Science in One Health 1 (2022) 100007

Contents lists available at ScienceDirect

Science in One Health

journal homepage: www.journals.elsevier.com/science-in-one-health

Short Communication

Incidence of dog bite injuries and its associated factors in Punjab province of Pakistan

Muhammad Alfahad [a], Farwa Butt [a], Muhammad Adnan Aslam [b], Tariq Abbas [a,*], Adnan Ahmad Qazi [a], Qudratullah [a]

[a] Cholistan University of Veterinary and Animal Sciences, Bahawalpur, Pakistan
[b] University of Veterinary and Animal Sciences, Lahore, Pakistan

ARTICLE INFO

Keywords:
Dog bites
Rabies
Nighttime lights
Incidence
Spatial analysis
Pakistan
Socio-economic
Demographic

ABSTRACT

Dog bites are a major cause for transmission of rabies virus to humans. Pakistan ranks fifth among most rabies affected countries in the world. There are a few regional (ecological) studies that investigated factors that explain geographic disparities in incidence of dog bite injuries. The main objective of this research was to document findings of spatial exploratory data analysis of incidence of reported cases of dog bite in Punjab province of Pakistan (2016–2019). In addition, we have quantified the association between incidence of dog bites and a set of selected socio-economic and demographic variables. District-wise data about reported cases of dog bites from 2016 to 2019 were used to map annual crude incidence per 100,000 of population. There was an obvious spatial variation in incidence of dog bites but there was no evidence of spatial autocorrelation. The risk of dog bite attacks was relatively higher in districts with low human population density (per sq. km), poor literacy rate, more rural population (% of total population), and lower median nighttime lights.

1. Introduction

Dog bite injuries represent a neglected public health problem that has increased over time in many countries of the world. The consequences of a dog bite injury may be trauma, transmission of zoonotic diseases, infection at wound site and even death due to rabies. In addition, such injuries have a negative economic impact on affected individuals and health services. In developing countries, most bites are caused by stray dogs [1]. It is estimated that each year, over 10 million people get post-exposure prophylaxis of rabies which indicates the gravity of the problem [2,3]. The situation is even more alarming in developing countries where morbidity and mortality due to dog mediated rabies remains higher and unabated. Pakistan ranks fifth among most rabies affected countries in the world with 2000–5000 deaths each year [4]. Various hospitals in the country have reported 25 to 30 cases of dog bites per day [5]. Globally, different approaches such as culling, sheltering, fertility control, combination of fertility control and sheltering have been implemented to manage population [6]. Recently, the country has introduced a capture neuter-vaccinate-and-release program in Punjab province to control stray dog population and reduce transmission of rabies. With limited resources, it is important to prioritize districts for this program and support other programs to control dog population and eliminate rabies [7].

Earlier studies about dog bites in Pakistan are limited by spatial scale i.e., restricted to a few districts or mega cities [8]. Moreover, the routinely collected data by the health department has not been investigated to map disparity in distribution of incidence of dog bites. Also, there is a little empirical evidence about determinants of dog bites at district level which is the usual scale for planning control programs. It remains unclear which district level socio-economic, demographic and importantly remote sensing variables are associated with incidence of dog bites. Mapping the distribution and risk of dog bites is important to prioritize districts for dog population management, rabies control programs/interventions as well for further research on this issue. The objective(s) of this research were to map the incidence of dog bites and explore its association with selected socio-economic and demographic variables.

2. Materials and methods

Data about reported cases of dog bites from 2016 to 2019 was acquired from the Directorate of General Health Service, Punjab. The data

* Corresponding author.
E-mail address: tariqabbas@cuvas.edu.pk (T. Abbas).

https://doi.org/10.1016/j.soh.2023.100007
Received 26 September 2022; Accepted 4 January 2023
Available online 7 January 2023

were collected by the Directorate through the District Health Management System using DHIS2 software. The data were aggregated to calculate the count of reported cases for each district. The data were joined to a shapefile of districts that was downloaded from https://data.world. Crude incidence per 100,000 population and standardized incidence ratio were calculated for each district using the EpiR package in R software. For incidence calculation, data about population census carried out in 2017 was used as the denominator (https://www.pbs.gov.pk). The variable crude incidence was subjected to spatial exploratory analysis. The R package called "spdep" was used to detect spatial autocorrelation using Global Moran's Istatistic. For spatial autocorrelation analysis, weight matrix was based on first-order rook's contiguity. There was no spatial autocorrelation in incidence. The distribution of incidence was right (positive skewed); therefore log transformation was applied.

For our analyses, we considered following district level independent variables: i) human population density (persons per sq. km), ii) percent of rural population, iii) median nighttime light (radiance in nW/cm2/sr) as proxy of socio-economic activity, iv) multidimensional poverty index (transformed to 100 point scale), and iv) percent of illiterate population. The data about human population density, percent of rural population, and percent of population were collected from https://www.citypopulation.de. The website provides these data according to the latest national census carried out in 2017. The multidimensional poverty index values were obtained from https://peri.punjab.gov.pk/. Monthly images of nighttime data called visible infrared imaging radiometer suite (VIIRS) Day/Night Band (DNB) were retrieved through Google Earth Engine (period: January 2016 to December 2019). A composite image from the image collection was created. The "reduceRegions" function of the google earth engine was used to calculate median night light. The spearman's correlation between pairs of dependent and independent variables was plotted. Moreover, the simple linear regression analysis was carried out to assess association between dependent variable and each independent variable. For multiple linear regression analysis, we ran three separate models to ensure that independent variables with absolute value of correlation coefficient above 0.5 don't appear in the same model. We called those regression equations as model 1, model 2 and model 3. The independent variables included in each model are shown in the results section. The cutoff for absolute value of correlation was decided based on evidence of weak association in univariate analysis and review of literature [9].

3. Results

Overall incidence in the province remained 896 cases per 100,000. From 2016 to 2019, a total of 993,240 cases were reported across Punjab. Relative frequency of cases was highest (n = 68,791) in Bahawalpur district and lowest (n = 11,317) for Hafizabad district. Fig. 1 shows a map of Punjab and distribution of annual crude incidence per 100,000 populations. The median district level crude incidence ratio was 935 with interquartile range (IQR): 573 per 100,000. Median standardised incidence ratio was 1.04 with IQR: 0.64. About half of the districts (17/36) had standardised incidence values greater than one that reported cases were more than expected cases. The distribution crude incidence was not normally distributed (skewness: 1.27 and kurtosis: 4.5). The highest incidence was found in the following six districts: Bhakkar, Mianwali, Bahawalpur, Rajanpur, Vehari, and Kasur. There was no significant spatial autocorrelation (i.e. clustering) in incidence values (Global Moran's I: 0.07, p value 0.15). Among 99 permutated values of I, no value was greater than calculated value. In simple words, the incidence was randomly distributed across Punjab.

Fig. 2 shows pair-wise spearman's correlation coefficient (r) and coefficient determination (r^2) between study variables. The incidence was

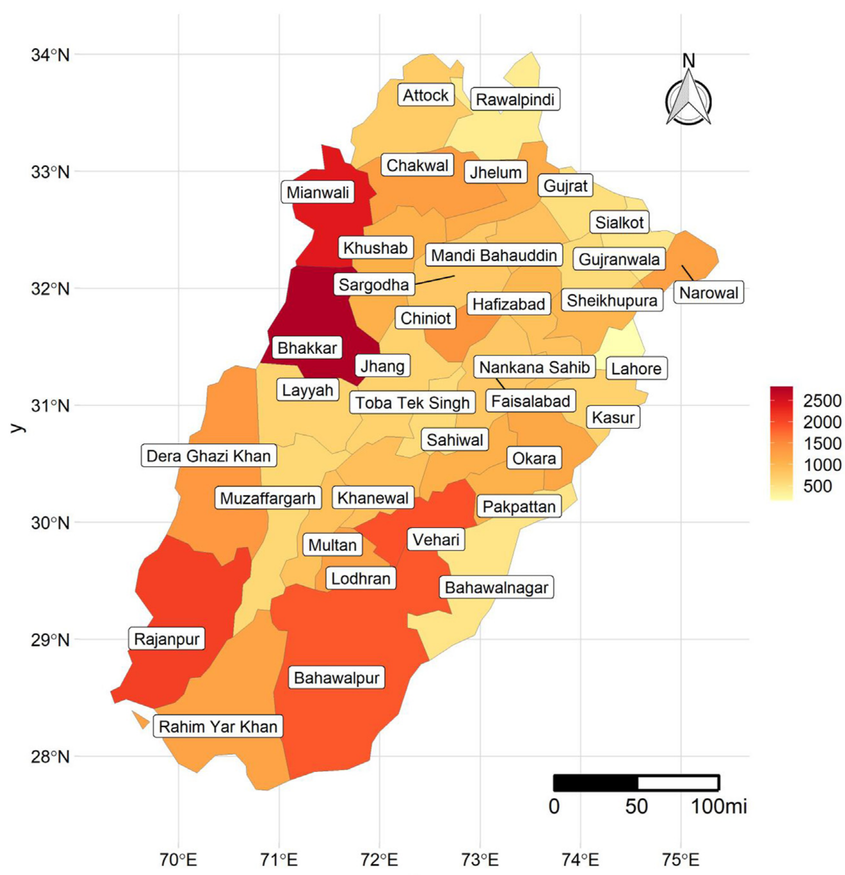

Fig. 1. Annual incidence of dog bites per 100,000 of population at risk in Punjab, Pakistan (2016–2019).

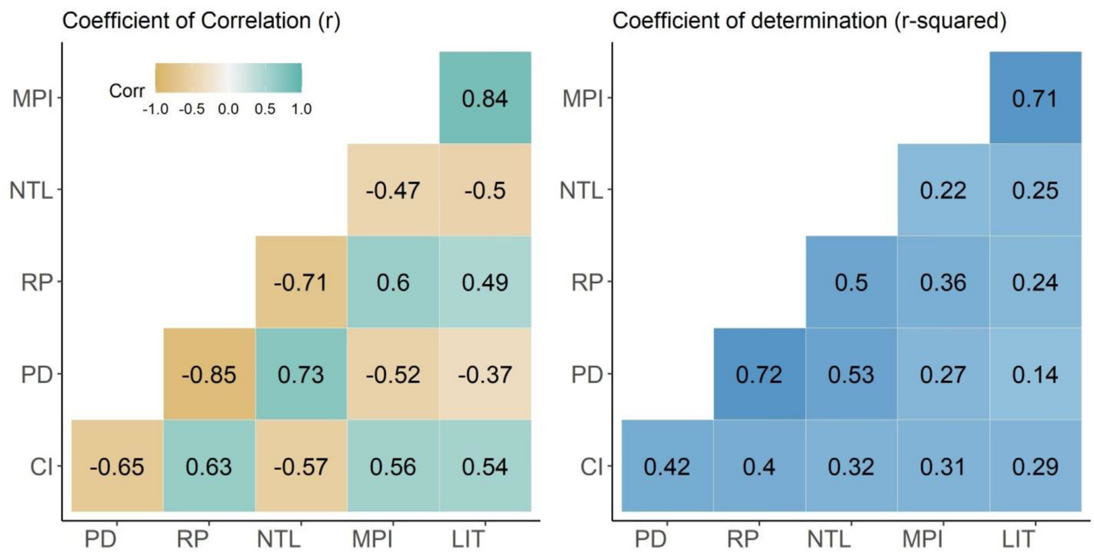

Fig. 2. Pair-wise spearman's correlation coefficient (r) and coefficient determination (r^2) between study variables. **Abbreviations:** CI: annual incidence of dog bites per 100,000 population at risk (log transformed), PD: Human population density (per sq. km), RP: Rural population (% of total population), NTL: median night time light as proxy of socio-economic activity, MPI: Multidimensional poverty index (values converted on 100 point scale), LIT: Percent of illiterate population.

significantly and positively correlated with percent of rural population ($r^2 = 0.40$), multidimensional poverty index ($r^2 = 0.31$) and percent of illiterate population ($r^2 = 0.29$). The incidence was significantly and negatively correlated with human population density ($r^2 = 0.42$), and median nighttime lights ($r^2 = 0.32$). Human population density was strongly correlated with percent of rural population ($r^2 = 0.72$) and median nighttime lights ($r^2 = 0.53$). Percent of the rural population was also found to have strong correlation with median nighttime light ($r^2 = 0.5$) and moderate correlation with multidimensional poverty ($r^2 = 0.36$). A strong correlation was evident between multidimensional poverty index and percent of literate population ($r^2 = 0.71$). Multiple regression analysis was performed with combinations of independent variables with absolute value of correlation coefficient below 0.5.

Table 1 shows the summary of univariate linear regression. All five independent variables were found to have significant association with the dependent variable. In other words, each independent variable significantly predicted the dependent variable. The intercept and beta coefficient for each variable can be written as a fitted regression model/equation from the values provided in the table. For instance, in case of the first dependent variable i.e., PD, fitted regression model will be: Annual incidence of dog bites per 100,000 populations = 7.0954 + −0.0004 *(human population density (per square kilometer). For this variable, the overall regression was statistically significant ($R^2 = 0.427$, $F (1, 18) = 44.99$, $p <$ -0.00). The association of the remaining four independent variables may be interpreted in a similar pattern.

Table 2 shows the summary of multiple linear regression models. Model 1, 2, and 3, had different combinations of independent variables. Those combinations were decided to exclude correlated variables (i.e. variables with absolute value of correlation above 0.5) in the same model. The model 1 has three independent variables abbreviated as PD, MPI and LIT, out of which only PD was significantly and negatively associated with dependent variable. The fitted regression equation for model for model 2 could be written as: Annual incidence of dog bites per 100,000 populations = 6.3134 + 5.0839* (percent of illiterate population) + 5.0544 *(percent of rural population. The overall model 2 was statistically significant ($R^2 = 0.73$, $F (2, 17) = 23.46$, $p = < 0.000$). The model 1 and model 2 can be interpreted in a similar pattern. Based on adjusted R^2 value and AIC, model 1 performed better but there was not much different from model 2 and model 3. For all the models, F- statistic was significant which means each model was better fit compared to the null model ($p \leq 0.05$).

4. Discussion

In this study, we have mapped spatial distribution of annual incidence of dog bites per 100,000 of population in various districts of Punjab. In addition, we have quantified the association between incidence of dog

Table 1
Output of simple linear (univariate) regression analysis.

	PD	RP	NTL	MPI	LIT
Predictors	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*
Intercept	7.0954 ***	5.2872 ***	7.3064 ***	3.4277 ***	5.8101 ***
PD	−0.0004 ***				
RP		0.0214 ***			
NTL			−0.5670 ***		
MPI				0.0386 ***	
LIT					0.0263 ***
Observations	36	36	36	36	36
R^2/R^2 adjusted	0.427/0.410	0.397/0.379	0.328/0.309	0.318/0.298	0.288/0.267
AIC	44.988	46.827	50.697	51.238	52.794

**p < 0.05   **p < 0.01   ***p < 0.001.*
***Note: Dependent variable:** Annual incidence of dog bites per 100,000 of population at risk (log transformed), **Independent variables and their abbreviations:** PD: Human population density (per sq. km), RP: Rural population (% of total population), NTL: median night time light as proxy of socio-economic activity, MPI: Multidimensional poverty index (values converted on 100 point scale), LIT: Percent of illiterate population.*

Table 2
Output of multiple linear regression models.

	Model 1	Model 2	Model 3
Predictors	*Estimates*	*Estimates*	*Estimates*
(Intercept)	6.3134 ***	5.0839 ***	5.0544 ***
PD	−0.0003 ***		
MPI	0.0013		0.0224
LIT	0.0160	0.0146 *	0.0033
RP		0.0164 **	
NTL			−0.3832 *
Observations	36	36	36
R^2/R^2 adjusted	0.526/0.481	0.464/0.432	0.442/0.390
AIC	42.152	44.569	47.992

*$p < 0.05$ **$p < 0.01$ ***$p < 0.001$.
Note: Dependent variable: *Annual incidence of dog bites* per *100,000 of population at risk (log transformed),* ***Independent variables and their abbreviations:*** *PD: Human population density* (per *sq. km), RP: Rural population (% of total population), NTL: median night time light as proxy of socio-economic activity, MPI: Multidimensional poverty index (values converted on 100 point scale), LIT: Percent of illiterate population. Each model contains independent variables with absolute value of correlation coefficient below 0.5.*

bites and five selected socio-economic and demographic factors (i.e. human population density, percent of rural population, median light time lights, multidimensional poverty, and percent of illiterate population). To avoid multicollinearity, we used three models each with different sets of independent variables. In brief, the risk of dog bite attacks was relatively higher in districts with low human population density (model 1), poor literacy rate, more rural population (% of total population) (model 2) and lower median nighttime lights as a proxy of economic activity (model 3).

This study revealed significant differences in incidence of dog bites among districts. This could be attributed to demographic, sanitary and environmental factors affecting human–dog interaction leading to dog bite injuries. In a study [10] researchers described factors associated with dogs, victims of dog bite, and context in which dog bites occur. Dog bites are more frequent in children and males. Unneutered male dogs in packs are more likely to bite. Aggression in dogs is also another complex reason. Equally important is the context of dog bite attacks. The distribution of these factors may vary among districts leading to apparent differences in district wise incidence.

The effect of human population density on risk of dog bites has been reported in several studies [11,12]. We have found a negative association between incidence of dog bites and human population density. This finding is in agreement with [13] that also reported inverse relation between those two variables. Districts with low population density have sparse/dispersed populations as in rural areas where likelihood of dog bite is higher. It is also evident in correlation matrix.

Another interesting outcome of our analysis is association of dog bites with night time lights. The R^2 value of nighttime was higher compared to the multidimensional poverty index. Several area-level studies have documented the association between the incidence of dog bites and socio-economic status [10,14–17]. Those studies used socio-economic indicators collected through surveys. However, for many parts of the world, reliable estimates of socio-economic variables are not available and/or outdated. As an alternate, a remote sensing dataset called nighttime lights has been used as a proxy for a wide range of parameters including urbanization, human settlements, poverty, population growth and socio-economic activity [18]. These factors are also likely to influence the risk of dog bite injuries. The mean of nighttime lights in an area is indicative of its socio-economic development [19]. Nighttime lights due to better spatial and temporal resolution may be an alternate source of anthropogenic activities in situations where official figures are inconsistent, unreliable and/not up to date [20]. With nighttime light images, it is possible to aggregate pixel values according to the scale of analysis which is district/county in our study. Nighttime light data have already been used as covariate in modeling bat borne rabies [21]. It also has been applied to model health phenomena [22].

The multidimensional poverty index was significant in univariate analysis but became not significant in multiple regression analysis. One reason for this could be its correlation with other two predictors variables i.e., night time lights and illiteracy. The possible explanation for the higher incidence in socio-economically and multidimensionally poorer districts could be the following: i) poor waste management [5,8,23], ii) abundance of free roaming dogs, especially unneutered, large male dogs in packs [10,24,25], iii) more exposure that is a context for injury e.g. distance from schools [1,26], iv) factors promoting aggression in dogs [27], v) less awareness, vi) culture of keeping dogs for security of home as well as livestock, vii) inadequate management of rural dog population, viii) slum areas [28], age-sex distribution of population ix) population displacement e.g. due to floods [29].

This study has several limitations. One major limitation is use of passively reported data. Such data are often incomplete. It may not include cases managed at tertiary level health facilities, private clinics/hospitals, patients who did not get post exposure prophylactic treatment, patients far flung areas or consulted alternative medicine practitioners. Disease/injury notification data has already been used for similar analysis with the assumption that reported cases provide crude approximation of incidence. Bias due to poor quality and incompleteness of data used in our study is unknown and cannot be excluded. Another limitation of this study is the spatial scale of analyses. Although data has been analysed at district level which is usual resolution in many spatial epidemiological studies, however such approach may not detect spatial clustering and may underestimate association/differences at sub district level. As it was an ecological study, therefore patient level factors (e.g., age, gender etc.) were not considered to avoid ecological fallacy. Moreover, it was not feasible to retrieve demographic details of the cases. Due to non-availability of demographic data, the incidence could not be standardized by age and gender. The origin/district of the patients are unknown, however due to long distances between districts, the patients are assumed to prefer the home district for post-exposure prophylaxis. Spill over due to cross district movement is expected but with low likelihood. We could not include other socio-economic and demographic variables because data about those were not publically available. Those variables were district-wise: i) GDP, ii) dog bite cases reported in livestock, iii) dog population density, iv) human population stratified by age groups, v) human population stratified by gender and, v) municipal wastes production. The covariates derived from remote sensing that we could not consider were: i) poverty, ii) slum areas, iii) flood inundated areas, iv) travel time to schools, v) human settlements, vi) road density and vii) land use and land cover.

We conclude that incidence of dog bites is relatively higher in most districts of the Punjab because observed incidence was greater than expected incidence in seventeen out of thirty six districts considered. The problem of dog bites is endemic across the province as no hotspot was detected keeping the district as a unit for spatial analysis. However, it may be interesting to do either spatial or spatiotemporal analysis with sub-district level data (sub-districts locally called "tehsils"). The predictor variables considered in this study were found to have weak but still significant association. The fitness of the model should be improved by strengthening case reporting and exploring additional covariates.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The dataset were obtained from Directorate of General Health Service, Punjab. The aforesaid dataset can be provided upon request. Requests to access these datasets should be directed to tariqabbas@cuvas.edu.pk.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

MF and FB share the equal contribution and also share the first authorship in this manuscript. TA share senior authorship. AQ and QU share equal and last authorship. All authors contributed to the article and approved the submitted version.

Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

[1] Munibullah, et al., Incidence of animal-bite injuries registered in public hospitals of post-conflict swat district, Pakistan in 2014, Am. J. Trop. Med. Hyg. 104 (1) (Oct 12 2020) 329–337, https://doi.org/10.4269/ajtmh.20-0208, in eng.

[2] M. Janatolmakan, M. Delpak, A. Abdi, S. Mohamadi, B. Andayeshgar, A. Khatony, Epidemiological study on animal bite cases referred to Haji Daii health Center in Kermanshah province, Iran during 2013-2017, *BMC Public Health,* Evaluation Study 20 (1) (Mar 30 2020) 412, https://doi.org/10.1186/s12889-020-08556-1 (in eng).

[3] S. Ghosh, et al., Trends and clinico-epidemiological features of human rabies cases in Bangladesh 2006-2018, Sci. Rep. 10 (1) (Feb 12 2020) 2410, https://doi.org/10.1038/s41598-020-59109-w (in eng).

[4] F.B. Mughal, B.H.I. Ali, Epidemiology of rabies in Pakistan: a review of literature, J Infectious Disease Med Microbiol 2 (1) (2018) 18–21. J Infectious Disease Med Microbiol 2018 Volume 2 Issue, vol. 1, 2018.

[5] N. Wright, D. Subedi, S. Pantha, K.P. Acharya, L.H. Nel, The role of waste management in control of rabies: a neglected issue, Viruses 13 (2) (Feb 1 2021), https://doi.org/10.3390/v13020225 (in eng).

[6] L.M. Smith, S. Hartmann, A.M. Munteanu, P. Dalla Villa, R.J. Quinnell, L.M. Collins, The effectiveness of dog population management: a systematic review, in eng, Animals (Basel) 9 (12) (Nov 22 2019), https://doi.org/10.3390/ani9121020. submitted for publication.

[7] W. Ahmad, M.A. Naeem, Q. Akram, S. Ahmad, M. Younus, Exploring rabies endemicity in Pakistan: major constraints & possible solutions, Acta Trop. 221 (2021), 106011, https://doi.org/10.1016/j.actatropica.2021.106011.

[8] S.M. Zaidi, et al., Geographic variation in access to dog-bite care in Pakistan and risk of dog-bite exposure in Karachi: prospective surveillance using a low-cost mobile phone system (in eng), PLoS Neglected Trop. Dis. 7 (12) (2013) e2574, https://doi.org/10.1371/journal.pntd.0002574. Research Support, Non-U.S. Gov't.

[9] K.P. Vatcheva, M. Lee, J.B. McCormick, M.H. Rahbar, Multicollinearity in regression analyses conducted in epidemiologic studies, Epidemiology 6 (2) (Apr 2016), https://doi.org/10.4172/2161-1165.1000227 (in eng).

[10] J. Vertalka, L.A. Reese, M.J. Wilkins, J.M. Pizarro, Environmental correlates of urban dog bites: a spatial analysis, J. Urban Aff. 40 (3) (2017) 311–328, https://doi.org/10.1080/07352166.2017.1355666.

[11] P.P. Mshelbwala, et al., Spatiotemporal heterogeneity and determinants of canine rabies evidence at Local Government Area Level in Nigeria: implications for rabies prevention and control, One Health 14 (Jun 2022), 100378, https://doi.org/10.1016/j.onehlt.2022.100378 in eng.

[12] C. Sararat, S. Changruenngam, A. Chumkaeo, A. Wiratsudakul, W. Pan-Ngum, C. Modchang, The effects of geographical distributions of buildings and roads on the spatiotemporal spread of canine rabies: an individual-based modeling study (in eng), PLoS Neglected Trop. Dis. 16 (5) (May 2022) e0010397, https://doi.org/10.1371/journal.pntd.0010397. Research Support, Non-U.S. Gov't.

[13] O. Yurachai, S. Hinjoy, R.M. Wallace, An epidemiological study of suspected rabies exposures and adherence to rabies post-exposure prophylaxis in Eastern Thailand (in eng), PLoS Neglected Trop. Dis. 14 (2) (2015) e0007248, https://doi.org/10.1371/journal.pntd.0007248. Feb 2020.

[14] C.J. Lee, et al., Surgical treatment of pediatric dog-bite wounds: a 5-year retrospective review, West. J. Emerg. Med. 22 (6) (Oct 27 2021) 1301–1310, https://doi.org/10.5811/westjem.2021.9.52235 (in eng).

[15] M. Raghavan, P.J. Martens, C. Burchill, Exploring the relationship between socioeconomic status and dog-bite injuries through spatial analysis (in eng), Rural Rem. Health 14 (3) (2014) 2846 [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/25124792.

[16] J.A. Ndon, G.J. Jach, W.B. Wehrenberg, Incidence of dog bites in Milwaukee, wis (in eng), Wis. Med. J. 95 (4) (Apr 1996) 237–241 [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/8992798.

[17] J. Yu, et al., The impact of anthropogenic and environmental factors on human rabies cases in China (in eng), Transbound Emerg Dis 67 (6) (Nov 2020) 2544–2553, https://doi.org/10.1111/tbed.13600.

[18] Zhao, et al., Applications of satellite remote sensing of nighttime light observations: advances, challenges, and perspectives, Rem. Sens. 11 (17) (2019) 1971, https://doi.org/10.3390/rs11171971.

[19] E. Dugoua, R. Kennedy, J. Urpelainen, Satellite data for the social sciences: measuring rural electrification with night-time lights, Int. J. Rem. Sens. 39 (9) (2018/05/03 2018) 2690–2701, https://doi.org/10.1080/01431161.2017.1420936.

[20] A.M. Noor, V.A. Alegana, P.W. Gething, A.J. Tatem, R.W. Snow, Using remotely sensed night-time light as a proxy for poverty in Africa, Popul. Health Metrics 6 (Oct 21 2008) 5, https://doi.org/10.1186/1478-7954-6-5 (in eng).

[21] L.E. Escobar, et al., Ecological approaches in veterinary epidemiology: mapping the risk of bat-borne rabies using vegetation indices and night-time light satellite imagery, Vet. Res., Research Support, Non-U.S. Gov't 46 (1) (Sep 4 2015) 92, https://doi.org/10.1186/s13567-015-0235-7 (in eng).

[22] Q. Huang, X. Yang, B. Gao, Y. Yang, Y. Zhao, Application of DMSP/OLS nighttime light images: a meta-analysis and a systematic literature review, Rem. Sens. 6 (8) (2014) 6844–6866, https://doi.org/10.3390/rs6086844.

[23] B.O. Olugasa, O.S. Okeke, O.O. Ishola, Geographic access to street food sources for dogs and its association with spatial patterns of animal bite injuries in Enugu, Nigeria, 2005-2011 (in eng), Afr. J. Med. Med. Sci., Research Support, Non-U.S. Gov't 43 (Dec 2014) 79–86 [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/26949784.

[24] M.E. Gompper, Free-ranging Dogs and Wildlife Conservation, Oxford University Press, 2013.

[25] L.A. Reese, J.J. Vertalka, M.J. Wilkins, J.M. Pizarro, Demographic and urban environmental variables associated with dog bites in Detroit, J. Am. Vet. Med. Assoc. 254 (8) (Apr 15 2019) 986–990, https://doi.org/10.2460/javma.254.8.986, in eng).

[26] J.A. Oxley, R. Christley, C. Westgarth, Contexts and consequences of dog bite incidents, J Vet Behav 23 (2018) 33–39, https://doi.org/10.1016/j.jveb.2017.10.005.

[27] C.M. Shuler, E.E. DeBess, J.A. Lapidus, K. Hedberg, Canine and human factors related to dog bite injuries, J. Am. Vet. Med. Assoc. 232 (4) (Feb 15 2008) 542–546, https://doi.org/10.2460/javma.232.4.542, in eng.

[28] S. Sharma, A. Agarwal, A.M. Khan, G.K. Ingle, Prevalence of dog bites in rural and urban slums of Delhi: a community-based study, Ann. Med. Health Sci. Res. 6 (2) (Mar-Apr 2016) 115–119, https://doi.org/10.4103/2141-9248.181836 (in eng).

[29] A. Ghanghro, M. Jokhio, Epidemiology of dog bites during floods in district Naushahro Feroze, Sind, Pakistan, Int. J. Infect. Dis. 21 (2014) 391, https://doi.org/10.1016/j.ijid.2014.03.1226, 2010.