Dog demography, rabies awareness and dog bite cases in Bishoftu town, Ethiopia

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Abstract

Rabies is a zoonotic viral disease that affects humans and animals and dogs are the primary source of infection. Information on domestic dog populations is vitally important for rabies control. The present study is to assess the demography of dogs, the incidence of dog bites, and the knowledge, attitude, and practice (KAP) of the communities concerning rabies in Bishoftu town. Cross-sectional household surveys were conducted from April to June 2021 involving a questionnaire survey and collection of retrospective patient records from healthcare facilities. A total of 244 respondents were interviewed using a structured questionnaire format to determine their KAP about rabies and dog ownership. Data on the incidence of dog bites and suspected cases of rabies from November 2019 to June 2021 were retrieved from the records of four health centers in Bishoftu town. In interviewed households (HH) 51.2 % owned at least one dog with a dog: human ratio of 1:9 and 1.54 dogs/household. In the participating households, 71% of dogs had been vaccinated against rabies. Almost all, 99% of the respondents had heard of rabies and identified the mode of transmission of rabies. However, 61.8%, had a moderate level of knowledge and 59.8% had an intermediate level of attitude, and 64.3% satisfactory level of appropriate rabies prevention practices score. There was a statistically significant association between knowledge score and age, occupation, and source of information as well as attitude score with age and source of information ($p<0.05$). Respondents who attend higher education were more likely to have higher practice scores in the prevention of rabies ($p <0.05$). There were significant correlations among the participant's knowledge, attitude, and practice ($p<0.01$). A total of 612 victims were registered and received the post-exposure vaccine in Bishoftu over two years (2019 to 2021). We identified critical knowledge gaps related to factors influencing rabies prevention and control. The veterinary and public health sectors should play an important role in educating

and raising community awareness. Moreover, the production and use of the banned nerve tissue vaccine in the public health sector in Ethiopia need attention.

Keywords: Knowledge; Attitude; Practice; Bishoftu; dog demography; Rabies.

Introduction

Dogs have been known to have a close relationship with humans since their domestication which made them a source of several diseases to humans such as rabies (Rinzin *et al*., 2016). Rabies is a deadly viral zoonosis, which causes encephalitis in warm-blooded animals and humans caused by the rabies virus, which belongs to the genus *Lyssavirus*. The virus is transmitted to humans from rabid animals through the bite and sometimes scratches. Despite the invention and application of the rabies vaccine since long time ago, rabies still causes deadly diseases worldwide (Zulu *et al*., 2009) It has been anticipated that about 60,000 people die every year due to canine rabies globally, of which the highest death is in Asia and Africa; dogs (almost 99%) remain the major animal reservoirs in these continents (Undurraga *et al*., 2017).

In Ethiopia, 10 years (1990-2000) retrospective data-based study revealed that annually, on average, about 2200 people received post-exposure anti-rabies treatments and 96.2% of whom were bitten by dogs. During the same period, 322 fatal human rabies cases were recorded and 95% of these were acquired from dogs (Yimer *et al*., 2002). During the next decade (2001-2009) the number of fatal cases increased to 386 ranging from 35 to 58 per year. The magnitude of post-exposure vaccination escalated to 17,204 mostly from Addis Ababa. During this period a total of 3,460 brains were examined from animals involved in human bites and 75% of them were positive. A total of 130,673 doses of rabies vaccine were administered to humans and 85,055 doses were administered to animals during this period (Deressa *et al*., 2010). Moreover, a hospital-based study from the southern Ethiopian pastoral area revealed that 98% of rabies suspected animals bite were due to dog bites (Gum *et al*., 2019).

Dogs are classified as owned, that are restricted within a fenced yard or in the homestead under the owners' supervision, or ownerless/stray dogs that are not under direct human control or not prohibited from freely roaming (Smith *et al*., 2019). In Ethiopia, both owned and ownerless dogs bite humans and con-

tribute to the transmission of rabies. Between the years 2009 and 2011, a total of 1,088 dogs and cats were examined for rabies, of which 73.62% of dogs and 5.1% of cats were found positive. The majority of the rabid dogs were ownerless or those whose ownership was not known (Reta *et al.*, 2014). The annual mortality due to rabies was estimated at 10,000 people making Ethiopia to be one of the worst-affected countries in the world. The incidence, however, varies both temporally and spatially. Dog-borne rabies remains a public health concern in the country, especially in urban settings where there is a large pet dog population (Shite *et al.*, 2015). Studies showed that the dog population in urban areas including Africa (Reece, 2000) creates favorable conditions for the transmission of dog-borne rabies to humans (Baneth *et al.,* 2016; Damborg *et al.,* 2016). It is highly associated with the presence of a large population of uncontrolled and stray dogs (Hampson *et al.,* 2015). Poor public awareness of rabies is considered one of the bottlenecks to the prevention and control of the disease in Ethiopia (Jemberu *et al.,* 2013). In addition, knowledge about dog demography and quantification of rabies-suspected animal bites are relevant for the prevention and control of dog-borne zoonosis as used in several countries, is limited (Gsell *et al.*, 2012; Rinzin *et al.,* 2016; Tiwari *et al.,* 2019).

Rabies is endemic in several parts of Ethiopia. However, data on dog demography such as population densities, population structure, and owner characteristics is extremely scarce. Reliable information on dog demography and ecology is important for developing and implementing vaccination programs and estimating the vaccine coverage needed to control dog-borne rabies (Rinzin *et al*., 2016). In Bishoftu town, the current study area, there are several slaughterhouses and slabs where leftovers are thrown to scavengers, which attract several stray dogs. As a result, there is a large number of roaming dogs in the town. Hence the total dog population of the town is on the rise. This study, therefore, was carried out to identify the status of dog demography, pinpoint the impacts of dog demography on the occurrence of rabies in animals and humans, and assess knowledge, attitude, and practices of the community in Bishoftu town, central Ethiopia.

Materials and methods

Study areas

This study was conducted in Bishoftu town which is located at a distance of 45km southeast of Addis Ababa, Ethiopia (Figure 1). The town is located in Ada'a district, East Shewa zone of Oromia Regional State at 9° N and 40° E having an average altitude of 1850 meters above sea level. The area receives an annual rainfall of 866 mm with bimodal occurrence. The mean annual maximum and minimum temperatures of the area are 26°C and 14°C, respectively, with a mean relative humidity of 61.3%. The town is home to 127,678 people (59,589 men and 68,090 women) (CSA, 2015) and is divided into 14 administrative units. Besides, since the town is surrounded by several beautiful lakes, there are several resorts visited by several non-inhabitants. Although an estimate of the dog population of the town is lacking, there is a large number of dogs in the town.

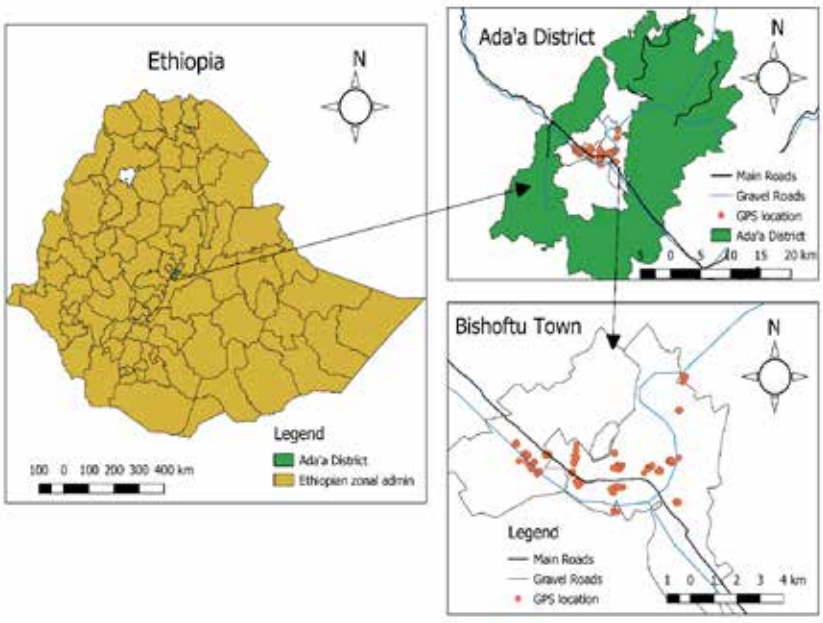

Figure 1. Map of Ethiopia depicting the location of study areas. The specific area where data was collected is depicted using GPS data.

Study design

A community-based cross-sectional study was conducted from April 2021- June 2021 to gather data on dog demography and the community's KAP using a questionnaire. A publicly available map of Bishoftu town was downloaded from Google Earth (https://earth.google.com/web.) and the entire residential areas were divided into non-overlapping approximately equal-sized blocks demarcated by main roads and adjacent blocks were marked using four different colors: red, yellow, blue, and green (Figure 2A). Hence, Bishoftu town was divided into 80 blocks. One of the four colors was randomly chosen using a lottery system. Hence, the blue color was selected. Twenty blocks were identified but due to a shortage of logistics and time, only 16 of the selected blocks were included in this study (Figure 2B). The sixteen selected blocks were physically visited to mark their boundaries on the ground using turning roads and fixed landmarks such as hotels, buildings, and long fences. All living compounds within the marked boundaries in the selected blocks were included in the survey.

Two hundred and forty-four households were interviewed in this study. Only voluntary households were interviewed. The structured questionnaire was prepared and finally populated to Epcollect5 mobile and web application data gathering platform. Both open and close-ended questions were included. The questionnaire was first prepared in English and translated to Afan Oromo and Amharic for appropriateness and clarity in approaching the study participants. Before the interview began, they were briefed about the purpose of the study and were asked for their consent. The questionnaire focused on socio-demographic characteristics of the interviewed household, dog ownership, confinement status of every dog owned by the household, rabies vaccine coverage in dogs, dog-to-human population ratio, factors related to rabies awareness, and dog-related zoonosis, community knowledge on rabies, rabies prevention measures, treatment practices, and animal bite management and healthcare seeking behavior. All the information obtained from the study participants was kept confidential. Then, the responses from respondents were counted and scored. This score was then pooled together, and the mean score was computed to determine the overall KAP of respondents from zero to three with the right answers receiving the highest points.

Retrospective data collection

Retrospective data were retrieved from case books and registries from November 2019 to June 2021 in Bishoftu town. Registered data on dog bites and suspected cases of rabies were collected from the records books of four health stations (Zqual, Cheleleka, Babugaya, and Keta Health Centers) that provide rabies vaccines for the community inhabiting the town. Information on the date of the bite, species of animal which bite, sex of the victim, and body part bitten was retrieved from the patient recording books.

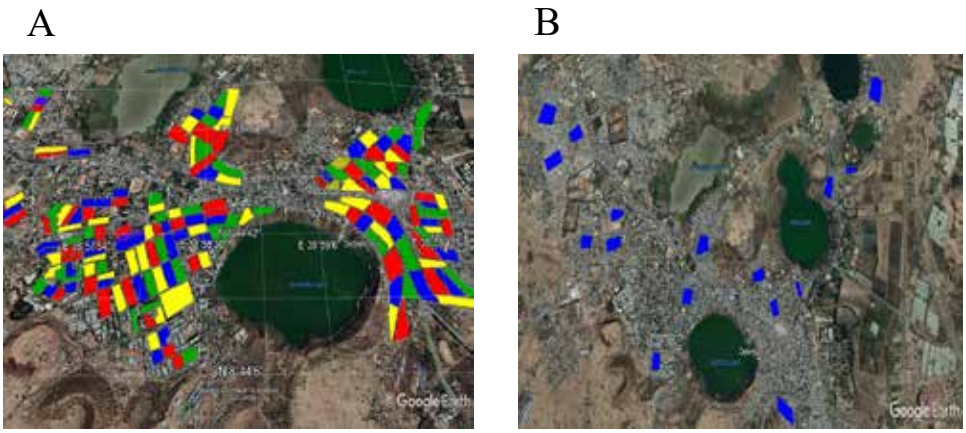

Figure 2. Map of Bishoftu town depicting all blocks and those included in the study: A) 80 approximately equal-sized non-overlapping blocks marked with four different colors; B) the randomly selected 16 Blue colored blocks included in this study

Data analysis

After collecting the data using the Epcollect5 platform, the data was downloaded and converted into Microsoft Excel 2010 spreadsheet and coded. All the descriptive and analytical statistics analyses were performed by using a statistical package for social sciences (SPSS) version 25. Data obtained were presented using tables and charts. Pearson's chi-square test and fisher exact test were used for calculating the association of all independent variables (gender, age, education level, occupation, dog ownership, and source of information on rabies) and each dependent variable (i.e. respondent knowledge, attitude, and practice level regarding the question). Descriptive statistics were used for

calculating the frequency and percentage of both dependent and independent variables. The p-values were used to describe statistical significance (judged as significant when the p-value is less than 0.05). The models were tested for correlations between each dependent variable.

Ethical clearance

This study was approved by the ethical review board of Addis Ababa University, Aklilu Lemma Institute of Pathobiology (Ref ALIPB IRB/16/2012/20, 09 March 2020). Each participant was informed about the aim of the study and verbal informed consent was obtained from each respondent. Participation in the study was voluntary and respondents were free to withdraw from the study at any time. Their consent was recorded (marked) on the questionnaire paper, the interview was anonymous, and data remained confidential throughout the study.

Results

Socio-demographic characters of the participants

A total of 244 households were interviewed during the study period. In study households, the average number of persons per household was 7, ranging from 1-30 per household. The age of the respondents ranged from 14 to 80 with a median age of 35 years. Fifty-nine percent of the respondents were female. Forty-point-two percent of the respondents attended secondary school and 41.8 % of them were college or university graduates (Table 1).

Table 1. The Socio-demographic characteristics of the respondents interviewed in this study

Characteristics	Category	N	%
Gender			
	Male	100	40.98
	Female	144	59.73
Age group			
	Range (Min,-Max)	14-80	
	Median age	35	
	<18	18	7.38
	19-35	73	29.92
	>36	153	62.70
Educational statues			
	No formal educations	15	6.15
	Primary education (1-8 grades)	29	11.88
	Secondary education (9-12 grades)	98	40.16
	Technical / Higher education	102	41.80
Occupations			
	Employed/ Professional	76	31.15
	Private business	58	23.77
	Housewife/ Unemployed	74	30.33
	Student	36	14.75
Head of household (HH)			
	Yes	163	66.80
	HH representative	81	33.2

Dog demography and rabies vaccine coverage

Households owned at least one dog was 51.2 % with a total number of 190 dogs, ranging from 1 to 4 dogs per household. There were on average 1.54 dogs per household. The estimated dog-to-human ratio for the households studied was 1:9. The female: male ratio of dogs was 1 to 3.75. About 71.2% of the HH possess indigenous breeds, whereas 16.8% and 12% were crossbreeds and exotic, respectively. In the present study area, 88% of owners kept dogs for house guarding purposes. Forty-six percent of the households confine their

dogs while 53% of the households let their dogs freely roam and scavenge in the environment.

Of a total of 190 dogs owned by the interviewed households, 71.58% (95% confidence interval [CI]: 64.05 – 77.39), (136) of them were vaccinated against rabies (Table 2). However, only 15 households had vaccination certificates. The respondents disclosed various reasons for not having their dogs vaccinated against rabies which include: distance from veterinary clinics (37%), lack of knowledge about the existence of rabies vaccine for animals (35%), and lack of awareness about the source of vaccines (16.9%). Other reasons include the inability to handle their dogs and fear of behavioral change after vaccination.

Table 2. The demographic structure of the dog population owned by the 125 households included in this study

Variable	Category	N(HH)	%
Sex of dog			
	Male	150	78.95
	Female	40	21.05
Age of dog			
	Adult >1year	180	94.74
	Puppy <1year	10	5.26
Breed			
	Local	136	71.58
	Cross	36	18.95
	Exotic	18	9.47
Source of dog			
	Received as gift	144	75.79
	Bought	30	15.79
	From own bitch	16	8.42
Reason for dog ownership			
	Guard dogs/protection	158	83.16
	Love and affection/pet	32	16.84
Confinement of dog			
	Allow to roaming	102	53.68
	Never allowed to leave the premises	88	46.32

Variable	Category	N(HH)	%
Feeding of dog			
	Household member	169	88.95
	Neighbors /household	15	7.89
	Roaming around	16	8.42
Rabies vaccination status			
	Vaccinated	136	71.58
	Not vaccinated	54	28.42
Housing system			
	Specially constructed house/cage	76	40.00
	Anywhere on the premises	66	34.74
	On house passageway/corridor	48	25.26

Knowledge, Attitude, and Practice of the community concerning rabies

Out of the total respondents, 10.7% of them correctly identified the features of rabies as an infectious disease caused by a virus, and 96.3% of respondents were aware of the transmission of the infection to humans. Only 8.1% of the respondents correctly described the symptoms of rabies in humans and 60% of them described the symptoms of rabies in animals. In this study, 96% of the respondents correctly identified the different modes of transmission of rabies whereas only 5.3% of the respondents were aware of pre-exposure vaccines in humans and 76.6% of them revealed that stray dogs transmit the disease to humans. The data showed that 67.6% of the respondents correctly identified rabies prevention measures, and 34% of them correctly mentioned actions to be taken against rabies suspected animals (Table 3).

Table 3. Knowledge, attitude, and practice of respondents about rabies in Bishoftu, Ethiopia

Code	Questions	Correct answer		Partially correct answer		Incorrectly answered	
		n	%	n	%	n	%
K1	What causes rabies in a dog?	26	10.7	-	-	218	89.3
K2	Is rabies a transmissible disease humans?	235	96.3	-	-	9	3.7
K3	Is rabies a fatal disease in humans and animals?	184	73.4			60	24.6
K4	Which animals can be affected by rabies?	63	26	131	53.7	50	20.5
K5	Which species of animals are sources of rabies to humans?	112	46	91	37	41	16.8
K6	What are the symptoms of rabies in animals?	148	60.7	79	32.4	17	7
K7	What are the symptoms of rabies in humans?	20	8.1	132	54.1	92	37.7
K8	How rabies can be transmitted to humans?	234	96	1	0.4	9	3.7
K9	Do you know the rabies vaccine for humans that work before a dog bite?	13	5.3	-	-	231	94.7
	Attitude question						
A1	Do you think rabies can be cured once the animal show the symptoms	135	54.1	-	-	109	44.7
A2	Do you think rabies can be cured once a person shows the symptoms	74	30.3	-	-	170	69.7

Code	Questions	Correct answer		Partially correct answer		Incorrectly answered	
A3	Do you agree with the statement that stray dogs can cause a problem for human	192	76.6	-	-	52	21.3
	Practice question						
P1	How can rabies be prevented in dogs?	165	67.6	36	14.8	43	17.6
P2	As a first-aid measure, what would you do after a bite?	29	12.1	148	60.7	67	27.4
P3	What action do you take on rabies suspected animals?	83	34.1	152	62.3	9	3.7

K=knowledge, A= attitude, P= practice

The data showed that 61.8%, 59.8 %, and 64.3% of the respondents had a moderate level of knowledge, attitude scores, and appropriate practices, respectively toward rabies (Table 4).

Table 4. Number of questions, range, scores, and levels of knowledge, attitude, and practice regarding rabies

				Level (%) N=244		
Variable	Number of question	Range score	Total score (mean ±SD)	Low	Moderate	High
Knowledge	10	0-15	10.4±2.5	19.3	61.8	18.9
Attitude	3	0-3	2.5±1.2	17.2	59.8	23
Practice	3	0-8	5.5 ±2	17.2	64.3	18.4

Determinants of Knowledge, Attitude, and Practice concerning rabies

The results showed that there was a significant association between knowledge scores and the age of the respondents ($x^2 = 15.027$; p=0.003); those respondents who were older than 36 years had good knowledge than the other respondents (Table 5). Similarly, it was associated with the sources of information ($x^2 = 15.007$; p=0.009). The source of information was significantly associated with attitude score (17.697. p = 0.003) (Table 6).

Table 5. Relationships among knowledge scores on rabies and some key independent Variables between study respondents

	High	Moderate	Low			
Variables	**No (%)**	**No (%)**	**No (%)**		**Df**	**P-value**
Head of households				4.225	2	0.121
Yes	36 (22.09)	101 (61.96)	26 (15.95)			
No	11 (13.58)	50 (61.73)	20 (24.69)			
Sex				0.071	2	0.965
Male	20 (20.00)	61 (61.00)	19 (19.00)			
Female	27 (18.75)	90 (62.50)	27 (18.75)			
Age (year)				15.027	4	0.003
<18	4 (22.22)	9 (50.00)	5 (27.78)			
19-35	7 (9.59)	44 (60.27)	22 (30.14)			
>36	36 (23.53)	98 (64.05)	19 (12.42)			
Education status				11.598	12	0.479
No formal educations	2 (13.33)	11 (73.33)	2 (13.33)			
Primary education (1-8 grades)	4 (13.79)	19 (65.52)	6 (20.69)			
Secondary education (9-12 grades)	18 (18.37)	65 (66.33)	15 (15.31)			
Technical / University	23 (22.55)	56 (54.90)	23 (22.55)			
Occupation				9.721	6	0.137
Employed/ Professional	17 (22.37)	50 (65.79)	9 (11.84)			
Privet business	11 (18.97)	37 (63.79)	10 (17.24)			
Housewife /Do not have work	14 (18.92)	46 (62.16)	14 (18.92)			
Student	5 (13.51)	18 (48.65)	14 (37.84)			
Dog ownership				2.250	2	0.325

	High	Moderate	Low			
Variables	**No (%)**	**No (%)**	**No (%)**		**Df**	**P-value**
Yes	28 (22.40)	72 (57.60)	25 (20.00)			
No	19 (15.97)	79 (66.39)	21 (17.65)			
Source of information				15.007	6	0.009
Formal	11 (29.73)	24 (64.86)	2 (5.41)			
Informal	31 (16.23)	118 (61.78)	42 (21.99)			
Mixed source	4 (33.33)	8 (66.76)	0.00			

Table 6. Relationship between rabies attitudes score and some significant independent variables among study participants

	High	Moderate	Low			
Variables	**No (%)**	**No (%)**	**No (%)**		**Df**	**P-value**
Head of households				4.162	2	0.125
Yes	27 (16.6)	112 (68.7)	24 (14.7)			
No	18 (27.2)	45 (55.6)	18 (22.2)			
Sex				0.827	2	0.830
Male	18 (18)	63 (63)	19 (19)			
Female	27 (18.8)	94 (65.5)	23 (16)			
Age (years)				9.133	4	0.072
<18	5 (27.8)	9 (50)	4 (22.2)			
19-35	17 (23.3)	39 (53.4)	17 (23.3)			
>36	23 (15)	109 (71.2)	21 (13.7)			
Education status				12.333	6	0.060
No formal educations	1 (6.7)	6 (40)	8 (53.3)			
Primary education (1-8 grades)	6 (20.7)	17 (58.6)	6 (20.7)			

	High	Moderate	Low			
Variables	**No (%)**	**No (%)**	**No (%)**		**Df**	**P-value**
Secondary education (9-12 grades)	18 (18.4)	65 (66.3)	15 (15.3)			
Technical / University	20 (29.6)	67 (65.7)	15 (14.7)			
Occupation				4.175	6	0.678
Employed non-health Professional	17 (22.4)	48 (63.2)	11 (14.5)			
Privet business	12 (20.7)	37 (63.8)	9 (15.5)			
Housewife /Do not have work	8 (12.2)	51 (68.9)	14 (18.9)			
Student	7 (19.4)	21 (53.3)	8 (22.2)			
Dog ownership				4.099	2	0.129
Yes	22 (17.6)	87 (69.6)	16 (12.8)			
No	23 (19.3)	70 (58.8)	26 (21.8)			
Source of information				17.697	6	0.003
Formal	5 (13.5)	30 (81.1)	()			
Informal	35 (18.3)	120 (62.8)	36 (18.8)			
Mixed source	5 (41.7)	6 (50)	1 (8)			

Both levels of education and sources of information were associated with practice scores (12,333. p = 0.046 and 17,697. p = 0.003), respectively (table7)

Table 7. Relationship between rabies preventive practice scores and some significant independent variables among study participants

	Good	Satisfactory	Low			
Variables	**No (%)**	**No (%)**	**No (%)**		**Df**	**P-value**
Head of households				4.162	2	0.125
Yes	27 (16.6)	112 (68.7)	24 (14.7)			
No	18 (22.2)	45 (55.6)	18 (22.2)			

	Good	Satisfactory	Low			
Variables	**No (%)**	**No (%)**	**No (%)**		**Df**	**P-value**
Sex				0.380	2	0.827
Male	18(18)	63(63)	19 (19)			
Female	27(18.8)	94 (65.3)	23 (16)			
Age (year)				9.133	8	0.051
<18	5 (27.8)	9 (50)	4 (22.2)			
19-35	17 (23.3)	39 (53.4)	17 (23.3)			
>36	23 (15)	109 (71.2)	21 (13.7)			
Education status				12.333	6	0.046
No formal educations	1 (20.7)	6 (40)	8 (53.3)			
Primary education (1-8 grades)	6 (20.7)	17 (58.6)	6 (20.7)			
Secondary education (9-12)	18 (18.4)	67 (68.4)	13 (13.3)			
Technical / University	20 (19.6)	67 (62.7)	15 (14.7)			
Occupation				3.936	6	0.691
Employed/ Professional	17 (22.4)	48 (63.2)	11 (11.5)			
Privet business	12 (20.7)	37 (63.8)	9 (15.5)			
Housewife /Do not have work	9 (12.2)	51 (68.9)	14 (19.9)			
Student	5 (13.5)	18 (48.6)	14 (37.8)			
Dog ownership				4.099	2	0.129
Yes	22(17.6)	87(69.6)	16(12.8)			
No	23(19.3)	70(58.3)	26(21.8)			
Source of information				17.697	6	0.003
Formal	5 (13.5)	30 (81.1)	2 (5.4)			
Informal	35 (18.3)	120 (62.8)	36 (18.8)			
Mixed source	5 (41.7)	6 (50)	1 (8.3)			

KAP correlation analysis

Linear correlation analysis was done based on individual scores to determine the relationship between Knowledge, Attitude, and Practice. There was a significant positive correlation between Knowledge and Attitude ($p< 0.01$), between knowledge and practice ($p<0.05$), and between attitude and practice ($p=0.007$). People with good knowledge scores had a good score for attitude and practice than others.

Results of retrospective survey on animal bite cases in humans during 2019-2021

During the period from November 2019 to Jun 2021, a total of 612 bites by rabies suspected animals were recorded in Bishoftu town all of whom received post-exposure vaccines. The average incidence of bite cases was 204 cases per year. A total of 355 (58.01 %; CI: 53.98, 61.95) of the victims were male and 257 (41.99 %; CI: 38.05, 46.02) were female (Table 8.). Individuals aged between 14 and 29 years were most commonly bitten by dogs followed by those aged between 30 and 64 years whereas the lowest bite cases were recorded in older individuals. The results of this study also showed that the leg (68%) was the most commonly bitten body part, followed by the hand (22.7%), face (4.8%), thigh (2.8%), abdomen (0.9%), and breast (0.8%). Out of the 612 rabies/bite cases, 608 (99.35 %; CI: 98.34, 99.82) of them were by dogs, 2 (0.33; CI: 0.04, 1.18) were by cats whereas donkey and horse inflicted 1 case each.

Table 8. Gender and age-wise distribution of rabies cases in humans (2019-2021)

Age in year	Gender		Total (%)
	Number of Males (%)	Number of Females (%)	
≤5	31 (5.1)	18 (3)	49 (8.1)
6-13	88 (14.3)	64 (10.4)	152 (24.8)
14-29	128 (21)	87 (14.2)	215 (35.2)
30-64	97 (15.8)	79 (13)	176 (28.8)
≥65	11 (1.8)	9 (1.4)	20 (3.2)
Total	355 (58.01)	257 (41.99)	612 (100%)

Discussion

Dog demography and vaccination coverage

Rabies remains an important disease both in humans and animals in the study area where the Fermi-type vaccine has been widely used. The knowledge of the dog population and demography is essential for planning an effective control of dog-transmitted rabies. During this study, about 190 dogs were found in the homestead of the selected households. That is, more than half of the households surveyed own dogs. This suggests the potential for the spread of rabies in such very crowded residential areas in which dogs roam freely. Similar dog ownership structures were previously reported in Ethiopia although the proportion of households owning dogs varies. For instance, a slightly higher proportion was reported from the West Shoa zone of the Oromia Region 65.1% (Gebremedhin *et al*., 2020). In contrast, a lower proportion of dog ownership was reported from Karayu pastoralism in Eastern Ethiopia 33 % (Tschopp *et al*., 2016). Elsewhere in Africa, 79.6 % of the population own dogs in Côte d'Ivoire (Kallo *et al*., 2020), 63 % in Kenya (Kitala *et al*., 2001). Initially, all households were visited to collect information on dog ecology and demography based on WHO guidelines and to collect serum for rabies antibody detection. A second visit was made 1 year later, to obtain follow-up data on births, deaths, dog movements and other events since the first visit. Dog ownership was common, with a range of 53--81% (mean=63%, 14 % in Tanzania (Gsell *et al*., 2012) such information is still rare for African domestic dog populations, particularly so in urban areas. This study describes the demographic structure and population dynamics of a domestic dog population in an urban sub-Saharan African setting. In July to November 2005, we conducted a full household-level census and a cross-sectional dog demography survey in four urban wards of Iringa Municipality, Tanzania. The achievable vaccination coverage was assessed by a two-stage vaccination campaign, and the proportion of feral dogs was estimated by a mark-recapture transect study. The estimated size of the domestic dog population in Iringa was six times larger than official town records assumed, however, the proportion of feral dogs was estimated to account for less than 1% of the whole population. An average of 13% of all households owned dogs which equalled a dog:human ratio of 1:14, or 0.31 dogs per household or 334 dogs km-2. Dog female:male ratio was 1:1.4. The average age of the population was 2.2 years, 52% of all individuals were less than one year old. But mortality within the first year was high (72%, 17% in South Africa (Conan *et al*., 2015) and 35 % in Ghana (Tasiame *et al*., 2019) this information is unavailable in Ghana. This study describes dog population structure in Kumasi, Ghana. A

household cross sectional survey was conducted from January through April 2016 in Ayeduase and Kwame Nkrumah University of Science and Technology (KNUST). The reported variation between studies and countries may be due to variations in sociocultural attitudes to keeping the dog, population density, agroecology, and livelihood.

The survey showed that 71.0% of the dog population was vaccinated with the anti-rabies vaccine, which is according to the recommendations of the World Health Organization for the control of canine rabies. The vaccine coverage reported in this study is higher than the vaccine coverage reported in other African countries such as Congo (24.0%), Malawi (59.0%), Nigeria (47.9 %), Chad (0.5 %), South Africa (56.0%), Madagascar (22.0%), Kenya (29.0%) and Zambia (20.0%) (De Balogh *et al*., 1993; Jonasson, 2014; Kitala *et al*., 2001; Mbilo *et al*., 2019, 2017; Ratsitorahina *et al*., 2009)190 households were interviewed. In the urban study area (Mutendere, a low income suburb of Lusaka. The higher vaccine coverage in the current study area may be due to the rabies vaccination campaign by the College of Veterinary Medicine and Agriculture, the availability of rabies vaccine at the National Veterinary Institute in Bishoftu, and the provision of door-to-door vaccination by private veterinary practitioners. Moreover, the price of anti-rabies vaccines is also within the reach of average people (ETB 100 – 150 which is equivalent to USD 2 – 3) per dose of the vaccine, which has contri*but*ed to adequate vaccine coverage. In most African countries where dog vaccination is not free, dog owners are generally unwilling to pay for dog rabies vaccination because they see no direct economic and/or health benefits. This is supported by the fact that the vast majority of humans who have been bitten were not bitten by their dogs (Jibat *et al*., 2015) where the majority of the human cases results from dog bites. Mass dog vaccination is considered to be the most effective method to prevent rabies in humans. Our objective was to systematically review research articles on dog rabies parenteral vaccination coverage in Africa in relation to dog accessibility and vaccination cost recovery arrangement (i.e.free of charge or owner charged. Even though in the present study the dogs' vaccine coverage in Bishoftu town is 71% and within the range of disrupting urban rabies transmission in African cities (Zinsstag *et al*., 2017)dog-transmitted human rabies persists and has reemerged in Africa. Two consecutive dog vaccination campaigns took place in Chad in 2012 and 2013 (coverage of 71% in both years the present retrospective survey of rabies-suspected bites in four health centers in Bishoftu, 99.4% of them were bitten by dogs. This may be due to the current vaccine coverage did not include

ownerless dogs and free-roaming dogs, which may sustain rabies transmission in the area.

In the present study, the average number of dogs per household was 1.54. A comparable result was reported from the Philippines, 1.8 dogs/household, while variable results were reported from Ethiopia 1.1 dogs/household (Gebremedhin *et al.,* 2020), Philippines 1.21 dogs/household (Dizon *et al*., 2022) and Nigeria 1.1 dogs/household (Kwaghe *et al.*, 2019). The observed differences between studies and countries may be due to socio-cultural ties between dogs and humans in different societies. It is these close ties, if not handled carefully and appropriately, that result in the incidence of rabies. For example in developed countries where there are strict dog ownership regulations and awareness about the importance of veterinary services and certification, the incidence of dog-borne rabies is low. In contrast, although the mean number of dogs per household is similar, the incidence of rabies is higher in developing countries due to a lack of regulations, sufficient veterinary services, and certifications. In addition to the average number of dogs per household, the dog: human ratio (1:9) observed in this study was comparable with reports from Ethiopia 1:7 (Gebremedhin *et al.,* 2020), Tunisia 1:11 (Kalthoum *et al.,* 2021) and Nigeria 1.1: 6 (Kwaghe *et al.,* 2019). The observed differences may be due to differences in human and dog population density in the given communities and countries. Ninety-four percent of the dog population in the study area were adults and 78 % were male, which is in agreement with the observations reported in sub-Saharan Africa(Conan *et al.*, 2015; Mauti *et al.,* 2017; Mbilo *et al.,* 2019; Ratsitorahina *et al.*, 2009; Sambo *et al.*, 2018). In our study, the majority of the community prefers to own a male dog over a female dog, which may be due to the perception of considering a male dog as an effective guard dog or maybe to control breeding, since female dogs give birth to more puppies in a short period. We also observed the predominance of male dogs in our study. Some studies explain the predominance of male dogs in Tanzania and South Africa (Conan *et al*., 2015; Knobel *et al*., 2008).

Community Knowledge Attitude and Practice (KAPs) on rabies

In this study, the overall KAP revealed that the majority of the respondents had a moderate level of knowledge, attitude, and appropriate practices toward rabies. A moderate level of knowledge and attitude is an attribute that can be considered for the control of rabies. Since the community had a moderate level of knowledge it would be easier to participate in the control activities. This

study also identified factors responsible for positive practices and knowledge related to rabies. For example, 52.0% of the respondents in this study had attained primary and secondary schools, which helped them to understand the disease. Similar results have been reported elsewhere in the world such as in Rwanda, Kenya, Tanzanian, and India (Ntampaka *et al*., 2019; Sambo *et al*., 2014; Sivagurunathan *et al*., 2021). The survey revealed that the communities are well aware of rabies. This finding was consistent with results from northern Ethiopia (Gebeyehu and Teshome, 2016) and Tanzania (Sambo *et al*., 2014). In contrast, this finding is lower than the study conducted in Kombolcha, Southern Wollo (Gebremeskel *et al*., 2019), Philippines (Davlin *et al*., 2014), Thailand (Kongkaew *et al*., 2004), Cambodia (Lunney *et al*., 2012). However, it is higher than the study conducted in the Dedo district of the Jimma zone (Abdela *et al*., 2017). These differences may be due to differences in the source of information, the composition of the selected population, and the way by which the information was collected.

The majority of respondents identified bite as a means of disease transmission and also many participants (44%) believed that any direct or indirect contact with saliva could transmit rabies. Fifty-point-four percent (50.4 %) of the respondents, mentioned water and feed shortages and being exposed to a long drought be associated with the disease. This idea is most likely explained by the belief that stress such as hunger and thirst may induce the development of clinical rabies in asymptomatic carrier dogs (Wilde *et al*., 2005) nevertheless, remains a public health threat in many parts of the world. Lack of motivation by governments, cultural issues and inadequate funding remain barriers. This is amazing since the number of human rabies deaths worldwide is greater than that from polio, meningococcal meningitis, Japanese encephalitis, yellow fever, SARS, bird flue and other scourges that attract more attention. Safe and effective vaccines are now widely available. Reduced dose effective and less expensive post-exposure vaccination regimens have helped eliminate nerve tissue vaccines in Thailand, Philippines and Sri Lanka. India and Pakistan, the major users of dangerous nerve tissue derived Semple type vaccine, are now considering following suite. Immediate wound care and prompt use of a potent vaccine will save a majority of infected persons. Rabies immunoglobulin, injected into and around bite wounds, provides added safety for the severely exposed. The high cost of rabies immunoglobulin and tissue culture vaccines are remaining barriers, but new manufacturers and the use of intradermal vaccination schedules can reduce costs. Ultimately, it is the need to control

rabies in dogs that must occupy most of our attention. The tools are available, but attitudes must change before they can be applied. There have been many new developments since publication of the last WHO rabies expert committee report in 1992 (new version in print. However, the idea of clinical rabies development is a controversial issue (Jemberu *et al*., 2013) we estimated the incidence of rabies in humans and domestic animals, and assessed the people's awareness about the disease in North Gondar zone, Ethiopia. The incidence of rabies in humans and domestic animals was prospectively followed up for one year period based on clinical observation. A questionnaire was also administered to 120 randomly selected dog owners and 5 traditional healers to assess the knowledge and practices about the disease. We found an annual estimated rabies incidence of 2.33 cases per 100,000 in humans, 412.83 cases per 100,000 in dogs, 19.89 cases per 100,000 in cattle, 67.68 cases per 100,000 in equines, and 14.45 cases per 100,000 in goats. Dog bite was the source of infection for all fatal rabies cases. Ninety eight percent of the questionnaire respondents were familiar with rabies and mentioned dog bite as a means of transmission. But discordant with current scientific knowledge, 84% and 32% of the respondents respectively mentioned any type of contact (irrespective of skin condition.

The public needs to be aware of the signs of rabies to identify suspected animals and take appropriate measures, such as informing the veterinary personnel. Most of the study participants correctly described the symptoms of rabies in animals. An accurate description of the clinical signs of rabies reported by the study population shows that the disease is among the predominant problems in the study area. The majority of respondents mentioned paralysis as a possible sign of rabies, which is typical of the "dumb" or paralytic form of rabies. This may be cases of paralytic rabies being detected. However, only 8.1% of respondents correctly mentioned symptoms of rabies in humans. Human rabies has a non-specific clinical manifestation, which can lead to a misdiagnosis of the disease (Mbilo *et al*., 2017). In contrast, although rabies is invariably fatal once clinical signs develop in both animals and humans, 70% of the respondents to this survey were unaware that rabies is fatal.

Many of the respondents exhibited a lack of detailed knowledge about the prevention of rabies and the risks associated with its occurrence. According to WHO guidelines, wounds must be washed with water and soap for 15 minutes and disinfected immediately before being admitted to the hospital. It helps

to remove animal saliva from bite sites and reduce viral load. We found that the majority of respondents had no awareness of the importance of immediately washing wounds with water and soap. Similarly, only 12.0% of the respondents were aware of first aid measures that should be taken after an animal bite. Studies conducted in Tanzania, Uganda, Chad, South Africa, India, and Pakistan where rabies is endemic, also showed that a lower proportion of people practice wound washing with soap and water (Hergert and Nel, 2013; Ichhpujani *et al*., 2008; Mbilo *et al*., 2017; Sambo *et al*., 2014) a disease of antiquity continues to be a major public health problem in India. Multiple factors contribute to high mortality and morbidity due to animal bites. An effective strategy for control of rabies takes into account the epidemiology of animal bites, rabies and factors influencing post exposure treatment. The study was carried out as a part of Agreement for Performance of Work (APW). In this study, two-thirds (67.6 %) of the participants knew that vaccinating dog is an effective measure to prevent rabies in humans and animals. Restriction of movement of dogs, killing stray dogs and preventing dogs from starving, hunger, and drought are also mentioned as rabies prevention measures. The level of practice toward rabies prevention measures among the study participants was satisfactory.

Schoolmates, friends, family members, and neighbors played a more significant role in disseminating information about rabies than mass media, health centers, and veterinary services. In this study, the majority of the respondents showed that they gained knowledge about rabies from the informal sources mentioned here. In consent to our observation, a study carried out in Côte d'Ivoire (Tiembré *et al*., 2014) revealed that 82.9 % of the study participants knew about rabies and 88.6 % of them revealed that the sources of information were schools. This demonstrates the important roles that schools play in creating awareness about rabies. The medical and veterinary services did not play an important role in disseminating information. However, the community in the study area practices inadvertent killing of rabies suspected dogs without the knowledge of veterinary authorities, obscuring the diagnosis and surveillance of the disease. Similar findings were also reported in Ethiopia (Gebeyehu and Teshome, 2016), Kenya (Muriuki, 2016), and Congo (Mbilo *et al*., 2019).

Animal bites cases in humans

The incidence of bites by rabies-suspected animals reported in this study is considerable. In the absence of appropriate diagnosis and surveillance programs the bites, most of the time result in rabies. Since society mostly kills suspected dogs, it is inevitable to provide post-exposure vaccines to the victims. This contributes to the huge health and economic burden associated with rabies. This finding is similar to the report of Beyene *et al.* (2018).In contrast, it is lower than what was reported in Addis Ababa (Aklilu *et al*., 2021). Males were most frequently bitten than females. Similar observations were reported in other parts of Ethiopia (Aklilu *et al*., 2021), Nigeria (Ikye-Tor *et al*., 2020), Tanzania (De Nardo *et al*., 2018)many endemic countries are not able to assess their rabies burden and implement appropriate solutions. This study reports the incidence of animal bites considered at risk of rabies transmission, along with rates and determinants of the adherence to post-exposure prophylaxis (PEP, and the USA (Tuckel and Milczarski, 2020). This could be attributed to the outdoor activities in which male individuals are engaged, whereas females are more likely to remain indoors for socio-cultural and religious reasons. Most bites occurred in individuals who were older than 14 years as this is the productive age when most individuals especially males are engaged in various activities and are exposed to stray and roaming dogs and other carnivores. We also observed that most of the dog bites were on the legs and hands. It is a fact that these body regions are most likely used by people to protect themselves from dog attacks (Guy *et al*., 2001)their homes, and their victims were gathered in a detailed telephone survey of general veterinary clientele in the Canadian provinces of New Brunswick, Nova Scotia, and Prince Edward Island. All of the dogs had bitten either someone living in the same household, or someone who was a frequent visitor and was well known to the dog. There were 117 male and 110 female dogs included in this case series. Significantly more female dogs were neutered (p=0.03.)

In addition, post-exposure prophylaxis was given to victims bitten, without confirmation of the rabies status of the animal. Three types of rabies vaccines are available; outdated nerve tissue vaccines, cell culture vaccines, and embryotic egg vaccines. The cell culture and embryonated egg vaccines are the ones recommended for use by WHO. They are considerably safer and well-tolerated. In developed countries, nerve tissue vaccines have been replaced by cell culture and embryonated egg vaccines. In contrast, nerve tissue vaccines can

cause severe adverse reactions that can last for 4–7 months in 0.03–0.08% of cases, including the risk of rabies due to incomplete virus inactivation, are less immunogenic and also contribute to vaccine failure. The World Health Organization has banned this vaccine since 1980. However, in developing countries, including Ethiopia, the mammalian neural tissue vaccine is still widely used and needs attention. While cell culture is effective and immunogenic, however, it is also expensive (Beyene *et al*., 2018) there is a need for quantitative data on the public health burden and costs of diseases to support intervention prioritization. This study aimed at estimating the health burden and post-exposure treatment (PET).

Limitations of the study

The demography of stray dogs was not included in the present study and the relatively small sample size used in our study may affect the quality of the work.

Conclusions

Although the overall level of knowledge, attitude, and practice towards rabies of the majority of the respondents were moderate and, was gained from informal sources, there are still KAP gaps regarding preventive measures, the deadly nature of the disease, and lack of awareness of the first aid measures to be taken after a case of rabies suspected animal bite. Furthermore, this study showed the presence of high dog populations with the potential to cause health and economic burdens in Bishoftu town. A high incidence of rabies-suspected animal (dog) bites was recorded in the study town. Production and use of banned nerve tissue vaccine in Ethiopia need government attention to replace the recommended vaccine.

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