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Determinants of bovine ephemeral fever outbreak during 2013, in Qazvin Province, Iran

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ABSTRACT

Objective: To investigate the first outbreak of bovine ephemeral fever (BEF) in the province of Qazvin in 2013, explore the potential associations that exist between disease occurrence and meteorological data, and identify risk factors associated with BEF.

Methods: This study was conducted using case-control design in Qazvin Province during June to October of 2013. The questionnaire for independent variables was designed for detecting risk factors of BEF and was completed through a direct interview with the owners. The weather data was taken from meteorological centers.

Results: Totally 1800 cattle out of 25000 were affected [within-herd incidence rate was 7.20% and 95% confidence interval (CI) for incidence rate was 6.88%–7.52%] and 464 cattle died (mortality rate was 1.86% and 95% CI for mortality rate was 1.69%–2.02% and case fatality rate was 25.78% and 95% CI for case fatality rate was 23.76%–27.80%). The results of this study showed that among the variables studied, inappropriate management of collecting manure and communication between farm workers were detected as risk factors.

Conclusions: Because of the role of biological vectors in the incidence of this disease, when an outbreak happened it is necessary to monitor weather situation to evaluate the effect of weather on vectors activities to apply effective control measures. In addition, early detection and subsequent treatment of identified cases are the golden key to controlling this disease.

1. Introduction

Bovine ephemeral fever (BEF) is a viral disease of ruminants causing sub-clinical disease in cattle and buffalo. The causative agent of BEF, bovine ephemeral fever virus, is an arthropod-borne virus classified as type species of the genus *Ephemerovirus* in Rhabdoviridae family[1-3]. Clinical manifestations include biphasic or multiple-phasic fever, depression, anorexia, salivation, ocular and nasal discharge, ruminal stasis, lameness, recumbency, muscle stiffness and other inflammatory

responses[4].

BEF leads to considerable economic losses due to abortion, decreased male fertility, reduction in milk production, lameness, death in severe cases, and international trade restrictions[2,5-7]. The mortality rate in affected animals is relatively low, but it can be higher (about more than 30%) in animals in good condition[2].

Hematologic changes that are often observed in affected animals include transient leucopenia and neutrophilic leukocytosis, decrease in blood serum calcium and increase in plasma fibrinogen, all of which should be taken into account when developing strategies for treatment[8-10]. Infected animals also show lifelong immunity[11,12], and the best confirmatory diagnostic test is the isolation of the bovine ephemeral fever virus during the fever phase[3,13].

First reports of BEF go back to the 19th century in South Africa. Later on, the disease has observed in Rhodesia, Kenya,

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Indonesia, India, Egypt, Palestine, Australia, and Japan. It has been reported in China in 1955, and in Saudi Arabia in 1983 for the first time[5,14,15]. An increase in outbreaks frequency has been seen during the first decade of current century[4,16,17].

BEF is prevalent in tropical sections of the continents Asia, Africa, and Australia[1]. It is considered as an endemic disease in Africa and most areas of the Middle East[18,19] being reported from Jordan, Syria, Iraq, Turkey, and Iran. In some African and Asian countries, the epidemic form of the disease has been reported as well[5,16].

In some southern and warm parts of Iran, BEF can be observed in sporadic form[2]. First reports of the disease in Iran go back to the provinces of Fars and Ilam. Afterwards, the disease has been reported from provinces of Tehran, Qome, Khorasan, Yazd, Khoozestan, and Bushehr. Currently affected provinces include Gilan, Mazandaran, Semnan, Tehran, and Qazvin (unpublished data).

The aims of the present study were to a) investigate the first outbreak of BEF in the province of Qazvin in 2013, b) explore the potential associations that exist between disease occurrence and meteorological data, and c) identify risk factors associated with BEF.

2. Materials and methods

A case-control study was conducted from June to October of 2013, to explore the prevalence of BEF in the dairy farms across the city of Abyek, the province of Qazvin, Iran. A total of 35 dairy farms were selected and enrolled in this study.

Heparinized blood samples were collected from animals existing in affected farms. Viral RNA was extracted using QIAamp® Viral RNA Mini Kit (Qiagen).

According to manufacturer’s protocol, virus detection was conducted using PCR based on the described method[20]. A comprehensive questionnaire was prepared according to expert opinions and data were collected through an interview held with dairy farmers and their farm veterinarians. Data related to climate factors were collected from meteorological state administration of the province of Qazvin. *Chi*-squared test and logistic regression were used to investigate associations between variables and *P*-values < 0.05 were considered to be statistically significant. Moreover, odds ratio (OR) and their confidence intervals (CI) were calculated to evaluate the strength of these associations. All statistical analyses were implemented using SPSS 16 (SPSS Inc, Chicago, IL) software.

3. Results

The first affected dairy farm was reported on June 5th, 2013 and the last one was reported on October 2nd, 2013. During 120 days of the outbreak, a total of 21 out of 35 dairy farms were

reported to become affected (Figure 1). Incidence on farm level was equal to 60% (95% CI: 43.77%–76.23%). In this study, the disease was observed in all age groups of animals. Animal level incidences within different age groups are shown in Table 1. During this outbreak, a total of 1800 animals (out of 25000 animals belonging to the dairy farms across the city of Abyek) were affected. Animal level incidence was equal to 7.20% (95% CI: 6.88%–7.52%). A total of 464 animals were dead, resulting in a mortality rate equal to 1.86% (95% CI: 1.69%–2.02%) and case fatality rate equal to 25.78% (95% CI: 23.76%–27.80%).

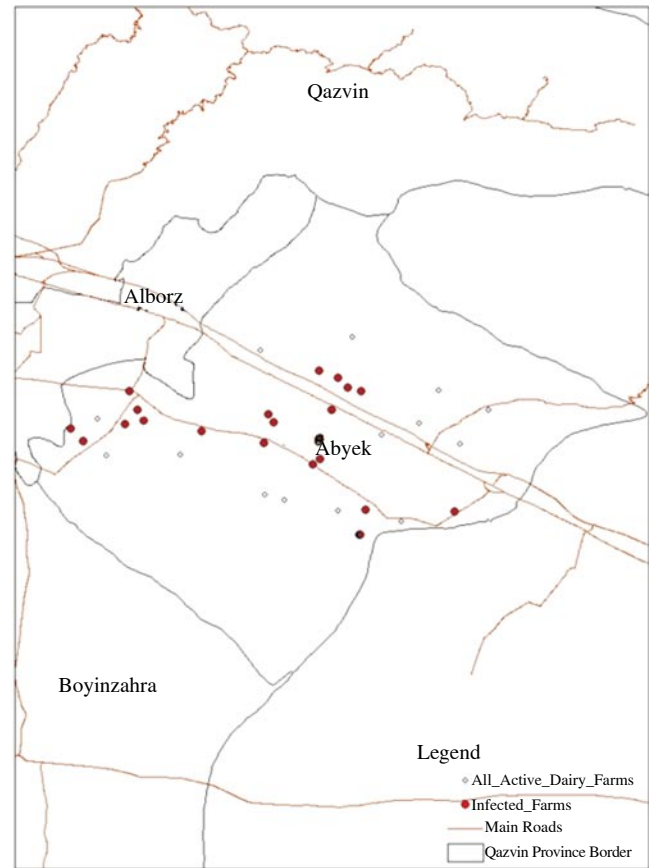


Figure 1. BEF infected epidemiological units (2013).

Table 1

Incidence rates in different age groups in Abyek City (2013).

Age group	All animals	Affected animals	Incidence rate	Healthy animals	Percent
Calves under 6 months	699	119	17.02	580	82.98
Heifers 6 months to 2 years	1 600	256	16.00	1 344	84.00
Cattle over 2 years	3 698	646	17.47	3 052	82.53
Total	5 997	1 021	17.03	4 976	82.97

The highest rates of precipitations were recorded during the months of October and November of 2013 (Figure 2). On another note, interestingly, rainfalls were recorded for 16 days in April, with 8 of these in a row of continuous rainfall. This was a unique incidence that was not observed in other months of that year.

Figure 3 displays the mean of the least daily temperatures of the city of Abyek during 2013. It was observed that the highest temperatures were recorded during May to October.

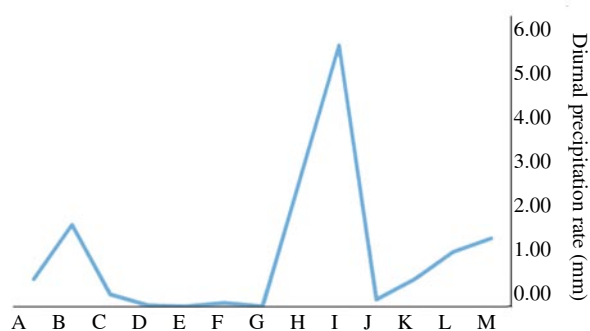


Figure 2. Mean of diurnal precipitation rate in Abyek (2013). A: Mar 2013; B: Apr 2013; C: May 2013; D: Jun 2013; E: Jul 2013; F: Aug 2013; G: Sep 2013; H: Oct 2013; I: Nov 2013; J: Dec 2013; K: Jan 2013; L: Feb 2013; M: Mar 2014.

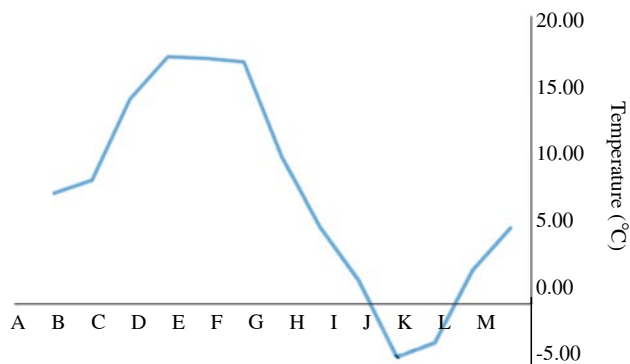


Figure 3. Mean of least diurnal temperature (°C) in Abyek (2013). A: Mar 2013; B: Apr 2013; C: May 2013; D: Jun 2013; E: Jul 2013; F: Aug 2013; G: Sep 2013; H: Oct 2013; I: Nov 2013; J: Dec 2013; K: Jan 2013; L: Feb 2013; M: Mar 2014.

The results of the one variable analyses (Table 2) indicated that there were no statistically significant associations between qualitative variables ($P > 0.05$). Nonetheless, inappropriate management of manure and communication between farm workers were identified as risk factors for disease occurrence in multivariable analyses (Table 3).

Table 2

Statistical test results for qualitative variables.

Risk/protective factor	State	Infected		OR	95% CI for OR		P-value
		Yes	No				
Active disinfecting pool	Yes	15	11	0.68	0.13	3.34	0.71
	No	6	3				
Preparing all required equipment for visitors	Yes	8	10	0.24	0.06	1.06	0.09
	No	13	4				
Appropriate management of manure	Yes	6	5	0.77	0.18	3.30	1.00
	No	14	9				
Communication between farm workers	Yes	11	3	3.67	0.78	17.25	0.15
	No	10	10				
Animal entry	Yes	2	0	2.25	0.21	23.83	0.63
	No	19	14				
Distance to other farms	< 1 km	16	8	1.60	0.34	7.65	0.69
	> 1 km	5	4				

Table 3

Multiple logistic regression analysis results.

Risk/protective factor	P-value	OR	CI
Constant	0.01	0.001	–
Car entrance/exit	0.09	1.000	0.99–1.08
Inappropriate management of manure	0.04	3.140	1.08–9.16
Communication between farm workers	0.04	9.820	1.18–82.24

4. Discussion

This outbreak has occurred in Qazvin Province for the first time, and BEF vaccine has never been used in Qazvin dairy farms, so disease has spread very quickly through dairy farms.

Compared to other investigations conducted in the Middle East, farm level incidence in this outbreak was low. Farm level incidence in Palestine outbreaks in 1990, 1999 and 2004 was 78%, 98% and 100%, respectively[19]. Momtaz *et al.* reported animal level incidence in the province of Khuzestan, Iran, to be higher than what we observed in this study[5], whereas others[21] reported similar findings to ours.

Case fatality rate in this outbreak was relatively high (about 26%). Authors believed that this is probably because of the virulence of virus strain and high sensitivity of cattle population in the province of Qazvin. Low level of awareness among practitioners, owners, and farm managers about this disease, which could have resulted in delayed diagnosis and treatments, could have also contributed to the high mortality and case fatality rates.

Meanwhile, this is likely the reason for higher morbidity in calves under 6 months age group (about 17%) in spite of many other study results. Other investigators have reported that all age groups of cattle are susceptible to BEF, but it has been usually reported more frequently in calves under 2 years old compared to other age groups[3,5,17,19].

Investigation of the meteorological data revealed that during the first 3 months of 2013, wind blows were recorded for 15 days from the province of Tehran with an average speed equal to 5.5 m/s, for 18 days from the province of Mazandaran with an average speed equal to 6.5 m/s, and for 2 days from the province of Gilan with an average speed equal to 8 m/s. So it could be speculated that infected mosquitoes could have been transmitted from Tehran and Mazandaran to Qazvin.

Mosquito populations need 70% humidity and 25 degrees of Celsius temperature for growth and proliferation[22]. So, regarding above-mentioned information and Figures 2 and 3, during April to May 2013, ideal conditions have been available for mosquito populations to grow and proliferate. Similar to this outbreak, 2 outbreaks of BEF occurred in New South Wales of Australia in 2008, which were following the heavy rainfalls of December 2007[23]. Weather condition in some provinces of our country in summer season has reported to be suitable for the growth and proliferation of mosquito populations[5].

According to the results of present study, inappropriate management of collecting manure and communication between farm workers were identified as risk factors for disease occurrence, but car entrance/exit was not associated with increased incidence of the disease ($P = 0.09$).

It is believed that regular collection and infertilization of manure can be effective in the control of BEF, as otherwise, untreated manure could provide a suitable environment for mosquitoes to lay eggs and increase population size. This is the reason for high OR

acquired in farms which didn't have an appropriate management of collected manure.

It is possible for affected animals in convalescent phase to transmit viruses to new farms by movement; however, in the present study, animal entry was not identified as a risk factor. Nonetheless, authors believe that more comprehensive studies are needed in order to investigate all the contributing factors to the prevalence of BEF.

In order to investigate the role of biologic vectors in disease transmission and implement effective control programs such as vaccination, determining quarantine zones, etc. it is of utmost importance to record weather conditions and investigate their effect on mosquito's populations. In the present study, inappropriate management of collected manure and communication between farms workers were identified as major risk factors that should be taken into account when planning for preventive and/or control strategies for BEF.

In addition, authors believe that early detecting and immediate treatment of affected animals are the golden key to control of this disease.

Conflict of interest statement

We declare that we have no conflict of interest.

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