

Schmallenberg virus: seroprevalence, risk and protective factors in aborted dairy cows in Algeria

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Abstract

The Schmallenberg virus (SBV), an orthobunyavirus, recently emerged in Germany in 2011. It spreads rapidly via the *Culicoides* vector, causing a decline in milk production, abortions and malformations in cattle, sheep and goats. These significant economic losses for farmers, as well as the difficulty in diagnosing the disease due to its similarity to other abortive diseases such as bluetongue, epizootic haemorrhagic disease, bovine viral diarrhoea and infectious bovine rhinotracheitis, make it an important subject of study in Algeria. The aim of this study was to detect the presence of antibodies against the Schmallenberg virus in dairy cows that had aborted in Algeria. 458 serum samples from cows that had aborted, belonging to 159 farms, were tested for the presence of anti-SBV antibodies using an indirect ELISA kit, supplemented by a survey questionnaire designed to identify risk factors associated with exposure to the Schmallenberg virus. The individual seroprevalence obtained was 46.3 % (212/458), with the year of visit in 2016 (odds ratio [OR] = 9.84; P = 0.007) and 2019 (OR = 14.39; P = 0.004) and the winter season (OR = 2.05; P = 0.037) being factors associated with an increased risk of individual exposure. Another factor identified as being associated with a reduced risk of exposure was the 4th month of gestation (OR = 0.41; P = 0.038). The seroprevalence of the herd was 73.6 % (117/159). At the herd level, herd size was the only factor associated with an increased risk of exposure to SBV (OR = 1.04; P = 0.01). The factors were associated with a reduced risk of exposure (implementation of a rodent and pest control plan, and presence of moulds in animal feed). The implementation of surveillance and prevention protocols for this disease is essential to protect animal health and the economy of cattle farms.

Keywords: Abortion; Dairy cow; Algeria, Seroprevalence, Risk factor; Schmallenberg virus.

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Study contribution

Abortions are a real scourge for dairy farms in Algeria, given the significant losses and economic consequences they entail, such as a decline in milk production, the loss of a calf, and the costs of treating the female that has aborted. In Algeria, in a survey conducted between 2014 and 2016 among 331 audited veterinarians, 48.7 % reported a prevalence of bovine abortion greater than 5 % during the last 12 months of follow-up. It should be noted that the amount of compensation paid for cattle and goats slaughtered due to brucellosis between 2002 and 2004 was estimated at €618 624.⁽¹⁾ In Algeria, only brucellosis is considered an abortive disease and is notifiable. Several studies have looked at other infectious abortive agents such as Q fever, chlamydiosis, toxoplasmosis and infectious bovine rhinotracheitis.^(2, 3) Very little data is available on the presence of the Schmallenberg virus in the context of abortions and reproductive disorders in dairy cattle in Algeria, which prompted us to undertake research to determine both the seroprevalence and the various risk and protective factors associated with exposure to this virus.

Introduction

Schmallenberg virus (SBV), an Orthobunyavirus belonging to the family Bunyaviridae, is an emerging pathogen affecting ruminants throughout Europe. It was first detected in Germany in November 2011 near the town of Schmallenberg in the Rhineland province in plasma samples from febrile dairy cattle with reduced milk yield and severe diarrhea.⁽⁴⁾ In 2012, several European countries (the Netherlands, Belgium, Spain, France, the UK and Italy) reported the presence of SBV in their herds.^(5, 6) The virus has also been identified in Asia and Africa.^(7–11) SBV is a segmented, enveloped, single-stranded RNA virus closely related to Akabane, Shamonda and Aino viruses. Based on its segmental genomic characteristics and phylogenetic analysis, SBV is currently classified in the Simbu serogroup, the genus *Orthobunyavirus* and the family Bunyaviridae.^(4, 12) It is transmitted by haematophagous arthropods and biting midges of the genus *Culicoides*.^(13, 14)

The first clinical signs of SBV infection reported in cattle are transient fever (> 40 °C), loss of appetite, deterioration of the animal's general condition, a drop in milk production (up to 50 %) and severe diarrhea. Other more serious signs have been reported such as abortions, mummified foetuses, stillbirths and the birth of malformed calves (arthrogryposis and hydranencephaly).⁽¹⁵⁾ Due to the recent emergence of SBV (2011) compared to other infectious agents, as well as its similarity to the Shamonda, Akabane and Aino viruses, it is difficult to obtain exact proportions. Indeed, the proportions vary depending on several factors, including the stage of gestation, individual variability, the cow's general state of health, various concomitant infections, etc. Detection of infected animals and confirmation of infection in diseased animals was initially carried out using the real-time reverse transcriptase polymerase chain reaction (RT-PCR) technique developed by researchers at the Friedrich Loeffler Institute.^(4, 16)

Subsequently, RT-PCR kits, serological tests (ELISA), neutralization tests and indirect immunofluorescence tests were developed, used and marketed for the direct or indirect diagnosis of SBV infection from the brain, spleen and blood of malformed foetuses and/or from blood in adult animals.^(12, 15) Numerous studies have characterise individual and herd seroprevalence and factors associated with increased or decreased risk of exposure to SBV, most often by means of an ELISA test. From these studies, it appears that individual SBV seroprevalence varies from 13.4 %.⁽¹⁷⁾ to 94 %.⁽¹⁸⁾ Herd seroprevalence of SBV ranges from 87–100 %.^(7, 10) Factors associated with a decreased or increased risk of SBV exposure and reported in the literature are herd size,^(19, 20) species,⁽²¹⁾ age,^(19, 21–23) application of insecticide treatment for animals,⁽²¹⁾ and the season with its climatic conditions, mainly temperature, wind speed, and humidity.⁽²⁴⁾

In Algeria, to our knowledge, there is little data on the presence of SBV and its impact on reproduction in dairy cattle. This study was conducted in the Mitidja region, a highly fertile plain located in northern Algeria. It is an important dairy basin given the very favorable conditions for livestock farming (climate and agricultural land suitable for fodder production), which explains the high concentration of dairy farms in the region and its economic importance. This explains the interest of researchers in studying the various factors influencing milk production and its impact on the country's economy. The objective of this study is to determine the seroprevalence of anti-SBV antibodies in cows that have aborted in the Mitidja region and to identify the various risk and protective factors associated with this exposure.

Materials and methods

Ethical statement

All methods used in this study were applied in accordance with current guidelines and regulations. The veterinarians who handled the animals applied best practices in accordance with the ethical guidelines and animal welfare regulations set out in Chapter 7.8 (Use of Animals for Research and Teaching) of the WOA (formerly -OIE) *Terrestrial Animal Health Code* (2011). Animals must be used in such a way as to cause as little pain, suffering and/or stress as possible (Chapter 7.8.3. Principle of the 3R). In addition, all farmers included in this study gave their informed consent verbally. It should be noted that this study was not subject to ethical approval.

Study area and sampling

The study was carried out between October 2014 and March 2019. It involved 458 cases of clinical abortion in 53 heifers and 405 cows from 159 farms declared free of brucellosis and tuberculosis and located in northern Algeria (Mitidja plain) belonging to the wilayas of Blida ($n = 53$), Algiers ($n = 21$), Tipaza ($n = 40$) and Boumerdès ($n = 45$), with an average (4 samples per farm), a maximum (21 samples per farm) and a minimum (1 sample per farm). The samples collected in 2014, 2015, and 2016 were used in a previous publication⁽²⁾ and subsequently stored carefully. In 2019, Schmallenberg ELISA kits were obtained free of charge from ID Vet, Montpellier, France, and the samples were therefore completed in 2019, hence the absence of samples in 2017 and 2018.

This sample represents 1.35 % of heifers and cows in the Mitidja region, according to data from the Ministry of Agriculture and Rural Development (2009), the only data available. In fact, the cattle population in Algeria is not stable, with fluctuations from one year to the next (for example, in 2009, the national cattle population was 1.6 million head, whereas from 2015 onwards, a significant decline was observed, with the number falling to 900 000 head) in different regions of Algeria (the study area is considered the cradle of dairy production). This makes our sample representative and statistically reliable. The climate is Mediterranean, with a continental influence (sirocco in summer), with rainy, mild winters and hot, dry summers.

The present study was conducted following a previous study (seroprevalence and risk factor study) investigating several abortive agents (*Coxiella burnetii*, *Chlamydia abortus* and *Toxoplasma gondii*).⁽²⁾ Some of the blood sera and the database (cow/herd) were available, and the study was completed to increase the sample size. Also, the proximity to the location where the ELISA tests were carried out (laboratory) and the willingness of farmers to participate in this study favored this choice. It should be noted that the sample size was not calculated; all cases meeting the selection criteria were included and retained.

Each farm was visited following the occurrence of an abortion visible to the farmer (after the third month of gestation). This visit enabled the collection of data necessary to assess the factors associated with an increase or decrease in the risk of exposure to the virus under study. This data concerns the year of the farm visit, the number of cattle, the number of females, the type of housing (free-range, tethered or semi-tethered), grazing practices, the insemination method used (artificial insemination or natural mating), the season in which abortions occur (spring, summer, autumn, winter), feed storage conditions (good, average, poor), water source (shared pipe, cistern, deep borehole, shallow well, stream), whether or not the animals are dewormed, whether or not a plan is in place to control rodents and other pests, the estimated frequency of abortions, introduction of new animals in the last 12 months, and whether a veterinarian was called when abortions occurred. It should be noted that reproduction occurs throughout the year, with no grouping of calving.

Each cow that had aborted underwent a 5 mL blood sample collection from the caudal vein by a veterinarian using a 5 mL Vacutainer tube (Becton, Dickinson and Company, USA), made of red silicone plastic (PET) of the dry type, measuring 13 × 75 mm. The samples were collected within two months of the abortion. The samples were then transported to the laboratory in a cooler at +4 °C and centrifuged for 5 minutes at 3 000 rpm. The sera were stored at -20 °C until the serological test was performed.⁽²⁾

Serological analysis

The presence of Schmallenberg virus antibodies was detected using an ELISA kit (IDVET, Montpellier, France). The kit used for the detection of Schmallenberg virus antibodies is the ID Screen® Schmallenberg virus competition multispecies kit, which uses a recombinant Schmallenberg virus nucleoprotein. The diagnostic specificity and sensitivity of this test are 100 % respectively, as indicated by the manufacturer. The test used was validated on the basis of a negative control optical density (OD_{cn}) greater than 0.7 and a ratio between the average positive control (OD_{cp}) and the average negative control (OD_{cn}) less than 0.3 (< 30 %). Once these two conditions were met, the optical densities of the test samples were measured at a wavelength of 450 nm. The S/N percentages (sample/negative control serum) were calculated using equation 1 and interpreted in accordance with the ELISA test manufacturer's instructions (Table 1).

$$\frac{S}{N} \% = \frac{OD \text{ sample}}{OD \text{ Negative control}} \times 100$$

A herd was considered seropositive if at least one cow belonging to that herd was seropositive. Seroprevalence was calculated by dividing the number of serologically positive and doubtful sera by the total number of sera tested. It should be noted that sera with doubtful serological status underwent a second serological analysis for confirmation.

Table 1. Interpretation thresholds of the enzyme-linked immunosorbent assay kit for detection of antibodies against the Schmallenberg virus

Interpretation	Schmallenberg virus
Positive result	S/N% ≤ 40 %
Doubtful result	40 % < S/N% ≤ 50 %
Negative result	S/N% > 50 %

S/N: Sample (sample tested)/Negative control sample.

ELISA: Enzyme-Linked Immunosorbent Assay.

Statistical analysis

The individual true prevalence (TP) rate of SBV virus was estimated from the apparent prevalence (AP) rate calculated in this study, i.e., the seroprevalence, and the specificity (Sp), and individual diagnostic sensitivity (Se) announced by the kit manufacturer, using the Rogan and Gladen formula.⁽²⁵⁾

$$TP = \frac{PA + Sp - 1}{Se + Sp - 1}$$

For the AP, specificity and sensitivity values of the ELISA, a uniform variable accounting for the extreme values of the 95 % confidence interval (CI) was used and a stochastic simulation model (1000 Monte Carlo simulations) was run in @Risk 7.5.2 (Palisade Corporation, Ithaca, New York, USA) to estimate the TP with a 95 % CI using equation 2. Statistical identification of factors associated with increased or decreased risk of exposure to SBV virus was performed using STATA/SE Acad. 14.2 (Stata Corp., College Station, Texas, USA). In a first step, a multilevel mixed effects model was used to take into account the possible herd level as a random effect. As the random effect was not observed, logistic regression was used to model the probabilities of an animal being seropositive or suspect as a function of factors associated with an increased or decreased risk of exposure to the pathogen of interest.

The initial identification of potential factors associated with an increased or decreased risk of exposure to the virus under study was carried out in a first step using univariate regression. In a second step, a multivariate logistic regression including all variables with a value of $P < 0.20$ in the univariate analysis was used. Finally, in the initial multivariate model, non-significant variables ($P > 0.05$) were removed in a step-by-step approach (the variable with the highest P value). At each step, a likelihood ratio test was used to compare the complex and simplified models. When there was no significant difference among them, the simplified model was retained. Correlations among variables that passed the univariate analysis were not tested, as they were not biologically relevant ($P > 0.05$).

Results

Individual and herd prevalence rates

The individual apparent seroprevalence rate (positive and doubtful results) for SBV virus was 46.3 % (Table 2). It should be noted that the percentage of doubtful sera for SBV virus was 1.1 %. Using the formula of Rogan and Gladen,⁽²⁵⁾ the true individual prevalence rate of SBV virus was estimated at 45.2 %. The apparent SBV seroprevalence rate at the herd level was 73.6 % (Table 2).

Factors associated with increased or decreased risk of exposure to Schmallenberg virus

At the individual level, the multivariate logistic regression analysis showed that the fourth month of pregnancy (23/458; $P = 0.038$) was considered a factor associated with a reduced risk of exposure to SBV. Conversely, the years 2016 (79/458; $P = 0.007$) and 2019 (51/458; $P = 0.004$) as well as the winter season (84/458; $P = 0.037$) were found to be factors associated with an increased risk of exposure to this pathogen (Table 3). At the herd level (Table 4), a multivariate logistic regression identified several factors associated with a reduced risk of exposure to SBV, namely the implementation of a plan to control rodents and other pests ($P = 0.02$) and the presence of mould in animal feed ($P = 0.03$). Conversely, herd size ($P = 0.01$) was associated with an increased risk of exposure to SBV.

Table 2. Individual and herd seroprevalences of Schmallenberg virus

Pathogen	Number (individuals)			Individual prevalence rate (95 % CI)	Number (herds)			Herd prevalence rate (95 % CI)
	P	D	N	$= \frac{(P + D)}{(P + D + N)}$	P	D	N	$= \frac{(P + D)}{(P + D + N)}$
SBV virus	207	5	246	46.28 % (95 % CI: 39.71–52.65)	117	0	42	73.6 % (95 % CI: 60.93–81.34)

Schmallenberg virus: SBV virus

CI: confidence interval; P: positive; D: doubtful; N: negative

Table 3. Multivariate logistic regression at individual level for risk factors and protection factors associated with exposure to Schmallenberg virus

Pathogen	Multivariate logistic regression at individual level					
	Variable	Modality	Variable/total	OR	(95 % CI)	Value of P*
SBV virus	Wilaya concerned	Alger		Reference		-
		Blida	22/458	0.37	(0.13–1.01)	0.52
		Boumerdès	65/458	0.24	(0.07–0.87)	0.29
		Tipaza	60/458	0.28	(0.09–0.86)	0.27
	Year	2014		Reference		-
		2015	63/458	2.65	(0.73–9.58)	0.14
		2016	79/458	9.84	(1.86–51.94)	0.007
		2019	51/458	14.39	(2.40–86.33)	0.004
	Season	Autumn		Reference		-
		Summer	12/458	1.32	(0.50–3.49)	0.57
		Winter	84/458	2.05	(1.05–4.02)	0.037
		Spring	69/458	1.71	(0.69–4.26)	0.25
	Month of gestation	3rd month		Reference		-
		4th month	23/458	0.41	(0.18–0.95)	0.038
		5th month	33/458	0.60	(0.26–1.39)	0.23
		6th month	51/458	0.71	(0.31–1.59)	0.40
		7th month	47/458	0.66	(0.29–1.50)	0.32
		8th month	23/458	0.66	(0.26–1.65)	0.37

Schmallenberg virus: SBV. Exposure to SBV virus = P < 0.05 OR: odds ratio;

CI: confidence interval.

Likelihood ratio (LR) of models for SBV virus (LR chi² (14) = 56.72; P = 0

Table 4. Multivariate logistic regression at herd level for risk factors and protection factors associated with exposure to Schmallenberg virus

Pathogen	Multivariate logistic regression at herd level				
	Variable	Modality	OR	(95 % CI)	Value of P*
SBV virus	Herd size	—	1.04	(1.01–1.08)	0.01
	Food preservation	Mean	Reference		—
		Good	1.89	(0.74–4.80)	0.18
		Bad	0.31	(0.01–9.11)	0.5
	Presence of mold in the food	No	Reference		—
		Yes	0.18	(0.04–0.82)	0.03
	Rodent and pest control plan	No	Reference		—
		Yes	0.25	(0.08–0.81)	0.02
	Call from the veterinarian	No	Reference		—
		Yes	3.53	(0.96–12.91)	0.06

Schmallenberg virus: SBV

Exposure to SBV virus = $P < 0.05$. OR: odds ratio; CI: confidence interval

Likelihood ratio (LR) of models for SBV virus (LR χ^2 (17) = 38.01; $P = 0.0025$)

Discussion

The individual seroprevalence of SBV virus was estimated at 46.3 % (population of aborted dairy cows). This can be compared with other studies carried out in the same context (bovine abortions and reproductive disorders) and using the same serological diagnostic technique (ELISA). The individual seroprevalence observed in this study is lower than that observed in other countries, namely 56.6 % and 64.7 % in Ethiopia,^(11, 22) 57.4 % in China,⁽⁷⁾ 61 % in Tanzania,⁽¹⁰⁾ 69.9 % in Ireland⁽²⁶⁾ and 94 % in the United Kingdom.⁽¹⁸⁾ However, it remains higher than those observed in Serbia (13.4 %),⁽¹⁷⁾ Nigeria (29.2 %)⁽²⁷⁾ and Poland (37.7 %).⁽²⁸⁾ Regarding the 53.7 % of aborted cows that tested negative for SBV antibodies, they may have been infected by other abortifacient agents such as *Coxiella burnetii*, *Chlamydia abortus*, *Toxoplasma gondii*, infectious bovine rhinotracheitis virus (IBR), bovine viral diarrhea virus (BVD), Akabane virus and Rift Valley fever virus.

The lack of resources, due to the unavailability of ELISA kits to test for other abortive agents, was an obstacle to further study of the proportion of SBV-seronegative samples. Further studies are strongly recommended, to create a panel of different bovine abortive diseases in Algeria. In our study, the seroprevalence of SBV virus in the herd was 73.6 %, which is lower than in Tanzania (87 %)⁽¹⁰⁾ and China (100 %).⁽⁷⁾ At the individual level, exposure to SBV in the fourth month of gestation is associated with a reduced risk of abortion. As with the Akabane virus, which is pathologically and genetically similar to SBV, it is possible that the observed lesions (hydranencephaly, porencephaly and arthrogryposis) may appear after the 249th day of gestation and that embryos younger than two months are protected.^(29, 30)

It cannot be ruled out that SBV can induce abortion between days 100 and 260 of gestation.⁽³¹⁾ Thus, our results differ from those reported by Kirkland et al.,⁽²⁹⁾ Charles⁽³⁰⁾ and Wernike et al.,⁽³¹⁾ whose critical exposure periods to SBV were, respectively, between 80 and 150 days,⁽²⁹⁾ late gestation,⁽³⁰⁾ and between 75 and 175 days.⁽³¹⁾ There was a greater increase in SBV-positive cases in 2016 and 2019. This was likely due to the climatic conditions recorded during these years.

The survival and vectorial activity of *Culicoides* (biting midges) depend on various environmental and climatic factors, such as temperature, precipitation and wind speed, all of which considerably influence the biology and seasonal dynamics of *Culicoides*. Temperatures between 13 °C and 34 °C favors the reproduction of SBV in cattle, increasing the population size of vectors and their vectorial capacity.

Conversely, low temperatures render vectors inactive. Excessive rainfall can destroy some larvae and prevent adult flight.⁽³²⁾ *Culicoides* can travel longer distances due to winds and warm air currents.⁽³³⁾ According to Bessell et al.,⁽²⁴⁾ SBV spread was reduced in cooler years, with a reported threshold temperature of 12.3 °C for virus replication and development within *Culicoides*, with faster replication occurring above this threshold (0.03 per degree day). In winter, when the monthly mean temperature is above 12.5 °C, the area is favorable for *Culicoides* survival.^(33, 34) The average monthly temperatures recorded in the first six months of 2016 and the first three months of 2019 were 18.1 °C and 14.6 °C, respectively (www.infoclimat.fr), and the monthly rainfall recorded in the first six months of 2016 and the first three months of 2019 was 327 mm and 168.3 mm, respectively.

These results are consistent with those reported by Perie et al.⁽³³⁾ Unfortunately, due to a lack of data on wind speed and direction in the study area, it was not possible to assess the impact of this factor on SBV. Overall, the climatic conditions in the study area in 2016 and 2019 were favorable for *Culicoides* populations and therefore conducive to the spread of SBV. Winter has been identified as a factor associated with an increased risk of SBV seropositivity. Climate change may be responsible for increased average temperatures and flooding, which contribute to vector population growth and spread. It has also been observed that transmission of SBV by biting midges is lower in Central Europe in winter than in autumn or summer. The reason for this is thought to be a reduction in vector activity and inhibition of viral replication within the insect as a result of the drop in temperature.^(35, 36)

However, minimal vector activity seems to be sufficient for the spread of SBV, as acute infections have been detected in winter.⁽³⁷⁾ Our observations contrast with those of Wernike et al.⁽³¹⁾ in Germany and Steinrigl et al.⁽²⁰⁾ in Austria; they found high SBV seroprevalence during autumn, when midges are most active: in October (OR = 236.23; 95 % CI: 103.47–539.34; P < 0.001) and November (OR = 328.39; 95 % CI: 128.45–839.53; P < 0.001). The high SBV seroprevalence reported in Algeria during the winter can be explained by the milder temperatures characteristic of Algerian winters compared to summers, when temperatures exceeding 40 °C observed in some regions (including our study area), thus favouring the spread of SBV by biting midges in winter.

At herd level, implementing a control plan for rodents and other pests was identified as a factor associated with reduced SBV exposure risk. According to data provided by the Friedrich-Loeffler-Institute,⁽¹⁶⁾ SBV is an enveloped virus and the majority of commonly used disinfectants (bleach, chlorhexidine, alcohol- and phenol-based cleaners and detergents) are sufficient to ensure its inactivation. According to OIE (2013) (Office International des Épizooties) data,⁽¹²⁾ SBV is sensitive to the following chemical agents and disinfectants: 1 % sodium hypochlorite, 2 % glutaraldehyde, 70 % ethanol and formalin. With regard to the persistence of the virus during the winter period, the increased use of anti-insect agents on susceptible animals is sufficient to reduce the spread of SBV pests and vectors, as well as the risk of spread among livestock.⁽¹⁶⁾ Thus, the application of different control measures (insecticides and pesticides) will help to reduce the spread of SBV.⁽³⁷⁾

Our results are similar to those reported in Spain, where insecticide treatment of ruminants was found to be associated with a reduced risk of SBV exposure (OR = 0.13; 95 % CI: 0.05–0.37; P < 0.001). This suggests that insecticide treatment can protect against SBV infection.⁽²¹⁾

The presence of mould in livestock feed has been identified as a factor associated with reduced exposure to SBV. Moulds in feed (such as straw and silage that has not been properly preserved) produce mycotoxins that are harmful to the development of *Culicoides* insect larvae, which carry SBV. Farms provide several types of habitat for larval breeding, such as anthropic substrates linked to livestock farming (manure, silage and straw), which are favorable for the development of the main virus vectors, including SBV.⁽³⁸⁾

Thus, species such as *Culicoides obsoletus* and *Culicoides scoticus* are very abundant in silage residues (e.g. maize silage) mixed with straw.^(38 39) The mycotoxins produced by the moulds create an environment that is unfavorable for the survival of the larvae, causing their death and thus reducing the *Culicoides* population, which is the vector of SBV. A high herd size was identified as a factor associated with an increased risk of SBV exposure. Indeed, the probability of cattle testing positive for SBV depends significantly on local cattle density. This differs from the results reported by Veldhuis et al.,⁽¹⁹⁾ who found that SBV risk decreased with increasing herd size (OR = 0.98; 95 % CI: 0.97–1.00; P = 0.021). However, similar results were reported by Steinrigl et al.,⁽²⁰⁾ who found that the number of positive SBV tests increased with decreasing cattle density (OR = 0.99; 95 % CI: 0.98–0.994; P < 0.001). These results suggest that SBV transmission may also depend on the vector/host ratio.

Conclusion

This study initially confirmed the presence of Schmallenberg virus (SBV) in dairy cattle herds, given the significant seroprevalence rates obtained. It subsequently confirmed a possible association between SBV and cases of bovine abortion, as identified through various risk factors at individual and herd levels. Further studies on the pathogenesis and molecular characteristics of SBV are strongly recommended. Ideally, SBV DNA would have been identified by PCR, but this step was not carried out due to the lack of abortions and the high cost of PCR. To better manage various vector-borne diseases, such as SBV, and limit the risk of spread to non-endemic regions, it is essential to establish an entomological surveillance system for the vector as soon as possible. Based on our observations, we encourage farmers and veterinarians to join the fight against these abortive agents, which cause economic losses and impact public health.

Data availability

All relevant data are within the manuscript and its supporting information files.

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Conflicts of interest

The authors have no conflict of interest to declare in regard to this publication.

Author contributions

Conceptualization and methodology: N Djellata, C Saegerman.

Data curation and writing-original draft: N Djellata.

Formal analysis and software: C Saegerman.

Investigation: A Yahimi.

Supervision: N Djellata, A Yahimi.

Validation: C Hanzen.

Writing-review and editing: N Djellata, C Hanzen.

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