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Serological monitoring of Newcastle disease in the Russian Federation in 2023–2024

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ABSTRACT

Introduction. Newcastle disease is a highly contagious viral infection of birds that is reported in many countries around the world. Newcastle disease cases shall be notified to the World Organization for Animal Health.

Objective. The objective of this research is to ensure monitoring of Newcastle disease using serological methods and analyze the findings obtained for 2023–2024 in the Russian Federation.

Materials and methods. The Territorial Administrations of Russian Federal Service for Veterinary and Phytosanitary Supervision sampled biological material in 74 subjects of the Russian Federation (more than 66,700 samples of avian sera). Tests for antibodies to Newcastle disease virus were conducted at the Reference Laboratory for Avian Viral Diseases, housed within the Federal Centre for Animal Health (Vladimir, Russia). Enzyme-linked immunosorbent assay and hemagglutination inhibition assay were performed using diagnostic kits manufactured by the Federal Centre for Animal Health.

Results. The conducted tests revealed significant variations of seroprevalence in commercial and backyards poultry flocks and in wild birds. High Newcastle disease virus seroprevalence was observed in chickens and turkeys within closed commercial farming systems due to routine mass vaccination against the disease. At the same time, the overall seropositivity rate for all poultry species was 74% in 2023, increasing to 81% in 2024. In backyards, antibodies to Newcastle disease virus were detected in 35% of all the tested sera samples from chickens and turkeys in 2023 and in 53% of the tested samples in 2024. Specific antibodies were also detected in samples from the vaccinated guinea fowl and pheasants and from non-vaccinated geese and ducks. Antibodies to Newcastle disease virus were also detected in wild birds across several Russian regions, suggesting their role of a natural reservoir for Newcastle disease virus strains of varying pathogenicity.

Conclusion. Therefore, the monitoring data indicate that routine flock vaccination helps to control successfully Newcastle disease in commercial poultry flocks, creating a stable epizootological situation. However, a significant risk of Newcastle disease virus introduction and spread from infected backyard poultry and wild bird reservoirs still persists.

Keywords: Newcastle disease, epizootology, monitoring, poultry, wild birds, synanthropic birds

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Серологический мониторинг ньюкаслской болезни в Российской Федерации в 2023–2024 гг.

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РЕЗЮМЕ

Введение. Ньюкаслская болезнь – высококонтагиозная вирусная инфекция птиц, которая регистрируется во многих странах мира. О случаях инфицирования вирусом ньюкаслской болезни необходимо уведомлять Всемирную организацию здравоохранения животных.

Цель исследования. Проведение в течение 2023–2024 гг. на территории Российской Федерации мониторинговых исследований по ньюкаслской болезни с использованием серологических методов и анализ полученных результатов.

Материалы и методы. Биологический материал (более 66 700 проб сыворотки крови птиц) был отобран территориальными управлениями Россельхознадзора в 74 субъектах Российской Федерации. Исследования выполнены на базе референтной лаборатории вирусных болезней птиц ФГБУ «ВНИИЗЖ» (г. Владимир) с использованием диагностических наборов для выявления антител к вирусу ньюкаслской болезни иммуноферментным методом и в реакции торможения гемагглютинации производства ФГБУ «ВНИИЗЖ».

Результаты. Проведенные исследования показали разную степень серопревалентности у сельскохозяйственной птицы промышленных птицеводческих хозяйств, индивидуального сектора и дикой птицы. Для кур и индеек в промышленных хозяйствах закрытого типа была установлена высокая серопревалентность по ньюкаслской болезни, что связано с массовой вакцинацией птиц против данного заболевания. При этом доля выявленной серопозитивной

птицы (в целом по всем видам сельскохозяйственной птицы) была равна 74% в 2023 г. и 81% в 2024 г. В индивидуальном секторе антитела к вирусу ньюкаслской болезни были обнаружены в 35% случаев от числа всех исследованных проб сывороток крови кур и индеек в 2023 г. и в 53% случаев – в 2024 г. Специфические антитела были выявлены также в пробах от вакцинированных цесарок и фазанов и от непривитых гусей и уток. В нескольких регионах Российской Федерации антитела к вирусу ньюкаслской болезни обнаружены у птиц дикой фауны, которые, вероятнее всего, являются естественным резервуаром возбудителя ньюкаслской болезни различной степени патогенности.

Заключение. Таким образом, результаты мониторинговых исследований свидетельствуют о благополучной ситуации по ньюкаслской болезни в промышленных птицеводческих хозяйствах, обусловленной плановой вакцинацией поголовья. В то же время сохраняется угроза заноса и распространения ньюкаслской болезни птиц из неблагополучных индивидуальных хозяйств и дикой фауны.

Ключевые слова: ньюкаслская болезнь, эпизоотология, мониторинг, домашняя птица, дикая птица, синантропная птица

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INTRODUCTION

Newcastle disease (ND) is a highly contagious viral disease of birds that poses a general threat to global poultry industry resulting from significant economic losses [1].

The ND pathogen is the RNA-containing virus of *Avian orthoavulavirus javaense* species, which belongs to the *Paramyxoviridae* family, *Avulavirinae* subfamily, *Orthoavulavirus* genus, previously classified as *Avian paramyxovirus* 1, or Newcastle disease virus (NDV) [2]. Dimitrov K. M. et al. in 2019, offered a classification based on the genetic properties of NDV [3]. Out of the two distinguished NDV classes, class I included genotype 1 only. Class II consisted of at least 20 different genotypes, which were divided into subgenotypes. In recent decades, genotype V, circulating in Americas, and genotype VII, circulating in other countries of the world, have become the most crucial for poultry industry. In the Russian Federation, NDV isolates are represented by different genetic and biological groups, including virulent and avirulent viruses, as well as vaccine strains [4].

Newcastle disease virus is capable of infecting over 200 avian species. Domestic *Galliformes* demonstrate the highest susceptibility to NDV. Infected birds have pathological lesions in the respiratory and digestive tracts, as well as the central nervous system. Mortality rates in non-vaccinated poultry flocks can be up to 100% [5]. Disease cases are also registered in geese, pheasants and guinea fowls [6]. Quails are susceptible to NDV infection: experimental infection with NDV virulent strains resulted in clinical signs that occur on days 3 to 14 post infection and mortality rates lower than in chickens [7, 8]. At the same time, specific antibodies are recorded on day 14 post infection. In quails vaccinated against ND (La Sota strain), the antibody peak is observed on day 40 post vaccination, with further decrease after day 46.

Synanthropic (magpies, pigeons, sparrows, etc.) and wild birds are natural NDV carriers [9, 10]. Wild waterfowl and migratory birds serve as the primary natural reservoirs for NDV. The disease exhibits seasonal patterns, largely driven by the annual migrations of wild birds. Waterfowl (domestic ducks and geese) are considered NDV reservoirs, since these birds are resistant to strains that are highly virulent for chickens.

However, since the 1990s there have been reports of ND outbreaks in domestic waterfowl in the Asian countries, including Korea, Japan and China. In the infected duck flocks, a drop in egg production was observed, with a morbidity rate of approximately 80% and a mortality rate ranging from 30 to 50%. Affected birds exhibited both diarrheal and neurological symptoms. Similar ND outbreaks were reported in geese flocks in China [6, 11]. Virulent NDV strains detected in geese across Asia during the 2000s were classified as genotype VIId. Xu Q. et al. [11] demonstrated that experimental infection of geese with virulent genotype VIId NDV strain induced a robust early cellular immune response, a finding associated with the unique characteristics of ND pathogenesis in geese [11]. Wan H. et al. described virus transmission from infected geese to chickens under contact housing conditions [6].

Newcastle disease is reported in many countries worldwide and there is a mandatory requirement to send corresponding notifications on disease cases triggered by highly virulent isolates of the *Avian orthoavulavirus javaense* to the World Organization for Animal Health (WOAH).

Newcastle disease outbreaks, notified to the WOAH over the past four years, were registered in more than 50 countries around the world (in Asia, Europe, America and Africa), including Russia. According to the WOAH data, ND outbreaks in poultry were reported over a four-year period in backyards of 16 subjects included

into to the Central, Volga, Ural, Siberian, Far Eastern and Southern Federal Districts of the Russian Federation. Recent ND epizootics in numerous Asian and European countries have been caused by viruses from various subtypes of genotype VII [12, 13]. In the Russian Federation, this genotype was first isolated from chickens in 2006, during an ND outbreak on a poultry farm in the Amur Oblast. Subsequently, NDV genotype VII caused sporadic outbreaks among backyard poultry in different regions of the country [14, 15, 16, 17]. ND cases in pigeons are recorded annually in Russia [9, 15, 16].

In order to prevent ND, some countries, including the Russian Federation, vaccinate poultry with various vaccines [18, 19, 20]. Vaccination efficacy is assessed by measuring specific antibody titers against NDV before immunization and at various time points thereafter, using hemagglutination inhibition (HI) or enzyme-linked immunosorbent assay (ELISA) methods [21, 22]. Serological tests are of limited value for ND surveillance and diagnosis owing to the widespread implementation of poultry vaccination programs [23, 24].

This paper provides results of serological monitoring program for ND in poultry, implemented in 2023–2024. The surveillance was carried out under the state mandate of the Russian Federal Service for Veterinary and Phytosanitary Supervision (Rosselkhoznadzor) for the oversight of highly dangerous infectious diseases.

MATERIALS AND METHODS

Biological material tested. The Rosselkhoznadzor Territorial Administrations sampled biological material (avian sera) in 2023–2024.

Test methods. The collected sera samples were tested using commercial diagnostic kits produced by the Federal Centre for Animal Health (Russia), i.e. HI test-kit for detection of antibodies against Newcastle disease virus and single-dilution ELISA test-kit for detection of antibodies against Newcastle disease virus in compliance with the instructions for use.

Treatment of the tested samples. Before the test procedure, all sera samples received for the tests were inactivated at 56 °C for 30 minutes in a serum inactivator (or in a water bath).

RESULTS AND DISCUSSION

This work was conducted under the state assignment for epizootiological monitoring, as stipulated by Decrees No. 1915 (dated 20 December 2022) and No. 1630 (dated 22 December 2023) of the Russian Federal Service for Veterinary and Phytosanitary Surveillance (Rosselkhoznadzor). More than 66,700 samples were tested for antibodies to NDV. Avian sera were delivered from 69 and 74 regions of the Russian Federation in 2023 (35,005 samples) and in 2024 (31,766 samples), respectively.

Currently, poultry farming in the Russian Federation is represented by large commercial poultry farms using intensive farming systems, small family-operated farms and backyards.

26,983 and 26,004 sera samples were collected from commercial poultry in 2023 and 2024, respectively. Table 1 gives information on antibodies against NDV detected in poultry sera (from chickens, turkeys, ducks, geese, and quails) taken on commercial poultry farms in the Russian Federation.

In 2023, monitoring tests included samples from 237 commercial farms (establishments) of 60 RF Subjects, in 2024 – from 280 farms of 74 RF Subjects. In 2024, more positive samples were detected in the Russian Federation as a whole than in the previous year (81 and 74%).

Results of detecting antibodies to NDV in chicken sera (collected on commercial poultry farms in 2023–2024 and tested in HI and ELISA) are illustrated in Figures 1 and 2.

Table 1
Antibodies to NDV detected in poultry sera collected on commercial poultry farms of the Russian Federation in 2023–2024

Federal District	Number of samples tested in 2023		Number of farms / RF Subjects in 2023	Number of samples tested in 2024		Number of farms/ RF Subjects in 2024
	total	positive		total	positive	
Northwestern	2,646	1,640	23/7	2,540	1,936	20/8
Central	5,915	4,964	55/12	6,916	5,480	61/13
Volga	9,413	6,481	64/14	5,993	5,073	75/14
Ural	2,221	1,390	23/4	2,650	2,002	28/6
Siberian	1,907	1,497	32/9	2,601	2,234	38/11
Far Eastern	1,076	973	10/7	1,571	1,336	17/8
Southern	3,080	2,618	27/5	2,601	2,054	31/9
North Caucasian	725	419	3/2	1,132	941	10/5
Total	26,983	19,982 (74%)*	237/60	26,004	21,056 (81%)	280/74

* percentage of positive samples from the total number of the tested ones.

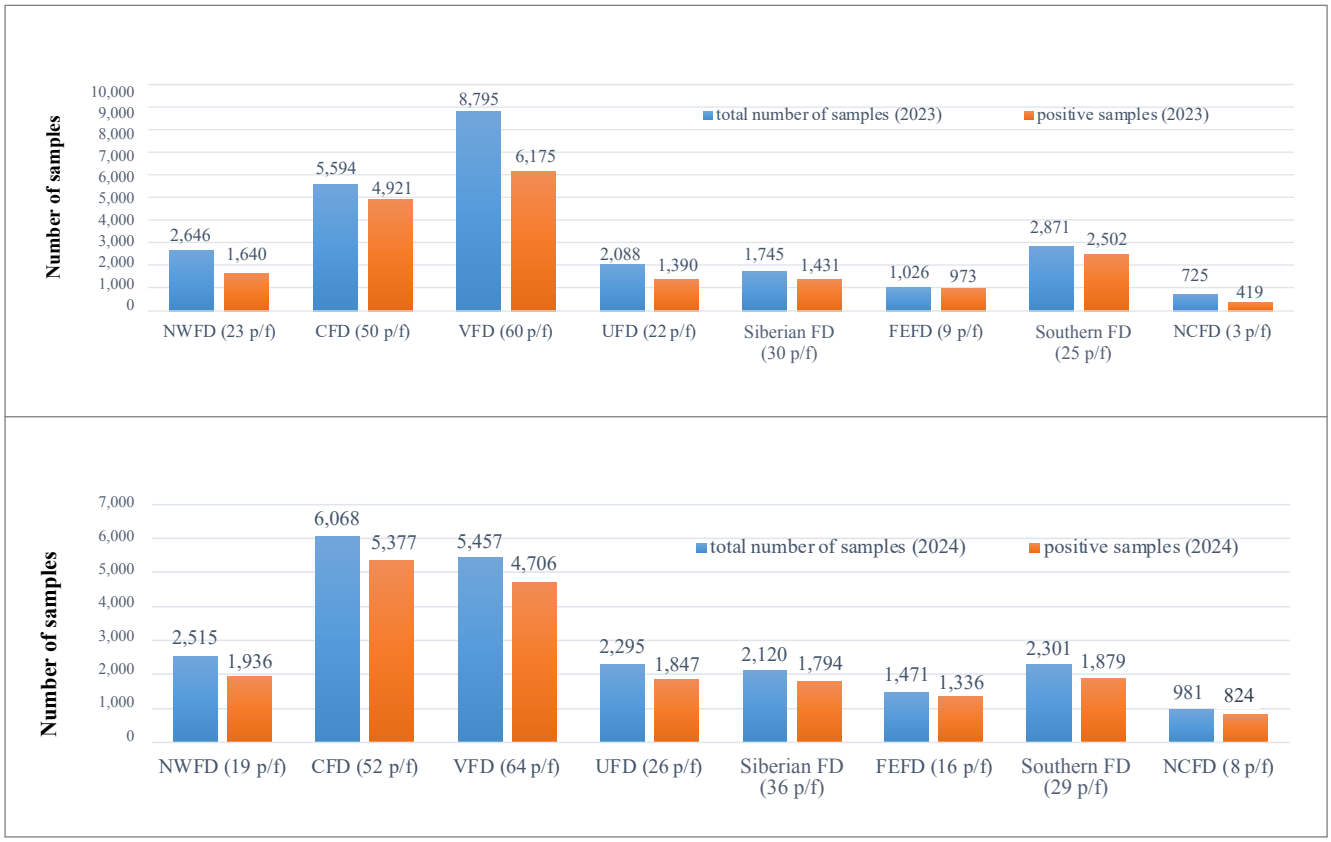

Fig. 1. Detection of antibodies to NDV in chicken sera collected on commercial poultry farms (p/f) in 2023–2024

In 2023, 25,490 samples from chicken collected on 222 commercial poultry farms in 8 RF Federal Districts were tested, antibodies to NDV were detected in 19,451 samples (76%). In 2024, antibodies to NDV were detected in 19,699 (85%) out of 23,208 samples from 250 poultry farms (Fig. 1).

ND serological tests conducted in 2023 revealed the minimum percentage of positive samples (58%) in the North Caucasian Federal District (NCFD). Slightly more positive samples, between 62 and 70%, were detected in chickens from the Northwestern (NWFD), Ural (UFD) and Volga (VFD) Federal Districts. In the Siberian (Siberian FD), Southern (Southern FD) and Central (CFD) Federal Districts, number of positive samples ranged between 82 and 88%, and the maximum number (95%) was detected in the Far Eastern (FEFD) Federal District. In 2024, in 7 out of 8 Federal Districts, with the exception for the NWFD (77%), the proportion of seropositive chickens ranged from 80 to 91% (Fig. 2).

Results of detecting antibodies to NDV in sera from other poultry species collected on commercial poultry farms are illustrated in Figures 3 and 4. Turkey sera were tested using two methods: ELISA and HI test; only HI was used for geese, ducks and quails.

989 turkey sera samples collected in 2023 on 8 poultry farms in 4 RF Federal Districts (CFD, VFD, Siberian FD and Southern FD) were tested and antibodies were detected in 529 (54%). In 2024, antibodies to NDV were detected

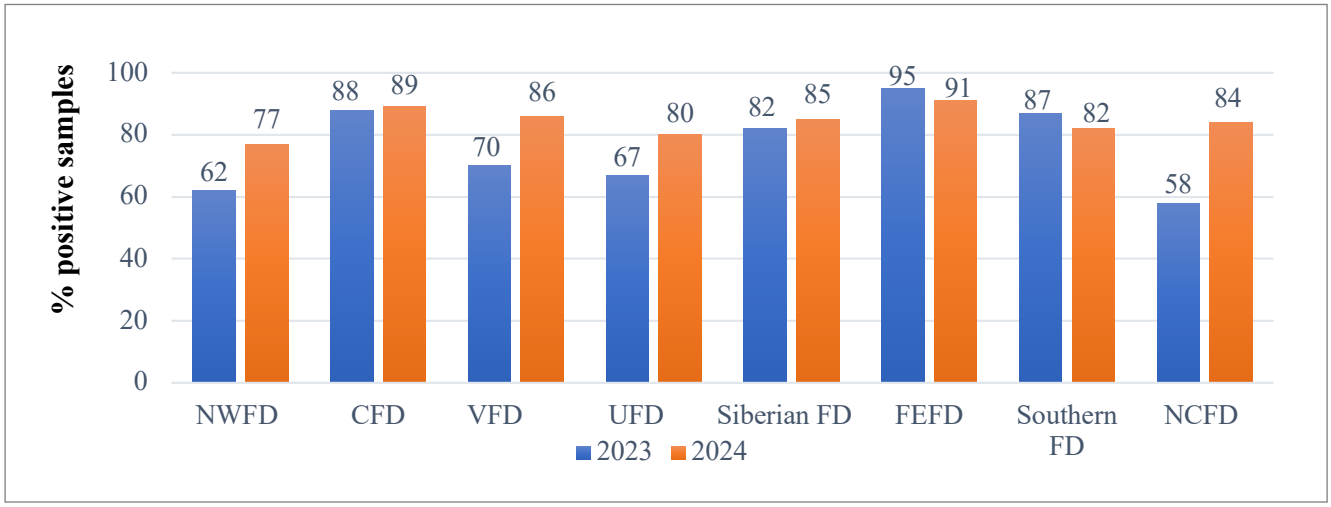

Fig. 2. Percentage of positive samples (chicken sera) detected in 2023–2024 on commercial poultry farms in various Federal Districts of the Russian Federation

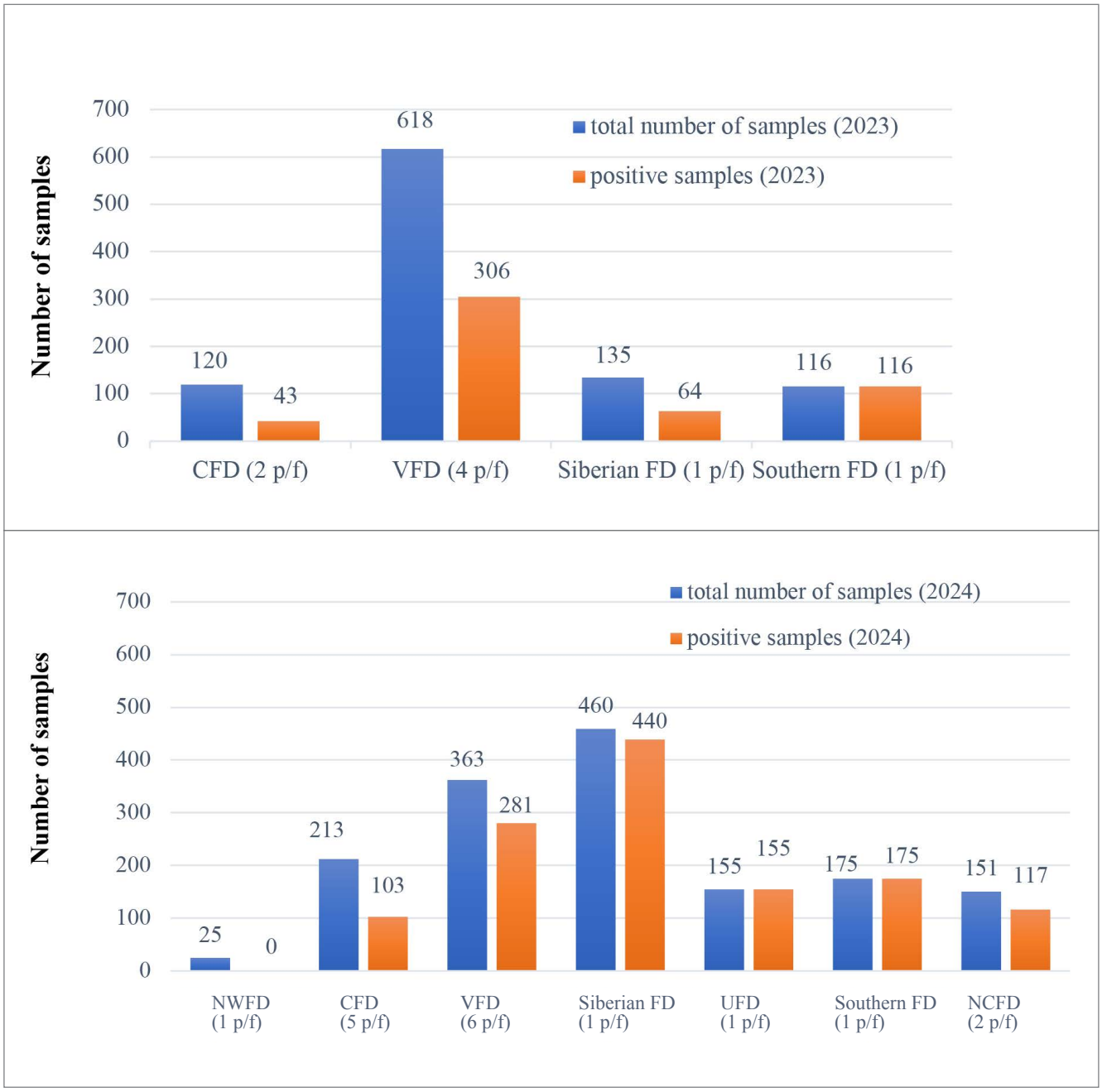

Fig. 3. Detection of antibodies to NDV in turkey sera collected on commercial poultry farms (p/f) in 2023–2024

in 1,271 (82%) out of 1,542 sera samples from 17 poultry farms in 7 Federal Districts (excluding the FEFD). Samples from turkeys that are not vaccinated against ND from the NWFD showed negative results (Fig. 3).

As illustrated by the accompanying documents from the farms, the detected specific antibodies were produced in response to live or inactivated ND vaccines. Number of seropositive poultry on farms depended on a number of factors, including the vaccine type and the vaccination schedule. Use of new, more effective vaccines, including those inactivated and produced from virulent NDV strains, increased the proportion of immunized birds in the flock and enhanced the level of the immune response [25, 26, 27].

Sera from ducks were delivered from the CFD, the Siberian FD and the Southern FD: 290 samples from 4 poultry farms in 2023 and 591 samples from 4 poultry farms in 2024. Antibodies specific to NDV were detected in only 2 samples (0.7%) on one poultry farm in the Siberian FD in 2023 (Fig. 4).

In 2023, 133 samples from geese were collected on the UFD poultry farms and tested; no antibodies to NDV were detected. In 2024, 373 samples taken from 6 poultry farms in the VFD and UFD were tested. Antibodies to NDV were detected in 86 samples (23%) from geese not vaccinated against ND (from the Republics of Bashkortostan and Tatarstan). Domestic waterfowl (ducks and geese) are rarely vaccinated against ND on commercial farms, since these avian species are less susceptible to ND than chickens, but at the same time they can be the disease reservoir on poultry farms [11, 28].

No antibodies to NDV were detected in quail sera collected in two Federal Districts (CFD and FEFD) and tested within two years, including those from the vaccinated birds (Fig. 4). The absence of specific antibodies in the vaccinated quails observed in our monitoring tests

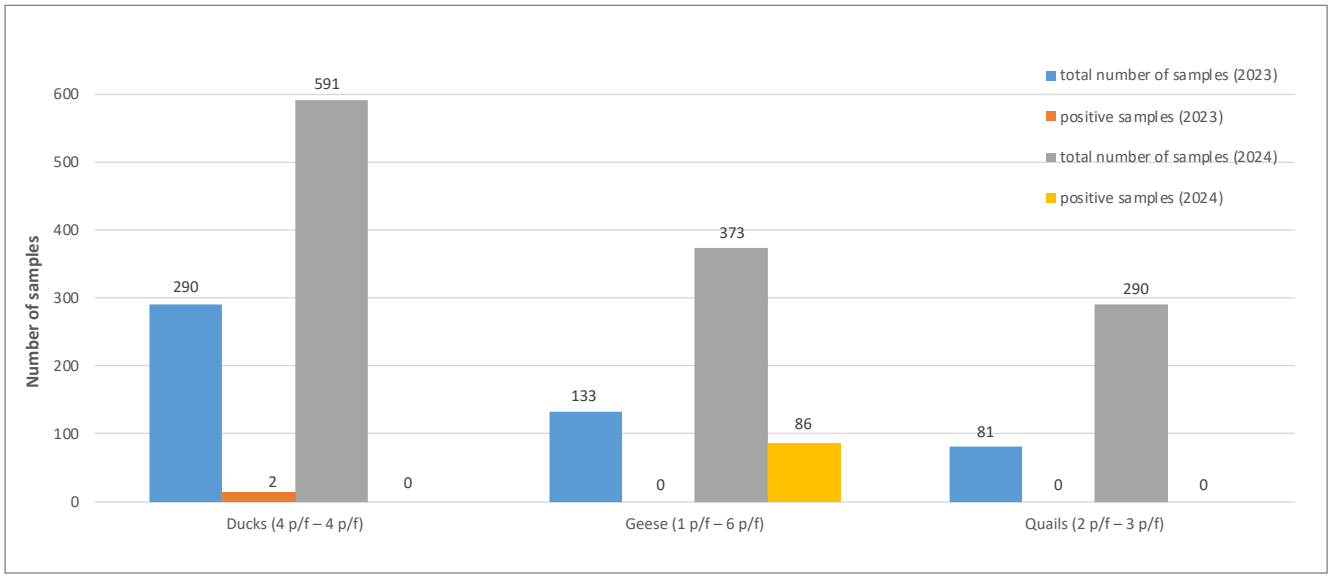

Fig. 4. Detection of antibodies to NDV in sera collected on commercial poultry farms (p/f) in 2023–2024

may result from incorrect sampling time after vaccination or an incorrect vaccination schedule.

In 2023 and 2024, 7,796 and 5,484 poultry sera samples were collected in backyards and on family-operated farms, respectively, in 39 RF Subjects of 8 Federal Districts and tested for antibodies to NDV (Tables 2 and 3).

Tests of poultry sera collected in backyards and on family-operated farms detected antibodies specific to NDV in chickens, turkeys, ducks, geese and guinea fowls in 2023 and in chickens, turkeys, geese and pheasants in 2024.

As for chickens and turkeys, antibodies to NDV were detected in 35 and 53% of samples tested in 2023 and 2024, respectively.

As indicated in the accompanying documents, ND vaccination was not universally implemented across

Table 2
Antibodies to NDV detected in chicken and turkey sera collected in backyards and on family-operated farms of the Russian Federation. Samples tested in ELISA and HI assay (data for 2023–2024)

Federal District	Poultry species	Number of samples (2023)		Number of samples (2024)	
		total/positive	% pos. samples	total/positive	% pos. samples
Northwestern	chickens	96/15	16	54/0	0
Central	chickens	928/253	27	751/298	40
Volga	chickens	2,023/689	34	1,227/669	55
	turkeys	45/0	0	n/t	n/t
Ural	chickens	200/41	21	120/15	13
Siberian	chickens	607/250	41	278/165	59
	turkeys	10/0	0	10/0	0
Far Eastern	chickens	1,222/223	18	643/286	45
	turkeys	167/146	87	117/54	46
Southern	chickens	500/411	82	759/538	71
	turkeys	n/t	n/t	25/25	100
North Caucasian	chickens	981/334	34	689/437	63
	turkeys	10/10	100	n/t	n/t
Total		6,789/2,372	35	4,673/2,487	53

n/t – not tested; pos. – positive.

Table 3
Antibodies to NDV detected in sera from various poultry species collected in backyards and on family-operated farms of the Russian Federation. Samples tested in HI assay (data for 2023–2024)

Federal District	Poultry species	Number of samples (2023)		Number of samples (2024)	
		total/positive	% pos. samples	total/positive	% pos. samples
Northwestern	ducks	75/0	0	106/0	0
	guinea fowls	5/0	0	10/0	0
	pheasants	5/0	0	10/0	0
	ostriches	4/0	0	n/t	n/t
	peacocks	5/0	0	n/t	n/t
Central	ducks	14/0	0	61/0	0
	geese	96/6	6	30/0	0
	quails	50/0	0	73/0	0
Volga	ducks	171/10	6	28/0	0
	geese	378/61	16	269/24	9
	quails	20/0	0	75/0	0
	guinea fowls	30/30	100*	n/t	n/t
Ural	quails	5/0	0	10/0	0
Siberian	geese	8/0	0	15/0	0
	quails	10/0	0	n/t	n/t
Far Eastern	ducks	10/0	0	24/0	0
	quails	75/0	0	75/0	0
	geese	46/0	0	n/t	n/t
Southern	pheasants	n/t	n/t	25/25	100*
Total		1,007/107	11	811/49	6

n/t – not tested; * samples from poultry vaccinated against ND; pos. – positive.

all backyards and family-operated poultry farms. Poultry for backyards were mainly purchased from poultry farms, where ND vaccination was implemented. Vaccine was typically administered at a single dose. Live vaccines, which were more frequently utilized, often induced a short-term immunity. The increase in vaccination coverage against ND in backyard flocks is evidenced by the rise in positive test results ranging from 35% in 2023 to 53% in 2024.

528 and 314 samples from domestic geese were delivered for tests in 2023 and 2024, respectively. Antibodies to NDV were detected in 67 (2023) and 24 (2024) samples from non-vaccinated geese brought from the CFD and the VFD. Antibodies were detected in sera from domestic ducks in 10 samples out of the 270 tested ones (VFD). In 2024, no specific antibodies to NDV were detected in duck sera. Presence of antibodies in domestic waterfowl not vaccinated against ND may be associated with circulation of avirulent NDV strains, since samples for the test were taken from clinically healthy birds [11, 28]. Antibodies to NDV were detected in all samples from the vaccinated guinea fowl and pheasants.

Many species of wild birds are natural reservoirs and carriers of infectious disease pathogens [4, 17], and therefore monitoring in wild fauna makes it possible to control occurrence and spread of dangerous avian infections, including ND.

Table 4 shows HI results for sera from wild birds collected during 2023–2024.

Testing sera samples from wild birds collected in seven RF Subjects revealed antibodies to NDV in 74 out

Table 4
Antibodies to NDV detected in wild birds using HI assay

Federal District (RF Subject)	Poultry species	Number of samples (2023)		Number of samples (2024)	
		total	positive	total	positive
Northwestern (Vologda Oblast)	wild ducks	85	6	41	2
	wild geese	54	0	62	6
	seagulls	1	0	15	1
Central (Lipetsk and Smolensk Oblasts)	synanthropic birds	17	0	35	0
	wild birds	17	0	35	0
	wild ducks	7	0	n/t	n/t
Volga (Republic of Tatarstan)	wild birds	20	0	n/t	n/t
	pigeons	14	3	n/t	n/t
Far Eastern (Primorsky Krai)	zoo birds	11	0	n/t	n/t
Siberian (Krasnoyarsk Krai, Omsk Oblast)	pigeons	n/t	n/t	90	56
Total		226	9 (4%)*	278	65 (23%)

n/t – not tested; * percentage of positive samples from the total number of the tested ones.

of 504 submitted samples. Samples from birds from the NWFD, the VFD and the Siberian FD were positive: 59 samples from synanthropic birds (pigeons) and 15 samples from wild birds (ducks, geese and seagulls). Two-year monitoring in the Vologda Oblast revealed specific antibodies to NDV in samples from wild birds. Positive samples from pigeons were obtained from the Republic of Tatarstan, the Krasnoyarsk Krai and the Omsk Oblast. In most cases, they were collected next to large commercial poultry farms, thus suggesting a threat of infection spread to poultry.

CONCLUSION

In 2023–2024, ND situation in the Russian Federation was assessed using field sera samples from various poultry species and wild birds. Due to routine vaccination with live and inactivated vaccines throughout the poultry rearing cycle, commercial poultry demonstrated a high level of seropositivity to NDV. Due to insufficient protection against ND, backyard poultry pose a persistent threat as a potential source of a primary disease outbreak driven by virulent strains of the virus. Antibodies to NDV were detected in wild and synanthropic birds in 4 regions of the Russian Federation.

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