

Free roaming dogs and the communities' knowledge, attitude and practices of rabies incidence/human exposures: Cases of selected settings in Ethiopia and Kenya

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Abstract

Background: According to the recommendation made by World Health organization, vaccinating 70% of the dog population helps to control rabies and prevent rabies virus in human population. However, the exponential increase in the population of free roaming dogs is a serious challenge to this strategy in Eastern African countries including Ethiopia and Kenya. Understanding the dynamics of free roaming dog populations is, thus, a step to be taken prior to designing effective rabies prevention and control strategy in these countries.

Objectives: The present study was designed to determine the number of free roaming dogs in selected settings in Ethiopia and Kenya, and describe the level of community knowledge, attitude and practice (KAP) on rabies incidence/human exposures. The study also described the socio-cultural value of dog keeping in the areas considered in the study.

Methodology: Counting free roaming dogs were a major means of collecting data in both Ethiopia and Kenya. Dog count was made using the markup capture approach. Other than counting, questionnaire was used to obtain data for the study. Three-hundred and ninety-eight copies of questionnaires were administered to the study participants in Ethiopia, while the number of respondents to the questionnaire in Kenya was 351. In addition, a five-year retrospective data on dog/animal bite cases were collected from selected health facilities of the study sites.

Results: A total of 2991 and 386 free roaming dogs were counted in Ethiopia and Kenya, respectively. A five-year retrospective data showed cases of 1524 (in Mekelle) and 429 (Assela) individuals who were bitten/infected by rabies-suspected animals. Evidence obtained from the health facilities in Mekelle and Assela showed the bitten/infected individuals took PEP within the specified period.

In Kenya, a total of 3441 and 4997 animal bite cases were reported from 2010-2014 in Kisumu and Siaya, respectively. The number of animal bite cases may signify the economic burden incurred (cost of PEP and other related costs), public health impact and social value of the disease. The questionnaire data also indicated the existing dog management practices, awareness of the community about rabies and its zoonotic importance, the first line of action taken at home for individuals bitten by rabies suspected animal, awareness of the community on dog vaccination, importance of free roaming dogs and their management.

Conclusion: The significant proportion of free roaming dogs and number of animal bite cases calls for an integrated action between human and veterinary professionals to control the number of free roaming dog population, initiate awareness creation programs in the community and increase the vaccination of owned dogs there by to control and prevent rabies. *Ethiop. J. Health Dev.* 2018;32(1):27-35]

Key words: Ethiopia, Kenya, Free roaming dogs, rabies, animal bites, KAP

Introduction

Rabies is a deadly zoonotic disease which is responsible for more than 55,000 deaths each year. The majority of rabies-caused deaths occur in Asia and Africa (www.rabiesalliance.org). About 99% of rabies deaths occur in developing countries (1). Of this, deaths in Asia account for 56%. The remaining 44% of the deaths are reported to be from Africa (2). Many of the victims are children, often young boys who are more likely to play with or approach Free Roaming Dogs (FRD). Despite its significant health impact in East African region, rabies has remained neglected by governments of the countries in the region.

The rapid yearly increase in the incidence of rabies is mainly associated with the increasing number of free

roaming dogs in urban centers. Different records in East African countries indicate a higher number of dog bite cases and deaths due to rabies. For example, estimates of about 11,041 dog bite cases were reported between 2003/4-2014/15 in Tigray region of Ethiopia. This is reported to have caused 53 deaths (3) in the region. Similarly, 146,000 dog bite cases were reported in Kenya in 2012 (4). In 1998, Ethiopia reported the highest human death rate due to rabies recorded in Africa, at 43 deaths per million people (5). In Kenya, the reported human deaths are 52 per million people (6).

Dogs are responsible for nearly all (i.e., about 99%) of rabies transmission that leads to over 55,000 human deaths every year. Millions of people also receive post-

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exposure prophylaxis following a bite each year (2, 7, 8). Effective control of rabies thus requires understanding the ecology of free roaming dogs and the epidemic theory.

The global dog population is estimated to be around 700 million (9). According to WHO's recommendation, vaccinating at least 70% of the dog population helps to control rabies and thus prevent the rabies virus from circulating amongst susceptible animals (1, 10). However, the exponential increase in the population of free roaming dogs is a serious challenge to rabies control. Apparently, many dog owners in developing countries do not control their dogs inside their fence either due to lack of knowledge about diseases dogs can transmit or due to reasons associated with poverty (such as failure to feed dogs at home). This ultimately results in an increase in the population of free roaming dogs that are not vaccinated. When infected with rabies, free roaming dogs become the primary source of infection to humans and other domestic animals (9, 11, 12). It is therefore important to recognize that any entry of rabies into such a population of dogs leads to a rapid increase in the rate of human and animal infection with rabies.

One very crucial strategy in rabies control is community involvement. However, there is a gap in understanding and documenting community knowledge, attitude and practices about rabies and its control in the study areas. In addition, the knowledge, attitude and practices (KAP) of the community on rabies incidence and human exposures in relation to free roaming dogs has not been adequately documented. Furthermore, understanding the socio-cultural value of dog keeping by the community will help in designing appropriate rabies prevention and control strategy in the areas. Therefore, the present study was designed to assess the number of free roaming dogs in major cities of Ethiopia and Kenya. An attempt will also be made in the study to determine the level of the community knowledge, attitude and practice (KAP) on rabies incidence/human exposures, and the socio-cultural value of dog keeping. Assessing the retrospective data from the health facilities of the respective study sites on dog/animal bite cases is also another objective this study was designed to achieve.

Methods

Study Areas: This study was conducted in four major towns in Ethiopia and Kenya. The towns included in the study in Ethiopia were Mekelle and Asella, while Kisumu and Siaya were the two towns considered in the study from Kenya. The study period was from November 2014 to April 2015.

Mekelle and Asella, Ethiopia: Mekelle and Asella are towns in Ethiopia. Mekelle is the capital city Tigray National Regional State. It is found about 783 km away from Addis Ababa, the capital of the country. Mekelle is located north of Addis Ababa at 39°38' E longitude and 13°23' N latitude. The altitude of town ranges from 2000-2200 meters above sea level. The mean annual rainfall of the area is 628.8 mm and the annual

minimum and maximum temperatures are 11.8°C and 29.94°C, respectively. The population of Mekelle is estimated to be about 350,000 (13).

Asella is a town located about 175 Km southeast of Addis Ababa in Oromia National Regional State. It is located at 6° 59' to 8° 49'N latitude and 38° 41' to 40° 44' E longitude. Assela receives the mean annual rainfall of 1200 mm, with minimum and maximum temperature of 5°C and 28°C, respectively (14).

Kisumu and Siaya

Kisumu and Siaya are the two counties in Kenya considered in the present study. Kisumu county is one of the newly devolved counties in Kenya. Its borders follow those of the original Kisumu district, one of the former administrative districts of the former Nyanza Province in western Kenya. Kisumu county has 7 sub-counties. The headquarters of the sub-counties are in Kisumu city. Kisumu county has a population of 968,909 (15). The land area of the county is 2085.9 km².

Siaya is one of the counties in the former Nyanza Province in the southwest part of Kenya. It shares a water border with Homa Bay county which is located south of Siaya county. The total area of the county is approximately 2,496.1 km². The county lies between latitude 0° 26' to 0° 18' north and longitude 33° 58' east and 34° 33' west. Siaya has six districts.

Study Target Groups: As mentioned earlier, the study was carried out in four selected sites in Ethiopia and Kenya. The target groups of the study were stray dogs found roaming in the sites selected for the study. The questionnaire survey considered participants from Mekelle and Asella (from Ethiopia,) and Kisumu and Siaya (from Kenya). The study sites were purposively selected for inclusion in the study. Proximity of the sites, respondents' lifestyle, rabies incidence and abundance of free roaming dogs in the areas were among the criteria considered in the decision made to select the research sites. Within the study sites, sub-cities/sub-counties and respondents were selected randomly. Participants used as respondents to the questionnaire were selected from dog owners, community members, municipality workers, and veterinary and medical professionals found in the study sites.

Study Population

Free roaming dog population size and demographics assessment: Two strategies were used in the survey of free roaming dogs. One is a direct observation and the other is counting of free roaming dogs in the selected study sites. The counting was made using permanent animal marking spray. In other words, a dog was marked with a spray mark immediately after it was counted. This helped the data collectors not to count the same dogs more than one time. The counting of free roaming dogs was carried out daily early in the morning starting from 06:00 to 09:00 AM time. Early morning was preferred because dogs are at rest early in the morning. The reason for doing the counting on a

daily basis arose from the need to ensure that the spray used to mark counted dogs was still visible from the dog. The exact length of time the spray mark stays visible on the dog was not easy to know. White, green or yellow colors were used for marking dogs in the present study. The color of the dog to be marked determined the specific color to use to mark the dog. The marking was done from a two meter distance using automatic spray or rope wrapped with sponge and soaked in the marking spray from one end (16, 17).

Determination of Knowledge, Attitude and Practices (KAP): For the questionnaire-based survey, the sample size was calculated using the formula developed by WHO for questionnaire-based studies in health research: $n = Z^2 * P (1-P) / d^2$ where n = number of respondents in the study, Z = test statistic which allows calculating the result with 95% confidence (1.96), d = the level of precision (5%), and P = proportion to be used on estimates which was expressed in decimal (so to increase the sample size, $p = 0.5$ was used) (18). Since the total respondents in each study site were fewer than 10,000, the following correction formula ($nf = ni / (1 + ni/N)$) where N = total respondents in Mekelle and Assela (5835), and in Siaya and Kisumu (1740), The respondents from each study site were selected using probability proportion ($ni = Ni * n/N$), where ni = total number of participants in each study site, Ni = total number of respondents in each study site, n = total number of study subjects obtained and N = total number of respondents in each of the two the study areas. A 6-8% non-response rate was considered to maximize the precision.

Participants selected from the four study sites completed a total of 749 questionnaires. This means that 398 copies of the questionnaire were administered to respondents from the two towns in Ethiopia while participants from Kenya completed the remaining 351 questionnaires. A further look at the details of the respondents from all the study sites shows that 252 copies of the questionnaire were administered to respondents in Mekelle and 146 copies to participants in Asella, Ethiopia. Of the 351 copies of the questionnaire used in Kenya, participants in Siaya completed 183 copies and 168 copies were filled in by respondents in Kisumu County.

The data collection instrument used in this study was structured questionnaire. Structured questionnaires were, first prepared in English and then translated to the local languages for ease of administration. Proper care was taken to ensure correct translation of the questionnaire into the desired local languages. After translating the questionnaire to local language, it was pretested and finalized. Administration of the questionnaire was made after incorporating the feedback obtained during the pre-testing of the questionnaire.

A multi-stage sampling technique was used in the selection of the respondents. First, the study towns were selected purposively. This was followed by random selection of sub-cities/sub-counties within the

towns/counties. Similarly, respondents from each study site were randomly selected. Household heads or members of the household, aged 15 years and above acted as study participants. Selection for inclusion in the study was on a voluntary basis. In addition, neither sex nor religion was considered significant in allowing people to become data sources. The purpose of the questionnaire survey was to assess participants' awareness of rabies-caused illness and information on how they managed their dogs. The questionnaire had two parts. Part I of the questionnaire asked respondents to supply general information such as name, address, sex, religion, etc. about themselves. The purpose of the second part of the questionnaire was to assess participants' knowledge about rabies, their attitude towards free roaming dogs and their awareness about rabies incidence and human exposure in their areas. Trained research assistants collected data. Training focused on the purpose of the study, questionnaire administration and response gathering as well as ethical issues to be observed during data collection. Similar procedures of data collection were followed both in Ethiopia and in Kenya. In addition, proper supervision was made by the research team in all the research sites in order to ensure the quality of the data needed for the research.

Retrospective Data on Animal/dog Bites:

Retrospective data was needed to get information on the burden of dog/animal bite cases in the study settings over a fairly extended length of time. Accordingly, retrospective data covering a period of five years (i.e., 2009 - 2013 in Ethiopia); and (2010 - 2014 in Kenya) was collected from regional and district health facilities in the two countries considered in the study. During retrospective data collection, disaggregating the number of bite cases per year according to the age and gender of the victims was made.

Human and Other Animal Ethical Considerations:

During data collection, ethical issues related with human subjects were faithfully considered. Primarily, the study proposal was confirmed followed by getting consent from the community before the survey. Permission to conduct the study was obtained from institutional review boards of Mekelle University College of Health Sciences and the University of Nairobi. The need to consult two universities arose from the fact that the studies were carried out in two countries. Moreover, animal welfare issues were considered during the counting of free roaming dogs. The dogs were fed before they were marked and counted.

Data Management and Statistical Analysis: The data from questionnaire survey and retrospective findings were entered into Excel spread sheet and descriptive statistics was employed to summarize the data and analyzed using Microsoft Excel application and STATA version (12.1) statistical software (19).

Results

Free Roaming Dog Population: Fig 1 summarizes the number of counted free roaming dogs in the 4 research settings selected from the two countries. As can be seen from the data in Fig. 1, the number of free roaming dogs counted in Mekelle was 1606 followed

by 1385 dogs in Assella. The number of dogs counted and marked in Kisumu and Siaya is slightly over seven times fewer than the number recorded in Assella. In more specific terms, 196 dogs and 190 dogs were counted in Kisumu and Siaya, respectively.

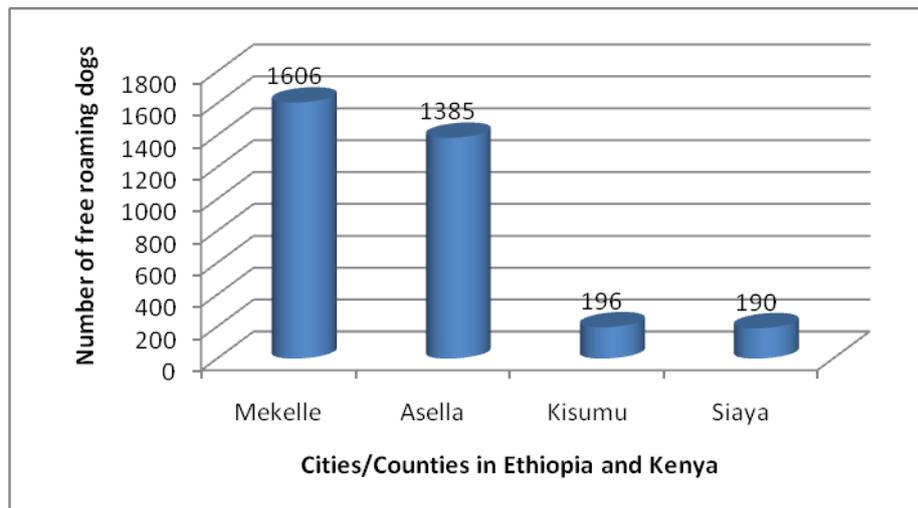


Figure 1: Number of free roaming dogs counted in selected cities/counties

Results of Retrospective Data: The retrospective data for the five-year period (2009-2013) in Ethiopia showed cases of 1524 and 429 individuals who were bitten/infected by rabies-suspected animals and took PEP within the specified period in Mekelle and Asella

respectively. In Kenya, 14058 and 17288 cases of animal bite were recorded in Kisumu and Siaya, respectively in the five-year period (2010-2014) as shown in Table 1.

Table 1: Retrospective data on animal/dog bite cases in Ethiopia and Kenya

Cities/Counties	Year and Animal/Dog bite cases					
	2009	2010	2011	2012	2013	2014
Mekelle	657	484	104	176	103	-
Asella	92	140	81	56	60	-
Kisumu	-	1976	3267	2906	2468	3441
Siaya	-	1372	3407	3400	4112	4997

Results of the Questionnaire Survey

A total of 252, 146, 183, and 168 completed and returned the questionnaire during the study period from

Mekelle, Asella, Kisumu and Siaya respectively (Figure 2).

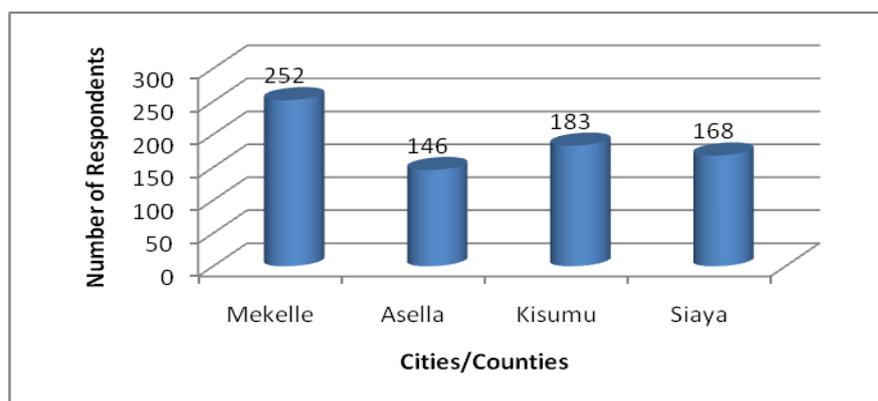


Figure 2: Distribution of respondents by city/county in Ethiopia and Kenya

In all the study sites, the proportion of male respondents was consistently slightly higher than that of female respondents (Table 2). In Asella, the highest numbers of respondents were within the age range of 20-29 years (37.7%) while in Mekelle the age range of the highest number of respondents falls between 30-39

(57.9%) years. In Kenya, the highest number of the respondents was above 30 years of age (Table 2). The highest proportion of respondents in Mekelle and Asella had secondary and university level education while in Kisumu and Siaya, they had primary and secondary education.

Table 2: Demographic data about respondents

Variables	Ethiopia		Kenya	
	Assela	Mekelle	Kisumu	Siaya
	No. (%)	No. (%)	No. (%)	No. (%)
Gender				
Male	80 (54.8)	144 (57.1)	92 (50.3)	90 (53.6)
Female	66 (45.2)	108 (42.9)	91 (49.7)	78 (46.4)
Age				
15-19 years	32 (21.9)	14 (5.6)	5 (2.7)	4 (2.4)
20-29 years	55 (37.7)	68 (27.0)	45 (24.6)	30 (17.9)
30-39 years	43 (29.5)	146 (57.9)	53 (29.0)	48 (28.6)
Above 40 years	16 (11.0)	24 (9.5)	80 (43.7)	86 (51.2)
Education status				
Illiterate	9 (6.2)	32 (12.7)	24(13.1)	10(6.0)
Primary	23 (15.8)	41 (16.3)	64(35.0)	62(36.9)
Secondary	57 (39.0)	137 (54.4)	60(32.8)	82(48.8)
Tertiary	57 (39.0)	42 (16.7)	35(19.1)	14(8.3)

In Mekelle, Asella, Kisumu and Siaya, 94.8%, 48.6%, 61.8% and 71.4% of the respondents had dogs/cats, respectively. In all the study sites, dogs were reported to be kept for house guarding. However, in Mekelle

and Kisumu, 6.1% and 1.89% of the respondents keep dogs/cats as pets, respectively. Majority of the respondents in all the study areas reported not restraining the movement of their dogs (Table 3).

Table 3: Information related to existence of dogs and their management

Variables	Ethiopia		Kenya	
	Assela	Mekelle	Kisumu	Siaya
	No. (%)	No. (%)	No. (%)	No. (%)
Existence of Dogs/cat				
Yes	71 (48.6)	239 (94.8)	113 (61.8)	120 (71.4)
No	75 (51.4)	13 (5.2)	70 (38.2)	48 (28.6)
Purpose of dog/cat keeping				
House guard	71 (100.0)	231 (93.9)	104 (98.11)	118 (100.0)
Salon pet	0 (0.0)	15 (6.1)	2 (1.9)	0 (0.0)
Management of dogs				
Tied/housed	36 (50.7)	54 (22.6)	24 (22.9)	78 (65.5)
Not tied but fenced	23 (32.4)	110 (46.0)	9 (8.5)	7 (5.9)
Free roaming	12 (16.9)	75 (31.4)	72 (68.6)	34 (28.6)

The major target of the present study was to assess the KAP of the community about rabies: The results indicated that above 90% of the respondents in the study areas of Ethiopia and Kenya were aware of rabies and above 95% knew dogs were the primarily affected animals. About 89.5%, 73.5%, 93.9% and 96.3 of the respondents in Mekelle, Asella, Kisumu and Siaya respectively had information about the zoonotic

importance of rabies. In both countries, participants mentioned school/friends/neighbors as the major sources of their information about rabies. Significant proportions of the respondents in Asella (78.8%), Mekelle (67.9%), Kisumu (89.22%) and Siaya (74.23%) reported they were aware that free roaming dogs transmitted rabies (Table 4).

Table 4: Knowledge, Attitude and Practices related to Rabies

Variables	Ethiopia		Kenya	
	Assella	Mekelle	Kisumu	Siaya
	No. (%)	No. (%)	No. (%)	No. (%)
Heard about Rabies				
Yes	132 (90.4)	239 (94.8)	167 (91.3)	16 (97.0)
No	14 (9.6)	13 (5.2)	16 (8.7)	5 (3.0)
Source of Information				
Media	7 (5.3)	33 (13.8)	20 (12.0)	14 (8.6)
School/friend/neighbor	84 (63.6)	124 (51.9)	130 (77.8)	99 (60.7)
Vet Services	2 (1.5)	53 (22.2)	2 (1.2)	17 (10.4)
Health Centers	4 (3.0)	5 (2.1)	6 (3.6)	10 (6.1)
Media plus other sources	35 (26.5)	24 (10.1)	9 (5.4)	23 (14.1)
Zoonotic nature of Rabies				
Yes	97 (73.5)	214 (89.5)	154 (93.9)	157 (96.3)
No	33 (26.5)	25 (10.5)	10 (6.1)	6 (3.7)
Knowledge on routes of transmission				
Yes	107 (81.1)	190 (79.5)	138 (89.0)	149 (94.9)
No	25 (18.9)	49 (20.5)	17 (11.0)	8 (5.1)
Animals affected by rabies				
Dog	130 (98.4)	228 (95.4)	165 (100.0)	158 (96.9)
Cat	1 (0.8)	2 (0.8)	65 (39.6)	42 (25.8)
Other animals	1 (0.8)	9 (3.8)	22 (13.2)	31 (19.0)
Role of FRDs in rabies transmission				
Yes	115 (78.8)	171 (67.9)	149 (89.2)	121 (74.2)
No	33 (21.2)	81 (32.1)	18 (10.8)	42 (25.8)

The first line of action taken at home for a person or an animal bitten by rabies-suspected animal in Asella (45.2%) is washing the wounded area with water and soap but in Mekelle traditional medication (38.5%) is the major action followed by washing the wound with water and soap (22.6%). Significant proportions of the respondents in Asella (13.5%) only wash the wound with water in case of dog bites. In Kisumu and Siaya, majority of respondents (52.5% and 32.5% respectively) were not aware of any home-level action to take in case an animal or a person were bitten by a suspected rabid animal. Only 8.6% and 26.4% of the respondents in Kisumu and Siaya said they would wash bites with soap and water.

About 47% of respondents in Asella had no idea about the strategies for the prevention and control of rabies. However, nearly the same percentage (40.9% from Asella, and 39.8% from Mekelle) of respondents suggested vaccination as a strategy of prevention and control of rabies. However, the respondents in both towns didn't take into account the role of awareness creation programs in the prevention and control of rabies.

In Kisumu and Siaya, 78.5% and 66.9% of the participants, respectively, suggested vaccination as a strategy of rabies prevention. Nearly 17% of respondents from Kisumu and almost 28% from Siaya reported having no idea of rabies prevention strategy.

In Asella and Mekelle about 40.8% and 60.6% of the respondents, respectively, vaccinated their dogs regularly and the frequency of vaccination in Asella is three years, whereas, in Mekelle it is one year. In Kisumu and Siaya, only 20.35% and 19.12% of the respondents with dogs had vaccinated their dogs as proved by vaccination records, respectively.

Just over half (i.e., 58%) of the respondents from Asella and slightly over three-fourths (83.7%) of those from Mekelle had suggested elimination as a strategy of getting rid of roaming dogs. A significant proportion of respondents from Asella (31.5%), however, did not know what to do about free roaming dogs. Close to three-fourths of the respondents in Kisumu (71%), and just over three-fourths (78%) of them from Siaya suggested elimination of free roaming dogs as a method of preventing rabies (Table 5).

Table 5: Knowledge, Attitude and Practice about dog/animal bite management and prevention of Rabies

Variables	Ethiopia		Kenya	
	Assela	Mekelle	Kisumu	Siaya
	No. (%)	No. (%)	No. (%)	No. (%)
First line action for a person/animal bitten by rabies suspected case				
Wound wash by water	20 (13.7)	24 (9.5)	9 (5.1)	9 (5.5)
Wound wash by water and soap	58 (39.7)	57 (22.6)	15 (8.6)	43 (26.4)
Apply Alcohol	40 (27.4)	31 (12.3)	29 (16.6)	44 (27.0)
Apply irritants like lemon	1 (0.7)	8 (3.2)	1 (0.6)	11 (6.8)
Traditional treatment	19 (13.0)	97 (38.5)	29 (16.6)	3 (1.8)
No Idea	8 (5.5)	35 (13.9)	92 (52.5)	53 (32.5)
Possible strategies for the prevention and control of rabies				
Vaccination of owned dogs	38 (28.8)	103 (43.1)	121 (78.5)	109 (66.9)
Eradication of stray dogs	8 (6.1)	81 (33.9)	7 (4.6)	9 (5.5)
Animal birth control	2 (1.5)	3 (1.3)	0 (0.)	0 (0)
Awareness creation	6 (4.6)	0 (0)	0 (0)	0 (0)
Vaccination of dogs plus others	16 (12.1)	40 (16.7)	0 (0)	0 (0)
No idea	62 (47.0)	12 (5.0)	26 (16.9)	45 (27.6)
Vaccination of dogs/cats				
Yes	29 (40.8)	210 (60.6)	23 (20.3)	23 (19.1)
No	42 (59.2)	36 (39.4)	90 (79.7)	97 (80.9)
Options for management of FRDs				
Eradication of free roaming dogs	85 (58.2)	211 (83.7)	127 (71.0)	131 (78.0)
Animal birth control method	15 (10.3)	20 (7.9)	25 (13.9)	16 (9.5)
No idea	46 (31.5)	21 (8.3)	27 (15.1)	21 (12.5)

Discussion

Studies of Knowledge, Attitude and Practices (KAP) have been used widely to help increase community knowledge and thus change attitude and improve practices that may aid in disease prevention and control (20-22). This study, could therefore serve as a baseline study to determine the number of free roaming dogs in the countries in the future and develop appropriate prevention and control strategies against rabies.

The data used in the present study revealed that more than 60% of dog owners in the communities in the study did not control their dogs during the day time. This means that dogs were found free roaming at any time in the communities. This finding is similar to confinement status statistics found in comparable settings in Madagascar (23), Kenya (4), and Chile. Findings of studies in Madagascar (23), Kenya (4), and Chile indicated that urban areas had higher proportions of confined animals on the one hand, while on the other, the number of reported ownerless dogs roaming free in urban settlements is much higher than the number of those reported in rural areas (24). Apparently, there are no stray dogs in free roaming dogs in rural areas other than dogs that roam free as a result of lack of owners' willingness to confine their animals (25, 26).

The findings of this study indicate that respondents from Mekelle were more familiar with the diseases of dogs and other animals than were respondents from all other communities in this study. This could perhaps be the result of awareness creation programs carried out in Mekelle by different stakeholders (27). However, over 60% of the respondents in both countries in the study had attained primary, secondary or tertiary level of education. This compares well with the finding reported in a similar study carried out in Tanzania (21) where 74% of respondents had achieved primary school education. Primary school level of education may have a significant role to play in raising the people's awareness about diseases of dogs and other animals and their willingness to confine their animals around their homestead.

Of the surveyed households, 94.8% from Mekelle; 71.4% from Siaya; 61.8% from Kusumu, and 48.6% from Assela were reported to have dogs. The present finding is somewhat similar to the findings reported in the earlier studies carried out in three countries. A study carried out in Kenya, for example reported that 53-81% of the respondents had dogs. A similar study in Zimbabwe reported that 54% of the surveyed participants had owned dogs. According to an earlier study conducted in Zambia, 42% (28) of the surveyed respondents had dogs.

The existence of abundant free-roaming dogs could be a result of poor management of owned dogs. Needless to mention, owners' poor dog management allows the dogs to roam around in search of food. The finding of the present study is similar to the finding of the study conducted in Madagascar where 79% of the population allowed their dogs to roam freely scavenging for food (23). Failure to restrain dogs may either be due to lack of knowledge about diseases that can be transmitted by dogs or poverty. As mentioned earlier in this report, dogs are responsible for about 99% of transmission of rabies virus that leads to over 55,000 human deaths every year. Free roaming dogs have much opportunity for exposure to rabies infection. They also have much opportunity to pass the rabies virus on to other animals, and this, in turn, widens the replied that primary source of transmission of rabies virus to humans (9, 28). The presence of a large population of unrestrained dogs is therefore a threat to designing strategies to control the transmission infection by rabies virus.

According to WHO's recommendation, vaccinating 70% of the dog population helps to control rabies, and thus, prevent the rabies virus from circulating amongst susceptible animals (10). However, the reported dog vaccination coverage in Mekelle (60.6%), Assela (40.8%); Kisumu (20.4%) and Siaya (19.1%), was much less than the level desired to achieve WHO's recommendation. In connection with the frequency of dog vaccination, the surveyed respondents from Assela replied that vaccination of their dogs is at the interval of three years, whereas respondents from Mekelle said they got their dogs vaccinated once a year. Worse is the report that slightly fewer than a quarter (i.e., 20.35% from Kisumu and 19.12% from Siaya) of the surveyed dog owning respondents produced evidence of vaccination of their dogs.

Given the presence of a huge number of free roaming dogs in the study settings, there is a pressing need for more responsible dog keeping laws to be put in place in the study setting. The breaking of such laws should lead to holding free roaming dog owners responsible for any damage caused by improperly restrained dogs in the study areas.

According to the finding of the study, a significant proportion of respondents (Mekelle-38.5%, Kisumu-16.6%, Assela-13%) reported using traditional treatment after a dog bite. Several studies indicate the potential values of medicinal plants against bacterial, fungal and viral infection. However, it is important to point out that the effectiveness of traditional medicine on rabies virus has not been documented. Investigating the role indigenous knowledge, including the role of traditional medication in the treatment of rabies, is among the areas suggested for future research.

Vaccination of domestic dogs is a highly recommended strategy to prevent and control rabies. However, culling, which is an immediate and visible response to public concerns about rabies, is still frequently carried out in response to rabies outbreaks. This is an

indication of an inadequate practice of vaccinating domestic dogs as a strategy to control rabies.

In most Eastern African countries including Ethiopia, culling is the main means practiced to control human and canine rabies. This is not the best strategy to control rabies. One major reason for banning the use of strychnine (a chemical used for eradication of free roaming dogs) in the developed world is that the chemical is highly dangerous and has a serious environmental impact (1, 26). Clearly, dogs receive little veterinary care in developing countries. This contributes to the spread of disease and a high mortality rate among dogs (1). This means that fear of rabies leads to a high rate of death of free-roaming dogs. Yet, it should be noted that WHO and the findings of other pertinent researches suggest that killing cannot be the ultimate solution to check the growing size of free-roaming dogs and the subsequent transmission of rabies-causing virus.

Conclusion

The findings of the present research showed that there are significant proportions of free roaming dogs in Mekelle, Asella, Kisumu and Siaya. The retrospective survey revealed a high number of reported rabid dog bite cases in the study areas. Such a high number of rabid dog bite cases in the study areas could be linked to the high number of free roaming dogs in the areas. Furthermore, the questionnaire survey indicated the existence of dogs in most homesteads, loose management of dogs and low level of awareness of the community about the importance of dog vaccination in rabies prevention and control. It is also evident from the findings that schools/friends/neighbors were the major sources of information for the communities about rabies and its zoonotic importance. The role of media was found to be low in disseminating information to the public about this deadly but completely preventable disease.

Acknowledgements

This research project received financial support from One Health Central and Eastern Africa Research Innovations Project (ORIP). The researchers like to acknowledge the generous financial support received from the OHCEA secretariat and ORIP project coordinators to undertake this project. The researchers are also thankful to the study participants and veterinary and public health professionals who facilitated the acquisition of the required information.

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