Title: ESTIMATION OF ANIMAL BITES USING GPS AND GOOGLE EARTH IN AN URBAN LOW INCOME AREA OF BANGALURU, SOUTH INDIA

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Keywords Dog bite incidence, GPS and Google Earth,, Location of dogs

Abstract 17.4 million animal bite cases were reported annually in India, 2003. A lot has changed during the last decade includig increased awareness about th eanimal bites, availablity of rabes immunobiologicals animal bite control programme and access to newer technology like internet and mobile. It is assumed that teh incidence of animal bites would have come down.

Original Article

ESTIMATION OF ANIMAL BITES USING GPS AND GOOGLE EARTH IN AN URBAN LOW INCOME AREA OF BENGALURU, SOUTH INDIA

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ABSTRACT

Background: 17.4 million animal bite cases were reported annually in India, 2003. A lot has changed during the last decade including increased awareness about the animal bites, availability of rabies immunobiologicals, animal bite control programme and access to newer technology like internet and mobile. It is assumed that the incidence of animal bites would have come down.

Objectives: To find out the incidence of animal bites and human rabies in an urban low income area, to describe socio demographic profile of animal bite cases and to describe the spatial relationship between dog bite cases and location of the dogs in the study area.

Methodology: A community based cross sectional study was conducted in an urban low income area in Bangalore in 2015. 2500 (20% of the population) people were surveyed. People residing in the study area (resident for minimum of 6 months) were included. A hand held GPS (GarminGPS72H) receiver was used for recording of GPS coordinates. Using google maps on google earth, spatial mapping of households of dog bite cases ,place of animal bite and location of dogs was done.

Results: The incidence of animal bites was observed to be 1.6%. 77.5% of the cases were males and majority belonged to middle & lower middle income group. Dog was the only biting animal for all the cases and 92.5% of cases were due to bites/exposure from stray dogs. 75% of the cases were of category III exposures. 32.5 % of the cases had adequate wound treatment, 80% had received anti rabies vaccination and only 10% received anti rabies serum. Using GPS technology and google earth the dog bite cases were spatially mapped. It was observed that out of 40 dog bite cases recorded, 12 (30%) dog bite cases was reported from outside the study area and 28(70%) cases had occurred within the study area All the dog bite cases were mapped and spatial relationship between them was observed.

Conclusion: The incidence of dog bite was1.6%.GPS and google earth was useful in describing the spatial relationship between bite cases and location of dogs.

Key Words : Dog bite incidence, GPS and Google Earth, Location of dogs.

Introduction

Rabies is an acute, progressive encephalo myelitis caused by a Lyssa virus and is almost always fatal. Virus is typically present in the saliva of clinically ill mammals and is transmitted through a bite/scratch/lick.[1,2] All mammal species seem to be susceptible to infection, but domestic dogs are the main reservoirs of human infection.[3] There are no global estimates of dog bite incidence, however studies suggest that dog bites account for tens of millions of injuries annually. Dog bite fatality rates are higher in low- and middle-income countries than in high-income countries as rabies is a problem in many of these countries, and there may be a lack of post-exposure treatment and appropriate access to health care.[4]

After an animal bite, post-exposure rabies prophylaxis is the only way to prevent rabies. Most of the deaths occur due to ignorance. There is no comprehensive treatment possible after the clinical occurrence of rabies, which can result in mortality.[5] In India every year, an estimated 20,000 human rabies deaths and 17.4 million animal bite cases are known to occur annually which accounts to an annual animal bite incidence rate of 1.74%.[6,7] A survey done by NICD, Delhi (2000) from four of its centres from urban communities revealed an incidence of animal bites of

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2.1/1000 population/year.[8] There is a growing need to re-estimate the incidence of animal bites in the country and there are no field based surveys on measurement of animal bites in urban areas of India since the WHO-APCRI survey.[6] A lot has changed during the last decade including increased awareness about animal bites and human rabies prevention, availability of modern rabies immunobiologicals, animal birth control programme, etc. Global Positioning System (GPS) is a satellite-based navigation system that sends and receives radio signals and by three-point trigonometry localizes a specific site.[9] An attempt was made to look at Spatial relationship between dog bite cases and location of dogs by using GPS and google earth. There are no such research articles published on this subject. Bengaluru has been in the forefront of the rabies prevention activities as the medical and veterinary organizations have contributed significantly to the control of the problem in the country and it is assumed that the incidence of animal bites would have come down in the city. In this background, the present study was under taken with the following objectives - to find out the incidence of animal bites and human rabies in an **urban low income area**, to describe socio demographic profile of animal bite cases and to assess the spatial relationship between dog bite cases and location of the dogs in the study area.

Materials and Methods:

A community based exploratory study was conducted in urban field practice area of a medical college situated in one ward (12,500 residents) of the local corporation, Bengaluru urban district, during May-July, 2015. 2500 (20%) of the population (resident for minimum of 6 months) were surveyed for incidence of animal bites and human rabies. Every tenth household was surveyed using systematic random sampling technique until the required sample size was covered. The information regarding animal bite/exposures in the past one year, socio demographic profile, rabies immunebiologicals used was collected using standard questionnaire. The dog survey was done on four separate days on four different times (10am - 12pm, 2pm - 4pm, 4pm - 6pm & 6pm - 8pm) using direct count method and capture method.[10]

A hand held GPS (Garmin GPS72H) receiver was used. The GPS receiver was switched on in front of households of animal bite cases and GPS coordinates (North and East) of households displayed in the information page were recorded in the standard questionnaire. Similarly, GPS coordinates of the actual place of bite/ exposure and location of dogs within the study area were also recorded. Using google maps on google earth in a computer, all the GPS coordinates were entered for spatial mapping.

Ethics statement: The study was approved by the institution ethics committee. All adult subjects provided oral informed consent to participate in the study and parent of child provided oral informed consent on their behalf. The institutional review board approved the use of oral consent. The oral consent was documented in the questioner of each subject. The data was anonymised.

Results:

Out of the 2500 people surveyed, animal bites was reported among 40 subjects i.e. an incidence of 1.6%. The animal bite incidence among children and adults were found to be 2.26% & 1.23% respectively. The median age was 14 years with inter quartile range 7 – 26.5 years. The youngest case was 5 years old and the oldest was of 55 years of age. 77% of animal bites/ exposures was observed among males. Most of them belonged to middle (45%) and lower middle (42%) classes per modified BG Prasad's classification.[11] 62% of the cases were students (of whom primary school students constituted 50%).

Dog was the only biting animal and most of the bites were by stray dogs (93%). 57% of biting animals were healthy after 10 days of observation. 70% of the animal bites occurred within the study area, 67% were unprovoked bites, 65% occurred during daytime and 70% were category III as described in Table I.

62 % of the bite cases washed the wound with water. 17% applied lime over the wound and most of them did not apply any local applicants. 80 % of them had taken anti rabies vaccine (ARV) within 12 hours of exposure and 50 % of them had taken 4 doses of vaccine (Intra Muscular/Intra Dermal). 75% of the bite cases took anti rabies vaccine as they were aware about the need to take vaccine. Most cases were not administered rabies immunoglobulin (RIG) and the reason was that they were not advised at the hospital (Table II). There was no human rabies case.

Using GPS and google earth the dog bite cases were spatially mapped. 40 dog bite cases were reported in the last one year. In 12 (30%) cases exposure/bite had occurred outside the study area. 28(70%) cases, exposure/ bite had occurred within the study area. 1 case exposure to dog bite had occurred at home. 7 cases

Table I :
Description of biting animal and bites/exposures

Characteristics Biting animal	Male (n=31)	Female (n=9)	Total (n=40)
Dog	31 (100.0)	9(100.0)	40 (100.0)
Stray dog	29 (93.5)	8(88.9)	37(92.5)
Pet dog	2 (6.5)	1(11.1)	3 (7.5)
Fate of animal			
Available	18(58.1)	5(55.6)	23(57.5)
Killed	2 (6.4)	-	2 (5.0)
Unavailable	11(35.5)	4(44.4)	15(37.5)
Place of bite			
Inside home	1(3.2)	-	1(2.5)
Same street	6 (19.4)	1(11.1)	7(17.5)
Neighbour Street	7(22.6)	3(33.3)	10(25.0)
Within study area	9(29.0)	1(11.1)	10(25.0)
Outside study area	8(25.8)	4(44.5)	12(30.0)
Type of bite			
Provoked	11(35.5)	2(22.2)	13(32.5)
Unprovoked	20(64.5)	7(77.8)	27(67.5)
Walking	18(90.0)	6(85.7)	24(88.8)
Driving two wheeler	2(10.0)	1(14.3)	3(11.2)
Time of bite			
6 am - 6 pm	19(61.3)	7(77.8)	26(65.0)
6 pm - 6 am	12(38.7)	2(22.0)	14(35.0)
Category of exposure			
Category II	9 (29.0)	1(11.1)	10(25.0)
Category III	22(71.0)	8(88.9)	30(75.0)

Note : figures in parenthesis indicate percentages

exposure was in the same street, 10 cases from neighbourhood street and 10 cases exposure was within the study area. In figure-1, the triangle indicates the household of dog bite cases and pin indicates location of actual exposure to dog bites spatially. The households and location of exposure to dog bites are depicted in different colours.

Description :

Same street bite- Household of dog bite case is shown as red triangle and red pin is the location of exposure to dog bite of the same case (eg. 14 is the household of case and 14A is location of exposure to dog bite). Similarly yellow triangle indicates household of cases and yellow pin is the location of exposure to dog bite in neighborhood street. (eg. 16 household of case and 16A is location of exposure). Likewise, the green triangle indicates household of dog bite cases and green pin is location of exposure to dog bite within study area(eg. 40 household of case and 40A is location of

Table II :
Description of biting animal and bites/exposures

Characteristics	Male(n=31)	Female(n=9)	Total(n=40)
ARV administered	24(77.4)	8(88.9)	32(80.0)
Reason for taking ARV			
Fear of disease	6(25.0)	2(25.0)	8(25.0)
Awareness	18(75.0)	6(75.0)	24(75.0)
Reason for not taking ARV			
Nothing will happen	2(28.6)	1(100.0)	3(37.5)
Cost Factor	2(28.6)	-	2 (25.0)
Time Factor	3(42.8)	-	3(37.5)
RIG administered	2(9.1)	1(12.5)	3(10.0)
Advised at hospital	2(9.1)	1(12.5)	3(10.0)
RIG not administered	20(90.9)	7(87.5)	27(90.0)
Not Advised at hospital	19(95.0)	7(100.0)	26(96.3)
Nothing will happen	1(5.0)	-	1(3.7)

Note : figures in parenthesis indicate percentages

exposure). The blue triangle indicates location of household of cases in whom the exposure had occurred outside the study area.

Direct count & capture method were used to count the number of dogs. The direct count method simply consists of direct visual counts of individual dogs in defined geographical area and within a limited period of time. The capture method was done on four different days in different timings and all dogs were identified by photographs. On the first visit, 40 dogs were counted. On the second visit, 24 different dogs were counted. During 3rd visit 12 dogs were identified and finally in the 4th visit, 6 additional dogs were counted. Care was taken not to count the same dogs again during the visits by following the methodology recommended for survey. Estimated number of stray dogs in the study area was found to be 82 by direct count and capture method and GPS location of dogs was recorded. Stray dogs

Fig 1 : Spatial map describing the spatial relationship between actual place of dog bite cases &households[12]

Fig 2 : Spatial map to describe the spatial relationship between location of dogs and place of dog bites[12]

aggregation was observed more near hotels, meat shops and garbage collection points. An exploratory analysis of spatial relationship between location of dogs, number of dogs and dog bites are described in figure-2 . When the study area was divided into 5 equal circles, from the circle **A** it was observed that with 4 cases and 15 dogs, the occurrence of human cases to total number of dogs was 27% i.e 4/15, **B** was 33% (5 cases/15 dogs), **C** was 18% (2 cases/11 dogs), **D** was 57% (4 cases/7 dogs) and circle **E** was 125% (5 cases/4 dogs). Based on the above observations we can conclude that people living in location D and E had increased chance of dog bites. On the other hand if the study area was divided into four equal halves, then the incidence of bites observed would be different. With spatial mapping different permutations on occurrence of bite and location of dogs can be analyzed for better understanding of the problem.

Among the households surveyed, 12 cats (35.71%), 8 dogs (28.57%), 15 hens (25%), 6 sheep's (10.71%) and 2 cows (7.14%) were the domestic animals present. 50% of pet dogs were vaccinated against rabies. The pet dog: man ratio was found to be 1: 310.

Dog : human bite ratio was found to be 1 : 2.60 % of the household respondents reported dog menace & 53% of them reported aggregation of dogs in the night.

Discussion :

The annual incidence of dog bites was 1.6 %, which is 0.1 % less than Indian rabies survey of 2003. [7]Estimated animal bite incidence rate was 1.7% in India and 1.4%in Bangladesh[7,13]. Dog bite was observed more in children and among males similar to other studies[14-17]. Majority of the cases were bitten by stray dogs and unprovoked similar to other studies[18]. The bite occurred mostly during day time and within the study area. Majority of the biting animals were healthy after 10 days of observation. 61.8% of dogs were alive and healthy following dog bite[19].

Majority of the cases had taken anti rabies vaccine indicating increased awareness. However, majority of the category III bite cases were not administered RIG, the reason being not advised at the hospital is the disturbing feature. RIG usage was low, most of cases were never vaccinated (78%) and only 1% each received appropriate wound treatment, or rabies immunoglobulin (RIG)[16].

Stray dogs aggregation was observed near hotels, meat shops and garbage collections. With GPS and google earth, it was possible to pin point the location of the household of cases and the actual location of exposure to dog bite. The spatial relationship between number of dogs present and number of cases reported was also possible . It was observed from spatial mapping that with less number of dogs there were more bites and with more number of dogs there were less number of bites. One needs to be very clear that spatial relationship does not necessarily mean causal association.

However, the spatial map definitely gives information about location of dogs and place of exposure to dog bite. These places can be avoided. The information is available visually and data can be stored permanently on a computer. GPS technology was able to pin point the exact location of household of animal bite cases[20]. The present study has gone beyond just location of household of cases and mapped the actual location of exposure of dog bites so as to look at the spatial relationship. The Google Earth also identified locations which required action. GPS technology and Google Earth was helpful in data storage and will be useful at a later date for comparison and trend analysis. Way points and routes saved in the GPS receiver can be used for follow up of households. The spatial distribution of cases also showed the distance of the household from each other, and distance to the nearest government health care provider. The location of the cases can be recorded permanently and can be cross-checked independently. The advantage of GPS technology and Google Earth is that it can be used at an affordable cost, thus avoiding use of expensive sophisticated software like Geographical Information System and other technologies available[21]. GPS, Geographical Information System and Remote Sensing are useful

complimentary tool to augment the understanding of distribution of disease in the community, provision of reliable estimates of population at risk, prediction of disease distribution and guidance of intervention strategies[22,23].

There are four techniques to obtain the estimates of dog densities viz. total or direct counts, estimates from rate of captures, estimates from recaptures, estimates from photographic recaptures. To find out the dog population sizes more than one method needs to be considered[10]. A better method for the present study would have been follow up of dogs with GPS attached to collars. This would have given a 24 hour data of dogs and a better understanding of the problem.

Conclusion:

The incidence of dog bite was 1.6%. GPS and google earth was useful in describing the spatial relationship between bite cases and location of dogs.

References :

1. WHO Expert consultation on rabies. World Health Organ Tech Rep Ser 982. Geneva: World Health Organization; 2013.
2. Manning SE, Rupprecht CE, Fishbein D, Hanlon CA, Lumlertdacha B, Guerra M, et al. Human rabies prevention - United States, 2008 Recommendations of the Advisory Committee on Immunization Practices (AICP). Morbidity and Mortality Weekly Report, CDC 2008;57(3):1-26,28.
3. Rupprecht CE, Hanlon CA, Hemachudha T. Rabies re-examined. Lancet Infect Dis 2002;2:327-43.
4. Animal bites fact sheet – WHO. [Online] 2013 Feb [cited 2015 July 10] Available from URL:http://www.who.int/mediacentre/factsheets/fs373/en
5. Human and dog rabies prevention and control. Report of the WHO/Bill & Melinda Gates Foundation Consultation Annecy, France 7–9 October 2009. Geneva: World Health Organization; 2010;7.
6. Association for Prevention and Control of Rabies in India. Assessing the Burden of Rabies in India. Report of WHO sponsored national multi-centric rabies survey 2003.
7. Sudarshan MK, Mahendra BJ, Madhusudana SN, Ashwathnarayana DH, Rahaman A, Rao NSN, et al. An epidemiological study of animal bites in India: results of a WHO sponsored national multicentric rabies survey. J Commun Dis 2006;38(1):32-9.
8. Ichhpujani RL, Chhabra M, Mittal V, Bhattacharya D, Singh J, Lal S. Knowledge, attitude and practices about animal bites and rabies in general community- a multicentric study. J Commun Dis 2006;38(4):355-61.
9. GPS72H Owner's manual -Garmin[Online] 2009 Sep [cited 2015 July 13] Available from URL :http://www8.garmin.com/manuals/GPS72H_OwnersManual.pdf
10. World Society for the Protection of Animals (WSPA): Guidelines for Dog Population Management. Geneva, Switzerland: World Health Organization (WHO) and World Society for the Protection of Animals (WSPA); 1990: p.18-22.
11. AbhaMangal , Varun Kumar , SanjeetPanesar , RichaTalwar , Deepak Raut, Saudan Singh.Updated BG Prasad Socioeconomic Classification, A Commentary.Indian Journal of Public Health2015; 59(1).
12. Google earth. California: Google Inc. c2015-[cited 2015 Jun 15]. Available from: https://www.google.com/maps/@12.9172,77.56657,3130m/data=!3m1!1e3
13. Hossain M, Ahmed K, Bulbul T, Hossain S, Rahman A, Biswas MN et al. Human rabies in rural Bangladesh. Epidemiol Infect 2012;140(11):1964-7.
14. Sudarshan MK, NagarajSavitha, Savitha B, Veena SG. An epidemiological study of rabies in Bangalore City. JIMA 1995; 93 (1): 14-16.
15. Singh Jagvir, Jain DC, Bhatia Rajesh et al. Epidemiological characteristics of rabies in Delhi and surrounding areas, 1998, Indian Paediatr 2001; 38: 1354-1360.
16. Sudarshan MK, Mahendra BJ and Ashwathnarayana DH. A community survey of dog bites anti-rabies treatment, rabies and dog population management in Bangalore City. J Com Dis 2001; 33 (4): 245-251.
17. Agarwal N and Reddaiah VP. Knowledge, attitude and practice following dog bite: A community based epidemiological study. Health and population. Perspective and issues 2003; 26 (4); 154-161.
18. Tenzin, Dhand NK, Gyeltshen T, Firestone S, Zangmo C Dema C, Gyeltshen R, Ward MP. Dog bites in humans and estimating human rabies mortality in rabies endemic areas of Bhutan. PLoSNegl Trop Dis 2011;5(11):e1391.
19. Kale KM, Wadhva SK, Aswar NR, Vasudeo ND. Dog Bites in Children, Indian J Community Med 2006; 31(1):24-5.
20. NR Ramesh Masthi, MalateshUndi. Global Positioning System: a new tool for measurement of animal bites in a rural area near Bangalore, South India. Trop Doct 2014; 44 (4)223-225.
21. N.R. Ramesh Masthi, Madhusudan M. &Yannick P. Puthussery Global positioning system & Google Earth in the investigation of an outbreak of cholera in a village of Bengaluru Urban district, Karnataka. Indian J Med Res.2015 Nov;142(5):533-7.
22. Maddison R,NiMhurchu C. Global positioning system: a new opportunity in physical activity measurement.Int J BehavNutrPhys Act2009;6:73.
23. Yang GJ, Vounatsou P, Zhou XN, UtzingerJ,Tanner M. A review of geographical information system and remote sensing with applications the epidemiology and control of schistosomiasis in china. Acta Top 2005;96:117-29