A Retrospective Study of Suspected Human Rabies Exposure Cases in Addis Ababa, Ethiopia

Zerihun Mesfin

Animal Quarantine Import Export Inspection and Certification Directorate, Ministry of Agriculture, Addis Ababa, Ethiopia

Email address:
zerihunmesfin@yahoo.com

To cite this article:
Zerihun Mesfin. A Retrospective Study of Suspected Human Rabies Exposure Cases in Addis Ababa, Ethiopia. *American Journal of Health Research*. Vol. 10, No. 3, 2022, pp. 44-50. doi: 10.11648/j.ajhr.20221003.11

Abstract: *Background:* Rabies is a neglected viral zoonotic disease caused by the rabies virus. It is widely distributed in many regions of the world. It is a fatal viral disease in human and animals. Ethiopia is one of the African countries with the highest number of rabies cases and deaths. However, there is a lack of information in the research area about the trend, seasonal distribution, and incidence of suspected human rabies cases. We analyzed suspected human rabies cases and deaths by dog bite to describe trends, incidence, seasonality, and distribution of suspected human rabies cases and deaths in Addis Ababa from 2015-2019. *Methods:* Suspected human rabies exposure cases in Addis Ababa from 2015 to 2019 collected secondary data of PHEM data base weekly report were analyzed using Microsoft Excel 2010. *Results:* The results showed 1772 suspected human rabies exposure cases by dog bites and eight deaths were reported in Addis Ababa from 2015 - 2019. The trend of suspected human rabies exposure cases and deaths by dog bite were increased from 2015-2020. The highest number of cases by dog bites was recorded in 2019 (1139/1772, 64.3%). The highest deaths (5/8, 75%) were reported in 2017. The highest numbers of cases of suspected rabies exposure through dog bites were reported in the months of December, October and September. The highest number of suspected human rabies exposure cases by dog bite was recorded from Kirkos sub-city (897/1772, 50.6%) while the lowest cases were from Bole sub-city (1/1772, 0.06%). The average annual incidence rate of suspected human rabies exposure cases and deaths by dog bite were (8.4/100000) and (0.04 /100000) respectively. The incidence trend of suspected human rabies exposure cases by dog bite increased from 2015 to 2019 (0 to 24.8/100000). *Conclusions:*. The present study shows a trend in which suspected cases of human exposure to rabies have increased and spread to all sub-cities in Addis Ababa.. Suspected human rabies remains causing serious challenge on human health and life in Addis Ababa. Hence, integrated One Health approach must be strengthened and encouraged in the study area; with its strategic control methods are recommended to control the disease.

Keywords: Exposure, Incidence, Rabies, Addis Ababa, Suspected

1. Background

Rabies is caused by the rabies virus, in the genus Lyssa virus, family Rhabdoviridae, which affects the central nervous system of mammals [1]. It is a widespread, neglected and under-reported zoonosis which is 100% fatal in untreated humans and animals, causing a significant social and economic burden in many countries and the disease is transmitted mainly by the bite or scratch of a rabid dog [2].

Globally, rabies is widely distributed, except for the Antarctica [2]. An estimated 59,000 human deaths due to rabies occur annually [3]. The majority of rabies-related deaths occur in Africa, followed by Asia [4]. Rabies is also responsible for estimated annual human deaths of about 31,000 and 24,000 in Asia and Africa regions respectively [4]. Africa and Asia recorded over 95% of the fatal cases of rabies worldwide, and the greatest risk to human life from rabies occurs in these regions [4].

In Ethiopia, thousands of people are infected with rabies and an estimated 2,700 people die annually which makes it to be one of the most affected countries in the world [5]. Official reports in Ethiopia showed 12 exposure cases per 100,000 populations and 1.6 rabies deaths per 100,000 populations [5]. Nevertheless, a true number of deaths caused by rabies is unknown since the disease is underreported and rabies diagnostic laboratories are not established in every corner of the country [6]. The large dog populations in combination with poor dog management contribute to high endemicity of canine rabies in Ethiopia [7].

There are insufficient regional epidemiological data in

human rabies exposure cases which results in underestimating of the disease and lack of scientific works reflecting its burden and distribution at sub city level. Therefore, the objective of the study was to describe trends, seasonal distribution of human rabies exposure and deaths by time, place and person reported from 2015 to 2019 in Addis Ababa.

2. Materials and Methods

2.1. Study Area and Period

The study was conducted at Addis Ababa from February 10-April 29, 2020. Addis Ababa is the capital and largest city of Ethiopia. It is located at 9°1′48″N latitude and 38°44′24″E longitude with an altitudinal range of 2326-3000 meters above sea level. The mean annual rainfall is 1089mm. The mean annual maximum and minimum temperatures are 20°C and 12°C, respectively with an average annual relative humidity of 60.7% [8]. The City Administration of Addis Ababa has a population density of 165.1./km^2 and the total area of 540 km² sub-divided into 10 sub-cities and 118 woredas. According to UN population projection, Addis Ababa has a total population of 4,592,000 urban and rural inhabitants in 2019 [9].

2.2. Study Design

A cross - sectional surveillance report based on a retrospective record review of secondary data on suspected human rabies exposures and deaths was conducted in Addis Ababa.

2.3. Source of Data

Secondary data of suspected human rabies cases and deaths were taken from the EPHI/PHEM data base weekly report from 2015-2019.

2.4. Statistical Analysis

Data were analyzed using Microsoft Excel 2010. Microsoft Excel was used to generate tables and charts.

2.5. Case Definitions

According to the standard case definition of WHO [10]:

Human rabies cases can be classified into suspected, probable, and confirmed cases:

  a) A suspected rabies case: the patient is determined to be a case consistent with the clinical case definition;
  b) A probable rabies case: the patient is defined as a suspected case plus a history of reliable contact with a suspected rabid animal;
  c) A confirmed case: the patient has been identified as a suspected or probable case which is laboratory confirmed.

Human rabies exposure can be classified into possible exposure, probable exposure and exposed:

  a) Possible exposure: A person who had close contact (usually a bite or scratch) with a rabies-susceptible animal in (or originating from) a rabies-infected area.
  b) Probable exposure: A person who had close contact (usually a bite or scratch) with an animal displaying clinical signs consistent with rabies at the time of the exposure, or within 10 days following exposure in a rabies-infected area.
  c) Exposed: A person who has had close contact (usually a bite or scratch) with a laboratory-confirmed rabid animal.

3. Results

3.1. Annual Trends of Suspected Human Rabies Exposure Cases and Human Deaths by Time

A total of 1772 suspected human rabies exposure cases by dog bite were reported from 2015 to 2019 in Addis Ababa. The highest number of suspected human rabies exposure cases by dog bite was observed in 2019 (64.3%, 1139) followed by 2018 (30.8%, 543). The number of suspected human rabies exposure cases by dog bite increased from 2015 to 2019. In Addis Ababa, a total of eight human deaths has been reported due to suspected human rabies over a five-year period. The highest number of deaths from suspected human rabies was recorded in 2017 (62.5%, 5), followed by 2019 (25%, 2). However, no deaths were reported in 2015 and 2016 at Addis Ababa. The suspected human rabies deaths showed increased from 2016 to 2017 and it reached its peak in 2017 then sharply fall to 2018 and again increased in 2019 (Figure 1).
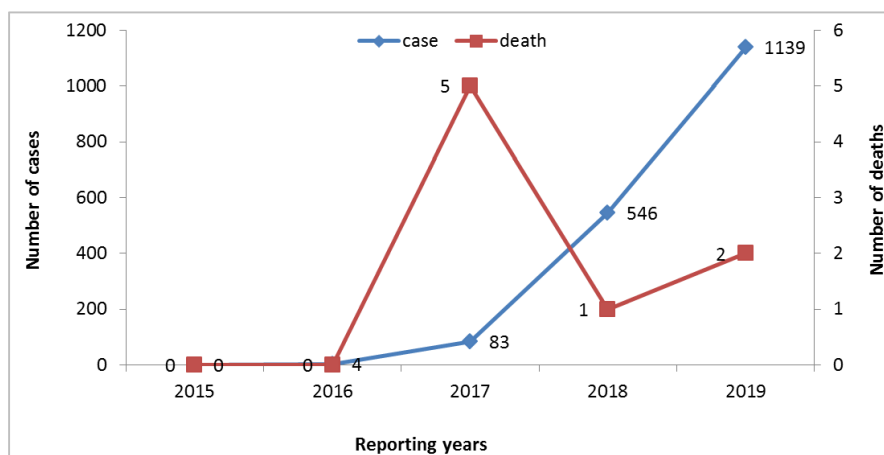

Figure 1. Suspected human rabies exposure cases and deaths by dog bites by years in Addis Ababa, Ethiopia (2015-2019).

Suspected human rabies exposure cases by dog bite were reported from January to December. However, 145 cases occurred in December, 2019 followed by October (134) and September (120) 2019 and reached its peak in December 2019 (Figure 2).
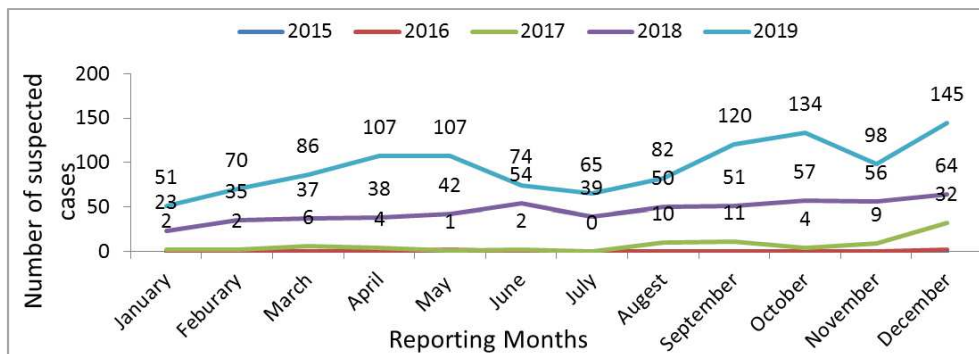

***Figure 2.** Monthly distribution of suspected human rabies exposure cases by dog bites in Addis Ababa, Ethiopia (2015-2019).*

From the total recorded suspected human deaths by dog bite, the highest (5) suspected human deaths occurred in August 2017 (Figure 3).
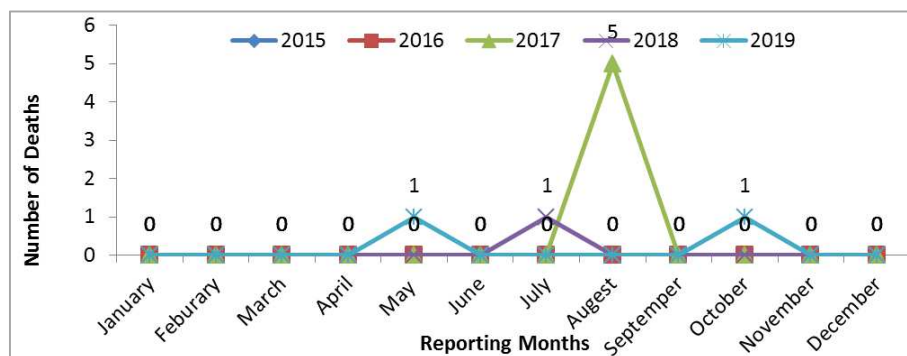
***Figure 3.** Monthly distribution of deaths from suspected human rabies by month in Addis Ababa, Ethiopia (2015-2019).*

3.2. Distribution of Suspected Human Rabies Exposure Cases and Deaths by Place

During the last five years (2015 to 2019), suspected human rabies exposure cases by dog bite were reported from all Sub Cities. However, more suspected human rabies exposure cases by dog bites were reported in Kirkos Sub city (50.6%, 897) and followed by Kolefe Keranio Sub city (35.9%, 536). In contrast, the lowest suspected cases by dog bite were reported in Bole Sub city 1 (0.06%). From the total suspected cases by dog bite, the highest percent of suspected cases by dog bite were observed in Kolfe Keranio Sub -City 549 (31%) and followed by Kirkos Sub -City 445 (25.1%) in 2019 (Figure 4).
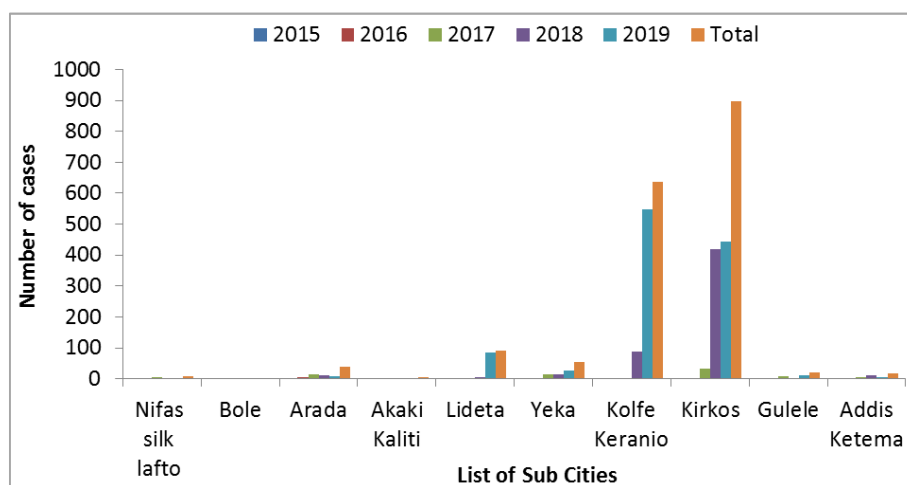
***Figure 4.** Distribution of suspected human rabies exposure cases by dog bites by sub cities, Addis Ababa, Ethiopia (2015-2019).*

In the last five years, the distribution of suspected human rabies deaths by dog bite was highest in Kirkos Sub-City 5 (62%) and no deaths were reported in the rest of sub-cities (Figure 5).
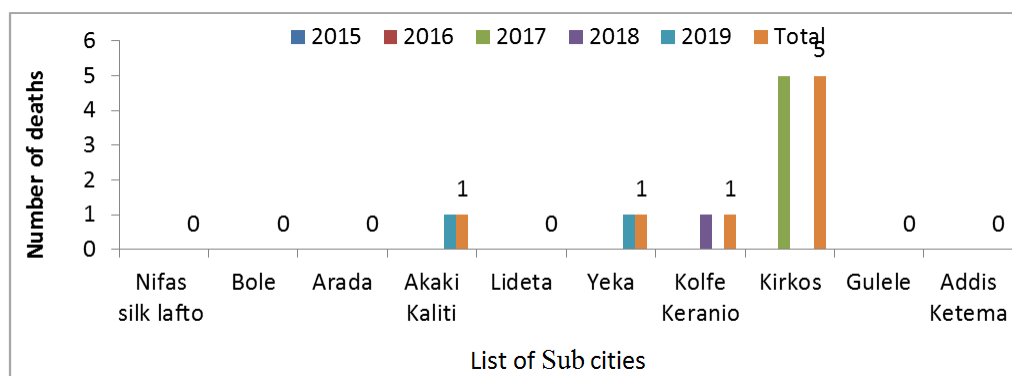

Figure 5. *Distribution of suspected human rabies deaths by Sub Cities, Addis Ababa, Ethiopia (2015-2019).*

3.3. Incidence of Suspected Human Rabies Exposure Cases and Deaths

The overall incidence rate of suspected human rabies exposure cases by dog bites were 8.4. The highest suspected human rabies exposure from dog bites were reported in 2019 (24.8 per 100,000, 1,139). Whereas, the highest incidence of fatal suspected human rabies exposure cases by dog bites were reported in 2017 (0.12 per 100,000, 5 deaths) (Table 1).

Table 1. *Incidence of suspected human rabies exposure cases and deaths by dog bite in Addis Ababa, Ethiopia (2015-2019).*

Years	Population at risk	No of suspected rabies cases	Incidence per 100,000 Populations	No of Deaths	Deaths/100000 populations
2015	3871000	0	0	0	0
2016	4040000	4	0.1	0	0
2017	4216000	83	1.97	5	0.12
2018	4400000	546	12.4	1	0.02
2019	4592000	1139	24.8	2	0.04

The highest incidence rate of suspected human rabies exposure cases by dogs bite was reported in Kirkos Sub city (52 per 100000), followed by Kolfe keranio Sub city (20 per 100000) in the study area. Furthermore, the least incidence rate was reported from Bole Sub city (0.1 per 100000) (Table 2).

Table 2. *Incidence of suspected human rabies cases by Sub Cities, Addis Ababa, Ethiopia 2015 to 2019 per 100,000 populations.*

Sub city	2015		2016		2017		2018		2019		Total	
	Rabies exposure cases	Incidence rate per 100000 populations	Rabies exposure Cases	Incidence rate per 100000 populations	Rabies exposure cases	Incidence rate per 100000 populations	Rabies exposure cases	Incidence rate per 100000 populations	Rabies exposure cases	Incidence rate per 100000 populations	Rabies exposure cases	Incidence rate per 100000 populations
Nifas silk lafto	0	0	0	0	6	1.2	0	0	2	0.4	8	0.3
Bole	0	0	0	0	1	0.3	0	0	0	0	1	0.1
Arada	0	0	4	0.9	15	3.2	11	2.2	10	3	40	2
AkakiKaliti	0	0	0	0	1	0.4	0	0	3	1	4	0.3
Lideta	0	0	0	0	0	0	4	1.2	86	24.6	90	6
Yeka	0	0	0	0	14	2.6	14	2.5	27	4.6	55	2
KolfeKeranio	0	0	0	0	0	0	87	12.8	549	79	636	20
Kirkos	0	0	0	0	34	10	418	116	445	118	897	52
Gulele	0	0	0	0	8	2	1	0.2	13	3	22	1
Addis Ketema	0	0	0	0	4	1	11	3	4	1	19	1
Total	0	0	4	0.1	83	2	546	12.4	1139	25	1772	8.4

From 2015 to 2019, the overall incidence rate of suspected human rabies deaths by dog bite was 0.04 per 100000 in the study area. The highest incidence rate of suspected human rabies deaths by dog bite was reported in 2017 in Kirkos Sub city (1.5 per 100000) (Table 3).

Table 3. *Case specific mortality rate (CSMR) of suspected human rabies deaths by Sub Cities, Addis Ababa, Ethiopia, 2015 to 2019 per 100,000 populations.*

Sub city	2015		2016		2017		2018		2019		Total	
	Deaths	CSMR	Deaths	CSMR	Deaths	CSMR	Deaths	CSMR	Deaths	CSMR	Deaths	CSMR
Nifas silk lafto	0	0	0	0	0	0	0	0	0	0	0	0
Bole	0	0	0	0	0	0	0	0	0	0	0	0
Arada	0	0	0	0	0	0	0	0	0	0	0	0
Akaki Kaliti	0	0	0	0	0	0	0	0	1	0.3	1	0.07
Lideta	0	0	0	0	0	0	0	0	0	0	0	0
Yeka	0	0	0	0	0	0	0	0	1	0.2	1	0.03
Kolfe Keranio	0	0	0	0	0	0	1	0.2	0	0	1	0.03
Kirkos	0	0	0	0	5	1.5	0	0	0	0	5	0.3
Gulele	0	0	0	0	0	0	0	0	0	0	0	0
Addis Ketema	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	5	0.1	1	0.02	2	0.04	8	0.04

3.4. Seasonal Distribution of Suspected Human Rabies Exposure Cases and Deaths

Of the total cases of suspected human rabies exposure from dog bites, 601 (33.9%), 431 (24.3%), 428 (24.2%) and 312 (17.6%) were reported during Autumn, Spring, Summer and Winter seasons, respectively. The highest number of suspected human rabies exposure from dog bites occurred in Autumn (33.9%, 601). While the lowest suspected number human rabies exposure cases by dog bites reported in Winter season (312/1772, 17.6%) (Table 4).

Table 4. *Seasonal distribution of suspected human rabies cases by a dog bite in Addis Ababa, Ethiopia (2015 - 2019).*

Years	Spring	Winter	Autumn	Summer
2015	0	0	0	0
2016	2	0	2	0
2017	7	10	45	21
2018	134	95	177	140
2019	288	207	377	267
Total	431 (24.3%)	312 (17.6%)	601 (33.9%)	428 (24.2%)

The highest suspected human deaths by dog bite occurred during summer season (75%) followed by spring (12.5%) and autumn (12.5%) (Table 5) respectively and no deaths were reported during winter in Addis Ababa.

Table 5. *Seasonal distribution of suspected human rabies deaths by dog bite in Addis Ababa, Ethiopia (2015 - 2019).*

Years	Spring	Winter	Autumn	summer
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	5
2018	0	0	0	1
2019	1	0	1	0
Total	1 (12.5%)	0 (0%)	1 (12.5%)	6 (75%)

4. Discussion

A total of 1772 suspected human rabies exposure cases by dog bite were reported to Ethiopian Public Health Institute Public Health Emergency Management from 2015 to 2019. This finding is significantly higher than that of study conducted in northwestern, Amhara, Ethiopia in the year 2017 [11] and it is lower than the study conducted in Northwestern Tigray, Jimma Zone and Surrounding Areas and Addis Ababa where 2180, 2302 and 6927 human rabies exposure cases by dog bite were reported respectively [12-14]. This might be due to an incense of awareness on suspected human rabies by dog bites and improvement in health seeking behavior which might have increased in the report of suspected human rabies cases by dog bite.

The current findings indicate that the annual trend of suspected human rabies exposure cases from dog bites has increased from year to year during the last five years. This is consistent with the study conducted in Northwestern Tigray [12]. This might be due to having good awareness on the consequences of rabies, increasing people's trust in services and the tendency to report and poor implementation of prevention and control strategies in the study areas.

In our findings, the number of suspected human rabies cases by dog bite during the study period reached peak in December. However, a study conducted in Chongqing, China [15] showed the opposite, where cases reached a peak in October. The difference might be due to the higher risk of exposure during these months and the longer incubation period of rabies, geographical and seasonal variation.

The current study shows that the number of human death from suspected human rabies by dog bites was 8 in the last five years (2015-2019). This finding is lower than the study conducted from 1990-2000 and 2001-2009 which showed suspected human deaths were 322 and 386 respectively in Ethiopia [16, 7]. But this finding is in line with a study conducted in Bhutan [17]. This might be due to giving of anti-rabies post- exposure treatment against rabies for those exposed people.

The incidence rate of suspected human rabies exposure cases by dog bite was 24.8, 12.4, 1.97, 0.1 and 0 in 2019, 2018, 2017, 2016, and 2015, respectively, and the overall incidence of the present study was 8.4, which is higher than that of a study conducted in North Gondar Zone [18]. This might be due to the presence of many stray dogs and no adequate vaccination coverage at the study area during the study period. This finding is by far lower than the study conducted in Tanzania (58/100,000), Central Iran (Yazd Province) (168.4/100,000), Eastern Region of Ghana (172/100,000) and Kenya (289/100,000) [19-22] respectively. This difference might be due to differences in socio-cultural factors, such as animal-human relationships.

In the present study, the annual incidence rate of death

from suspected rabies cases by dog bite was 0.04 per 100000 populations. This finding is different from the study conducted in Bhutan and Ethiopia [17, 14]. This might be due to effective dog bite management and low reporting of death in Addis Ababa.

A high number of suspected human rabies exposure cases by dog bites were recorded during autumn 33.9%. This is in harmony with the report from Zhejiang Province, China [23]. This is largely associated with the breeding season of dogs. In contrary to this finding, studies conducted in Northwestern, Tigray [24], Bhutan [17], North Gondar Zone [18] and Jimma zone and its surroundings areas [13] reported high numbers of suspected human rabies exposure cases in Spring and winter. These different findings might be associated with difference in geographical locations.

This study showed that 75% of suspected human rabies deaths by dog bite were recorded in Addis Ababa during summer season. This finding is in agreement with study done in Northwestern, Tigray Region, Ethiopia [24].

5. Limitations

All human rabies cases and deaths were reported in weekly summary report format to PHEM which was difficult to get sex, age, and human post-exposure prophylaxis data. In addition, cases of human rabies were not classified as suspected, probable and confirmed according to the standard WHO case definition.

6. Conclusion

In recent years, suspected human rabies exposure cases by dog bites are a major public health problem and endemic disease in Addis Ababa. According to our analysis, the trend of suspected human rabies exposure cases from dog bites increased from 2015 to 2019. Suspected human rabies cases bites were distributed across all Sub Cities of Addis Ababa. Nevertheless, the trend of deaths increased from 2016-2017 and sharply declined in 2018 and again increased 2019. The highest and the lowest seasonal distribution of suspected human rabies exposure cases by dog bites were reported during autumn and winter season respectively. The majority of deaths of suspected human rabies cases by dog bites were observed at summer season and with no death recorded during winter season. There is no existence of laboratory-confirmed cases, which may be due to a lack of laboratory facilities in the city. Besides this, the study did not include sex and age, post exposure prophylaxis data of human, and classifications of cases as suspected, probable, and confirmed human rabies cases. In addition, the reporting formats do not contain data on sex, age, and human post-exposure prophylaxis and classifications of cases as suspected, probable, and confirmed human rabies. Based on the above findings, the following recommendations are forwarded:

a) Improving and strengthen a multi-sectoral and collaborative approach under one health concept to mitigate the problem.

b) Human and animal health sectors should supply human and animal vaccine and implement strategies of prevention and control together to reduce the risk.

c) Local governments and stakeholders should initiate and maintain effective programs based on the "One Health" concept, including the implementation of mass rabies vaccination, dog population management, strict control of stray dogs, educate the community on rabies risk and prevention, implement routine rabies surveillance, and train medical and veterinarian staffs.

d) Community awareness on rabies transmission, prevention and control mainly at primary and secondary school students.

e) Multi-sectoral rabies surveillance system, diagnostic capacity and reporting system of the disease should be strengthens for early detection and response.

f) PHEM guideline for rabies case definition should be revised and update according to WHO guideline.

Abbreviations

°C: Degree centigrade; masl: meters above sea level; EPHI/PHEM: Ethiopia public health institute/Public Health Emergency Management; mm: Millimeters; SNNPR: South nation nationality people region; WHO: World Health Organization.

Declarations

The authors declare that they have no competing interests.

Availability of Data and Materials

All data used in the analysis during retrospective study of suspected human rabies exposure cases is available with the corresponding Author Zerihun Mesfin.

Authors' Contributions

ZM: Collect data, data entry, data analysis, writing, design study, supervise data, review and editing and approved the final manuscript.

Acknowledgements

References

[1] Pal M, Hailu A, Agarwal RK and Dave P. Recent developments in the diagnosis of rabies in humans and animals. Journal of Veterinary Public Health, 11: 77-82. 2013.

[2] MOH and MOALF (Ministry of Health and Ministry of Agriculture, Livestock and Fisheries). Strategic Plan for the Elimination of Human Rabies in Kenya. 2014.

[3]   Hampson K, Coudeville L, Lembo T, et al., "Estimating the global burden of endemic canine rabies," *PLOS NeglectedTropical Diseases*, vol. 9, no. 4, p. e0003709, 2015.

[4]   Knobel DL, Cleaveland S, Coleman PG, Fèvre EM, Meltzer MI, Miranda MEG, et al. Re-evaluating the burden of rabies in Africa and Asia. 2005; 008862 (03).

[5]   Ali, A. National rabies survey preliminary report: household assessment. Proceedings of the National Workshop on Rabies Prevention and Control in Ethiopia. Adama, Ethiopia, 18-19 October 2012. Pp. 81-90.

[6]   CDC. https://www.cdc.gov/worldrabiesday/ethiopia.html last updated: September 28, 2017.

[7]   Deressa A, Ali A, Beyene M, Selassie BN, Yimer E, Hussen K. The status of rabies in Ethiopia : A retrospective record review. Ethiop. J. Health Dev. 2010; 24 (2): 127-132.

[8]   http://en.wikipedia.org/wiki/Addis_Ababa

[9]   United Nations - World Population Prospects. Ethiopia Metro Area Population 1950-2020."www.macrotrends.net".

[10] WHO. WHO expert consultation on rabies. World Health Organization - Technical Report Series. 2005..

[11] Yizengaw E, Getahun T, Mulu Yizengaw E, Getahun T, Mulu W, Ashagrie M, Abdela I. Incidence of human rabies virus exposure in northwestern Amhara, Ethiopia. 2018; 1–7.

[12] Teklu GG, Hailu TG, Eshetu R. High Incidence of Human Rabies Exposure in Northwestern Tigray, Ethiopia : A Four-Year Retrospective Study. 2017; 1–11.

[13] Tadele K, Worku T and Benti D. Occurrence of Suspected Rabies Cases in Humans Jimma Zone and Surrounding Areas, South West Ethiopia. International Journal of Basic and Applied Virology 3 (2): 2014; 28-34.

[14] Fantu L, U. Rabies in Addis Ababa, Ethiopia, 2012–2016: Descriptive cross sectional study. 4th International Conference on Influenza & Zoonotic Diseases 10th International Virology Summit & July 02-04, 2018 | Vienna, Austria.

[15] Qi L, Su K, Shen T, Tang W, Xiao B, Long J, et al. Epidemiological characteristics and post-exposure prophylaxis of human rabies in Chongqing, China, 2007–2016. 2018; 1–7.

[16] Yimer E, Newayeselassie B, Teferra G, Mekonnen Y, Bogale Y. Situation of Rabies in Ethiopia : A retrospective study 1990-2000. 2002; (January 2019).

[17] Dhand NK, Gyeltshen T, Firestone S, Zangmo C, Dema C. Dog Bites in Humans and Estimating Human Rabies Mortality in Rabies Dog Bites in Humans and Estimating Human Rabies Mortality in Rabies Endemic Areas of Bhutan. 2011; (June 2014).

[18] 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. 2013; 7 (5).

[19] Mazigo HD, Okumu FO, Kweka EJ, Mnyone LL. Retrospective Analysis of Suspected Rabies Cases Reported at Bugando ReferralHospital, Mwanza, Tanzania. 2014, 4, 222-228.

[20] Dehghani A, Ali S, Ardakani P, Jambarsang S, Majidpour F, Karimi A, et al. Epidemiological patterns of animal bites in Yazd Province (central Iran) between 2013 and 2017. 2019; 8 (5): 195–9.

[21] Adomako B, Baiden F, Sackey S, Ameme DK, Wurapa F, Nyarko KM, et al. Dog Bites and Rabies in the Eastern Region of Ghana in 2013 – 2015 : A Call for a One-Health Approach. 2018; 7-12.

[22] Ngugi JN, Maza AK, Omolo OJ, Obonyo M. Epidemiology and surveillance of human animal-bite injuries and rabies post- exposure prophylaxis, in selected counties in Kenya, 2011 – 2016. 2018; 1–9.

[23] Ren J, Gong Z, Chen E, Lin J, Lv H, Wang W, et al. International Journal of Infectious Diseases Human rabies in Zhejiang Province, China §. Int J Infect Dis [Internet]. 2015; 38: 77–82. Available from: http://dx.doi.org/10.1016/j.ijid.2015.07.013.

[24] Gebru G, Romha G, Asefa A, Hadush H. Risk Factors and Spatio-Temporal Patterns of Human Rabies Exposure in Northwestern Tigray, Ethiopia. 2019; 85 (1): 1–12.