The situation of Animal Rabies in Nepal from 2013 to 2017

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ABSTRACT

Rabies is endemic in Asia and Africa, including Nepal. About 100 to 300 livestock and 10 to 100 humans are estimated dying of rabies in Nepal annually, but these numbers are likely underestimated. The cross-sectional study was conducted to analyse the pattern of animal Rabies using five years (2013-2017) historic data. The animal rabies case, human-dog bite case, data related to demography, and Nepal's socioeconomic have been collected from concerned government agencies. The animal, time, place, and exposure factors like human dog bite cases, literacy rate, and forest area were considered independent variables for an epidemiological study. QGIS 3.4.9 was used for mapping and GIS plotting. Microsoft Excel and STATA 14 were used as statistical tools for univariate and multivariate analysis. During this period (2013 to 2017), a total of 343 outbreaks (mean 5.84 and SD 9.76) with 1,121 animal rabies death (mean 14.55 and SD 24.24) cases were reported to the veterinary epidemiology section and central veterinary laboratory, Nepal. Among the 77 districts, 55 districts had found at least one or more outbreak(s) during this period. Out of total cases, 87.4% of cases were clinically diagnosed. The association (p<0.05, 95%CI) between animal rabies and human-dog bites was significant. While analyzing the five years' data, it can be concluded that rabies is almost evenly distributed throughout the country, including ten different animal species. Our study may provide valuable information for review of the surveillance plan, control, and eradication strategies of rabies in the future.

Keyword: Animal rabies, Cross-sectional study, Nepal

INTRODUCTION

World Health Organization (WHO), World Animal Health Organization (OIE), Food and Agriculture Organization (FAO), and the Global Alliance for Rabies Control (GARC) have set a global target of "zero dog mediated human rabies deaths by 2030" (FAO, WHO, and Global Alliance for Rabies Control 2018). Globally, rabies causes the deaths of 59,000 people per year. Asia and Africa continents share 95% of human rabies (DoHS 2018; Guo et al. 2013). The global economic loss due to canine-mediated rabies is about $8.6 billion. The most significant component of economic loss is due to premature death (55%) followed by PEP (15.5%), dog vaccination (1.5%), and additional costs to communities from livestock losses (6%) (Hampson et al. 2015).

It is known to be present in more than 150 countries and territories on all continents except Antarctica. Dogs are the primary source of human rabies deaths contributing up to 99% of all

rabies transmissions. Forty percent of people bit by suspected rabid animals are children under 15 years of age (WHO 2015). Dog-mediated human rabies disproportionately affects poor rural communities of Asia and Africa, particularly children. (Khan et al. 2019). Out of the annual global deaths due to rabies, 45% of these deaths occur on the Indian subcontinent, and approximately 33% take place in India alone (Rahman and Isloor 2018). The majority (84%) of these deaths occur in rural areas (Rabies in Asia Foundation 2013; Yao et al. 2015).

Rabies virus, prevalent in Nepal, has been characterized at the molecular level, and it was found that the virus resembled the South Asian type (Pant 2010). Rabies has been diagnosed in Nepal for a long time, but the information on its epidemiology, impact, and control remains scattered (VEC 2015). Official reports show that each year 100-300 livestock and 10 to 100 humans die of rabies in Nepal, but these numbers very likely underestimate the actual rabies burden (EDCD 2019; VEC-2018). This review could be supportive of the control and eradication plan of rabies in Nepal. This study's main objective was to explore the distribution of animal rabies in Nepal from 2013 to 2019 and to measure the possible association of animal rabies and other risk factors.

METHODOLOGY

A cross-sectional study of secondary data of animal rabies in Nepal from 2013 to 2017 was conducted. The five years (2013-2017) district level animal rabies data and human dog bite cases data of Nepal had accessed, and based on these data, tried to explore the status of animal rabies in Nepal. The ecozone, human-dog bite cases, low literacy rate, and high forest area of district were taken as indepandant variables for epidemiological analysis of disease. The Microsoft Excel and Epi-info as statistical tools were used for data analysis. QGIS 3.4.9 was used for mapping and GIS plotting. During the data analysis, concerning risk factors were considered, spatial distribution was conducted by the district, province, and ecozone concerning outbreaks and animal deaths. Similarly, temporal distribution was analyzed by months, seasons, and years. Data were collected from 75 districts of Nepal by Veterinary Epidemiology Section (VES), but the same data were analyzed as per the new administrative division (77 districts and seven provinces) of Nepal. Data were categorized in the spreadsheet. For data analysis, seven provinces, three ecological zones (mountain, hill, and terai), and four seasons (winter, autumn, spring, and summer) with other relevant risk factors were considered.

The animal rabies and animal population data have been collected from the VES, Central Veterinary Laboratory (CVL), and Department of Livestock Services (DLS) of Nepal. The animal rabies data were the cumulative data of monthly epidemiological reports of District Livestock Service Offices (DLSOs) and CVL. Similarly, human rabies and dog bite case data were collected from the Department of Health Services (DoHS), Nepal. DoHS collect the data by the Health Management Information System (HMIS), which is the online database system of DoHS.
For the descriptive study suspected case was defined as Municipality level animal rabies cases reported by the DLSO to VES, diagnosed based on the clinical sign of animal rabies (abnormal behavior, difficulty in swallowing, hyper-salivation, excitable, bark and snap at imaginary objects, development of muscular incoordination, disorientation, and seizure and paralysis) by the district veterinary officer between 2013 to 2017. Municipality or Village Development Committee (VDC) level animal rabies cases reported by CVL to the VES from 2013 to 2017, confirmation was made by Fluorescence Antibody Test (FAT) was defined as a confirmed case. All collected data were

verified and validated from the authorized organization after cleaning. Animal rabies data were broadly classified into the confirmed and suspected case. Spatial distribution of animal rabies and dog bite cases were done by using district centroid. The temporal distribution of the animal rabies and dog bite cases were presented in graph and tables.

RESULTS

From 2013 to 2017, there were 343 animal rabies outbreaks (mean 4.45 and SD 6.81), and 1121 (mean 14.55 and SD 24.24) cases were reported form the 77 district. The number of animal rabies outbreaks and cases was found to be in increasing trend from 2013 to 2017. Among 1121 cases, 141(12.6%) cases were diagnosed with FAT by CVL, and the remaining 980 (87.4%) cases were found clinically diagnosed as animal rabies by the DLSOs. Among the 55 districts of rabies cases, only 17 districts had positive laboratory diagnosis, most of them were from Bagmati, which shared 90.7% (127). Map 1 showed that most of the laboratory-confirmed cases were represented form the vicinity of RVL and CVL.
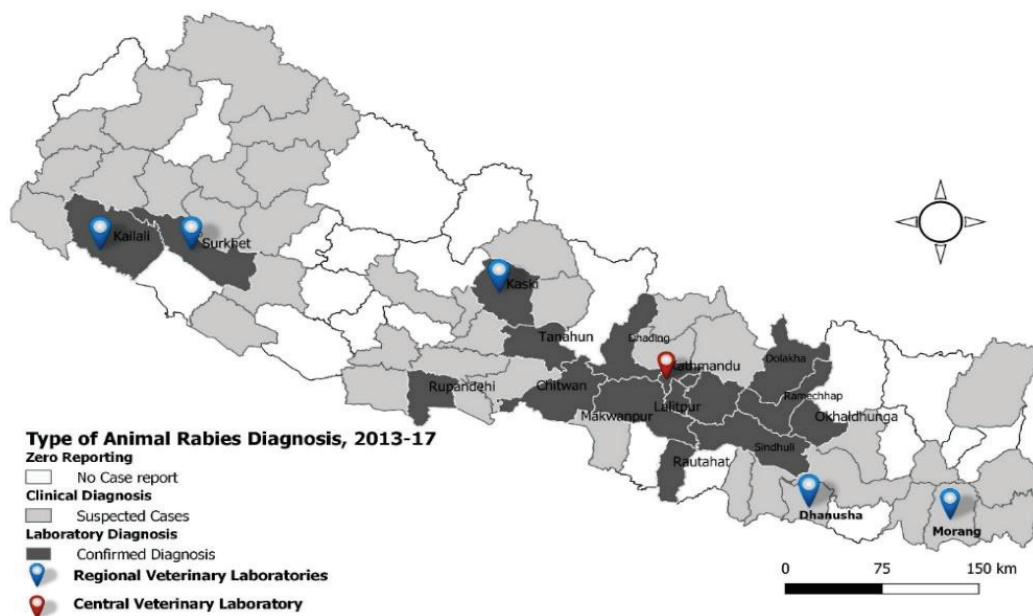
Map 1: Type of diagnosis of animal rabies by district from 2013-17

During the study period, ten animal species were found positive with rabies, including wildlife (Jackal). Cattle, dog, buffalo, and goat were found to be the main species with a high number of cases, respectively. The least number of cases were reported in yak (1), jackal (2), and cat (3). District coverage of rabies was high in the dog (38 districts) followed by cattle (37) and buffalo (32) out of the 77 districts. The mean value of animal rabies cases of cattle was found to 10.2 with SD 14.6, followed by the dog (mean 8, SD 12) and buffalo (mean 7.7, SD 7.7) (Table 1).

Table 1: Species-wise descriptive statistics of animal rabies case from 2013 to 2017

	Buffalo	Cattle	Dog	Goat	Equine	Pig	Cat	Jackal	Sheep	Yak	Total
Animal rabies case	245 (21.85%)	377 (33.6%)	304 (27%)	164 (14.6%)	11(0.9%)	5(0.4%)	3(0.2%)	2 (0.1%)	9 (0.8%)	1 (0.1%)	1121
Mean	7.7	10.2	8.0	6.07	3.67	2.50	1.50	1	4.50	1.00	14.6
Median	5.5	6.0	4.0	4	1.00	2.50	1.50	1	4.50	1.00	5.0
SD	7.7	14.6	12.0	7.05	4.62	0.71	0.71	0	0.71	N/A	24.2
District count	32	37	38	27	3	2	2	2	2	1	55

Source: VES & CVL, Nepal, 2019

Out of total 141 confirmed case, two in jackal (100%), three in cat (100%), 102 in dog (34%), 27 in buffalo (11%), 6 in goat (4%) and one in equine (9%) found positive. All reported cattle, pig, sheep, and yak cases have been diagnosed based on clinical signs (
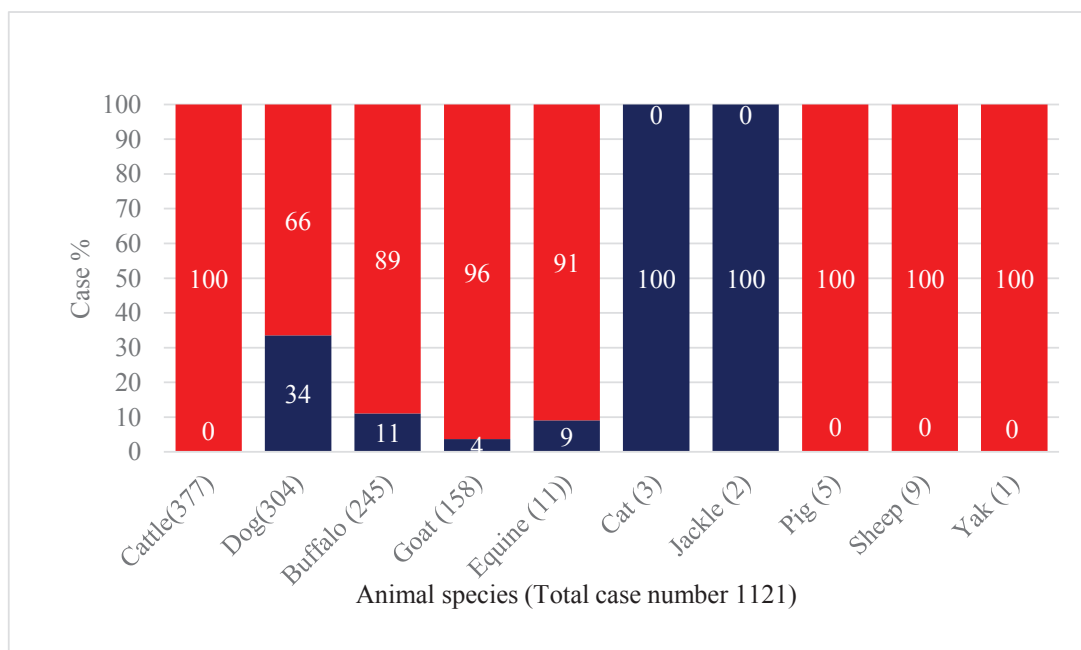
Figure **2**).

Figure 2: Animal rabies cases by species (Blue indicates laboratory confirmed while red indicates clinically suspected cases)

From 2013 to 2017, the number of human-dog bite cases was ranged from 20,151 to 37,226, with a mean of 31,445 per year. Similarly, total district-wise human dog bites cases were 153742 with mean 1996 and SD 1644 (Figure 3). The number of animal rabies cases was found 111 (2013), 225 (2014), 233 (2015), 251 (2016), and 301 (2017). Similarly, the highest number of outbreaks was 81 (2017), followed by 75 (2016), 71 (2015), 63 (2014), and 53 (2013). The animal rabies deaths increased by about three times in 2017 (301) than in 2013 (111 deaths). Similarly, human rabies death was in increasing trend from 2013 (10) to 2017 (32) (Figure 2**Error! Reference source not found.**).
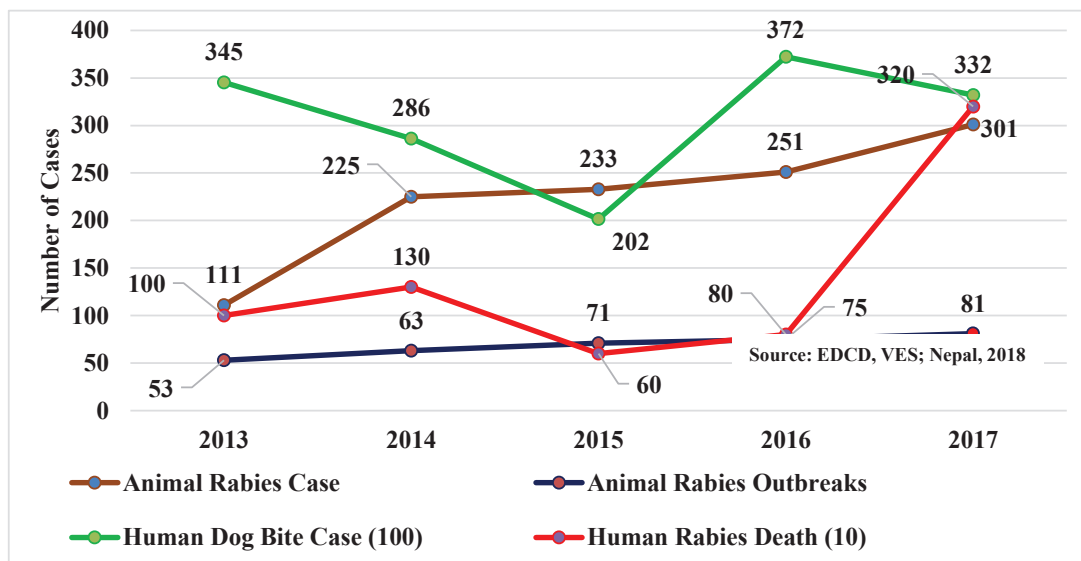

Figure 3: Human dog bite, animal rabies, and human rabies death from 2013-17

The high number of animal rabies cases were reported in spring season 347(30.95%), but summer 331(29.52%) and winter season 311 (27.28%) had slightly lower animal cases. However, the least number of deaths was occurred in autumn 132 (11.77%). However, the number of outbreaks was found higher in summer season 110 (32.1%), followed by Spring 98 (28.57%), winter 95 (27.69%), and the least number of outbreaks seen in autumn 40 (11.66%). The highest number of animal rabies cases were found in April (168), followed by January (143), September (116), February (102), and March (105), and the least number of animal cases was reported in November (55). Similarly, the highest number of outbreaks were reported in January (36), followed by March (36), April (36), September (35), and February (30), but the least number of outbreaks were found in November (17) and June (21). The average number of animal rabies cases is presented in Figure 4.

Spatial distribution of animal rabies cases form 2013-17

Among the 77 districts, only 55 districts had rabies outbreaks, and 22 districts found zero reporting from 2013 to 2017. Dailekh district had the highest number of cases (150), followed by Siraha (78), Kathmandu (71), Jajarkot (56), Ramechhap (56), Kanchanpur (49), and Bajhang (32). Kathmandu (34) district had the highest number of outbreaks, which was followed by the Dailekh

(30), Chitwan (26), Siraha (20), and Kanchanpur (20). The 22 districts including mountain, hill, and terai (Bajura, Bara, Bardiya, Bhojpur, Dang, Darchula, Dolpa, Gorkha, Gulmi, Mustang, Myagdi, Panchthar, Pyuthan, Rolpa, Rukum_Eeast, Rukum_West, Sankhuwasabha, Saptari Sarlahi, Sindhuli, Solukhambu, and Terahathum) did not have any case recorded during this period. Out of the 77 districts, the highest district coverage of animal rabies cases was found in 2014 (29 districts), which was followed by the 2015 (25 districts), 2016 (25 districts), 2017 (22 districts), and 2013 (17 districts) (Map 2; **Error! Reference source not found.**).
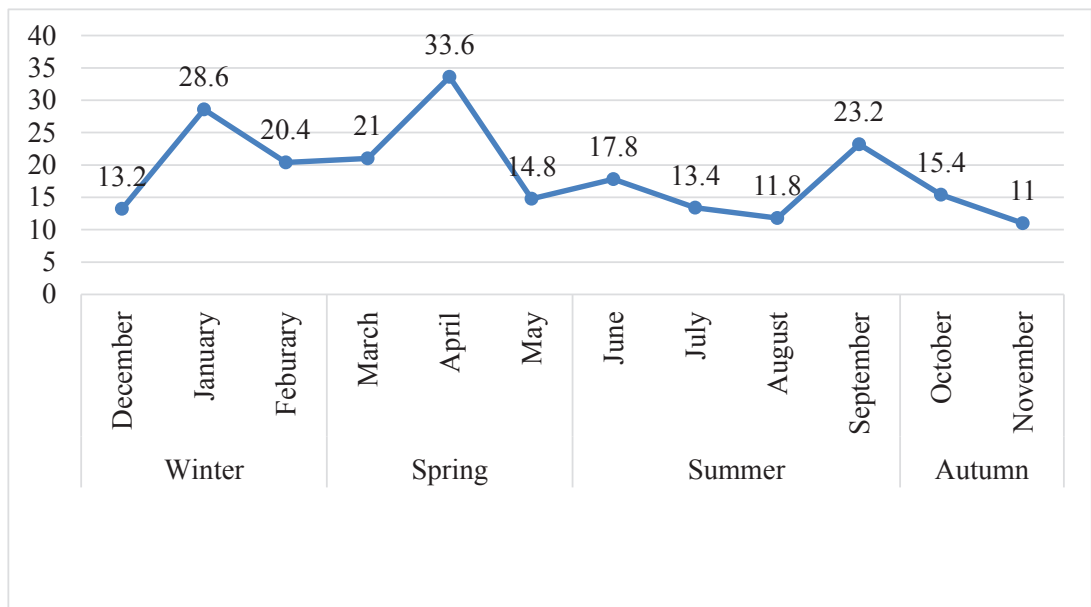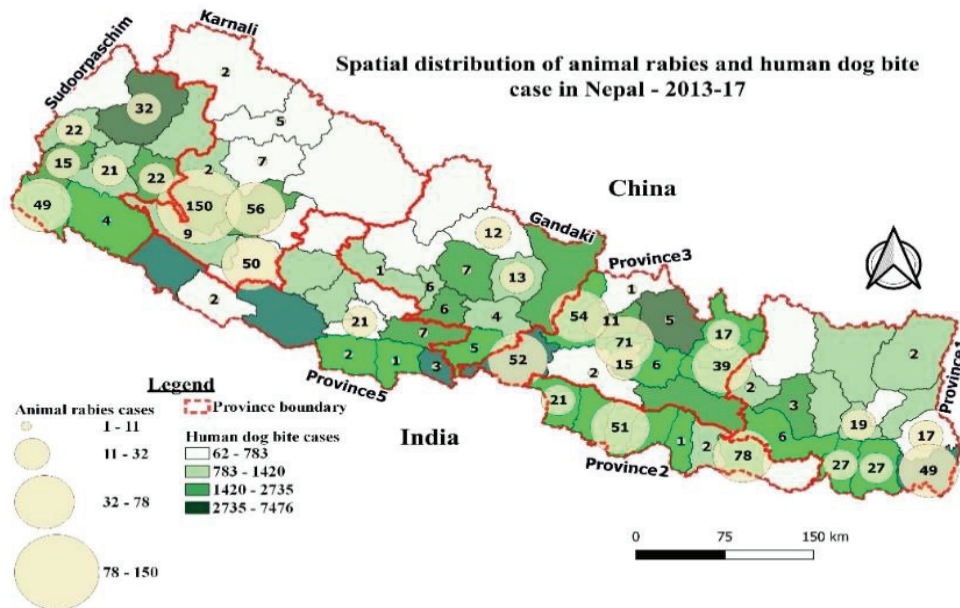

Figure 4: Month-wise average of animal rabies case from 2013-17

Map 2: Spatial distribution of animal rabies and human-dog bite cases from 2013-17

Karnali and Bagmati had more animal cases compare with other provinces. It was found that Karnali Province had 281 (25.1%) animal rabies deaths with 49 (14.28%) outbreaks followed by Bagmati with 280 (25%) deaths and 119 (34.69%) outbreaks, Sudoorpaschim province with 165 (14.5%) deaths and 50 (14.58%) outbreaks. Similarly, province 2 had 153 (13.6%) deaths and 40(11.66%) outbreaks, province 1 had 152(13.6%) deaths, and 43(12.54%) outbreaks, Gandaki with 54(4.8%) deaths and 13(3.79%) outbreaks and least number of outbreaks and deaths was found in Lumbini 13 (3.79%), 36(3.2%) respectively (

Table **2** and **Error! Reference source not found.**3). The hilly region had a significant number of animal rabies outbreaks (54.2%), and cases (59.1%) than the terai region with 36.44% outbreaks and 33.4% cases and the mountain region had 9.32% outbreaks and 7.6% deaths (

Figure **5**).

Table 2: Province-wise animal rabies and human-dog bite from 2013 to 2017

| Name of Province	Number of District	Animal Rabies Outbreaks	Animal Deaths	Human-Dog-bite (2012/13-2016/17)
Province 1	14	43 (12.5%)	152 (13.5%)	23324 (15.2%)
Province 2	8	40 (11.8%)	153 (13.6%)	30417 (19.7%)
Bagmati	13	119 (34.7%)	280 (25%)	31839 (20.7%)
Gandaki	11	29 (8.45%)	54 (4.8%)	17360 (11.3%)
Lumbini	12	13 (3.8%)	36 (3.2%)	21786 (14.2%)
Karnali	10	49 (14.3%)	281 (25%)	8607 (5.6%)
Sudoorpaschim	9	50 (14.6%)	165 (14.7%)	20409 (13.3%)
Grand Total	**77**	**343**	**1121**	**153742**
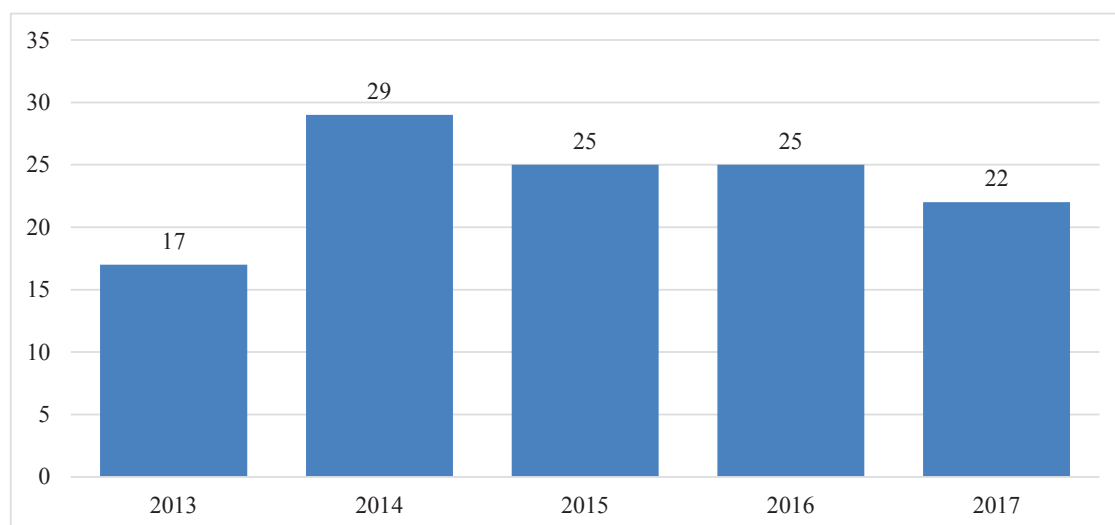
Figure 4. Number of districts from where Rabies were reported by year

Among 77 districts of Nepal, 37 districts not share the border any country, 25 districts shared border with India, 13 with china, and remaining two district shared border with both India and china. All border districts with China and India had 558 (49.78%) animal deaths and 178 (51.89%) outbreaks, while non-border districts with any countries had 563 (50.22%) animal deaths and 165 (47.81%) outbreaks. The only border with china had 128 deaths, and the only border with India had 428 deaths out of 1121 total deaths (

Figure **5**6).
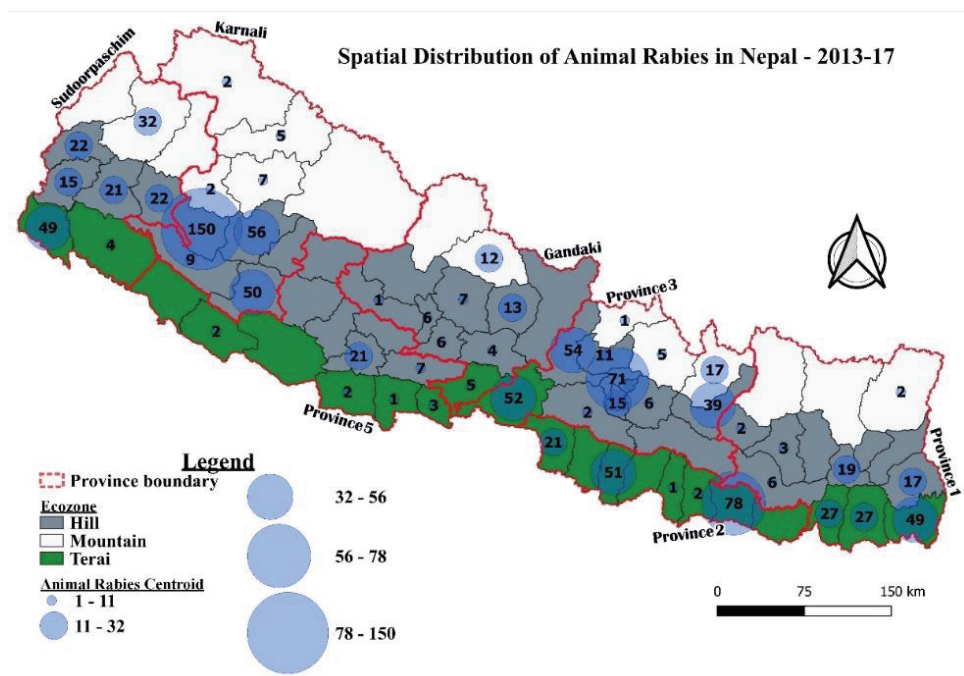
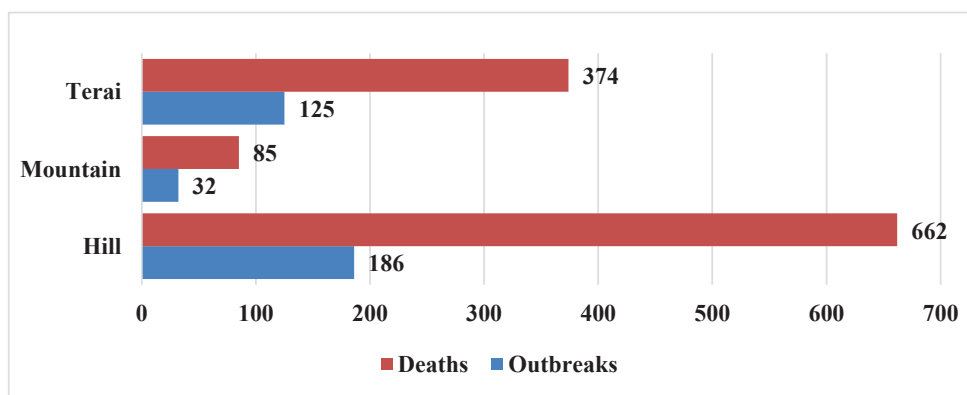Map 3: Spatial distribution of animal rabies case in Nepal, 2013-17

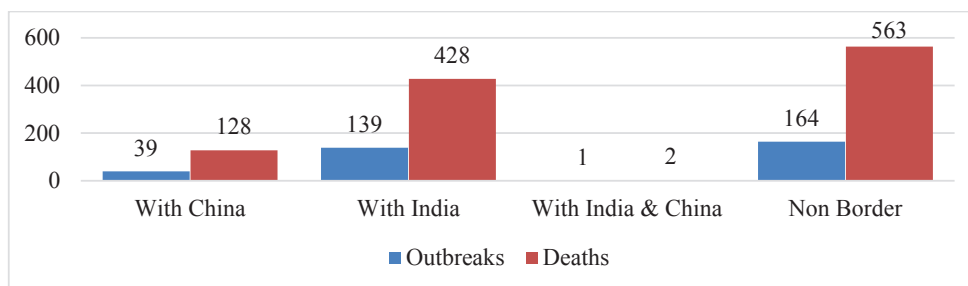Figure 5: Ecozone-wise animal rabies outbreaks and cases from 2013-17

Figure 6: Border district-wise animal rabies outbreaks and deaths from 2013-17

DISCUSSION

A total of 1121 rabies cases were found from 2013 to 2017, which was relatively higher than cases reported (1713) from 2000 to 2009 in Nepal (Yadav 2012). This study showed that out of 77 districts of Nepal, 55 had rabies outbreaks remaining did zero reporting or no reporting, which means districts' coverage was like an endemic (S. Karki and K. C. Thakuri 2010). 980 (87.4%) cases of rabies were clinically diagnosed by DLSOs, and only 141(12.6%) cases diagnosed by laboratory confirmation, but as per the previous study before 2009 there were almost suspected cases were clinically diagnosed (Yadav 2012). This study showed 90.7% of total laboratory-confirmed cases (141) from Bagmati, where CVL is located. It might be due to access to transportation and the Central Veterinary Laboratory. Among the ten rabies reported species, there were no confirmed cases from cattle, pig, sheep, and yak, and it may be due to the difficulty in sampling and long-distance form the laboratory. During the study period, ten animal species (cattle, dog, buffalo, goat, equine, sheep, pig, cat, jackal, and yak) had a death due to rabies. Out of the 1121 cases, the highest cases found in cattle (33.63%) may be due to the religious resion, and street cattle, which is similar to previous findings (Yadav 2012) conducted between 2000 to 2009. In the same period, rabies was reported other than yak, jackal, and sheep species (Spickler 2009).

Studies in China showed that rabies cases are high in the hot season because people tend to wear less and have outdoor activity (Yao et al. 2015). This study also revealed that spring (30.95%) and summer season (29.52%) had higher animal rabies death. Some authors said that breeding seasonality of dogs and wild carnivores is also associated with the increase of rabies cases (Devleesschauwer et al. 2016). This study showed an April had 168 animal deaths followed by January (143) and September (116). The previous study in Nepal also showed that breeding season of dogs (August or September) has higher contact rates, and they are often seen in groups (Yadav 2012), which is responsible for increase the chances of getting infected with the rabid dog or other animals.

Dailekh district had the highest number of death (150), followed by Siraha (78) and Kathmandu (71). There was no animal rabies reported from 2000 to 2009 from 7 districts (Argakhachi, Bajura, Dolpa, Gulmi, Mustang, Myagdi, Solukhumbu) of Nepal (S. Karki and K. C. Thakuri 2010; Yadav 2012). That might be due to several reasons like under-reporting and laboratory facilities. Hilly region has a higher rabies death 662 (59.1%); the previous study also showed hilly regions had higher rabies cases, 988 (58%), followed by 625 (36%) in the terai and 100 (6%) cases in the mountain region (Yadav 2012).

Similarly, in logistic regression, odds of animal rabies outbreak were found higher with increasing the human-dog bites (OR=3.41) and dog population density (OR=2.08) of exposure population. The highest literacy rate is reported in Kathmandu district (86.3 %) and the lowest in Rautahat (41.7%) (McKenney 2012). It was found that there were 15 districts that had the number of outbreaks and forest area was more than average. Similarly, there were only 12 districts that had below-average literacy rates with an outbreak above the average. Pro-poor rural areas, low literacy rates, and ignorance compounds are the problems of rabies (Talha Burki 2008; Yadav 2012), but our study did not find an association between animal rabies and a literacy rate of the districts (OR 0.73, p-value 0.69).

Due to the lack of clinical rabies surveillance, most of the cases are deemed to be under-reporting. Still, these data did not reflect the exact picture of the animal rabies of Nepal. Most of the zero rabies reported districts had an equal chance of rabies outbreak than the neighboring districts. There were several limitation of this study. The absence of clinical surveillance and under-reporting of data, all cases of animal rabies by district and year might be less than actual prevalence. All passive surveillance data of the district cannot give the exact GIS location of every rabies cases, therefore centroid of district was used for mapping.

CONCLUSION AND RECOMMENDATIONS

While analyzing the five years' data, it can be concluded that rabies is almost evenly distributed throughout the country. Moreover, the number of animal rabies death is increasing every year. Most cases are reported as a suspected case; even there is no confirmed case reported from some species like cattle, pig, equine, etc. Most of the mountain and hilly region's districts are far from the central and regional veterinary laboratories; there is a possibility of under-reporting due to transportation, difficulty in the sample collection, and distance from the laboratory. Our study may provide valuable information for review of the surveillance plan and control and eradication strategies of rabies in the future.

Detail records of animal health surveillance should be kept in an online or electronic database system with individual cases or samples. The validation of the monthly epidemiological report is highly recommended. The strengthening or capacity enhancement of district or regional laboratories for disease diagnosis and disease surveillance. There should be the mandatory provision of detailed animal health data reporting provision to the veterinary epidemiology section. The coverage of laboratory services should be increased to increase the surveillance system's sensitivity, especially from the hilly and mountain regions. The strengthening and evaluation of the rabies surveillance systems, including wildlife, is highly recommended. The mandatory legal provision of rabies case reporting, dog population management, and vaccination should be inbuilt in local government legislation.

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