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Sero-Prevalence and Socioeconomic Impacts of Peste Des Petits Ruminants in Small Ruminants of Selected Districts of Afar, Ethiopia

Fikru Gizaw[1*], Olana Merera[1], Fikre Zeru[2], Hailegabriel Bedada[1], Mu'uz Gebru[2] and Reta Duguma Abdi[3,4]

[1]*College of Veterinary Medicine, Samara University, Samara, Afar, Ethiopia*

[2]*College of Veterinary Medicine, Mekelle University, Mekelle, Tigray, Ethiopia*

[3]*College of Veterinary Medicine and Agriculture, Addis Ababa University, Bishoftu, Oromia, Ethiopia*

[4]*Department of Animal Science, Institute of Agriculture, The University of Tennessee, Knoxville, USA*

[*]**Corresponding author:** Fikru Gizaw, College of Veterinary Medicine, Samara University, Samara, Afar, Ethiopia, Tel: + 251-910-784909; E-mail: i.fikirgiza1978@yahoo.com

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Abstract

The aim of this study was to estimate the sero-prevalence of Peste des petits ruminants (PPR) in sheep and goat and its direct socio-economic impact on pastoral community in Afar region, Ethiopia. We sampled sera of 229 of sheep (n=94) and goats (n=135) from two districts and tested the sera for anti-PPR antibody positivity by competitive enzyme-linked immunosorbent assay (cELISA). We also conducted interview with 45 pastorals pertaining to PPR mortality, production losses, costs incurred and impact on animal. The respondents indicated that communal use of available resources (feed, water) and practices of animal gift, flock migration and admixture is common in the area, which could facilitate the spread PPR. They indicated that migration for searching of grazing and water during drought season, contact with wildlife and unknown factors within-flock was associated with the serious PPR disease outbreaks. The serological result showed that the prevalence of anti-PPR virus antibody in sheep and goats was 41.5% (95% confidence interval (CI): 31.4, 52.1) and 39.3 % (95% CI: 31 to 48), respectively. The overall prevalence of PPR was 40.2% (95% CI: 33.8 to 46.8). The total financial losses due to PPR varied during drought and non-drought periods as the monitory value of animals decreases during drought time due to emaciation. Accordingly, the financial loss of PPR was 652, 595 birr (drought time) and 1,683,120 birr (without drought) in a shoat population of 3905 heads in the study area. A systematic intensive surveillance and timely vaccination along the route of migration via herders' participation could be the best and low-cost preventive measure to control such deadly preventable disease outbreaks.

Keywords: Afar; Economic losses; Goat; Peste des petits ruminants; Risk factors; Sheep; Seroprevalence

Background

Peste des petits ruminants (PPR) is highly contagious viral disease of small ruminants both in domestic and wild life [1]. It is characterized by fever, anorexia, necrotic stomatitis, diarrhea, mucopurulent nasal and ocular discharges, enteritis and pneumonia [2]. The synonyms of PPR include Kata, pseudo-rinderpest, pneumo-enteritis complex and stomatitis-pneumoenteritis syndrome [3]. The PPR virus belongs to Morbillivirus in Paramyxoviridae, which is closely related to the rinderpest virus of bovines and buffaloes, distemper virus of dogs and other wild carnivores, human measles virus and Morbilliviruses of marine mammals [4].

PPR was first described in Côte d'Ivoire [5] and soon distributed to Nigeria, Senegal and Ghana [6]. Severe epidemics are recently reported from sub-Saharan Africa, the Middle East and Asia [7]. The prevalence of antibodies to PPR virus in small ruminants and other species is available from Sultanate of Oman, Jordan, Sudan, Turkey and various African countries [8]. The prevalence of PPR was 29% and 49% in Northern Jordan [9] and 35.8% and 49.5% in Pakistan [10] in sheep and goats, respectively. PPR entered Ethiopia in 1989 in the southern Omo River valley, moved east to Borana then northwards along the Rift Valley and reached Awash in 1991. It gained epizootic status during 1994 and 1996 and expanded northwards into the central Afar region and then eastwards into the Ogaden [11]. Widespread distribution of PPR has been reported from different regions of Ethiopia before 10-20 years ago [4,12].

The PPR epidemics can cause mortality proportion of 50–80% in naive sheep and goats populations [13]. Based on assumption that goats experience an outbreak every 5 years, [14] estimated an annual sum ranging from 2.47£ per goat at high loss and 0.36 £ per goat at lowest loss. Effectively, the disease pushed the poorest families into destitution or near destitution and the wealthy families down one or two classes into poverty. It is an economically significant disease of small ruminants such as sheep and goats [15].

There are multiple compelling reasons to start an immediate concerted effort on PPR. These include (i) the need to stop the spread of the disease in already affected countries and at-risk regions, (ii) to mitigate the economic impact of the disease on people relying on small ruminants for subsistence (food and income), and (iii) eliminating PPR is a key to poverty reduction in the world's most vulnerable pastoral or agro-pastoralist communities [7]. The Afar pastoralists have shown an increasing interest in keeping larger numbers of sheep and goats in recent years. The fact that exports of meat and live animals is increasing in Ethiopia. So, they don't worry for market demand for their sheep and goats besides providing food (milk) and income to the household. However, the prevalence and endemic nature of the diseases such as PPR are major causes in the decline of this supply [7].

Progressive control or eradication of PPR requires clear information on the epidemiology of the diseases in order to target the intervention to high-risk zones and endemic populations. In addition, economic losses (particularly losses due to mortality outbreaks) caused by PPR of the sheep and goat population in Afar is not adequately studied. Therefore, the aim of this study was to estimate (i) the sero-prevalence of PPR, and (ii) direct economic losses due to PPR infection in sheep and goat population in Afar pastoral area.

Material and Methods

Description of the study areas

The study was conducted in Adar and Mille districts of Afar national regional State of Ethiopia. The Afar national regional state is located in the Great Rift Valley, comprising rangeland in northeast Ethiopia with an estimated area of 95,958 Km^2 [16]. It is geographically located between 39°34′ and 42°28′ East Longitude and 8°49′ and 14°30′ North Latitude. The region shares common international boundaries with the state of Eritrea in the northeast and Djibouti in the east, as well as regional boundaries with the Regional States of Tigray in the northwest, Amhara in the southwest, Oromia in the south and Somali in the southeast.

Study animals

The study populations was indigenous breed of sheep and goats kept under pastoral husbandry which allows high mobility of animals and these animals are usually kept mixed with other animal species. Blood samples were collected from sedentary non-vaccinated sheep and goats (above 6 months old).

Study design and sample size

Sampling size: The sample size for this study was determined by the following formula given by Thrusfield.

$$n=1.96^2 \times P^{exp} (1-P^{exp})/d^2$$

Where 1.96=the value of Z at 95% confidence interval, d=desired absolute precision, n=required sample size, and P^{exp}=expected prevalence Therefore, by using the above formula and taking in to account 95% confidence interval, desired absolute precision of 5% and an expected prevalence of 15.3% [], the estimated sample size is 199 but to increase precision total sample size is 229.

Study design: Cross-sectional study design was used for both sero-prevalence and questionnaire survey between March 2015 to January 2016 to estimate the sero-prevalence and socioeconomic impact of PPR in sheep and goat production system. There is no serological test available to differentiate animals vaccinated with PPR vaccine from animals that had recovered from a natural PPR infection in Ethiopia. Therefore, questionnaire was deemed the best source of information regarding vaccination status of sheep and goats to aid in sampling.

Sampling method and sample collection

Sampling method serology: The Afar region has 5 administrative zones, 32 districts (woredas) and 331 kebeles or peasant associations. The study was begun by identifying the vaccination and PPR outbreak history in zone, districts, peasant associations (PAs) and herds. The zone and districts were selected purposively based on reports of PPR outbreak history, absence of PPR vaccination history, sheep and goat population, and willingness of pastoralists and accessibility to roads for vehicles. The representative kebeles or peasant associations, herds and sheep and goats were selected by simple random sampling. So that, from the five administrative zones, one zone (zone 1) was selected. Then two districts from the zone, four PAs from each districts, and three herds from each PAs and maximum eleven animals (sheep and goats) from each respective herd were randomly selected, and included as study population. Proportional allocation i.e., the number of sheep and goat sampled is proportional to the herd sizes. Accordingly, 11 shoats are selected from very large herd sizes, 9 or 10 shoat from middle herd sizes, 8 shoat from the smallest herd sizes. Accordingly, a total of 229 sheep and goat (94 sheep and 135 goats), twenty four herds, eight kebeles or peasant associations and two districts (woredas) were included in the study.

Questioner survey: A cross-sectional survey of sheep and goat producers was done to assess the nature, extent and impact of disease across randomly selected eight PAs to study the nature of disease in different spatial locations. Accordingly, a total of forty five (24 farm owners from were serum was collected and 21 herds were selected from the same kebele or PAs randomly to increase the sample size of questionnaire) farm households/pastorals constituted the sample from where the data were collected for analysis were interviewed. A questionnaire was used to collect information on flock size and structure, sources of income and costs, disease outbreaks and impacts on farm productivity. Further, data on movement of the animals and farm products, feeding and watering habits and source of grazing were also collected. The collected data were tabulated, classified and further categorized for systematic and suitable statistical analysis.

Sample collection for serology survey: Overall, 229 whole blood samples were collected from sheep and goats, All herds that contributed blood samples were from the herds that contributed information for the questionnaire. Serum samples were collected from animals, which had no history of PPR vaccination. Data related to previous history of the PPR and vaccination was obtained from Ministry of Agriculture, Regional Agricultural Center or district clinic records and/or by interview with the owner of the farms. All factors including number of animal vaccinated in each district, vaccinated age group, vaccine quality, and month/season of vaccination, facility such as icebox, human resources and personal quality (experience and professional status) was carefully recorded. Age, sex, species and type of breed of sampled animals was also recorded.

Approximately 10 ml of blood from each sheep and goat was collected aseptically using sterile plain vacutainer tubes and needles. The samples were properly labeled and vacutainer tubes having blood was left for 24 hours at room temperature for clotting. The next day, the sera was separated and transferred to other sterile vials, and kept at -20°C until tested for presence of PPR antibody.

Laboratory examination

All sera were transported to National Veterinary Institute laboratory in icebox and stored at −20°C until processed. Samples were processed based on standard and appropriate laboratory procedures of each specimen for the desired test in National Veterinary Institute, Bishoftu, Ethiopia. The nucleoprotein-based cELISA kit obtained from IDvet, 310, rue Luouis Pasteur-Grabels-France, has been used and the test was carried out according to the manufacturer's protocol [17]. Accordingly, first calculate the Optical Density of the negative control (ODNC) and the test is validated if the mean value of the Optical Density of the negative control (ODNC) is greater than 0.7. Also the

test is validated if the mean value of the optical density of the positive control (ODPC) is less than 30% of the ODNC.

The interpretation of the result is depends on calculation of the competition percentage

(Sample/Negative control × 100)

S/N%=OD sample/ODNc × 100. Then according to this calculation samples presenting aS/N%:

- Less than or equal to 50% are considered positive result.
- Less than and greater or equal to 60% is doubtful and
- Greater than or equal to 60% are considered as negative result.

The data collected through questionnaire survey and serology test results of the collected samples were entered into Excel databases and analyzed using SPSS software package (SPSS 20.0 for window 7, SPSS Inc, Chicago, Illinois). Descriptive statistics such as percentages, proportions and frequency distributions were applied to compute the nature and the characteristics of the data. The sero-prevalence was calculated as the number of serologically positive samples divided by the total number of samples tested. The difference between the effects of different risk factors on prevalence was analyzed using the Pearson chi-square (χ^2) test. Logistic regression analyses were used to assess the strength of association and were calculated to quantify the association of different risk factors (district, species, sex and breed) with the prevalence of PPR diseases by adjusting herd as a cluster effect. A statistically significant association between variables was said to exist if the calculated P-value is less than 0.05 and if the 95% confidence interval (CI) for OR does not include 1.

Economic impact assessment methods

A static and structured spreadsheet model was used to assess the costs of inaction on PPR in sheep and goats. The direct costs of this disease refer to the monetary values of physical losses due to the disease [18]. Since PPR is more acute disease, these physical losses are only the results of mortality associated with disease. Mortality induces losses associated with the cost of dead animals. Disease burden is defined as the sum of direct costs of the disease, which include cost of mortality, and the incurred costs of treatment and additional feed cost.

The first step in this process was to determine the population at risk, which depends on the degree to which livestock population is protected by existing prophylactic measures. In that regard, background information on livestock across agro-ecological zones, vaccine availability, treatment availability and the degree to which disease surveillance programs are implemented are important. The data required are livestock population number, livestock production parameters, price/cost data and epidemiological parameters. The livestock population data are disaggregated by species, age and sex. Livestock production parameters are also collected by species and agro-ecological zones. The price/cost data to use as inputs in the spreadsheet model include cost of feed, price of live animals by species and age category, cost of treatment. The data used in this study are presented in Appendix part and are all for the year 20015/16 or adjusted to that year when applicable. The epidemiological parameters involve disease incidence rate, affection rate (i.e., morbidity proportion and mortality proportion), rate of vaccination coverage, extent of disease surveillance, disease treatment rate and impact of affection on productivity. These data were gathered from secondary sources, published studies and through interview.

In this exercise, data collected through questionnaire were compared and contrasted with data collected from secondary sources and judgments were made about the magnitude of the parameter estimates to use. Hence, the incurred costs of treatment and additional feed used to calculate the disease burden are elective, based on data collected through questionnaire, or from secondary sources, or from our assessment based on the two. The costs of treatment and feed were referred to as actual intervention costs and include for activities conducted by private and public entities.

Results

Social attributes of respondents

The respondents indicated that no specific housing system (86.67%) was available for sheep and goat in the area. Grazing and watering resource management was communal among all (100%) households. Majority of respondents were illiterate (98%), followed by some (2%) with primary level education. Peoples in the study area are engaged in subsistence livestock production for the social and cultural values as well as life it renders to kinship groups and the society (40%). High (91.1%) mobility was common in search of grazing and water. Majority (77.8%) of the owners treat sick animals by themselves. The respondents (78.5%) indicate that modern medicaments are used as a management method of most of common diseases. Most of them (75.6%) also isolated sick animals from the flock. Most of the respondents (86.67%) indicated that their flocks had the chance to meet wildlife. The respondents associated the incidence of PPR with emergence of drought, within flock unknown factors, and contact with wildlife. The status of flock management practices and possible risk factors for the occurrence of PPR in small ruminants in the study area was summarized in Table 1.

Variables	Categories	Numbers	%
Have you had enteritis-stomatitis syndrome in shoats of your flock?	Yes	45	100
	No	0	0
Have you had PPR (Local name) in your shoats?	Yes	45	100
	No	O	0
When did the disease commence in the area (PA)?	<2 months	11	24.44
	2-5 Months	15	33.33
	Before 1 year	19	42.22
Have you seen such outbreak in the area before this time?	Yes	45	100
	No	0	0
How frequent PPR reoccurs in the area?	Related with drought	45	100
	Every 1 yr	0	0
	Every 2 yrs	0	0
	>3 yrs	0	100
Origin of PPR outbreak in to your village?	neighboring PA or District	11	24.44
	From market	0	0

	Unknown/ Within flock	34	75.56
Do you move your shoats to other place for grazing seasonally?	yes	41	91.1
If yes,	No	4	8.9
when,	Dry season	41	100
where,	Neighbor	41	100
how long did you keep them there?	Until raining	41	100
Did season changing that lead to movements resulting to share grazing?	Yes	41	91.1
	No	4	8.9
Do you consider PPR as an important disease and how do you score it?	Very severe	43	95.56
	Severe	2	4.44
	Moderate	0	0
	Low	0	0
Housing system	Fenced stable	4	8.89
	House barn	2	4.44
	Free/no house	39	86.67
Have purchase feed	Yes	20	44.4
	No	25	55.6
Did you separate sick and health animals?	Yes	34	75.6
	No	11	24.4
Grazing and watering resource managements	Communal	45	100
	Private	0	0
Did you separate different age groups of small stock?	Yes	25	55.6
	No	20	44.4
Did you mix shoat with other species of animals?	Yes	24	53.3
	No	21	46.7
Have you bought new shoats or introduced new shoats since 3 months before the onset of the outbreak?	Yes	18	40
If yes, origin of the shoats?	No	27	60
	From market	9	50
	Gift	9	50
Did you vaccinate your shoats for PPR?	Yes	21	46.67
	No	24	53.33
If yes, when?	<3 month	0	0
	3 month-1 years	0	0
	>3 years	21	100
What do you do when the shoat fall sick due to PPR?	Treat them my self	35	77.8
	Call in the vet professional	4	8.89
	Kill them immediately	0	0
	Sell them immediately	0	0
	Traditional healer	6	13.33
Have you received sheep and goat as gifts?	Yes	18	40
	No	27	60
Did your flock Contacts with wildlife?	Yes	39	86.67
	No	6	13.33

Table 1: Descriptive statistics of qualitative variables.

Sero-prevalence of PPR

Sero-prevalence calculation of PPR was carried out by cELISA kit obtained from IDvet, 310, rue Luouis Pasteur-Grabels-France, and the result was interpreted according to [17]. Accordingly, the prevalence of PPR was 92 (40.2%) out of 229 analyzed serum samples. The seropositive rate of the sample from Ada'ar district was 41.1% (95% CI of 32, 50.3) and those from Mile district had 39% (CI of 29.7, 49.1) as shown in Table 2.

District	Species of animals	No. examined	No. positive (prevalence, %)	95% CI	
Ada'ar	Goat	66	27(40.9)	29	53.7
	Sheep	58	24(41.4)	28.6	55.1
	Total	124	51(41.1)	32	50.3
Mile	Goat	69	26(37.7)	26.3	50.2
	Sheep	36	15 (41.7)	25.5	59.2
	Total	105	41(39.0)	29.7	49.1
Total	Sheep	94	39(41.5)	31.4	52.1
	Goats	135	53(39.3)	31	48
	Sheep and goats	229	92(40.2)	33.8	46.8

Table 2: Sero-prevalence of PPR in sheep and goats of two districts of Afar.

Risk factors for positive serological status against PPR

Area, species, age groups and sex showed the prevalence of PPR seropositive animals. All of the factors (age, sex, species and area) did not significantly associate with PPR sero-positivity status of the animal (Table 3).

	Risk factors	No. examined	No. positive (%)	X^2	p-value	df	Odds Ratio	95% CI	p-value
Age	6 month-1 year	20	9(45)	6.73	0.08	3	1	ref	-
	1-2 years	42	14(33.3)				0.61	0.21,1.81	0.38
	2-3.5 years	129	47(36.4)				0.7	0.27,1.81	0.46
	3.5-4 years	38	22(57.9)				1.68	0.56, 5.0	0.35
Sex	Female	169	65(38.5)	0.78	0.38	1	1	ref	-
	Male	60	27(45)				1.31	0.72,2.38	0.38
Species	Goat	135	53(39.3)	0.11	0.74	1	1	ref	-
	Sheep	94	39(41.5)				1.1	0.64,1.88	0.74
Area	Ada'ar	124	51(41.1)	0.1	0.75	1	1	ref	-
	Mile	105	41(39.0)				0.92	0.54,1.56	0.75
Herd size	<30 (4 herds)	40	18(45)	0.48	0.79	2	1	ref	-
	30-50 (16 herds)	145	57(39.3)				0.79	0.4, 1.6	0.52
	>50 (4 herds)	44	17(38.6)				0.77	0.32,1.84	0.56

Table 3: Association between some of the factors with occurrence of PPR in small ruminant farm.

Costs and financial burden of PPR

The estimated annual physical losses of sheep and goats due to PPR were presented in Table 4. The total numbers of dead sheep and goats were 1,280 and 1,195, respectively. About 63.3% of the total population of sheep and goats were lost each year due to PPR. The financial loss due to mortality in the affected animal farm was on an average 2,146,875.00 birr/92,140.56$ (cost of animals when showing clinical sign and cost of animals when not showing clinical sign) both in sheep farm and in goat farm (Table 4).

Species	Age group	N	dead	price/shoat (when Showing clinical sign)		price/shoat (when not Showing clinical sign)		Cost of animals (when Showing clinical sign)		cost of animals (when not Showing clinical sign)	
				EBr	US dollars	EBr	US dollars	EBr	US dollars	EBr	US dollars
Sheep	<3 month male	1875	225	25	1.073	135	5.794	5625	241.416	30375	1303.648
	<3 month female		225	25	1.073	135	5.794	5625	241.416	30375	1303.648
	Male 3 m-1 yr		100	265	11.373	950	40.773	26500	1137.339	95000	4077.253
	Female 3 m-1 yr		195	265	11.373	950	40.772	51675	2217.811	185250	7950.644
	Female>1 yr		255	320	13.734	750	32.189	81600	3502.146	191250	8208.155
	Male>1 yr		120	650	27.897	1650	70.815	78000	3347.64	198000	8497.854
	Pregnant		160	320	13.734	800	34.335	51200	2197.425	128000	5493.562
	Sub Total		1280					3,00,225	12885.19	8,58,250	36834.76
Goat	<3 month male	2030	240	25	1.073	135	5.794	6000	257.511	32400	1390.558
	<3 month female		180	25	1.073	135	5.794	4500	193.133	24300	1042.918
	Male 3 m-1 yr		75	265	11.373	950	40.773	19875	853.004	71250	3057.94
	Female 3 m-1 yr		175	265	11.373	950	40.772	46375	1990.343	166250	7135.193
	Female>1 yr		355	320	13.734	750	32.189	113600	4875.537	266250	11427.04

	Male>1 yr		40	650	27.897	1650	70.815	26000	1115.88	66000	2832.618
	Pregnant		130	320	13.734	800	34.335	41600	1785.408	104000	4463.519
	Sub Total		1195					257950	11070.82	730450	31349.79
Total		3905	2475					5,58,175	23,956.01	######	68,184.55

Table 4: Estimated physical losses (heads) and direct costs of sheep and goats due to PPR. *price in birr. 1 US $=23.3 Ethiopian birr (EBr).

There were additional costs of the disease that pertain to treatment, vaccination, and surveillance. However, secondary data and expert opinions revealed a lack of any credible surveillance and vaccination program for PPR. Despite the absence of any effective treatment against PPR clinical cases, producers still provided various forms of treatment to their flocks in order to save their sick animals. On average, nearly 77.8% of the flock holders confirmed having carried out treatment for PPR. The total cost incurred to treat PPR disease was found to be 25,620 birr/10.99.56$ in sheep and goat in general. To find out the costs of treatment, we only considered cost on medicine spent by the owner. Information collected through interview coupled with compiled secondary data, indicated sheep and goats were not vaccinated for three consecutive years across all agro-ecological district. Total PPR burden amounts to 1.68 million birr/72,103$ (Table 5).

The risk (incidence rate) that a susceptible individual in a population has the chances of contracting PPR was similar in sheep (83.2%) and goat (83.74%).

Cost components	Cost when showing PPR clinical sign (birr)	Cost when not Showing PPR clinical sign (birr)
Direct costs	5,58,175	15,88,700
Treatment cost	25,620	25,620
Feed cost	68,800	68,800
Cost of actual intervention	94,420	94,420
Disease burden	6,52,595	16,83,120

Table 5: Direct costs, cost of intervention and financial burden of PPR (Ethiopian birr). *price in birr. 1 US $=23.3 Ethiopian birr (EBr).

The proportion of animals dying (mortality proportion) in a population due to PPR disease was found to be 68.27% in sheep and 58.87% in goat (Table 6).

Species	Local name of sheep and goats	Age group	Total animal in the group	No. infected in the group	No. dead in the group	IR%	MR%
	Mana'atu	<3 month male	265	225	225	84.91	84.91
	Mana'atu	<3 month female	265	225	225	84.91	84.91
	Sibene	Male 3 m-1 yr	160	130	100	81.25	62.5
	Sibene/virgin sheep	Female 3 m-1 yr	285	250	195	87.72	68.42
	Ili	Female>1 yr	455	395	255	86.81	56.04
	Ili	Male>1 yr	185	145	120	78.38	64.865
	Ili	Pregnant	260	190	160	73.08	61.54
Sheep	Over all MR and IR of sheep	1875	1560	1280	83.2	68.27	
	Barkilo	<3 month male	335	310	240	92.54	71.64
	Barkilo	<3 month female	305	275	180	90.16	59.02
	Rihido	Male 3 m-1 yr	190	140	75	73.68	39.47
	Rihido	Female 3 m-1 yr	305	255	175	83.61	57.38
	Wadar/Riyta	Female>1 yr	570	500	355	87.72	62.28
	Wadar/Riyta	Male>1 yr	90	55	40	61.11	44.44
	Wadar/Riyta	Pregnants	235	165	130	70.21	55.32
Goat	Over all MR and IR of goat	2030	1700	1195	83.75	58.87	
Over all MR and IR of sheep and goat			3905	3260	2475	83.48	63.38

	Mana'atu	<3 month male	1875	225	225	12	12
	Mana'atu	<3 month female		225	225	12	12
	Sibene	Male 3 m-1 yr		130	100	6.93	5.33
	Sibene/virgin sheep	Female 3 m-1 yr		250	195	13.33	10.4
	Ili	Female>1 yr		395	255	21.07	13.6
	Ili	Male>1 yr		145	120	7.73	6.4
	Ili	Pregnant		190	160	10.13	8.53
Sheep	Over all MR and IR of sheep	1560	1280	83.2	68.27		
	Barkilo	<3 month male	2030	310	240	15.27	11.82
	Barkilo	<3 month female		275	180	13.55	8.87
	Rihido	Male 3 m-1 yr		140	75	6.9	3.69
	Rihido	Female 3 m-1 yr		255	175	12.56	8.62
	Wadar/Riyta	Female>1 yr		500	355	24.63	17.49
	Wadar/Riyta	Male>1 yr		55	40	2.71	1.97
	Wadar/Riyta	Pregnants		165	130	8.13	6.4
Goat	Over all MR and IR of goat	1700	1195	83.74	58.87		
Over all MR and IR of sheep and goat			3905	3260	2475	83.48	63.38

Table 6: Mortality and incidence rate of sheep and goats. Note: MR=mortality rate, IR=incidence rate.

Discussion

Small ruminant production system in the study area is associated with agro-ecological zones. The area is too dry to sustain crop production. High mobility in search of grazing and water for animals is common in the area. According to our questionnaire results, all respondents migration for searching of grazing and water during drought season is related with acquisition of serious diseases mainly PPR. All the selected farms scored PPR as very important disease although they did not have access for PPR vaccine for their sheep and goatss since three years. Thus, PPR disease entrenched itself and became endemic in Afar, thus it causes cyclic massive mortality outbreaks that perpetually result in continuous economic losses to the herders. This invites regular monitoring and surveillance to contain the disease.

In this study, the overall prevalence of PPR was 40.2%. It was higher than the 6.1% prevalence reported from the neighboring district of Gewane [19], 1.7% before outbreak and 36.6% after outbreak from other district of Awash Fentale [20]. Lack of vaccination for the last three years in the study area can explain the higher prevalence of active viral infection in our findings. Our current sero-prevalence finding of 39.3% in goats and 41.5% PPR in sheep was in agreement with previous reports in the country and outside. Accordingly, a seroprevalence of PPR was 30.9% in Afar [15], 9% in goat and 13% in sheep in Borena [1]. The report from eastern Amhara was 28.1%, 64.5% and 56.5% in vaccinated, unvaccinated and unknown vaccination status of small ruminants and up to 54.8% in Gambella reported by [21] and Megersa et al. [22] respectively. A study in India reported 41.35% PPR prevalence in sheep and 34.91% in goats. However, our current finding was higher than the previous findings of PPR prevalence in sheep and goat. For instance Megersa et al. [22] reports 31.3% in goats and 29.5% in sheep in Gambella and Delil et al. [20] reports prevalence of PPR 7.3% in sheep and 42.6% in goats in Awash Fentale. Contrast findings have been also documented in other countries. Contrary to our findings, higher prevalence in goats than in sheep was reported from India [8], from northern Jordan in sheep (29%) and goats (49%) [9] and from Pakistan 35.8% in sheep and 49.5% in goats [10]. In another study in Pakistan goats were more susceptible than sheep to PPR with an overall prevalence of 40.9% [23]. This indicates within and between nation's variation in PPR prevalence among sheep and goats. The variation can be attributed to the variations in sheep and goat husbandry practices in different countries, agro-climatic conditions, socio-economic status of individual farmers, difference in vaccination program and the migration of livestock in countries.

Since the production losses due to PPR were conceived to be different for different age groups of small ruminant, herd structures for goats and sheep were established through discussions with the herders. The mortality proportion due to PPR disease was reported to be 68.27% in sheep and 58.87% in goat. The respondents indicated that seasonal mortality proportion was variable due to drought, lack of vaccination, delay in diagnosis of disease and insufficient veterinary services and availability of doctors during the outbreak period. The mortality proportion due to PPR disease in Maharstra was found to be 13.50% in sheep and 8.53% in goat [24]. Recent study in Turkana indicated that mortalities due to diseases were 70% and 74.2% in sheep and goats, which was higher than our finding [25]. However, previous studies had reported lower percentages, for example 41% mortalities in

small stock due to various causes, including disease [26] and 62% to 68% losses due to drought and diseases [27]. The annual loss due to goat disease with 11% mortality was estimated to be of Tk 870 million in Bangladesh [28].

Based on farmer's response and animal's price, the loss was estimated to be of over one million birr/43,478.3$ in this study. Only the value of animal was considered for estimating the loss due to mortality in a farm in our study. In Afar regional state, sheep and goat population is around 6.73 million (4.27 million goats and 2.46 million sheep) [29]. Therefore, death of 68.27% in sheep and 58.87% in goat population can provide a loss not in millions but in billions to small and poor farmers.

Conclusions and Recommendations

In Afar area, animal mobility is high in search of feed, water, trading and gift year-round, but particularly animal migration increases during drought season in search of pasture and water. Communal use of available resources (feed, water) and flock admixture is a common practice, which can facilitate the spread PPR. The respondents associated the incidence of PPR with the emergence of drought, with contact with wildlife and with unknown factors within the flock. In the area, our serological test indicated that PPR virus infects 41.5% of sheep and 39.3% of goat populations. However, respondents claimed that the population that contracted PPR was high in sheep (83.2%) and goat (83.74%), which is about twice of our serological findings. They also indicated that 68.27% in sheep and 58.87% in goat population die due to PPR disease. Vaccination coverage against PPR in Afar region for the last three years is lacking. Waves of PPR outbreaks are associated with massive illnesses and mortality. Thus, PPR is currently a major socio-economic animal health problem in the area. Our study provides preliminary information on PPR sero-prevalence, socio-economic impact and possible associated risk factors. Therefore, we recommend a more systematic intensive and active serological and virological surveillance programs in the area in addition to implementing intensive vaccination campaigns.

Competing Interest

The authors declare that they have no competing interests.

Ethical Clearance

Ethics approval and consent to participate Permission on ethical approval was obtained from the College of Veterinary Medicine Samara University (Ref. ERC 0012/2015).

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