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FMD EPIDEMIC PROCESS CHARACTERISTICS
IN RUSSIA IN 2010 – FIRST QUARTER OF 2019

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SUMMARY

Foot-and-mouth disease is a highly contagious viral disease of cloven-hoofed livestock and wild animals. Europe, North America and Oceania have long been FMD free; at the same time, the virus is widely spread in Asian and African countries. In the period from 2010 to March 2019, FMD was notified to the World Organization for Animal Health (OIE) by 89 countries of the world. Local FMD outbreaks were also reported in several regions of the Russian Federation throughout this period. The research was aimed at studying some characteristics of the FMD epidemic process in the Russian Federation. The undertaken epidemiological analysis covers the Russian Federation regions where FMD outbreaks were reported between 2010 and March 2019. During the period under consideration, FMD cases were reported in 9 regions of the Russian Federation, mainly in the settlements located in close proximity to the Russia-China and Russia-Mongolia international borders. Most of the outbreaks were caused by serotype O and A FMD viruses. In most cases, FMD was reported in cattle and pigs and, less frequently, in sheep and goats. The analysis of the FMD epidemic situation in the Russian Federation Subjects was performed through epidemic process assessment based on the following estimates: the proportion of infected settlements, epidemic, contagiousness and morbidity rates. The Zabaykalsky and Primorsky Krais have a lead in the number of infected settlements. The highest morbidity rate in pigs was recorded in the Primorsky Krai, in cattle – in the Amur Oblast. The epidemic rate was the highest in the Primorsky and Zabaykalsky Krais. The Primorsky Krai also accounted for the highest contagiousness rates in 2014 and 2019 when FMD occurred on several large pig farms.

Key words: foot-and-mouth disease, virus, infected settlements, outbreak areas, morbidity, analysis, epidemic situation.

INTRODUCTION

Foot-and-mouth disease is caused by a virus of the genus *Aphthovirus,* family *Picornaviridae*. More than 100 species of domestic and wild cloven-hoofed animals are susceptible to FMD. The disease is characterized by aphthous lesions of mucosal membranes lined with multilayered epithelium and hairless skin. Clinical signs can vary from mild to severe. Amongst livestock, cattle and pigs develop a more severe form of FMD than other species [3]. Cattle demonstrate the most apparent clinical signs. By contrast, the clinical manifestations in sheep and goats are often mild. Lameness is the key sign of FMD in small ruminants.

FMD is one of highly dangerous transboundary diseases and is notifiable to the World Organization for Animal Health (OIE). The disease outbreak can take the form of an epidemic or a pandemic with serious social and economic consequences [1, 8]. The epidemic significance of the disease depends upon the degree of animal susceptibility, the husbandry system, the density and extent of populations and contacts between them [8].

Most of European and American countries, as well as Oceania have long been FMD free. However, the analysis of the OIE data and mass media reports shows that the global FMD epidemic situation remains rather tense in spite of the measures taken, and FMD can be introduced to any country at any time. According to the OIE official data, 87 countries (43 African, 36 Asian, 4 American and 4 European countries) were FMD infected in 2010 – March 2019 [9].

Such Russian Federation bordering countries as Mongolia and China have the greatest impact on FMD epidemic situation in Russia, especially given the country's

Table 1
FMD in the regions of the Russian Federation in 2010 – March 2019 [9]

Region (serotype)	Number of outbreaks during the year										Total
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Amur Oblast (A)	–	–	–	6	–	–	–	–	–	–	6
Vladimir Oblast (Asia-1)	–	–	–	–	–	–	1	–	–	–	1
Zabaykalsky Krai (A)	–	–	–	9	3	0	0	–	–	–	12
Zabaykalsky Krai (O)	2	1	–	–	1	0	3	–	5	1	13
Kabardino-Balkar Republic (A)	–	–	–	1	–	–	–	–	–	–	1
Karachay-Cherkess Republic (A)	–	–	–	2	–	–	–	–	–	–	2
Krasnodar Krai (A)	–	–	–	3	–	–	–	–	–	–	3
Primorsky Krai (O)	–	–	2	–	7	–	–	–	–	15	24
Republic of Bashkortostan (O)	–	–	–	–	–	–	–	5	–	–	5
Khabarovsk Krai (O)	–	–	–	–	–	–	–	–	–	1	1
Total	2	1	2	21	11	0	4	5	5	17	68

intense trade relationships with them. More than 130 FMD outbreaks were reported in the two countries during the past 10 years.

MATERIALS AND METHODS

Data on FMD situation is Russia were collected based on the OIE database, in particular, on notifications made through the WAHID/WAHIS information systems, as well as reports submitted by the veterinary services of the RF Subjects to the FGBI "Centre of Veterinary Medicine" [9, 10]. The analysis of FMD epidemic situation in the Russian Federation Subjects was performed through epidemic process assessment based on the following estimates: the proportion of infected settlements, epidemic, contagiousness and morbidity rates.

The proportion of infected settlements was determined by calculating the percentage ratio between the number of FMD infected settlements and the total number of settlements in a particular administrative territory; epidemic rate – by dividing the length of the period during which the disease cases were reported by the length of the period under consideration. Contagiousness rate was estimated through determination of the mean number of diseased animals in the infected settlements; morbidity rate – by dividing the number of diseased animals by the total number of susceptible animals [4–7].

All estimates presented in the article are based on the official information available.

The text contains such terms as "an outbreak area" and "an infected settlement". An outbreak area means any facility/area where the sources of a particular disease agent were detected and from which its transmission and spread are possible among susceptible animals under given conditions [6]. Within this study, any settlement in the territory of which at least one FMD case was reported was considered infected.

RESULTS AND DISCUSSION

During the past 10 years, FMD cases were reported in the Russian Federation every year. In 2015, no new FMD outbreaks were reported in Russia, but the settlement of Kuti, the Zabaykalsky Krai, remained infected. Between 2010 and March 2019, FMD was mainly reported in the Russian Federation regions bordering FMD infected countries. The infection outbreaks occurred mainly in the settlements located in close proximity to the Russia-China and Russia-Mongolia international borders. In 2016 and then in 2017, FMD cases were reported in the RF regions that had previously been recognized FMD free by the OIE (Table 1); as a result, Russia's status of a country having an FMD free zone where vaccination is not practiced was suspended. Russia regained this status in May 2019.

During the period under consideration, FMD outbreaks were reported in 9 regions of the Russian Federation. It should be noted that in seven of them FMD was reported only once (during one calendar year); FMD was detected more than once in the Zabaykalsky and Primorsky Krais only.

Most of FMD outbreaks during the period analyzed were caused by serotype O FMD virus. Two serotypes (O and A) were reported in the Zabaykalsky Krai. Only one virus type (A, O or Asia-1) was reported in the rest of the regions (Table 1).

Tables 2–5 present the analysis results with respect to FMD epidemic situation in the Russian Federation in the period from 2010 to March 2019.

The Primorsky Krai where FMD was reported on several large pig farms in 2019 has a lead as regards the number of diseased animals in the outbreak areas, as well as the number of susceptible animals. However, the data on the number of diseased animals are questionable, since 100% FMD morbidity was registered in two pig breeding complexes in January 2019.

Morbidity rate is heavily influenced by both the accuracy of data on the number of infected animals submitted by the veterinary service and the timeliness of diagnosis. When an FMD outbreak occurs in the Russian Federation, all susceptible animals in the outbreak areas are slaughtered (destroyed). There is no doubt that morbidity is lower when the diagnosis is made early and sanitary restriction

Table 2
Summarized statistical data characterizing FMD epidemic process in the Russian Federation in 2010 – March 2019

Region	Number of animals in outbreak areas [9]	Number of diseased animals [9]	Total number of settlements [2]	Number of infected settlements [9]	Proportion of infected settlements (%)	Epidemic rate
Amur Oblast	2,071	457	643	5	0.77	0.1
Vladimir Oblast	814	90	2,524	1	0.04	0.1
Zabaykalsky Krai	29,010	3,542	858	19	2.21	0.7
Kabardino-Balkar Republic	2,127	23	180	1	0.55	0.1
Karachay-Cherkess Republic	896	130	149	2	1.34	0.1
Krasnodar Krai	395	16	1,766	3	0.17	0.1
Primorsky Krai	96,575	90,213	684	17	2.49	0.3
Republic of Bashkortostan	241	94	4,556	5	0.11	0.1
Khabarovsk Krai	1,751	159	430	1	0.23	0.1

Table 3
FMD morbidity rates ($k_{morbidity}$) in the Russian Federation by years

Year	Cattle		Small ruminants		Pigs	
	Number of diseased / susceptible animals	$k_{morbidity}$, %	Number of diseased / susceptible animals	$k_{morbidity}$, %	Number of diseased / susceptible animals	$k_{morbidity}$, %
2010	207/2,351	9	52/662	8	99/232	43
2011	183/1,518	12	–	–	1/73	1
2012	89/609	15	22/47	47	–	–
2013	2,066/16,691	12	154/385	40	11/255	4
2014	199/5,281	4	–	–	14,874/20,045	74
2015	No new outbreaks were reported					
2016	480/2,338	20			–	–
2017	15/161	9	79/81	97	–	–
2018	636/1,263	50	15/1,070	1	–	–
1st quarter of 2019	–	–	–	–	75,365/77,589	99

measures are taken than when the epidemic process develops naturally.

Morbidity rate was calculated for each susceptible animal species in the outbreak areas across 10 years and by regions.

As previously mentioned, morbidity rates were the highest in pigs in 2019. High morbidity rates were also registered in small ruminants in 2017 and in pigs in 2014. Morbidity rates for cattle herds vary from 4% in 2014 to 50% in 2018 (Table 3).

Region-wise, morbidity rates for pigs were the highest in the Primorsky Krai, for small ruminants – in the Republic of Bashkortostan, for cattle – in the Amur Oblast (Table 4).

FMD was most commonly reported in cattle (47%) and pigs (34%). FMD was also reported in the outbreak areas where multispecies herds comprising cattle and pigs or cattle and small ruminants were kept (19%) (Fig. 1).

Within this study, any settlement in the territory of which at least one FMD case was reported was considered infected. The number of infected settlements was the highest in the Zabaykalsky and Primorsky Krais over a period of approximately 10 years. The number of infected settlements was the lowest (1 to 2) in four RF regions: the Vladimir Oblast, the Khabarovsk Krai, Karachay-Cherkessia and Kabardino-Balkaria. The number of infected settlements in other regions (the Krasnodar Krai, the Amur Oblast and the Republic of Bashkortostan) was 3 to 5.

The proportion of infected settlements was estimated as the ratio between the number of infected settlements and the total number of settlements in the region (oblast, krai, republic) to assess the extent of the disease in each region [6, 7]. The estimation results showed that FMD was most widely spread in the Primorsky and the Zabaykalsky

Table 4
FMD morbidity rates by the regions of the Russian Federation in 2010 – March 2019

Region	Animal species	Number of susceptible animals	Number of diseased animals	Morbidity rate, %
Amur Oblast	cattle	1,561	296	19
	small ruminants	385	154	40
	pigs	125	7	5.5
Vladimir Oblast	cattle	814	90	11
Zabaykalsky Krai	cattle	23,065	3,222	14
	small ruminants	1,732	67	4
	pigs	3,843	249	6.5
Kabardino-Balkar Republic	cattle	2,721	234	1
Karachay-Cherkess Republic	cattle	896	130	14.5
Krasnodar Krai	cattle	395	16	4
Primorsky Krai	cattle	609	89	14.5
	small ruminants	47	22	47
	pigs	95,886	90,080	94
Republic of Bashkortostan	cattle	160	15	9.5
	small ruminants	81	79	97.5
Khabarovsk Krai	pigs	1,751	159	9

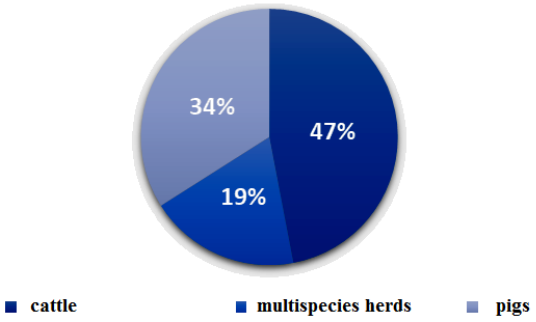

Fig. 1. FMD reported in animals of different species (%) in the Russian Federation in 2010 – March 2019.

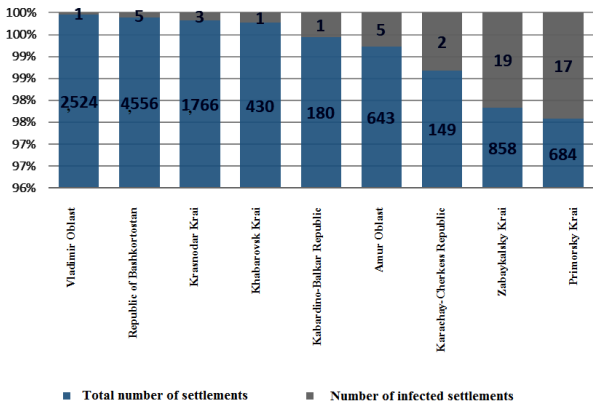

Fig. 2. Proportions of FMD infected settlements in the regions of the Russian Federation (2010 – March 2019)

Krais, as well as in the Karachay-Cherkess Republic, where the disease was reported in 2013 (Fig. 2).

Epidemic and contagiousness rates were calculated to estimate the extent of infection.

Epidemic rate is a retrospectively estimated epidemic situation severity. This reflects the multiyear dynamics of the epidemic situation [8]. Within the study, epidemic rate was estimated as the ratio between the number of years during which the disease was reported in this particular area and the number of years of observation. Figure 3 presents the comparative assessment of epidemic rates for the Russian Federation regions in which FMD was reported during the period under analysis.

Mean epidemic rate for the regions where FMD outbreaks were reported is 0.19. Epidemic rates for the Zabaykalsky and Primorsky Krais are higher than mean one.

Contagiousness rate reflects the intensity and the nature of the epidemic manifestation. It is determined on a region-by-region basis by dividing the number of diseased animals by the number of infected settlements. Contagiousness rate was calculated for each year of the period under analysis (Table 5). Contagiousness rates for the Zabaykasky Krai vary from 202.3 in 2013 to 2 in 2019. Contagiousness rate for the Primorsky Krai increased from 55.5 in 2012 to 5,372.6 in 2019.

CONCLUSION

In 2010–2019, FMD was reported in the Russian Federation every year. During the period under consideration (2010 – March 2019), the disease was mainly reported in the RF regions sharing borders with FMD infected countries.

During the specified period, FMD cases were reported in 9 regions of the country: the Amur and Vladimir Oblasts,

Table 5
FMD contagiousness rates for the regions of the Russian Federation

Region	Year								
	2010	2011	2012	2013	2014	2016	2017	2018	2019
Amur Oblast	–	–	–	91.4	–	–	–	–	–
Vladimir Oblast	–	–	–	–	–	90	–	–	–
Zabaykalsky Krai	179	184	–	202.3	63.8	157.3	–	162.8	2
Kabardino-Balkar Republic	–	–	–	23	–	–	–	–	–
Karachay-Cherkess Republic	–	–	–	65	–	–	–	–	–
Krasnodar Krai	–	–	–	5.3	–	–	–	–	–
Primorsky Krai	–	–	55.5	–	2,479	–	–	–	5,372.6
Republic of Bashkortostan	–	–	–	–	–	–	18.8	–	–
Khabarovsk Krai	–	–	–	–	–	–	–	–	159

the Republic of Bashkortostan, Kabardino-Balkaria and Karachay-Cherkessia, the Zabaykalsky, Primorsky, Krasnodar and Khabarovsk Krais. Most of the outbreaks were caused by serotype O and A FMD viruses (43 and 24 outbreaks, respectively). One serotype Asia-1 FMDV outbreak was reported in 2016.

In the period between 2010 and the first quarter of 2019, FMD was most frequently reported in cattle (47%) and pigs (34%). FMD was also detected in the outbreak areas where multispecies (cattle and pigs or cattle and small ruminants) herds were kept (19%). The Zabaykalsky and Primorsky Krais have a lead in the number of infected settlements. These regions also account for the highest number of diseased and destroyed animals.

The highest morbidity rate in pigs was recorded in the Primorsky Krai, in cattle – in the Amur Oblast, in small ruminants – in the Republic of Bashkortostan. Epidemic rates were the highest in the Zabaykalsky and Primorsky Krais. The morbidity rate for the remaining seven RF Subjects was 0.1. The mean epidemic rate for the regions where FMD outbreaks were reported was 0.19. FMD was most widely spread in the Primorsky and Zabaykalsky Krais, as well as in the Karachay-Cherkess Republic in 2013. The contagiousness rates were the highest for the Primorsky Krai where FMD was reported on several large pig farms in 2014 and 2019.

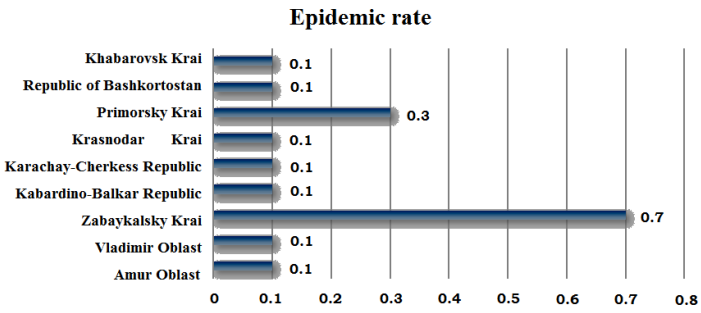

Fig. 3. FMD epidemic rates for the regions of the Russian Federation

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