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Seroprevalence and postmortem lesions of contagious bovine pleuropneumonia in selected abattoirs and dairy farms in South Wollo Zone, Northeast, Ethiopia

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Abstract: Contagious bovine pleuropneumonia is a highly contagious respiratory disease of cattle. A cross-sectional study was conducted from December 2019 to August 2020 to determine the seroprevalence, suggestive lesions prevalence, and factors associated with contagious bovine pleuropneumonia in selected abattoirs and dairy farms of the south Wollo zone, Ethiopia. A total of 384 (local and cross-breed) animals, 192 from dairy farms and 192 from abattoirs were selected using simple random and systematic random sampling techniques res pectively. For serological investigation, blood samples were collected from each animal, and sera were harvested and subjected to competitive-enzyme-linked immunosorbent assay (c-ELISA at the National Veterinary Institute of Ethiopia. Of the 384 sera, thirteen (13/384) were found to be positive with an overall prevalence of 3.4%. Seroprevalence of contagious bovine pleuropneumonia (CBPP) was statistically significantly associated with body condition (P-value =0.001, OR=9.7) and age (P-value= 0.037, OR= 3.28). However, the sex, breed, and origin of the animals were not statistically significantly associated with the occurrence of CBPP. Regarding the abattoir survey, all 192 blood-sampled animals were subjected to postmortem examination, and contagious bovine pleuropneumonia suggestive lesions were identified in the lungs of 10 animals and the abattoir survey prevalence was calculated as 5.2%. In the present study, contagious bovine pleuropneumonia suggestive lesions were observed in all seropositive animals and three seronegative animals. This indicated that there was strong test agreement between c-ELISA and postmortem examination (Kappa = 0.816) in the diagnosis of the disease. In postmortem examination of the lungs, suggestive lesions including marbling, hepatization, pleural adhesion, and yellowish fluid in the thoracic cavity were the main gross pathologies. The present findings seem lower but the contagious nature of the disease and its economic significance make it worse so appropriate prevention measures such as annual immunization, movement restriction, and proper management practices should be implemented and continued surveillance at the abattoirs and subsequent epidemiological investigation of suspected cases should be done.
Keywords: Abattoir, Contagious bovine pleuropneumonia, Dairy farm, Pathology, Seroprevalence, South Wollo.

1. Introduction

The livelihood of the majority of communities in Ethiopia depends on agricultural products in general and livestock in particular (Solomon et al., 2003), and the livestock sector has a higher contribution to the national and agricultural gross domestic products (GDP) of the country (Leta and Mesele, 2014; Solomon et al., 2003; Tesfaye and Gutema, 2021). Among the livestock species that are found in Ethiopia, cattle are the most populated and important livestock species (Metaferia et al., 2011; Tesfaye and Gutema, 2021). They are used as a source of draft power, milk, meat, manure, and cash income and also have socio-cultural value, especially for the pastoral and agro-pastoral communities of Ethiopia (Andualem, 2016; Tesfaye and Gutema, 2021).

According to a recent estimation by a central statistical agency, Ethiopia is home to more than 70 million cattle population (CSA (Central Statistical Authority), 2021). However, the country does not benefit from the industry as much as the number of cattle can provide. This might be due to many reasons and animal diseases are among the major constraints. With a high rate of morbidity and mortality, contagious bovine pleuropneumonia (CBPP) is one of the most economically important cattle diseases (Tesfaye and Gutema, 2021). Feed and water shortage (Drought), overcrowding at watering and feeding areas, and the high sensitivity of animals could all make this disease more severe (Tesfaye and Gutema, 2021; World Bank, 2016).

Contagious bovine pleuropneumonia (CBPP) is a highly contagious disease of cattle caused by *Mycoplasma mycoides subsp. mycoides small colony* (SC). Inappetence, increased body temperature, and respiratory signs are the characteristic manifestations of the disease (OIE, 2021; Tesfaye and Gutema, 2021). It is principally transmitted by inhalation of infective droplets and outbreaks are more extensive in stressed animals (Radostits et al., 2007; Tesfaye and Gutema, 2021). Factors such as agedness, stress, and co-morbidities may predispose to the severe form of the disease. It is considered to have economic because of its high mortality rate, production loss, increased production cost, reduced plowing ability, reduced productivity, and loss of international trade income (Radostits et al., 2007; Tambi et al., 2006; Tesfaye and Gutema, 2021). As a result, the World Organization for Animal Health, WOAH declared it as one of the most economically important, notifiable, and transboundary animal diseases (TAD) (FAO, 2002). The disease is enzootic in Africa (FAO, 2002; Tesfaye and Gutema, 2021; Wade et al., 2015).

Since 1992/93, Ethiopia has conducted yearly CBPP vaccination in conjunction with render pest eradication campaigns (Tesfaye and Gutema, 2021). As a result, the disease's prevalence remained relatively modest. However, the vaccine against CBPP was discontinued after render pest was eliminated, which permitted CBPP to re-emerge and generate significant losses owing to an increase in epidemics and mortality (Admassu et al., 2015).

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In many African countries including Ethiopia, control of CBPP is based only on vaccination of the susceptible animals and treatment of diseased animals. But other continents use early diagnosis, cattle movement restriction or quarantine, and test and slaughter strategies to control the disease (OIE, 2021; Radostis et al., 2007; Tesfaye and Gutema, 2021). Moreover, in many developing countries the disease persists even if the cattle are vaccinated. This might be associated with ineffective vaccination, inadequate vaccination coverage, unrestricted cattle movement, and lack of disease surveillance strategy (Tesfaye and Gutema, 2021). Therefore, to control the disease effectively, the epidemiological scenario of the disease should be well-determined. In Ethiopia, different epidemiological investigations have been conducted since 2006 on CBPP and reported seroprevalence of 0.4%-55% (Alemayehu et al., 2015; Aliyi et al., 2018; Atnafie et al., 2015; Ebisa et al., 2016; Minda et al., 2017; Teklue, 2015).

Contagious bovine pleuropneumonia affects cattle productivity, production, and health through direct losses and indirect losses. Direct losses are visible losses which include mortality and morbidity losses, while indirect losses are invisible and include the cost of managing the disease in herds, its effect on international and domestic trade, and socio-cultural losses (Tambi et al., 2006; Tesfaye and Gutema, 2021). CBPP has been causing significant economic losses in the agricultural sector and the national economy of Ethiopia. It accounts for a loss of over 8.96 million US dollars per year (Tesfaye and Gutema, 2021). Moreover, as indicated in the 2015/20 strategic livestock Roadmaps for growth and transformation based on its impact on the livelihood of farmers, livestock markets and value chains, and intensive system of production, CBPP is the 2nd most important prioritized transboundary animal disease next to FMD and has denied the country's access to international markets and makes it vulnerable to trade bans (Jibat et al., 2013; Tesfaye and Gutema, 2021). There was a previous report of CBPP in the neighboring region of Afar (Gulima, 2011). The presence of cattle migration during the drought season from neighboring regions to zones of the eastern part of the Amhara regional state of Ethiopia might lead spread of the disease to the study area. However, there is no sufficient information and research work regarding its predisposing factors and prevalence in the south Wollo zone of the country. Hence, it is important to quantify the extent of the disease using different diagnostic techniques. Thus, the present study was initiated and designed to determine the seroprevalence and prevalence of lesions, an association of potential disease determinants of CBPP in selected abattoirs and dairy farms in south Wollo zone, northeast Ethiopia.

2. Materials e Methods

2.1. Study areas

The study was conducted in the south Wollo zone, Amhara region, Ethiopia. It is bordered on the south by north Shoa and the Oromia region, on the west by east Gojjam, on the northwest by south Gondar, on the north by the Wollo, on the northeast by Afar region, and the east by the Oromia Zone and the Argobba special woreda. It is situated between 10°15'–11°30' N and 38°25'–39°30' E (Figure 1), has a total landmass of 17,067 km^2 and 24 districts. Elevation varies from 1,000 (Chefameda) to 4,247 (Amba Ferit) meters above sea level. The annual range of temperature and rainfall are 10–25 °C and 900-1200 mm respectively. It is a home for 1,952,374 head of cattle, 1, 538,406 sheep, 1,390,763 goats, 734,607 equines, 1,965,306 poultry, and 156,088 bee hives (CSA (Central Statistical Authority), 2021). The Zone has the second highest livestock population in Amhara National Regional State. It is constrained by economic livestock diseases like lumpy skin disease, fasciolosis, reproductive problems, internal and external parasites, and other zoonotic diseases which can cause financial losses (Hassen et al., 2019).

Dessie is located 401km northeast of Addis Ababa on the main road from Addis Abba to Mekele at 11°07′59.81¨N and 39°37′ 59.83¨ E (Figure 1). It is the main town and the capital city of the south Wollo zone. It has an elevation ranging from 2400 - 2550 m above sea level. Its temperature ranges from 11.7°c and 24°c and its average relative humidity is about 60%. Its average rainfall is 1150 mm and experiences bi-modal rainfall patterns with a short rainy season from February to March and a long rainy season from the end of June to September (Ethiopian National Meteorology Service Agency, 2014). Dessie municipal abattoir, which has the highest slaughtering capacity (~20/day on average) in south Wollo zone, is located in this town. In addition, there are around seven legally registered dairy farms in Dessie (Dessie Town Administration Urban Agriculture Office, 2019).

Kombolcha is found 375 km far from the capital city of Ethiopia in the northeast direction. The geographical location of the town is at 11°08′ N and 39° 73′E (Figure 1) with the altitude ranging from 1500 to 2600 m above sea level. The daily temperature ranges from 19.5°c to 27.5ºc. The mean annual rainfall of the area is 1150 mm (Ethiopian National Meteorology service agency, 2014). Kombolcha is a town where one municipal abattoir, one private (ELFORA agro-industries plc.) abattoir, and a regional laboratory are located. The report on animal production of the Kombolcha Agriculture Office (KAO) indicated that more than 140 legally registered dairy farms are found in the town (Kombolcha Town Urban Agriculture Office, 2019).

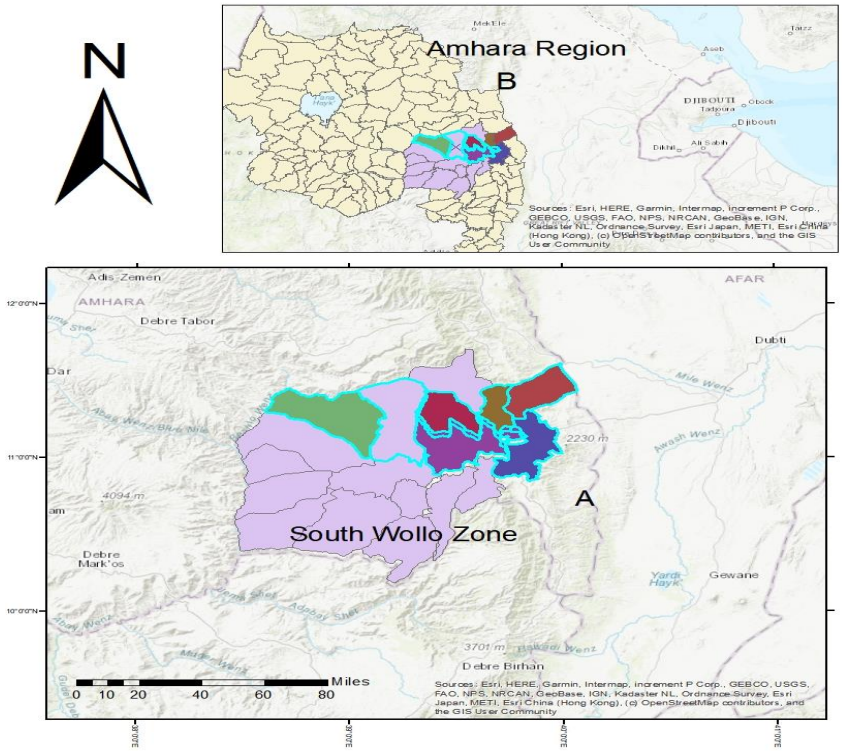


Figure 1 – Map of the study area (A) Districts in south Wollo zone where animals for slaughter originated (Werehimeno (Green), Kutaber (Rose), (Dessie Zuria (Purple), Tehuledere (Brown), Kalu (Blue) and Werebabu (Red); (B) map of Amhara region, which is one of the regional states in Ethiopia where the present study areas are located.

2.2. Study animals

The study animals were cattle presented for slaughtering in municipal and ELFORA abattoirs in the study area and cattle kept in the intensive dairy farms of Dessie and Kombolcha towns which were not vaccinated for the last twelve months without discrimination of their sex, breed, and body condition. Calves that were under the age of six months were not included as a sampling unit. The dentition of the animals was used to determine the age and categorized as, young (< 2 years), adult (2–5 years), and old (> 5 years (Pope, 2019). Breed of animals were distinguished by their phenotypic characteristics and body condition score was made based on the condition of observable body parts such as spins, ribs etcetera and registered as poor, medium, and good accordingly (Nicolson and Butterworth , 1986).

The objective and importance of the study were justified and explained to the farm owners, focal groups, and abattoir managers. Then only volunteer farm owners were included in the study. The authors confirm that informed consent was made with dairy farm owners in the two towns and abattoir managers to use the animals for the research. The sample collection was made considering the humane way; reducing pain and stress on the sampling animals with verbal communication and consent with owners.

2.3. Study design and period

The study was conducted cross-sectionally from December 2019 to August 2020 to study the prevalence of CBPP and associated risk factors on selected dairy farms, municipal and ELFORA abattoirs.

2.4. Sample size determination and sampling techniques

The total number of cattle required for the present study was determined based on the formula given by (Thrusfield, 2013). When there is no previous information regarding the prevalence of contagious bovine pleuropneumonia in the study areas it is obvious to assume 50% expected prevalence with 5% desired level of precision and 95% of the confidence interval for the maximum sample.

$$N = \frac{1.96^2 \times Pexp(1 - Pexp))}{D^2}$$

Where N= Sample size, Pexp= expected prevalence, d= desired absolute precision. Therefore, the total number of animals considered for this study was 384.

An equal number of animals were examined both from the abattoirs and dairy farms. For the abattoir survey only, cattle originating from the South Wollo zone were selected, and then a systematic random sampling technique was used to select sampled animals. The proportion of cattle for Dessie municipal and Kombolcha ELFORA abattoirs was calculated based on their daily slaughtering capacity. During the study period, the average daily slaughtering capacity of Dessie municipal and Kombolcha ELFORA abattoirs was 20 and 85 heads respectively. However, most of the cattle slaughtered in the Kombolcha ELFORA abattoir originated from the north Wollo zone and those that originated from the south Wollo zone were few in number. So, the samples taken from Kombolcha ELFORA abattoir were lower than from Dessie municipal abattoir.

152 legally registered dairy farms from both Dessie and Kombolcha towns were obtained from the urban agricultural offices. Off these, 23 dairy farms were selected randomly using the list of farms as a sampling frame. Those farms where the owners were not willing to give samples were replaced by another. Finally, sampled animals were selected from each farm using a simple random sampling technique and the proportion of study animals in each dairy farm was weighted according to their herd size. In the selected dairy farms, the minimum and maximum herd sizes were 6 and 45 respectively.

2.5. Sample collection, transportation, and storage

2.5.1. Blood sample collection

Both in the abattoirs and dairy farms, the associated risk factors such as age, breed, sex, body condition and origin, as well as herd size (only for dairy cattle), were determined and recorded. Then 5 ml of whole blood samples were collected using plain vacutainer tubes fitted with the needle through jugular vein puncture. The collected whole blood was placed in slanted position and allowed to clot for 2 hours at room temperature. Sera were separated/harvested from the clot by centrifugation at 3000 rpm for 10 min and transferred to Eppendorf tubes. Then the separated sera were labeled and then frozen at -20^{o}C until submitted to the National Veterinary Institute (NVI) of Ethiopia for serological test.

2.5.2. Tissue sample collection

In the abattoirs, all the 192 blood sampled animals were subjected for postmortem examination and during necropsy a total of 10 approximately 5 cm tissue samples from suspected/affected lungs were collected by adding some normal tissue and fixed in 10% neutralized buffered formalin (Swai et al., 2013) for detailed histopathological investigation at National animal health diagnostic and investigation center (NAHDIC), Sebeta.

2.6. Diagnostic techniques

2.6.1. Competitive enzyme-linked immunosorbent assay (c-ELISA)

The separated sera were transported to NVI for serological investigation. Serum samples were examined by c-ELISA for the presence of *Mycoplasma mycoides subsp. mycoides* small colonies antibody using a specific monoclonal antibody to identify CBPP seropositive and negative animals following the manufacturer's (IDEXX Europe, the Netherlands) kit instructions/ protocol (Annex 1) (Hurisa, 2015).

2.6.2. Gross pathological examination

All blood-sampled animals at ante-mortem examination were subjected for postmortem examination and their lungs and associated lymph nodes were examined grossly by visualization, palpation and incision. Identification of changes in affected lungs were conducted depending on their size, color, consistency and shape, as well as other gross abnormalities were recorded and characterized (Swai et al., 2013).

2.7. Data management and analysis

All the collected data were entered and coded to Microsoft Excel spread-sheet and statistical analysis was carried out using SPSS version 20 of United States of America (Cambridge, USA). A descriptive statistic was used to determine the prevalence of the disease in the study area. Categorical data were expressed in percentages, and prevalence was calculated by dividing the number of positive samples by the total samples examined. Binary logistic regression was computed to see the association of the risk factors with the occurrence of CBPP and a 95% confidence interval (CI), odds ratio was used to determine the degree of variation in the occurrence of the disease within the groups of associated factors. For the abattoir survey the test agreement between serological test and postmortem examination was analyzed using Kappa statistics. For all analysis, a p value < 0.05 was taken as significant.

3. Results

3.1. Serological result

3.1.1. Overall seroprevalence of contagious bovine pleuropneumonia

Out of 384 sera tested with c- ELISA thirteen (n = 13) sera were found to be positive with an overall seroprevalence of 3.4 %. Among 192 sera tested from each study site (dairy farms and abattoirs), 6 (3.1%) and 7 (3.65%) were found positive, respectively. In this study, there was no statistically significant difference ($p > 0.05$) in the seropositivity of CBPP between animals in the abattoirs and dairy farms.

3.1.2. Logistic regression analysis of potential risk factors of contagious bovine pleuropneumonia

Old age group animals had the highest seroprevalence (6%) and there was a statistically significant difference observed among age groups and the occurrence of CBPP in this study ($p < 0.05$). The odds of CBPP seropositivity in older animals were 3.28 times more likely than in the other age groups. High prevalence of CBPP was recorded in poor (13.5 %), followed by medium (2.1 %), and low prevalence was obtained in animals that had good body condition (1.6%). There was a statistically significant difference in the occurrence of CBPP among the three body condition categories ($p < 0.05$). Odds of seropositivity to CBPP in animals categorized in poor body condition were 9.7 times more likely than the others (Table 1).

The proportion of CBPP was higher in females than in males and local breed animals than cross breeds. However, the difference was not statistically significant ($p > 0.05$). The associations of seropositivity to CBPP among selected districts were shown by logistic regression analysis and there was no statistically significant variation ($p > 0.05$), but the highest proportion of seropositive animals was reported in Werehimeno; however, no seropositive animal was found in animals originated from Kutaber and Werebabo (Table 1).

Risk factors	Category	No of Animals	No (+) animals (proportion)	P Value	**OR (95% CI)**
Sex	Male	185	6(3.2)	0.882	0.92 (0.30 -2.79)
	Female	199	7(3.5)		
Age	Young	76	1(1.3)	0.037	3.28 (1.07 -10.03)
	Adult	126	1(0.8)		
	Old	182	11(6)		
Body conditions	Poor	52	7(13.5)	0.001	9.7 (1.64 38.06)
	Moderate	142	3(2.1)		
	Good	190	3(1.6)		
Breed	Local	194	8(4.1)	0.425	0.63 (0.20 -1.95)
	Cross	190	5(2.6)		
Origin	Dessie Zuria	76	2(2.6)	0.803	1.03 (0.80 – 1.33)
	Kalu	30	1(3.3)		
	Tehuledere	56	2(3.6)		
	Werebabo	4	0(0)		
	Kutaber	7	0(0)		
	Werehimeno	8	1(12.5)		
	Dessie	41	2(4.9)		
	Kombolcha	162	5(3.1)		
Cattle location	Cattle from farms	192	6(3.1)		
	Cattle in abattoirs	192	7(3.6)	0.775	0.85 (0.28 -2.59)
Total		384	13(3.4)		

OR= Odds ratio (odds of the disease in older animals and animals having poor body condition was more likely)

Table 1 – Logistic regression analysis on the seroprevalence and potential risk factors of contagious bovine pleuropneumonia in south Wollo zone, northeast Ethiopia in 2020.

3.2. Abattoir survey result

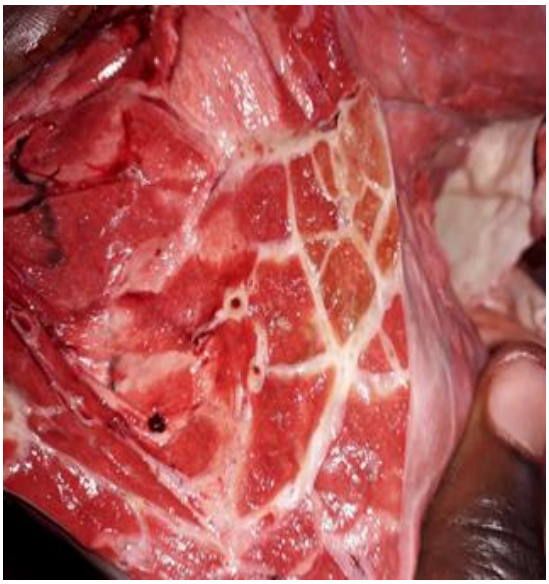
3.2.1. Prevalence of contagious bovine pleuropneumonia lesions in the abattoirs

Among the examined cattle in the abattoirs, 10 (5.2 %) cattle had lesions suggestive of CBPP but out of 10 postmortem-positive cattle 7 were seropositive. The prevalence of lesions was significantly ($p < 0.05$) higher in poor body-conditioned animals compared to others. Sex, age, breed, and origin of the slaughtered animals were not significantly associated with CBPP lesions ($p >$

0.05). In the present study, there was strong test agreement between c-ELISA and postmortem examination (Kappa = 0.816) in the diagnosis of CBPP.

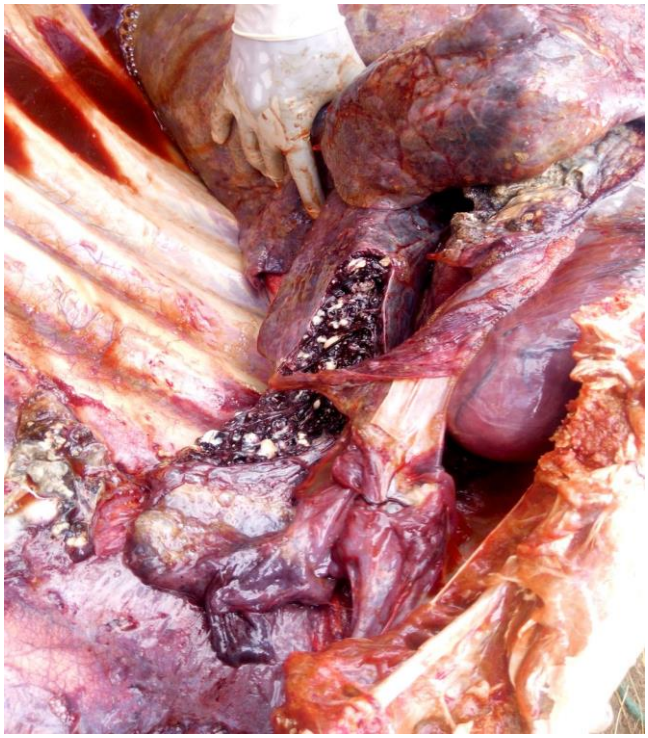
3.2.2. Gross pathological lesions

Upon post-mortem examination, lung tissue was encapsulated and separated by a network of pale bands made thickening extensive fibrosis (marbling), the lung tissue became hepatized or had a meaty appearance (Figure 2 a), and pleural adhesion (lungs were strongly attached to chest walls, Figure 2 b and Figure 2 c) were observed. In addition to these yellowish fluid in the thoracic cavity was observed in one animal (Figure 2 d).



(a)

(b)



(c)

(d)

Figure 2 – Postmortem lesions of CBPP identified during postmortem examination. Picture (a) indicated the marbling appearance of lung tissue, pictures (b) and "c" showed pleural adhesion and picture (d) showed that yellowish fluid collected from the thoracic cavity of an animal that had lung lesions.

4. Discussion

Epidemiological studies are the basis for selecting and deciding to apply any strategy for controlling transboundary animal diseases (TADs) including CBPP. In the present study, the seroprevalence of CBPP was 3.4%. This result is in agreement with a report of (Minda et al., 2017) at Sawena district of Bale zone which is 3.89% and (Kassaye and Molla, 2012) 4 % seroprevalence in and around Adama, Ethiopia. Compared to prevalence reports from Bale Zone (1,39%) (Lemu and Worku, 2017) and in bulls originated from Borena zone (0.4%) (Alemayehu, 2014) of Ethiopia and northern Tanzania (0.91%) (Swai et al., 2013), the present finding showed relatively higher prevalence of CBPP. These differences might be associated with the settings of the study population, the sample size, the production system, agroecology, and the laboratory techniques used.

On the other hand, the current finding is lower when compared with the previous prevalence reports from Sidama zone (Malicha et al., 2017), Amaro special district (Ebisa et al., 2016), East Wellega and west Shoa (Cherinet, 2017), Derashe district (Aliyi et al., 2018) and Gimbo district (Mamo et al., 2018) of Ethiopia who reported overall seroprevalence of 25.3%, 31.8%, 14.6%, 55.05% and 8.1% respectively. It is also lower than the findings reported in the Niamey region, Niger (Yansambou et al., 2018), which reported seroprevalence of CBPP as 6.8%. The prevalence discrepancies observed between the current and the previous studies might be due to the variations that exist in the epidemiology of the disease (strain variation) and it could be due to differences in agro-ecological system. Previously, cattle production system was more extensive, as a result, there were higher contact rates at communal grazing and watering areas, therefore, animals in these areas were having a higher probability of contact with each other as well as with the infected animals and easily exposed to different diseases including CBPP as compared to the present study. The other probable difference in the seroprevalence might be due to CBPP control measures exercised in the areas, for example, currently, the government strategy in animal health in the provision of preventive services through mass vaccination of CBPP and antibiotic treatment plays a great role in the reduction of disease. Another reason might be related to the diagnostic techniques used (c-ELISA test), it is well understood that c-ELISA is more sensitive in detecting cattle with chronic stage than any other test, and it is more prone to miss individual animals at the early stage of infection (Muuka et al., 2011; Schubert et al., 2011).

Age and body condition of the animals were statistically significantly associated with the occurrence of CBPP in the current study. CBPP occurred in older animals 3.28 times more likely than the other age groups. This is in line with the claim that CBPP is mostly a disease of older animals (Andrews et al., 2004; Cherinet, 2017; Kassaye and Molla, 2012). The higher prevalence of CBPP in older as compared to young animals is also supported by the finding of Swai et al. (2013), who reported relatively higher seroprevalence in older as compared to young cows. This might be due to the long-time exposure and life span of the older animals than the younger ones and the persistency of sequestrum for a long period in CBPP-recovered animals. On the other hand, the low prevalence of CBPP in young cows might be due to the decreased contact with the infected animals and the c-ELISA test being more sensitive in detecting cattle with chronic stage than any other test (Muuka et al., 2011; Schubert et al., 2011) The result obtained in this study regarding the age of the animals disagrees with (Aliyi et al., 2018; Ebisa et al., 2016; Malicha et al., 2017; Teklue, 2015), who indicated that age is not significantly associated with seroprevalence of CBPP.

In the present study, the body condition of cattle showed a highly statistically-significant association with the prevalence of serum CBPP infection with a higher prevalence in animals with poor body condition (13.5%) compared to animals in average and good physical condition. The odds of CBPP seropositivity are 9.7 times more likely in poor body-conditioned animals than in others. This result was in line with the report (Atnafie et al., 2015) in Bishoftu abattoir and export-oriented feedlots around Adama town who reported that animals with poor body condition had higher seropositivity as compared to the moderate and good body conditions. It is also in line with (Ebisa et al., 2016; Kassaye and Molla, 2012) and (Minda et al., 2017) who showed that body condition is a major risk factor for seroprevalence of contagious bovine pleuropneumonia. This might be because animals that are in poor physical condition with other comorbidities and or are malnourished are not able to protect themselves well against the disease**.** But the present report was not agreed with previous reports (Kassaye and Molla, 2012; Malicha et al., 2017; Teklue, 2015). Because, those previous studies were conducted in export quarantine centers and feedlots the result presented might be obtained from serum samples collected from bulls which were selected based on good body condition.

Regarding the sex of the animal there was a slightly higher prevalence of CBPP in female animals. However, there was no statically significant difference within sex. This agrees with a study (Mersha, 2016) who indicating that the sex of animals is not associated with the disease. But this result is contradicted with the other study in southern Ethiopia (Malicha et al., 2017) who reported statically significant difference between sexes. In the present study there was no significance difference between the two breeds (local breeds and crossbreeds of animals but slightly higher prevalence was recorded in local breeds than exotic. This disagrees with (Radostits et al., 2007) who reported that European breeds and their crosses with zebu are more susceptible to CBPP.

Proportions of seropositive animals were higher in those from Werehimeno than others but there was no statistically significant difference among origins. This is in line with (Atnafie et al., 2015; Malicha et al., 2017) who reported that there was no statistically significant association of seroprevalence with the origin of the animal in Bishoftu abattoir and export-oriented feedlots around Adama town and Sidama Zone, Ethiopia respectively. The absence of a statistically significant association of the disease with origin is not parallel with the study in Adama-Modjo livestock export industry (Birhanu, 2014).

In addition to the seroprevalence in the present study, the pathology of CBPP was studied in the abattoirs; of the total of 192 cattle slaughtered and examined for pneumonic lesions of CBPP in the selected abattoirs during the survey period, 5.2 % of cattle had lesions suggestive of CBPP. Up on postmortem examination marbling appearance and hepatization of lung tissue, pleural adhesion, and yellowish fluid in the thoracic cavity were the major CBPP suggestive lesions. Among the risk factors assessed during

the study period, only the body condition of the animals was statistically significantly associated with the prevalence of CBPP suggestive lesions in the abattoirs. The number of suspected CBPP lesions detected in this study has been higher than (Swai et al., 2013) who reported abattoir survey prevalence of 0.91 % in northern Tanzania. In the present study, prevalence based on gross examination is slightly higher than those obtained using serological techniques. This might be due to the reason that many other diseases are responsible for gross pathological findings on the lung tissues and there may be due to the c-ELISA test being more sensitive in detecting cattle with chronic stage than animals at the early stage of infection, some samples with lesions suggestive of CBPP were tested negative in c-ELSA but there was strong test agreement between c-ELISA and postmortem examination (Kappa = 0.816) in the diagnosis of CBPP.

5. Conclusion and Recommendations

In general, this serological and gross lesion-based overall prevalence (3.4%) of CBPP gives an insight into the status of CBPP in the study area and warrants measures for their control. It is concluded from this study that CBPP remains a problem in the South Wollo Zone. The presence of statistically significant variation in the prevalence of CBPP among different body conditions and age categories indicates that the disease is more likely in older and poor body-conditioned animals. Hepatization, marbling, pleural adhesion, and accumulation of yellowish fluid in the thoracic cavity were the lesions or abnormalities identified during the abattoir survey. Due to logistic limitations, the present study is restricted to narrower locations and with only postmortem examination and c-ELISA test but it is better to use a combination of tests. Even if the tissue samples have been collected from CBPP suspected lungs for detailed histopathological investigation at NAHDIC, Sebeta, currently due to SARS CoV2 pandemic, NAHDIC is not working the routine laboratory activities rather the center is busy with the diagnosis of COVID-19. Therefore, histopathological result was not included in this study. However, the study indicated that contagious bovine pleuropneumonia is a threat in the study area. Therefore, appropriate preventive measures such as vaccination, isolation, and good husbandry should be implemented. Both the federal and regional government of the country has to focus on controlling and preventing this economically devastating disease. Farm owners should practice isolation of new entry animals before mixing with the former herd and strict measures should be taken in terms of feeding and watering. In addition, further epidemiological studies using histopathology, culture, isolation, and molecular techniques should be conducted to know the true picture of the disease in the area.

Declarations

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Data Availability and Materials – The data supporting the result of the present study will be available upon request from the first and corresponding author.

Ethical Consideration – The authors confirm that the study Prevalence of contagious bovine pleuropneumonia in selected abattoirs and dairy farms is the original work conducted recently. Consent was taken from animal owners to conduct the research and only voluntary farms were contacted to collect data. A humane method of handling was used to reduce and minimize the pain during sample collection and laboratory analysis.

Competing of Interest – The authors have declared that no competing interest exists.

Authors Contribution – JT and TT participated in the investigation, methodology, conceptualization, data curating formal analysis, visualization, writing the original draft, and review edition (YB). YW, TB, and TT were supervising, fund acquiring, and administering the project with BA. AA contributes to data curating, software, formal analysis, validation, and visualization.

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