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*Full Length Research Paper*

# Rabies in animals and humans in and around Addis Ababa, the capital city of Ethiopia: A retrospective and questionnaire based study

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**Reliable data is required on diseases like rabies by policy makers and professionals. This study was therefore aimed at assessing the situation of rabies in and around Addis Ababa using retrospective data obtained during 2008 to 2011. Besides, a questionnaire was used to generate information on factors associated with the occurrence of rabies. A total of 935 brain samples from different species of animals were examined for rabies virus antigen during 2008 to 2011, of which 77.6% (n = 726) of them were tested positive. The highest proportion, 87.2% (n = 633) of the positive cases, was recorded in dogs followed by cats, 5.1% (n = 37). Between the years 2008 and 2011, a total of 1,088 dogs were examined for rabies, of which 801 (73.62%) were confirmed to be rabid. The proportion of rabid female dogs (87.5%) was higher than that of males (73.44%), and dogs 3 to 12 months old were diagnosed with rabies more frequently (76.6%) than dogs belonging to other age category. The highest proportion of rabid dogs was recorded in dogs whose ownership was not known followed by ownerless dogs. Rabies cases were confirmed both in vaccinated and non-vaccinated dogs. The number of confirmed rabies cases was higher during September and lower during November. Significant variation was seen among years in occurrence of rabies. The study shows that the principal vector of rabies in Addis Ababa and its surroundings, but most likely in entire Ethiopia, is the dog. Effective rabies management and control based on confirmed cases is recommended.**

**Key words:** Dog, Ethiopia, post-exposure prophylaxis, rabies.

## INTRODUCTION

Rabies is a deadly zoonotic disease with world-wide occurrence and is transmitted mostly by carnivores to humans and livestock. It is known to cause large number of deaths in humans and animals each year. It has been responsible for estimated annual human mortalities of 31,000 and 24,000 in Asia and Africa, respectively, with

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people mostly at risk of dying due to rabies being those who live in rural areas of these continents (Knobel et al., 2005). Deaths due to rabies occur despite the availability of effective vaccines which can prevent the development of fatal rabies cases (World Health Organization (WHO), 2005). In Ethiopia, rabies remains to be one of the most feared infectious diseases and has been diagnosed for several years at the Ethiopian Health and Nutrition Research Institute (Fekadu, 1972). However, systematic recording and organization of the results of diagnosis was rarely carried out. Available data during the years 2001 to 2009 at the institute showed that 35 to 58 annual human deaths were recorded (Deressa et al., 2010) mostly in Addis Ababa, the capital city of the country.

Previous reports showed that dogs were the dominant species responsible for transmission of rabies virus to humans and livestock in the country. The demographic characteristics of dogs biting humans and livestock have not been fully elucidated. Besides, the rabies status of dogs biting humans has not been known. It has been a common practice to provide post-exposure vaccines to humans bitten by dogs irrespective of their rabies status. This increases the risk of complications associated with the Fermi type vaccines, as this vaccine accounts for 88% of the vaccines used throughout. The Fermi type vaccine is produced at the Ethiopian Health and Nutrition Research Institute. Imported cell culture vaccines are used in 12% of the cases. No immunoglobulin has been available for use in treating rabies in the country to our knowledge. During the 2008 to 2011 fiscal years, the administration of the capital city has launched spraying of female dogs, vaccination of owned dogs, killing of stray dogs and public awareness, using the available mass media. Besides, the expanding construction in the city is thought to reduce the number of stray dogs. Therefore, analysis of retrospective data and current information on rabies in animals and humans with special focus on the capital city, Addis Ababa, is important to understand the epidemiological situation of rabies. This will be crucial for effective planning of rabies management, prevention or control programs. In this study we investigated the prevalence of confirmed rabies cases during the years 2008 to 2011. In addition, we identified the demographic characteristics of animals responsible for human rabies and tried to quantify the number of humans exposed to rabid animals.

## MATERIALS AND METHODS

### Study areas

The samples diagnosed at the Ethiopian Health and Nutrition Research Institute orginated from various parts of the country but the majority of the samples were from the capital city, Addis Ababa and its vicinity. Therefore, the focus of this study was Addis Ababa and areas within about 100 km radius of the city. The city covers an area of 530 $km^2$ and is divided into 10 sub-cities. Laboratory work was done at Ethiopian Health and Nutrition Research Institute, which is the only rabies diagnostic center in the country. The study area is depicted in Figure 1. The dog population in the city is estimated to be 250,000 to 350,000 (UAECP, 2011).

### Study design

Retrospective data was collected from record books of rabies in animals and humans at the Ethiopian Health and Nutrition Research Institute. The data on rabies cases in animals covered the period from September, 2008 to February, 2011. The brains of animals biting humans have been submitted to the diagnostic laboratory by the public and government veterinarians for confirmation of rabies. The laboratory utilizes the fluorescent antibody test (FAT) to confirm the presence of rabies virus in the samples. Those dogs that were available for quarantine or killed after bite were tested. The data on rabies in humans was a one year data from September, 2010 to September, 2011. Recorded information on rabies including species of animal, sex, age, vaccination status and the type of vaccine used in humans were obtained from the records when available.

A questionnaire was developed and used to collect data during the period from March to September, 2011 in addition to the retrospective data. Among those individuals who submitted the samples, volunteers were interviewed. They were briefed about the purpose of the study and asked for their consent before the interview commenced. The questionnaire was carried out by interviewing individuals who submitted samples for rabies diagnosis. Whenever additional information was required, the owner of the animals or anyone who had enough information about the case was asked. The questionnaire includes information like dog ownership and number of humans exposed to suspected or confirmed cases. The dog ownership was classified into three groups. Owned and restricted dogs: those dogs that were completely under the control of their owners. They were fully restricted to owners' premises. Owned and roaming: this group were owned but let to roam for varying periods of time in a day. Unknown ownership/ownerless: these were dogs to which no one is claimed as owner; they roamed freely and were known by the community in the area. Responses about the dog ownership were cross-checked from the victims who were exposed to the animals if they know about the ownership of the dog before the exposure. Rabies vaccination status was checked in the vaccination certificate.

### Statistical analysis

The data collected were subjected to statistical package for social sciences (SPSS) version 20 for analysis. Descriptive methods such as chi-squared tests were used to test the presence of association among categorical variables such as occurrence of rabies and location. Logistic regression analysis was used to identify predictor of rabies.

## RESULTS

### Rabies in animals

A total of 935 brain samples from different animal species

**Table 1.** Demographic characteristics of rabid dogs diagnosed at Ethiopian Health and Nutrition Research Institute, Addis Ababa during the years 2008 to 2011.

| Characteristic | No. tested | No. positive | Percent |
|---|---|---|---|
| **Sex** | | | |
| Male | 241 | 177 | 73.44 |
| Female | 72 | 63 | 87.5 |
| Sub total | 313 | 240 | 76.7 |
| | | | |
| **Age** | | | |
| ≤ 3months | 19 | 11 | 57.9 |
| >3≤ 12 months | 47 | 36 | 76.6 |
| >12 months | 126 | 91 | 72.22 |
| Sub total | 192 | 138 | 71.8 |
| | | | |
| **Dog ownership** | | | |
| Owned and restricted | 81 | 52 | 64.19 |
| Owned and roaming | 28 | 24 | 85.71 |
| Ownership unknown/ Ownerless | 30 | 29 | 96.67 |
| Sub total | 139 | 105 | 75.54 |
| | | | |
| **Vaccination status** | | | |
| unvaccinated | 428 | 310 | 73.43 |
| vaccinated | 16 | 8 | 50 |
| Sub total | 444 | 318 | 71.62 |

were examined for rabies virus during 2008 to 2011, of which 726 (77.6%) were found to be positive. Rabies virus was more frequently detected in brain samples from carnivores (94.5%) than other animal species. The proportion of rabid dogs that were positive for the virus during this time period was 87.2%. This was followed by cats (5.1%) while the proportion of rabies cases in other domestic animal species was 5.8%. Only 2.1% of the rabies cases diagnosed were attributed to wild animals.

## The demographic characteristics of rabid dogs

Since dogs remain the most important animal species diagnosed with rabies, further analysis of demographic characteristics of rabid dogs including sex, age and ownership and vaccination status was carried out (Table 1). During the years 2008 and 2011, 87.19% of the dogs examined were confirmed to be rabid. The proportion of rabid female dogs (87.5%) was higher than that of males (73.44%) and dogs 3 to 12 months old were diagnosed with rabies more frequently (76.6%) than dogs belonging to other age category. The majority of rabies cases were diagnosed in dogs whose ownership was not known or which were ownerless. The proportion of dogs diagnosed with rabies was 96.67%% in dogs categorized into this group. Rabies was diagnosed in both vaccinated and unvaccinated dogs but a higher proportion was observed in unvaccinated dogs.

## Spatio- temporal distribution of rabies

During the years 2008 to 2011, a total of 881 brain samples were tested for rabies virus from various regions of the country of which 687 (78%) were from Addis Ababa, 169 (9.2%) were from Oromia and 17 (1.9%) from Southern Nations, Nationalities and People's region. Eight samples (0.9%) originated from Amhara, Tigray and Somali regions. None were submitted from the remaining administrative regions. In Addis Ababa, the number of confirmed rabies caes ranged from 34 in Lideta to 140 in Kolfe Karanyo (Figure 2). When the distribution of confirmed rabies cases in the vicinity of Addis Ababa was considered, the highest was from Oromia special zone followed by east Shewa zone (Figure 3). Rabies cases were diagnosed throughout the year even though slight variations in the distribution of confirmed cases were being in September and the lowest being in November (Figure 4). However, the variation in the confirmed rabies

**Table 2.** Species of animals responsible for PEP in humans in and around Addia Ababa, Ethiopia during 2010/2011 (n = 2337).

| Species | No. of humans exposed | Percent |
|---|---|---|
| Dog | 2046 | 87.54 |
| Humans | 93 | 3.98 |
| Cats | 61 | 2.60 |
| Bovines | 55 | 2.35 |
| Donkeys | 35 | 1.49 |
| Monkeys | 15 | 0.64 |
| Foxes | 12 | 0.51 |
| Hyenas | 11 | 0.47 |
| Horses | 3 | 0.12 |
| Goats | 2 | 0.10 |
| Sheep | 2 | 0.10 |
| Cheetah | 2 | 0.10 |

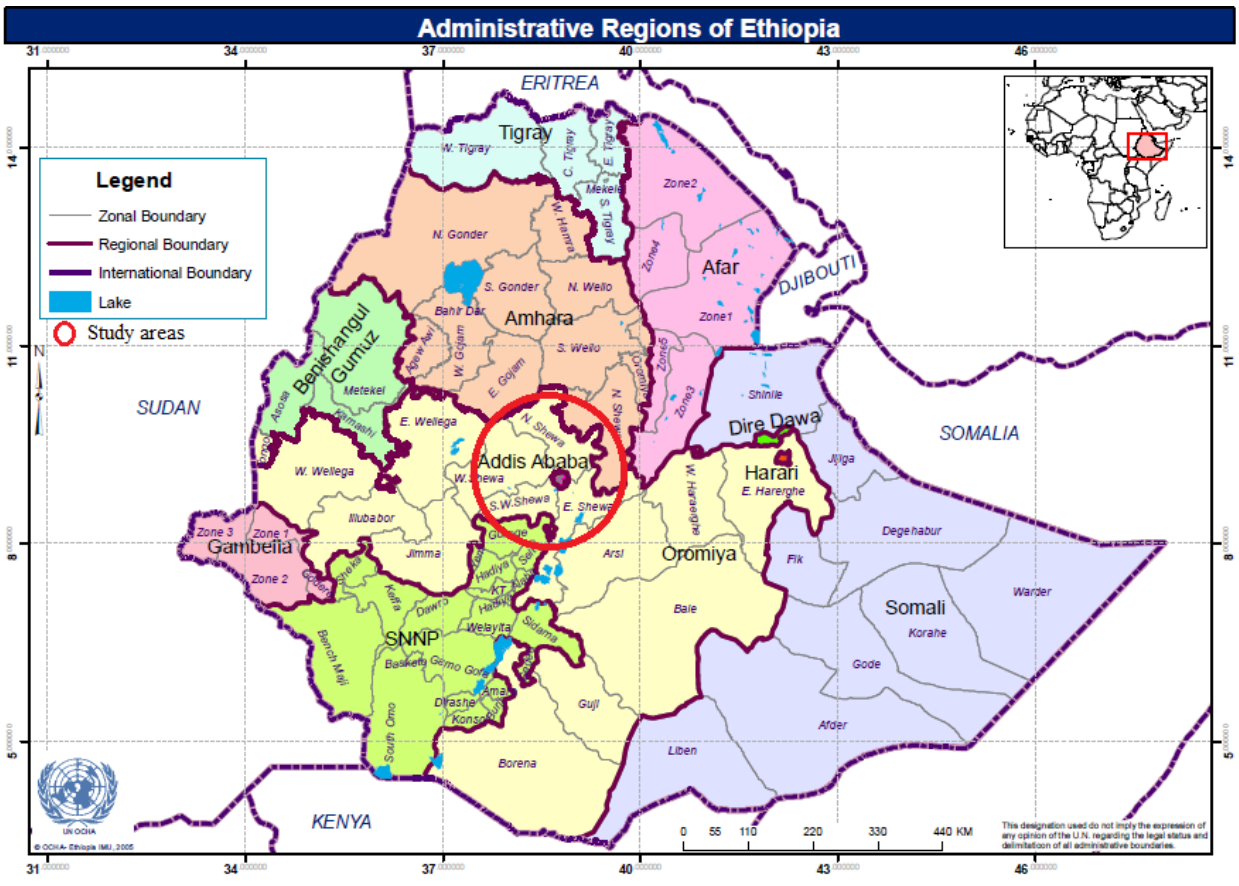


**Figure 1.** Map of Ethiopia showing the study area.

cases among months was only marginally statistically significant (p = 0.05). Statistically significant difference (p = 0.03) was observed in the distribution of confirmed rabies cases among the three years (Figure 5).

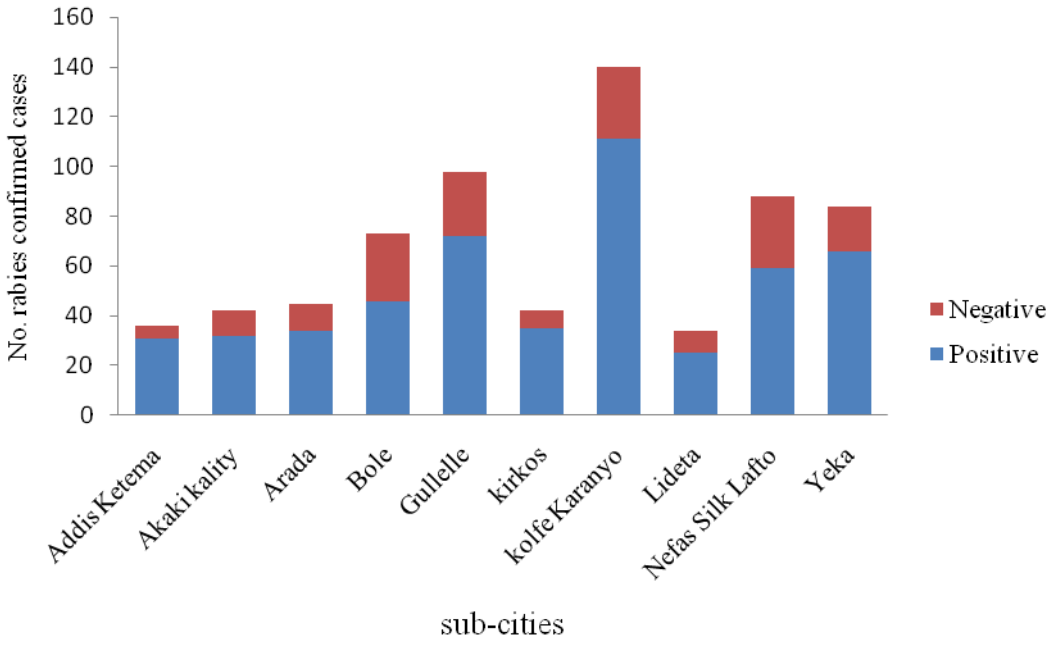


**Figure 2.** Spatial distribution of rabies confirmed cases in Addis Ababa sub-cities, Ethiopia during 2008 to 2011.

**Administration of post-exposure prophylaxis in humans**

Retrospective data showed that post-exposure prophylaxis (PEP) was provided to humans following a bite incident irrespective of the rabies status of the biting animals. A total of 2,337 people received post-exposure prophylaxis in 2010/2011 against rabies as a result of exposure to rabid or rabies suspected animals and humans. The greater proportion of post-exposure prophylaxis was given to humans exposed to rabid or rabies suspected dogs. The majority, 72.3% (1653/2286), of the post-exposure prophylaxis was given to humans bitten by animals with an unknown rabies status. Some of the PEP vaccines were prescribed while the dogs were under quarantine and observation for the development of clinical rabies. The majority of the PEP (78%) was given to humans bitten by animals in which their rabies status was unknown while 28% (633/2286) of the PEP was given to humans bitten by animals in which rabies was confirmed (Figure 6). During the year 2010 to 2011, 2,337 people were provided with PEP after being bitten by different species of animals and humans suspected or confirmed to be rabid (Table 2). The most important animal species responsible for PEP was dogs. Post-exposure prophylaxis due to exposure to suspected humans was considerable while other domestic and wild animals were responsible for the PEP to a lesser extent. Nerve tissue vaccine (NTV) produced from rabies virus infected brain of sheep was the most common (81%) vaccine type used for PEP in and around Addis Ababa. This vaccine is locally produced at Ethiopian Health and Nutrition Research Institute. The use of cell culture vaccine for PEP was limited (19%). No immunoglobulin has been available for use in treating rabies in the country to our knowledge. Active human rabies search during the period of March to September, 2011 was carried out at the Ethiopian Health and Nutrition Research Institute. The result showed that a total of 271 persons were recorded to be exposed to 95 rabid animals. Two hundred fifty seven (94.83 %) of them were exposed to 88 rabid dogs, 9 (3.32 %) persons were exposed to 2 rabid bovines, 4 (1.48 %) persons were exposed to 4 rabid cats and 1 person was bitten by a rabid donkey. In general, the ratio of humans exposed to rabid animals was 2.85.

**DISCUSSION**

The overall 77.6% prevalence of rabies virus in the samples submitted from geographically limited areas by few people who have awareness showed that rabies is wide spread in the country. If submission of all potential rabies cases were made, the number of rabies cases could even be higher than this. Hence, rabies remains endemic in Central Ethiopia and represents a serious

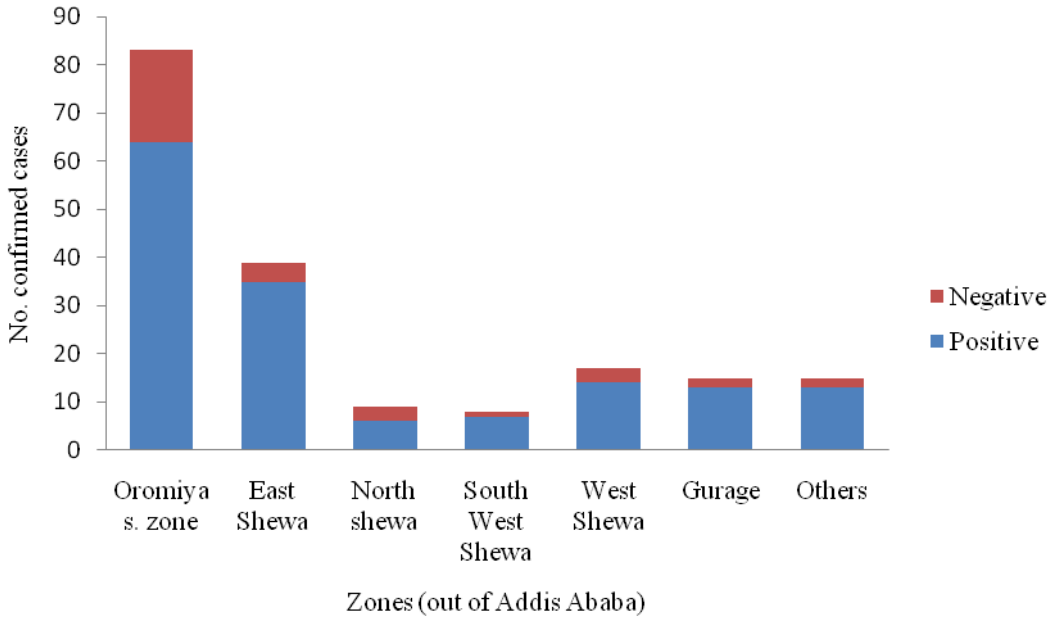


**Figure 3.** Distribution of confirmed rabies cases in areas surrounding Addis Ababa, Ethiopia during 2008-2011

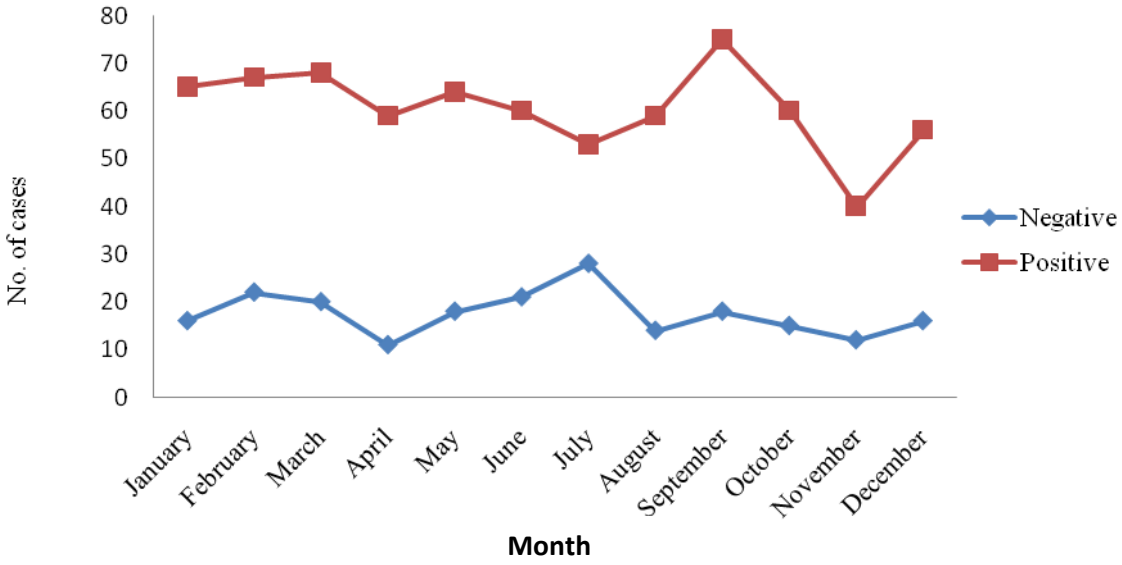


**Figure 4.** Distribution of rabies confirmed cases by months in Ethiopia during 2008 to 2011.

veterinary and public health problem. Domestic carnivores were the principal animals responsible for maintenance and transmission of rabies in the area even though several animal species were involed. This shows that no emphasis has been given to rabies by the relevant veterinary, medical and public authorities in contrast to European and American countries where rabies due to domestic carnivores has been controlled and wildlife rabies is a problem (Warrell, 2004; Blanton et al., 2010).

Similar to the finding in this study, Jemberu et al. (2013)

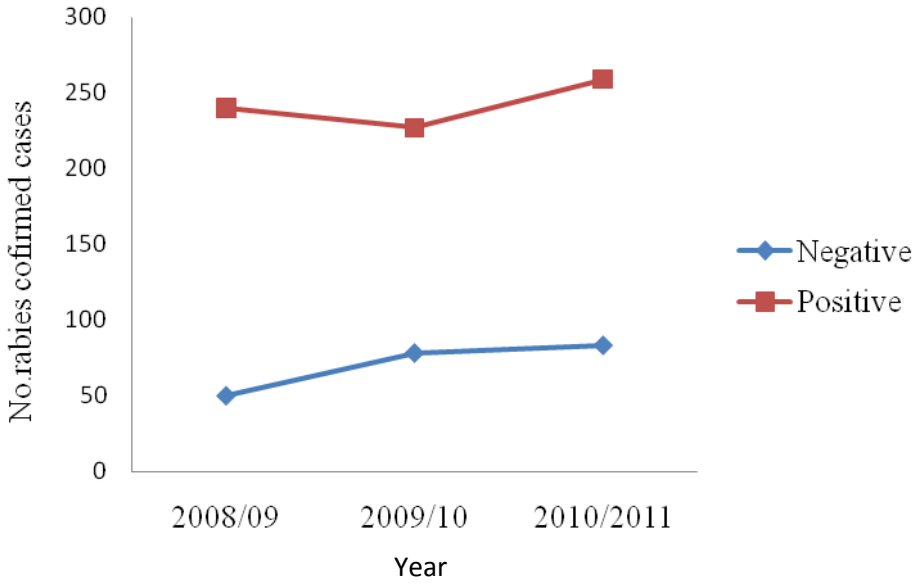


**Figure 5.** Occurrence of confirmed rabies cases by years in Ethiopia during 2008 to 2011.

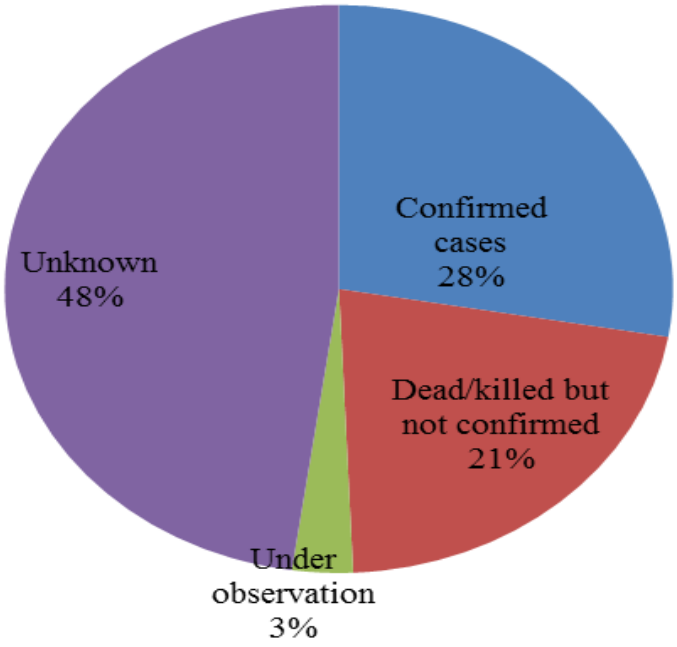


**Figure 6.** Proportion of people receiving PEP in relation to the rabies status of biting animals in and around Addis Ababa, Ethiopia during the year 2010/2011.

reported the preponderant occurrence of rabies in dogs than other animals. The involvement of herbivores and humans to limited extent in the transmission of rabies to humans was also made by these authors. In contrary to the results of this study, Jemberu et al. (2013) based their study on clinical observation without laboratory

confirmation. The findings of this study are in consent with reports from other African countries in which 80 to 95% of rabies cases were due to dogs (Edelsten, 1995; Kitala et al*.,* 2000; Tefera et al., 2002; WHO, 2005). The proportion of confirmed rabies cases reported in this study is higher than the reports of Kretzmann (1993), Dlamini (1995), Kitala and McDermott (1997) and Kayali et al. (2003) from various African countries. However it is lower than the reports of Dürr et al. (2008).

Few confirmed rabies cases were observed in wildlife and domestic animals other than carnivores. This makes the role of wildlife in the maintenance and transmission of rabies to be elusive under Ethiopian conditions. This is due to the fact that most of the samples submitted to the diagnostic laboratory were from the capital city and its surroundings where the wildlife population is low. People also traditionally link rabies with dogs and rarely submit brain samples from other animal species including wildlife. This underestimates the potential role of wildlife in the transmission of rabies but wildlife transmitted rabies has been documented in Southern Africa (WHO, 2005). Rabies transmitted by wildlife species could be a future challenge in the country when rabies transmitted by domestic carnivores is controlled.

The number of samples examined from male dogs was higher than that from female ones but higher proportion of samples from female dogs were diagnosed with rabies virus than those from male dogs. The higher proportion in female dogs could be due to the possible contact of few females by several males, especially during estrus and the probability of being bitten by several dogs. But our finding is in contrary to the previous reports made elsewhere in the world (Brooks, 1990; Eng et al*.,* 1993; Kayali et al*.,* 2003*,* Dürr et al., 2008). Larger proportion of dogs in all age groups examined was positive for rabies virus but rabies cases were more prevalent in dogs older than 3 months. Dogs older than 3 months usually wander outside the home compound and have chances of being bitten by rabid dogs. The lower incidence of rabies among younger dogs could also be due to protection by maternal antibodies to some extent if the dam is vaccinated. In consent to our observation, Foggin (1988), Brooks (1990) and Kayali et al. (2003) reported higher rabies cases in dogs older than 3 months while correspondingly lower proportion of dogs younger than 3 months were found to be rabid elswhere in Africa. The confirmation of rabies in all age groups, however, shows the neccessity of including dogs of all age group during vaccination campaign. Exclusion of puppies from the campaigns has been suggested to reduce the level of herd immunity and could culminate in rabies cases during the interval between campaigns (Sudarshan et al., 2006; Kammer and Ertl, 2002).

Both vaccinated and non-vaccinated dogs were diagnosed with rabies even though the proportion of rabid dogs was higher in non-vaccinated ones. The detection of rabies virus in brain samples from vaccinated dogs could be due to vaccine failure. There has been frequent power disruption, lack of cold chain during transportation of vaccines and lack of storage facilities in the country. Thus, administration of the product does not necessarily guarantee the desired protection. Therefore vaccine failure as a result of miss-handling and inappropriate storage could occur frequently.

The existence of Lagos bat virus in dogs (Mebatsion et al., 1992) in the country could be another reason for the occurrence of rabies in vaccinated dogs as vaccination is not protective against this genotype. Highest proportion of confirmed rabies cases was observed in dogs whose ownership was not known or in ownerless dogs. Owned dogs that roam freely were also more prone to rabies than owned and restricted dogs. The higher proportion of rabies in dogs to which no owner is attributed is due to absence of vaccination and restriction in this group of dogs. Their free roaming nature can easily expose them to rabid animals so that they can be rabid more frequently. Our result is in agreement with the previous reports of Foggin (1988) and Kitala and McDermott (1997). In contrary to our observation, Dürr et al*.* (2008) and Kayali et al. (2003) reported higher proportion of rabies cases in owned dogs than ownerless ones in Chad.

Slight fluctuation in the occurrence of rabies was observed among the months of the year. The highest incedence was recorded in September while the lowest was observed in November. This peak occurrence probably coincides with breeding season of dogs which is from June to September. The decline in November could be due to mass destruction of unconfined dogs in response to increased movement during mating and increased rabies cases. The lower cases of rabies during the year 2009 and 2010 are due to discontinued killing of unconfined dogs. During the years 2008 to 2011, the administration of the Addis Ababa city has launched a rabies control activity including vaccination, birth control and removal of unconfined dogs. Public awareness by using television, radio and pamphlets to strengthen the control activities were also focused during the years. These activities together with the expanding construction in the city have reduced the number of dogs to 250,000 from about 500,000. Despite these control activities, dogs remain to be the main vector of rabies.

Rabid dogs were shown to be responsible for most of the rabies cases in humans. Our finding agrees with the reports of Kayali et al. (2003), yimer et al. (2002) and Eng et al. (1993). This shows that control activities need to be strengthened in developing countries to minimize the extent of rabies transmitted by dogs. Even though human-to-human transmission is extremely rare (Haaheim et al., 2002; Carter and Saunders, 2007), individuals in close contact with rabies suspected humans

received PEP in fear of acquiring the disease.

The majority of PEP in humans was administered without rabies diagnosis and only in 28% of cases PEP was administered after confirmation of the cases. The main reason for this low rate of confirmation before adminstration of PEP is the lack of diagnostic laboratories and simple and easier diagnostic tests. But it could also be due to lack of awareness by the community to collect and submit samples to the central laboratory. This has led to indescriminate administration of PEP to all rabies suspected human cases. This is a risk in Ethiopia where Fermi type (nerve tissue) vaccine is widely used. Fermi type vaccine was known for its post vaccination reactions and its use for humans was turned down by World Health Organization (WHO) in 1973 (WHO, 1973). The wide spread use of this vaccine in the absence of confirmation is a serious problem for the community. It can be assumed that the situation in rural areas of the country might be worse than the situation observed in Addis Ababa and its surroundings where cell culture vaccines are available in a few private pharmacies and the central diagnostic laboratory is located. This is in agreement with the observation of Jemberu et al. (2013) who have reported that 84% of people exposed to rabid dogs or other animals rely on traditional treatments.

## Conclusion

The study shows that the principal vector of rabies in Addis Ababa and its surroundings, but most likely in entire Ethiopia, is the dog. Effective rabies management and control based on confirmed cases and the use cell cultured derived vaccine is recommended.

## Conflict of Interests

The author(s) have not declared any conflict of interests.

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