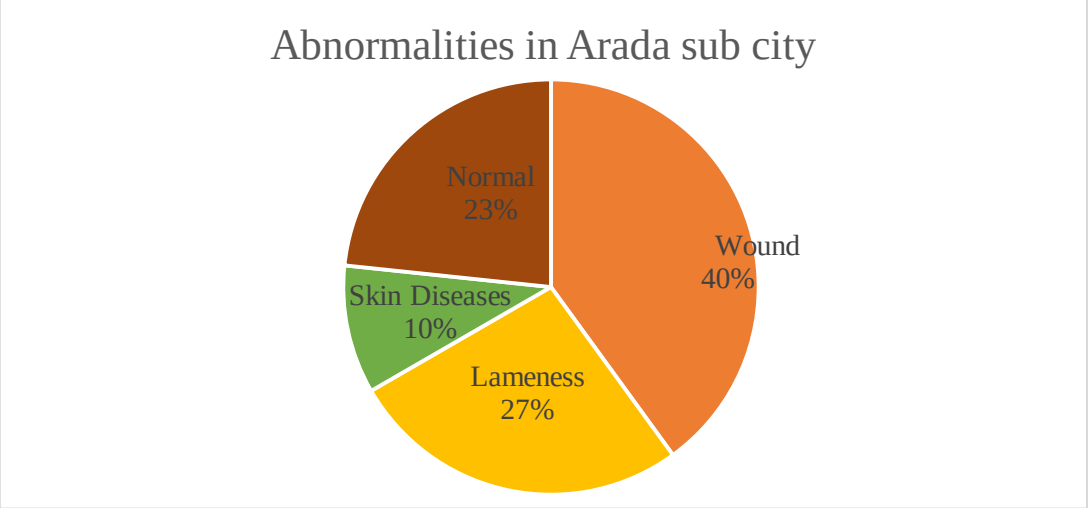

Figure 14: Stray dog Abnormality in Arada Sub city

5. DISCUSSION

5.1.Dog population and vaccination

Planning an efficient approach for controlling dog-borne zoonotic disease and managing the dog population requires an understanding of canine populations and demography. Determining dog demographics and population structure for rabies management plans was one of the study's objectives. In randomly selected households with at least one to five dogs, there were over 463 dogs registered (96.35%). In the sub city under research, 299 families (80.81%) had one dog, 53 households (14.32%) had two dogs, 15 households (4.05%) had three dogs, 2 households (0.54%) had four dogs, and 1 household (0.27%) had five dogs.

The number of entirely movement limited dogs (dogs confined inside the home) was larger than the number of partially restricted and free-living dogs in the research sub cities, according to the current questioner survey. Most of the dog-owning families surveyed in this survey (80.81%) had only one dog, most often a male (95.03%) and a local breed (57.14%) in the studied sub city. Dogs used to be home security. Given that most of the households surveyed kept dogs for this purpose, the preference seems to be related to guarding responsibilities.

Employed (84.64%), students (8.59%), and jobless (6.77%) are the groups most frequently represented by the dogs used to protect the interview; employed people make up 15.06%, unemployed people make up 3.84%, and students make up 24.24%. This was consistent with the observation that, among the dog-owning households surveyed for this survey, the majority of study locations had only one dog, usually a male of a local breed. Dogs used to be home security. Given that most of the households surveyed kept dogs for this purpose, the preference seems to be related to guarding responsibilities. There is a propensity in some nations, such Madagascar, Tanzania, and the Philippines, to retain dogs as security (Knobel *et al.*, 2008).

Male dogs scored higher than female dogs in this study. This was consistent with earlier research that was published (Margawani and Robertson, 1995), which stated that there are more male dogs than female dogs in the population of limited and free-roaming canines. This may be because male animals are kept as guard dogs and because female animals die more frequently during pregnancy and childbirth (Belo *et al.,* 2013).

Occupation and the initial knowledge of rabies acquired from individuals in the study area are related. A higher percentage of respondents to the questionnaire stated that they learned about the disease from their family and local community, while a lower percentage said they learned about it from school or other local health sources.

The World Health Organization's recommended vaccine coverage for canine rabies control is within reach, as indicated by the vaccination status survey, which indicates that 70.35% of dog owners had received the anti-rabies vaccine in the last 12 months. However, the study's figure is higher than what has been reported (De Balogh *et al.,* 1993; Kitala *et al.,* 2000; Ratsitorahina *et al.,* 2009; Van Sittert, *et al.,* 2010; Jonasson, 2014; Mbilo *et al.,* 2017; Mbilo *et al.,* 2019). The reported figures are 24% in the Congo, 59% in Malawi, 47.9% in Nigeria, and 0.5% in Chad, 56% in South Africa, 22% in Madagascar, 29% in Kenya, and 20% in Zambia.

Men household heads have given their dogs more vaccinations than women, with women outnumbering men by (OR=0.4947 and CI= 0.2047-1.078) and men having given their dogs more vaccination certificates than women (OR= 2.165). A logistic study based on the family's highest education level reveals that college or university degree and above have a statistically significant impact on a household dog's vaccination certificate. We saw the predominance of male dogs in our study, and the majority of the population prefers to own male dogs over female dogs because they believe the former to be more successful as security dogs. Studies have provided an explanation for why dogs in South Africa and Tanzania tend to be male (Knobel *et al.,* 2008; Conan *et al.,* 2015).

This is conceivable, in part, because most dog owners are prepared to cover the cost of private sector door-to-door vaccination campaigns. Each vaccinated dog cost between 400 and 800 ETB (5-8 USD) on average, depending on the exchange rate in effect at the time the study was conducted. However, few people regularly vaccinate their dogs at the facility. Dog

owners are typically reluctant to pay for their dogs' rabies vaccinations in the majority of African nations where the immunization is not free because they do not perceive any immediate financial or health benefits. The majority of humans who have been bitten did not receive the bite from their dogs, which lends credence to this (Jibat *et al.,* 2015).

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

By identifying behavioral patterns, cultural attitudes, and knowledge gaps, the KAP survey can be used to improve the generation of information aimed at controlling and preventing specific problems. It is also frequently utilized to improve practice, alter attitudes, and broaden community knowledge (Fabienne, 2009). This poll can provide insight on a number of factors that contribute to "bad" behavior, including the causes of particular attitudes and behaviors associated to rabies. In this study, 41.67% of respondents completed a degree program, while 15.36% obtained a diploma, 6.51% obtained a master's degree, 2.34 % did not complete any formal education, 6.25% completed primary school, and 27.86 % completed secondary school. These results are consistent with similar studies conducted in Rwanda (59%), Kenya (67%), Tanzania (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.

In Ethiopia, rabies is a serious public health concern. The importance of rabies in the studied area was demonstrated by the study's findings. According to the poll, there is a notable level of community awareness of the diseases. Every respondent, 100% of them, has heard of a sickness known locally as "Ebdwusha." Ethiopia and other places have reported comparable outcomes. For example, 98% of study participants in Gonder (Jemberu *et al.,* 2013), 95% in Tanzania (Sambo *et al.,* 2014), and 96.4% of study participants in Dessie (Gebeyaw and Teshome, 2019) had heard of rabies. Studies carried out in Asia have also revealed a greater degree of awareness: 94% in the Philippines (Davlin *et al.,* 2014), 93% in Thailand (Kongkaew *et al.,* 2004), and 93% in Cambodia (Lunney *et al*.2014). The community does not have a thorough understanding of rabies, despite their awareness of the disease. The investigation found numerous errors about the origin, mode, and causation of transmission.

All (100%) of respondents said that dogs that were infected were the source of disease transmission, whereas 65.1% said that dog bites were the source. Over 27.34% of dogs infected by wild animals and 1.56% of participants cited inadequate access to water and feed, prolonged drought exposure, and tainted feed as contributing factors to the illness. This theory is most likely explained by the theory held by asymptomatic rabies carrier dogs, which states that stressors like hunger and thirst might cause carrier dogs to develop clinical rabies (Wilde *et al.,* 2007). However, there is debate surrounding the concept of clinical rabies development (Jemberu *et al.,* 2013).

Dogs are the main source of human rabies deaths in many regions of the world, especially in Asia and Africa, where dog bites account for 85–95% of human rabies deaths (Assefa *et al.,* 2010; Fitzpatrick *et al.,* 2012). In addition to rabies in humans and wild animals, dogs were identified in this study as the primary cause of infection in the majority of fatal human cases. Livestock was cited as the second most prevalent source of human infection. According to Eshetu *et al.* (2002) and Gebeyaw and Teshome (2019), similar results were also obtained.

To identify suspected rabid animals in the community and take necessary action, such as notifying the veterinary service, the people must be informed of the signs of rabies. The majority of research participants accurately identified the signs of animal rabies. The study population's accurate description of rabies symptoms strongly suggests that the disease is prevalent in the study location. As is typical of the "dumb" or paralytic type of rabies, most responders indicated paralysis as a potential symptom. This could lead to the discovery of paralytic rabies cases. Only 8.1% of responders, however, accurately identified human rabies symptoms. The non-specific clinical presentation of human rabies can result in an incorrect diagnosis of the disease (Mbilo *et al.,* 2017).

When clinical symptoms appear, the death rate from rabies in both humans and domestic animals is around 100% (Digafe *et al.,* 2015). Human case fatality rates were found to be lower, according to study participants. The fact that 70% of respondents were ignorant that rabies worsens the condition and is lethal after symptoms appear is very alarming. Planning, carrying out, and assessing public awareness and rabies control activities will use these data as a baseline (Muriuki, 2016).

A large number of the responses showed a lack of thorough understanding of the prevention of sickness and the dangers of rabies. Prior to being brought to the hospital, wounds must be cleansed right away and cleaned with water and soap for 15 minutes, according WHO guidelines. It lessens the viral load and helps clean bite wounds of animal saliva (WHO, 2013). It was discovered that most of the participants lacked knowledge regarding the significance of promptly cleaning the wound with soap and water. Of those surveyed, just 23.7% are aware of the first aid protocols that ought to be followed following an animal bite. Research conducted in Pakistan, India, South Africa, Tanzania, Uganda, and Chad. Additionally, it revealed that a small percentage of persons in rabies-endemic areas cleanse their wounds with soap and water (Chhabra *et al.,* 2004; Fevre *et al.,* 2005; Ichhpujani *et al.*, 2008; Sambo, 2012; Hergert and Nel, 2013; Mbilo *et al.,* 2017).

Nearly all of the study's participants 90.6% were aware that rabies can be contracted from both humans and animals through dog vaccine. The prevention of rabies also includes restraining dogs, euthanizing stray dogs, keeping dogs from malnutrition, drought, or contact with wild animals. The research participants exhibited a satisfactory degree of practice about preventive measures against rabies.

When it comes to spreading knowledge, neighbors, friends, family, and school are more important than veterinary clinics, health centers, and the media. According to these results, the majority of respondents said they had learned anything about rabies from unofficial sources. According to research in Côte d'Ivoire (*Tiembre et al.,* 2008), 88.6% of participants said their primary source of information on rabies was their school. Of the participants, 82.9% knew about the disease. This highlights the critical role those educational institutions play in raising public knowledge about rabies. Information was not widely distributed by the veterinary and medical services. A significant number of responders would kill an animal if they feared it had rabies, but very few would report the animal to a veterinarian. Comparable results were also documented in Dessie (Gebeyaw and Teshome, 2019). in Congo (Mbilo *et al.,* 2019) and Kenya (Muriuki, 2016). A positive link between knowledge and attitude and knowledge and practice scores was found by the correlation analysis's results. This implies that a positive attitude and proactive approach to rabies prevention are correlated with a solid understanding of the disease.

5.3.Dog counting

Dog counting is helpful for vaccination campaigns. The total number of dogs tallied was determined by dividing the number of dogs counted by the total number of blocks on the town map, which was based on a guideline from the World Society for the Protection of Animals (WSPA). It was said that estimating the quantity of roaming dogs per unit area within the sample blocks and multiplying the result by the city's area would result in a biased estimate and is not advised.

It was said that estimating the quantity of roaming dogs per unit area within the sample blocks and multiplying the result by the city's area would result in a biased estimate and is not advised. The total estimated dog population in Bishoftu town was 4188, with an interval of 3222 to 5254 dogs. The total estimated dog population in Modjo town was 1619, with an interval of 945 to 2293 dogs. The total estimated dog population in Dukem town was 944, with an interval of 639 to 1248 dogs. The total estimated dog population in the study towns was 6733, with an interval of 5694 to 7791 dogs. Based on these estimates, we can prepare enough vaccine for those study towns so that at least 70% to 100% of the population is vaccinated the next time (Tegegne and Mengesha , 2022).

In Addis Ababa the total stray dog population statues is unknown. In this study by using the photo capture method the total stray dog counting is done in 3 sub city (Gulele, Yeka and Arada) the result will be 1050,783, 1282 respectively. The dogs were found in different area of the sub city like garbage, on road side, Butchery shop side, market, River side, and with homeless peoples.

However, the simple method used in this survey was adequate to provide an initial estimate of the ownerless dog population at urban sites, and was appropriate given the limited time period for dog counting (two days at each woreda) that could complete. In this study stray dog population identified from the counted survey in study site were higher than the estimates from photo recapture.

The total count statistic of the study area sum is 2856; mean 64.90, 22.24 SD, 20 Max, 103 Min and p50 63. The number of female dogs in the selected area was 163,163 and 259 Arada, Gulele and Yeka respectively. The total female stray dogs were 585. So, the large female dogs were found that is more birth or reproduction will be expected if they are fertile.

In this study pairs wise comparison of mean with equal variance at the selected study area was done so the result will be Gulele Vs Arada 30.57 contrast, 5.33 SD and P>0.000. Yeka Vs Arada 6.95 contrast, 5.99 SD and P> 0.484. Yeka Vs Gulele show that 37.52 contrast, 5.02 SD and P> 0.000. The result shows that there is significant difference in the study area of Gulele Vs Arada and Yeka Vs Gulele.

Dogs who have been strayed have numerous management issues. The management of stray dogs cannot be limited to sheltering alone due to the high cost of providing food, treating illnesses, yearly vaccinations and dewormings, and suitable quarantines, among other necessities. In this sense, the demands for managing stray dogs will always exceed the amount of money and resources available (Lyu, 2015).

A number of things need to be taken into account in order to solve the ethical problems and wellbeing of stray animals, including food, shelter, medical attention, and occasionally, human connection. By giving the animals the care they require, the caregivers are supposed to demonstrate compassion and moral consideration (Levy, 2002). This study examined a wide range of anomalies in stray dogs were experienced. For example, the most prevalent conditions in the areas chosen are lameness, skin diseases, eye issues, and wounds. These demonstrate the necessity for more animal welfare intentions toward stray dogs.

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6. CONCLUSION AND RECOMMENDATIONS

According to the study, there is a comparatively high prevalence of dog-to-household and dog-to-human ratios which may serve as high prevalence of rabies and other dog-related zoonoses that are linked to intimate contact between dogs and humans. Even though most of respondents answer as they vaccinate their dogs only 163 (42.45%) owners were able to present a vaccination certificate as proof of their immunization. In the meantime, 104 (27.08%) respondents have never vaccinated their dogs. Lack of knowledge (72.4%) was the most frequent cause of non-vaccinating a dog. However, the expense of the rabies vaccination accounts for 49.48% of households' response followed with 26.22% of respondents citing incapacity to manage their dog. According to an assessment of their knowledge of rabies and its zoonotic features, all of them are 100% aware of the virus. In the region, rabies is a well-known illness that is acknowledged as a serious public health concern. Even so, the results of this study demonstrate that while the population of owned dogs is vaccinated, a lack of knowledge about diseases may have detrimental effects on the neighborhood. The results of the KAP survey showed that most respondents had a reasonable level of knowledge of rabies and prevention techniques in addition to a moderate level of knowledge and attitude toward rabies. Although vaccination rates have above the WHO recommended threshold, the number of dog bite incidents is continuously rising. Drawing from the present research, there is a huge stray dog population requires immediate solutions to manage their population. Retrospective data revealed that stray dogs are a major contributing factor in bite cases. This is the main reason why rabies cases are rising. As part of a program to lessen the possibility of a potential rabies invasion getting established, dog owners in Arada, Yeka, and Gulele's population need to be educated about the control and management of their pets.

Therefore, the following recommendations are forwarded:

- A well-planned and well-executed community awareness program is highly recommended using radio, TV, and newspapers.
- Vaccination program should include stray dog vaccination.
- The inclusion of rabies in school curricula is crucial.

- ❖ Cooperation between Public health officials, environmental protection authority and veterinary services should in place
- ❖ Further studies needed to be done on stray dog contribution of rabies occurrence, country wide population and demography study should be implemented

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8. **ANNEXS**

Annex I: KAP scoring procedures

a) Knowledge questions

Questions	Answer	score	Overall score
K1. Is rabies a transmissible disease to human?	Correctly answered rabies caused by a virus	1	1
	Don't know /wrong answer	0	
K2. Dose rabies fatal disease in humans and animal?	Yes	1	1
	No, /don't know the answer	0	
K3. Which species of animals is a source of rabies to a human?	Who mentioned 3 and more	2	3
	Who mentioned 1 or 2	1	
	Don't know /wrong answer	0	
K4. What are the symptoms of rabies in the dog?	Who mentioned 3 and more	2	3
	Who mentioned 1 or 2	1	
	Don't know /wrong answer	0	
K5. What are the symptoms of rabies in humans?	Who mentioned 3 and more animals	2	3
	Who mentioned 1 or 2 animals	1	
	Don't know /wrong answer	0	
K6. How rabies can be transmitted to humans?	Who mentioned 3 and more symptoms	2	3
	Who mentioned 1 or 2 symptoms	1	
	Don't know /wrong answer	0	
	No	0	

K7. Do you know the rabies vaccine for humans that work Before a dog bite?	Yes	1	1
	No	0	
K8. At what age should dogs receive first dose of rabies vaccine?			
Overall knowledge score			15

b) Attitude questions

Questions	Answer	score	Overall score
A1. Do you think rabies can be cured once the animal shows 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	
Overall attitude score			3

c) Practice questions

Questions	Answer	core	verall core
P1. How can rabies be prevented in dogs?	Who mentioned the dog vaccination restrain dogs and killing stray dogs	3	5
	Restrain dogs and killing a stray dog	2	
	n dogs	1	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	6
	Who claimed to seek medical	2	
	Who claimed applies alcohol	1	
	aimed to do noting	0	
P3. Getting medical treatment after bite?	yes		
	no		
Overall practice score			12

Annex II: Questioners

Dog demography and zoonosis Urban dog demography

General characteristics

Instruction for the interviewer (read before starting and explains 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).

1. Consent received from respondent?
   ◯ Yes ◯ no
2. Date and time interview starts? _____
3. GPS location? _____

Demographic Data

1. Respondent's address_____
2. Respondent's name _____
3. Respondents phone number? _____
4. Name of sub city?
   ◯ Yeka
   ◯ Gullele
   ◯ Arada
5. Name of village?_____
6. Sex of respondents?
   ◯ Male
   ◯ Female
7. Age of the respondent?_____
8. Education status of the respondent?
   ◯ No formal education ◯ Primary school
   ◯ Secondary school ◯ Diploma
   ◯ Degree ◯ Masters and above
9. Religion?
   ◯ Orthodox ◯ Muslim ◯ catholic
   ◯ Don't mention ◯ protestant

10. Occupation?

◯ government employee ◯ private business ◯ NGO
◯ Pensioner ◯ student ◯ house maid

11. How many people are living in the same house and sharing meal in your household?
12. How many children (less than 10years) have?
13. Dog ownership information and demography do you own dog?

◯ Yes ◯ No

Interview questions for households with dog

1. How many dog/-s belong to the household?
2. Number of male dogs? _____
3. Number of female dogs? _____
4. How many are adult dogs greater than 6 months? _____
5. How many are puppies (younger than six months)? _____
6. Housing system of the dog?

☐ Specially constructed house/cage
☐ On house passage way/corridor
☐ Anywhere on the premises

7. What is the breed of your dog

☐ local breed ☐ cross breed ☐ exotic breed

8. From where did you get the dog/-s?

☐ Own bitch ☐ brought ☐ gift ☐ road side

9. What is the purpose of keeping dog?

☐ Protection/guard
☐ Sale/breeding
☐ Hobby
☐ Love and affection/pet

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

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

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

    ◯ Yes ◯ No

12. Dog was any vaccine campaign in your area in the last 3 years?

    ◯ Yes ◯ No

13. Is your dog vaccinated against rabies?

    ◯ Yes ◯ No

◯ If the answer is no for the above question what is the reason the dog has not vaccinated?

- ☐ Distance to veterinary clinic/ no near vet clinic
- ☐ The dog not up to vaccinated age
- ☐ Didn't know where to find the vaccine
- ☐ Lack of information
- ☐ Cost of the vaccination
- ☐ Unable to handle the dog
- ☐ Feared that the dog might change its behavior after vaccination

14. Why you vaccinate your dog?

- ☐ Prevention of rabies
- ☐ Prevention of other disease
- ☐ Don't know

15. Can we see the certificate?

    ◯ yes ◯ no

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

Stray dog information

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

    ◯ yes ◯ no

18. Does the presence of stray dogs affect you and/or your family in the area you live in?

    ◯ Yes ◯ No

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

    ◯ Agree

◯ Don’t agree

20. How can rabies be prevented in dog?

☐ Vaccination of dog

☐ Prevent dog from wild animal contact ☐ killing stray dogs

☐ Prevent dog from long draught ☐ restraining of dogs

☐ Giving appropriate feed and water

☐ 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?

◯ Yes ◯ No

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

☐ Drinking traditional medicine

☐ Visit traditional healers

☐ Clean and flush the wound with soap and water for 15 minutes

☐ Applies traditional medicine

☐ Getting medical care

☐ Burning the wound

☐ Applied alcohol and lemon ☐ Visit a veterinarian

☐ Go to spiritual places ☐ Don't do anything

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

◯ Yes ◯ No ◯ Don’t know

25. How many case that has happened? _____

26. Gender of the victim?

Male female

27. Types of dog bite the victim?

Own dog stray

28. What action was taken after bite?

- Medical care
- Went to traditional healer
- Went to spiritual place
- Don’t know

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

Survived death

30. How rabies can be transmitted to dog?

- bite
- From another dog
- From wild animal
- Water and food shortage/long drought
- Contamination/food

Respondent knowledge about rabies

1. Have you ever got training about rabies?

Yes no

2. Is rabies transmissible disease to human?

Yes no

3. Do you think rabies is fatal disease?

Yes no

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

- Dogs
- Human
- Livestock
- Wild animals
- Don’t know

5. How rabies can be transmitted to dog?

- Bite
- From another dog
- from wild animal
- Water and food shortage/long drought
- contamination/food

6. How rabies can be transmitted to dog?

- ◯ Bite
- ◯ From another dog
- ◯ from wild animal
- ◯ Water and food shortage/long drought
- ◯ food contamination
- ◯ Don't know

7. Have you seen rabid animal?

- ◯ Yes
- ◯ no

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

- ◯ Yes
- ◯ no

9. Can you tell us symptoms of rabies in dog?_____

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

- ◯ Yes
- ◯ No
- ◯ Don't know

11. What do you do if the dog shows the symptom?

- ◯ Killing the animal
- ◯ Feeding an appropriate diet
- ◯ Report to veterinarian
- ◯ Don't know

12. How rabies can be transmitted to human?

- ◯ Dog bite
- ◯ Eating raw meat
- ◯ Drinking raw milk
- ◯ Blood contact
- ◯ Saliva through broken skin
- ◯ Contact unspecific with dog
- ◯ Wind/air
- ◯ Don't know

13. Have you seen rabid human?

- ◯ Yes
- ◯ No

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

- ◯ The dog bark inside the abdomen
- ◯ Confusion/agitation
- ◯ Muscle paralysis o headache
- ◯ Fever
- ◯ Abnormal behavior
- ◯ Mad o act like a dog
- ◯ Paralysis o insomnia
- ◯ Hydrophobia (fear of water)
- ◯ Don't know the symptoms

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

    ◯ Yes

    ◯ No

    ◯ Don’t know

16. Have you heard of rabies?

    ◯ Yes ◯ No

Attitude of respondent against rabies

1. Can you tell us a disease that can transmit between dogs and humans?
2. Have you heard of rabies?

    ◯ Yes ◯ No

    ◯ Formal (newspaper, tv/radio)

    ◯ Informal

    ◯ Mixed source

    ◯ Governmental rabies vaccine campaigns