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Assessment of the current rabies situation and its management in epidemic areas of southern Ethiopia

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Abstract

Rabies infection is almost always a 100% lethal viral disease in all mammals, including humans. Although rabies is vaccine preventable disease, more than 60,000 people worldwide, and 2,700 people in Ethiopia die of fatal human rabies annually. The aim of this study was to generate strategic information on the extent of the burden of rabies and the existing major response strategies, in order to overcome and bring attention to the management of rabies outbreaks. Cross-sectional study design was used to assess the current situation of rabies burden in the Southern Nations, Nationalities, and Peoples' Regional States of Ethiopia. Data analysis revealed a total of 16 fatal human rabies and 287 suspected rabies exposures. The highest attack rate of 116.3 cases per 100,000 human subjects was reported in Tembaro woreda. As a result, 48 animal deaths of rabies have been reported, while cattle (28) have been more affected than other animal species. The lack of dog immunization, lack of community awareness of dog management, and inaccessibility and inefficiency of anti-rabies vaccines were major risk factors associated with the spread of rabies exposure between humans and animals. In conclusion, this study has clearly shown that both the existence and the high magnitude of fatal human and animal rabies are significant in the area. Multidisciplinary approach interventions to increase community awareness of dog vaccination, effective and immediate treatment of exposed individuals is recommended as a method of disease control and prevention.

Keywords: Animal, anti-rabies, human, outbreak, rabies exposure, SNNP.

Introduction

Rabies exposure can always be either 100% fatal or 100% preventable double burden viral disease here in Ethiopia and around the world. Rabies exposure is 100% fatal, once a clinical symptom has been developed, even if it is characterized by a long incubation period of 2–3 months on average, but may vary from 1 week to 1 year depending on factors such as location of entry and viral load, short disease duration and death within 7 to 10 days of onset of clinical symptoms [1]. While rabies exposure is a 100% preventable disease with effective treatment soon after exposure to rabies, and may even be eradicated if government and donor attention is given to developing a control program/strategy and regulatory system to promote control of rabies in dogs as a key strategy for controlling rabies in humans through sustained dog vaccination programs.

Thus, the management and registration of the dog population, community awareness and cooperation of all stakeholders improve the cost - effectiveness of vaccination intervention as a key measure [2-4].

Globally, the burden of fatal human rabies is that 60,000 people die every year; almost 99% of human rabies exposure is caused by dogs. About 95% of death occurs in developing countries, particularly in Africa and Asia [5]. In developing countries, successful zoonoses are difficult to prevent and control, some of the main factors being zoonoses such as rabies that are neglected, under-reported, joint multi-sectoral preparedness and response interventions that remain unsatisfactory due to gaps in the legal framework. Other factors attributing to rabies exposure include failure of dog immunization, abundantly free roaming dogs, and insufficient government attention, which may be due to underreporting of cases and lack of community awareness. Children's and poor rural communities have a significant impact on the risk of rabies exposure across society, as well as a high gap in access and affordability of anti-rabies vaccines [2, 4, 6].

Rabies is endemic in Ethiopia and places a huge burden on the economy and public health. Every year, 2,700 people in the country die of rabies. While there is no regulatory system for the prevention and control of rabies as mitigation, so far there is no legislation for the prevention of rabies. However, the Ethiopian Public Health Institute / EPHI has played a key role in selected country pilot project areas in collaboration with various government and international partners, as one of the priority activities of the Global Health Security Agenda, CDC, OSU, FAO and other partners have started working together to build an effective national rabies elimination strategy [7, 8].

Rabies is underreported in different corners of this country. As a result, its impact is underestimated due to existing challenges such as the lack of rabies diagnostic facilities at least one laboratory at each regional level and the lack of awareness-raising activities for health professionals and the lack of awareness-raising activities for the community. For example, there are different rare reports from the Southern Nation, Nationalities and People's Regional State (SNNPRS) of Ethiopia on the occurrence of rabies exposure (mainly from suspected rabid dogs) in humans from different epidemic sites in the regional state. Our aim is to (a) assess the outbreak of rabies in both humans and animals, and (b) generate strategic information on the extent of the burden of rabies and major response to informed decisions on the prevention and control of rabies.

Methods

Study area description

The Southern Nations, Nationalities and Peoples' Regional State (SNNPRS) is one of the largest and most

ethnically diverse regions of Ethiopia. Geographically located in the southern part of the country surrounding Kenya in the south, the Republic of South Sudan in the southwest, the State of Gambella in the northwest and the State of Oromia in the north and east. The total population size of the SNNP is estimated to be 20,767,937 in 2018, of which 93.2% of the total population is in rural areas of the State. The region is also well known for having more than 1,5956,100 different livestock populations, 23 species of wild animals and 300 species of birds and water resources that can be used for fishery, irrigation and hydroelectric development. There are seven preserved locations in the forest. Forests and bushes cover around 18% of the state [9].

Rabies exposures studied were Hawassa Zuria woreda, Mareka woreda, Soro woreda, Tembaro woreda, Tercha town and Gena Bossa woreda of SNNPRS. Hawassa Zuria is located in the Sidama zone; Tembaro is located in the Kembata Tembaro zone; Soro is located in the Hadiya zone and Tercha, Mareka and Gena Bossa are located in the Dawuro zone of SNNPRS, Ethiopia. These areas are the focus of numerous wildlife, forests and water resources, including the Gilgel Gibe River Basin and the Gilgel Gibe III Dam. Its geographical location is shown in (**Figure 1**).

Study design

Cross-sectional study was conducted in selected rabies-epidemic areas of SNNPRS, Ethiopia.

Human rabies exposure assessment

All humans with any animal bite without discrimination of the socio-demographic characteristics of the victims during the investigation period from July 2017 to May 2018. In the case of suspected human rabies exposure assessment, bite/exposure of animal history, bite site, date of bite, date of admission to the health facility, clinical sign and symptom status and outcome of each human exposure were addressed.

Livestock rabies exposure assessment

All animal species with unusual signs or rabies suggestive behavioral changes have been included in this particular investigation without discrimination of species, immunization status and animal bite history.

Questionnaire survey

Semi-structured questionnaires were administered by health care providers, primarily those engaged in emergency care management at selected SNNPRS health facilities in Ethiopia. The main focus areas of the interview and observation were all interested emergency health care providers who participated in taking time on the mode of transmission of rabies, methods of control and prevention, and possible ways of managing and diagnosing animal bite cases in their health facilities and at the same time addressing anti-rabies treatment.

Anti-rabies handling and utilization assessment

The anti-rabies vaccine service was assessed by the total amount of vaccine available, the storage and

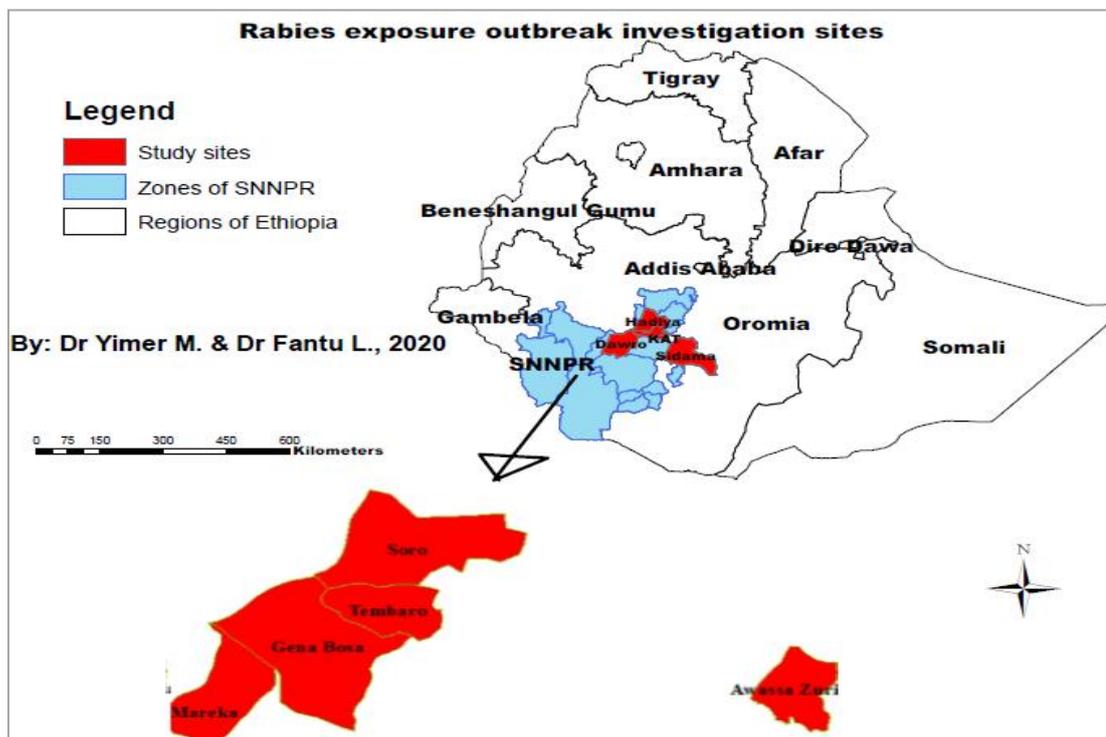


Figure 1. Geographic location of the investigation/study area.

management of the cold chain, the proper administration and the proportion of use.

Anti-rabies handling and utilization assessment

The anti-rabies vaccine service was assessed by the total amount of vaccine available, the storage and management of the cold chain, the proper administration and the proportion of use.

Sampling Technique

Purposive sampling methods have been used for this particular study to address all these rabies-epidemic areas based on disease outbreak reports in the study area.

Data collectors/study team

Multidisciplinary team first organized by the Ethiopian Public Health Institute (EPHI): Public Health Emergency Management (PHEM), Zoonotic Disease Research and Anti-Rabies Vaccine Production directorates, St. Paul's Hospital Millennium Medical College and the Ministry of Agriculture (former Ministry of Livestock and Fishery Resources) were deployed in the hot spot areas of Southern Nations Nationalities and Peoples Region (SNNPR).

Data collection

Primary and secondary data were collected from public health offices, veterinary offices and health facilities through key informant interviews and interviews with experts and health care providers using standard semi-structured questionnaires. Personal observations were made during interviews with health care facilities. The deployed team met with the SNNPR, PHEM Directorate. The owner of the PHEM core process referred to four hot spot areas (Dawuro Zone, Kembata Tembaro Zone, Hadiya and Sidama Zone) and their prospective woreda areas accordingly. Active community and office searches and visits to health facilities

were conducted as well as the major associated risk factor, PEP utilization, laboratory findings and burden assessments were also addressed.

Ethical consideration

Ethical approval was not obtained from the Institutional Review Board, as there were time constraints to respond in a timely manner to public health emergency management issues. However, the purpose of this study was explained to the intended study participants and verbal consent was obtained from them before proceeding with the study/data collection.

Data analysis

Descriptive data from this study from human and veterinary health facilities and the community were analyzed and reported on the status of rabies outbreaks and human and animal burden assessments, major risk factors, PEP utilization and laboratory findings.

Results

Rabies outbreak status and human burden assessment

A total of 16 suspected human rabies deaths have been reported from Tercha General Hospital, Mudula Primary Hospital, Bushillo, Gimbicho and Jacho Health Centers in public health facilities. Analysis of secondary data revealed a total of 287 suspected rabies exposures that had been observed during the follow-up of anti-rabies in these sites during the investigation period. Of the 16 suspected deaths of human rabies, 9 were male and 7 were female. The site of the bite / exposure to the human victims was the leg, finger, lip and arm. Domestic dogs were responsible for all human exposure, as detailed in (Table 1).

Table 1. Suspected fatal human rabies case scenario from investigation sites of SNNP, Ethiopia.

S.N	Age	Sex	Woreda/Site	Date of bite	Site of exposure	Exposing animal	Duration after exposure	Remark
1	13	Female	Tembaro	November 16, 2017	Leg	Dog	3 months	
2	28	Male	Tembaro	January 20, 2018	Finger	Dog	3 months	Came to HF with clinical signs
3	7	Female	Tembaro	September 27, 2017	Leg	Dog	3 months	Death after 6 days of onset of illness
4	5	Male	Tembaro	February 13, 2018	Leg	Dog	2 months	After 7 days of illness
5	60	Female	Tembaro	January 23, 2018	Finger	Dog	3 months	After 5 days of illness
6	7	Male	Tembaro	January 17, 2018	Lip	Dog	2 months	took 15 doses and died
7	56	Male	Tembaro	January 25, 2018	Leg	Dog	2 months	Came to HF with clinical signs
8	-	Male	Soro		Leg	Dog		Was referred to Mudulla hospital after onset of clinical sign and died
9	-	Male	Tembaro		Lip	Dog		Died after 12 th dose of NTV
10	14	Male	Mareka	December 25, 2017	unknown	Dog	2 months	
11	7	Female	Mareka		Arm	Dog		6 cattle died after being bitten by the same dog
12	46	Female	Soro	March 18, 2017	Leg	Dog	1 months	
13	28	Male	Soro	January 8, 2018	Leg	Dog	3 months	
14	16	Female	Mareka		Finger	Cat		
15	27	Female	Hawassa zuria	March 12, 2018	leg	Dog		Initially diagnosed as typhoid fever and was being managed with ceftriaxone
16	21	Male	Hawassa zuria			Dog		

The highest rate of rabies exposure was reported from Tembaro woreda (116.3 per 100,000 population at risk); 55.3, 13.6, 12.1, 5.4 per 100,000 population at risk attack rates were reported in Hawassa Zuria woreda, Mareka woreda, Soro woreda and Gena Bossa woreda, respectively.

Rabies outbreak status and burden assessments in animals

During the investigation period, 48 animal rabies deaths were detected and 28 cattle, 12 goats, 5 sheep and 3 equines were identified. Death report due to suspected rabies in the dog was not counted as a result of dog elimination activity conducted using strychnine. Of these human-exposed dogs, only 10 rabies-suspected samples were submitted to the National Rabies Laboratory of the Ethiopian Public Health Institute (EPHI). Of the total samples, 80% were positive for rabies virus infection, and dogs were the most biting / exposing animals for animals and human victims during the time and area of investigation, as shown in (Figure 2).

Major contributing risk factors for rabies outbreak in place

Summary of the major associated risk factors for the occurrence and spread of rabies exposure among humans and animals has been identified.

Absence of dog immunization and lack of community awareness of dog management

In this investigation, the engaged community is once remote from rural areas and keeps the dog on guard for reasons of lack of awareness of the possibility of disease transmission. All respondents responded that they had a single dog (47%) or more than one dog (53%), and their dogs were free to move to the surrounding area (free roaming dog) and no history of deworming and/or vaccination of dogs. The absence of immunization for dogs has also been reported by the livestock sector, which has created a chance for the occurrence and spread of rabies exposure by addressing multiple factors such as community ignorance, unaffordable cost of anti-rabies vaccine for dogs and little government attention.

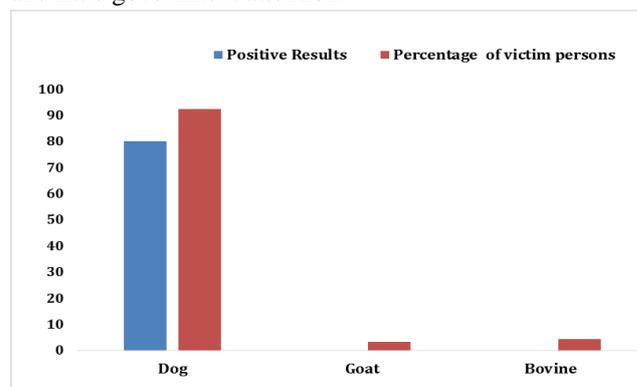


Figure 2. Rabies exposure Laboratory findings and human victims by animal bite during investigation time and area (SNNP).

Challenges on anti-rabies vaccine and inadequate human rabies exposure management

Inaccessibility and unavailability of cell culture anti-rabies vaccine (modern vaccine by the National Pharmaceutical Supply Agency) and shortage of nerve tissue vaccine (old anti-rabies) human anti-rabies vaccine have been observed (**Figure 3**). Although vaccine shortages have occurred, consistent cold chain management problems have also been observed in health facilities. In fact, the nerve tissue (old anti-rabies PEP) anti-rabies vaccine production capacity of EPHI has so far not met the demand for and severely affected the required response to deadly diseases.

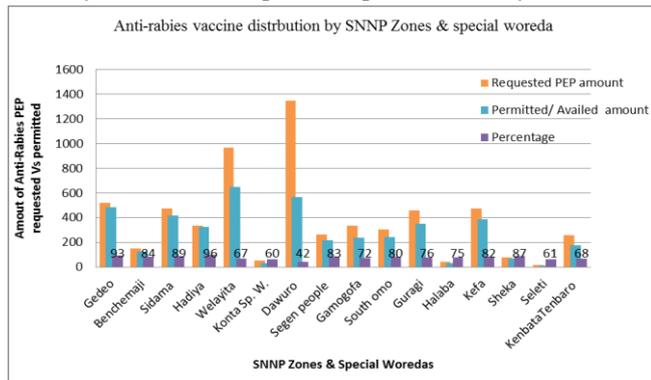


Figure 3. Coverage of anti-rabies vaccine in SNNP before the investigation date of the fiscal year.

Inadequate health care provider’s knowledge and skill at those health facilities

The opinion and level of knowledge and skills of healthcare professionals in the area of rabies exposure management with selected HFs were assessed on the basis of their interest in semi-structured self-governing interviews. We found that, 46.6 % (14/30) of the respondents had knowledge of the mode of transmission via saliva from suspected animal bites, in particular dog bites (**Table 2**).

Ecological factors for increased spillover

The existence of natural forests, mountains and rivers such as the Gilgel Gibe river basin has created a suitable environment for the occurrence and spread of rabies exposure , especially the over filling of the Gilgel Gibe III dam, which plays a significant role in displacing the normal habitat of wildlife for interaction and co-existence with domestic animals and peoples. Dogs, cats, foxes and donkeys were among the most frequently exposed animals found during the investigation. Increased interaction of wild life with dogs and high prevalence of free roaming dogs were considered risk factors for increased exposure to rabies.

Table 2. Opinion of healthcare providers and their inadequate knowledge and skill on human rabies exposure management.

Variables	Category	Frequencies	Proportion
Sex of Respondents	Male	18	60
	Female	12	40
Respondents HF	Tercha GH(Dawuro)	16	53
	Gimbichu & jacho HC	11	37
	Mudula Hospital	3	10
Is rabies a major problem in your HF	Yes	24	80
	No	6	20
Knowledge & skill of health care providers on mode of transmission	Yes	14	47
	No	16	53
Knowledge & skill on Clinical signs/symptoms in human	Yes	20	67
	No	10	33
Throughout the year rabies exposure occurrence	Yes	25	83
	No	5	17
Is there any preventing & control guideline/legislation	Yes	5	17
	No	25	83
Which control option do you use	Health Education (HE)	14	47
	Anti-rabies vaccination (PEP)	12	40
	All options HE, PEP & wound Mg't	4	13
After exposure where they go?	Health facility	24	80
	Traditional Healer	4	13
	Other	1	3
what are the major challenges of human rabies exposure	lack of regular animal rabies control activity (ARC)	6	20
	lack of community awareness(CA)	14	47
	lack of training(TOT)	3	10
	Combination factors of above	5	17

Discussion

Rabies is one of the most neglected tropical and zoonotic diseases with an increasing trend in human burden [10]. This investigation revealed a high rate of rabies and its exposure in humans and animals and a lack of immunization in dogs compared to studies reported in the Ethiopian Rabies Review (1990 to 2000) in which a total of 322 human deaths were reported [11]. There is also another annual estimate of 2700 human deaths in 2017 [7], which has shown an increasing burden on public health and still needs to be addressed in order to achieve the global rabies elimination program 'zero rabies in humans' by 2030 [1,12].

In this study, fatal human and animal rabies of 16 and 48 were found mainly due to rabies-specific symptoms and epidemiological factors, as the standards of rabies diagnostic methods could not be applied. This is due to the lack of standardized laboratory settings and the difficult nature of rabies cases of CNS in suspected human rabies exposure.

This study found the highest rates of attack in Tembaro woreda with 116.3 cases per 100,000 human population, followed by 55.3 cases in Hawassa Zuria woreda, 13.6 cases in Mareka woreda, 12.1 cases in Soro woreda, and 5.4 cases in Gena Bossa woreda per 100,000 population at risk of attack. This finding is considerably higher than that of 2.33 cases per 100,000 human population in northern Gondar, Ethiopia [13].

Overall, human rabies exposure in this investigation has been admitted to the health care facility too late and varies from area to area for an average of 2-3 months from the date of bite or after onset of clinical symptoms as described in (Table 1). This was due to the high perceptions of local people in that country and the widespread use of traditional medicine among the urban and rural population of Ethiopia could be attributed to cultural acceptability, physical accessibility and economic affordability compared to modern medicine [14]. A high free roaming dog population with a never-vaccination history and a high level of wildlife interaction was identified as an existing fueling factor for rabies outbreaks. This finding is consistent with the findings reported by Admassu and Mekonnen that, in 2014 in the same country, a large number of dogs in both urban and rural settings and a low vaccination risk of rabies circulation and spread to humans and other domestic animal populations [14].

In order to manage this burden of human rabies exposure in the SNNP region, a lack of anti-rabies vaccine was observed during the investigation, and EPHI distributed a total of 4305 rabies post-exposure prophylaxis per 10 months until the investigation was conducted to protect the public. The Dawuro and Kembata Tembaro zones reported the highest levels of exposure to rabies and human fatal cases of rabies, but vaccine coverage was 42 and 68,

respectively. This result is in agreement with the findings reported by Abraham in this country [15].

This sample was tested in a national rabies laboratory for laboratory analysis of 10 suspected animal brain tissue samples, 80 per cent of which were positive for Rabies. All of the positive samples were from the dog. Samples submitted to the national rabies laboratory were only ten, due to a number of reasons such as lack of regional laboratory facilities in the area; lack of awareness was a key factor due to remote rural communities.

The World Health Organization recommends that at least 70% of the dog population be vaccinated to control and potentially eliminate human-mediated rabies in dogs [16]. In this study, no organized dog vaccination activity was performed, instead of vaccination, by the community in communication with local authorities to overcome dog bite and rabies exposure in humans and animals. The reason for the elimination of dogs was due to inaccessibility and unaffordability of the anti-rabies vaccine and high free roaming dog population.

As a limitation, although the main objective of this study is to respond to rabies outbreaks, there are no estimates of the sample size to include all study participants and standard confirmatory tests in human and animal subjects. Some suspected human rabies death data have not yet been completed and a documentary system has been recorded.

Conclusion and Recommendation

This study team detected cases of human and animal fatal rabies in the community and at selected public health facilities in SNNP, Ethiopia, in 2018. The team verified the occurrence of an outbreak of rabies exposure. The multi-sectoral and multi-disciplinary "one health approach" has been seen as very critical in addressing such burdens in the human and animal domains. Poor collaboration between sectors, inaccessibility/shortness of anti-rabies vaccines and community awareness gaps have been identified as major challenges. High free roaming and unvaccinated dog populations as well as high interactions with wildlife were also observed. On the basis of the above conclusion, the following recommendations are forwarded:

1. Awareness-creation and social mobilization programs and events related to rabies problems should be undertaken through the use of different media and other tools for the Community, health professionals and policy makers.
2. Communication and collaboration between the human and animal professions should be encouraged for an effective system of surveillance, control and prevention of rabies exposure.

3. Mass vaccination of dogs, the prevention of free movement of dogs and contact with wild life and the management of dog populations should be carried out in order to achieve zero rabies in humans and animals.
4. The availability and affordability of the anti-rabies vaccine (PEP) for humans and dogs should be addressed with national and international partners.
5. Quality cell culture anti-rabies vaccine must be available and accessible to the affected community as a whole.

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Authors' Contributions

YM was responsible for the study, collection and analysis of the data and wrote the manuscript. **FL, AA, MY, ZA, ES, MB,** contributed to the collection of data, the study methodology and the co-writing of the manuscript. **GK, GG, DS** and **MA** have contributed to laboratory work and guidance. **FR** and **AD** contributed to the revision and editing of manuscripts. The final manuscript was read and approved by all authors.

References

1. WHO. Rabies fact sheet. <https://www.who.int/news-room/fact-sheets/detail/rabies> 2019 [cited 2019 May 21].
2. Takahashi-Omoe H, Omoe K, Okabe N. Regulatory systems for prevention and control of rabies, Japan. *Emerging infectious diseases*. 2008 Sep;14(9):1368.
3. FAO, Developing a stepwise approach for rabies prevention and control. Proceedings of the FAO/GARC Workshop, November 2012, Rome, Italy. *FAO Animal Production and Health Proceedings*, 2013. 18.
4. WHO, WHO expert consultation on rabies: Frist report, in Technical report series 2005, WHO: Geneva.
5. Undurraga EA, Blanton JD, Thumbi SM, Mwatondo A, Muturi M, Wallace RM. Tool for eliminating dog-mediated human rabies through mass dog vaccination campaigns. *Emerging infectious diseases*. 2017 Dec;23(12):2114.
6. Oyda S, Megersa B. A review of rabies in livestock and humans in ethiopia. *International Journal of Research - Granthaalayah*, 2017. 5(6): 561-577.
7. CDC. Rabies in Ethiopia. World Rabies Day, Prevent Rabies around the World 2017.
8. Deressa A, Ali A, Bayene M, Selassie BN, Yimer E, Hussen K. The status of rabies in Ethiopia: A retrospective record review. *Ethiopian Journal of Health Development*. 2010;24(2).
9. Adugna A, SNNPR, Southern Nations Nationalities and Peoples Demography and Health. *Ethiodemography and health*, 2018.
10. FAO/OIE/WHO, Inter-agency meeting on planning NZDS prevention and control. 2011.
11. Moges N. Rabies in Ethiopia: review article. *Academic Journal of Animal Diseases*. 2015;4(2):74-81.
12. Wallace RM, Undurraga EA, Blanton JD, Cleaton J, Franka R. Elimination of dog-mediated human rabies deaths by 2030: needs assessment and alternatives for progress based on dog vaccination. *Frontiers in veterinary science*. 2017 Feb 10;4:9.
13. Jemberu WT, Molla W, Almaw G, Alemu S. Incidence of rabies in humans and domestic animals and people's awareness in North Gondar Zone, Ethiopia. *PLoS Negl Trop Dis*. 2013 May 9;7(5):e2216.
14. Admasu P, Mekonnen Y. Rabies and its Folk Drugs Remedies in Ethiopia: A Review. *International Journal of Basic and Applied Virology*. 2014;3(2):22-7.
15. Abraham A, Daddi J, Milliyan W, Almaz A, Fikir T. National surveillance for human rabies cases. In: impact, limitation and needs in developing countries. *Ethiopian health and Nutrition Research Institute*, 2010.
16. WHO, WHO Expert Consultation on Rabies: Third report. WHO Technical Report Series, No. 1012. Licence: CC BY-NC-SA 3.0 IGO, 2018.