

Research Article

Estimation of Owned and Street Dog Population by Questionnaire Survey and Mark-Recapture Method in Three Urban Areas: Bishoftu, Dukem and Modjo Towns

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The understanding of the structure of free-roaming and owning dog population's estimation is of extreme importance for the planning and monitoring of dog population control strategies, animal welfare and health. The methods used to estimate the abundance of this group of dogs are more complex than the ones used with domiciled owned dogs. We point to enhancements necessary for the implementation of the studies and to potential updates and revisions to the recommendations of the World Health Organization with respect to the estimation of free-ranging and owning dog populations. Rabies is a fatal viral disease of animals and people. People usually infected via bites from an infected animal (e.g. dog). Post Exposure Prophylaxis (PEP) has to initiate immediately after bite wounds of suspected rabid animals in order to avoid fatalities. The situation of rabies poorly known in Ethiopia. Questionnaire survey was conducted in selected blocks in Dukem, Bishoftu and Modjo towns in order to capture information on dog population size estimates using mark-resight surveys has provided useful baseline data for understanding the population dynamics of dogs at the study sites. Mark-resight surveys provide useful information for designing and managing the logistics of dog vaccination or assessing vaccination coverage and for evaluating the impact of neutering programs on the size and structure of dogs' populations over time. As part of a dog born zoonosis disease risk assessment project, surveys conducted to estimate the size of the dog population and to describe dog management practices of households belonging to different ethnic groups. A marked-recapture method employed and the number of unowned dogs estimated. A total of 599 dog owning households and 276 non-dog household interviewed from at selected 19 blocks at study sites. Owned dogs were more likely male, local breed and for the purpose of used to guard. These households kept their dogs either fully restricted, semi and free roaming but full restriction have reported only at the higher percentage of the total dog households. By counted method, study the ownerless dogs higher than owning and semi-restricted dogs.

Keywords: Estimate *dog population*; *free roaming dog*; *Rabies***Introduction**

The domestic dog (*Canis familiaris*) is the most numerous carnivores in the world [15]. Dogs recognised to play a role in about 100 zoonotic diseases [49]. They have also been implicated as the source of infection for several disease outbreaks affecting wild carnivores, including Canine Distemper Virus (CDV) and rabies [12,21], which have caused epidemics in wild populations [24,39].

Dogs are closely associated with humans, kept by households as companions and often considered as part of the family, especially in developed countries [46]. In some communities, for instance indigenous communities in Australia and some ethnic groups in Indonesia, dogs play an important role in the culture of the community [36]. However, when dogs not fully provided with food and shelter, then they will roam if not confined. Semi-roaming and free-roaming dog populations can create risks for public health due to zoonotic diseases, such as rabies [41]. Thus, understanding the

dog-human relationship in a community is critical for planning rabies prevention and control. The demographic characteristics of host populations have a profound impact on the transmission and maintenance of microparasites (Grenfell and Dobson, 1995).

Although a great percentage of dogs are domiciliary and restricted, there are still a great percentage of dogs continuously circulating on the street [28] forming specific population groups, which named free roaming, stray, wandering, not domiciled or unrestricted. Stray dogs considered the primary victims of irresponsible owners who reject their pets into the streets [2].

The existence of free-roaming dogs considered an important problem, not only for the animal welfare but also for Public Health [22]. Adequate estimates of the size and of the characteristics of the population of free-roaming dogs are essential in planning and monitoring the effectiveness of strategies adopted for the control and for the welfare of the population [19], for the management of risks

associated with their presence [16] and to quantify the prevalence of zoonosis and other diseases present in these animals. The methods used to estimate the abundance of domiciliary dogs, such as the assessment of veterinary records or sampling based on questionnaires to owners, are useful to estimate the abundance of free-ranging dogs [40].

Internationally, the control and prevention of urban rabies has been based on dog vaccination and population management [37]. Both vaccination and population control programs require data on the distribution and numbers of free-roaming dogs. Thus, estimation of the free-roaming dog population size is a necessary first step in planning rabies control programs [3]. I initiated to study this title due to the presence of increased free roaming dog population in the study towns and conditional risk of dog borne diseases.

A. Therefore, the objective of this study was General objective of the study

To identify and improve public health and welfare of owned and stray dog population by reduce numbers of stray dogs to an acceptable level in the study area.

B. Specific objectives of the study

1. To estimate the dog population to enable devising realistic plans for dog population management, zoonosis control and monitoring the success of future interventions.

2. To estimate the total dog population with owners and street dog in order to enable better planning of the control actions against diseases involving these animals.

Materials and Methods

Study Area

The study conducted in three towns found in central Ethiopia: from February to May 2017 in Dukem, Bishoftu and Modjo towns. Dukem is a town in central Ethiopia. It named after the Dukem River. Located in the Oromia Special Zone Surrounding Finfinne of the Oromia Region, 37 kilometers southeast of Addis Ababa and 10 kilometers northwest of Bishoftu, this town has a latitude and longitude 08N,48N and 38E,54E respectively and an elevation of 1950 meters above sea level and the climate is warm and temperate. The summers here have a good deal of rainfall, while the winters have very little. The average annual temperature is 18.7 °C and the average rainfall is 907 mm. Based on the Central Statistical Agency in 2005, Dukem has an estimated total population of 8,704 of whom 4,095 are men and 4,609 are women [23].

Bishoftu is a town and separate woreda of Ethiopia, lying southeast of Addis Ababa. It formerly known as Debre Zeyit, However since the late 1990s it officially known by the Oromo name, Bishoftu [31]. This was its name until 1955. The town is located in the Misraq Shewa Zone of the Oromia Region, Bishoftu is located 47.9 kilometres southeast of Addis Ababa [23]. A cluster of volcanic crater Lakes and popular spiritual sites found around the town characterizes Bishoftu's tourist offer. Because of its low altitude up to 1850 masl, Bishoftu for the Oromo people at Lake Hora has a warm climate. The major resort lakes are Lake Hora Arsade, Lake Bishoftu, Lake Babogaya, Lake Kuriftu, Lake Kilol and Lake Magarsa. The 2007 national census

reported a total population for Bishoftu of 99,928, of whom 47,860 were men and 52,068 were women. The majority of the inhabitants said they practiced Ethiopian Orthodox Christianity with 79.75% of the population reporting they observed this belief, while 13.82% of the populations were Protestant and 4.98% of the populations were Muslim [5].

The three largest ethnic groups reported for this town were the Amhara (42.86%), the Oromo (39.4%) and the Gurage (8.3%), all other ethnic groups made up 9.44% of the population. Amharic spoken as a first language by 71.95% and 20.12% spoke Oromiffa, the remaining 7.93% spoke all other primary languages reported (Population and Housing Census of Ethiopia, 1994). The climate here is mild, and generally warm and temperate. In winter, there is much less rainfall in DebreZe it than in summer. The average annual temperature in DebreZe it is 18.7°C. In a year, the average rainfall is 892 mm [5].

Modjo is a town in central Ethiopia, named after the nearby Modjo River. Located in the Misraq Shewa Zone of the Oromia Region, it has a latitude and longitude of 8°39'N39°5'E with an elevation between 1788 and 1825 meters above sea level and climate here is mild, and generally warm and temperate. When compared with winter, the summers have much more rainfall. The average annual temperature in Modjo is 20.1°C and the rainfall here averages 863 mm. Based on the Central Statistical Agency in 2005, Modjo has an estimated total population of 39,316 of whom 19,278 were males and 20,038 were females [14].

Study Design and Sampling

A cross-sectional study conducted from January to May 2017 in three town sin Dukem, Bishoftu and Modjo towns to estimate dog population to inform Rabies Prevention and control. The google map of each study town was downloaded from google website and the entire regions of the towns were divided in to non-overlapping an approximately equal sized blocks surrounded by wide asphalt or cobblestone roads on the map. Then each block was marked with four different colors and one of the colors randomly selected by lottery system. Since the work requires three persons per block including two enumerators to fill the questioners and conduct dog count, one 'Keble' or local administration representative and to mark dogs and dog owning households and limited human resource availability to include all selected 60 blocks of Bishoftu town, a random selection was made by lottery system and 15 selected blocks of 60 green colored blocks of Bishoftu were renumbered 1-10 and included in the study. The selected areas then visited to mark their boundaries on the ground using turning roads and fixed permanent posts such as hotels, building and long fences etc. as markers. The selected areas were non adjusted to be within one by two kilometer square when the boundaries made on the map larger than what can be covered by two surveyors, who administering questionnaires one whole day and conduct dog counts on the next day both in the morning from 6:00 to 8:00 AM and in the afternoon from 5:00 to 7:00 PM.

Questionnaire Design and Implementation

A structured questionnaire designed to obtain data on number of dogs owned, dog function, dog management and dog bites from dog-owning households. The questionnaire developed in English and translated into Amharic and oromiffa. Then back to translate from



Figure 1: During estrus, cycle marked outside.

Amharic and or omifa into English by a member of the research team. The questionnaire survey conducted from January to May 2017. The team had a one -day training to become familiar with the dog-management questionnaire.

The questionnaire administered via a face-to-face interview with the person responsible for the dog management at the household residence. The interviews were completed within 3 to 5 minutes were given to participants on completion of the interview and participants provided written informed consent to participate in this study.

Mark -Recapture (MR) and Counted Methods

After the MR conducted for one day and counted the next consecutive days. Mark took place on the first day at 6:00-8:00 am when most stray dogs were present in the public areas and count the visible dogs while walking through the communities. Locations and number of dog also recorded. Similar activities repeated at the same period on the afternoon. Dogs then identified by characteristics, including type of color seen in the photographs as well as color of the mark. In Bishoftu, Dukem and Modjo District, the most feasible time was at night from 6:00 pm to 1:00 pm and the feasible time was early morning between 6:00 am and 8:00 am, when traffic was minimal and natural light sufficient for observations (the lack of street lighting at this site prohibited dog counting at night-time). The counting carried out at each location on two consecutive days. The target dogs for the dog counting activity were unowned dogs defined as being free to roam and having no identifiable owner. As distinguishing free-roaming owned dogs from unowned dogs was challenging, dog owners (through kebele leaders during community gatherings) at these sites asked to doghouse holder their dogs during the dog-counting activity. However, confined owned dogs were not included in the MR since the method only allows counting the dogs that can be marked outside the houses. The number of dogs derived between capture and recapture differentiated, counted and recorded.

Data Management and Analysis

The data collected from the study area was enter into Micro soft ware Excel spreadsheets (windows) and analyzed by using STATA for Windows (Version 13) statistical software. The percentage of owned and stray dog population calculated for all data as the number of owned and stray dog individuals divided by the number of sampled individual $\times 100$. In all of the analysis, 95% confidence intervals and

P-value was held at <0.05 for significance.

Results

599 dog-owning households and 276 non-dog households interviewed in the study towns. Each household in selected blocks will be visited in the morning and all owned dogs were marked with paint suitable for animal marking that could be visible from distance and then the streets were visited in the afternoon the same day and the next day in the AM to re-sight and count all dogs found in the streets of selected blocks. Then the dogs were recorded based on the location of re-sight (in the compound, out of the compound), (marked, not marked), reproductive status (male, female, puppy).

Dog Ownership

For 599 dog-owning households interviewed. In Dukem, Bishoftu and Modjo towns, the households comprise the total number of dogs surveyed, among the study towns dog-owning households, 413(68.95%) owned one dog, 147(24.54%) owned two dogs, 24(4.01%) owned three dogs, 11(1.84%) owned four dogs, 1(0.17%) owned five dogs, 1(0.17%) owned six dogs and one(0.17%) owned nine dogs.

For dog owners, it is probable that veterinary services obtained in the event of disease and for vaccinations, and that food and shelter are available. This leads to the supposition that this group carries lower risk for the human population. However, the care given to these animals varies greatly and the degree of restriction is one reflection of these differences. In this sense, the semi-restricted and free at all-time dogs is a segment presenting risk, because of the contact they have with ownerless and neighborhood dogs, which more exposed to diseases, and because of their simultaneous interaction with other dogs with owners. The results obtained from the study indicated that the most frequent classification related to restricted dogs (56.02%). However, given the epidemiological importance of the group of semi-restricted dogs, the percentage found (31.77%) and free at all (12.35%) indicate in the (Table 2) below. Of the dog-owning households interviewed in this survey, the majority (at the study towns) owned only one dog (68.95%), most commonly local breed and more commonly male (86.42%). Dog used to guard houses. The preference appears to relate to guarding duties, given the majority of interviewed households keep dogs for this reason. Most of the time dogs used to guard the interview indicates farmers (96.30%) and employed (92.86%) from and for pet purpose farmers are 0 %, labors 6.45 %, private 8.99% and



Figure 2: Not marked around the house Marked outside.

Table 1: Total doghouse hold and no doghouse hold in the study three towns indicated table.

Site	Dog house hold No. (%)	No dog house hold No. (%)	Total interviewed No. (%)
Dukem	82 (56.94)	62 (43.06)	144 (16.46)
Bishoftu	334 (71.22)	135 (28.78)	469 (53.6)
Modjo	183 (69.85)	79 (30.15)	262 (29.94)
Total	599 (68.46)	276 (31.54)	875 (100)

Table 2: Restriction status of households dogs from the three towns.

Full restriction No. (%)	Semi restriction No. (%)	Free all time No. (%)	Total No. (%)
335 (56.02)	190 (31.77)	74 (12.35)	599 (100)

Table 3: According to occupation, daily income and religion with vaccination status of their dogs in the study area indicated in the table.

Variables	Vaccination(2016/17)	
	Vaccinated No. (%)	Not vaccinated No. (%)
Occupation		
Farmer	6 (22.22)	21 (77.78)
Laborers	15 (50.00)	15 (50.00)
Private business	154 (58.11)	111 (41.89)
Employed	104 (62.28)	63 (37.72)
Other	69 (66.35)	35 (33.65)
Daily income/day		
<40 birr	84 (52.17)	77 (47.83)
40-100 birr	117 (58.79)	82 (41.21)
101-200 birr	89 (63.57)	51 (36.43)
>200 birr	58 (62.37)	35 (37.63)
Religions		
Christian	338 (62.37)	238 (37.63)
Muslim	9 (60.00)	6 (40.00)
Others	1 (50.00)	1 (50.00)

employed 2.38% (Table 4).

According to occupation and the first knowledge obtained from the people about rabies in the study area the higher percentage questioner survey information indicated that from local community and family and don't know remember is also at higher percentage

but lower percentage of the first knowledge obtained from the people about rabies are from school, local health clinic, media, veterinarian, and newspaper.

According to vaccination status Highest educational level of the family highly associated with to college /university/ and above and high school stages had a defined association, and an association was recorded between the classification of the dog's vaccination and the education level of the family most of the time more association vaccination status of the dog ($p < 0.007$ and 0.023 , $CI=1.239-3.793$ and $CI=1.018-2.858$).

According to gender females family head are more vaccination to their dogs than males, females greater than males by ($OR=1.026$ and $CI=0.770-1.368$) (Table 6).

According to gender females had more vaccination certificate to their dogs than males family head ($OR=1.261$) (Table 7). Based on the highest education level of the family logistic analysis shows college (university) and above education level has statistically significant to the vaccination certificate of house hold dogs. Comparatively, presence of vaccination certificate on college (university) and above education level people were 3.773 times more than No formal educated people ($OR=3.773$, $P=0.00.$, $CI=1.867-7.625$). However, technical college trainers was not statistically significant with vaccination certificate ($p>0.05$).

Estimating the Total Dog Count

The total number of dog counts was made based on recommendation made by the world society for the protection of animals(WSPA) and calculated as the number of dogs counted divided by the number of selected blocks/ the total numbers of blocks on the town's map. Calculating the number of roaming dogs per unit area within the sample blocks and then multiplying by the area of the city was said to give a biased estimate and not recommended. The total dog estimation of Bishoftu town had be estimate 4188 with in interval between 3222 to 5254 dog numbers estimated, In Modjo town the total estimate of dog population 1619 between the interval 945 to 2293 dog numbers estimated and Dukem town total estimated dog population 944 between the interval 639 to 1248, then the total study towns dog population estimated 6733 with between the interval 5694 to 7771,depending on this estimated we can prepare adequate vaccine for those study town to cover minimum 70% to 100% vaccinated to

Table 4: Vaccination certificate and purpose of dog keeping for three studied towns.

Types of occupation	With vaccination certificate No. (%)	Without vaccination certificate No. (%)	Used for guard No. (%)	Used for herding No. (%)	Used for pet No. (%)
Farmers	6 (22.22)	21 (77.78)	26 (96.30)	1 (3.70)	0 (0.00)
Labors	16 (51.61)	15 (48.39)	21 (93.55)	0 (0.00)	2 (6.45)
Privet bus	154 (57.68)	113 (42.32)	217 (81.27)	26 (9.74)	24 (8.99)
Employed	104 (61.90)	64 (38.10)	156 (92.86)	9 (4.76)	4 (2.38)
Others	69 (66.35)	35 (33.65)	89 (86.41)	4 (3.88)	10 (9.71)
Total	349 (58.46)	248 (41.54)	509 (86.42)	40 (6.79)	40 (6.79)

Table 5: Type of occupation and the first knowledge obtained from the people about rabies in the study area.

Occupation	From Veterinarian	From Media	From Family	From School	From Local Health Clinic	From Local Community	Don't Remember	Other	News paper
Farmer	1 (5.88)	0 (0.00)	11 (5.31)	1 (1.23)	0 (0.00)	15 (3.63)	7 (11.11)	2 (33.33)	0 (0.00)
Laborers	0 (0.00)	7 (8.75)	13 (6.28)	4 (4.94)	0 (0.00)	27 (6.54)	5 (7.94)	1 (16.67)	1 (25)
Private	7 (41.18)	31 (38.75)	93 (44.93)	31 (38.27)	2 (66.67)	189 (45.76)	34 (53.97)	1 (16.67)	1 (25)
Employs	9 (52.94)	29 (36.25)	52 (25.12)	32 (39.51)	1 (33.33)	103 (24.94)	7 (11.11)	2 (33.33)	1 (25)
Others	0 (0.00)	13 (16.25)	38 (18.36)	13 (16.05)	0 (0.00)	79 (19.13)	10 (15.87)	0 (0.0)	1 (25)
Total	17 (100)	80 (100)	207 (100)	81 (100)	3 (100)	413 (100)	63 (100)	6 (100)	3 (100)

Table 6: Vaccination status of the doghouse hold according to gender and highest education level of the family in the table.

Vaccination status	OR	P – value	[95% CI]
Gender			
M	1		
F	1.026	0.859	0.770 – 1.368
Highest educational level of the family			
No formal education	1		
Elementary (0 – 6)	1.469	0.178	0.840 – 2.570
High school (7 – 12)	1.758	0.023	1.018 – 2.858
Technical college trainer	0.748	0.550	0.289 – 1.937
College (university) and above	2.167	0.007	1.239 – 3.793

Table 7: Vaccination certificate of the doghouse hold according to gender and highest education level of the family in the table.

Vaccination certificate	Odds ratio	P – value	[95% CI]
Gender			
M	1		
F	1.261	0.199	0.885 – 1.797
Highest educational level of the family			
No formal education	1		
Elementary (0 – 6)	1.996	0.049	1.004 – 3.971
High school (7 – 12)	2.244	0.007	1.242 – 4.053
Technical college trainer	1.313	0.631	0.433 – 3.977
College (university) and above	3.773	0.000	1.867 – 7.625

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$$\text{Estimated dogs (N)} = (n_1+1) (n_2+1)/(m+1)$$

$$\text{Variance (N)} = [(n_1+1) (n_2+1) (n_1-m) (n_2-m)]/(m+1)^2 (m+2)$$

According to Lincoln Peterson Estimation formula, the total dog population in Bishotu counted and estimated at the morning (AM) are, 4440 dogs and afternoon (PM) are 3804 dogs. Respectively Modjo in the morning (AM) are 1676 dogs and afternoon (PM) is 1562 dogs and in Dukem at the morning (AM) counted to 1024 dogs and afternoon (PM) to be counted 863 dogs. The overall estimation dog population in the three towns at the morning (AM) is 7118 dogs and afternoon (PM) counted estimated is 6236 dogs.

Marked status associated with partially restricted and ownerless free roaming dog counted because the p value less than 0.005 or p value=0.0135 and 0.0000 and CI=(7.6-15.9) AM and 13.3-25.2 PM and CI of ownerless free roaming and un marked counted outside=(22.5-38.6) AM and (14.6-26.5)PM. More highly associated from the two was ownerless free roaming dogs indicated the (Table).

Discussions

In the present questioner, survey 599 dog-owning households interviewed in the study districts. The households comprise the total number of dogs ranging from 1-9 dogs. Among households interviewed in the study towns 413(68.95%) had one dog, 147(24.54%) had two dogs, 24(4.01%) had three dogs, 11(1.84%) had four dogs, 1(0.17%) had five dogs, 1(0.17%) had six dogs and one (0.17%) had nine dogs. According to the present questioner survey in the study, towns the number of fully movement restricted dogs (dogs kept in the house) were higher than partial restricted and free-living dogs. Of the dog-owning households interviewed in this survey, the majority (at the study towns) owned only one dog (68.95%), most commonly local breed and more commonly male (86.42%). Dogs used to guard houses. The preference appears to relate to guarding duties, given the majority of interviewed households keep dogs for this reason. Most of the time dogs used to guard the interview indicates farmers (96.30%) and employed (92.86%) from and for pet purpose farmers are 0%, labors 6.45 %, private 8.99% and employed 2.38%. This was in agreement with (on the other hand Of the dog-owning households interviewed in this survey, the majority study sites owned only one

Table 8: Number of marked and recaptured dog populations.

Town	Block	No.of marked dogs- n_1	Recaptured marked dogs- m_2		Total non-marked dogs counted		Total dogs counted- n_2		Estimated number of dogs per each town (mean*total No. of sampling blocks)	
			AM	PM	AM	PM	AM	PM	AM	PM
Bishoftu	B1	38	36	34	55	21	91	55	74 74*60=4440	63.4 63.4*60=3804
	B2	49	45	48	28	32	79	98		
	B3	75	63	63	41	18	110	91		
	B4	18	13	17	21	13	37	34		
	B5	58	54	54	22	16	76	70		
	B6	48	45	46	60	45	105	91		
	B7	49	47	43	32	8	82	55		
	B8	40	31	31	18	9	52	44		
	B9	18	18	18	42	28	60	46		
	B10	69	35	42	11	4	48	50		
Modjo	M1	28	25	26	26	26	56	57	79.8 79.8*21=1676	74.4 74.4*21=1562
	M2	41	41	41	19	13	62	56		
	M3	71	38	39	13	29	78	88		
	M4	60	59	57	71	39	137	102		
	M5	45	42	42	24	27	66	69		
Dukem	D1	28	28	28	22	4	52	33	60.25 60.25*17=1024	50.75 50.75*17=863
	D2	25	21	21	31	34	56	62		
	D3	65	54	54	11	3	78	60		
	D4	23	20	18	33	22	55	48		
Over all	Sum	848	715	722	580	391	1380	1209	7118	6236
	Mean	44.6	37.6	38	30.5	20.6	72.6	63.6		

Table 9: Lincoln Peterson Estimation table.

Blocks	Lincoln Peterson Estimate						Real count per block	
	Point estimate		95% CI of the point estimate				AM	PM
	AM	PM	Lower AM	Upper AM	Lower PM	Upper PM		
B1	96	61	90	102	57	66	91	55
B2	86	100	81	91	97	103	79	98
B3	131	108	122	139	102	114	110	91
B4	51	36	39	63	33	39	37	34
B5	82	75	79	85	73	78	76	70
B6	112	95	106	118	91	99	105	91
B7	85	63	82	89	60	66	82	55
B8	67	57	60	74	52	62	52	44
B9	60	46	60	60	46	46	60	46
B10	95	82	83	106	76	88	48	50
D1	52	33	52	52	33	33	52	33
D2	67	74	58	76	64	84	56	62
D3	94	72	88	100	70	75	78	60
D4	63	61	55	71	51	72	55	48
M1	63	61	57	69	57	66	56	57
M2	62	56	62	62	56	56	62	56
M3	146	160	123	168	135	185	78	88
M4	139	107	136	143	103	112	137	102
M5	71	74	67	74	70	78	66	69

M=Modjo, D=Dukem, B=Bishoftu

Table 10: Total mean (average of morning and afternoon) dog population count of three towns: Bishoftu, Modjo and Dukem.

Reproductive status	Towns	No. of blocks		Count time	Mean	(95% CI) Of the means	Estimated Dog population
		Total on map blocks	Sampled blocks				
Male dogs	Bishoftu	60	10	AM	56.5	[39.6-73.4]	3390 [2376-4404]
				PM	51.7	[34.5-68.9]	3102 [2070-3562.13]
	Modjo	21	5	AM	61.0	[35.1-86.9]	1281 [737.11824.9]
				PM	61.6	[37.0-86.2]	1293.6[7771810.2]
	Dukem	17	4	AM	41.8	[16.5-67.0]	710.6[280.5-1139]
				PM	34.0	[9.7-58.3]	578 [164.9-991.1]
Over all	98	19	AM	54.6	[44.2-65.0]	5351[4332-6370]	
			PM	50.6	[39.7-61.5]	4959[3891-6027]	
Female dogs	Bishoftu	60	10	AM	11.9	[8.9-14.9]	714[534-894]
				PM	9	[5.4-12.6]	540[324-756]
	Modjo	21	5	AM	13.4	[4.7-22.1]	281[99-464]
				PM	9.8	[3.8-15.8]	206[80-332]
	Dukem	17	4	AM	10.5	[2.2-18.8]	179[37-320]
				PM	7.25	[3.7-10.8]	123[63-184]
Over all	98	19	AM	12	[181.7-274.3]	1176[17807-26881]	
			PM	8.8	[7.6-28.4]	862[744.8-2783.2]	
Puppy	Bishoftu	60	10	AM	1.2	[1-25.1]	72[60-1506]
				PM	1.7	[1.6-25]	102[96-1500]
	Modjo	21	5	AM	2.6	[1.9-38]	50[39.9-798]
				PM	0.6	[0.5-21.8]	13[10.5-457.8]
	Dukem	17	4	AM	1.4	[1.3-18]	24[22-306]
				PM	6.5	[6.2-15.7]	111[105.4-266.9]
Over all	98	19	AM	7.3	[7.1-9.8]	715[695.8-960.4]	
			PM	9	[7.5-10.3]	882[735-1009.4]	
Un known sex	Bishoftu	60	10	AM	2.3	[1.8-8.6]	138[108-516]
				PM	1.1	[1-3.5]	66[60-210]
	Modjo	21	5	AM	3.2	[3.1-7.5]	67[65.1-157.5]
				PM	2.4		50
	Dukem	17	4	AM	4.5		77
				PM	3.0		51
Over all	98	19	AM	10		980	
			PM	6.5		637	
Total	Bishoftu	60	10		69.8	[53.7-85.9]	4188[3222-5154]
	Modjo	21	5		77.1	[45.0-109.2]	1619[945-2293]
	Dukem	17	4		55.5	[37.6-73.4]	944[639-1248]
	Over all	98	19		68.7	[51.1-79.3]	6733[5694-7771]

dog, most commonly local breed and more commonly male. Dogs used to guard houses. The preference appears to relate to guarding duties, given the majority of interviewed households keep dogs for this reason. A preference for keeping dogs for guarding purposes observed in other countries such as Madagascar, Tanzania and the Philippines [26].

In this study, male dogs were higher than female dogs. This was agreement with previous findings documented [27] who reported

male dogs outnumber female dogs in the population of free-roaming and restricted dogs. This could be due to the use of male animals as guard dogs and by a higher mortality among female animals due to pregnancy and childbirth [9]. According to occupation and the first knowledge obtained from the people about rabies in the study area the higher percentage questioner survey information indicated that from local community and family and don't know remember is also at higher percentage but lower percentage of the first knowledge obtained from the people about rabies are from school, local health

Table: Total population of restricted, partially restricted and free roaming dogs of the three towns (n=19).

Total dogs of the three towns	Mark status and count location	Count time	Mean count	[95% CI]	P - value
Restriction	Marked and counted inside owner's compound	AM	31.0	[24.1-37.9]	0.4808
		PM	29.8	[22.8-36.9]	
Partially restricted	Marked counted outside or un marked counted inside	AM	11.8	[7.6-15.9]	0.0135
		PM	19.2	[13.3-25.2]	
Ownerless free roaming	Un marked counted outside	AM	30.5	[22.5-38.6]	0.0000
		PM	20.6	[14.6-26.5]	
Over all mean dog count of the three towns: Bishoftu, Dukem and Modjo			68.7	[58.1-79.3]	

clinic, media, veterinarian, and newspaper.

According to vaccination status Highest educational level of the family highly associated with to college /university/ and above and high school stages had a defined association, and an association was recorded between the classification of the dog's vaccination and the education level of the family most of the time more association vaccination status of the dog ($p < 0.007$ and 0.023 , $CI=1.239-3.793$ and $CI=1.018-2.858$).

According to gender females family head are more vaccination to their dogs than males, females greater than males by ($OR=1.026$ and $CI=0.770-1.368$) and According to gender females had more vaccination certificate to their dogs than males family head ($OR=1.261$) (Table 7). Based on the highest education level of the family logistic analysis shows college (university) and above education level has statistically significant to the vaccination certificate of house hold dogs. Comparatively, presence of vaccination certificate on college (university) and above education level people were 3.773 times more than No formal educated people ($OR=3.773$, $P=0.00$, $CI=1.867-7.625$). However, technical college trainers was not statistically significant with vaccination certificate ($p>0.05$).

The total number of dog counts was made based on recommendation made by the world society for the protection of animals(WSPA) and calculated as the number of dogs counted divided by the number of selected blocks/ the total numbers of blocks on the town's map. Calculating the number of roaming dogs per unit area within the sample blocks and then multiplying by the area of the city was said to give a biased estimate and not recommended. The total dog estimation of Bishoftu town had be estimate 4188 with in interval between 3222 to 5254 dog numbers estimated, In Modjo town the total estimate of dog population 1619 between the interval 945 to 2293 dog numbers estimated and Dukem town total estimated dog population 944 between the interval 639 to 1248, then the total study towns dog population estimated 6733 with between the interval 5694 to 7771, depending on this estimated we can prepare adequate vaccine for those study town to cover minimum 70% to 100% vaccinated to the next time.

Dog counting at the urban sites are provided initial data about the unowned dog population in urban. The main limitation of this was utilization of a simple dog population estimation method used to estimate the unowned dog population. This method have not been the best way to estimate the number of dogs [10]. However, the simple method used in this survey was adequate to provide an initial estimate of the ownerless dog population at urban sites, and was appropriate given the limited time period for dog counting (two days at each site)

that could completed. In addition, the interview survey conducted should repeat to validate its findings also to monitor changes in dog management practices.

In this study stray dog population identified from the counted survey in study towns were higher than the estimates from marke-recapture, this was in line with the results of previous findings that estimated dog population by count survey [11]. However, marke-recapture cannot used to count the confined owned dogs. Although the method cannot distinguish types of dog without having sign or mark, this study conferred the particular limitation by putting different colors for owned and stray dogs, and performing marke-recapture survey soon after. However, reporting bias might still exist. This might be due to stray dogs can be recounted; there was no practice of stray dog population control like spaying and disexing.

Conclusion and Recommendations

The pattern of dog ownership on Bishoftu, Modjo and Dukemtowns' population of education of dog owners about the control and management of their dogs needed as part of a program to reduce the likelihood of a potential rabies incursion becoming established. There needs to be an emphasis on responsible dog ownership (particularly dog confinement and desexing). Therefore, more researches that are scientific need to executed. Critical attention needed from the country's responsible bodies focusing on mass dog vaccination campaigns and public awareness to control the risk of rabies in the country.

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