Survey of the prevalence of bovine abortions and notification and management practices by veterinary practitioners in Algeria

This paper (No. 20072020-00166-FR) is a translation of the original French article, which was peer-reviewed, accepted, edited, and corrected by authors before being translated. It has not yet been formatted for printing. It will be published in issue **39** (3) of the *Scientific and Technical Review*, in 2021.

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Summary

Whether the cause is infection or not, abortions result in major economic losses on Algerian cattle farms. However, little is known about their prevalence and the factors influencing their notification by Algerian veterinarians. In order to bridge this knowledge gap, an epidemiological survey was conducted between September 2014 and

February 2016, in the form of direct interviews with 331 veterinarians randomly distributed in ten wilayas in northern and central Algeria. Influencing factors were analysed using a univariate, then multivariate, logistic regression model and a classification tree analysis. The statistical significance was set to 5% (*p* value of 0.05). According to 48.7% of the veterinarians interviewed, the average prevalence of abortions on the dairy farms monitored by each veterinarian during the past 12 months was greater than 5%. The results of the multivariate logistic regression model confirmed that abortion notification is far more systematic if accompanied by sampling for laboratory diagnosis (odds ratio [OR] = 467; confidence interval [CI] 95%: 56–3,897; $p < 0.001$). Conversely, notification is less frequent if the abortion occurred during the summer (OR = 0.14; CI 95%: 0.03–0.58; $p = 0.007$). The classification tree generated from the survey data indicates that the three variables most predictive of abortion notification are (in decreasing order of importance): sampling for laboratory analysis to identify the cause of abortions; the wilaya of origin; and the season during which the abortions occurred. Finally, an overall weighted score (on a scale of 0 to 100) was assigned and allowed the evaluation of the notification and management of bovine abortions by veterinarians. Evidently there is plenty of scope for improvement because two-thirds of veterinarians achieved scores between 0 and 25. Recommendations were made to improve notification and the management of bovine abortions in Algeria, including publishing an agreed standard procedure for abortions, conducting information and awareness-raising campaigns aimed at farmers and veterinarians and allocating additional resources to laboratory analysis of the causes of abortion and incentives to encourage notification of abortions. Another proposal was the creation of an agricultural fund to compensate cattle farmers for losses resulting from bovine abortions caused by notifiable diseases.

Keywords

Abortion – Algeria – Dairy cattle – Epidemiological survey – Farmer – Management – Notification – Protective factor – Risk factor – Veterinarian.

Introduction

In Algeria, livestock farming provides a large proportion of household income with a national herd of around 2 million cattle, 31 million small ruminants and 350,000 camels, reared under a traditional extensive farming system, although intensive farming systems have recently been introduced in the country (1). Extensive farms are often family-run. Cattle are largely grass fed. Forage (cereals, pulses) required in winter is generally grown on the farm. Cattle dung provides a natural fertiliser for the fields. Extensive systems are characterised by small- to medium-sized farms and a low animal population per hectare.

From a legal standpoint (French Decree of 24 December 1965), abortion is the expulsion of a foetus or a calf, either stillborn or dead, within 48 hours of birth (2). From a biological standpoint, abortion is the interruption of gestation between the 42nd and 260th day, regardless of whether it is followed by expulsion of the foetus. Before the 42nd day of gestation, it is considered to be embryonic mortality, while between 260 and 285 days, parturition is considered to be premature. A distinction needs to be made between clinical abortion (evidence of abortion and/or foetal sacs) and abortions not properly determined (presumed abortion), in other words, identified by positive earlier gestation followed by later negative gestation (3). This study only relates to clinical abortions.

Abortions have significant economic consequences in terms of reduced milk output, longer calving intervals, premature culling of animals and even the death of cattle. In the Republic of Korea, abortions in dairy cattle resulted in an estimated economic loss of € 2,100 per cow (4). In Switzerland, with an annual abortion rate of 2% to 4%, the total loss was estimated at between € 19.64 million and € 39.27 million (5). In Algeria, the estimated amount of compensation paid out for cattle and goats slaughtered because of brucellosis between 2002 and 2004 was € 618,624. When the origin is zoonotic, abortions also pose a risk to public health. For example, Q fever (due to *Coxiella burnetii*) can cause flu-like symptoms, as well as granulomatous hepatitis or atypical pneumonia in humans. Subjects with risk factors (patients with valvulopathies, vascular prostheses, pregnant women, immunocompromised individuals) represent a population at risk of chronic infection, which could result in endocarditis (6).

Abortions are characterised by: difficulty in assigning a precise aetiological diagnosis; the diversity of associated causes and risk factors; the broad range of hosts; the variety of clinical signs; and the relative absence of accompanying pathognomonic lesions. Added to this are the difficulty of taking samples and the lack of laboratories to analyse them (7, 8). Although contagious abortive diseases such as brucellosis are notifiable in Algeria (9, 10), reporting by veterinarians is far from systematic. There are many reasons for this. For example, fear of repercussions from notification, especially for brucellosis (culling of cattle, inadequate compensation to purchase replacement animals), the long delay between sending a sample to the laboratory and receiving the diagnostic test results, and fear of an incorrect diagnosis leading to unnecessary animal euthanasia.

The purpose of this study is to estimate the rate of clinical abortions in dairy herds by means of an epidemiological survey among veterinarians practising in northern and central Algeria, as well as to identify the factors influencing abortion notification practices by veterinary practitioners to the authorities concerned, in order to improve the national surveillance system for abortions in cattle in Algeria.

Materials and methods

Region of study, sampling and type of survey

The region studied is located in northern and central Algeria, comprising the wilayas of Blida, Algiers, Tipaza, Boumerdès, Chlef, Bejaïa, Bouira, Tizi Ouzou, Médéa and Aïn Defla. This large agricultural plain is bordered to the west by the wilaya of Chlef and to the east by the wilayas of Bejaïa, Tizi Ouzou and Bouira. The climate is Mediterranean with a continental influence (sirocco in summer), with hot, dry summers and mild, rainy winters.

The survey, based on a 30-minute direct interview, was conducted between September 2014 and February 2016 with 331 veterinarians selected at random from the 1,304 veterinarians who provide animal health surveillance for 383,012 dairy cattle in 63,101 herds in the ten wilayas of central and northern Algeria: Chlef ($n = 40$ veterinarians), Bouira and Tizi Ouzou ($n = 77$), Médéa ($n = 40$), Algiers, Blida and Tipaza ($n = 71$), Aïn Defla ($n = 20$), Bejaïa ($n = 40$) and Boumerdès ($n = 43$). This represents a polling rate of 25%; none of the veterinarians included in the study refused to participate.

The survey questionnaire was administered by the same person (standardisation) and included general information concerning the professional experience of the veterinarian (< 10 years, > 10 years) and the wilaya where they practice (Chlef, Bouira–Tizi Ouzou, Médéa, Algiers–Blida–Tipaza, Aïn Defla, Bejaïa, Boumerdès), as well as information specific to abortions. This included the average prevalence of abortions on the dairy farms monitored by each veterinarian over the course of the past 12 months (recorded as sporadic if the prevalence was less than 5% and epizootic if the prevalence was greater than 5%); the season in which abortion was most likely to occur (spring, summer, autumn, winter or throughout the year); the stage of gestation (1st, 2nd or 3rd trimester); the delay in the farmer contacting the veterinarian (3, 6, 12, 24 hours following abortion, or no contact); the outcome of the abortion (incineration, burial); whether the veterinarian had taken abortion samples (yes/no: no if the farmer had already disposed of the abortion and otherwise, yes; each veterinarian replied to this question relating to the last abortion case that they had encountered); the cause suspected by the veterinarian, depending on the case history (infection, trauma, parasite, medication, nutrition); and, finally, notification of the abortion by the veterinarian to the authorities concerned (yes/no) (Table I).

Table I

Descriptive data and results of the univariate logistic regression analysis of the factors influencing notification of bovine abortions by veterinarians in the region under study (northern and central Algeria)

Parameter	Modality	N	Percentage	OR (95% CI)	Value of p (χ^2)
Wilaya concerned	Aïn Defla	20	6.0	Reference	–
	Blida / Algiers / Tipaza	71	21.4	3.89 (1.18–12.79)	0.025*
	Bejaïa	40	12.1	3.27 (0.93–11.54)	0.065
	Bouira / Tizi Ouzou	77	23.3	2.84 (0.87–9.31)	0.08
	Boumerdès	43	13.0	1.21 (0.33–4.47)	0.77
	Chlef	40	12.1	0.57 (0.14–2.42)	0.45
	Médéa	40	12.1	0.71 (0.17–2.86)	0.63
Professional experience	≥ 10 years	247	74.6	Reference	–
	< 10 years	84	25.4	0.75 (0.44–1.29)	0.30
Abortion frequency	> 5%	161	48.6	Reference	–
	< 5%	170	51.4	0.78 (0.49–1.24)	0.29
Season of abortions	All year	45	13.6	Reference	–
	Winter	86	26.0	2.33 (1.05–5.21)	0.04*
	Spring	108	32.6	1.42 (0.64–3.14)	0.39
	Summer	62	18.7	1.26 (0.53–3.03)	0.60
	Autumn	30	9.1	1.55 (0.56–4.28)	0.40

Stage of gestation of abortion	1st trimester	27	8.2	Reference	–
	2nd trimester	111	33.5	2.83 (0.79–10.10)	0.11
	3rd trimester	193	58.3	5.43 (1.58–18.64)	0.007*
Suspected cause of abortions	Infection	177	53.5	Reference	–
	Trauma	107	32.3	0.60 (0.35–1.01)	0.052
	Parasite	16	4.8	0.23 (0.05–1.04)	0.056
	Medication	25	7.6	0.75 (0.31–1.84)	0.54
	Nutrition	6	1.8	1.60 (0.31–8.17)	0.57
Delay in calling veterinarian	3 hours after	43	13.0	Reference	–
	6 hours after	42	12.7	0.85 (0.35–2.05)	0.72
	12 hours after	71	21.5	0.69 (0.31–1.52)	0.35
	24 hours after	159	48.0	0.70 (0.34–1.41)	0.32
	Never	16	4.8	0.92 (0.28–2.99)	0.89
Samples taken for diagnosis	No	268	81.0	Reference	–
	Yes	63	19.0	62.76 (21.80–180.71)	<0.001*

CI: confidence interval
N: number of veterinarians audited
OR: odds ratio
*: $p < 0.05$

Statistical analyses and assignment of an overall weighted score for notification and management of abortions by veterinarians

Descriptive analysis

The prevalence data were estimated with a confidence interval (CI) of 95%, assuming a precise binomial distribution (with *n* samples and *p* probabilities of success with each sample).

Logistic regression analysis

Statistical identification of factors associated with an increased or decreased probability of notification of bovine abortions was carried out using the software STATA/SE Acad. 14.2 (Stata Corp., College Station, Texas, United States of America). The initial identification of potential factors associated with an increased or decreased probability of notification of bovine abortions (variable of interest) was initially conducted using a univariate logistic regression model. Following this, a multivariate logistic regression model was applied to the univariate analysis, including all the variables with a value of $p < 0.20$. Finally, in the initial multivariate model, the non-significant variables ($p > 0.05$) were eliminated in a step-by-step approach (starting with the least significant variable, i.e. the variable with the highest value of p). At each stage, a likelihood ratio test was used to compare the complex and simplified models. Where there was no significant difference between them, the simplified model was used. The correlations between variables that passed the multivariate logistic regression analysis were not tested because they were of no biological relevance. The fitting of the final multivariate logistic regression model was evaluated using the Hosmer-Lemeshow test (11).

Classification tree analysis

A classification and regression tree (CART) analysis is a discrimination method based on the construction of a binary decision tree. The goal is to construct subgroups of a population that are as homogeneous as possible for a given characteristic (variable to be explained). In this study, the variable to be explained is notification or non-notification of abortions. The CART analysis is used to construct a tree with successive divisions according to the explanatory variables, which can be continuous or categorical (see Table I for the list of explanatory variables). The extremities of the tree represent homogeneous subgroups. The basic idea is to create subgroups (referred to as children) where the mix is less than in the initial population (referred to as the parent group, including all abortions whether notified or not). When the dependent variable is categorical (which is the case in this study), it is referred to as a classification tree, as opposed to a regression tree, which concerns a continuous dependent variable (12, 13).

The Salford Predictive Modeler software (Salford Systems, San Diego, California, United States of America) was used to split all data into increasingly homogeneous subgroups until they were stratified and satisfied the specified criteria. The Gini index method is used for splitting with tenfold cross-validation to test the predictive capacity of the trees obtained (12). The CART analysis carries out cross-validation, growing optimum trees on data subgroups, then calculating the error rates based on the parts of the complete dataset not used. The CART analysis divides all the data into ten almost equal parts selected at random, with each part containing a similar distribution of data from the populations under consideration (namely notification or non-notification of abortions). The analysis then uses the first nine datasets (9/10) to construct the largest possible tree and uses the last part of the remaining data (1/10) to estimate the error rate of the selected tree. The process is repeated using different combinations of the nine remaining data subsets and a different data subset to test the resulting tree. This process is repeated until each 1/10 data subset has been used to test a tree developed using another data subset (9/10). The results of the ten mini-tests are then combined to calculate the error rates for each possible size of tree. These error rates are then applied to prune the tree that was developed using all the data. The outcome of this complex process is a set of relatively reliable independent estimates of the accuracy of the clinical decision tree prediction. For each node in a tree generated by CART, the main separator is the variable that best divides the node, thereby maximising the purity of the resulting nodes. To test the diagnostic power of the final decision tree generated, a receiver operating characteristic (ROC) was employed both for the original dataset used to construct the tree (training data) and for the dataset used to test the relevance of the data tree (test data).

Assignment of an overall weighted score for notification and management of abortions

A matrix was constructed to assign an overall weighted score for the notification and management of abortions by veterinarians (Table II). To do this, four elements were selected and weighted by distributing 100 points between these elements. The elements selected were those most closely linked with optimum notification and management of abortions from a Veterinary Services standpoint. The distribution of points (weighting) proposed by the authors of this article was based on their experience of the relative weight of each element represented. These elements were: notification of an abortion to the veterinarian by the farmer; the delay before the farmer contacted the veterinarian; biological sampling by the veterinarian to diagnose the cause of the abortion; and management of the abortion. Each veterinarian was scored using this matrix after the data from the questionnaires was compiled. Using this system, the minimum or maximum overall weighted scores achievable are 0 (worst situation) or 100 points (best situation), respectively.

Table II

Matrix used to assign a weighted overall score for notification and management practices for bovine abortions by veterinarians during the survey conducted in northern and central Algeria

Variable	Variable code	Modality	Score	Weighting assigned by the authors	Weighted score
Notification of abortion	DAV	1: yes	1	50	50
		0: no	0	50	0
Delay by farmer in contacting veterinarian	DCV	0: < 3 h	1	5	5
		1: < 6 h	0.75	5	3.75
		2: < 12 h	0.5	5	2.5
		3: < 24 h	0.25	5	1.25
		4: never	0	5	0

Biological sample of abortion taken for diagnosis	PAV	1: yes	1	40	40
		0: no	0	40	0
Abortion management	CAAV	1: incineration	1	5	5
		0: burial	0	5	0

DAV: notification of abortion to the authorities concerned
DCV: delay by farmer in contacting veterinarian when abortions occur
PAV: abortion samples taken for analysis
CAAV: conduct regarding abortion

Results

Descriptive analysis

The majority of the veterinarians in the survey (74.6%; CI = 95%: 69.6–79.2) had been practising for more than ten years. In comparison with the threshold abortion rate considered to suggest an epizootic event, in this case ≥ 5% (8), the average prevalence of abortions found in the dairy farms monitored over the past 12 months by each veterinarian was estimated to be greater than 5% in 48.6% of cases (CI = 95%: 43.1–54.2). Abortions occurred mainly during the spring (32.6%; CI = 95%: 27.6–38.0) and during the last three months of gestation (58.3%; CI = 95%: 52.8–63.7). According to the veterinarians interviewed, abortions were caused mainly by infections (53.5%; CI = 95%: 47.9–58.9). Veterinarians were called out within 24 hours of the abortion in 48% of cases (CI = 95%: 42.5–53.6). They notified 33.2% of the clinical abortions encountered to the competent authorities (CI = 95%: 28.2–38.6) (regardless of the average prevalence of abortions encountered by their clients). Only 19% (CI = 95%: 14.9–23.7) of veterinarians carried out sampling to investigate the cause of abortion through laboratory testing (Table I).

Logistic regression analysis

The univariate logistic analysis resulted in the following significant variables: the region of practice (Algiers, Blida and Tipaza); the winter season; taking abortion samples for laboratory testing; and the stage of gestation (last trimester) (Table I).

The multivariate regression analysis showed that notification of bovine abortions by veterinarians was significantly higher in wilayas other than Aïn Defla, which was used as a reference. Notification of abortions was also significantly higher where the veterinarian took samples of the abortion (OR: = 467; CI = 95%: 56–3,897; $p < 0.001$). Conversely, the notification of abortions by veterinarians was significantly less frequent during the summer months (OR = 0.14; CI = 95%: 0.03–0.58; $p = 0.007$) than during the other seasons (Table III). The fitting of the final multivariate logistic regression model compared with the data was good (Hosmer-Lemeshow test, χ^2 (8 degrees of freedom) = 7.46; value of $p = 0.49$).

Table III

Results of the multivariate analysis of factors influencing notification of an abortion highlighted by the univariate analysis

Variable	Modality	OR (95% CI)	Value of p (χ^2)
Veterinarian region of practice	Aïn Defla	Reference	–
	Bejaïa	193.20 (13.59–2,746.25)	<0.001*
	Blida / Algiers / Tipaza	232.24 (16.32–3,304.78)	<0.001*
	Bouira / Tizi Ouzou	61.78 (4.54–840.68)	0.002*
	Boumerdès	48.99 (3.37–712.69)	0.004*
	Chlef	28.37 (1.75–458.67)	0.02*
	Médéa	20.68 (1.40–304.50)	0.03*
Season of abortions	All year	Reference	–
	Winter	0.78 (0.26–2.36)	0.65
	Spring	0.38 (0.13–1.14)	0.09
	Summer	0.14 (0.03–0.58)	0.007*
	Autumn	0.65 (0.16–2.60)	0.54

Stage of gestation of abortion	1st trimester	Reference	–
	2nd trimester	1.55 (0.38–6.39)	0.54
	3rd trimester	2.66 (0.69–10.33)	0.16
Samples taken for diagnosis	No	Reference	–
	Yes	467.09 (55.99–3,896.72)	<0.001*

CI: confidence interval
OR: odds ratio
*: $p < 0.05$

Classification tree analysis

The classification tree that best explains whether or not abortions were notified by veterinarians is shown in Figure 1. According to a scale from 0 to 100 for the significance of variables, the three main predictive variables of the classification tree are (in decreasing order of importance): taking samples for laboratory testing to identify the cause of the abortion (significance of the variable = 100); the wilaya of origin (significance of the variable = 27.3); and the season in which the abortion occurred (significance of the variable = 6.4). The sensitivity (Se) and specificity (Sp) of the classification tree relating to whether or not abortions were notified by the veterinarian were respectively 80.9% (CI = 95%: 72.3–87.8) and 81% (CI = 95%: 75.2–86.0) for the dataset used to construct the clinical decision tree (training data) and 77.3% (CI = 95%: 68.3–84.7) and 81.4% (CI = 95%: 75.7–86.3) for the dataset used to test the relevance of the data tree (test data). The ROC curves of the training dataset and the test dataset are shown in Figure 2. The area below the ROC curve of the training dataset is 0.86 while the area below the ROC curve of the test dataset is 0.84. These values should be interpreted taking into account the range of possible values for the area below the curve (from 0 to 1). When the area below the curve is less than or equal to 0.5, the proportion of true positives (Se) is less than or equal to the proportion of false positives (1–Sp). The diagnostic potential of the proposed tree is therefore good to very good.

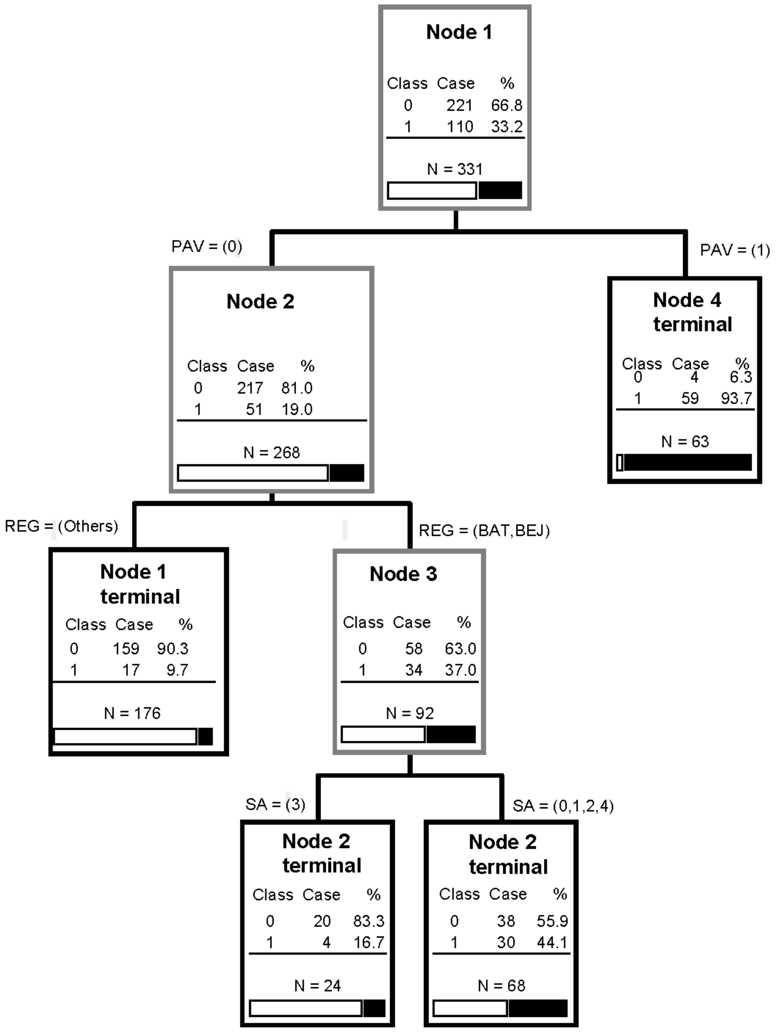

Fig. 1

Classification tree for notification or non-notification of abortions

Class:	1 where abortions are notified and 0 where abortions are not notified
Case:	number of cases per class
%:	percentage of cases. The percentage of cases where the class equals 0 is represented by a blank rectangle (the longer the rectangle, the higher the percentage). The percentage of cases where the class equals 1 is represented by a black rectangle (the longer the rectangle, the higher the percentage)
N:	number of veterinarians concerned
Nodes 1, 2 and 3:	primary nodes
PAV:	sample taken for laboratory diagnosis to identify the cause of abortions (1 = yes; 0 = no)
REG:	wilaya of origin (BAT = Blida, Algiers and Tipaza; BEJ = Bejaïa; Others = Chlef, Bouira, Tizi Ouzou, Médéa, Aïn Defla and Boumerdès)
SA:	season of abortions (0 = all seasons, 1 = winter, 2 = spring, 3 = summer, 4 = autumn)

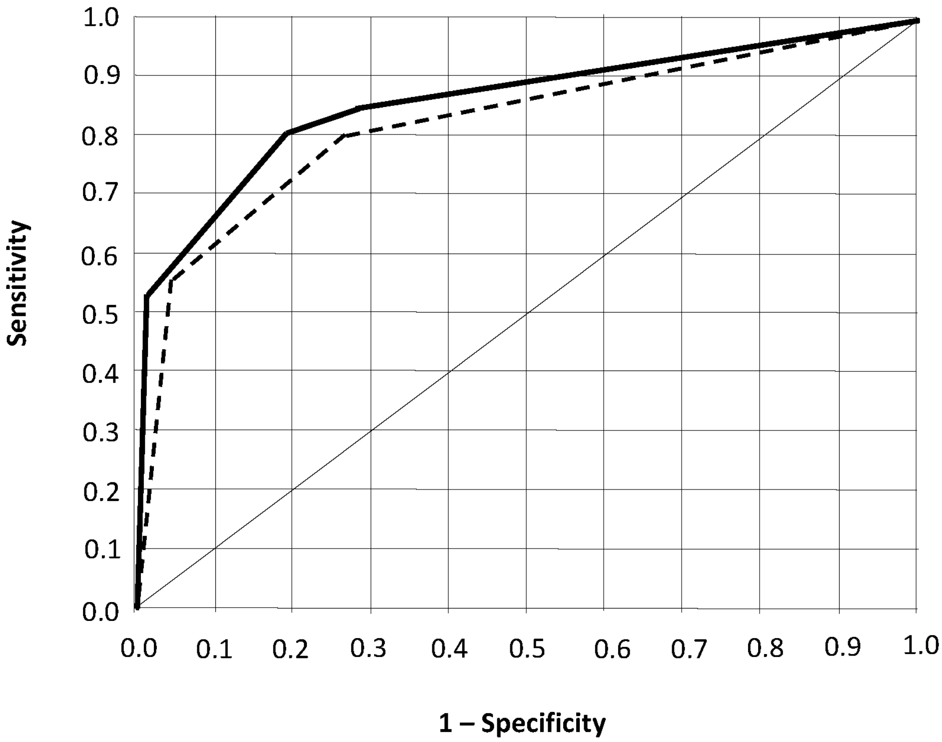

Fig. 2

Receiver operating characteristic (ROC) curve obtained from the classification tree for the training dataset and test dataset

Continuous line: training dataset
Dotted line: test dataset

The area below the ROC curve of the training dataset is 0.86, while the area below the ROC curve of the test dataset is 0.84. The closer the curve is to 1, the greater the diagnostic value of the tree.

Overall weighted score for notification and management of abortions by veterinarians

The frequency histogram for the number of veterinarians in relation to an overall weighted score for notification and management of bovine abortions in Algeria ranges from 1 to 25 (on a scale of 0 to 100) in the majority of cases (65.56%; CI = 95%: 60.17–70.67) (Fig. 3). Only 17.82% of veterinarians obtained an overall weighted score of more than or equal to 75. Overall weighted scores varied widely between the different wilayas.

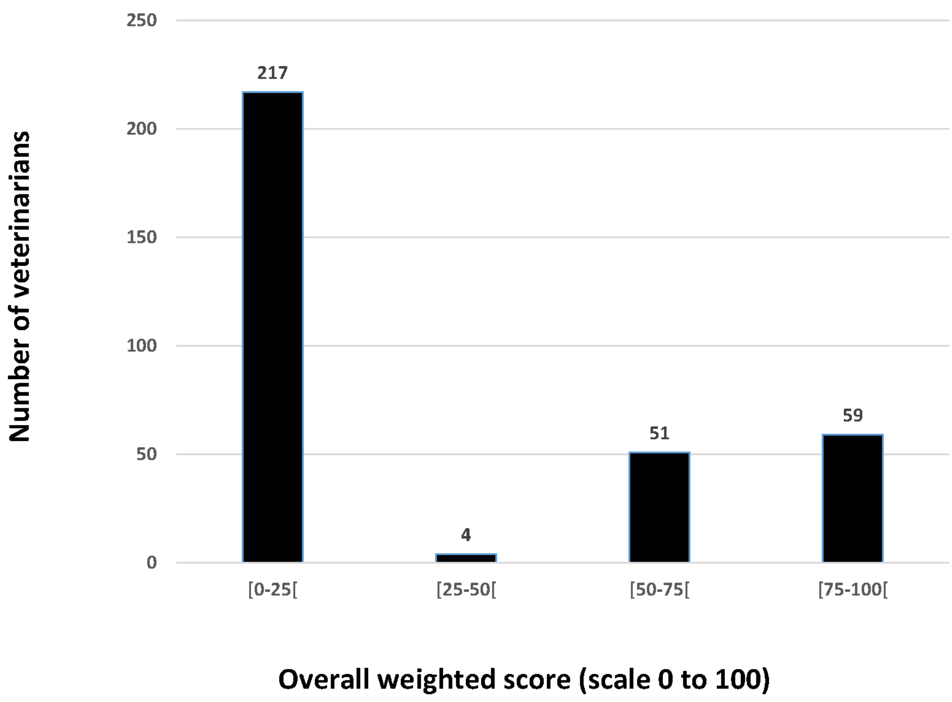

Fig. 3

Frequency histogram of the number of veterinarians based on the overall weighted score assigned for notification and management of bovine abortions in Algeria

Discussion

Generally speaking, when one or more abortions occur, either they pass unnoticed, or they are noticed by the farmer. In the latter case, they may be sporadic or multiple, or even epizootic. Faced with this situation, the farmers concerned decide whether or not to report the occurrence to their veterinarian. The veterinarians contacted then analyse the situation and decide whether or not to notify the Veterinary Services. Surveys are needed to better understand what makes a farmer, or a veterinarian, decide whether or not to notify an abortion and how to manage it. This initial survey concerns veterinary practitioners. The survey started with veterinarians because a previous pilot study highlighted the very low number of abortions that led to a request for a laboratory test by veterinarians (14). This study relates in particular to the prevalence and practices of notification and management of clinical abortions by Algerian veterinarians. However, clinical abortions are only the tip of the iceberg. It is generally acknowledged that a foetus aged less than 150 days is unlikely to be detected (15). If we consider the total risk period for abortion (from day 45 to day 215 of gestation), or 215 days, the period during which a clinical abortion is observable (110 days) covers only half the period. This means that, statistically speaking, for every clinical abortion detected, there is one subclinical abortion, if we assume that the risk of abortion is the same throughout gestation. It is therefore necessary to encourage veterinarians, as far as possible, to notify abortions, in particular multiple and epizootic abortions.

The characteristics of veterinary practices in cases of abortion and their quantification have been very little studied in the Algerian context. According to a previous survey of 105 farmers in central Algeria conducted between 2010 and 2013, more abortions occurred in sheep (56% of all abortions reported) than in goats (34%) and cattle (10%), with 90% of farmers having witnessed several abortions a year, compared with only 10% who had rarely or never encountered an abortion. When abortions occurred, a veterinarian was called out in 55% of cases. The cow that had aborted was only isolated from the herd by 27% of farmers and 29% of farmers did not destroy the placentas and foetal membranes. In terms of farmers' knowledge of the different diseases that cause abortion, 49% had received no relevant information on abortive pathogenic agents, the transmission mode of abortive diseases or the clinical signs, and 35% of farmers only knew about brucellosis (16).

The results of the survey show that only 33.2% of veterinarians notify abortions to the authorities and 19% take samples for laboratory analysis in order to determine the cause. These figures appear to show an improvement in practices because, according to a survey carried out in 2010 on 250 veterinarians in the same study area, 47.5% did not notify any abortions and no veterinarians took samples for laboratory analysis (14). It is nevertheless surprising to find that, despite the high prevalence of abortions in Algeria of between 22.2% (17) and 41.3% (1), few veterinarians notified abortions or took the samples required for aetiological diagnosis. In this study, notification rates varied between wilayas, which seems to indicate differing levels of awareness amongst veterinarians. The absence of notification and lack of sampling indicates that, in the majority of cases, the causal agent was not identified. However, systematic sampling of successive cases of abortions, accompanied by good case histories, would dramatically increase the probability of identifying the cause of abortion in a herd, as well as preventing some abortions (possible vaccination against certain pathogens).

The survey results also show that the majority of farmers (95.2%) call out a veterinarian in the event of an abortion (Table I). This high percentage indicates their growing awareness of the importance of involving a veterinarian, because a previous study in 2010 mentioned that farmers only called out a veterinarian in the case of a retained placenta (14).

Notification of an abortion correlates closely with sampling and the veterinarian requesting an analysis for aetiological diagnosis (Table I). The lack of systematic sampling may come as a surprise. The fact is that a veterinarian's animal health or therapeutic recommendations depend on the epidemiological characteristics of the causal agent. The lack of notification and sampling, for a possible variety of reasons (such as fear of the repercussions of notification or long delays between sending samples to the laboratory and receiving the test results), most certainly contribute to the spread of the infectious agent potentially responsible for abortions both within and outside the farm. In the case of a zoonosis (such as bovine brucellosis or Q fever), this also poses a significant risk to the health of farmers and their families. Finally, this makes it difficult for animal health officials to set up an abortion control plan.

According to 48.7% of veterinarians, the average prevalence of abortions on the dairy farms they had monitored over the past 12 months was greater than 5%. This often points to their epizootic nature, assuming we accept the threshold of 5% of abortions proposed by Givens and Marley (18). Most of these abortions are infectious in origin (53.5%), occurring mainly during the last trimester of gestation (58.3%) and mostly in the spring (32.6%). The observations of this study do nevertheless differ from those reported in Algeria by Mammeri *et al.* (19), who found a higher frequency of abortions in autumn (25.8%) and during the second trimester of gestation (58%). However, their study concerned a different region of Algeria and a low number of farmers, some of whom practised transhumance.

The number of abortions reported by veterinarians in summer was smaller than during the other seasons. This could result from a lower frequency of abortions during this season and/or from a reduction in observations during this period. This corroborates another result reported in Algeria (19), where the risk of bovine abortions is higher in autumn and winter than in summer. A greater prevalence of bovine abortions in winter compared with the other seasons was also reported in Ireland (20), Mexico (21), the United States of America (22) and Nigeria (23), where the risk of abortion was found to be higher. This result differs from a report from Iran (24), where the mortality of calves within 24 hours of calving was higher in summer and lower in winter, although the difference is not significant. It also differs from results obtained by Carpenter *et al.* (25) and by Norman *et al.* (26), who found a higher frequency of abortions in July, with an increase from May to September and a reduction from October to February. The difference in these two studies could stem from agro-ecological factors, the breeds concerned and the farming systems employed. The higher frequency of abortions in summer could be due to high summer temperatures, humidity and heat stress.

The classification tree analysis shows that increased use of laboratory analyses for abortion diagnostics is the best predictor for notification of an abortion. Sampling for analysis should therefore be encouraged.

Finally, the distribution of overall weighted scores for notification and management of abortions by veterinarians (Fig. 3) indicates huge potential for improvement.

Various means or approaches could be considered for improving notification and management of abortions by veterinarians (non-exhaustive list):

– government funding for research into bovine brucellosis, which is a major zoonosis and a frequent cause of abortions in Algeria (1, 27). Another effective means employed in European countries is a panel of experts to review the most frequently observed causes in the country concerned (28). Even if the herd is not affected by brucellosis, the fact of searching for other causes of abortion could motivate veterinarians and farmers to practice notification;

– drawing up a joint procedure agreed by the stakeholders affected by abortions is likely to build trust between these actors and standardise the approach for all the wilayas;

– implementing information and awareness campaigns aimed at farmers and veterinarians;

– allocating additional resources to laboratory diagnosis of the causes of abortion, with rapid feedback;

– twinning laboratories to develop expertise in priority diseases. This system is promoted by the World Organisation for Animal Health (OIE) (see www.oie.int/en/solidarity/laboratory-twinning/);

– the creation of an agricultural fund to compensate farmers for losses resulting from abortions in cattle caused by notifiable diseases.

The survey also explores the limits intrinsic in the general declarative nature of the abortion situation, relying heavily on the recollection of veterinarians.

Finally, as mentioned earlier in the discussion, notification of abortions involves several stakeholders. In addition to a survey among veterinarians, it would be useful to conduct a similar survey among cattle farmers. Moreover, a study of the factors determining whether or not a farmer or veterinarian notifies an abortion is of great importance. A socio-anthropological study would therefore be very useful in identifying the determinants on which it is possible to intervene.

Conclusion

Abortion is notifiable in Algeria. However, farmers and veterinarians are not yet sufficiently aware of this. It is true that aetiological diagnosis is not easy and is still too rarely carried out. Moreover, the appropriate analyses require quality samples backed by good case histories, as well as laboratory capacity to carry out diagnoses.

The competent health authorities must increase the resources needed to control bovine brucellosis, the main indicator of which is abortion, as this disease is a major zoonosis and causes significant economic losses. Resources must be earmarked to: draw up an agreed standardised procedure for the analysis and management of bovine abortions; raise awareness among livestock farmers and veterinarians of the usefulness of reporting abortions; improve laboratory capacity; analyse the causes of abortion; and increase funding to encourage the reporting of abortions, for example, by covering some or all of the costs associated with the diagnosis of abortions.

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