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Article

Seroprevalence and Associated Risk Factor of Bovine Herpes Virus Infection in and Around Jimma Town Dairy Cattle, Oromia Regional State, Ethiopia

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Simple Summary

Bovine herpesvirus-1 (BoHV-1) is a viral disease affecting cattle worldwide, causing respiratory illness and reproductive problems such as abortion and infertility. In this study of 349 dairy cattle from 39 herds, 14.57% of animals and 61.53% of herds tested positive for BoHV-1 antibodies. Purchased cattle and cows with a history of abortion or infertility were at higher risk of infection. These results highlight the significant impact of BoHV-1 on cattle reproduction and emphasize the need for biosecurity, screening of new animals, and vaccination to control its spread.

Abstract

Bovine herpesvirus-1 (BoHV-1) is the causative agent of infectious bovine rhinotracheitis (IBR), infectious pustular vulvovaginitis (IPV) in cows, and infectious pustular balanoposthitis (IPB) in bulls, and it occurs worldwide. It is an important infectious viral disease of cattle responsible for respiratory and reproductive losses in cattle population, especially in developing nations. Across sectional study was conducted on a total of 349 randomly selected dairy cattle from 39 herds. Competitive enzyme-linked immunosorbent assay (cELISA) was applied to detect antibodies specific to BoHV-1. Added to this, semi-structured questionnaire was administered and farm records were assessed to identify potential risk factors associated with BoHV-1 seropositivity. Logistic regression analyses were used to potential risk factors associated with BoHV-1 serostatus. Model fitness was assessed by using the Hosmer and Lemeshow method. An Overall animal level BoHV-1 seroprevalence of 14.57% (95% confidence interval [CI]: 11.41-18.23%) and herd level seroprevalence of 61.53% (95% CI: 44.62-76.63%) were found. In multivariable logistic regress model, the seroprevalence of BoHV-1 exposure was higher in purchased cattle (Odd ratio [OR] = 94; P-value: 0.0001) than homebred dairy cattle. Cows with a history of abortion were 20.06 times more likely to be seropositive than cows without such a history (OR = 20.06; P-value: 0.005), indicating a strong link between BoHV-1 infection and reproductive losses. Cow with history of infertility were 37.38 (OR=37.38, P-value: 0.001) more likelihood of seropositive that cows without such problem. BoHV-1 infection was widespread at both animal (14.57%) and herd level (61.53%). Purchased cattle, abortion, and infertility were strongly associated with seropositivity, indicating the virus' major role in reproductive losses. These findings underscore the importance of implementing preventive measures, including strict biosecurity, screening of newly introduced animals, and vaccination strategies, to reduce BoHV-1 transmission and its economic consequences.

Keywords: abortion; BoHV-1; cELISA; dairy cattle; purchased; Jimma town

1. Introduction

Infectious bovine rhinotracheitis is a serious disease of the respiratory and reproductive tract of animals that occurs all over the world and with varying prevalence across wide geographic regions[1]. Infectious Bovine Rhinotracheitis is caused by bovine herpes virus 1 (BoHV-1), which belongs to the genus Varicellovirus of family herpes viridae [2,3]. There are three subtypes of BoHV-1: respiratory (BoHV-1.1), genital (BoHV-1.2a) and encephalic (BoHV-1.2b) [3,4]. All three subtypes have major economic consequences for the cattle industry (loss of body weight, reduced milk production, fertility disorders, embryonic mortality, abortion, stillbirth and treatment costs due to secondary bacterial infections) [5,6].

The disease is a highly contagious viral disease that affects cattle of all ages. Infection occurs by inhalation and contact between animals, and once it is established within disease-free populations it spreads rapidly from infected cattle to immunocompromised susceptible cattle [2,7]. During pick period of virus perpetuation in body of infected animal it excreted through vaginal secretions, nasal discharges or droplets, semen, mucosal discharges, fetal fluid and tissues [8,9]. The direct contact of susceptible animal with these contaminated body excretion will lead to transmission of the disease. The virus also transmitted through aerosol infection in the respiratory form [10,11]. Latently infected animals are lifelong carriers of BoHV-1 and potential transmitters of the virus between herds [12].

Natural BoHV-1 infection occurs via contact with contaminated mucous membranes of the respiratory or genital tracts [13]. Transmission occurs through aerosols, nasal secretions, mating, or infected semen. Virus entry into the respiratory tract can occur via aerosol or by direct contact with virus present in nasal secretions [14]. It causes two main syndromes: infectious bovine rhinotracheitis (IBR) in the respiratory tract and infectious pustular vulvovaginitis/balanoposthitis (IPV/IPB) in the genital tract. IBR symptoms include fever, lethargy, rapid breathing with harsh cough, anorexia, and reduced milk yield in dairy cows [13]. Depending on the stage of gestation, the infection can result in early embryonic death and infertility, or late-term abortion. Fetal mummification and stillbirth are also part of the infection sequel[15,16].

The occurrence and spread of the disease is influenced by many risk factors. Stress factors such as temperature, nutritional deficiencies, overcrowding, and improper transportation weaken the animal's immune system, triggering the activation of the latent virus to develop clinical symptoms and transmit the virus to susceptible animals [17,18]. Purchasing infected cattle, taking part in agricultural shows, increased herd size, and faulty production system are among the management and environmental risk factors that have contributed to the spread of BoHV-1. The disease also spreads because of uncontrolled movement of animals and guests inside the farm [19,20]. Unvaccinated breeding or feedlot cattle are susceptible to epidemics of abortion and respiratory disease. When colostrum antibodies are insufficient or passive immunity is compromised in newborn calves, the disease frequently manifests as the systemic form [21].

Ethiopia, one of the world's most populous countries, has the largest livestock population in Africa. It homes nearly about 70.3 million cattle, which supports approximately about 80% of task force and contributes about 45% to the of the agricultural GDP [22]. BoHV-1 is an economically significant viral disease in the dairy industry worldwide, including sub-Saharan African countries [15]. Several studies report seroprevalence levels ranging from 35.9–77.5% in Europe and 37–60.8% in Latin America [23]. Only few studies have been reported from Sub-Sharan Africa with varying level of seroprevalence, the variation is caused by differences in climates, stocking densities and management, among other factors [24,25]. The finding in the region includes 48.3% in Southern Zambia [26], 69% in Ghana [27], 31.17% in Algeria [28], and 74.5% in Gauteng province of South Africa [29].

The disease was first reported in Ethiopia 50 years ago in 1975 in Harrar and Sidamo [30]. Afterward, it has become one of the major causes of reproductive disorders in dairy cattle, significantly hindering livestock development in recent decades [31]. Some studies have documented the spread of IBR across different parts of the country. For example, Tesfaye *et al.* [32] reported a 34.7% seroprevalence in central Ethiopia. Asmare *et al.* (2018) and Sibhat *et al.* (2018) confirmed the

presence of IBR in central, southern, and southwestern regions. In addition, Wedajo et al. [33] reported cases in Kombolcha district. More recently, Kolech *et al.* [34] a 72% seroprevalence from Debark and Lay-Armachiho districts of Gonder Zone. In spite of its well-defined economic impacts on dairy industry, yet there is insufficient information available regarding the frequency and spread of IBR in the southern western Oromia region of Ethiopia. Therefore, this cross-sectional study was carried out to estimate seroprevalence of BoHV-1 and identify associated risk factors in small-scale dairy farm in and around Jimma town.

2. Materials and Methods

2.1. Study Design, Study Population and Target Population

A cross-sectional study was conducted from December 2023 to April 2024, targeting dairy cattle in and around Jimma town, southwestern part of Oromia, Ethiopia. The study population consists of dairy herds in kept under both intensive and sem-intensive management in the study area (Figure 1). Since Vaccination against BoHV-1/IBR is not practiced in Ethiopia, the sampled individuals were assumed Unvaccinated. Blood samples were collected from dairy cows within the selected herds, and all sampling procedures were carried out by well-trained veterinary professionals including laboratory experts of serological lab.

2.2. Sample size Determination and Sampling Methods

The sample size for this study was determined by using the formula given in the Equation (1) [35].

$$n = \frac{(Z)^2 (P_{exp})(1-P_{exp})}{d^2} \tag{1}$$

In this equation, Z is the Z-score for 95% confidence level, which is 1.96. P_{exp} represents the expected prevalence, set at 34.4% or 0.344 [32], and d is the precision, determined to be 5% or 0.05. Based on these assumptions, the calculated sample size was 346. However, a total of 439 samples were finally collected to increase the statistical power of the study and enhance the precision of estimates. Out of 65 dairy farms registered at the study area, 39 farms/dairy herds were selected randomly and 30% of individual cattle were recruited randomly from each involved farms to proportionate.

2.3. Collection of Blood Samples

Approximately about 7-10 ml of blood samples were collected aseptically from the jugular vein using plain vacutainer tubes and an 18 gauge (18G) disposable needle after the animals was well restrained. Each samples were labelled, and kept at inclined position, then transported to Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) and left to stay at room temperature for 2-4 hours to allow clotting of blood and serum separation with centrifugation. Harvested serum samples were stored at -20 °C until further analysis at Animal Health institute, Sebeta.

2.4. Farm- and Cow-Level Data Collection

Farm- and individual-animal level data on potential risk factors were collected using semi-structured questionnaires. Farm/herd level data includes herd size, service type, feeding Place, watering Practice, the number of lactating cows, the annual number of abortions; retention of fetal membrane; daily milk yield, source of semen for breeding and origin of stock replacement. Individual animal level data (animal biodata) includes age, the animal origin, body condition, parity, abortion history, repeat breeder, reproductive disorders, and history of respiratory problem.

2.5. Processing of the Blood Samples

The blood samples were positioned at inclined angle to harvest serum. Then each serum was decanted into 1.5ml labeled Eppendorf tubes and placed in a 96-well plate (no-ELISA plate). Wells A1 and B1 contained positive controls, whereas C1 and D1 contained negative controls. The remaining 92 wells were filled with serum to facilitate the rapid transfer of both controls and samples to the ELISA plate using a 12-channel micropipette.

2.6. Competitive Enzyme Linked Immunosorbent Assay (cELISA)

The collected sera sample were analyzed using Aseptically ID.vet IBR gB antibody competitive ELISA kits ((iD.vet IBR gB Competition ELISA, France), following the manufacturer's instructions to detect antibodies against BoHV-1. Reagents were brought to room temperature ($21^{\circ}\text{C} \pm 5^{\circ}\text{C}$) before use. The sera were homogenized using Vortex. Then 100 μL of positive control was added to wells A1 and B1, 100 μL of negative control to wells C1 and D1, 100 μL of each serum samples to the remaining wells. The plate were then covered with sterile plastic and incubated for 2 hours at $5^{\circ}\text{C} (\pm 3^{\circ}\text{C})$. Then, the wells emptied and washed three times with washing solution. Ready to use conjugate was added to each wells and incubated at $21^{\circ}\text{C} (\pm 5^{\circ}\text{C})$ for 30 minutes. Unbounded conjugate was washed out by three times by 300 μL of wash solution. To finalize the procedure, a substrate solution was added to each well and incubated at $21^{\circ}\text{C} (\pm 5^{\circ}\text{C})$ for 15 minutes in dark area. Stop solution was added to each well to stop the reaction. The Optical Density (OD) value at 450 nm was read using Spectrophotometer.

2.7. Test Validation and Interpretation

The test was deemed to be valid if the mean value of the negative control OD (ODNC) is greater than 0.7 ($\text{ODNC} < 0.7$) and the mean value of the positive control is less than 30% of the ODNC ($\text{ODPC}/\text{ODNC} < 0.3$). The competition percentage (S/N %) for each sample was calculated using the formula $\text{S/N}\% = (\text{OD sample}/\text{ODNC}) \times 100$. A result was classified as positive if the S/N% was $\leq 45\%$ and negative if it was $\geq 55\%$, and the value $45\% < \text{S/N}\% < 55\%$ was regarded as doubtful.

2.8. Data Analysis

2.8.1. Descriptive Statistics

Numerical data such as herd size, and the herd size, service type, the number of lactating cows, the annual number of abortions; retention of fetal membrane; daily milk yield, source of semen for breeding and origin of stock replacement, age, and lactation age were summarized by descriptive statistics function in STATA version 17 (Statacorp, LLC, Texas 77845, USA). The seroprevalence of IBR antibodies at both the farm and cow levels, along with its 95% confidence interval, was determined using the syntax 'cii prop' function in STATA version 17.

2.8.2. Identification of Risk Factors

Herd was classified as IBR seropositive if at least one cattle tested positive for BoHV-1 specific antibodies using the commercial cELISA test. An individual animal was classified as BoHV-1 seropositive if its serum tested positive in the CELISA test. Initially Univariable logistic regression analyses were performed herd level BoHV-1 seropositivity as outcome and each independent variables as a predictor. Variables having a p-value ≤ 0.25 were selected for inclusion in the multivariable logistic regression analysis to assess the strength of associations between two or more risk factors and the outcome variables. Using the variance inflation factor (VIF), multicollinearity was further examined for the explanatory factors ($p < 0.25$). Variance inflation factor > 10 or tolerance below 0.1 were regarded as the cut-off points [36]. The odds ratio (OR) with its 95% confidence interval (CI) was used to see the strength of the association to predict the logistic regression model. The P-value

<0.05 was used to rule out the statistical significance value of the associations between the independent and dependent variables.

3. Results

3.1. Summary Statistics

This study involves 39 dairy herds across seven farmer’s associations. Out of the total 439 sera samples tested, highest (28.50%) seroprevalence of BoHV-1 was reported in Ginjo and whereas the least (4.34%) was reported in Bore (Figure 2).

3.2. Animal- and farm- level Seroprevalence

The finding shown individual-level seroprevalence of 14.57% (95% CI: 11.41-18.23), in which 64 animals were found seropositive. The herd-level prevalence of BoHV-1 was 61.53% (95% CI: 44.62-76.64), where the 24 farms that had at least one seropositive BoHV-1 antibody out of 39 sampled dairy farms. There was a difference in seroprevalence of BoHV-1 among herd size, age, animal origin, body condition, parity, repeated breeding, and history of abortion, infertility, and animals with respiratory problem categories (Table 1).

Table 1. Seroprevalence of BoHV-1 antibodies in Jimma town dairy cattle of different categories.

Risk factors	Categories	No of examined Animals	No of positives	Prevalence (95% CI)
Herd size	≤10 Animals	363	53	14.60% (11.13-18.65)
	>10 Animals	76	11	14.66% (7.55 – 24.72)
Age	> 6Year	137	32	23.35% (16.55-31.34)
	3-6 Year	174	27	15.51% (10.48-21.76)
	< 3 Year	128	5	3.90% (1.28 -8.88)
Animal Origin	Homebred	355	41	11.50% (8.58 -14.8)
	Purchased	84	23	27.4% (17.9 - 36.9)
Body Condition	Poor	133	31	23.30% (16.9-31.4)
	Medium	238	28	11.70% (7.96 -16.5)
	Good	68	5	7.35% (5.46 -23.3)
Parity	Multiparous	131	32	24.42% (16.9-31.57)
	Uniparous	98	19	19.38% (11.5-27.16)
	Pregnant	13	2	15.38% (-4.26-34.5)
	Non pregnant	197	11	5.58% (2.53-9.06)
Abortion history	Aborted	74	37	50.0% (38.6-6.85)
	Not Aborted	365	27	8.12% (5.37-11.67)
Repeated Breeding	Present	302	55	18.21% (14.02-23.05)
	Absent	137	9	6.56% (3.04- 12.10)
Infertility	Yes	118	42	35.59% (26.99- 44.93)
	No	321	22	7.63% (4.33-10.92)
Respiratory Problem	Present	93	38	40.8% (30.8-50.78)
	Absent	346	26	7.50% (5.17-10.8)

3.3. Animal Level-Risk Factors Analysis

Logistic regression analysis among the risk factors against BoHV-1 seropositivity was done on age, animal origin, body condition, parity, abortion, repeated breeding, infertility, and respiratory problems. The model shows that the risk/odds of being positive for BoHV-1 were significantly associated with animal origin, where purchased dairy animals had a higher odds ratio (AOR = 94; p-value: 0.0001) than homebred animals. The analysis revealed that dairy animals having respiratory

problem (AOR = 20.06; p-value: 0.001) were more likelihood of developing the disease compared to those with no respiratory problem. The present study revealed a strong association between abortion history and BoHV-1 seropositivity, where cows with a history of abortion were 20.06 times more likely to be infected compared to those without abortion. The study also demonstrated a highly significant association between infertility and BoHV-1 seropositivity. Cows with a history of infertility were 37.38 times more likely to be infected with BoHV-1 compared to their fertile counterparts. The rest of the explanatory variables (age, repeated breeding) were not statistically associated with BoHV-1 serostatus (Table 2).

Table 2. Association of risk factors with BoHV-1 antibodies seropositivity in the study area.

Risk factors	Categories	Univariable analysis		Multivariable analysis	
		COR	P-value	AOR	P-value
Age	≥ 6Year	7.37 (2.77-19.63)	.0001	1.30 (0.30-5.62)	
	3-6 Year	4.38 (1.63-11.74)	.003	0.542 (0.12-2.39)	0.420
	< 3 Year	*		*	
Animal Origin	Purchased	2.88 (1.61-5.15)	.0001	94 (11.05 -810.25)	0.0001
	Homebred	*		*	
Body Condition	Poor	3.82 (1.41-10.38)	.008	5.79 (.49.48- 67.83	0.162
	Medium	1.68 (0.62-4.53)	.306		
	Good	*		*	
Parity	Multiparous	5.46 (2.64-11.30)	.0001	2.77 (1.04-7.37)	
	Uniparous	4.06 (1.84-8.94)	.0001	2.30 (1.41-11.83)	0.071
	Pregnant	3.07(0.60-15)	.176	1.30 (0.20-8.34)	
	Heifers	*		*	
Abortion history	Aborted	12.90 (7.05-23.61)	.0001	20.06 (2.53-159.00)	0.005
	Not Aborted	*		*	
Repeat Breeder	Yes	3.16 (1.51 -6.61)	.002	0.99 (0.08-11.79)	0.999
	No	*		*	
Infertility	Present	7.51 (4.22-13.34)0	.0001	37.38 (4.39-317.83)	0.001
	Absent	*			
Respiratory problems	Present	8.50 (4.78-15.11)	.000	0.38 (0.38-386)	0.417
	Absent	*		*	

CI: Confidence interval; COR= crude odds Ratio; AOR= Adjusted odds Ration; * = reference factor.

3.4. Herd Level Risk Factor Analysis for BoHV-1

The seroprevalence occurrence of BoHV-1 with the size of the herd, service type, stock source, feeding, and the watering place was assessed through a semi-structured questionnaire. The higher prevalence of the disease was seen in herds with <10 animals (69.2% (9/13), 100% (2/2) in dairy animals using both AI and bull service, 70% (7/10) in those feeding their dairy animals on the floor, 75% (3/4) in group watering, and 69.2% (9/13) in farms using both home and purchase stock replacement dairy herds as compared to their counterparts. However, the random effect logistic regression analysis of the different management problems and the seroprevalence of BoHV-1 did not show a significant association (Table 4).

Table 4. Logistic regression analysis of BoHV-1 in relation to herd level farm managements.

Key questions	Categories	No of respondents (%)	No of positive herd	Odds Ratio	P-value
Herd size	< 10 animals	13 (33.3%)	69.2% (9/13)	0.26 (0 -2.30)	0.24
	≥ 10 animals	26 (66.6%)	57.6% (15/26)		
	AI	37 (94.8%)	59.45 (22/37)	1 (0.025-+Inf)	1.00

Service type	Both AI and Bull	2 (5.12%)	100% (2/2)		
Feeding Place	On feeder	29 (74.3%)	58.6% (17/29)	1.95 (0.28-17.1)	0.70
	On floor	10 (25.6%)	70% (7/10)		
Watering Practice	Individual	35 (89.7%)	60% (21/35)	0.90 (0.009-83)	1.00
	Group watering	4 (10.25%)	75% (3/4)		
Stock	Home breed	26 (66.6%)	57.6% (15/26)	5.35(0.61-+Inf)	0.13
Source	Home & Purchase	13 (33.3%)	69.2% (9/13)		

The semi-structured questionnaire was presented to farm owners/animal attendants to assess the previous history of reproductive problem challenges like retained fetal membrane (RFM), abortion history together with experienced abortion stage, and the history of respiratory problems. The highest seroprevalence of BoHV-1 was seen in dairy herds with previous RFM challenges at 64.3% (9/14), dairy herds with the challenges of repeated breeders at 64.7% (23/34), and dairy herds with abortion cases in 5-7 months pregnant animals at 86.6% (13/15), followed by 80% (4/5) in 8-9 months pregnant periods and in herds with respiratory problems at 76% (19/25) as compared to their counterparts. The exact logistic regression analysis shows a significant association for abortion history with OR = 2.2; P < 0.05, while the other categories were not significant (Table 5).

Table 5. The exact logistic regression analysis of BoHV-1 in relation to herd level health problems.

Key questions/ variables	Categories	No of respondents	NPH (%)	Odds Ratio	P-value
Problem of RFM	No	25 (64.1%)	15 (60%)	0.59 (0.063-4.11)	0.868
	Yes	14 (35.8%)	9 (64.3%)		
Presence of repeated breeder	Absent	5 (12.8%)	2(40%)	2.62 (0.08-90)	0.974
	Present	34 (87.1%)	22 (64.7%)		
Abortion stage	No Abortion	11 (28.2%)	4 (36.3%)	.22 (1.12-5.15)	0.017
	1-4 month	8 (20.5%)	3 (37.5%)		
	8-9 month	5 (12.8%)	4 (80%0		
	5-7 months	15 (38.4%)	13 86.6%)		
Respiratory problem	Absent	14 (35.8%)	5 (35.7%)	3.32 (0.53-23.58)	0.258
	Present	25 (64.1%)	19 (76%)		

RFM= retained fetal membrane; NPH = Number of Positive herd.

4. Discussion

The current study investigates the seroprevalence of BoHV-1 in and around Jimma town from J The study of BoHV-1 antibody at the individual level seroprevalence was 14.57%. The seroprevalence observed reflect exposure to natural infection, as cattle are not vaccinated against BHV-1 in Ethiopia. The overall seroprevalence of BoHV-1 reported in present study was lower compared to previous studies findings in Ethiopia like the pooled seroprevalence reported Tesfaye et al. [32] in Bishoftu (23.1%), Bahirdar (28.5%), Nekemte (34.4%) and in Holeta (41.5%). Also, 25.6% [37] from Desse and Kombolcha towns dairy cattle of the Amhara region; 41% [31] in the central, southern, and southwestern parts of the Ethiopian country; and 77.6% reported by Zewde et al. [38]in northwestern and central Ethiopia. On contrary, the current finding was higher relative to findings (8.56%) reported by Jain et al. [38] from Tamil Nadu and Andhra Pradesh and 10.39% in Garwal district of Uttaranchal State of India [38]. These discrepancies in seroprevalence could be attributed to factors like management system differences in study animals, study period, breeds of animal, or ecological variation of the study area from other places since Jimma town and zone receive year-round rain.

The present finding almost similar with seroprevalence reported from other countries by Yousef et al. [39] and Kaddour et al. [40] with result of 17.4% and 14.16% in Saud Arabian and northeastern part of Algerian dairy cattle respectively. Likewise, different authors obtained relatively lower anti-

IBR/BoHV-1 antibodies in dairy cattle: 10.39% and 22.3% in Uttarakhand by Lata et al. [41], 11.4% in Iran [42] and 17.37% in Kenya [43]. The anti-IBR/BoHV-1 antibodies have been identified in other parts of the world ranged from 17.1% to 60.84% [40,44,45].

The herd level seroprevalence of BoHV-1 was notably high, indicating significant presence of the disease with the studied population. It implies the existence of a large pool of latently infected cattle that could potentially serve as a source of infection for other animals, as infected cattle are considered to be infected for life (Muylkens et al., 2007). However, it was relatively low compared with the previous report by Asmare et al. [15] in dairy herd seroprevalence (81.8%) within the country in three different milk sheds (central, southern and western areas) of Ethiopia. It is comparable with result reported from Southern Mexico by Segura-Correa et al. [46] with findings of 85.4%; 84.0% IBR/BoHV-1 virus from dairy herds of Belgium by Boelaert et al. [47], and 90% in Irish cattle population [48].

On contrary, the present-herd-level serostatus of IBR/BoHV-1 was in agreement with report of 69.8% in central part of Ethiopia [49] and 68.3% [50] in Gondar city dairy farms, 54.4% to 60.3% in northeastern and northwestern mesoregions of the State of Rio Grande do Sul, Brazil [51]. Previous studies conclude that non-vaccination, introducing or mixing unscreened animals, insemination from unscreened bulls, and intensive rearing are key drivers of IBR/BoHV-1 spread and high herd prevalence [52].

In this study, purchased animals were 94 (AOR=94) times more likely to be infected than homebred animals. This result agrees with the previous findings that reported stock source as the risk factor for BoHV-1 infection [32,38,53]. This reflects a higher possibility of getting the virus due to animal movement from the infected herd to herds free from the disease. This is a reason for the herd-level likely high seroprevalence with few users of purchased stock replacement.

The study revealed a significant association between a history of abortion in cows and seropositivity for BoHV-1 infection ($p = 0.005$). Cows with a history of abortion were 20.06 times more likely to be seropositive than cows without such a history ($OR = 20.06$), indicating a strong link between BoHV-1 infection and reproductive losses. This result is consistent with previous studies reporting BoHV-1 as a major cause of abortion in cattle [53,54]. BoHV-1 infection can lead to embryonic death or abortion, particularly in the second trimester, due to viral replication in the reproductive tract [55]. The high odds ratio observed underscores the importance of BoHV-1 in herd reproductive health and highlights the need for control measures such as vaccination, strict biosecurity, and screening of newly introduced animals [18].

In the present study, reproductive disorders showed a strong association with BoHV-1 infection. Cows with a history of abortion were 20.06 times more likely to be seropositive for BoHV-1, while those with infertility problems were 37.38 times more likely to be infected compared to their counterparts without such histories. These findings highlight the significant reproductive consequences of BoHV-1 infection in dairy herds. Similar associations have been reported elsewhere, where BoHV-1 was linked to abortion, reduced conception rates, and repeat breeding [53,56,57]. The high odds ratios observed in this study suggest that BoHV-1 may play an important role in reproductive inefficiency, leading to considerable economic losses. Therefore, the integration of preventive strategies such as vaccination, herd-level biosecurity, and pre-breeding screening is essential to minimize BoHV-1-related reproductive failures and improve herd productivity.

The study also assessed herd management practices in relation to BoHV-1 seroprevalence. Higher prevalence was observed in small herds (69.2%) compared to large herds (57.6%). This agrees with a previous report [58] where small herds showed higher prevalence than large ones, but contrasts with another study that found higher seroprevalence in large herds (82.8%) compared to medium (76.2%) and small (70.4%) herds.

Regarding the usage of services for cows during the heat or estrus period about 94.8% of dairy farms breed with AI service, but the seroprevalence of BoHV-1 was higher in farms using both AI and bull (100%) than AI service (59.5%). This study is in line with the finding of ⁴ that 95.7% in bulls, 76.9% in both AI and Bull, and 70.1% in AI service breeding farms [58] report 56.25% in bull service

than 43.75% in AI service practicing farm. However, the current study differed from the report of ²³, which is 25.8% higher in AI service than 25% in bull service. Herd-level seroprevalence of BoHV-1 was markedly higher in herds with respiratory problems (76%) compared to those without respiratory problems (36%). This finding indicates that BoHV-1 infection is strongly associated with both reproductive and respiratory disorders, consistent with previous reports [58].

5. Conclusions and Recommendation

Among all suspected risk factors, animal origin and animals with respiratory problems were identified as potential risk factors. The dairy farms challenged with retained fetal membrane, repeated breeders, and respiratory problems also had a high prevalence of the disease. The result of this study showed the presence of BoHV-1 antibody among dairy cattle of Jimma town, which helps to prove the circulation of the disease in dairy herds in the country, as many researches have been carried out in different areas with various seroprevalence. Based on the above conclusion, the following recommendations are forwarded.

Dairy animals with a history of abortion and respiratory problems were better if tested for BoHV-1 and properly managed, as they act as potential sources of infection.

It is better to quarantine the newly purchased animals since they are the potential risk factor for the spread of the disease from one herd to the other.

Farm owner training on good farm management, especially on feeding and watering practices; separation of dairy animals with reproduction and respiratory problems.

Testing and slaughtering of positive animals and the well implementation of biosecurity were the best control strategies for the disease.

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Data Availability Statement: The datasets generated during and/or analyzed during the current study are at: <https://figshare.com/s/a813c4dd97ea006459cc>.

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