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Sero-Prevalence of Pesti Des Petitis Ruminants (PPR) in Selected Districts of Hawassa Zuriya, Konso Special and Zala using Competitive ELISA (C-ELISA) Technique

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Abstract: A cross-sectional study to investigate the sero-prevalence of Peste des Petits Ruminants (PPR) was conducted between January and May, 2017 in selected districts of Hawassa Zuriya, Konso and Zala in the working areas of Sodo Regional Veterinary Laboratory. A total of 644 serum samples were collected from both the species of sheep and goats. Competitive Enzyme Linked Immunosorbent Assay (c-ELISA) was used to detect the presence of antibodies in the sera of shoats as indicator of exposure to the PPR virus. The results showed an overall individual animal sero-prevalence of 35.86% (231/644). The sero prevalence of the disease in the different districts of Konso, Hawassa Zuriya and Zala was 59.9% (182/304), 15.3% (34/314) and 12.7% (15/118), respectively where there is statistical significance difference in the different sites ($p<0.05$). The prevalence in sheep and goat was 35.6% (37/104) and 35.92% (194/540) where there is statistical significance difference in the different sites ($p<0.05$). At the same time the sero-prevalence in the young and adult goats was 32.3% (140/434) and 43.3% (91/210/1) respectively and there was statistically significant ($p<0.05$). Similarly the prevalence of the disease in male and female in both sexes was 36.4% (52/143) in male and 35.7% (179/501) in female and it was statistical significance between male and female goats ($p<0.05$). The seropre valence of PPR illustrates the endemicity in the study districts. Besides it is distribution to new areas because it is trans-boundary and uncontrolled animal movement cause detrimental effect to small ruminant rearing community thereby causing substantial economic losses, affecting the livelihood of poor farmers and pastoralists. The need for implementing feasible control measures including the implementation of national PPR control and eradication program should applied regularly to minimize the losses associated with the disease.

INTRODUCTION

Sheep and goat population in Ethiopia are estimated to be 25.5 and 22.8 million, respectively (CSA, 2012). The distribution of sheep population across different agro-ecology was reported to be an even distribution between highlands and lowlands gut goat population are found more dominant in the lowland areas of the country (Aklilu and Catley, 2010). Sheep and goats contribute 25% of the domestic meat consumption; about 50% of the domestic wool requirements about 40% fresh skins and 92% of the value of semi-processed skin and hide export trade. It is estimated that 1,078,000 sheep and 1,128,000 goats are used in Ethiopia for domestic consumption annually. The current annual off-take rate of sheep and goats is 33 and 35%, respectively (Adane and Girma, 2008). There is also a growing export market for sheep and goat and live animal. In 2010/11, the export value from sheep and goats meat and live animal were about 63 and 148 million USD, respectively (USAID., 2011).

Owing to their high fertility, short generation interval and adaptation even in harsh environment, sheep and goat are considered as an important asset of poor farmers. Small ruminants are exploited in the country for divers purpose (Abebe *et al*., 2011). However, small ruminant production and productivity and producers benefits are far below expectations due to diseases and other factors. Peste des Petits Ruminant (PPR) is one of the important diseases affecting the productivity of small ruminants (Gopilo, 2005).

Small ruminants are also a readily available source of income for households through sales of live animals, milk, meat and skins. The domestic and export trade in live animals, hides, skins and chilled carcasses generates the foreign currencies for importation and purchase of essential food items and thus, contributes significantly to ensuring food and nutritional security among the livestock-dependent communities. Sheep and goats constitute >90% of the livestock exports from the Sahel and Horn of Africa regions. Unfortunately, the production and trade and marketing of sheep and goats in Africa is seriously constrained by the continuous presence of Transboundary Animal Diseases (TADs) which limit the productivity of animals and their access to markets. These diseases often cause large financial losses, particularly detrimental to smallholder livestock keepers. Furthermore, then maintenanceand endemicity of TADs including Peste des Petits Ruminants (PPR) in parts of Africa, represents a threat to the small ruminant populations of other regions of the world which are free from these diseases (Pan African Programme, 2017-2021).

Pest des Petites Ruminants (PPR) is an acute, contagious and frequently fatal disease of sheep and goats, caused by morbillivirus related to the virus that cause cattle Rinder pest (RP), human measles and canine distemper. The disease is characterized by fever, ocular and nasal discharge, oral erosions, broncho-pneomonia and diarrhea. The severity of clinical signs, the morbidity rate and the case fatality rate can vary depending on the virulence of the virus strain, the species and the breed, concurrent infection and anti-body from previous exposure of the population to PPR Virus (PPRV) both vaccine and wild virus. Very mild, even subclinical infection is not uncommon in endemic areas (FAO., 2017).

Peste des Petits Ruminants (PPR) also known as "goat plague" is a highly contagious notifiable and economically important trans-boundary viral disease which is listed by the World Organization for Animal Health (OIE) that mainly affects sheep and goats. The disease was first described in the Ivory Coast, West Africa (Gargadennec and Lalanne, 1942) and later from sub-Saharan Africa, the Arabian Peninsula, the Middle East, Southwest Asia and other countries. Heavy losses can be seen, especially in goats with morbidity and mortality rates sometimes approaching 80-100%. At one time, peste des petits ruminant was thought to be restricted to the Middle East and limited areas of Africa and Asia. Recently, its range has expanded in both Africa and Asia. In addition, infections and clinical cases have been recognized in other ungulates, particularly antelope and wild relatives of sheep and goats but also camels and water buffalo. Some clinical cases and outbreaks in these animals have been severe and there is a risk that PPR could threaten the conservation of certain wildlife.

Transmission requires close contact between infected animals in the febrile stage and susceptible animals because of the labality of the virus outside the living host. The discharges from eyes, nose and mouth, as well as the loose feces, contain large amounts of the virus. Fine infective droplets are released into the air from these secretions and excretions, particularly when affected animals cough and sneeze (Bundza *et al*., 1988; Taylor, 1984). Animals in close contact inhale the droplets and are likely to become infected. Although, close contact is the most important way of transmitting the disease, it is suspected that infectious materials can also contaminate water and feed troughs and bedding, turning them into additional sources of infection.

In Africa today, PPR is widespread in the sub-Saharan and Sahelian zones. However, it was isolated to the Sahel, Sudan and Ethiopia until relatively recently. The eradication of rinderpest may have influenced a Southern movement which was detected first in Uganda in 2004 amongst wildlife species through serological surveillance. This was followed by the livestock outbreak in Kenya in 2006-7 and cases occurring subsequently in Tanzania. The chronological sequence of new reports of PPR gives the impression that the disease has spread steadily East-and Southwards from its origin in West Africa.

In Ethiopia, clinical PPR was suspected in 1977 in Afar region, East of the country (Pegram and Tareke, 1981; Roeder *et al*., 1994). Clinical and serological evidence of its presence confirmed in 1991 by Addis Abrham. Gelagay (1996) has reported that 14.6% of sheep sampled along 4 roads from Debre Berhan to Addis Ababa were seropositive for PPR. Waret-Szkuta *et al.* (2008) has also reported an overall sero-prevalence of 1.7% in Oromia, 21.3% in Somalia, Amhara region of Ethiopia. Most recently an overall sero-prevalence record of 30.9% from sheep and goat in pastoral and agro-pastoral area of Afar and Gambella region of Ethiopia has been reported Megersa *et al*. (2011).

Small ruminants in this country mainly thrive on free-range pasture land, shrubs and forest cover. Due to the shrinkage in pasture land and forest area these animals move to long distance in search of fodder and water during dry season. This phenomenon is common due to different Summer and Winter grazing grounds depending upon the altitude. PPR is transmitted through direct contact between infected animal and susceptible population. During nomadism, animal scome in contact with local sheep and goat population from where they pick up the infection or spread disease if nomadic flock is pre-exposed. Therefore, migratory flocks play an important role in transmission epidemiology of PPR. Movement of animals and introduction of newly purchased animals from the market also play an important role in transmission and maintenance of the virus. This could be one of the possible reasons for higher frequency of PPR outbreaksbetween March to June (Gopilo, 2005) which also correspond to lean period of kidding. Although, seasonal occurrence of PPR virus outbreaks is disputed, disease transmission is certainly affected by animal movement for which socioeconomic factors and variations in agro climatic conditions are responsible. Large group of animals move to large areas and even between 58 different districts. With the start of rains, the movement of animals is restricted due to the easy availability of local fodder. Nutritional status of the animals also gets improved during the rains. This may reduce disease transmission after the start of rains and during the period of easy availability of fodder. Similar, observations were also recorded in tropical humid zone of Southern Nigeria during a period of 5 years of observations (Taylor, 1984).

In view of its socio-economic importance, PPR is targeted to be eradicated from the planet by 2030. To this end, global, continental, regional and national strategies for its control and eradication have been developed by FAO and OIE (2018). Ethiopia like other countries has joined this line with the ambition of eradicating the disease by 2025. The success of this fight requires a better knowledge of the epidemiology of the disease including its prevalence and its geographical distribution. The present study aims at determining the sero-prevalence of PPR using Competitive ELISA (C-ELISA) and knowing its geographical distribution that can be used to help in progressive control and possible eradication of the disease. Therefore, the objective of this study was to determine the sero-prevalence of Peste des Petits Ruminant's (PPR) in goats and sheep by using PPR C-ELISA tests on sera samples of small ruminants.

MATERIALS AND METHODS

Study animals: The study animals will be goats and sheep of different age groups and the age group of sampled animals will be in the range of 1-3 years to rule out maternal immunity (>1 year) and to discover recent infection (<3 year). Accordingly 644 (104 sheep and 540 goats) was examined for PPR sero-prevalence study. The number of goats to sheep ratio is higher because relatively in the study area goats are more reared than sheep.

Study area

Hawassa Zuria district: The Hawassa Zuria district (07° 01 54"-07°50 36"N and 38°15 39"-38°25 43"E) is located 290 km from Addis Ababa in the Sidama zone, Southern Nations, Nationalities and People's Region (SNNPR) of Ethiopia, bordering Tula town in the East, Lake Hawassa in the North, the Oromia region in the West and the Boricha district to the South. This district has a total population of 124,472 of whom 62,774 are men and 61,698 women (CSA., 2007). The altitudinal range is 1700 m to 1850 masl. The annual mean maximum and minimum temperatures are 30 and 17°C, respectively and the mean annual rainfall is 1015 mm. The size of the district is 22,643 ha and the dry zone accounts for 75% (SZFEDB., 2003) and consists of 23 kebeles (farmer's associations).

Konso special district: Konso is one of the woredas in the Southern Nations, Nationalities and People's Region (SNNPR) of Ethiopia. Prior to 2011, Konso was not part of any zone in the SNNPR and was therefore, considered a special woreda an administrative subdivision which is similar to an autonomous area. In 2011, the Segen area peoples zone was established which includes Konsoworeda and the 3 former special woredas surrounding it. The area is located in 50 20'00"N latitude and 37010'00'E longitudes. Located in the Great Rift valley, Konso is bordered on the South by the Oromia region on the West by the Alle special woreda which separates it from the Alle special woreda, on the North by the Dirashe special woreda on the Northeast by Amaro special woreda and on the East by Burji special woreda. The Sagan river which flows South then West to join the Weito, defines part of the woreda's boundary with Burji and the entire length of the boundary with the Oromia region. The administrative center is Karati; other towns in Konso include Fasha and Sagan.

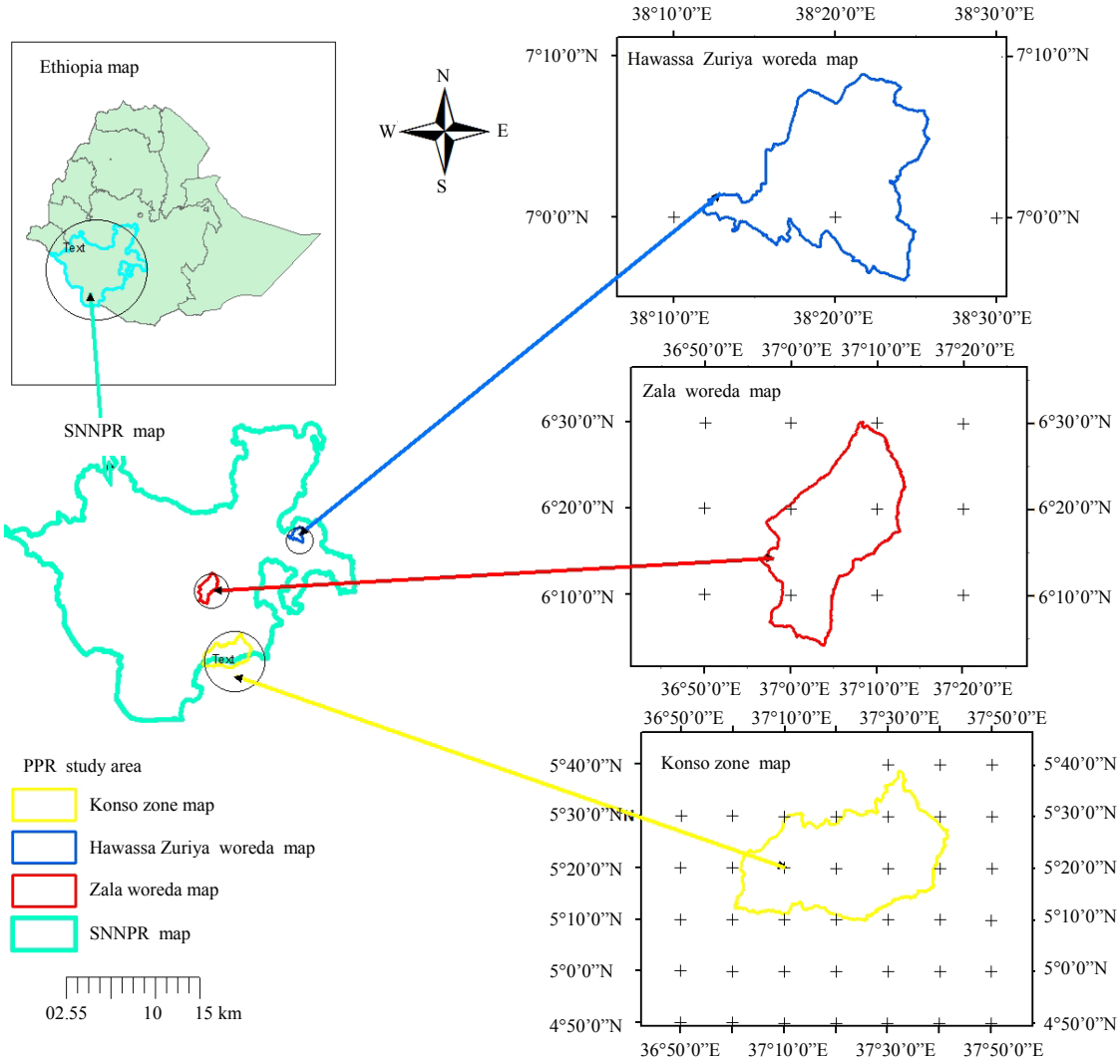

Fig. 1: Map of the study area

Zala district: A Zala district is a part of Gamo Gofa zone and located in the Southern nation nationality and people regional state of Ethiopia. Zala is bordered by on the South and South West by Uba Debretsehay and Kemba districts on the North and North East by Demeba Gofa and Kucha districts on the East by Deremalo districts and on the West by Uba Debretsehay districts. The districts are located 810 km from Addis Ababa, 284 km from regional city Hawasa and 240 km from zone. Population numbers of the districts were estimated to be 92,666 and Agro ecologically Zala is divided in to low land (Kolla) 90% and midland (Weyena Dega) 10%. The geographical location lies within the co-ordinates of 06°04'-14°00' North altitude and 36° 27'-37°32' North latitude and -36° 58'-14°20' East altitude and 36°37'-13°30' East longitude. The altitude of Zala districts longitude ranges from 6.46-7.26 masl. and the latitude range is 36.32-36.87 masl maximum and minimum rainfall of the district is 900 and 1700 mm, respectively. The temperature variation of Zala districts were between 18-32°C.

Study design and sampling strategy: A cross sectional study was conducted from January-May, 2017 to investigate the sero-prevalence of Peste des Petitis Ruminants (PPR) in goat and sheep in selected districts of different zones of SNNPR. Peasant association was selected randomly. A multi stage simplerandom sampling was used for selection of animals from individual households. First the threestudy districts were selected purposely. Then a list of Peasant Associations (PAs) within district was obtained from the districts livestock and fishery office (second stage) and sampling PAs was selected based on representation of the respective districts and accessibility. Villages were selected by purposive

sampling on the basis of prior information, i.e., vaccination status (unvaccinated), farmer's cooperation, logistics, share of communal grazing land and accessibility (Third stage). Finally, animals were examined to test the occurrence ofthe disease in the selected areas. Concerning the agecriteria, goats and sheep will be divided between two categories of individuals where young (<6 months of age) and adult individuals are considered also belonging to the local breed.

Sample size: The sample size is determined by using expected previous prevalence of 50% according to the formula given by Thrusfield (2005). The age group of sampled goats and sheep range in 1-3 years to rule out maternal antibody (>1 year) and to discover recent infection (<3 years):

$$N = \frac{1.962\, p_{exp}\left(1\text{-}p_{exp}\right)}{d^2}$$

Where:
n : Required sample size
P_{exp} : Expected Prevalence (%)
d : Desired absolute precision (%)

Due to absence of previous study findings in the area, a total of 384 goats and sheep required but to increase the precision the number of sheep and goat sampled was increased to 644s.

Sample collection: Blood samples was collected randomly from sheep and goats of age >1 year that had no previous history of vaccination against PPR and a total of 644 consisting of 540 goats and 104 sheep was sampled and the age of the animals was determined by dentition (pair of permanent incisors) for collection of serum samples 4 mL of blood from the jugular vein of sheep and goats were collected using plain vacutainer tubes and the blood was put at room temperature for about 24 h in tilted position. After 24 h the serum was harvested using cryo-vials and put in the refrigerator and kept on ice for transportation to the laboratory. In the laboratory, the serum was centrifuged for 2000 rpm for 5 min to remove the remaining red blood cells before being transferred to 2-mL cryo-vials and stored at -20°C.

Laboratory examination

Competitive ELISA (Competitive Enzyme-linked Immunosorbent Assay): The diagnostic kit is designed to detect antibodies directed against the nucleoprotein of the Peste des Petites Ruminants (PPR) virus. All the reagents and samples come to room temperature (21°C+/5°C) before testing the sample. Serum samples were analyzed by sodo regional veterinary laboratory (SRVL,Wolaita sodo, Ethiopia) using a competitive ELISA kit according to the instructions of the manufacture. PPR c-ELISA kit was used for detection of PPRV antibodiesin terms of Percentage Inhibition (PI) as per the method described earlier (Libeau *et al*., 1995). Briefly, ELISA plates (CIRAD-EMVT, Montpellier, France) were coated with the PPRV antigen (96 wells). After addition of 25 mL of dilution buffer 13 to each well, 25 mL of the positive control to wells A1 and B1, 25 mL of the negative control to wells C1 and D1, 25 mL of each sample tobe tested added to the remaining wells. After incubation for 45 min (+/4 min) at 37ºC (+/3ºC) the wells were washed three times with 300 mL wash solutionof Phosphate-Buffered Saline (PBS). Then the 100 mL of prepared conjugate solution in dilution buffer 4 in 1:10 was added and incubated for 21°C (+/_5ºC) to and washed with 300 mL of wash solution three times.

Finally, 100 mL substrate solution was added and incubated for 15 min (+/_2 min) for 21°C (+/_5ºC) in each well and color reaction was developedfor 10 min before stopping the reaction with 100 mL of stop solution to each well in order to stop the reaction. For the test be valid the mean value of the negative control OD (OD_{NC}) is >0.7 OD_{NC}>0.700 and the mean value of the positive control (OD_{pC}) is less 30% of the OD_{NC} OD_{PC}/OD_{NC}<30%. And OD was measured at a wavelength of 492 nm:

$$S/N\% = \frac{OD\,sample}{OD_{NC}} \times 100$$

Samples presenting S/N%:

- ≤50% are considered positive
- >50% and ≤60% are considered doubtful
- <60% are considered negative

The samples with PI>50% (cut-off) were considered as positives.

Data analysis: All epidemiological information collected as raw data were entered in Microsoft Excell spread sheet 2010 to calculate the frequency of PPR samples with respective attributable factors of origin of animals, species, age and sex. Chi-square test (χ^2) was used to test the significance of proportions between animals tested negative and those tested positive. t-test for multiple regressions (Logistic model) at 95% CI was used to see the correlation between the serological statues of animal with the risk factors associated with PPR transmission.

RESULTS AND DISCUSSION

Overall prevalence of peste des petits ruminants: Of the 644 blood samples examined using CELISA by serology, 231 tested positive for PPR, representing a prevalence of 35.86%. The prevalence in goats and sheep was almost similar 35.92% in sheep and 35.6% in goats and statitistically significant difference (p = 0.000). (Table 1).

Table 1: Relationship between PPR sero-prevalence in different districts

Districts	Total No. of examined animals	Total No. of positives (Prevalence) (%)	Confidence intervals 95%	χ^2	p-values
Hawassa Zuria	314	34 (15.3)	CI = 178-189	χ^2 = 144.39	p = 0.000
Konso special	304	182 (59.9)			
Zala wereda	118	15 (12.7)			
Total	644	231(35.9)			

Table 2: Relationship between species and sero-prevalence of PPR

Districts	Species	Total No. of examined	Total positive in (prevalence) (%)	Confidence intervals 95%	χ^2	p-values
Hawassa	Caprine	179	26 (14.50)	CI = 113-119	χ^2 = 165.94	p = 0.000
	Ovine	43	8 (18.60)			
Konso	Caprine	243	153 (63.00)			
	Ovine	61	29 (47.50)			
Zala	Caprine	118	15 (12.70)			
	Ovine	0	-			
Total	Caprine	540	194 (35.92)			
	Ovine	104	37 (35.60)			

Table 3: Relationship between sero-prevalence of PPR and age

Districts	Age groups	No. of examined animals	Total positive (prevalence) (%)	Confidence intervals 95%	χ^2	p-values
Hawassa Zuria	Young	170	29 (17.0)	CI = 129-136	χ^2 = 85.24	p = 0.000
	Adult	52	5 (9.6)			
Konso special	Young	150	98 (65.3)			
	Adult	154	84 (54.5)			
Zala	Young	114	13 (11.4)			
	Adult	4	2 (50.0)			
Total	Young	434	140 (32.3)			
	Adult	210	91 (43.3)			

Table 4: Relationship between sero-prevalence of PPR and sex

Districts	Age groups	No. of examined animals	Total positive (prevalence) (%)	Confidence intervals 95%	χ^2	p-values
Hawassa Zuria	Male	69	13 (18.8)	CI = 174.5-181	χ^2 = 85.24	p = 0.000
	Female	153	21 (13.7)			
Konso special	Male	49	34 (69.4)			
	Female	255	148 (58.0)			
Zala	Male	25	5 (20.0)			
	Female	93	10 (10.7)			
Total	Male	143	52 (36.4)			
	Female	501	179 (35.7)			

Prevalence of peste des petits ruminants according to location: The prevalence of PPR in sheep and goats varied between sampling areas. In all the three districts (Konso, Hawassa Zuriya and Zala) of the study area true prevalence in goats was higher than in sheep. The prevalence in the Konso district 59.9% was higher than that of Hawassa Zuriya district 15.3% and Zala district 12.7%. The difference was statistically significant (p = 0.000) (Table 2).

Prevalence of peste des petits ruminants according to age: Except in Konso district, the prevalence of PPR in adults is higher than younger population. In Konso district, positive cases and prevalence in younger is higher than adults and the difference was statistically significance (p = 0.000) (Table 3).

Prevalence of peste des petits ruminants according to sex: The prevalence of PPR in female sheep and goat was approximately similar 36.4% (n = 179) (although, statistically significant p = 0.000) to male sheep and goats 35.7% (n = 52) in all three districts However, the it be explained by the disease status in both sexes has equal ratio, since, male and female graze together with equal chance for virus exposure (Table 4).

The current study finding revealed that the overall sero-prevalence rate of 35.86%. This result indicated that the disease has important portion in the study districts of Hawassa Zuriya, Konso and Zalla which needs particular attention of Sodo Regional Veterinary Laboratory working areas as it is one of the most economically important disease affecting both productivity and production. The overall sero-prevalence of 35.86% observed in the current study was lower than the report of

46.53 in Southern parts of Tigray region, Ethiopia, 52.5% from Somalia region, Ethiopia (Waret-Szkuta *et al*., 2008). Moreover, the result of the current study is also lower, compared to the findings 41.21% in India (Balamurugan *et al*., 2014), 45% in Republic of Niger, 52.9 (+/_1.6%) A Republic of Chad of 55% in Nigeria (El-Yuguda *et al*., 2013), 55.95% in Saudi Arabia (Elshemey and Mahmoud, 2011), 57.6% in Uganda (Mulindwa *et al*., 2011) and 61.8% in Sudan (Abdalla *et al*., 2012). Other hand, the current finding is higher compared to the study findings of 29.2% by Gizachew, (2018) in Silti and Meskan districts of Southern Ethiopa, 30.5% by Jilo, (2016). A standard review in Ethiopia, Banik *et al*. (2008) in Bangladesh with the prevalence of 25% and Singh *et al*., 2004 in India reported the prevalence of 33%. The difference in Agro climatic conditions, cultural and social practice could the reason for the variations between the current report and the previous report.

The study findings revealed that statistically significant (p = 0.000) difference among the three study districts but higher sero-prevalence was observed 59.9% in Konso district followed by Hawassa Zuriya and Zala districts comprising the prevalence of 15.3 and 12.7%, respectively. This could possibly be explained as difference in geographical location, various forms of stress factors as predisposing factors, management and/or infectious factors and the high prevalence in Konso is because bordering of Konso district with pastoralist areas of Bena-Tsemay, Hamer, Alle districts and pastoral and agro-pastoral areas of Borena zones of Oromiya region which have high movement of animals.

The study showed that sero prevalence rate in sheep 35.6% (n = 37) is almost similar prevalence rate in goats 35.92% (n = 194) and statistically significance difference exists (p = 0.000). But different observation made by other authors in different parts of the globe in Ethiopia; Sow *et al*. (2008) in Northern Burkina Faso; Mahamat *et al*. (2018) in Republic of Chad and Balamurugan *et al*. (2014) in India as the prevalence rate in sheep is higher than goats. Other studies have revealed the reverse as Gizachew (2018) in Silti and Meskan districts Tamirat *et al*. (2017) in Bench Maji zone, Ethiopia; in Republic of Niger; Awa *et al*. (2002) by Cameroon and Singh *et al*. (2004) in India they identified higher prevalence in goats than sheep. These varying results show that the sensitivity to PPR is not necessarily linked to the given species of small ruminants but rather to rearing conditions and other individual factors and equal chances of exposure to the virus as long as they were managed and grazing together.

The findings of our current study revealed that in general, the sero-prevalence rate is higher in adult animals than in younger ones. This is again in agreement with other researchers who reported (Tounkara *et al*., 1996; Sow *et al*., 2008; Balamurugan *et al*., 2014 Tamirat *et al*., 2017, Gizachew, 2018; Mahamat *et al*., 2018). But the findings contradicts with that by Sauaibou etc. who reported the the more prevalence rate in younger animals than adult. It is because of the reason that the older the animal, the more likely it is to have contracted PPR virus because of long time exposure in the circulating virus. This is probably reinforced by livestock management. Typically, young animals graze around the camp/home while adults are driven at long distances in search of pastures and drink in pools or rivers where animals from the area infected with the virus coalescences which promote their exposure to the PPR virus.

The study revealed that the overall (all three districts) sero-prevalence for male 36.4% (n = 52) was almost similar as in females 35.7% (n =179) and male konso 69.4% (n = 34), Hawassa 18.8% (n = 13), Zala 20% (n = 5) and female Konso 58% (n =148), Hawassa 13.7% (n = 21), Zala 10.7% (n = 10), respectively. Similar study work conducted by Gizachew, 2018 who reported 29.6 % in males and 28.66 % in females and significant difference in sero-positivity between males and females of small ruminants tested ($p<0.05$). But this significance has no biological exposure plausibility for PPR disease between two sexes and agrees with Elhag *et al*. (2005) findings that the sex of animals had no effect on the development of PPRV antibodies.

CONCLUSION

The present findings of 35.68% prevalence indicates the significance proportion of the virus is still circulating in the study districts specially those agro-pastoral areas sharing similar epidemiology with pastoral border due to uncontrolled livestock movement in search for feed and water is a bottleneck for disease control and prevention efforts. Coordinated efforts of the government, awareness creation about the devastating nature of PPR disease to the society, mobilization of resources, implementing national control and eradication program beyond the pastoral area would reduce the detrimental effect and thereby reduce the burdens of the disease on the small ruminant keeping community. Besides further study including the isolation of PPRV lineages is helpful in the progressive control and prevention measures to be applied.

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