JIMMA UNIVERSITY

COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

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INVESTIGATION OF KNOWLEDGE, ATTITUDE AND PRACTICE (KAP); AND BURDEN OF RABIES IN GIMBI AND NEJO DISTRICTS OF WEST WOLLEGA ZONE, WESTERN ETHIOPIA

MSc. THESIS

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DERARA BIRASA

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INVESTIGATION OF KNOWLEDGE, ATTITUDE AND PRACTICE (KAP); AND BURDEN OF RABIES IN GIMBI AND NEJO DISTRICTS OF WEST WOLLEGA ZONE, WESTERN ETHIOPIA

Msc. Thesis

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Advisor: Dr. Feyissa Begna (DVM, Msc, Asso. Professor)

Co-advisor: Professor Tadele Tolosa (DVM, PHD)

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Name of student: **Derara Birasa Jigi** **ID No: RM 1160/10**

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I have incorporated the suggestion and modification given during the internal thesis defense and got the approval of my advisers. Hence, I hereby kindly request the department to allow me to submit my thesis for external thesis defense.

Derara Birasa ______________ ____________________

Name of student signature Date

We, the thesis advisers, have verified that the student has incorporated the suggestions and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

Major advisor:

Dr. Feyissa Begna (DVM, MSc, Asso. Prof.) __________________ _______/____/_____

Name Signature Date

Co-advisors:

Professor Tadele Tolosa (DVM, Msc, PhD) _________________ _____/____/_____

Name Signature Date

Decision/suggestion of Department Graduate Council (DGC)

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Chair Person, DGC Signature Date

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Chair Person, CGS Signature Date

DEDICATION

This thesis is dedicated to all the victims of rabies in the world, may there be no more. May the finding of this thesis help in preventing this neglected and fatal zoonosis.

STATEMENT OF THE AUTHOR

Apart from the assistance stated in the acknowledgement and where reference is made in the text, I declare that this thesis represents the original work of the author and all sources of materials that were used for the preparation of this thesis have been duly acknowledged. I certify that this thesis has not been submitted for any other degree or qualification at any other university or institution.

Name of the author: Derara Birasa

Date ___________________________

Signature _________________________

BIOGRAPHICAL SKETCH

Dr. Derara was born in 1989 G.C from his father Birasa Jigi and his mother Alemnesh Dinagde in Nejo District, West Wollega Zone, Oromia Regional state, Ethiopia. He attended his primary education at Wakgari Buna elementary school up to grade eight and secondary education at Nejo Senior secondary and preparatory school, Nejo District. After the successful completion of his education from preparatory school, he joined Jimma University, College of Agriculture and Veterinary Medicine, school of veterinary medicine in 2008 G.C and graduated with the award of Doctor of Veterinary medicine (DVM) degree in June, 2012. After his graduation, he was employed at Nejo District livestock development and fishery office and served up to 2016. Then, in 2017, he has changed his work place to Leta Sibu District, west wollega zone and served until he obtained an opportunity to undertake his training in September, 2017/2018, by joining Jimma University, College of Agriculture and Veterinary Medicine, School of veterinary medicine to pursue his Master of science in Veterinary Epidemiology.

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LIST OF ABVERIVIATONS

ABLV	Australian Bat Lyssa Virus
AE	Adverse Events
ARAV	Aravan Virus
CCS	Critical Community Size
CDC	Center for Disease Control and Prevention
CNS	Central Nervous System
DALYs	Disable-Adjusted Life Years
DFAT	Direct Fluorescent Antibody Test
DRIT	Direct Rapid Neuro Immunohistochemistry Test
DUVV	Duvenhage Virus
EBLV-1	European Bat Lyssa Virus-1
EBLV-2	European Bat Lyssa Virus-2
FAT	Fluorescent Antibody Test
GDP	Growth Domestic Product
GWAO	Gimbi Woreda Agriculture Office
GWLFRO	Gimbi Woreda Lifestock and Fishery Resource Office
ICTV	International Committee on Taxonomy of Viruses
ID	Intradermal
IM	Intramuscular
JUCAVM	Jimma University College of Agriculture and Veterinary Medicine
KAP	Knowledge, Attitude and Practice
KHUV	Khujand Virus
LBV	Lagos Bat Virus
MOKV	Mokola Virus
NTVs	Nerve Tissue Vaccines
NWAO	Nejo Woreda Agriculture Office
NWLFRO	Nejo Woreda Lifestock and Fishery Resource Office
PAs	Peasant Associations
PEP	Post Exposure Prophylaxis
RABV	Rabies Virus
RIG	Rabies Immunoglobulin
RNP	Packaged Ribo Nucleocapsid
RT-PCR	Reverse Transcription- Polymerase Chain Reaction
SHIBV	Shimoni Bat Virus
TCIT	Tissue Culture Infection Technique
USD	United State Dollar
WCBV	West Caucasian Bat Virus
WHO	World Health Organization
YLD	Years of Life Lived with Disability
YLL	Years of Life Lost

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ABSTRACT

Rabies is a fatal viral zoonotic disease largely transmitted by bites of infected dogs, results in a large economic and public health burden in rabies endemic areas. A cross-sectional and retrospective study was conducted between November, 2018 to August, 2019 to investigate the Knowledge, Attitude and Practice (KAP); and economic and public health burden of rabies in Gimbi and Nejo districts. For KAP assessment, Peasant associations (PAs) were randomly selected using a lottery method based on proportional allocations of PAs per districts, followed by selection of households from each PAs using systematic random sampling. The KAP score was done to rank the level of KAP of the people as good, moderate and poor based on proportion of questions they answered. The strength of association between KAP scores and predictor variables was determined using multinomial Odds ratio. To quantify the economic and health burden of rabies, a one year data (2017-2018) were collected from both district's general Hospitals. After identifying the registered victims from Hospitals, the victims were followed and tracked for further information and the nest victims were identified using snowball method. Economic loss estimation was based on costs related to PEP, dog vaccination and control and surveillance and livestock death; whereas human health burden was estimated based on DALYs. Of 150 households interviewed, all were heard of rabies previously. About 42.7% (95% CI: 0.35-0.51), 40 %(95% CI: 0.32-0.48) and 63.3% (95% CI: 0.56-0.71) had good knowledge, poor attitude and poor practice about rabies, respectively. Respondents with primary levels of education had 0.05 times less likely a good knowledge compared to tertiary levels (OR=0.053). Males had 8.8 times more likely a moderate knowledge compared to females (OR=8.8), married respondents had 0.41 times less likely a moderate knowledge than unmarried (OR=0.41) and respondents with primary levels of education had 0.05 times less likely a moderate knowledge than tertiatry levels (OR=0.05). The probability of having a good attitude was higher in respondents having tertiary levels of education (OR= 36.9) and health professionals (OR=15.49). Female had 0.2 times less likely a moderate attitude than males (OR=0.2) and Muslims had 17.2 more likely a moderate attitude than orthodox (OR=17.2) respondents. Having tertiary levels of education (OR= 2.9) and being health professional (OR= 15.38) had a higher effect on having a good practice compared to non-formal and farmers. From 63 bite victims interviewed, 71.5% were from dog bites. Statistically significant variation was observed between residence area (χ^2=4.2, P=0.041) and age (χ^2=8.511, P=0.037) of the victims on their rabies or rabies suspected exposure. Of the 63 bite victims, three were died from rabies, resulting in 131.12 DALYs. The estimated economic burden of rabies for a period of one year was 28,513.82 US$, which was a big economic loss for these districts. Generally, rabies is familiar in Gimbi and Nejo districts causing large economic and public health burden to the communities. Hence, further community based health education is needed to raise accurate knowledge and to improve the peoples' attitude and practice toward rabies. Moreover, regular dog vaccination and other appropriate preventive measures are better to be implemented to reduce the public health and economic burden from rabies.

Key words: *Cross-sectional, DALYs, Economic, Gimbi, Health burden, KAP, Nejo, Rabies, Retrospective*

1. INTRODUCTION

Rabies is a fatal zoonosis caused by negative-stranded RNA virus of the genus *Lyssavirus* and family Rhabdoviridae that affects the central nervous system. The disease causes encephalitis and ultimate death in all warm-blooded animals including humans (Kaplin *et al.,* 1986; Wunner, 2007). The virus is mainly transmitted through the bite of a rabid animal of which domestic dogs are known to possess the vast majority (99%) of human deaths worldwide (Knobel *et al.,* 2005). Despite development of the first vaccine against rabies by Louis Pasteur in 1885, rabies remains a neglected viral zoonosis and causes a potential threat to more than 3.3 billion people in the world (WHO, 2010; Knobel *et al.,* 2005). The most recent assessment estimates 70,000 human deaths from rabies each year in the world with most deaths occurring in Asia and Africa (Hampson *et al.,* 2011). Of these African countries, Ethiopia is one of the worst affected countries with domestic dogs being the major sources of the infection to humans (Wunner and Jackson, 2010).

Rabies is an important disease that has been recognized for many years in Ethiopia (Alie *et al.,* 2015). Although the true number of deaths caused by rabies is unknown in Ethiopia because of under reporting, each year thousands of people are infected with rabies and an estimated 2,700 people die, which is one of the highest rabies death rates in the world (CDC, 2017). This might be linked to the presence of massive stray dog populations and the anti-rabies dog vaccination is limited to a small number of dogs found in urban settings in general (Ali *et al.,* 2010). The large dog population size, particularly massive dogs in rural areas in combination with poor dog management contribute to a high endemicity of canine rabies in Ethiopia (Yimer *et al.,* 2002). Currently, sufficient countrywide data on rabies are not available to reveal the actual magnitude of the problem in Ethiopia. However, the distribution of vaccine to the various regions and the fragmented reports on human and animal rabies cases are strong indicators of the widespread nature of the disease in the country (Abdela *et al*., 2017).

Rabies represents a significant economic burden and public health importance to society in rabies endemic countries (Knobel *et al.,* 2005). It has been estimated that globally ≥15 million people receive rabies prophylaxis annually, the majority of which live in China and India. The annual global expenditure for rabies prevention was estimated to exceed US$ 1 billion in 2005 (WHO, 2010). In Africa and Asia, the estimated annual cost of rabies is US$ 583.5 million, where the patient-borne costs for PEP form the bulk of expenditure, accounting for nearly half the total costs of rabies (Knobel *et al.,* 2005). The total cost in PEP (direct and indirect expenses) has been estimated to be equivalent to 5.8% of the annual per capita gross national income in Africa (US$ 40 per human treatment) and 3.9% (US$ 49 per human treatment) in Asia (Knobel *et al.,* 2005). In addition, the total cost of dog rabies control has been estimated to be US$ 86.7 million per year (US$ 9.7 million in Africa and US$ 77.0 million in Asia) while the annual cost of surveillance and livestock loss has been estimated at US$ 0.12 million and US$ 12.3 million, respectively (Knobel *et al.,* 2005). Despite rabies has a significant economic impact in developing World (Africa and Asia), no adequate research has been done to address the real magnitude of the disease, particularly in Ethiopia.

On the side of public health burden, deaths due to rabies are responsible for a loss of 3.7 million DALYs per year and about 8.6 billion USD of economic losses mainly due to premature deaths (productivity losses) and post-exposure treatment (PET) costs (Hampson, 2015). The burden of rabies is influenced by age-related and socio-economic factors. Rabies is most commonly reported in children below 15 years of age and in poor and low income people that have no access to treatment facilities (Pancharoen *et al.,* 2001; Cleave land *et al.,* 2002; Knobel *et al.,* 2005; Knobel *et al.,* 2007). Although canine rabies virus is highly devastating disease, its impacts through public health burden and economic costs are poorly known (WHO, 2013). This holds true mostly for sub-Saharan Africa countries, in particular Ethiopia, which may need further research to put the expected magnitude of health burden of rabies to prioritize and give due attention for the health burden of the disease

The major challenge faced to estimate the burden of rabies in appropriate way is the absence of reliable surveillance data for areas where the disease is most prevalent. Basic information on how many lives are lost due to rabies and the economic costs of preventing disease amongst those exposed are needed to advocate for sustainable control programmes. However, official reporting of incidence data on rabies and rabies exposures remains desperately poor in most canine rabies-endemic countries and is increasingly recognized to grossly underestimate the true number of cases (Cleaveland *et al.,* 2002; Deressa *et al.,* 2010). Although rabies virus has a vast public health burden and economic significance in developing countries like Ethiopia, the reliability of reported incidence data is expected to differ among the regions in Ethiopia due to geographical and cultural differences. For instance, in rural Ethiopia, individuals who are exposed to rabies often prefer to see traditional healers for the diagnosis and treatment of the disease because of cultural influences, lack of knowledge or limited accessibility to medical treatment. These widespread traditional practices of handling rabies cases might interfere with medical treatment seeking practice, resulting in an under reporting of the actual number of rabies cases and its related public health burden and economic importance (Beyene *et al*., 2018).

Knowledge, attitudes and practices (KAP) studies have been widely used around the world for different applications in public health based on the principle that increasing knowledge will result in changing attitudes and practices to minimize disease burden (Mascie *et al.,* 2003). However, reliable data on rabies, its perception and associated practices are scarce in many parts of the world, making it difficult to assess its real impact on human and animal health (Tandon *et al.,* 2017). Poor public awareness towards rabies is considered as one of the bottle necks for the prevention and control of the disease in Ethiopia. Understanding communities' perceptions of causes, mode of transmission, symptoms, treatment and possible intervention measures of rabies are important steps toward developing strategies aimed at controlling the disease, and determining implementation of planned activities in the future (Ali *et al.,* 2015).

Even though rabies is endemic in Ethiopia (Ali *et al.,* 2015) and street dogs are highly populated particularly in West Wollega zone, no research has been done yet to estimate the disease burden and its associated economic loss. Therefore, the motivation behind the present study is the need to provide baseline data on knowledge gaps through assessing the current status of rabies in west Wollega zone of selected districts, Gimbi and Nejo, by estimating public health and economic burdens of rabies using registered data from the hospitals, interviewing the victims to obtain relevant information, and assessing the Knowledge, Attitude and Practice (KAP) of the people toward rabies through community Survey.

1.1. Statement of the problem

Vertebrate animal bites, in which dog bites possessed a higher amount (99%), are a significant public health concern globally and mostly in developing countries (Knobel *et al.,* 2007). The global burden of rabies impacts on public health sector budgets, local communities and livestock economies with the highest risk in the poorest regions of the world was estimated approximately 59,000 human deaths, over 3.7 million disability-adjusted life years (DALYs) and 8.6 billion USD economic losses annually (Knobel *et al.,* 2005). The largest component of the economic burden is due to premature death, followed by direct costs of post-exposure prophylaxis (PEP) and lost income whilst seeking PEP, costs to the veterinary sector due to dog vaccination and additional costs to communities from livestock losses (Hampson *et al.,* 2015).

Rabies is responsible for the loss of approximately over 24, 000 life-years in Sub-Saharan Africa annually, predominantly among children (WHO, 2013), and more than 99% of human rabies cases results from exposure to rabid dogs. To assess the societal costs of rabies related to livestock, the reliable data that shows incidence in livestock is great importance. However, widespread under reporting of rabies in developing countries, including cases in livestock is a major obstacle to understand the true impact of the disease (Vos *et al.,* 2014).

In Ethiopia, Extrapolation of the districts (Bishoftu, Lemuna-bilbilo and Yabelo) at national level indicated annual estimate of approximately 3,000 human deaths resulting in about 194,000 DALYs per year and 97,000 exposed persons requiring on average 2 million USD treatment costs per year country wide (Beyene *et al.,* 2018). Understanding community knowledge, attitudes and practice(KAP) about rabies is important because of their influence on post-exposure treatment seeking behavior and community support is essential for rabies prevention and control programme (Tenziz *et al.,* 2012). However, there is lack of accurate quantitative information on rabies both in humans and animals and little is known on the awareness of the people about the disease to apply effective control measures in Ethiopia, which holds true in case of present study. Furthermore, public health and economic burden of rabies is not yet estimated in Gimbi and Nejo districts of West Wollega Zone. To address this issue, the ultimate goal of the present study is to assess the KAP of the people toward rabies and estimate the public health and economic burden associated with rabies in the study area.

1.2. Objectives of the study

1.2.1. Specific objectives

- To assess the Knowledge, Attitude and Practice (KAP) of the people toward rabies in Gimbi and Nejo districts
- To Estimate public health and economic burden of rabies in Gimbi and Nejo districts of West Wollega zones

2. LITERATURE REVIEW

2.1. Historical prospective of rabies

Rabies has been recognized as a disease of dog and man since ancient times. The Latin word 'rabies' is derived from an old Sanskrit word *'rabhas'* which means 'to do violence' (Wilkinson, 2002). The first references to mad dogs had appeared in legal documents in Mesopotamia as early as 2300 B.C. where the owners of mad dogs were held responsible for any deaths resulting from their bites (Tierkel, 1975; Wilkinson, 2002; Baer, 2007). It was apparent to them that the disease was transmissible from dog to man via bites and caused death of the bitten person (Baer, 2007). Isolation and control of mad dogs was used as an effective public health protective measure even during that time. Several types of remedies were described for dog bites and rabies in humans since 500 B.C. Cutting of the frenulum linguae (a mucous membrane) that attached the dog's tongue and removing a fold of mucus membrane was believed to have removed the worm that caused rabies and prevent rabies. Cauterization of the wound with hot iron, and keeping the wound open and application of ordinary blistering chemicals on it were some of the other remedies practiced. In addition, cupping, sucking and application of salts to the bite wound and giving a hot baths to hydrophobic patients were other remedies practiced in olden days (Baer, 2007).

In 1908, Fermi modified Pasteur's methods of vaccine preparation. He treated the infected nerve tissue with phenol to inactivate rabies virus which reduced the chance of infecting a patient with a live virus from the vaccine (Baer, 2007; Bakker *et al.,* 2008). In 1911, Sir David Semple, Englishman working at the Central Research Institute in Kasauli, India, also modified Pasteur vaccine (Baer, 2007; Bakker *et al.,* 2008). He developed nerve tissue vaccine from the brain tissue of young sheep and goats (called 'Semple vaccine') by inactivating the infected nerve tissue materials with phenol or beta propiolactone (Baer, 2007; Bakker *et al.,* 2008). Since then, the Semple vaccine production facilities have been established in Asia and the rest of the world. In 1955, Fuenzalida and Palacios made an improvement to nerve tissue vaccine and produced suckling-mouse brain tissue vaccine by inactivating the infected brain tissues of the suckling mouse with ultraviolet light or beta-propiolactone which reduced the sensitivity reaction to myelin tissue (Bakker *et al.,* 2008). However, since the nerve tissue vaccine contains myelin components of brain tissue had resulted in neuroparalytic adverse reactions, the WHO recommended complete replacement of nerve tissue rabies vaccines with modern cell culture rabies vaccines (Hemachudha *et al.*, 1987). Subsequently, the nerve tissue vaccine production and use has been stopped in most countries and switched over to cell culture vaccines, although it is still produced and used in developing countries like Pakistan, Bangladesh (Hossain *et al.*, 2011; Ward , 2012) and some of the Latin American countries (Suzuki *et al.*, 2008).

2.2. Rabies virus characteristics and the disease

2.2.1. Etiology

Rabies is caused by *rabies virus*, the prototype species of the genus *Lyssavirus*, family *Rhabdoviridae* and order *Mononegavirales* (De Novaes Oliveira *et al.*, 2010; Davis *et al.*, 2013). There are about 12 species classified under the *Lyssavirus* genus according to the International Committee on Taxonomy of Viruses (ICTV). Namely, *Rabies virus (RABV*), *Lagos bat virus (LBV), Mokola virus (MOKV), Duvenhage virus (DUVV), European bat Lyssavirus 1 (EBLV-1), European bat Lyssavirus 2 (EBLV-2), Australian bat Lyssavirus (ABLV), Aravan virus (ARAV), Khujand virus (KHUV) and West Caucasian bat virus (WCBV*) (Davis *et al.*, 2013). In 2009, a new virus, *Shimoni bat virus (SHIBV*) was identified from a bat in Kenya (Kuzmin *et al.*, 2010). It is now classified and accepted by ICTV as the twelfth species of *Lyssavirus genus* (Davis *et al.*, 2013).

2.2.2. Rabies virus structure

The RNA genome of *Lyssaviruses* is 12 kilo bases long, non-segmented and of negative polarity encoding five viral proteins (3´ to 5´) namely, nucleoprotein N, phosphorprotein P, matrix protein M, glycoprotein G and polymerase L. The bullet-shaped *Lyssavirus* particle has 100–300 nm in length and 75 nm in diameter (Fischer *et al.*, 2018).

The structure of virion is composed of two structural and functional sub-units. The internal helically packaged ribonucleocapsid complex (RNP) is formed by the N, P, and L proteins, associated with genome transcription and replication in the cytoplasm and potentially plays a role in the establishment of immunologic memory and long-lasting immunity (Ming *et al.*, 2009). The RNP is surrounded by a lipid bi-layer associated with the G and M proteins. The outer envelope is covered with spike-like projections (10 nm in length and 5 nm apart) corresponding to G-protein which recognize specific viral receptors on susceptible cell membranes. The envelope glycoprotein G of rabies virus induces the production of rabies virus-neutralizing antibodies, which are important in protection against rabies (Bahloul *et al.*, 1998; Bourhy *et al.*, 1999; Ming *et al.*, 2009). The protein M occupies an intermediate position between the envelopes and the RNP core and is associated with both the RNP and the G protein and responsible for virus budding and the bullet-shaped morphology (Ming *et al.*, 2009) (Figure 1).

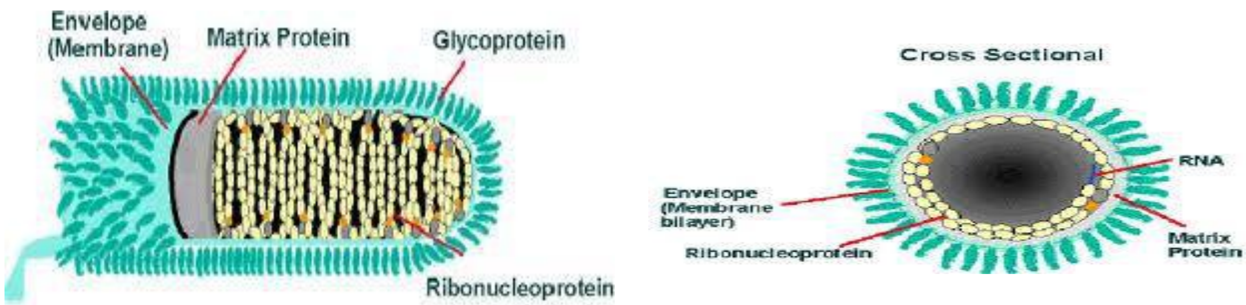

Figure 1 : Rabies virus virion. (source:http://www.cdc.gov/rabies/transmission/virus.html).

2.2.3. Physical properties of the virus

Rabies virus is quite fragile and can be destroyed by various concentrations of formalin, ether, phenol, halogens, mercurial, mineral acids, soap solution and other detergents. The virus can remain stable at pH values between 5 and 10 and becomes unstable on exposure to acid and alkaline condition (below pH 4 or above pH 10) (Murphy *et al.*, 1968). The virus is also rapidly inactivated by desiccation, ultraviolet radiation, sunlight, and does not survive for long periods in the environment. In experiments the virus was stable at 37°C for up to 2 hr, lost 90% of its infectivity after 4 to 6 hr and > 99.9% after 24 hr when partially purified rabies virus suspensions were exposed to different temperatures for different periods (Murphy *et al.*, 1968). However, the virus can remain stable for a few days at 0 to 4°C in the internal organs; in saliva in temperate climate for about 24 hours and survives indefinitely when freeze dried or kept at -70°C (Rupprecht *et al.*, 2002). Glycerol preserves the virus and therefore, brain and other tissues for laboratory examination are preserved in 50% glycerol in phosphate buffered saline solution (Zeynalova*et al.*, 2015).

2.3. The Epidemiology of rabies

Among the viral diseases, rabies is unique and it can affect a wide range of victims including all warm-blooded animals. It is prevalent throughout the world except in Islands. Many of the countries are endemic for rabies, except Australia and Antarctica (Singh *et al.,* 2017). According to a number of investigations, about 55,000 people die due to rabies in Africa and Asia each year. The immunization of pets at predictable expenses of approximately 300 million dollars in huge division accounts in favour of the lower rate of rabies in human inside the United States (Kongkaew *et al.,* 2004). Furthermore, the wild animals including bats, raccoons, foxes and skunks accounted more than 92% of rabies caused by animals in cases presented to the United States Centers for Disease Control and Prevention (CDC) in 2005 (Velasco *et al.,* 2008).

As defined by World Health Organization (WHO), a country that has no record of indigenously acquired case of human or animal rabies within two years period due to surveillance and import regulations can claim rabies free status. But susceptibility to reintroduction from neighboring countries exist inspite of undertaking vaccination programmes in wildlife (Singh *et al.,* 2017). Travellers visiting developing nations having sympathy for pet animals find it difficult to avoid feral dogs and cats thereby violate the precautionary measures (Singh *et al.,* 2017).

Country maintaining the rabies-free status requires strict continuous monitoring, quarantine of imported animals and regulations to avoid the entrance of virus particularly with the import or introduction of infected animals (Ehnert and Galland, 2009). There is need of an upto date official list for a country to be rabies-free. Mere presence of rabies-related virus cannot prevent a country from achieving rabies-free status and same is the case with United Kingdom and Australia (Singh *et al.,* 2017). In the UK, rabies was officially eradicated in 1920. But in 2002, one death occurred in an unvaccinated bat conservationist in Dundee who contracted a *RABV (European bat lyssavirus type 2)* and did not receive PEP (Singh *et al.,* 2017).

2.3.1. Geographic distribution

Rabies still remains a fatal zoonotic infection in humans and animals, even with advances in laboratory methods and improved vaccination (Pal, 2007). It is a big problem all over the world, except in some countries where there is strict quarantine system, rigorous eradication program or natural barriers like mountains and rivers (Rupprecht and Tumphey, 2007). Rabies remains an important public health problem in resource limited countries, particularly in Asia and Africa. This situation occurs because dog rabies is endemic with dog-to-dog transmission of the infection, which is associated with an ongoing threat to humans due to dog bites (Blanton *et al*., 2010). The three principal global areas of countries with enzootic canine rabies include Asia countries, Latin America and Africa whereas countries in which canine rabies has been brought under control and wildlife rabies predominates include Western Europe, Canada and the United States and rabies-free countries are mostly islands, including England, Australia and Japan (De-Serres *et al.*, 2008) (Table 1)

Table 1: Geographic distribution, host range and respective genotype of Rabies virus

Region	Reservoir Species	Genotype
Europe	fox , bats	*European bat lyssavirus 1& 2*
Asia	Dogs	Classical/Dog *rabies virus*
Africa	dog, mongoose, antelope	*Lagos bat virus, Mokola virus*
North America	foxes, skunks, raccoons,	*Duvenhage virus*
South America	insectivorous bats	Classical *rabies virus*
Australia	dog, vampire bats	Classical *rabies virus*
Middle East	Insectivorous bats	*Australian Bat Lyssavirus*

Source: Barecha *et al.*, 2017

The following map represents continent wise distribution of rabies virus.

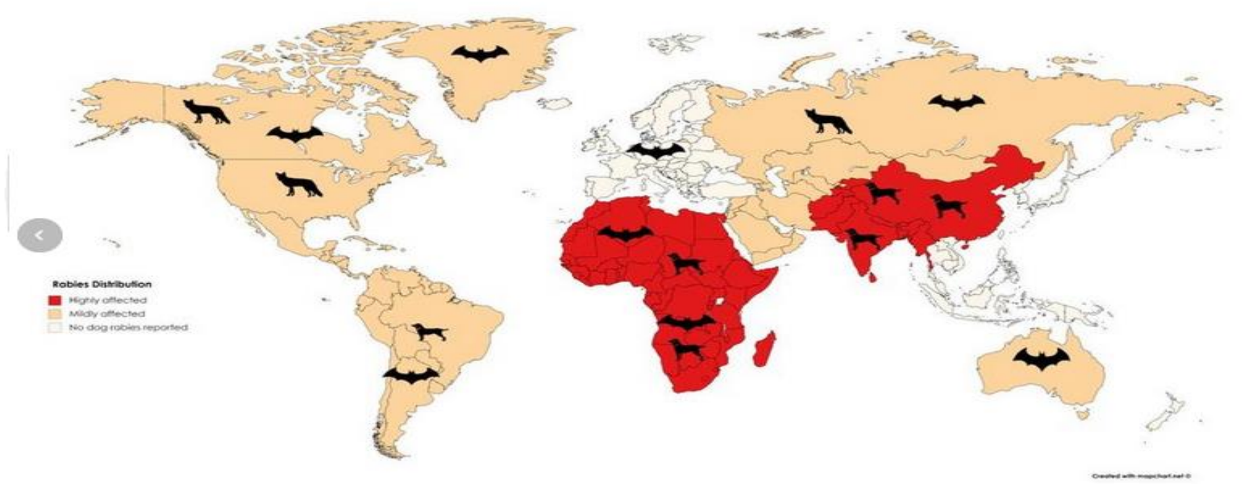

Figure 2: Representation of worldwide distribution of rabies virus affected area continent wise. Red indicates highly affected, pale yellow indicates mildly affected and white showing countries with rabies free of dogs (Sunil *et al.*, 2017).

2.3.2. Host range and susceptibility

Host range of a virus is the range of cell types and particularly host species that a virus is able to infect. Rabies virus infects all mammals with affinity to carnivores, which is capable of spreading the virus (Gyale *et al.,* 2014). All warm-blooded animals are susceptible to rabies, although dogs, wild carnivores and bats are considered the main natural reservoirs of rabies virus. In general, wolves, foxes, coyotes, jackals, dogs, cattle, raccoons, skunks, bats, and mongooses are highly susceptible to infection. Moderately susceptible hosts include cats, ferrets, primates, sheep, goats, and horses. Marsupials, including opossums, have a low degree of susceptibility. Some bird species can be experimentally infected but do not develop clinical signs and are unlikely hosts (Blanton *et al.*, 2012).

Not every bite from a rabid animal leads to rabies virus infection, and infection may not always culminate in death, unless clinical signs develop. Factors influencing the outcome after a bite from a rabid animal include the proximity of the bite site to the central nervous system (CNS), the degree of innervations of the bite site, the age of the host (young animals are more susceptible), the amount of virus inoculated, and the neuro invasiveness of the rabies virus variant involved (Monroe *et al*., 2016). Table 2 shows current classifications of Lyssa viruses.

Table 2 : Current classifications of Lyssa viruses with broad host range groups

Serotype and genotype	Major mammalian reservoirs	Distribution	Annual death
Rabies			
Serotype 1,genotype 1	Dogs, wild carnivores and bats	Worldwide (With exception of Australia, Antarctica and designated rabies free countries)	~50000
Lagos bat			
Serotype 2, genotype 2	Bats	Africa: Central Africa Republic, Ethiopia, Nigeria, Senegal &South Africa	Never report
Mokola			
Serotype 3, genotype3	Shrews, cat, dogs	Africa: Cameroon, Central Africa Republic, Ethiopia, Nigeria, S. Africa, Zimbabwe	Occasional
Duvenhage			
Serotype 4, genotype 4	Bats	Africa: South Africa, Guinea, Zimbabwe	Occasional
European bat Lyssavirus 1(Genotype 5)	Bats	Europe	Occasional
European bat Lyssavirus 2 (Genotype 5)	Bats	Europe	Occasional
Australian bat Lyssavirus(Genotype 7)	Bats	Australia	Occasional

Source: Moges, 2015

2.3.3. Reservoir hosts of rabies

Reservoirs are defined as a set of epidemiologically connected populations that permanently maintain a pathogen and transmit infection to particular target populations considered to require protection (Haydon *et al.,* 2002). The key components of reservoirs of directly transmitte micro parasites are the target populations of concern and maintenance populations (in which sustained transmission occurs). Some reservoir systems also involve source populations, which provide transmission links between maintenance and target populations. By definition, maintenance populations must exceed the minimum population size required for disease persistence (the Critical Community Size (CCS)). Populations smaller than the CCS (non-maintenance populations) cannot maintain a pathogen independently, but together with other maintenance or non-maintenance populations can constitute part of a reservoir (Haydon *et al.,* 2002).

The epidemiological cycles of Rabies is maintained in two inter-related, urban and sylvatic cycles. The Urban Rabies which affects mainly domestic dogs accounts for an estimated of 99% of all recorded human cases and 92% for all human PEP as cited by (King and Turner, 1993; Lembo *et al.,* 2008). Rabies transmitted by domestic dogs (Urban rabies) is predominant in the developing countries of Asia, Africa and South America. Wildlife of Canidae like dogs, jackals, wolves and foxes, Mephitidae (skunks), Herpestidae (mongoose spp.), Procyonidae (raccoons) and the order Chiroptera (bats spp.) are very important in maintaining the sylvatic cycle of rabies in different ecosystems of the world (Hanlon *et al.,* 2007; Aiyedun *et al.,* 2016).

2.3.4. Roles of Wildlife in Rabies transmission

Rabies is a zoonotic fatal disease characterized by encephalomyelitis and highly threatened Wildlife, domestic animals and humans worldwide. When wild animals are infected by the virus and become rabid, they approach to the towns and may attack both domestic animals and humans (Gortazar *et al.,* 2007; Miller *et al.,* 2013). Rabies is a highly public health concerns that can cause a mortality rate reach up to 100 %. It is approximated that between 50,000 -100,000 humans, many domestic animals and wildlife die due to rabies all over the world yearly (Lembo *et al.,* 2008; Gompper, 2014). There are various biotypes of rabies virus and each biotype is host specific. They are usually highly pathogenic, highly excreted while exhibiting low immune response in the host specie (Bernardi e*t al.,* 2005). From those wildlife, Bats, Jackals and

Mongooses are the more concerns in rabies viruses transmission (Aiyedun, *et al.,* 2016). Different variants are adapted to their reservoir species; however, they can be transmitted to other species. For instance, fox variant could be detected in a dog. Different variants of the virus can be identified at molecular analyses levels (Lembo *et al.,* 2008). The information relay on epidemiology of rabies concerning with the roles of wildlife are increasing particularly in the developing world globally. Rabies transmission risks have been linked with compounds of factors related to wildlife (Suzán *et al.,* 2015). In epidemiological survey, the limitations associated with rabies control are more related with wildlife and its ecology (Manning *et al.*, 2008).

2.3.5. Mode of Transmission of rabies

The lyassa virus infection is transmitted by all animals that are considered as warm-blooded, while the virus can also grow up in cells of cold-blooded animals (Mustafa *et al.,* 2015). Although all mammals are susceptible to and capable of transmitting the rabies virus, those considered reservoirs of the virus are carnivorous mammals and bats (Rupprecht and Gibbons, 2004). Canines are considered the primary vectors of the virus worldwide and are responsible for the majority of human rabies cases in Africa, Asia, Central America, Eastern Europe, Russia and South America (Nigg and Walker, 2009). In more developed regions like United States, where the prevalence of domestic animal vaccination is high, bats are responsible for the majority of human rabies cases. In addition to bats, raccoons, skunks, coyotes and foxes are among the common reservoirs for rabies in North America (Nigg and Walker, 2009; Slate *et al.,* 2009). The transmission of this disease requires entrance of virus through the saliva of an infected animal due to biting, wounds or unwrap cuts in fur or mucous membranes (Langley, 2009). Rabies virus is usually transmitted by the bite of a rabid animal (Moges, 2015; Barecha *et al.*, 2017).

Transmission is mostly from exposure to virus laden saliva of an infected animal, either due to the bite, from animal to animal or animal to man (Sudarshan *et al.,* 2007). Inhalation of aerosolized rabies virus could be a potential non-bite route of exposure. This type of spread can occur among laboratory workers and spelunkers. Other contacts, such as petting a rabid animal or contact with the blood, urine, or feces of a rabid animal, does not constitute an exposure and is not an indication for prophylaxis (Hatam *et al.,* 2013). The contamination of open wounds or abrasions including Scratches or mucous membranes with saliva or other potentially infectious material like neural tissue from a rabid animal constitutes a non-bite exposure (Barecha *et al.*, 2017).

Rabies in wildlife is perpetuated in much the same fashion as with urban rabies in nature. One or two mammalian species in a given ecosystem, typically carnivores and bats, are responsible for maintain its cycle in their respective ecosystem (Murray *et al.,* 2002). According to Jackson and Wunner (Brooks *et al.,* 2004), the major wildlife reservoirs for different variants of rabies virus vary by continent and geographic regions with in continents.

Deposition of virus of rabies is particularly important in Latin America and is transmitted by bite of bats. These bats usually transmit the bovine paralytic rabies and maintain the cycle in endemic areas while cattle and man are victims (Kuzmin *et al.,* 2011). Spread of the disease is often seasonal, with high incidence in late summer and autumn because of large scale movement of wild animals at the mating time and in pursuit of food (Radostits *et al.,* 2007).

2.4. Pathogenesis

The *Rabies Virus (RABV)* causes relatively slow but progressive disease without initial clinical signs, which turns fatal after onset of clinical signs. The virus at the injected site remains hidden (eclipse) for variable time (a threshold must exceed to cause disease). The incubation or eclipse period is highly variable from 2 weeks to 6 years (avg. 2–3 months), which entirely depends on the concentration of the virus inoculated, inoculation site and density of innervations (Singh *et al.,* 2017). The most common mode of rabies transmission is through the bite and virus-containing saliva of infected animals, usually domestic dogs (Knobel *et al.*, 2005). Another possible route of transmission is through oral, especially for animals feeding on dead infected animals (Hofmeyr *et al.,* 2004). Greatest risk factor is bites on the hands, neck, face and head mainly with bleeding lead to shorter incubation period due to the decreased length and greater number of neurons. Rabies Virus can persist in the muscle for prolonged duration, which may give a chance for post-exposure treatment and clearance of the virus by the host immune system (Hemachudha *et al.,* 2002). It gets attached through G-protein receptors to the target cells (myocytes, local sensory and motor neurons) and amplifies in muscle cells and in macrophages (Tsiang *et al.,* 1986) and then persist there up to 18 days.

Then, through muscle spindles of sensory nerves or neuromuscular junction of motor nerves the virus ascends centripetally along the nerves (3 mm/hr, experimental data) and reaches the CNS to infect the nerve cells. The RABV travels along the course of peripheral nerves (through fast axonal transport system) and the transport is sternly retrograde, that suggests the infection is via both motor and sensory nerves (Jackson, 2003). Due to the presence of large inoculums at the site of bite, the virus may also enter in blood. The virus then moves from the CNS via retrograde axoplasmic flow within the peripheral nerves, leading to infection of some of the adjacent non-nervous tissues. For instance secretory tissues salivary glands are the most involved organs. Then, the virus widely dissimilated through the body at the time of clinical onset. The first clinical symptom is usually neuropathic pain at wound site. This is caused by virus replication in dorsal root ganglia causing ganglionitis (Lang *et al*., 2012).

Two major presentations are observed, furious and paralytic forms that cannot be correlated with specific anatomical localization of rabies virus in CNS (Andrews, 2015). Peripheral nerve dysfunction is responsible for weakness in paralytic rabies. Generally, the pathogenesis of rabies virus is following primary infection (stage 1 of Figure 3), the uptake of virus into peripheral nerves is important for progressive infection to occur. After uptake into peripheral nerves (stage 2 of Figure 3), rabies virus is transported to the central nervous system via retrograde axonal flow (stage 3 of Figure 3). The incubation period (stage 1-3 of Figure 3), is the length of time between infection with the rabies virus and the onset of clinical signs. During this period the virus is multiplying within the body. If rabies is not prevented at an early stage, and the virus reaches the brain (stage 4 of Figure 3**)** and moves to the salivary glands (stage 5 of Figure 3), bite victims will begin to show the first signs of rabies. This period is called the infectious period and when signs of rabies begin, death is inevitable. The case fatality rate of rabies is 100% when symptoms present (Willoughby *et al.,* 2005). The infectious period from rabies in animals ranges from 2 days to approximately two weeks (Hampson *et al.,* 2009) (Figure 3)

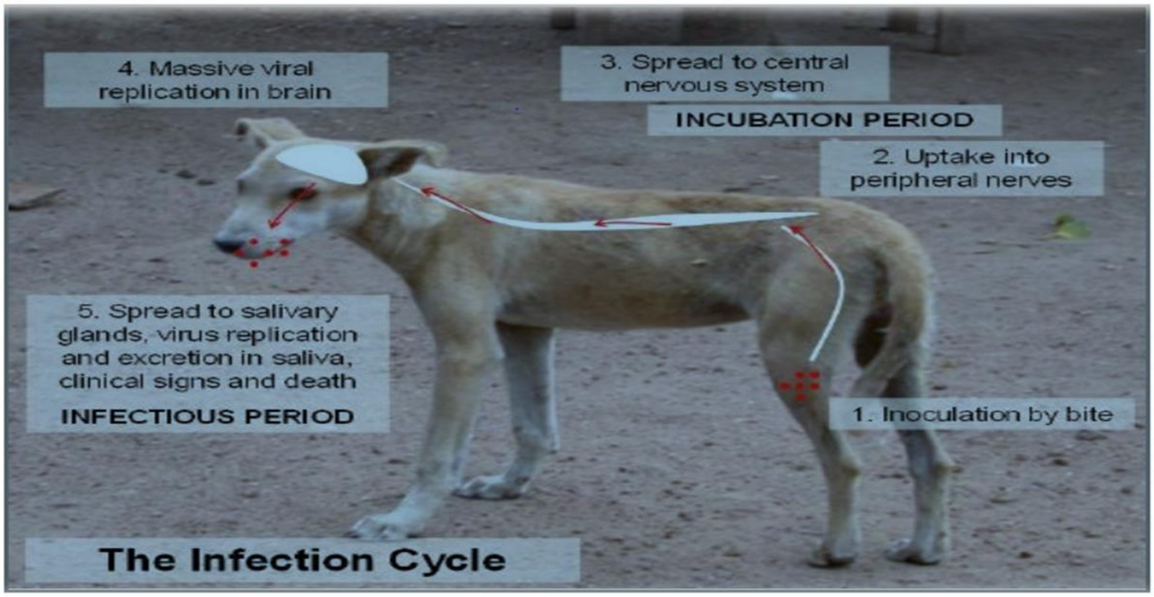

Figure 3: Diagram showing rabies pathogenesis, whereby the virus moves from the site of the bite to the central nervous system, then replicates in the brain (Sambo, 2012)

2.5. Clinical manifestation of Rabies

2.5.1. In animals

It is investigated that as the disease becomes advanced, the animal shows strange behavior. Every verified suspicion of rabies must be established by the confirmatory report of laboratory test (Chernet and Nejash, 2016). The primary clinical signs are frequently non-specific and can comprise anxiety, restiveness, anorexia or an improved appetite, nausea, diarrhea, a minor fever, dilation of the pupils, hyperactivity to any stimuli in addition to extreme salivation. The animals regularly comprise behavioral changes and might turn into either curiously aggressive (Banyard *et al*., 2013).

Prodromal Stage

Following a definite incubation phase, the beginning of clinical symptoms starts. This is the first stage typically ends within 1-3 days, during this stage slight behavioral modification may occur, like anger in domestic animals, daytime tricks in nocturnal animals, no fright of humans in the wild animals or else irregularities in the appetite (WHO, 2013).

Excitement (Furious) Phase

The furious type is described via agitation, wandering, weeping, polypnea, drooling and attacks upon other animals, community or unresponsive objects. Infected animals frequently ingest foreign items for instance firewood and gravels. The wild animals often drop their fright of humans and may harass humans or another surrounding animal that they would usually avoid. On the other hand, the nocturnal animals may be observable throughout the day. In cattle, strange attentiveness can be an indication of this phase (Banyard *et al.,* 2013).

Paralytic (dumb) Phase

The "dumb" type of rabies is usually characterized by the progressive paralysis. In this phase, the gullet and masseter muscles turn into paralyzed; the animal might be incapable of swallowing, and salivating abundantly. There may be a change in voice of infected animal due to laryngeal paralysis, including atypical bellowing in cattle and barking in dogs. In addition to that, there might be facial paralysis along with dropping of the lower jaw. Ruminants may become isolated from the herd (Fooks *et al.,* 2014). Furthermore, this stage is also characterized by dropping of foamy salivary secretion and paralysis of hind limbs eventually leading complete paralysis followed by death (WHO, 2013).

Hydrophobia

The term stands for the fright of water is the historic synonym of rabies (Bano *et al.,* 2017). This condition refers to a collection of warning signs during the advanced phases of an infection in which the patients have obscurity in swallowing and taking water. Any mammal infected by the virus may reveal hydrophobia. In this condition, there is over production of saliva, and animal struggles to drink and could suffer from painful spasms of the muscular tissues within the throat as well as in vocal cord. The virus remains in saliva and is spread due to bite of rabid animal (Mustafa *et al.,* 2015).

2.5.2. In humans

In humans, rabies typically manifests itself in five stages. These stages are; incubation period, prodrome phase, acute neurologic phase, coma and death.

*The incubation period***:** The duration of the incubation period ranges from a few days to several years, but typically is 1–2 months (Hemachudha *et al.*, 2002; Leung *et al.*, 2007). Rabies viruses bind to nicotinic receptors on the surface of muscle fibers, then replicate slowly within muscle and travel into nerve tissue through neuromuscular junctions (Hemachudha *et al.*, 2002; Willoughby *et al.*, 2005; Leung *et al.*, 2007). The variation in incubation periods may be associated with the time required to replicate within muscle tissue and transverse into neuronal axons. Deep lacerations or bites occurring on the head and neck in which the virus is directly inoculated into nerve tissue are generally associated with shorter incubation periods. Once the virus attaches to the axons of nerves, it travels in a retrograde fashion to the central nervous system (CNS), where rapid replication occurs.

The prodromal stage: Begins once the virus has traveled to the dorsal root ganglia and CNS, when non-specific symptoms such as fever, headache, malaise, irritability, nausea and vomiting, may occur (Nigg and Walker, 2009). Paresthesias, pain and pruritus may arise locally at the site of viral entry (Hemachudha *et al.*, 2002; Leung *et al.*, 2007). The prodrome generally lasts a few days to 2 weeks. Progression from the prodromal stage to the acute neurologic phase is characterized by neurologic dysfunction. At this point the virus begins invasive replication within the CNS, where it travels from neuron to neuron through synaptic junctions (Nigg and Walker, 2009). From the CNS, the virus moves into other organs, glands, and tissues and is copiously secreted in the saliva.

The acute neurologic phase: Can manifest as encephalitic (furious) or paralytic (dumb) rabies. Approximately 80% of patients present with the encephalitic form, whereas the remainder suffer from paralytic rabies (Meslin, 2005). Encephalitic rabies symptoms include hyper excitability, hyperactivity, hallucinations, excessive salivation, hydrophobia (fear of water) and aerophobia (fear of air) (Hemachudha *et al.*, 2002; Nigg and Walker, 2009). Hydrophobia and aerophobia may result from painful laryngeal and pharyngeal spasms (Leung *et al.*, 2007). Once the encephalitic form of rabies presents, the patient usually dies within 5 days (Hemachudha *et al.*, 2002). Patients with the paralytic form of rabies frequently present with limp paralysis of the limb initially exposed to the virus.

Coma: occurs in the late stages of clinical progression and is associated with multi-organ failure regardless of the form of presentation. In addition, hematemesis occurs in approximately 30–60% of patients during the last few hours of life (Hemachudha *et al.,* 2002). Cardiac arrhythmias occur in almost all cases with the cause of death related to cardiac and circulatory insufficiency. Death: results after the onset of diaphragmatic and bulbar paralysis within a few weeks (Leung *et al.,* 2007)

2.6. Diagnosis of Rabies

In humans, diagnosis of rabies based on history of bites and clinical symptoms alone is difficult and unreliable, except when there are specific clinical signs of hydrophobia or aerophobia (WHO, 2005). A diagnosis of rabies should be considered in any patient who presents encephalitis of unknown cause (Macedo *et al.,* 2006). The first clinical signs of rabies are non-specific, and the diagnosis is often confirmed later in the course of the disease or at postmortem. Delay in diagnosis can result in dissemination of the disease to contacts and unnecessary post exposure treatment of people at risk (Wacharapluesadee and Hemachudha, 2001). Early diagnosis can eliminate the expense of unnecessary diagnostic tests and inappropriate medical treatment. It also significantly reduces the number of potential exposures to the virus during contact with the patient and allows early identification of people who are candidates for prophylactic treatment (David *et al.,* 1999).

Diagnosis can only be confirmed by laboratory tests preferably conducted post mortem on central nervous system tissue removed from cranium (Dacheux *et al.,* 2008). Laboratory specimens used for ante mortem diagnosis include, cerebrospinal fluid, saliva, corneal impressions and biopsy of highly innervated regions such as neck-skin (Smith *et al.,* 2003). The rabies virus (RABV) is usually present in nerve cells surrounding the bases of hair follicles. Neck-skin biopsies are analyzed by a fluorescent antibody test (FAT) in frozen sections of the biopsy and by reverse transcription–polymerase chain reaction (RT-PCR) on RNA extracted from the biopsy (Macedo *et al.,* 2006).

Most diagnostic tests for rabies virus in animals need brain material for diagnosis, which may obtain from post mortem (Servat *et al.,* 2012). This can be made by taking any part from the affected brain. But the test must include tissues from at least two locations in brain, the brain stem and cerebellum in order to rule out rabies diagnosis. The following table shows (Table 3) many diagnostic methods for detection of rabies in animals, includes, direct florescent antibody, mouse inoculation technique, tissue culture infection technique and polymerase chain reaction (Chernet and Nejash, 2016). Brain samples are most readily taken by breaching the skull and sampling directly. Brain smears or touch impressions are used for the menidetection of virus antigen with the fluorescent antibody test (FAT) for both human and animal samples. In animals the direct fluorescent antibody test (dFAT) is the recommended diagnostic test. This test detects the presence of rabies antigens in brain tissue. Other diagnostic techniques include reverse transcription polymerase chain reaction (RT-PCR), direct rapid neur immunohistochemistry test (dRIT) and serological tests (Fluorescent antibody neutralization test, rapid pres fluorescent focus inhibition test). In humans, the rabies recommended test is dFAT on brain tissue. Other diagnostic tests that have been used are RT-PCR and dRIT (Bano *et al.*, 2017).

Table 3: Different Diagnostic techniques for rabies

Techniques	Specimens	Advantages/Disadvantages
Direct Fluorescent Antibody Technique (DFAT)	Target organs, such as brain, salivary glands, liver, spleen, pancreas, nuchal skin, brain is the most appropriate sample	Applicable with most tissue sources. Not applicable in decomposed tissue
Mouse Inoculation Technique (MIT)	Similar to DFA	Only use fresh tissues
Tissue Culture Infection technique (TCIT)	Similar to DFA	Only use fresh tissues
Polymerase Chain Reaction (PCR)	Similar to DFA including body fluids, saliva, urine, CSF	Applicable in all tissue conditions Expensive Need experienced technicians

Source: Chernet and Nejash, 2016

2.6.1. Differential diagnosis

Rabies should be suspected in any case where a patient presents with neurological signs having been bitten by a mammal, particularly in an endemic area. Possible differential diagnoses vary, depending on whether the presentation is as furious or paralytic rabies (McKay and Wallis, 2005). Diseases that may be confused with rabies includes distemper, infectious canine hepatitis, ehrlichiosis, tetanus, cerebral babesiosis, toxoplasmosis, cerebral cysticerosis (caused by *Taenia* *solium*), diminazine toxicity, pesticide (such as metaldehyde), strychnine poisonings in dogs, Cerebral theileriosis, babesiosis, thrombotic meningoencephalitis (caused by *Haemophilus somnus*), sporadic bovine encephalomyelitis (caused by *Chlamydophila pecorum*), botulism, lead, urea, chlorinated hydrocarbon, organophosphate poisonings, cerebrocortical necrosis (caused by thiamine deficiency) in cattle; *coenurus cerebralis* (*Taenia multistep* coenuriasis) in sheep, heartwater, a variety of plant poisonings and pesticide poisonings in all animals are episodes that made confusion with rabies (Swanepoel, 2004).

Furthermore, encephalitis caused by arboviruses such as Japanese, Eastern equine and West Nile viruses, enteroviruses, Nepah virus, Herpes virus, acute hepatic porphyria with neuropsychiatric disturbances and signs of autonomic dysfunction, substance abuse like alcohol withdrawal or delirium tremens, acute serotonin syndrome due to administration of serotonin uptake inhibitors, neuroparalytic accidents, when the patient is from a country where nerve-type vaccines are used, psychiatric disturbances, cerebrovascular accidents, epilepsy, poisoning by atropine-like compounds and poliomyelitis are also included in differential diagnosis of rabies (Delpietro *et al.,* 2001; Consales and Bolzan, 2007).

2.7. Control and prevention of rabies

2.7.1. In domestic animals

To prevent rabies, Vaccination is the effective measures to be employed (Moges, 2015). In domestic animals, rabies vaccines are used primarily for pre exposure prophylaxis, because treatment after exposure is not advised. Mass immunization of dogs has been employed for many years to control the spread of rabies by creating an immunological barrier between wildlife reservoirs of the disease and human populations. Rabies has a wide range of geographical distribution, however, several nations like Japan, England, Iceland and Scandinavian countries have eradicated rabies by implementing control programs and strict quarantine regulations (Moges, 2015).

Theoretically, vaccinating a minimum of 50% to 70% of dogs is necessary for controlling of rabies in dog populations. Eliminating unvaccinated feral dog population alone has not proved effective and is expensive. Furthermore, eradicating wild life populations is nearly impossible and is also expensive. Therefore, the control measures centered on vaccination of dogs and cats are most appealing and effective as reported by Knipe and Howley, 2001 (Moges, 2015 ;Chernet and Nejash, 2016). In addition, unvaccinated pets (dogs and cats) exposed to a rabid animal should be euthanized immediately. If the owner is unwilling to euthanize, the animal should be placed in strict isolation for 6 months and vaccinated 1 month before being released. Animals with expired vaccinations need to be evaluated on a case-by-case basis. Dogs and cats that are currently vaccinated should be revaccinated immediately, kept under the owner's control and observed for 45 days (Chernet and Nejash, 2016). For farm animals, the two useful control techniques are prevention of exposure and vaccination. The former can be achieved to a degree by destruction of wild fauna, muzzling, restraining and vaccination of all cats and dogs and keeping farm animals indoors (CDC, 2001).

2.7.2. In humans

Several key events have been contributed to the control of human rabies historically. These are, the development of a human rabies vaccine (1885), the discovery of the diagnosis Negribody (1903), the use of rabies vaccines for dogs (1904s), the addition of rabies immune globulin to human post exposure vaccination treatments (1954), the growth of rabies virus in cultured cells (1958) and the development of diagnostic fluorescent antibody test (1959) (Moges, 2015).

The two Approaches to Prevent Rabies in Humans are Pre-exposure vaccination and post-exposure prophylaxis. Pre-exposure vaccination is desirable for all persons who are at high risk of contact with rabid animals such as veterinarians, animal care personnel, certain laboratory workers and spelunkers. Persons traveling to developing countries where rabies control programs for domestic animals are not optimal should be given pre-exposure prophylaxis (Timoney *et al.*, 1988; Moges, 2015). However, pre-exposure prophylaxis does not eliminate the need for prompt post-exposure prophylaxis if an exposure to rabies occurs. So, immediate treatment after exposure is essential for all individuals known or suspected of having been exposed to a rabid animal (Timoney *et al.*, 1988).

Pre-exposure Vaccine Regime: it is a 1 dose of cell culture or purified duck embryo vaccine on days 0, 7, 28, a few days variation is acceptable. The dose is given in standard intramuscularly (1ml or 0.5 ml according to vaccine type). The vaccine may be given intradermally (0.1ml on day 0, 7, 28) except in anti-malarial chemoprophylaxis (e.g. chloroquine) is being used concurrently, when intramuscular injections are preferable, since the antibody response may be impaired if the intradermal method is used WHO (WHO, 2001) and this will provide 2 years of protection (Murray *et al.,* 2002). Booster (or serologic confirmation of adequate level) is given depending on the individual's continuing risk category (Moges, 2015).

Post exposure prophylaxis (PEP): Post exposure prophylaxis consists of a multimodal approach to decrease an individual's likelihood of developing clinical rabies after a possible exposure to the virus.Wound cleansing, administration of rabies vaccine and Human Rabies Immunoglobulin (HRIG) are the primary components of rabies post exposure prophylaxis(CDC, 1999). Post exposure prophylaxis should be discontinued if the animal in question is found to have a negative rabies test. Household pets involved in potential human exposures should be observed for 10 days for the presence of rabies. If the animal under observation does not show rabies symptoms, post exposure prophylaxis for the victim should be discontinued. When a bite wound is evident or an open wound is exposed to infectious substances, the wound should be promptly and thoroughly cleansed with soap and water for a minimum duration of 15 minutes (Nigg and Walker, 2009). The use of veridical antiseptics such as povidone iodine and ethanol is advocated for initial wound treatment. Topical antibiotics may also be considered depending on wound severity. In addition, closure of bite or scratch wounds should be avoided (McDermid *et al.,* 2008).

Following wound cleansing, post exposure prophylaxis regimens differ depending on the rabies immunization status of the individual exposed. For individuals who have not received pre exposure prophylaxis in the preceding 2 years, HRIG should be administered immediately (Leung *et al.,* 2007; Rupprecht and Gibbons, 2004). A dose of 20 IU/kg (0.133 ml/kg) of either HRIG product (HyperRAB S/D or Imogam Rabies HT) should be administered directly into the wound and the area surrounding the wound (Table 4). If it is not feasible to administer the entire dose near the wound or a wound is not apparent, any remaining volume should be given intramuscularly in the upper arm or lateral thigh muscle. For patients who have received recent (≤ 2years) pre exposure prophylaxis, two 1-ml intramuscular doses of the rabies vaccine should be administered (Table 4). The first dose should be given immediately and the second dose 3 days later. No HRIG is warranted, as passive antibody administration may interfere with innate antibody production (Nigg and Walker, 2009).

Table 4 : Pre and Post exposure Prophylaxis Regimens

Type of Prophylaxis	Product	Regimen
Pre exposure prophylaxis	Rabies vaccine	1 ml on days 0, 7, and 21 or 28
Post exposure prophylaxis	Rabies vaccine	1 ml on days 0, 3, 7, and 14
Patients not previously vaccinated, were vaccinated > 2 yrs earlier, or whose titers have decreased below 0.5 IU/ml	Human rabies immune globulin	20 IU/kg (0.133 ml/kg) on days 0–7d
Patients vaccinated within previous 2 yrs	Rabies vaccine	1 ml on days 0 and 3

Source: Nigg and Walker, 2009.

2.8. Public health and economic burden of Rabies

2.8.1. Health burden

Rabies infection in humans is still a major public health concern all over the world (Pal *et al.,* 2013). About 98% of the human rabies cases occur in developing countries that possess large number of dogs, many of which are strays (WHO, 2004). In rabies endemic areas, the infection occurs due to dog-to-dog transmission, which is associated with an ongoing threat to humans because of dog bites. The Estimation of human mortality due to endemic canine rabies in Asia and Africa annually exceed 30,000 and 23,000, respectively. The annual cost of rabies in Africa and Asia was estimated at 583.5 million USD most of which is due to cost of post exposure prophylaxis (PEP) (Knobel *et al.,* 2005).

The burden of rabies falls disproportionately on one of the most vulnerable sectors of society, namely children and particularly those in marginalized rural populations (Blanton *et al.,* 2010). Children from 5-15 years old have an increased risk of opportunity to be exposed and a higher probability of being bitten on the head, face or neck, resulting in a relatively high proportion of childhood rabies deaths. Bite victims who are in lower socio-economic brackets and that who live furthest from health facilities and undergo longer delays before receiving PEP, increases the risk of developing rabies. Even in countries where governments provide vaccine free of charge, considerable costs can be incurred by patients for travel and accommodation (often including the cost of an accompanying family member, in the case of child bite victims), according to the number of clinic visits required (four or five, for intramuscular regimens) (Swanepoel, 2004).

Rabies fits all the World Health Organization (WHO)'s criteria for diseases that have gotten a priority to control (WHO, 2000). Unlike many other emerging zoonoses, such as West Nile virus, safe and effective animal and human vaccines are widely available for its prevention and control. Despite the disease is entirely preventable through prompt administration of post-exposure prophylaxis (PEP) to bite victims and can be controlled through mass vaccination of domestic dogs, rabies is still very prevalent in developing countries and affects populations with limited access to health care.

In developing world, particularly Africa and Asian continents, where most human rabies deaths occur, rabies remains a neglected disease and is poorly controlled (Cleaveland *et al.,* 2002). A major factor resulted in the failure of rabies control in these continents is the low level of political commitment, lack of quantitative data on the true public health impact of the disease and the cost-effectiveness and cost benefits of controlling it (Bögel and Meslin, 1990). However, the disease is grossly underreported in these areas because most victims die at home. This leads to insufficient prioritization of rabies prevention in public health agendas (Hampson *et al.,* 2015). The most important impacts of rabies includes, loss of human lives (approximately 59,000 annually) and loss of productivity due to premature death from rabies and costs of obtaining PEP once an exposure has occurred. The greatest risk of developing rabies fell upon the poorest regions of the world, where domestic dog vaccination is not widely implemented and access to PEP is most limited. A greater focus on mass dog vaccination could eliminate the disease at its source, reducing the need for costly PEP and preventing the large and unnecessary burden of mortality on at-risk communities (Hampson *et al.,* 2015).

The disability-adjusted life year (DALY) is a standardized, comparative measure of disease impact developed to assess the relative impact of different diseases across different settings and at different stages of economic and public health development (Coleman *et al.,* 2004). The DALY is a combination of the years of life lost (YLL) due to premature death and the years of life lived with a disability (YLD). DALYs have been used to organize disease control in the health sector because interventions can be prioritized on the basis of their impact in reducing disease and on the cost-effectiveness of the intervention (Kakkar *et al.,* 2012). The rabies burden is made up of different components. Societal costs include mortality and productivity lost from premature death and morbidity from adverse events (AE) of vaccination using nerve tissue vaccines (NTVs) and psychological effects of exposure to this fatal disease, expressed as disability-adjusted life years (DALYs). Direct costs of PEP (depending on the use of rabies immunoglobulin (RIG) and the type of vaccine and regime, for example intramuscular (IM) versus intradermal (ID) administration) and indirect costs of seeking PEP (travel and accommodation for multiple clinic visits and lost income) fall upon the medical sector and affected communities, whilst the veterinary sector typically incurs costs related to dog vaccination. Veterinary and medical sectors both have responsibility for surveillance costs. Livestock losses depend on the size of at-risk livestock populations and preventative measures taken, and impact both national economies and households (Hampson *et al.*, 2015).

2.8.2. Economic burden

Canine rabies is an economically unique zoonotic disease, since most of its associated costs do not result from illness in the infected individual alone, but further extended to human deaths and efforts to prevent the disease in humans, livestock and companion animals. This pattern of costs indicates two basic facts; the case fatality rate of rabies in humans is nearly 100% and the disease is preventable through timely post-exposure prophylaxis (PEP) with rabies immune globulin (RIG) and multiple doses of rabies vaccine (Shwiff *et al.*, 2018). However, in most developing countries, RIG is often not available (Elser *et al.*, 2018).

Humans or livestock exposures to Rabies result in economic impacts associated with vaccination or death. Because rabies is a fatal disease and there is no effective treatment, the cost of illness is relatively small, especially in the developing world. In contrast, the major direct costs arising from factors such as PEP and livestock deaths have been characterized in numerous studies (Shwiff *et al.*, 2007). In addition to the direct costs, canine rabies also has indirect costs, including vaccination of livestock and companion animals and laboratory-based surveillance with diagnostic testing of animals suspected of rabies, although not done similarly in all countries (Shwiff *et al.*, 2018). Other impacts of rabies on the broader economy can be captured by examining changes in different sectors that result from the direct and indirect impacts of the disease. Knobel and colleagues (2005) estimated global monetary expenses resulting from rabies at $695 million annually (Knobel *et al.*, 2005), while Anderson and Shwiff (2015) updated and expanded this study to include the value of human life lost for a total global estimate of approximately 69,000 lives lost annually and a global burden of $1.2 billion USD (Anderson and

Shwiff, 2015). Hampson and colleagues (2015) estimated that approximately 59,000 people die globally from rabies and consistent with other studies, the majority of canine rabies burden falls on Africa and Asia. The impact and economic burdens of canine rabies and its variability among the three continents, Africa, Asia and Latin America is illustrated in table 5.

Furthermore, the impacts of canine rabies is not limited to global level, rather its impacts on local economy are enormous. In countries where rabies is endemic, livestock and other working animals could be adversely affected by rabies virus. In addition to loss in livestock and production, the need to pay for transport and expensive post-exposure prophylaxis for rabies exposed family or community members can lead to the unplanned sale of production animals and livelihoods assets, further impacting food and economic security (De Balogh *et al.*, 2012).

Table 5: Continent wise impacts and economic burdens of canine rabies

Impact	Africa	Asia	Latin America
Death	21,502	37,266	182
Death/100,000 population	209	0.93	0.03
DALYs lost	1,345,643	2,354,159	11,951
Exposure(to rabies, not all dog bites)	847,326	14,633,844	122,701
PEP treatments	1,387,848	26,589,22	835,656
Dog vaccination coverage	~14%	~16%	~60
Cost of prevention (US$)	15,948,303	42,115,175	63,287,263
Dog vaccination	14,520,789	38,528,371	61,033,617
Dog population management	1,305,247	3,369,953	1,930,503
Surveillance	122,267	216,851	323,143
Preventable costs (US$)	1,266,514,109	6,660,728,927	289,466,942
Productivity losses	773,352,665	3,852,276,021	30,242,012
Direct PEP	156,110,495	1,363,634,648	129,331,962
Indirect PEP	57,504,777	1,225,773,035	117,705,839
Livestock losses	279,546,173	219,045,223	12,187,129
Total costs (us$)	1,282,462412	6,702,844,102	352,754,205
Cost of prevention/person	0.02	0.01	0.12
Preventable costs/person	1.23	1.67	0.54

Source: Gemechu (2017).

2.9. The status of rabies in Ethiopia

In Ethiopia rabies is an important disease that has been recognized for many centuries. It is one of the most sever infectious disease with many cases of the disease diagnosed in various parts of the country. According to Richard Pankhurst, the first and only recorded of rabies case in Addis Ababa occurred in August 1903 (Deressa *et al.,* 2010). The incidence of human post exposure treatments and human rabies cases per million population of Ethiopia were 73.6 and 12.6, respectively. It is one of the public health concerns which need formulation of intervention strategy.

Each year, thousands of people are infected with rabies in Ethiopia and an estimated 2,700 people die, which is one of the highest rabies death rates in the world. But the true number of deaths caused by rabies is unknown, because the disease is underreported and rabies diagnostic laboratories are not well established. Furthermore, few places in Ethiopia offer life-saving human rabies post-exposure prophylaxis (PEP) and most people don't have the means to make it to a major hospital to get treated. In addition, people's awareness about what to do if bitten by dogs is low, and they often do not seek medical help when bitten (CDC, 2017).

As reported in 1998, many people died worldwide because of rabies (Warrell and Warrell, 1995) and Most of those deaths occurred in tropical developing countries like Ethiopia (Cleaveland *et al.,* 2002). Canine rabies and hence human exposure can be controlled by intervening in the animal reservoir. The domestic dog is the most Empirical observation and models of the transmission of canine rabies. It is indicated that rabies can be eradicated if 70% of the dog population is vaccinated repeatedly to achieve herd immunity (Deressa *et al.*, 2010). In Ethiopia domestic dogs are the principal reservoir of rabies (Yimer *et al.*, 2002). Studies on dog ownership pattern and awareness of rabies in Addis Ababa showed that 90.7% of the dog owners manage dogs for the safe guarding of their properties from theft out of which 52% of them are without regular vaccination (Deressa *et al*., 2010).

In Ethiopia alone, more than 32,000 doses of nerve tissue based vaccine is distributed each year (data from recent documentation). A more realistic approach will be to phase out the use of nerve tissue based vaccines through technology transfer and gradual replacement within a given period of time with safe and effective modern cell culture vaccines. To increase modern rabies biological availability, strong consideration should be given to commercial vaccine production technology transfers, joint regional purchases and tariff reduction for the direct acquisition. In parallel to this, existing old vaccines should be discontinued and as they are gradually phased out. Strategies for the control and elimination of rabies should be facilitated through the purchase of commercial products on the world market or via local production of modern cell culture vaccines. This will facilitate the effort of rabies prevention and control in combination with similar activities to implement the strategy (Abebe *et al.*, 2016).

As reported by Abebe in 2016, despite of the highest impact of rabies in developing countries, rabies control programmes are a low priority by governments compared to economic development. Despite its public health and economic impact, there is no clear responsibility and budgetary allocations for rabies programmes in either Ministries of Health or Ministry of Agriculture. Additionally, the costs of rabies elimination campaigns fall short of similar cost/benefit programmes when compared to food production and human health programmes like TB, malaria and HIV/AIDS (WHO, 2012). Therefore, existing political and economic situations in developing countries where rabies poses a significant public health problem usually interfere negatively with rabies control programmes. For this, political support must come from within individual countries accompanied by continuing support and pressure from World Health Organization. However, the most important influence for political change will have to originate from private citizens, medical professionals, and agricultural and health ministers within each country which encourage the success of the program (WHO, 2012).

3. MATERIALS AND METHODS

3.1. Study Area descriptions

The study was conducted from November, 2018 to August, 2019 in two purposely selected districts, namely: Nejo and Gimbi, WestWollega Zones of Oromia Region, Ethiopia. The general description of the study area is illustrated inTable 6**.**

Table 6: The study area descriptions of Nejo and Gimbi districts

Descriptions	Districts	
	Nejo district	Gimbi district
Distance from Addis Ababa	515 km	440km
Boundary		
In the North direction	Benishangul Gumuz	Benishangul Gumuz
In the South direction	Jarso Woreda	Haru Woreda
In the East direction	Boji Dirmeji Woreda	East Wollega Zone
In the West direction	Leta Sibu Woreda	Lalo Asabi Woreda
Altitude	1500-2345 m.a.s	1845-1930 m.a.s
Latitude and longitude	$9^{o}30'N-9^{o}37'E\&35^{o}30'E-35^{o}34'E$	$9^{o}10'N35^{o}55'$
Mean annual Rain fall	1350-2200mm	1300-1800 mm
Mean Minimum and Maximum temperature	$19^{o}c$ and $23^{o}c$	$22^{o}c$ and $28^{o}c$
Human populations (both urban & rural)	152,741	173,084
Male	74,074	91,313
Female	77,866	81,771
Total animal populations	210, 317	276,134
Cattle	34,638	111,697
Sheep	22,512	48,234
Goats	9,196	9,838
Equines	9,711	11,020
Poultry	48,259	95,345

Source: (GWAO and NWAO, 2018)

The main farming system adopted in these areas is mixed farming and among animal species, cattle are the main abundant animal kept in rural areas. Apart from other livestock, no registered data was available regarding dog populations from both districts. Figure 4 shows map of the study areas.

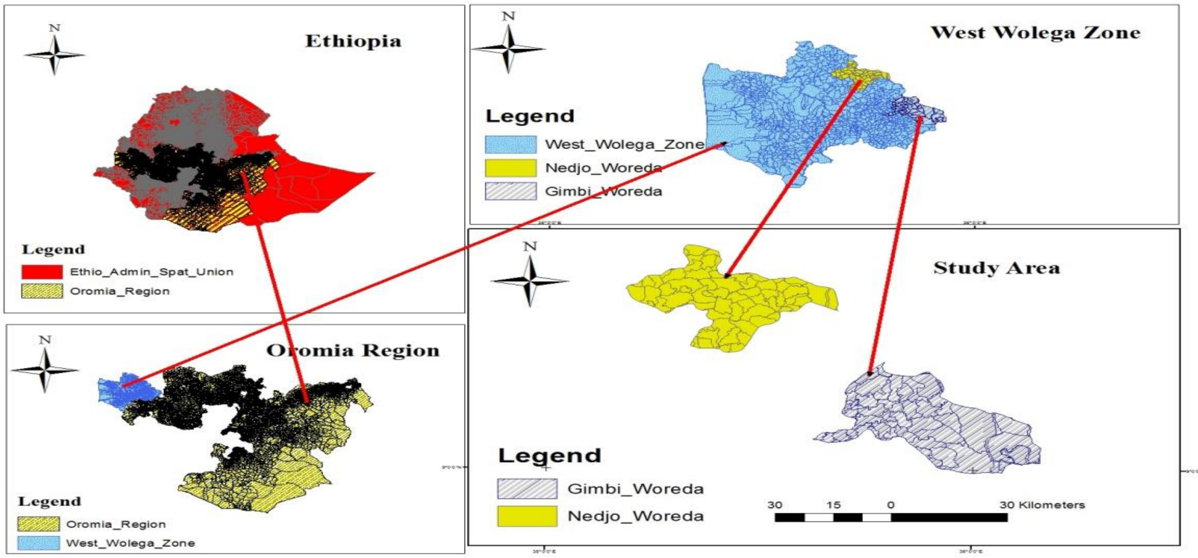

Figure 4: Map of the study areas

3.2. Study population

Dog or other animal bite victims registered to Gimbi and Nejo districts' General hospitals between September 2017 to September 2018 and unregistered victims searched extensively through linkage of the contacted victim using snowball method were considered as study population for retrospective study. The Heads of households (communities) of Gimbi and Nejo districs greater than 18 years selected from peasant Association (PA) were the study population for KAP study.

3.2.1. Inclusion and exclusion criteria

Patients with history of animal bites, particularly dogs, scratched and contacted with saliva of rabies suspected animals were included in to the study. For KAP study, all volunteer people (HHs) randomly selected from PA were recruited in to study. People less than 18 years, household who had not lived for 6 months as permanent resident and people who were unable to express their idea freely were excluded from this study.

3.2.2. Ethical consideration

The study was approved by Jimma University's Research and Post Graduate study, ethical review board of Jimma University College of Agriculture and Veterinary Medicine (JUCAVM). An oral consent was taken as illiteracy was there among the part of the respondents. Potential respondents (bite victims or their family members) were informed on the purposes of the research, the procedure followed during the interview on the subsequent use of their responses. Only completely voluntary people were enrolled to give their idea freely without any enforcement of the interviewer after they have selected randomly for KAP survey other wise the immediate next household was included in to the study. All respondents approached was agreed verbally to participate in the conducted interviews. Then, their response was registered on questionnaire paper, prepared prior to start the interview.

3.3. Study design

Cross-sectional and retrospective study design supported by pre-tested semi-structured questionnaire survey was conducted to assess the economic and pulic health burden of rabies; and people's indigenous knowledge, attitude and practice (KAP) toward rabies.

3.4. Sampling and sample size determination

The study districts, Gimbi and Nejo districts were selected purposely based on availability of hospitals that serves many people for PET for animal bite victims, information of rabies cases and ease of access for transportation. To contact those people registered to Hospitals with the history of dog bites, Peasant Associations (PAs) from the districts were also selected purposely based on obtained information from the hospitals as the most hit (prevalent) areas by rabies suspected dog or other animal bite cases. After contacting the registered animal bite victim by tracing back, unregistered bite victims were followed using snowball methods through the linkage made by the registered animal bite victim.

To assess the gaps on Knowledge, Attitude and Practice (KAP) of the people about rabies, simple random sampling technique was employed to select PAs. Gimbi district consists of 36 PAs whereas Nejo district consists of 39 PAs. Seventy five PAs from both districts were considered as the entire sampling units. From the entire sampling units, 17 PAs were selected using lottery method from the lists of PAs obtained at districts' administrative offices, i.e. Eight PAs from Gimbi and nine PAs from Nejo based on proportionl allocation of PAs per districts. Then, heads of households were selected using systematic random sampling from each PAs. The total sample size of households was determined using the formula recommended by Arsham (2007) for survey studies. That was;

$$N = 0.25/(SE)^2$$

Where; N = sample size and SE= standard error of the proportion.

Assuming the standard error of 4.1%, setting precision level at 5% and the confidence interval of 95%, then 150 households were selected for interview. To conduct the selection of households (HHs), list of HHs were obtained from recorded file cabinet found at each PAs administrative office. Then, sampling interval was calculated by deviding the entire number of HHs by the desired sample size of HHs required. From the sampling interval, the starting point was randomly selected and the interval was added to the random number to keep adding numbers in the sample until the required sample size was obtained. The numbers of households were selected based on proportional allocation of households found in each PAs. This was done by deviding the number of HHs in each PAs for the total numbers of HHs found in randomly selected PAs (17 PAs) and multiplied by 100. Then, the desired sample size per PAs was calculated proportionally from the total HHs selected for interview (150 HHs).

3.4.1. Retrospective hospital based survey data collection

Dog and other animal bite victims registered at Gimbi and Nejo districts' Hospitals for a period of one year (September 2017 to September 2018) were considered. Information gathered from the recorded case book and patient cards were: Patient's age, sex, residence (urban or rural), animal species biting, types of exposure, site of bite on the body part, the post exposure treatment (PET) given and types, presence of other treatments, the outcome of the bite, owner of animal and other relevant information (Appendix 1). Then, based on the eligible information, the victims were followed and asked for further information. In similar way, non-registered animal bite cases were contacted to be included in the study.

Questionnaire survey for Retrospective study

Dogs or other animal bite victims were interviewed in face to face using a pretested semi-structured questionnaire survey. In cases where the victim was deceased or a child, another family member was interviewed. Since most neighborhoods were socially close to each other and well informed about events happening to nearby their homes, an extensive searching for non-registered animal bite victims was made by asking the contacted victims whether they knew other people who were bitten but did not visit a hospital or health center. The indicated non-registered bite victims were subsequently contacted and interviewed, and then the linkage was made to another neighborhood in the same way. The animal data concerning rabies cases or suspected were taken concurrently with that of humans. The following information were included in to the questionnaires: Demographic features of the patient (age and gender), residence (urban or rural), body part bitten, ownership (own or unknown origin), site of bite, types of exposure, whether visited hospital and received PET, species of animal biting, the outcome of bite (died or survived), age at infection, if died, age at death and other information regarding their exposure (Appendix 2)**.**

To assess the economic and puplic health burdens due to rabies or rabies suspected exposure, data was simultaneously collected on the expenditures incurred related to direct economic lost such as; health care costs (treatment cost like vaccine, antibiotics, tetanus anti toxin and wound care costs), and non-health costs (transportation, accommodation, time lost while seeking treatments, number of workdays lost due to rabies suspected exposure, number of workdays other person lost to give care for his family members), economic loss resulted from animal death (direct and indirect loss) and cost incurred to treat animal. Indirect economic lost such as mortality (age at death) and morbidity (long-term effects of rabies or rabies suspected exposure, adverse effect from treatment, duration of illness until recovery) were also assessed in the same way. The questionnaire was initially developed in local language (Afan Oromo version) and translated to English language (Appendix 5).

3.5. Estimating the burden of Rabies in the areas

The public health and economic burden of rabies was assessed based on the cost classification by Jo (2014) with the Post Exposure Treatment (PET) costs indicated as the direct costs, consisting of health care and non-health care costs expressed in monetary terms and indirect costs in terms of DALYs as shown in the following table (Jo, 2014).

Table 7: Cost classification for burden of rabies exposure.

Direct costs		Indirect costs
Health care costs	Non-health care costs	• Mortality (DALYs) • Morbidity (DALYs)
• Diagnosis • Vaccine • Wound care and disinfection • Antibiotics • Tetanus immunization	• Transportation • Accommodation and food • Opportunity costs of time while seeking treatment • Travel time to hospital	

3.6. Data management and analysis

After collected, data were entered to Microsoft office Excel version 2010. Then, coded and imported to Stata version 14 statistical software (Stata Corp, 4905 Lakeway Drive College Station, Texas 77845 USA). Chi-square test was used to determine the association between independent variables (age, sex, and residence) and rabies or rabies suspected cases as dependent variable. The KAP score levels of respondents and key predictors (Residence, sex, age, marital status, educational status, occupation and religion) was analyzed using Multinomial logistic regression model and odds ratio was used to determine the strength of association between KAP scores and predictor variables.To assess the peoples' KAP toward rabies, the KAP Score levels of the community were ranked based on kaliyaperumal (2004) guidelines. Spearman's correlation analysis was used to assses the relationship between KAP scores and some key predictors (knowledge and Attitude, knowledge and practice, residence and knowledge, residence and attitude, residence and practice, levels of education and knowledge, levels of education and attitude, level of education and practice, occupation and knowledge, occupation and attitude, occupatinpon and practice, age and knowledge, age and attitude, age and practice) based on the rule of thumb for interpreting the size of correlation coefficient (Appendix Table 1). A p- value of < 5% was set for significance.

To estimate the economic burden, Cost incurred for PET per dog bite was considered as PET costs per sufficient treatment irrespective of the rabid status of biting dog. Then the value of the total direct PET costs per dog bite was expressed as the sum of health care and non-health care costs (Beyene *et al.,* 2018).The United States Dollar (USD) and Ethiopian birr (ETB) year exchange rate was estimated at 1 USD to 27 ETB during this study **(**Couharde *et al.*,2018).

These Costs were estimated based on the given interview responses of the bite victims regarding the doses of PET received, expenditures during the medical treatment related to transportation, accommodation, food and the opportunity time losses by themselves and their caregivers while seeking treatment, and previously recorded data from hospitals. The opportunity costs losses while seeking treatment was valued in monetary terms using the estimated day laborer cost (50 ETB/day) according to local contex.

Similarly, the economic loss related to livestock was estimated as direct economic loss due to animal death and indirect loss (treatment cost, dog vaccination and control costs, time spent for seeking treatment for animals, service year lost due to premature death, productivity loss from died cow and the salvage values of died animals). All the information regarding maximum parity of cow, year of service of ox, milk yield/cow/day and estimated costs of died animals were gathered from response of animal owners and assessed according to local context. However, to increase the validity of collected information prior to address in monetary terms, the study centered the national average milk yield of 1.371 Lit/cow/day and 6 months average lactation length of local lactating cows as Ethiopian context (CSA, 2017/18). All the summation of economic loss was valued in Ethiopian birr (ETB) and later converted to US dollars (USD) using the average annual exchange rate for the study period published by the National Bank of Ethiopia **(**Couharde *et al.*,2018).

To estimate public health burden of rabies, the adopted disability-adjusted life years (DALYs) estimation method developed by the World Health Organization (Fewtrell *et al.,* 2003) was applied. This states that, DALY is the sum of years of life lost (YLL) due to rabies and adverse effects of NTV and of years lived with disability (YLD) due to adverse effects of NTV. In accordance, one lost DALY is thought of as one lost year of healthy life and the total number of

DALY (i.e. the total burden of disease) as a measurement of the gap between the current health of a population and the ideal situation, where everyone in the population lives into old age in full health (Lapoze and Mathers, 2006).

Then, YLL was calculated as the number of human deaths within age category multiplied by the life expectancy of the concerned age category. In this study, the average Ethiopian life expectance taken was 65.5 years (Jembere *et al.,* 2018). Similarly, YLD was calculated by multiplying the total number of disability cases of the concerned age group with considering the duration of the disability (t in years) resulting from the NTV and its corresponding disability weight (DW) (Knobel *et al.*, 2005). In this study the disability weight for rabies was considered at 0.797**(**95% CI 0.718 **–** 0.864) (Ock *et al.*, 2016). When simplified,

DALYs= YLD + YLL, Where;

DALYs= Disability-Adjusted Life Years; YLD= Number of cases * Duration of illness* Disability weight of rabies; YLL = Number of Death * Life expectance at age of death

Finally, the economic and public health burdens regarding rabies or rabies suspected cases were assessed using summation of all direct and indirect economic losses, and public health burden in terms DALYs lost to summarize the findings.

4. RESULTS

4.1. Peoples' Knowledge, Attitude and Practice (KAP) toward rabies

4.1.1. Socio-demographic profiles of the respondents

A total of 150 households were interviewed to assess the peoples' indigenous Knowledge, Attitude and Practice (KAP) toward rabies in Gimbi and Nejo districts and their responses were subjected to be analyzed to summarize the findings. From these interviewees, 60(40%) where from Gimbi district; of which 40 (26.7%) were males and 20(13.3%) females. The remaining 90(60%) were from Nejo district, out of which 73(48.7%) were males and 17(11.3%) females. The majority of the respondents, 114(76%) were from rural areas whereas 36(24%) were from urban residents. The ages of respondents were devided in to three categories as 18-35, 36 -50 and ≥51 years in order to get information according to their ages. Accordingly, from the sampled interviewees, 61(40.7%) were between 18- 35 years old, 60(40%) were between 36-50 years and 29(19.3%) were ≥51 years old. The proportion of marital status was 22(14.7%) single, 124(82.7 %) married and 4(2.7%) were widowed. The majority of respondents had non-formal education (outside the formal school system like community education and life long education), accounted for 56(37.3%) whereas 42(28%), 25(16.7%) and 27(18%) respondents had tertiary, secondary and primary levels of education respectively. Farmers held a higher percentage, 89(59.3%) and the vast majority, 109(72.7%) were followers of protestant, whereas 39(26%) were followers of orthodox (Table 8).

Knowledge of respondents

From 150 household heads interviewed on their indigenous knowledge toward rabies, all of them have heard about rabies and out of which 98(65.3%) of them understand and able to describe the source of the disease as rabid dogs and 9(6%) were claimed the disease source to humans were foxes (Table 9). The Majority, 128(85.3%) heard about rabies from their families, 15(10%) heard from the community and health profossionals whereas few of them, 9(4.5%) were heard from teachers at school. Eighty five respondents, (56.7%), described that the cause of rabies as germs, 31(20.7%) as Satan and 32(21.3%) respondents didn't know the cause of the disease. Furthermore, description of knowledge of respondents towards rabies regarding the season of occurrence, source of infection to humans, clinical signs, means of identification from other fatal disease and the more common age groups of human affected were shown in the Table 9.

Table 8: Socio -demographic profiles of participants from Gimbi and Nejo districts, Western Oromia, Ethiopia

Socio -demographic characteristics	Districts (N=150)			Residence (N=150)		
	Gimbi	Nejo	Total	Urban	Rural	Total
Sex: Male	40(26.7%)	73(48.7%)	113 (75.3%)	30(20%)	83(55.3%)	113(75.3%)
Female	20(13.3%)	17(11.3%)	37(24.7)	6(4%)	31(20.7%)	37(24.7%)
Age (years) : 18- 35	29(19.3%)	32(21.3%)	61(40.7%)	13(8.7%)	48(32%)	61(40.7%)
36-50	22(14.7%)	38(25.3%)	60(40%)	17(11.3%)	43(28.7%)	60(40%)
≥ 51	9(6%)	20(13.3%)	29(19.3%)	6(4%)	23(15.3%)	29(19.3%)
Marital status: Single	13(8.7%)	9(6%)	22(14.7%)	7(4.7%)	15(10%)	(22(14.7%)
Married	45(30%)	79(52.7%)	124(82.7%)	28(18.7%)	96(64%)	124(82.7%)
Widowed	2(1.3%)	2(1.3%)	4(2.7%)	1(0.7%)	3(2%)	4(2.7%)
Educational status:						
Non-formal	16(10.6%)	40(26.7%)	56(37.3%)	4(2.7%)	52(37.6%)	56(37.3%)
Primary	9(6%)	18(12%)	27(18%)	2(1.3%)	25(16.7%)	27(18%)
Secondary	9(6%)	16(10.7%)	25(16.7%)	6(4%)	19(12.7%)	25(16.7%)
Tertiary	26(17.3%)	16(10.7%)	42(28%)	24(16%)	18(12%)	42(28%)
Occupation: Farmer	34(22.7%)	55(36.7%)	89(59.3%)	1(0.7%)	88(58.7%)	89(59.3%)
Animal and human H/worker	3(2%)	3(2%)	6(4%)	3(2%)	3(2%)	6(4%)
Teacher	4(2.7%)	8(5.3%)	12(8%)	5(3.3%)	7(4.7%)	12(8%)
*Others	19(12.7%)	24(16%)	43(28.7%)	27(18%)	16(10.7%)	43(28.7%)
Religion : Orthodox	17(11.3%)	22(14.7%)	39(26%)	6(4%)	33(22%)	39(26%)
Protestant	41(27.3%)	68(45.3%)	109(72.7%)	30(20%)	79(52.7%)	109(72.7%)
Muslim	2(1.3%)	0(0%)	2(1.3%)	0(0%)	2(1.3%)	2(1.3%)

H=Health; non-formal education (adult education, community education, life long education); * others=Traders, Jobless people, students above 18 years

Table 9: Knowledge of Participants on rabies regarding clinical signs, causes, and source of infection, means of identification and other information at the study areas

Knowledge of respondents toward rabies(**N=150**)	Frequency (No)	Percentage
Heard of rabies		
Yes	150	100%
Understanding on definition of rabies		
Disease causes madness to human and animals	10	6.7%
Disease comes from rabid dogs	98	65.3%
Disease comes from fox	9	6%
Disease comes from rabid dog and fox	17	16.3%
*Others	16	10.3%
Source of information about rabies:		
Family	128	85.3%
Teacher	7	4.7%
Others *	15	10%
Causes of rabies		
Germ	85	56.7%
Satan	31	20.7%
I don't know	32	21.3%
Others**	2	1.3%
Common season for occurrence of rabies case		
Spring	77	51.3%
Autumn	41	27.3%
Summer	20	13.3%
Winter	12	8%
Source of infection to human		
Rabid dog/dog	83	55.3%
Rabid dog/dog and fox	31	20.7%
Feeding of meat and milk of infected animals	11	7.3%
Others***	25	16.7%
Clinical sign/s an animal with rabies will show		
Salivation, aggressive , do not eat and drink	40	26.7%
Salivate, Restlessness , attempt to bite objects, animals& humans	56	37.3
Salivation, Expulsion of eyes, fears of water& light	16	10.7%
Others	38	25.3%
How to identify from other fatal disease		
Behavioral changes like mental illness and nervous	40	26.7%
Uncontrolled, bite every thing	23	15.3%
Hydrophobia, fear of light	34	22.7%
I don't know	37	24.7%
**Others	16	10.7%
Age groups of human more affected		
Young	40	26.7%
Adult	30	20%
All age groups	80	53.3%

Others (air, disease cause restlessness), others(community, H.profession), others** (air) others*** (contact with infected animals, air), **others (salivation, increased in eye size)

Attitude and practice of respondents

From 150 respondents interviewed, the vast majority, 143(93.5%) had positive response on seeking medical service if bitten by rabies suspect animals as soon as possible (Table 10). Higher proportion of respondents, 77(51.3%) disagreed with the idea that rabies is preventable by vaccination, while 73(48.7%) agreed it is preventable by vaccination. Almost all respondents, 137(91.3%) believed that rabies is a zoonotic disease, but very few of them 13(8.7%) claimed that it is not zoonotic. About 92 (61.3%) preferred modern veterinary drugs, whereas 58(38.7%) of them preferred traditional medicine if their animals are suspected from rabies. sixty nine (46%) of them used quarantine method for suspected cases of rabies in large animals (refere Table10**)**

Dog owners and their practice

Of 150 household heads interviewed, only 59 (39.3%) owned local breed dogs. From 59 dog owners, 31(52.5%) of them own two and above dogs per household, while 28 (47.5%) own only one dog per household. Fifty, 50(84.7%) of them keep their dogs for guarding of their house or properties whereas small numbers, 9(15.3%), keep for protecting wild life from crops at field. Regarding housing system, majority of dogs, 26(44%) were kept free range in field, 16(27%) lived free in house compound, 10(17%) were housed in cages, 5(8.5%) were mixed in house with families and smallest number 2(3.4%) were tied outside of the house (house with no compound). Higher proportions of respondents, 47(79.7%) didn't vaccinate their dogs during the past year or the year of this study. The reason claimed why not vaccinating given by 27(45.8%) was not aware of importance of dog vaccination, 17(28.8%) respond as didn't know the presence of vaccine for the disease, 4(6.8%) used traditional medicine and 12(20.3%) respondents vaccinated their dogs (Table11).

Table 10: Frequency distribution of Attitude and practice tool of participants toward rabies

Attitude and practice of respondents (N=150)	Frequency	Percentage
Any one exposed to rabies should seek medical evaluation immediately		
Yes	143	95.3%
No	7	4.7%
Rabies can be prevented by vaccination		
Yes	73	48.7%
No	77	51.3%
Traditional healers and herbal medicine can cure rabies		
Yes	106	70.7%
No	44	29.3%
Handling infected animals and feed offer can transmit rabies		
Yes	103	68.7%
No	47	31.3%
Do you belief Rabies is zoonotic?		
Yes	137	91.3%
No	13	8.7%
Dead animal from rabies will act as source of infection for other		
Yes	43	28.7%
No	107	71.3%
Rabies can be transmitted by eating carcass with case of rabies		
Yes	103	68.7%
No	47	31.3%
Practices		
Measures should be taken against suspected case of rabies in animals		
Quarantine	69	46%
Treat	60	40%
Vaccination	7	4.7%
Others	14	9.3%
Suspected case of rabies in dogs		
Killing immediately	125	83.3%
Tie and follow any abnormalities, if abnormal killing	21	14%
Others	4	2.7%
Treatment of choose for animal diseased from rabies		
Modern /veterinary drugs	92	61.3%
Traditional/herbal medicine	58	38.7%
Management of rabies outbreaks in herd/dog population		
Isolation	79	52.7%
Avoiding contact with infected herd	61	40.7%
Give vaccine	8	5.3%
Neither	2	1.3%
The immediate measures for symptomatic case of rabies		
Take to nearby vet clinic	41	27.3%
Kill and destroy	59	39.3%
Report to nearby vet clinic / health center	50	33.3%
How do you handle animal died off rabies?		
Burying	86	57.3%
Leave on open field for scavengers	64	42.7%

Table 11: Dog owners and their practice related to history of vaccination, housing system and others at the study areas

Dog owners and their practice (N=150)	Frequency	Percentage
Owned dogs		
Yes	59	39.3%
No	91	60.7%
Breed		
Local	59	100%
Number of dogs per house hold		
One	28	47.5%
Two and above	31	52.5%
Purpose of keeping dogs		
Guard of house or properties	50	84.7%
Protecting wild life from crops on field	9	15.3%
Housing system		
Live in house with family	5	8.5%
Free in house compound	16	27.1%
Free in the field	26	44%
Housed in cages	10	17%
Tie out side	2	3.4%
Kind of food they feed		
Normal food eat for them selves	30	50.8%
Normal food eat for themselves and what they get on field	29	49.2%
Vaccination history during this year or last year		
Yes	12	20.3%
No	47	79.7%
Reason for not vaccinating		
Not aware of importance of vaccinating dogs	27	45.8%
I don't know presence of vaccine for the disease	16	28.8%
Use traditional medicine	4	6.8%
Vaccinated	12	18.6%
Interested to vaccinate regularly		
Yes	55	93.2%
No	4	6.8%

4.1.2. Peoples' KAP score levels

The KAP scorewas used to rank the level of knowledge, attitude and practice of the people, by giving score of 1 for the correct answer and score of 0 for wrong answer. Then each response concerning questions was pooled together for each respondent and the KAP Score level of the people regarding rabies was computed. The total sums of the scores for questions pertaining to each tool was grouped in to three ranked categories, the highest score was referred to as good (answered ≥75%), the middle was referred to as moderate (answered 60-75%) and the lowest was referred to as poor (answered ≤60%) based on proportions of questions they answered (Table12).

Pertaining to knowledge score level, 16 questions were asked and majority of the people 64 (42.7%) (95% CI: 0.35-0.51) had good knowledge, 33 (22%)(95% CI: 0.15- 0.29) had moderate knowledge while 53(35.3%)(95% CI: 0.23-0.43) of them had poor knowledge score toward rabies. In the same way, to assess their attitude toward rabies, 9 questions were asked and the highest proportion 60(40%) (95% CI: 0.32-0.48) had poor attitude, 50(33.3%) (95% CI: 0.26-0.41) had good attitude whereas 40(26.7%) (95% CI, 0.20-0.34) had moderate attitude score level (Table 12). Regarding practice towards rabies, 12 questions were asked; 7questions to all respondents and 5 questions only to respondents who owned dogs (Table12). Majority of them 95(63.3%)(95% CI: 0.56-0.71) scored poor practice, 35(23.3%) (95% CI: 0.17-0.30) had scored moderate and the smallest proportion 20(13.3%)(95% CI: 0.08-0.19) had scored good practice toward rabies. Concerning practice involving only dog owners (59 dog owners), the highest proportion 43(73%) (95% CI: 0.62- 0.84) had poor practice level, 10(17%)(95% CI, 0.07- 0.27) of them scored moderate practice and the lowest proportion, 6(10%)(95% CI, 0.02- 0.18) had good practice score level on their dog management (Table 12).

Table 12: Frequency and percentage distributions of KAP Score levels respondents

KAP Score levels	Frequency	Percent (95% CI)
Knowledge score level (16Q)		
Good (≥ 75%)*	64	42.7% (0.35-0.51)
Moderate (60-75%)*	33	22% (0.15- 0.29)
Poor (≤60%)*	53	35.3% (0.23-0.43)
Attitude score level (9Q)		
Good (≥ 75%)*	50	33.3% (0.26- 0.41)
Moderate (60-75%)*	40	26.7% (0.20-0.34)
Poor (≤60%)*	60	40% (0.32-0.48)
Practice score level (7Q)		
Good (≥ 75%)*	20	13.3% (0.08-0.19)
Moderate (60-75%)*	35	23.3% (0.17-0.30)
Poor (≤60%)*	95	63.3% (0.56-0.71)
Dog owners and their practice(Q)		
Good (≥ 75%)*	6	10% (0.02- 0.18)
Moderate (60-75%)*	10	17% (0.07- 0.27)
Poor (≤60%)*	43	73% (0.62- 0.84)

Q :Questions; Good (≥ 75%*)= respondent answered ≥ 75%; Moderate (60-75%*) = Those answered 60-75% ; Poor (≤60%*) = Those answered (≤60%*)

4.1.3. Multinomial logistic regression analysis of KAP Scores and key predictor variables

The result of multinomial logistic regression analysis indicated that Statistically significant difference was observed between sex groups [OR = 8.8 (95%CI: 1.62-48.47), p= 0.012], Marital status[OR=0.41(95%CI:0.002-0.81), P=0.036] and levels of education [OR=0.053(95%CI:0.007-0.43), P=0.006; OR= 0.05(95%CI:0.007-0.34), p= 0.003] on the levels of respondents' knowledge about rabies. A higher proportion of moderate knowledge score was observed in male respondents (27.4%) compared to female respondents (5.4%). Male respondents had 8.8 times more likely a moderate knowledge than female respondents and married respondents had 0.41 times less likely a moderate knowledge compared with single respondents. The highest good knowledge (88.1%) was observed in respondents with tertiary education levels and the highest moderate knowledge (36%) was seen in respondents with secondary levels of education. A good knowledge score was observed 0.053 times less likely in farmer respondents compared to tertiary levels of education and a moderate knowledge score was observed 0.05 times less likely in farmer respondents compared with secondary levels of educations. Residence [OR=0.2(95%CI: 0.02-1.25), P=0.079] and ages [OR=2.7(95%CI: 0.36-20.41), p=0.33; 0.92(95%CI: 0.13-6.36), p=0.93] of respondents have no effect on the knowledge scores of respondents about rabies (Table 13)

Moreover, multinomial logistic regression analysis indicated that there was statistically significant difference between levels of education [OR= 36.9(95%CI: 3.06-443.74), P=0.005], Occupations [OR=15.49(12.42 -18.57), P=0.000], sex groups (OR=0.2(0.06-0.58), P=0.004) and Religions [OR= 17.2(15.08 - 19.43), p= 0.000] of respondents on their levels of attitude toward rabies. A good attitude score was revealed 36.9 times more likely in respondents with tertiary levels of education than respondents with primary levels of educations. Similarly, a good attitude score was observed 15.49 times more likely in health professionals than farmer respondents. A moderate knowledge score was observed 0.2 times less likely in female respondents than male respondents and 17.2 times more likely in Muslim respondents compared to orthodox followers (refere Table 14).

Pertaining to practice score levels of respondents towards rabies, significant difference was observed between levels of education [OR= 2.9 (95%CI: 0.51-5.33), P=0.018; OR=1.97(95%CI: 0.26-3.68), p= 0.024] and types of occupations (OR= 15.38(95%CI: 13.14-17.64), P =0.000;

OR= 14.59(95% CI: 12.36-16.83), p= 000]. A good practice score was observed 2.9 times more likely in respondents with tertiary levels of education compared to non-formal respondents and a moderate practice score was seen 1.97 times more likely in respondents with tertiary levels of education than respondents with no formal education levels. Similarly, being health professionals had an effect of having 15.38 times more likely good practice score than farmer respondents. A moderate practice score was also observed 14.59 times more likely in health professionals compared to farmers respondents (Table15).

Table 13: Multinomial logistic regression analysis of knowledge scores of Gimbi and Nejo districts' community and key predictor variables

Predictor variables	category	Good			Moderate		
		%	OR (95% CI)	p-v	%	OR (95%CI)	p-v
Residence	Rural*	31.6%	-	-	24.5%	-	-
	Urban	78%,	0.2(0.02-1.25)	0.079	14%	0.31(0.03-2.96)	0.31
Sex:	Female *	46%	-	-	5.4%	-	-
	Male	41%	1.05(0.22-4.91)	0.06	27.4%	8.8(1.62-48.47)	0.012
Age (years)	18-35*	55.7%	-	-	24.6%	-	-
	36-50	40%	2.7(0.36-20.41)	0.33	21.7%	1.6(0.40-6.44)	0.51
	≥51	20.7%	0.92(0.13-6.36)	0.93	17.2%	0.91(0.24-3.50)	0.89
M/ status	Single*	63.6%	-		27.3%	-	-
	Married	40.3%	0.86(0.10-7.14)	0.89	21.8%	0.41(0.002-0.81)	0.036
	Widowed	0%	-	-	0%	-	-
E/status	primary *	14.8%	-	-	25.9%	-	-
	secondary	52%	0.26(0.047-1.39)	0.114	36%	0.05(0.007-0.34)	0.003
	Tertiary	88.1%	0.053(0.007-0.43)	0.006	11.9%	$9.35e^{-9}(4.91e^{-10}-1.85e^{-7}$	0.000
	Non formal	17.9%	0.91(0.20-4.36)	0.90	21.4%	0.94(0.22-3.95)	0.93
Occupatn	Farmer*	23.6%	-	-	21.4%	-	-
	H. professional	100%	$6.26e^{-7}(5.24e^{-8}-7.49e^{-6})$	0.000	0%	0.14(0.01-3.38)	0.227
	Teacher	91.7%	0.6(0.078-4.60)	0.040	8.3%	$9.83e^{-8}(2.03e^{-8}-4.76e^{-7})$	0.000
	Others	60.5%	6.3(0.62-64.20)	0.12	30.2%	0.38(0.24-6.04)	0.49
Religion	Orthodox *	33.3%	-	-	23.1%	-	-
	Protestant	45.9%	0.8(0.21-3.04)	0.73	21.1%	1.2(0.35-4.36)	0.74
	Muslim	50%	1.6(0.13-19.10)	0.71	50%	$5.2e^{-8}(6.75e^{-9}-3.99e^{-7})$	0.000

*Indicated for reference category; H= Health; M= Marital; poor – reference gategory

Table 14: Multinomial logistic regression analysis of attitude scores Gimbi and Nejo districts' communities and key predictor variables

Predictors variables	Category	Good			Moderate		
		%	OR (95% CI)	p-v	%	OR (95%CI)	p-v
Residence	Rural*	27.2%	-	-	27.8%	-	-
	Urban	52.8%	0.4(0.06-2.60)	0.34	26.3%	1.2(0.16-8.92)	0.87
Sex	Female *	29.7%	-	-	3.5%	-	-
	Male	34.5%	0.3(0.08 -1.44)	0.14	31.9%	0.2(0.06-0.58)	0.004
Age (years):	18-35*	50.8%	-	-	21.3%	-	-
	36-50	28.3%	0.8(0.20-3.61)	0.82	28.3%	0.8(0.24-2.84)	0.76
	≥51	6.9%	0.2 (0.27-2.00)	0.18	34.5%	0.7(0.17-3.20)	0.68
M/status:	Single*	168.2%	-	-	22.7%	-	-
	Married	28.2%	0.78(0.2-2.89)	0.85	27.4%	0.67(0.05-9.73)	0.77
	Widowed	0%	-	-	25%	1.4(0.05-35.84)	0.8
Ed/status:	primary *	14.8%	-	-	26%	-	-
	secondary	36%	3.2(0.61-16.43)	0.17	36%	3.2(0.66-15.26)	0.15
	Tertiary	75%	36.9(3.06-443.74)	0.005	20.5%	16(1.11-229.45)	0.042
	Non formal	7.4%	0.6(0.12-2.83)	0.49	27.8%	1.2(0.38-3.91)	0.74
Occupation	Farmer*	12.4%	-	-	30.3%	-	-
	H. professional	100%	15.49(12.42 -18.57)	0.000	0%	-	-
	Teacher	83.3%	0.47(-2.87- 3.82)	0.78	8.3%	0.12(0.002-7.74)	0.32
	Others	54.5%	1.2(-0.83- 3.27)	0.24	27.3%	0.8(0.07-8.67)	0.83
Religion	Orthodox *	28.2%	-	-	23.1%	-	-
	Protestant	35.8%	0.7(0.2-2.89)	0.64	26.6%	0.15(0.86- 1.17)	0.76
	Muslim	0%	0.65(0.03-14.38)	0.78	100%	17.2(15.08- 19.43)	0.000

*Indicated for reference category; H= Health; M= Marital, poor is reference category

Table 15: Multinomial logistic regression analysis of practice scores of Gimbi and Nejo district's community and key predictor variables

Predictor variables	Category	Good			Moderate		
		%	OR (95% CI)	p-v	%	OR (95%CI)	p-v
Residence	Rural*	6.1%	-	-	23.7%	-	-
	Urban	36.1%	1.33(-0.34-3.0)	0.12	22.2%	0.12(-1.37-1.62)	0.87
Sex	Male *	15%	-	-	23%	-	-
	Female	8.1%	0.95(-2.88-0.96)	0.33	24.3%	0.25(-1.34-0.83)	0.64
Age (years)	18-35*	16.4%	-	-	29.5%	-	-
	36-50	30%	0.08(-1.59-1.74)	0.93	20%	0.2(-1.38-0.97)	0.73
	≥51	6.9%	0.16(-2.47-2.14)	0.89	17.2%	0.32(-1.92-1.27)	0.67
M/status:	Single*	22.7%	-		31.8%	-	-
	Married	12.1%	0.28(-2.08-1.52)	0.76	21.8%	0.32(-1.88-1.24)	0.67
	Widowed	0%			25%	0.6(-2.86-4.09)	0.72
Ed/status:	Non-formal*	1.9%	-	-	11.1%	-	-
	primary	3.7%	0.67(-2.48-3.82)	0.67	29.6%	1.09(-0.12-2.29)	0.074
	secondary	12%	1.8(-0.59-4.20)	0.14	28%	1.3(-0.04-2.70)	0.057
	Tertiary	34.1%	2.9(0.51-5.33)	0.018	31.8%	1.97(0.26-3.68)	0.024
Occupation	Farmer*	3.4%	-	-	20.2%	-	-
	H. professional	50%	15.38(13.14-17.64)	0.000	50%	14.59(12.36-16.83)	0.000
	Teacher	25%	0.38(-2.74-1.98)	0.75	33.3%	0.43(-2.56-1.69)	0.69
	Others	25.6%	0.41(-2.88-2.06)	0.74	23.2%	0.72(-2.33-0.88)	0.37
Religion	Orthodox *	7.7%	-	-	18%	-	-
	Protestant	15.6%	0.71(1.01-2.43)	0.41	25.7%	0.35(-0.75-1.44)	0.53
	Muslim	0%			0%		

*Indicated for reference category; H= Health; M= Marital; poor is reference category

4.1.4. Correlation Analysis of KAP Scores and some determinant predictors

The Spearman's correlation analysis (rho, r_s) was conducted to assess the relationship between some key predictors (residences, levels of education, occupation and age) and individual KAP scores. There was moderate positive correlation between levels of education and knowledge score (r_s= 0.622, P<0.001) and Occupation and settings of respondents (r_s= 0.657, P<0.001) and occupation and level of education(r=0.622, P< 0.001). Similarly, there was low positive correlation between attitude and knowledge scores (r_s=0.373, P<0.001), knowledge score and occupation (r_s=0.481, P<0.001), attitude score and occupation (r_s=0.483, P<0.001), and negligible positive correlation between practice scores and knowledge score (r_s=0.259, P<0.001). Furthermore, there was low negative correlation between ages and knowledge scores (r= -0.316, P<0.001), age and attitude scores (r=-0.322, P<0.001), age and levels of educational (r= -0.394, P< 0.001), age and occupation (r= -0.324, P<0.001), and negligible negative correlation between age and levels of practice (-0.171, P<0.037) (Table 16).

Table 16: Correlation analysis of key predictors variables and KAP Scores of the community of Gimbi and Nejo districts

Variables	Knowledge score	Attitude score	Practice score	Residence	Level of Education	Occupation	Age
	r_s p-value	r_s p-value	r_s p-value	r_s p-value	r_s p-value	r_s p-value	R p-value
Knowledge score	1 -						
Attitude score	0.373 0.001*	1 -					
Practice score	0.259 0.001	0.365 0.001*	1 -				
Residence	0.399 0.001	0.263 0.001	0.309 0.001*	1 -			
Education level	0.622 0.001*	0.571 0.001*	0.463 0.001*	0.460 0.001*	1 -		
Occupation	0.481 0.001*	0.483 0.001*	0.657 0.001*	0.657 0.001*	0.622 0.001*	1 -	
Age	-0.316 0.001*	-0.322 0.001*	-0.171 0.037	0.022 0.790	-0.394 0.001*	-0.324 0.001*	1 -

r_s = Spear's man ranked correlation analysis

4.2. Retrospective data on rabies suspected dogs/animal bites

Of 87 human rabies suspected cases obtained, 45(51.7%) were registered to hospitals and 42(48.3%) were non-registered obtained through extensive searching (Table 17). From Gimbi district the most rabies or rabies suspected outbreak PAs, i.e., Gagao kere seven victims (8%), Lelisa yesus twenty five victims (28.7%), Cholli Michael ten victims (11.5%), Gimbi-01 four victims (4.6%) and from Nejo district, Nejo-03 kebele seventeen victims (19.5%) were searched and interviewed (Figure 5).

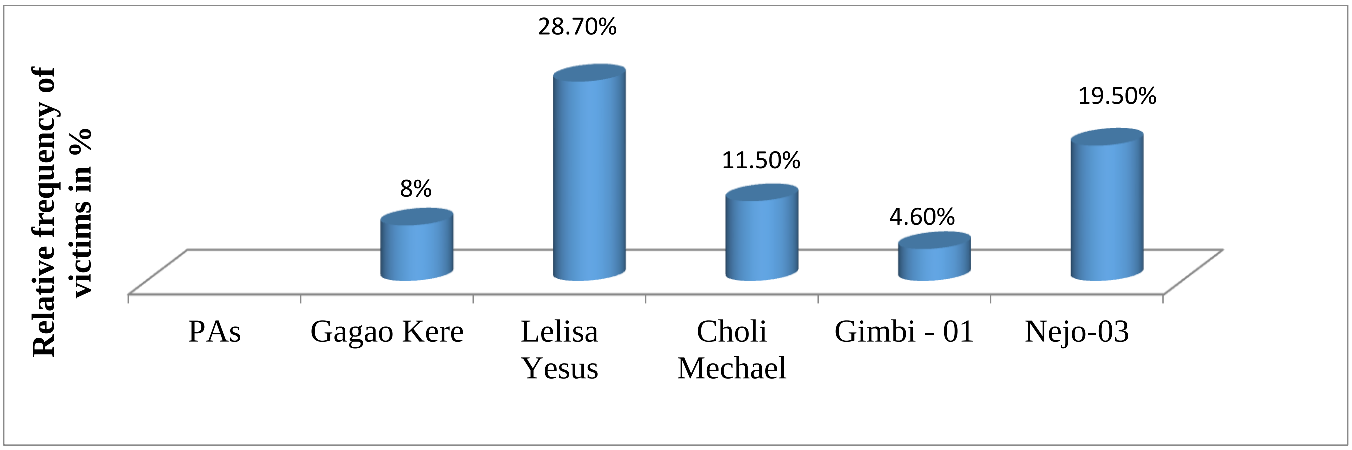

Figure 5: The most rabies suspected prevalence PAs from both Districts

Large number of suspected cases, 52(59.8%) were caused by unknown origin of animal bites while 35(40.2%) were from known origins. Among animals claimed to cause bites, dogs were responsible for the highest proportion, 65 (74.7%), followed by foxes 7(8%), donkey 6(6.9%) and 9(10.3%) cases were resulted from contacted with saliva of rabies suspected animals, contacted with rabies suspected animals and humans. Bitten on the legs was accounted for the highest percentage of all exposed sites, 41(47.1%) while each of hands and multiple site shared 20(23%) and 17(19.5%) respectively from the exposed parts of the body. On their post exposure practice, 66(75.9%) of the victims attended post exposure treatment (PET), where 21(24.1%) rabies suspected victims didn't attend PET. Majority of them have taken Nerve Tissue Vaccine 56(64.4%) and some, 10 (11.5%) have taken deltoid anti rabies vaccine (Table 17). Regarding the outcome of the treatments, 32(36.8%) of the victims were discharged with follow up, 34(39.1%) were discharged without follow up, 3(3.4%) were died and 18(20.7%) of them used traditional medicine at home.

Table 17: Descriptions of retrospective data on rabies suspected cases 2017- 2018, in selected PAs of Gimbi and Nejo districts

Descriptions	Frequency	Percent
Districts : Nejo	41	48.1%
Gimbi	46	51.9%
Residence		
Urban	32	36.8%
Rural	55	63.2%
Sex : Male	54	62.1%
Female	33	37.9%
Age (in year) : 0- 15	31	35.6%
16- 28	15	17.2%
29-50	30	34.5%
≥ 51	11	12.6%
Data source: *Registered case	45	51.7%
**Non- registered case	42	48.3%
Species of animal bitten them : Fox	7	8%
Dog	65	74.7%
Donkey	6	6.9%
*Others	9	10.3%
Owner ship of animals : Known	35	40.2%
Unknown	52	59.8%
Types of exposure : Laceration	22	25.3%
Scratch	25	28.7%
Puncture	29	33.3%
Contact with saliva	8	9.2%
Other	3	3.4%
Sites of bite : Leg	41	47.1%
Hand	20	23%
Multiple	17	19.5%
Other (finger, buttock)	9	10.3%
PET administered : Yes	66	75.9%
No	21	24.1%
Types of PET administered : NTV	56	64.4%
Deltoid vaccine	10	11.5%
Wound treatment at hospital : Yes	51	58.6%
No	36	41.4%
Other source of treatment options		
Traditional/ herbal medicine	23	31%
Outcome of the bite		
Discharge with follow up	32	36.8%
Discharge without follow up	34	39.1%
Death	3	3.4%
Used traditional medicine at home	18	20.7%

*Others – contact with rabies suspected animals and humans,*Registered - (obtained from patient cards)
**non- registered- (snowball methods)

Gimbi district shared the highest proportions of the cases, 46(52.9%) and Nejo district shared the proportions of 41(47.1%). Statistically significant difference was observed among urban and rural settings (χ^2=4.2, p=0.04) and the age groups (χ^2=8.511, p= 0.037) to be claimed as rabies or rabies suspected cases. Rural people were accounted for higher percentage of rabies suspected cases, 55(63.2%) compared to urban people, 32(36.8%). Moreover, males were more exposed 54(62.1%) than females 33(37.9%). However, no significant difference was revealed between males and females (χ^2 = 0.587, P= 0.443) on their rabies suspected exposure. The age of the victims was categorized as 0-15 years, 16- 28 years, 29-50 year and those found in 51 and above year. Those victims found between the ages of 0-15 years were accounted for the highest proportion 31(35.6%) of rabies or rabies suspected cases compared to the age groups found in 51 and above years (Table 18).

Table 18 : The Association between rabies suspected cases and key predictors

Predictors	Rabies suspected Cases (%)			χ^2	Df	P-value
	Dog/ other animal bite	None bite	Total (%)			
Residence:	72(100%)	15(100%)	87	4.2	1	0.041
Urban	23 (31.9%)	9 (60%)	32 (36.8%)			
Rural	49(68.1%)	6(40%)	55 (63.2%)			
Sex :	72(100%)	15(100%)	87	0.587	1	0.443
Male	46(63.9%)	8(53.3%)	54 (62.1%)			
Female	26(36.1%)	7(46.7%)	33(37.9%)			
Age (in year) :	72(100%)	15(100%)	87	8.511	3	0.037
0-15	25(34.7%)	6(40%)	31 (35.6%)			
16- 28	14(19.4%)	1(6.7%)	15 (17.2%)			
29-50	27(37.5%)	3(20%)	30 (34.5%)			
≥ 51	6(8.3%)	5(33.3%)	11(12.6%)			

4.3. Economic and public health burden of rabies in the study areas

4.3.1. The magnitude of Rabies in animals and humans between 2017 and 2018

Of 244 livestock species identified from the household interviewed, the cumulative incidence of animals suspected from rabies was 41% and the case fatality was 36%. Of 36 livestock death reported, cattle held higher proportions, 18(50%), followed by poultry due to bite injury, 11(30.56%), sheep 3(8.3%) and each donkeys and goats shared equal proportions of 2 (5.56%) (Table19)

Table 19 : Magnitude and number of rabies suspected animal cases at the most hit PAs of the districts

Districts	PAs	Spps of animals	Total animals	No. of suspected cases	Cumulative incidence (%)	No.died	Case fatality (%)
Nejo	Nejo-03	Cattle	11	1	9.1	1	100%
		Sheep	5	4	80%	3	75%
		Donkey	2	1	50%	1	100%
Gimbi	Gimbi -01	Cattle	3	1	33.3%	1	100%
	Lelisa –yesus	Cattle	48	11	22.9%	6	54.5%
		Sheep	27	-		-	-
		Goat	11	-		-	-
		Donkey	8	-		-	-
	Cholli michael	Cattle	85	57	67%	10	17.5%
		Goat	11	3	27.3%	2	66.7%
		Donkey	12	2	16.7%	1	50%
		Poultry	21	21	100%	11	52.4%
Total			**244**	**100**	**41%**	**36**	**36%**

From 63 rabies suspected human exposure cases interviewed, the highest proportions, 55 (87.3%) were resulted from bite cases in which dogs were the most dominant animal species 45 (71.4%) to cause the bite. Three human deaths (4.6%) were reported due to dog bites from both districts (Table 20).

Table 20 : The magnitudes of rabies suspected human cases in Gimbi and Nejo districts

Districts	PAs	Rabies suspected human cases	Bites			Total	Non-bite	No of died	Case fatality (%)
			Dog	Fox	Donkey				
Nejo	Nejo-03	17	12	0	2	14	3	2	11.76%
Gimbi	Gimbi -01	4	3	1	0	4	-	-	-
	Lelisa yesus	25	15	2	3	20	5	1	4%
	Cholli-Michael	10	10	0	0	10	0	-	-
	Gagao- kere	7	5	2	0	7	0	-	-
Total		**63**	**45(71.4%)**	**5(7.9%)**	**5(7.9%)**	**55(87.3%)**	**8(12.7%)**	**3**	**4.76%**

4.3.2. Estimation of socio-economic burden

Direct economic loss from Livestock deaths

Based on the obtained information, the total livestock death as a result of suspected dog bites in a year of 2017-2018 from both districts were 18 cattle, 3 sheep, 2 goats, 2 equines and 11 poultry (due to bite injuries). The direct economic losses resulted from all animal deaths were estimated independently and summed together to be expressed in monetary terms. During the occurrence of the disease, the average price of one ox was estimated at 9,000 ETB and the other was10, 000 ETB based on evidence from the client of the animals. From both districts 2 oxen were died and estimated at a price of 19,000 ETB (703.70 USD).

Three lactating cows, two dry cows and one pregnant cow were died from rabies suspected animals in the year enrolled for this study. The price of lactating cows ranged from 7,000 ETB birr to 8,000 ETB, on average it was estimated at 7,333 ETB. The total loss from three lactating cows was 3* 7,333 ETB = 21,999 ETB. The price of pregnant cow was estimated at12,000ETBand that of each dry cows was estimated at 6,300 ETB and5,700 ETB.Then,the total losses from three lactating cows, one pregnant and two dry cows was estimated at 21,999 ETB + 12,000ETB + 12,000ETB = 45,999 ETB (1,703.67USD). The data obtained from the owners of animals also suggested that, four steers, each estimated to an average value of 4,500 ETB, six heifers, estimated to minimum and maximum values of 3,000 ETB and 4,000 ETB, on average 3,500 ETB during the study year. Then the total losses from four steers and six heifers was 4,500 ETB * 4 + 3,500 ETB * 6 = 39,000 ETB (1,444.44 USD).

The death was also reported in one sheep and 2 lambs, one sheep's value was estimated to 1800 ETB, each lamb estimated to a value of 350 ETB, two pregnant goats, estimated to a value of 1,800 ETB and 2,400 ETB , two donkeys, estimated at 2,500 ETB and 3,500ETB and eleven exotic poultry were died due to bite injury from rabid dog, each of them estimated to a minimum and maximum values of 300 ETB(6poultry) and 350 ETB(5poultry) respectively and on average 322.70 ETB. Then the summation of total losses from one sheep, 2 lambs, 2 pregnant goats, two equines and eleven poultry was 1* 1,800 ETB + 2 * 350 ETB + 4,200ETB + 6,000ETB + 11* 322.70 ETB = 16,249.70 ETB(601.84 USD).

The overall direct economic losses resulted from animal deaths was expressed as the summations of the estimated values for each species of animals. That was 19,000 ETB + 45,999 ETB + 39,000 ETB+ 16,248.70 ETB = 120,248.70 ETB (4,453.66 USD).

Indirect losses

Expression of Service years lost in monetary terms due to livestock death

The monetary loss concerning service years lost due to livestock death was assessed by calculating the remaining life time at which the animal was passed away without giving service. This was estimated based on oral response of local people and supporting literature in Ethiopian context.

Draught oxen: In this study, two draught oxen were died due to rabies. One ox was died after giving service for three years and the other was died after giving service for one year (information obtained from the animal owners). The average service time of draught ox prior to stop ploughing was about 6 years (local people) and the rent price for a pair of oxen was about 100 ETB per day for ploughing and a single ox could be rented to 50 ETB. The average working seasons using oxen in western part of Ethiopia was around six months per year and the average working days per month was estimated to 16days/month (local people suggestion). Therefore, the service year lost resulted from the death of two oxen was estimated at 16days (working days/month) * 6months (working season per year) * three years (service years lost) + 16days (for second ox) 6months * five years (service years lost). Then the total time lost without service was 96 days * 3 + 96 days * 5 = 768 days were lost without giving any service, and in monetary terms 768 days * 50 ETB = 38,400 ETB(1422.22 USD) was lost due to death of two oxen resulted from dog bite without giving service. The feed lost from died animal whithout giving service was not encorporated to the study since they used extensive feeding from field and rural people couldn't able to estimate its value.

The study also attempted to assess the productive loss from deaths of lactating cows (milk yield) and pregnant cows. This was estimated based on information obtained from local people about the average number of parity (calves born from one cow through full time). According to their thoughts, a lactating cow could give at least 5 calves with an approximation of 8 months lactation length with adequate management and in absence of disease. However, to express the milk yield lost, the present study used the national average lactation period (about 6months) and average milk yield (1.371Lit./cow/day) for local cows reported by CSA, 2017/18. The parity of died lactating cows were: two for the first cow with four weeks lactation period, four for the second cow with lactation period of 5 months, one for the third cow with 3 months lactation periods and null for pregnant cow respectively. From economic point of view, thirteen calves (13) were left without born due to premature animal deaths and the study also estimated the values of calves left unborn in terms of monetary loss based on the information obtained from animal owners. The value of one Liter of milk was estimated at 18 ETB and the average approximated value of one died calf was estimated at 2,000 ETB during that period (information from animal owners).

Therefore, the overall service loss from the deaths of three lactating cows and one pregnant cow was estimated as the summations of milk yield loss due to death and calves left unborn. This was assessed independently for each animal and added together. Accordingly, the productivity lost from the first lactating cow was six months (the average national lactation length of local cow) * 3 (parity loss, since the cow gave 2 births before) + 4 months (lactation period lost at death) = 22 months of lactation periods were lost. For the second cow, six months *1 (parity loss) + 4.5 months (lactation time lost at death) = 10.5 months were lost. Similarly, for the third cow, six months * 4 (parity loss) + 4 months (lactation time lost at death) = 28 months were lost. The pregnant animal was died at the first stage of pregnancy. Hence, six months * 5 (parity loss) = 30months were lost. Therefore, the total lactation period lost without service was 22 months + 10.5 months + 28 months + 30 months = 90.5 months (2715days) of lactation periods were lost. Then, the cumulative monetary loss from average milk yield was estimated at 1.371Lit./cow/day *2715days= 3,722.265Lit. When multiplied by the price of 1Lit.of milk (18 ETB) = 67,000.77 ETB (2,481.51USD). When incorporated with the average estimated values of calves left unborn (13 calve * 2000 ETB i.e. average cost of one calf= 26,000ETB,) the total productivity loss from the death of cows and calves left unborn was estimated at about 93,000.77 ETB (3,444.47 USD).

To assess the economic loss related to milk cessations, the information on milk cessations related to rabies suspection was collected from 8 households. From this information, four households discontinued milking for three weeks, two households for six weeks and two households for four weeks. On average it was about 4.3 weeks. Majority of the households reported the milk yield lost as 2Lit/cow/day. However, to validate the assessed monetary loss from cessations of milk yield, the present study centered the national average milk yield reported on1.371Lit/cow/day (CSA, 2017/18). Therefore, the cessations of milk yield were 4.3 weeks * 7 days/week *1.371Lit. * 14 lactating cows, which was estimated at about 577.74 Liters of milk yield lost. Therefore, the total monetary loss from cessation of milk due to suspicious of animals bitten by rabies suspected dog was estimated at 577.74 Lit. * 18 ETB = 10,399.32 ETB (385.16USD).

Slaughtered salvage values

The study also estimated the amount of money expected to be received after the end of service years. Based on the information obtained from the animal owner, the estimated salvage value lost from two oxen was 9,500 ETB on average. Similarly the average salvaged value of cows after the end of service year was estimated at 3,850 ETB during that period. Therefore, the salvage values of four died cows were 4* 3850 ETB = 570.37USD. The total estimated monetary loss from salvage values of two oxen and four cows after the end of their service was 9,500 ETB + 15,400 ETB = 24,900 ETB (922.22USD).

Treatment cost and time lost for seeking treatment for animal

In this study, the information collected from the owners of animals through face to face interview regarding treatment cost of rabies suspected animals showed that the total cost incurred to buy traditional medicine was 17,645 ETB and the cost to buy modern veterinary drug was 1,075 ETB. The total cost of treatment was 17,645 ETB + 1,075 ETB = 693.33 USD.

The time lost while seeking treatment was estimated by adding all time lost to seek treatment for rabies suspected bitten animal and expressed in monetary terms based on local day laborer cost during the study period. The Ethiopian labor proclamation, in its article determines the Maximum daily or weekly hours of work, which states the normal hour of work shall not exceed eight hours per day or forty-eight hours a week. For this study, the total time lost for seeking treatment was estimated at 508.30hrs. Then, the normal hours of work day lost was 8hrs/24hrs * 508.3hrs = 169.43 hrs. When converted to days, it was about 7.06 days. The local day laborer cost during this period was estimated at 50 ETB. Therefore, the estimated economic loss of time lost was 7.06 days * 50 ETB = 353ETB (13.07 USD). The total direct and indirect economic loss related to animals was estimated at about 11,334.13USD (Table 21).

Cost for dog vaccination and control

To assess the cost incurred for dog vaccination and management, reported data from 2017 to 2018 was extracted from both district administrative towns, who collaboratively work with district's health centers and veterinary offices. Accordingly, 1,857 dogs were vaccinated at both districts (1257 at Gimbi and 600 at Nejo). The cost of one dose of anti- rabies vaccine was 13 ETB during this period. Therefore, the total cost for all given doses of vaccine was calculated at 1,857 * 13 ETB = 24,141 ETB. Controlling and managing of the stray dogs was undertaken two times at both districts during this period. The cost incurred to control the stray dogs was quantified as the summations of costs to buy strychnine to destroy stray dogs, cost incurred for perdium of professionals, labor wages (for people collecting and loading dead dogs in the car), transportation and fuel costs, cost incurred to buy meat, cost to prepare disposal areas to burry dead dogs and other miscellaneous costs. Then the total summation of cost incurred to control the stray dogs were: Cost incurred to buy strychnine, 19,445.60 ETB + perdium for professionals, 80,816 ETB + labor wages, 21,400 ETB + transportation cost, including fuels, 17,122.70 ETB + cost incurred to buy meat, 55, 008 ETB + cost for hole preparation, 17,000 ETB + miscellaneous costs(ropes, perdium for peace keepers or police, detergents, gloves and masks), 55,060 ETB = 265,852.30 ETB.The cumulative costs incurred for prevention (cost of vaccine) and control of stray dogs in both districts was 24,141 ETB + 265, 852.30 ETB = 289, 993.30 ETB(10,740.50 USD).

4.3.3. Estimation of rabies suspected burden in humans

Post exposure treatment (PET) costs

To assess the PET costs, cost related to anti-rabies vaccine was assessed based on information obtained from the hospital (cost incurred for a full dose of anti-rabies vaccine per person), whereas cost pertaining to treatment was obtained through interviewing the victims or escort in case of children and accounted as total money paid out of pocket. In this study, the cost for full doses of NTV was 167 ETB/person, whereas the cost for full doses of deltoid anti-rabies vaccine was 2000 ETB. Therefore, the total direct health care cost incurred was estimated as the summation of costs incurred for vaccine (29,352 ETB) and treatment costs (64,362 ETB) including traditional/herbal medicines; which was estimated at about 93,714 ETB (3470.89 USD).

Moreover, non-health care costs were assessed and expressed in monetary terms. All the time spent whilst seeking treatment were converted to days and expressed in monetary lost based on local labor cost during the study period (50 ETB). The total time spent in seeking treatment was 1133.667hrs (47.24 days) whereas the number of workdays lost due to exposure was 754 days and the number of workdays other person lost to give care was 232 days. Generally, the total non-health care costs were the summation of transportation costs, accommodation and food costs while seeking treatments, the time lost while seeking treatments, number of workdays lost due to exposure, the number of work days other people lost to give care for others and wage lost to seek treatments. This was estimated at 12,272 ETB + 12,880 ETB + 47.24 days *50 ETB + 754 days * 50 ETB + 232 days * 50 ETB + 3,300 ETB = 80, 114 ETB (2,968.30 USD). The cost incurred for PET was the summation of health care costs and non-health care costs, which was 173, 828 ETB (6,439.19 USD) (Table 21).

Estimation of health burden

Three (4.7%) victims were deceased from 63 victims at different ages due to dog bites. To calculate the public health burden of rabies, the adopted disability-adjusted life years was used. Ages of victims related to morbidity (YLD) and mortality (YLL) were calculated independently for each person and added together to yield DALYs. Accordingly, the years of life lost due to rabies (premature death) to the three died victims was estimated to be 127.5 years by taking the average Ethiopian Life Expectancy 65.5 years, whereas Years lived with Disability for 63 victims was estimated at 3.62 yearsby considering disability weights of rabies at 0.797**(**95% CI: 0.718 **–** 0.864**).** Therefore, in present study 127.5years (YLL) + 3.62 years (YLD) = 131.12 DALYs**,** i.e.131.12 years of healthy life was lost due to rabies and rabies suspected cases.

Table 21 : The summary of estimated economic and Health burdens of rabies in the study areas

Economic losses related to animals	Monetary loss(USD)
Direct economic loss	**4,453.66**
Financial loss from Livestock deaths	4.453.65
Indirect economic loss	**6,880.47**
Expression of Service years lost in monetary terms due to life stock death	**5,788.91**
Draught oxen	1,422.22
Productive loss from deaths of pregnant and lactating cows	2,481.51
Estimated values of calves left unborn	962.96
salvage values	922.22
Cessation in milk yield due to suspicious	**385.16**
Treatment cost and time lost for seeking treatment for animals	**706.40**
Treatment cost for animals	693.33
Time lost for seeking treatment for animals in monetary term	13.07
Total economic losses related to animal death	**11,334.13**
Cost for dog vaccination and control	**10,740.50**
Cost for dog vaccination	894.11
Cost incurred to control stray dogs	9,846.38
Estimations of burden in humans	
Post Exposure Treatment (PET) costs	**6,439.19**
Health care costs (Direct)	3,470.89
Non-health care costs(indirect)	2,968.30
The over all economic losses	**28,513.82**
Years of health life lost in DALYs	**131.12 DALYs**

5. DISCUSSION

The present study was conducted to assess the KAP of the people toward rabies and to estimate the public health and economic burden of rabies in Gimbi and Nejo districts. Of 150 interviewees, all of them heard of rabies and the majority defined rabies as the disease comes from rabid dogs. This was consistent with the findings of Ali *et al*. (2015);Yalemebrat *et al*. (2016), who reported 100% and 99.3% aware of the people about rabies in and around Debretabor, South Gondar and in Debark Woreda of North Gondar respectively. In these areas, about 85.3% heard of rabies from their families. This was disagree with the finding of Ali *et al.* (2015), who reported 52.6% of the people heard about rabies from mass media (formal source) in their study. The difference might be due to inadequate availability of formal mass media on awareness of rabies in the present study.

Dogs were claimed as the major source of infections in humans (55.3%). This finding was nearly in line with that of Yalemebrat *et al*. (2016), who reported dogs were responsible for 60.7% to be source of infection for humans, but in contrary, the finding of Dabuma *et al.* (2017) reported transmission of rabies by eating meat from infected animal was higher (29.1%) at Ambo rather than biting of rabid animals, which shows people in present study know the major means of rabies transmissions. Eighty five respondents, (56.7%) understood the cause of rabies as germs, 31(20.7%) Satan, 32(21.3%) respondents didn't know the cause of the disease. This was nearly agreed with the finding of Rine *et al*. (2017), who reported the cause of rabies 59% germs and 31% respondents with didn't know an answer in Nigeria on KAP study toward rabies.

The proportion of respondents who answered the most common seasons of rabies occurrence as spring (51.3%) was higher than a similar study conducted in and around Ambo (Dabuma *et al.*, 2017), who reported 34.5% occurrence in spring. In this finding, 27.3% respondents answered autumn was the second most common season for rabies occurrence, which was agreed with the same authors who reported 25.4% in and around Ambo.

The highest percentage (37.3%) of respondents answered the clinical signs animals with rabies would show as sudden behavioral changes like salivation, restlessness, attempt to bite objects, animals & humans, do not eat and drink water**.** This finding was consisted with the study of Alie *et al.* (2015) conducted in around Debretabor, South Gondar who reported the response of 36.5% respondents similar to the present study. This shows that the disease is well known in these areas.

One hundred forty three (93.5%) had a positive attitude on any one exposed to rabies should seek medical evaluation as soon as possible. This was consistent with the study conducted in western India, which reported 97% respondents recommended a dog bite victim should attend a medical evaluation as soon as possible (Tiwari *et al.,* 2019). In this study, the highest proportion of respondents (51.3%) had a negative attitude with the idea that rabies was preventable by vaccination while 73(48.7%) believed it was prevented by vaccination. This finding was not consistent with the study conducted in Jammu, India (Tandon *et al.,* 2017), who reported 83% and 17% positive and negative attitude respectively on the idea rabies is preventable by vaccination. This may be resulted from inadequate knowledge and low awareness on the importance of anti-rabies vaccine in Ethiopia, particularly in present areas, which needs further health education. The highest proportion of them, 137(91.3%) believed that rabies was zoonotic disease. This was in line with the finding of Alie *et al.* (2015), who reported 91.1% respondents believed as rabies was zoonotic in their study.

Of 150 respondents, 59(39.3%) owned local breed dogs and the general purpose of keeping their dogs was for protection. This was consistent with the finding of Ameh *et al*. (2014) who reported the purpose of keeping the dogs was 95% for protection in wukari Taraba, Nigeria. In contrary, the finding of Rine *et al*. (2017), reported 48.5% of the people in Nigeria kept their dogs housed in cages, the majority of poeple, 44% let their dogs roam freely in the field and 27.1% kept free in house compound in present study.

The overall KAP analysis revealed that, the highest proportion of respondents, 42.7% (95% CI: 0.35-0.51) had a good knowledge, 40 %(95% CI: 0.32-0.48) had a poor attitude and 63.3% (95% CI: 0.56-0.71) had a poor practice toward rabies. This result indicates, the people in these areas are familiar with the disease, but they are lack of attitude and practice about rabies. Consistent to this finding, higher knowledge, poor attitude and poor practice was reported in Jammu, India **(**Tandon *et al.,* 2017) and in contrary, the highest proportion of respondents with poor knowledge (53.9%), good attitude (50.5%) and good practice (63.5%) score was reported in, and around Ambo town (Dabuma *et al.,* 2017). The poor attitude and poor practice of respondents is resulted from the inadequate provision of health education which leads to lack of comprehensive understanding of the health and economic impact of the disease in case of present study. Concerning practice score level involved only dog owners (59), the highest proportion, 73% (95% CI: 0.62- 0.84) had a poor practice toward their dogs. This was similar with other study conducted in Addis Ababa, Ethiopia (Newayeselassie *et al.*, 2012).

A higher proportion of moderate knowledge score was observed in male respondents (27.4%) compared to female respondents (5.4%), and Multinomial logistic regression analysis indicated that there was statistically significant variation between sex groups [OR = 8.8 (95%CI: 1.62-48.47), P=0.012], in which a moderate knowledge was 8.8 times more likely in male respondents than female respondents. This finding is consistent with other KAP studies conducted in Bahir Dar town, North West of Addis Ababa (Guadu *et al.,* 2014) and North Gondor (Yalemebrat *et al*., 2016). The difference across sex groups may be related to the probability that males have more chance to acquire more information about rabies from their day to day activities through hearing, seeing and discussing with other community members while females were staying at home and lack of such information.

Furthermore, Significant difference was seen between Marital status [OR=0.41(95%CI: 0.002-0.81), P=0.036] and levels of education [OR=0.053(0.007-0.43), P=0.006; OR= 0.05(0.007-0.34), p= 0.003] on the respondents' knowledge score about rabies. Moderate knowledge score was observed 0.41 times less likely in married respondents than single respondents. The reason behind is that single respondents would have a high probability to obtain knowledge about rabies from reading and learning process since they might be found at the ages of progressive learning. The highest good knowledge score (88.1%) was observed in respondents with tertiary education levels and the highest moderate knowledge score (36%) was seen in respondents with secondary levels of education. A good knowledge score was 0.053 times less likely in respondents having primary levels of educations compared to tertiary levels of education and a moderate knowledge was 0.05 times less likely in respondents with primary levels compared to secondary levels of educations respondents. This was similar with the result of the study conducted in Bahir Dar town (Guadu *et al.,* 2014) and north Gondar (Yalemebrat *et al*., 2016). The difference in educational level would most likely arise from the opportunity to have read, seen or heard about the disease is higher in more educated people.

Moreover, statistically significant difference was observed between sex [OR=0.2(95%CI:0.06-0.58), p=0.004], levels of education [OR= 36.9 (95%CI: 3.06-443.74), P=0.005], Occupations [OR=15.49(12.42-18.57), P=0.000] and Religions [OR=17.2(15.08-19.43), P=0.000] of respondents on their levels of attitude toward rabies. Male respondents had a high percentage (31.9%) of moderate attitude score compared to female respondents (3.5%). Females respondents have 0.2 times less likely a moderate attitude compared to males. This finding was agreeing with the study conducted in Berhampur, Odisha, India (Tripathy *et al.*, 2017), but disagreeing with the result obtained in West India (Tiwari *et al.,* 2019). The explanation behind the difference across sex is that males have more opportunity to get information through the capturing of ideas and concepts more frequently from discussion with the community, work place, attending local meetings and developed their attitude on rabies than females. The highest proportion of respondents with tertiary education level (75%) and all health professionals had a good attitude. A good attitude score was revealed 36.9 times more likely in respondents with tertiary levels of education than respondents having primary levels. Similarly, a good attitude score was observed 15.49 times more likely in health professionals than farmer respondents. The largest difference shows how farmers are far from health professionals on the way of thinking, feeling and behaving about rabies. This result was in line with similar studies conducted in Bahir Dar town (Guadu *et al.,* 2014), north Gondar (Yalemebrat *et al*., 2016) and in Addis Ababa (Ali *et al.* 2013). The difference is resulted from the fact, the more the people are educated, the closer to source of information through the nature of their career, enhance the more likely they would have the opportunity to know and gain good attitude about phenomenon in their environment. All Muslim respondents had moderate level of attitudes compared to orthodox followers (23.1%). A moderate attitude score was also revealed 17.2more likely in Muslim respondents compared to orthodox followers. The big difference between attitude score may be due to religious influence, which makes the difference on ways of thinking and giving due attention about rabies.

Pertaining to practice score, significant difference was observed between levels of education [OR= 2.9 (95%CI: 0.51-5.33), P=0.018; OR=1.97(95%CI: 0.26-3.68), p= 0.024] and types of occupations (OR= 15.38(95%CI: 13.14-17.64), P =0.000; OR= 14.59(95% CI: 12.36-16.83), p= 000]. Respondents with tertiary levels of educations were accounted for the highest percentages (34.1%) of good practice score compared with non- formal educated (1.9%). Similarly, the highest proportions of good practice score (50%) was seen in health professionals compared with farmer respondents (3.4%). A good practice score was observed 2.9 times more likely in respondents with tertiary levels of educations compared to non-formal respondents and a moderate practice score was seen 1.97 times more likely in respondents with tertiary levels of education than respondents with non-formal educations. Health professionals scored a good practice 15.38 times more likely and a moderate practice score 14.59 times more likely than farmer respondents. This finding was in line with the study conducted in Odisha, India (Tripathy *et al.*, 2017; Tandon *et al.*, 2017) and north Gondor (Yalemebrat *et al*., 2016). The difference in level of education and occupation in this study is inherent from those respondents with lower education level and farmers would have no adequate knowledge and attitude on rabies which leads to low practice level. The more respondents are educated and employed and understand the impact of rabies, the better they would have acquired a good practice about rabies.

The relationship between KAP score and some key predictors was analyzed using Spearman's correlation analysis. There was a moderate positive correlation between knowledge score and level of education (r_s= 0.622, P<0.001), Occupation and residence of respondents (r_s= 0.657, P<0.001) and occupation and levels of educations(r=0.622, P<0.001). This result showed that having a high education level leads to have a good knowledge about rabies and most of the employed people are found at urban areas and well informed about rabies from different sources. Low positive correlation was observed between knowledge and attitude score (r_s=0.373, P<0.001); knowledge and practice score levels (r_s=0.259, P<0.001) and knowledge score and occupation (r_s=0.481, P<0.001); attitude score and occupation (r_s=0.483, P<0.001) of respondents. Contrary to this result, strong positive correlation between knowledge and attitude, knowledge and practice, and attitude and practice score was reported in Addis Ababa (Ali *et al.*, 2013). The present study suggests that, the people in these areas have knowledge about rabies; however, there is a huge gap regarding their attitude and practice, irrespective of their educational level, occupation and residence which needs the outreach of adequate health education to improve the gaps.

Eighty seven human rabies suspected cases were obtained; 45(51.7%) registered to hospitals and 42(48.3%) non-registered obtained through extensive searching. From human rabies suspected case obtained, 66 (76%) were administered anti-rabies vaccine, in which the vast majority used NTV (64.4%) and the remaining 11.5% used deltoid anti-rabies. The most rabies suspected PAs from both districts were reached and interviewed. From Gimbi district, all the most prevalent PAs by rabies suspected cases, i.e., Gagao kere, 7 victims (8%), Lelisa yesus, 25 victims (28.7%), Cholli Michael, 10 victims (11.5%), Gimbi-01, 4 victims (4.6%) and from Nejo district, Nejo-03 PA, 17 victims (19.5%) were interviewed. However, 24 victims (27.6%) were distributed in scattered patterns throughout almost all Nejo district's so that not reached and interviewed due to remoteness.

The study investigated statistically significant difference between residences (χ^2=4.2, p=0.041). The poor rural communities suffered disproportionately (63.2%) than urban communities. This result was in line with other study conducted in China (Tang *et al.,* 2005), who suggested the number of dog-mediated rabies was high, primarily in poor, rural communities and other studies reported similar finding in Bahir Dar and in Tanzania (Yizengaw *et al.*, 2018; Sambo, 2012) and the study conducted in Jimma Zone (kabeta *et al.,* 2014). A high number of cases in rural areas is due to a higher contact rate between domestic dogs and wildlife which leads to increased risk of rabies suspected cases. Moreover, lack of adequate intervention through appropriate awareness of the source of infection and means of rabies transmission in rural areas contributes to a higher risk of exposure.

Dogs were the most dominant species of animals claimed as the major source of rabies to humans (74.7%) although other domestic animals (donkeys) and wildlife (foxes) were involved in small proportion. This was similar to the finding of kabeta *et al.* (2014); Andrews (2015); Hambolu *et al.* (2014), who reported dogs were accounted for 90.4%, 95% and 95% for human rabies cases in Jimma Zone, Ethiopia, Machakos County, Kenya and Lagos State, Nigeria respectively. The possible explanation for this result is that domestic dogs are the most common reservoir of the virus and vaccine for dogs is limited to towns only in developing countries, in particular Gimbi and Nejo districts.

There was statistically significant variation between age groups on their rabies suspected exposure (χ^2=8.511, P=0.037). Those victims found in age groups of 0-15 years were more prone to be exposed (35.6%) while ≥ 51 years were affected in small proportion (12.6%). This was consistent with the finding of the study conducted in Machakos County, Kenya (Andrews, 2015); Jimma zone (kabeta *et al.*, 2014) and in Kagamega district, Kenya (Nelima, 2016), who reported the highest number of cases in children 0-14 and 5-12 years of ages respectively. The fact makes the children prone to contract rabies is most likely due to children below 15 years are unable to know the normal and abnormal behavior of animals and usually they like playing with dogs and at the highest risk of contracting rabies from rabid dogs. Furthermore, children like to play around the roadside and they could be exposed to unknown dogs.

Although rabies was not prioritized in the first global burden of disease survey (Murray *et al.*, 1996), the recent global estimates of disability adjusted life year lost for rabies placed the disease in the eighty-sixth position with respect to public health burden. However, this is underestimated as it is based on the incidence of officially reported cases only (Cleaveland *et al.,* 2002). The burden of rabies is not limited to, mortality or disability-adjusted life years lost to disease. Moreover, there are additional arguments in favors of increasing the resources available for rabies control (Wandeler, 1997).

In the present study, the magnitude of rabies in economic and health burden aspect was estimated. The economic burden of rabies was assessed along with PET as direct health care costs and indirect health care costs and incorporated with direct and indirect livestock death related losses. The economic loss related to health care costs; vaccine cost and the general money paid out of pockets for treatment, including antibiotic, tetanus immunization, diagnosis, wound treatments, disinfections and traditional/herbal medicine, which was estimated at 3,470.89 US$**.** The vast majority of the victims used NTV, which was not much costly relative to deltoid anti-rabies vaccine**.** The cost incurred for non-health care costs like transportation, costs related to accommodation and food while seeking treatments, average time spent in seeking treatments, number of workdays lost due to exposure, number of workdays other person lost to give care (family members for victim child) and wage lost due to seek treatment was quantified to be 2,968.30 US$. The incorporated health care cost and non-health care PET costs was estimated at 6,439.19 US$. This was similar to the finding of the study conducted in Tanzania (Sambo, 2012), and higher compared to study conducted in southern California to assess the direct and indirect costs of suspected human rabies exposure and reported an estimated cost of US$ 3,688 (Stephanie *et al.,* 2007). However, it was not consistent with the finding of other authors (Bögel and Meslin, 1990; Meslin, 1994), who reported a high cost of human post exposure treatment as a major economic burden on public health budgets and the estimated large economic loss as PET costs of 32,957.65 US$ in Bhutan (Tenzin *et al.*, 2008), which was about 55% of economic losses in their findings. Despite rabies was prevalent in this area, the economic incurred for PET was disproportionately underestimated.

The reasons for this finding are manifold. The first reason is that among the interviewed patients, the majority of them received NTV since there was no regular availability of deltoid anti-rabies in these areas which was discounted (167ETB = 6.20US$/dose) compared to deltoid ant-rabies (2,000ETB =15.75 US$/dose). Another reason is largely attributed to low awareness on reporting to hospitals or health centers when exposed to rabies suspected animals and preferred traditional healers which leads the scarcity of epidemiological data on human rabies suspected exposure. Moreover, the patients may more likely sought PET for elsewhere since there was no adequate availability of ant-rabies vaccine in these districts and used secretly, so left unreported. This was supported by the idea of (Meslin, 1994), who suggested the problems of access to adequate and appropriate health care are common in developing countries; most likely in Sub-Saharan Africa, where there are many reasons why prompt access to appropriate PEP remains a serious challenge for bite-victims. For instance, Cold chain requirements for storage of vaccines between 2–8^{o}C limits accesses to areas where electricity is available.

The greatest risk of developing rabies fell upon the poorest regions of the world, where domestic dog vaccination is not widely implemented and access to PEP is most limited (Hampson *et al.*, 2015). This holds true in most areas of Ethiopia, where there is no sufficient surveillance and monitoring program, notification of the disease and dog vaccination program, particularly in Gimbi and Nejo districts of west wollega zone. However, the current study aimed to estimate the expenditure costs incurred to control the stray or suspected dogs based on the data obtained from municipality and veterinary office of the districts. Based on obtaining data, the study mentioned the second potential economic loss was the cost associated with the stray or suspected dog control, which was calculated on the basis of actual expenditure incurred includes, cost for strychnine, labor wages, removal and impounding of dogs, perdium for health professional teams, vaccination of dogs (ETB 13/vaccine dose= 0.48$), travel and logistics costs.

During this study period, 1,857 dog populations were vaccinated in both districts. This was estimated to be 10,740.50US$, which was a huge economic loss for municipality and livestock office budget. This finding was much greater than the result of the study conducted in southern

California (Shwiff *et al.,* 2007), who assessed the economic loss of 229$ for dog control and nearly similar with the economic impact of rabies in Chhuchha District, Bhutan (Tenzin *et al.,* 2008), whose finding estimated the cost incurred for the implementation of the rabies control program was about 30% of the economic losses from rabies (17,826.00$). The reason behind the major economic loss for dog control in current study compared to the result of assessment in California is related to the fact; the major practice of controlling stray dogs in developing countries like Ethiopia, holds true for the present study is through mass killing of dog populations in the town, which enhances the increment in other expenditure costs than vaccine costs.

The other impact of rabies as a broader economy was associated with the direct and indirect losses from livestock deaths. Although there were no reliable recorded data on the death of livestock in these districts, the assessed economic impact of the disease on livestock was obtained from interviewing rabies suspected victims simultaneously about the death of their animals from rabies. From HHs interviewed, 36 livestock deaths were reported, cattle were important livestock populations most affected, 18(50%) followed by poultry, 11(30.56%) due to bite injury, sheep, 3(8.3%) and each equines and goats shared equal proportion, 2(5.56%). To estimate the total impacts associated with rabies in livestock the value of each species was incorporated.

The explored direct financial loss from livestock death was estimated at 4,453.66 US$, which was accounted for 39.67% of all economic losses from livestock. This was Similar to the study conducted in Turkey between 2008 and 2011 (Vos *et al.,* 2014). The other large portion economic loss related to livestock was from indirect losses, which was estimated at about 6,880.47US$, i.e. about 60.71% of the economic losses related to livestock. This consisted of treatment costs and the time spent in seeking treatment for animals, the service year lost due to livestock deaths including; draught oxen, productivity losses from lactating and pregnant cows (milk yield) and the salvage values. Thus, the total loss attributed to livestock affected by rabies and rabies suspected was estimated at 11,334.13 US$, which contributed a significant economic loss in this study, but it was relatively low when compared to the assessment reported in Kazakhstan (Sultanov *et al.,* 2016) and Viet Nam (Shwiff *et al.,* 2018), who conducted their study at the country level and reported the huge economic losses regarding livestock. However, it was a big loss for Poor households, despite of small catchment areas enrolled in the current study (the most prevalent), no epidemiological data that addressed the accurate evidence on animal death from rabies and limitation of the study to only one year.

Regarding public health burden, three humans were deid at different ages due to dog bites (12, 16 and 41 years) from 63 victims obtained. To calculate this burden, the adopted disability-adjusted life years (DALYs) estimation was applied. DALY estimate incorporates mortality and morbidity in terms of adverse reactions to nerve-tissue vaccines (NTVs), which are still widely used in some developing countries, such as Ethiopia (Lembo *et al.*, 2010). In the context of the present study, ages of the victims related to morbidity (YLD) and mortality (YLL) were calculated independently for each person and added together to yield DALYs. Accordingly, the years of life lost due to rabies (premature death) for the three died victims was estimated at 127.5 years by taking the average Ethiopian Life Expectancy 65.5 years (Jembere *et al.*, 2018), whereas Years lived with Disability for 63 victims was estimated at 3.62 years by considering disability weights of rabies at 0.797**(**95% CI 0.718 **–** 0.864**)** (Ock *et al.*, 2016)

Therefore, the aggregated health burden in Gimbi and Nejo districts for a period of one year was 127.5 years (YLL) + 3.62 years (YLD) = 131.12 DALYs, i.e. 131.12 years of healthy life lost due to rabies. This was nearly low when comparable to other findings in Tanzania (Cleaveland *et al.*, 2002), and Kazakhstan (Sultanov *et al.*, 2016) where rabies caused mortalities led to 154 DALYs, and health burden of 457 DALYs (95% CI: 338–594) per year respectively.

The largest contribution to health burden was resulted from YLL, contributed to about 97.2% of DALY scored. This was in agreeing to similar study conducted in Bishoftu, Lemuna-bilbilo and Yabelo districts of Ethiopia (Beyene *et al.*, 2018). The global estimated of rabies burden (Hampson *et al.*, 2015) also supports the current findings, which explored the vast majority (>99%) of DALYs lost (3.68 million) were due to the premature death of rabies victims (YLL) and a very small part (0.8%) of the DALY score was due to adverse effects in terms of YLD due to nerve tissue vaccines still in use in at least 10 countries. The explanation behind for the largest proportions of YLL is attributed from the resultant of death occurred disproportionately in children which accounted substantially more DALLYs. This study focused to only the most rabies suspected hit areas due to remoteness and security problems. Therefore, human death and bite cases may be left unreported at the marginal areas of the districts resulted in under reporting and attributing to substantially low DALY scored. Under reporting in Ethiopia primarily occurs due to the well adapted traditional practice of treating rabies by healers, which interferes with assessing the real magnitude of the problem (Deressa *et al.*, 2010). In agreement to this, the present study revealed that about 21% of the bite victims interviewed used traditional medicine at home without reporting to hospitals or health centers. This has resulted from lack of follow-up by health professionals through appropriate health education to aware the health impact of the disease in details.

Generally, the study demonstrated the overall economic losses associated with rabies; PET costs, direct and indirect loss of livestock and costs of dog vaccination and control estimated to be 28,513.82 US$; and 131.12 DALYs were lost. Therefore, this finding makes rabies a big economic and public health concerns for these districts. From this estimate, the direct economic losses (direct financial loss from livestock loss and human health related costs) were estimated at 7,924.55US$ and represented 27.8% of this economic burdens. The indirect costs of suspected rabies exposures in human and animals (20589.27 US$, 72.2%**)** was nearly three folded to that of the direct costs commonly associated with the cases**.** Irrespective of under reporting of the cases, the finding of the study confirmed rabies and rabies suspected cases exerted sizable economic burdens on municipalities and rural communities at large. Many reasons exist for under reported in both humans and animals. For instance, dog or other animal bitted people may be left unreported at the marginalized rural sides because of distance from hospitals, lack of awareness on impacts of the disease, scarcity of money for treatment, usage of herbal medicine at their home secretly due to cultural influence and the believing in traditional healers. Moreover, there were no reliable data that tells about the exact numbers of livestock deaths since animals are bitten on the field and died unknowingly.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on a KAP study, all respondents in these areas heard of rabies previously. The KAP score indicated, the communities in these areas have a good knowledge, a poor attitude and a poor practice toward rabies. Poor practices also prevailed in respondents that owned dogs. Children less than 15 years were more affected by dog bite and rabies suspected cases. From livestock death reported, cattle held the highest proportions, which imposed a huge direct and indirect economic loss to rural people. The indirect cost of suspected rabies exposures in human and animals was nearly threefold to that of the direct costs. The overall finding of the study revealed, the estimated economic burden from rabies for a period of one year was 28,513.82 US$, and 131.12 DALYs lost which was a big economic and years of health life lost for these districts. Based on these conclusions, the following recommendations are forwarded;

- Giving Community based health education is better to raise accurate knowledge, improve attitude and practice of these communities; and impact of the disease on economic and public health burden, in particular for the marginalized rural people.
- Both Health centers and Veterinary office are better to work collaboratively in one health approach to solve the problems of rabies in the area through effective dog vaccination efforts which reduces medical sector and societal costs.
- Further epidemiological surveillance is needed to address the accurate burdens of rabies in these districts.

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8. APPENDEXIS

Epidemiological investigation of Rabies in selected outbreak hit areas of Gimbi and Nejo Districts of West Wollega zone, Western Ethiopia.

Appendix 1: Retrospective hospital based survey of dog/ other animal bites.

Date and year of survey: (Date/Month/Year): ________/___________/__________

Hospital/ H. Center name ________________________ Interviewer**:** ____________________

Socio- demographic information

Q1. Address: Zone __________________ Woreda ___________ Kebele______________

Q2. Patient name _____________________________age _________________years

Q3. Patient sex: 1. Male 2. Female

Q4. Residence: 1. Urban 2. Rural

Q5. Species bitten: 1. Dog 2.Cat 3.Wild carnival (local name) _______4. Other animals_______

Q6. Owner of animal (if known): 1. Known 2. Unknown

Q7. Type of exposure:

1. Laceration 2. Puncture wound 3. Scratch 4. Contact with saliva 5. Other ___________

Q8. Site(s) of bite: 1. Head 2.Hands 3.Legs 4.Body 5.Multiple site 6.Others

Q9. Date of bitten ___________________ date of reported/treated _________________

Q10. Post exposure treatment (PET) administration. 1. Yes 2. No

Q11. Types of PET administrated; A. Nerve Tissue Vaccine B. Deltoid

Q12. The total cost for full doses of deltoid anti-rabies vaccine ______________ birr.

Q13.Total payment for full doses of NTV ____________________________

Q14. Local wound treatment (at hospitals): 1. Yes 2. No

Q15. If yes, for ques. 14, types ____

Q16. Recommended treatment given at the hospitals/ Health center (if known)

A. Antibiotics B. Vaccination C. Anti-tetanus D. others _____________

Q17. If give On Q 16, cost of antibiotics_____________ birr.

Q18. Cost incurred for anti tetanus ___________ birr

Q19. The outcome of the bite: **1.** Discharge with follow up 2**.** Discharge without follow up

3. Hospitalization 4. Death. 5. Others (specify) ___________________

Appendix 2: Questionnaire to assess socio-economic burden of Rabies in the study area (people who had been bitten by dog and the extensive searching for unregistered using Snow ball method)

Name of victimized person ______________________Interviewer:_________________
Address: zone ______________ Woreda _____________ Kebele____________
Residential: 1. Urban 2. Rural
Age _______years; **sex:** 1. Male 2. Female
Q1. Have you been bitten by animals? 1. Yes 2. No
Q2. If yes, which species of animal has bitten you? 1. Dog 2.Cat 3.Wild carnival (local name) _______ 4. Other animals_______; Owner of animal: 1. Known 2. Unknown
Q3.Type of exposure: 1. Laceration 2. Puncture wound 3. Scratch 4. Contact with saliva 5. Other _______________________
Q4. Site(s) of bite: 1. Head 2.Hands 3.Legs 4.Body 5.Multiple site 6.Others
Q5. Did you catch by any disease as a result of this biting? 1. Yes 2. No
Q6. If yes, what type of disease it was?____
____
Q7. Duration of illness until recovery or death_________________
Q8. Age at infection________years
Q9.If the fate of the patient was death, age at death_______years (obtained from family member or relatives if the victim was deceased).
Q10. Number of days in the bed before recovery or death__________________________
Q11. How many times did you (your child) visit a doctor because of rabies?___________
How long it would take you to get to the health center?__________________
Q12. Recommended treatment at the hospitals
A. Antibiotics B. Vaccination C. Anti-tetanus D. others
Q13. To the best of your memory, how much did you pay out of pocket for the treatments? (Include exam fees)? Birr_____________________________
Post exposure treatment administration.______________________Birr
Local wound treatment:_________________Birr; Anti-tetanus_______________Birr
Q14. To the best of your memory, how many days a week or (hours a day) did you work during the month before your exposure? Estimate as best as possible. ____Days per week ___ ______hours per day (unknown)
Q15. What was your income from your work (do not consider retirement pension) at the time during which you (your child) were seeking treatment? Estimate as best as possible. Indicate a payment rate, before taxes, monthly.____________Birr
Q16. Indicate the number of workdays lost due to your (your child's) rabies exposure? _________________days (Indicate "0" if none), (unknown)
Q17. Did you lose any wages as a result of seeking treatment? Please estimate the amount of lost wages. birr_________________ (Indicate "0" if none)
Q18. Did someone else miss work to care for you (your child) because of the rabies exposure? For example, did someone have to take off work to bring you to the doctor's for rabies treatment?
A. Yes B. No C. Don't know
Q19. If yes, please estimate the total number of workdays this person missed to care for you. ________________days (Indicate "0" if none)
Q20. Estimated wage loss due to time spent caring for you?______Birr

Travel Time and other Costs

Q21. Estimate the average amount of time you spent traveling to and from your medical visit for treatment. Each round-trip visit______________ minutes/hours/days (unknown)

Q22. Did you use any miscellaneous services such as transportation (bus, taxi) due to your rabies treatment?

A. Yes B. No C. Can't remember/Don't know

Q23. Approximately how much did you pay for these services? _____(total in birr) (unknown)

Q24. What extra cost you incurred due to your rabies exposure?____________________________
____

Q25. Please describe any other costs that we have not asked about that you (your child) paid as a result of being exposed to rabies. Indicate the reason for the expenditure and the total amount.______________________ (total in birr) for ______________________________________

Q26. Did you suffer any long-term effects (including emotional issues) from the rabies incident or the treatment you received? A. Yes B. No C. Can't remember/Don't know

If yes, describe these effects____
____

Q27. Do you know any person exposed to or died by rabies in your area?

1. Yes 2. No.

Q28. What is the source of his/her exposure to rabies? _________________

Q29. How many Animals do you have for the years in which rabies case occurred?

Cattle_________ Sheep_________ Goat__________ Equine _______ Dog_____

Q30. Which species of your animals were bitten by rabies suspected dogs/ other animals during this time? A. Cattle B. sheep C. Goat D. Equine E. other, specify _____

Q31. How many of them were suspected as diseased from rabies? Specify for each species. ____

Q32. How many of them were diseased from rabies?

Cattle_________ Sheep_________ Goat__________ Equine _______

Q33. Have you treated the diseased animals? 1. Yes 2. No.

Q34. If yes, what was the total cost of treatment (in ETB?)_______

Q35. What was the time spent for seeking treatment for your animal?_________________

Q36. Were there animals dead of rabies from your herd immediately? A. Yes B. No

Q37. If yes to Q 36, which species of animals were dead? Please! Specify__________________

Q38. How many of them died, if any?_________________________

Q39. Estimate the total money you lost as a result of animal died from rabies (cost of died animal in birr) __________Birr.

Q40. If not died, for how long they stayed under treatment?_____________

Q41. If cow, reduction/cessation in milk yield ________________

If cessation for how long ______________

Q42. what is the price of rent for health oxen per day?___________Birr.

Q43. Have you vaccinated your dog against rabies? 1. Yes 2. No.

Costs of Vaccine in ETB________________

Q44. Time spent in seeking vaccination?_____________________________

Questionnaire and check list format

Questionnaire number ___________________________Date of interview: ________________
Name of data collector:_______________________________
Date and year of survey: (Date/Month/Year): ________/___________/__________
Name of victim/non-victim______________________Interviewer:_________________________

Appendix 3: Questionnaire on Socio-demographic data and KAP of respondents: encircle the choice number or fill in the blank spaces

Q1: Address: Zone_______________________ Woreda ____________
Kebele__________________________________
Q2: Residence: 1. Urban 2. Rural
Q3: Individual demography: Age (in years): _______________
Sex: 1. Male 2. Female
Q4: Marital status: 1. Married 2. Single 3.Divorced 4. Widowed
Q5: Educational status: 1. Write and read 2. Primary 3.Secondary 4.Tertiary 5. Illiterate
Q6: Religion: 1. Orthodox 2.Protestant 3.Muslim 4.Catholic 5. Others
Q7: Occupation: 1. Farmer 2. Vet 3.Abattoir worker 4.Teacher 5.Health worker 6. Other (specify) ________
Q8: Have you ever heard of Rabies? 1. Yes 2. No
Q9: In your understanding what is Rabies?____
Q10: From where you heard of Rabies?
1. Family member (friends) 2.Mass media 3.Teacher 4. Other
Q11.Do you know that rabies is a fatal disease? A. Yes B. No C. Not sure
Q12: What do you think is the cause of Rabies?
1. Germ 2.Evil eye 3.Satan 4. Do not know 5. Others (specify) ____________
Q13: To the best of your knowledge, what is the source of Rabies?
To Animals____
To Humans____
Q14.Do you believe that rabies can be transmitted to humans from rabid dog/cat or other animals? A. yes B. no c. not sure
Q15: In which season Rabies is more common? A. Summer B. Autumn C. Winter D. Spring
Q16. Which Animal species commonly affected by Rabies?
A. Dog B. Cattle C. Sheep D. Goat E. Equine F. Other specify__________
Q17. Which Sex group of animal is more affected? A. Male B. Female
Q18. Which age group is more affected? A. Adult B. Young C. Older.
Q19: What are the clinical signs an animal with Rabies will show? __________________
Q20: How do you identify Rabies from other fatal diseases?_______________________________
____
Q21: Which are the symptoms of Rabies in human?____________________
Q22: What is the reservoir/s of Rabies? (Specify)___________________________________
Q23: Do you know about the fatal nature of Rabies? 1. Yes 2. No.
A. In Animals: 1. Yes 2. No. B. In humans: 1. Yes 2. No.
Q24: Do you know that Rabies is preventable? A. Yes B. No C. Do not know
Q25: Which age group of human will be affect more? 1.Young 2. Adult 3.Elders 4. All

Attitude and practice

Q26. Do you believe that rabies is a health risk (dangerous) to you/ Humans?
1. Yes 2. No 3. Do not know

Q27. Any one exposed to rabies should seek medical evaluation as soon as possible
1.Yes 2.No 3.don't know

Q28. Do you think rabies is preventable by Vaccination?
1. Yes 2.No 3.Don't know

Q29. If yes, to Q32, how frequent?____________________

Q30. Traditional healers and herbal medicine can cure rabies
1. Yes 2. No 3.Don't know

Q31. If your animal is diseased from rabies, which treatment do you prefer?
1.Traditional/ herbal B. modern/veterinary drugs

Q32. Do you think rabies is a zoonotic disease? 1. Yes 2. No 3. Don't know

Q33. If, one of your food animals is diseased from rabies, how do you handle?
1.Slaughter and eat 2. Take to clinic 3. Drink her milk (if cow) 4. Other (specify)_______
____

Q34. Do you think that dead Animal from rabies will act as a source of infection for the others?
1.Yes 2. No 3. Don't Know

Q35.What measure should be taken against suspected cases of rabies in animals?
1. Quarantine 2. Slaughter and serve to the public 3. Vaccinate 4. Treat 5. Others
If dog ____

Q36. How do you handle the animal died from rabies?
1.Eat 2. Leave on open flied for scavengers 3. Burn 4. Bury 5. Others__________

Q37. Can it be transmitted to human by eating carcasses with the case of rabies?
1.Yes 2. No

Q38. Do you think handling infected animals, unprotected treatment and feed offer can transmit the rabies to humans? 1. Yes 2. No.

Q39.How do you manage rabies cases during outbreak in your herd/ dog population?
1. Isolation 2. Avoiding contact with infected herd 3.Vaccination 4. Neither

Q40. If you observe symptomatic cases of rabies, what is your immediate measure?
1.Take to vet clinic 2. Kill and destroy 3. Report it to vet clinic/ health center

Dog owners and their practices

Q41**.** Do you have dogs? A. Yes B. No

Q42. How many dogs do you own? ___________

Q43. What breed is your dog? A. Local B. Other

Q44. What are the purposes of keeping dogs? A. As pet B. guard of house (properties). C. Other purposes. Please, specify__________

Q45. How do you keep your dogs? A. Housed in cages B. Tie outside C. Living inside the house with families D. Free in the house compound E. Free in the field

Q46. What kind of food do you feed your dogs? A. food that we eat normally
B. Others (please specify) ______________________

Q47. Have you vaccinated your dog against rabies (during last year or this year)? A. Yes B. No
If not, what were the reasons for not Vaccinating? _________________________________

Q48. Are you interested to vaccinate your dogs regularly? A. yes B. no

Q49**. If not,** on Ques. No 52, why? Specify_____________

Appendix 4: Surveillance data from veterinary clinics and health centers taken for rabies control and prevention; visited from the districts).

Date: ______________ Veterinary Office/ clinics: _____________ Interviewer: _____________

Q1. Did dog populations Vaccinated A. Yes B. No
Q2. If yes, Cost per dose________________Birr
Q3. Total doses of anti-rabies given ____________
Q4. How frequent? ___________________________
Q5. Is there any other measures take to control rabies? _______________
Q6.What was the total expense to undertake this measure? _____________
Q7. Have you heard rabies outbreak in this area? A. Yes B. No
Q8. If yes to Q7, how many animals were died due to the outbreak? ___________
Q9.Which species of animals were died? Please specify (for each in number) ______________________________
Q10. In what season the outbreak was occurred? _____________________

Date: ____________health center/ clinics: _____________ Interviewer**:** _____________

Q11. Did you use strychnine to destroy strayed/suspected dogs? A. yes B. No
Q12. If yes, on Q11, the total cost incurred to by strychnine _______________ birr
Q13. How many times would you by strychnine to kill the stray dogs_________ birr
Q14. The total wages for professionals to undertake this activity _________________ birr
Q15. The labor wages ____________________________ birr (if any)
Q16. Transportation cost to carry the died dogs (including fuels) _______________ birr
Q17. Cost of meat to give strychnine ______________ Birr
Q18. Other miscellanies money lost to control strayed/ suspected dogs _______________ birr

Appendix 5: Epidemiological investigation tools in Afan Oromo version

Kutaa I: Ragaa galmee dukkubsataa hospitaala/ buufata fayyaa jiru irraa fudhatame Odeeffannoo guutuu dhukkubsataa/ Nama gaafatamee

1. Teessoo : Godina____________________; Aanaa ______________; Ganda__________
2. Maqaa dhukkubsataa____________________________ , umrii_______________
3. Saala; 1. Male 2. Female
4. Bakka jireenyaa: 1. Magaalaa 2. Baadiyaa
5. Gosa beeyilada ciniinee; 1. Saree 2. Adurree 3. Bineensa caakkaa (maqaa naannoo) _____________ 4. Horii/ beeylada biroo
6. Abbaa qabeenyummaa beeyladaa; 1. Beekamaa 2. Hin beekamu
7. Akkaataa/ gosa ciniinnaa 1.Foon irraa kutee kaasuu 2. Ilkaan gadi fageenyaan seenuu 3. Gogaa quncisuu 4. Gorara tuquu 5. kan biroo________________

8. Kutaa qaamaa ciniiname; 1. Mataa 2.Harka 3.Miilla 4.Qaama guutuu 5. Ciniinnaa bakka baayyee 6. Kan biro

9. Guyyaa ciniinnaa ________________; guyyaa yaalame _________________

10. Ciniinnaa booda yaalli/ talaalliin kennameeraa? 1. Eeyyee 2. Waahuu/ lakki

11. Gosa talaallii ykn yaala kennamee? 1. Kan handhuurarraa waraanamu (nerve tissue vaccine)
2. Kan harka/ irree irra waraanamu (deltoid vaccine)

12. Kan harka/ irree irra waraanamu (deltoid vaccine) guutummaatti xumuruuf baasii baaftan, qar.______

13. Kan handhuurarraa waraanamu (nerve tissue vaccine) Doosii guutuu xumuruuf qarshii baasii ta'e, qar._____

14. Sadarkaa hospitaalaatti tajaajila wal'aansa madaaf godhame, 1.Jira. 2. Hin jiru

15. Deebiin gaaffii 15 jiraa yoo ta'e gosa tajaajilaa ______________________

16. Gosa yaalii/wal'aansaa hospitaala/ buufata fayyaatti godhamee

1. Farra baakteeriyaa 2. Talaallii 3.Farra tetaanasii 4. Kan birooo__________

17. Yoo gaaffii 17 irratti Kan kenname ta'e, doosii kenname________, gatii doosii tokkoo.qar______

18. Gatii farra tetanasiif ba'e, qar. __________________

19. Ciniinnaa booda wanta ta'e, 1. Kaffaltiin booda hordoffiin yaalamuu 2.Kaffaluun bitatanii bakka biraattti fudhatanii deemuu 3.Ciisanii yaalamuu 4.Du'a 5. Waan biraa yoo ta'e, ibsa_____________

Kutaa II: Ragaa namootaa sareen/ beeyladni biroon ciniintee galmee dhukkubsataa hospitaala irraa argame irratti hundaa'uun hordofuun baasii isaan baasanii fi miidhaa isaan mudate gaafachuu; kanneen hin galmoofnes barbaaduun hordofanii gaafachuu

Maqaa miidhamaa/ Nama ciniinamee________________________, Nama gaafate__________
Teessoo: Godina ________________Aanaa_______________ Ganda_________________
Bakka jireenyaa: 1. Magaalaa 2. Baadiyaa
Umrii ____________; saala: 1. Dhiira 2. Dhalaa

1.Beeyladaan ciniinamtanii turtanii? 1. Eeyyeen 2. Lakki

2.Eeyyee yoo ta'e gosa kam? 1. Saree 2. Adurree 3. Bineensa chaakkaa (maqaa naannoo)________________ 4. Beeylada biroo ________________________
3.Abbaan qabeenya beeylada kanaa beekamaadhaa? 1. Beekamaadha 2. Hin beekamu
4.Gosa ciniinnaa/ madaa uumamee: 1. Foon irraa kaasuu 2. Madaa ilkaaniin gad seename 3. Gogaa irraa kaasuu 4.Gororaan wal tuquu 5. Kan biroo______________
5. Qaama/ bakka ciniiname: 1. Mataa 2. Harka 3.Miilla 4.Guutummaa qaamaa 5.Ciniinnaa bakka baayyee 6. Kan biroo____________________

6.Ciniinamuu keessaniin wal qabatee dhibeen isin qabe jiraa? 1. Eeyyee 2. Lakkii

7. Eeyyee yoo taheef dhibee akkamiiti?

____

____

8.Dhukkubsattanii hanga fayyitanitti / du’as yoo ta’eef, yeroo hammamii isinitti fudhate? ____

9.Yeroo ciniinamtan/dhibamtan umriin keessan meeqa? ___________________

10.Yoo carraan Nama dhibamee du’a ture umrii meeqatti du’e? (odeeffannoo maatii ykn fira nama du’ee irraa argamu),________________________________

11.Hanga fayyetti/du’aatti guyyaa meeqaaf sireerra /ciisee ture? _____________________

12.Dhibee kanaaf atis ta’e maatiin kee yeroo meeqaaf ogeessa fayyaa/ doktoora bira deemtan? ________________________

13.Mana yaalaa/buufata fayyaa ga’uuf yeroo hagam isintti fudhata? _________________________

14.Kaffaltiin qorannoo ogeessaas ta’e yaaliin dhibee kanaaf godhame matuma keessaniin ta’ee?

1. Eeyyee 2. Lakkii 3. Anoo hin beeku

15.Mana yaalaatii qoricha kamtu isiiif kenname (yoo Kan beektan ta’e)? 1. Farra baakteeriyaa 2. Talaallii 3.Farra tetaanasii 4. Kan biroo________________________

16.Yaalamuu keessaniif walii galatti qarshii meeqa akka baaftan ni yaadattuu? qar.______________

Talaalli guutuu fudhachuuf qar.____________________

Wal’aaansa madaaf qar.____________

Farra tetanasii qar.____________________

17.Yeroo dhibeen Kun isin qabe/qabamuuf of shakkitan hojiin keessan maal ture? ____

18.Utuu dhibee kanaaf hin saaxilamin turban keessaa guyyaa meeqa (guyyaa keessaa sa’atii meeqa)? Tilmaamaan ;turban keessaa guyyaa_________, guyyaa keessaa sa’atii_____

19.Rakkoo dhibee kanaan wal-qabaateen yeroo yaalamaa (ijoollee keessaan yaalchisaa) turtan galiin isin hojii keessan irraa guyyaan/torbaniin/ji’aan argattan hagam ta’a? Tilmaamaa qar._____________ hinyaadadhu/hin beeku

20.Dhibee kanaaf saaxilamuu/shakkii jiruun guyyoota hojii keessan meeqa balleessitan? _________;Hin yaadhadhu/hin beeku, guyyaan hojii bade hin jiru

21.Yaalii barbaaduuf yeroo deemtan faayidaa biraa argachuu qabdan Kan dhabdan qabduu?

Tilmaamaan qar.________________ (yoo hin jirre 0)

22.Namni biraan hojii isaa dhiisee si yaalchisuuf (maatii kee yaalchisuuf) si waliin deeme jiraa?

1. Eeyyee 2. Lakkii 3. Hin beeku

23. Deebiin kee eeyyee yoo ta’e, tilmaamaan guyyaa meeqa hojii isaa dhiisee si waliin deeme? Guyyaa_______________, Yoo Kan hin deemne ta’eef (0)

24. Hojiin nama si waliin deemee Kun maal ture? ______________________________

25. Hojii isaa dhiisee si waliin deemuuf faayidaa biraa argachuu qabu kan dhabe qabaa? Yoo kan qabu ta’e tilmaamaan hagam ta’a?

Geejjibaa fi dhimma biroof baasii ba’e

26. Giddu galeessaan deemtanii doktoora/ ogeessa biratti ilaalamtanii deebi’uuf yeroo hagam isin fudhate? _____. Tokkoo tokkoo guyyoota deemtanii deebitaniif daqiiqaa/sa’atii/guyyaa meeqa isinitti fudhate? ________ Hinbeekamu (__________)

27. Konkolaataa mataa keessaniin kan deemtan yoo ta'e tokkoo tokkoo deemtanii yaalamtaniif tilmaamaan km meeqa deemtan? ___________________; hin beeku________________

28. Yaalii kana barbaachaaf bakkuma wal fakkaataa deemtanii? 1. Eeyyee 2. Lakkii 3. Hin beeku

29. Yoo deebiin keessan lakkii ta'e, bakka biroo deemtan ______________________________

30. Dhibee kanaan shakkamuu/qabamuu keessaniif baasii tajaajila birooof baaftan qabduu? (geejibaaf). 1. Eeyyee 2. Lakkii 3. Hin yaadadhu/hin beeku

31. Tilmaamaan tajaajila kanaaf qarshii meeqa baaftan? Qarshii ________; hin beeku________

32. Dhukkuba kanaan of shakkitanii/ qabamtanii baasii biraa baastan yoo qabaattan, qarshii____.

33. Baasii biraa baaftanii yoo hin gaafatamin haftan qarshii meeqa baastan? Sababa maaliif baastan? Qarshii______________;sababa baasii_____________________________.

34. Dhibee kanaan qabamuu / shakkuu keessanii fi yaalii fudhattan irraa dhiphina/ miidhaan isin irra gahe jiraa? 1. Eeyyee 2. Lakkii 3. Hin yaadadhu/hin beeku

35. Yoo deebiin keessan eeyyee ta'e, maal faadha?______________________________

36. Naannoo keessanii nama beeylada dhibee kanaan shakkamtuun tuqame/ du'e beektuu?

1. Eeyyee 2. Lakkii

37. Maddi dhibee kanaan qabamuu/ shakkamuu maali? _________________________________

40. Yeroo dhibeen Kun naannoo keessanitti mul'atee ture beeylada meeqa qabdu turtan?

Loon ___________, hoolaa__________, re'ee __________, kotte-duudaa________, saree________, kan biroo__________________

41. Gosoota beeylada keessanii keessaa beeylada/ saree dhibee kanaan shakkamten kamtu ciiiname/tuqame? 1. Loon 2. Hoolaa 3.Re'ee 4.Kotte-duudaa 5. Kan biroo,

42. Dhukkuba saree maraattee kanaan meeqan beeylada keessaniitu shakkame? Gosaan adda baasaa.____

43. Meeqan isaaniitu dhukkubsate? Loon ______, hoolaa _____, re'ee _____ kotte-duudaa___

Kan biroo__________

44. Horii dhibee saree maraattee kanaan dhukkubsatan wal'aansistaniittuu? 1. Eeyyee 2. Lakkii

45. Hoo deebiin keessan eeyyee ta'e walii gala qarshii meeqa baaftanii wal'aansistan? _________

46. Beeylada keessan deemtanii wal'aansisuuf yeroo hammamii isinitti fudhate?_____________

47. Beeyladoota keessan keessaa battala Kan du'an jiruu? 1. Eeyyee 2. Lakkii

48. Deebiin keessan eeyyee yoo ta'e, gosa beeyladaa kamtu du'e? _________, baay'inaan meeqa?____

49. Beeyladni keessan du’e tilmaamaan qarshii meeqa baasa? ___________________

50. Yoo hin dune ta’e yeroo hagamii wal’aansa jala turan? _________________

51. Saree keessan talaalchiftanii beektuu? 1. Eeyyee 2. Lakkii

52. Deemtanii talaalchiftanii deebi’uuf yeroo hammamii isinitti fudhate? __________________, gatiin talaallii saree tokkoof qarshii meeqa ture? Qarshii _____________

53. Beeyladni keessan dhibamuun galiin midhaanii dhabdan ______________________

Sangaan keessan osoo hin dhukkubsatin galii midhaanii ___________________

Tilmaama galii midhaan irraa argachuu dhabdan qarshiin _____________________

Yoo dhaltii ta’e, hanqina/ dhabamuu oomisha aannanii ___________________

Faayidaa aannan irraa argattan hagamiif dhabdan? ______________________

Sangaa keessan kireessuun waggaatti galiin argattan qarshiin _________________

54. Dhibee kanaan Kan ka’e gatiin gabaa beeylada keessanii hir’ate jiraa? 1. Eeyyee 2. Lakkii

55. Eeyyee yoo ta’e qarshii meeqa hir’ise? ______________________

56. Dhohiinsi dhukkuba kanaa yeroo hammamiif ture? ___________________

Kutaa III: Odeeffannoo guutuu nama gaafatamee, beekumsa, ilaalchaa fi shaakala/gocha hawaasni naannichaa dhibee kana irratti qaban (KAP Study).

1.Teessoo : godina _______________, aanaa_____________, ganda___________________
2.Bakka jireenyaa: 1. Magaalaa 2. Baadiyaa
3.Odeeffannoo dhuunfaa nama gaafatamee. Umrii _____, saala: 1. Dhiira 2. Dhalaa
4.Haala fuudhaaf heerumaa: 1. Kan fuudhe/heerumte 2. Hin fuune/heerumne 3. Kan wal-hiikan 4. Kan irraa du’e/jalaa duute
5.Sadarkaa barumsaa: 1. Kan barreessuuf dubbisuu qofadanda’u/dandeessu 2. Sadarkaa tokkoffaa 3.Sadarkaa lammaffaa 4.Sadarkaa sadaffaa 5. Barumsa hin qaban
6.Amantaa: 1. Ortodoksii 2.Protestaantii 3.Musiliima 4.Kaatoolikii 5. Kan biroo
7.Gosa hojii: 1. qonnaan bulaa 2.ogeessa yaala beeyladaa 3. Hojjetaa mana qalmaa 4. Barsiisaa 5.Hojjetaa fayyaa 6. Kan biroo
8.Dhukkuba saree maraatteen dhufu dhageessanii beektuu? 1. Eeyyee 2. Lakkii
9.Hubannaa qabdaniin dhukkubni Kun maali? ___________________________________
10.Eessaa dhageessan? 1. Maatiirra 2. Miidiyaa hawaasaa 3.Barsiisaa 4. Bakka biraa _____
11.Dhibee kana yoom dhageessan? 1. Saaxilamuun booda 2. Saaxilamuun dura
12.Dhibeen Kun ni ajjeesa jettanii yaadduu? 1. Eeyyee 2. Lakkii 3. Sirriitti hin beeku
13.Dhibeen Kun maaliin dhufa jettanii yaaddu? 1. Jarmii 2. Ilaaltuu 3.Seexana 4.Hin beeku 5. Waan biroo ______________________
14.Hubannoo qabdaniin dhibee kanaan beeyladni fi namni akkamiin qabamu jettanii yaaddu?____

15.Dhukkubni Kun saree/adurree / beeylada biraa maraatte/te irraa namatti ni darba jettanii yaadduu? 1. Eeyyee 2. Lakkii 3. Sirriitti hin beeku

16.Waqtii kam dhukkubni Kun bal'inaan mul'ata jettanii yaaddu? 1. Ganna 2. Arfaasaa 3. Bona 4. Birraa

17.Dhibee kanaan beeyladni baayyee saaxilaman: 1. Saree 2. Loon 3.Hoolaa 4.Re'ee 5. Kotte- duudaa 6. Kanneen biroo, ______________________________

18.Saala kamtu baayyee ittiin qabamuuf carraa qaba? 1. Dhiira 2. Dhalaa

19.Sanyii / gosa beeyladaa kamtu baayyee miidhama? 1. Kan biyya keessaa 2. Kan biyya alaa

20. Kan biyya alaa fi biyya keessaa irraa dhalate

21.Umrii beeyladaa kamtu baayyee dhukkuba kanaan miidhama? 1. Ga'eessa 2. Jabbiilee 3. Kanneen umriin isaanii deeme

22.Beeyladni dhibee kanaan qabamte mallattoo akkamii agarsiifti? ___________________

____

23.Dhukkuba haala kanaan ajjeesuu danda'an kan biraa irraa maaliin adda baafta?________

____

24.Dhibeen kun nama keessatti mallattoo akkamii agarsiisa? ____________________

25.Baattoon dhibee kanaa maal jettanii yaaddu? __________________________________

26.Naannoo keessanii bakka dhohiinsi dhibee kanaa itti mul'atee beeku beektuu? 1. Eeyyee 2. Lkkii

27.Haala dhibeen Kun ittiin ajjeeesu beektuu? 1. Eeyyee 2. Lakkii

Beeylada keessatti: 1. Eeyyee 2. Lakkii

Nama keessatti: 1. Eeyyee 2. Lakkii

28.Dhibee kana ittisuun ni danda'ama jettanii yaadduu? 1. Eeyyee 2. Lakkii 3. Hin beeku

29.Hawaasa waliin jiraattanis ta'e ofiikeessan mala biroo ittiin dhukkuba kana irraa ittisuu dandeessan beektuu? 1. Eeyyee 2. Lakkii ; Yoo beektan, ______________________

30.Sadarkaa gulantaa guddina namaa keessaa isa kamtu irra caalaa dhibee kanaaf saaxilama? 1. Daa'ima 2. Dargaggeessa 3.Jaarsa 4. Hunda

Ilaalchaa fi shaakala/gocha isaan qaban

31.Dhukkubni saree maraatteen dhufu Kun namaaf balaadha jettanii yaadduu? 1. Eeyyee 2. Lakkii 3. Hin beeku

32.Namni dhibee kanaaf saaxilame battaluma deemee yaalamuu qaba. 1. Sirriidh 2. Lakkii 3. Hin beeku

33 Talaalliin dhibee kana ni ittisa jettanii ni amantuu? 1. Eeyyee 2. Lakkii 3. Hin beeku

34.Deebiin keessan eeyyee yoo ta'e, waggaatti yeroo meeqa? ______________________

35.Ogeessooni aadaa fi qorichi baala mukaa irraa argamu dhibee kana ni fayyisa

1. Sirriidha. 2 lakkii 3. Hin beeku

36. Beeyladni keessan yoo dhibee kanaan qabamte mala yaalaa kamiin filattu?

1. Qoricha aadaa 2. Qoricha ammayyaa

37. Dhukkubni Kun ni beeylada irraa namatti ni daddarba jettanii yaadduu? 1. Eeyyee 2. Lakkii 3. Hin beeku

38. Beeyladni sooratni irraa argamu yoo isin jalaa dhibee kanaaf saaxilame akkam gootu?

1. Qaluun akka nyaatamu gochuu 2. Mana yaalaa geessuu 3.Aannan isaa dhuguu 4. Mala biraa ____

39. Dhibeen Kun beeylada dhukkuba kanaan du'een deebi'ee ni daddarba jettee yaaddaa?

1. Eeyyee 2. Lakkii 3. Hin beeku

40. Beeylada dhibee kanaan shakkame yoo argitan tarkaanfii akkamii fudhachuu dandeessu? 1. Beeylada biraan akka wal hin makne gochuu 2. Qalanii uummata nyaachisuu 3. Talaalchisuu 4.Yaalchisuu 5.Mala biraa, yoo saree ta'e ___________________________

41. Beeylada dhukkuba kanaan du'e haala kamiin ilaaltu/qabdu? 1. Nyaataaf oolchuu

2. Ooyiruu irrattti bineensaaf gatuu 3. Gubuu 4.Awwaaluu 5. Mala biraa

42. Beeylada dhukkuba saree maraatteen dhibame foon isaa nyaachuun dhibee kana ni dabarsa jettanii yaadduu? 1. Eeyyee 2. Lakkii 3. Hin beeku

43. Beeylada dhibee kanaan qabame tuttuquun, meeshaa inni ittiin yaalame tuquun akkasumas itti siqanii nyaachisuun dhibeen Kun namatti ni darba jettanii yaadduu? 1. Eeyyee 2. Lakkii

44. Dhohiinsi dhibee kanaa beeyladoota /saroota keessatti yoo ka'e akkamitti to'achuu dandeessu? 1. Beeylada dhibame adda baasuun 2. Beeylada dhibameen wal- tuquu dhiisuun 3.Talaalchisuun 4. Homaa wanta goonu hin qabnu

44. Beeylada mallattoo dhibee kanaa agarsiiftu yoo agartan tarkaanfii akkamii fudhattu/maal gootu? 1. Mana yaalaa geessuu 2. Ajjeesanii gatuu 3. Mana yaalaa beeyladaa/ buufata fayyaa beeksisuu

Namoota saree qabanii fi akkaataa qabiinsa isaanii

45. Saree qabduu? 1. Eeyyee 2. Lakkii /hinqabnu

46. Deebiin keessan eeyyee yoo ta'e meeqa qabdu? Dhiira ____ dhaltuu_____walii gala _______

47. Sanyii /gosa kamiin qabdu? 1. Kan biyya keessaa 2. Kan biyya alaa

48. Sareen keessan maaliif isin fayyadu? 1. Mana/ qabeenyaa eeguuf 2. waanuma saree ta'aniif qe'ee jiraatu 3. Dhimma biroof yoo ta'e, ______________________________________

49. Akkamittiin eegdu? 1. Mana seerawaa qabdi 2. Alatti hiina 3.Maatii waliin mana jiraatu 4.Walabummaan mooraa manaa keessa jiraatu 5. Ooyiruu irra bilisummaan jiraatu

50. Nyaata akkamii nyaachistu? 1. Wantuma ofii nyaannu 2. Nyaata biraa, ___________________

51. Bara kana / Bara darbe saree keessaan talaalchiftaniittuu? 1. Eeyyee 2. Lakkii, yoo Kan hin talaalchifne ta'e maaliif, ____

52. Walitti fufiinsaan yeroo barbaachisutti talaalchisuuf fedhii qabduu? 1. Eeyyee 2. Lakkii, yoo deebiin keessan lakkii ta'ee sababa isaa, ______________________________________

53. Waggaa waggaan saree talaalchisuun ni barbaachisa jettanii yaadduu? 1. Eeyyeen 2. Lakkii 3. Sirriitti hin beeku

Appendix Table 1: A guide to appropriate use of correlation coefficient

Size of correlation	Interpretation
0.90 to 1.00 (-0.90 to -1.00)	Very high positive (negative) correlation
0.70 to 0.90 (-0.70 to 0.90)	High positive (negative) correlation
0.50 to 0.70 (-0.50 to – 0.70)	Moderate positive (negative) correlation
0.30 to 0.50(-0.30 to -0.50)	Low positive (negative) correlation
0.00 to 0.30(0.00 to -0.30)	Negligible correlation

Source: Mukaka, 2012