

EVOLUTION OF HPAI AVIAN INFLUENZA VIRUS STRAINS IN EUROPE BETWEEN 2005 AND 2023

EVOLUȚIA TULPINILOR VIRUSULUI INFLUENȚEI AVIARE HPAI ÎN EUROPA ÎNTRE 2005 ȘI 2023

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ABSTRACT | REZUMAT

The paper presents results obtained after monitoring the situation of avian influenza produced by HPAI strains in European countries in the period 2005-2023. The monitored interval was subdivided into four periods: 2005-2009, 2010-2014, 2015-2019, and 2020-2023. Throughout the study period, several subtypes of highly pathogenic avian influenza type H5 and H7 were reported, which had irregular variations over time. From the World Organisation for Animals Health (WOAH) evidence, it appears that the most frequent subtypes were H5N1 and H5N8.

Keywords: Avian influenza virus, HPAI, H5N1, H5N8

În lucrare sunt prezentate rezultatele obținute după monitorizarea situației influenței aviare, produse de tulpini HPAI în țările din Europa, în perioada 2005 - 2023. Intervalul monitorizat a fost subîmpărțit în 4 perioade: 2005-2009, 2010-2014, 2015-2019 și 2020-2023. Pe întreaga perioadă luată în studiu au fost raportate mai multe subtipurile ale tipului H5 și H7 de influența virus aviar înalt patogene, care au avut variații neregulate în timp. Din evidențele Organizației Mondiale privind Sănătatea Animală (WOAH) reiese ca subtipurile cele mai frecvente au fost H5N1 și H5N8.

Cuvinte cheie: Influența aviară, HPAI, H5N1, H5N8

The first scientific evidence of avian influenza, according to most authors, is considered to be from the year 1878, when researchers first succeeded in differentiating the new poultry disease from other highly pathogenic infectious diseases that already existed (1). Avian influenza (AI) virus is classified according to the pathogenicity of the strains into low pathogenic avian influenza (LPAI) and highly pathogenic avian influenza (HPAI). Birds infected with LPAI strains may show slight signs such as reduced egg production, respiratory signs, and ruffled plumage, which subside after approximately 10 days. The main signs in HPAI-infected birds include severe respiratory and nervous signs and the collapse of various organs, ending with the *exitus* within 48-96 hours. The mortality rate in highly pathogenic strains can be up to 100% (4, 24).

Wild birds, especially waterfowl, represent the natural reservoir of AI and are the main vectors of the virus in poultry. The main route of transmission is faecal-oral via contaminated water sources, feed, and housing (the virus can survive in faeces for up to 35 days). Other secondary routes of transmission of the virus may be through aerosols, contaminated equipment, contaminated clothing and footwear of workers,

etc. (3, 20). The latest research shows that highly pathogenic viruses responsible for causing avian influenza arise through successive mutations of low pathogenic viruses after they have been introduced into extensive poultry farming systems. From the first evidence of this virus to the present day, avian influenza has been epidemic in nature, causing tens of millions of birds, and unfortunately, the same virus has also had a negative impact on society due to its infectious capacity in the population (12).

Due to the spread of this virus in many parts of the world, between 2005 and 2022, a total of 8534 outbreaks were detected, resulting in the loss of 389 million poultry around the world. The evolution of avian influenza between 2005 and 2022 had three major waves, namely: the first major wave between 2005 - 2010, produced by the H5N1 strain, which evolved in North America, Europe, Asia, and Africa and resulted in the extermination of 55.2 million birds. The second major wave occurred between 2011 and 2019 and resulted in the loss of 139.9 birds, with Europe again affected. The third major wave started in 2020, with the main outbreaks occurring in North America and Europe, although isolated cases have also been reported in Asia and Africa. The third wave was also the most aggressive, mainly due to infection with the H5N8 and H5N1 strains, resulting in the euthanasia and death of almost 200 million birds (11).

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Considering that a virus was detected more than 100 years ago, due to its increased pathogenicity leading to very high mortality rates (over 90%), research aimed at prophylaxis and control is of crucial importance soon.

MATERIALS AND METHODS

To accomplish the study's aim, peer-reviewed articles were selected from the PubMed database and data reported to the World Organisation for Animals Health (25). The articles included in the present study were published between January 2005 and December 2023. Even though the period considered covers several years, the study was intended to create an overview of the research conducted on AI and to build a solid basis for further research with the certain purpose of finding solutions to stop the spread of this virus and the appearance of new outbreaks.

The strategy used to search for scientific papers was to introduce three or four keywords in the search area of the database. The terms were represented by "avian influenza", the species of bird from which the virus has been isolated, the name of the country, and other specific terms (poultry, waterfowl, outbreaks, etc.). From the results, only the most relevant articles were selected, which provide reliable and suggestive data for the ongoing situation at the European level but also provide information on how the virus is transmitted via different routes (feed, equipment, cages, etc.) and strategies to stop this transmission.

RESULTS AND DISCUSSION

Before the 2000s, at the European level, very few local outbreaks of avian influenza were observed and

confirmed, which were quickly eliminated and did not cause very significant damage (except the 1999 HPAI outbreak in Italy). However, after the 2000s, things changed, as the virus caused several outbreaks that resulted in the culling of millions of birds. Taking into account the temporal distribution and the main AI episodes, four main periods of AI spread have been identified at the European level between 2005 and 2023.

First period: 2005-2009

The first significant outbreak was identified in Russia in the summer of 2005, caused by the H5 strain. The virus continued to spread across Russia and Kazakhstan during the same year, causing several outbreaks on poultry farms (Fig. 1). At the same time, cases have also been identified in wild birds, which is particularly important due to their high capacity to spread the virus over a very large territory in a short period (6).

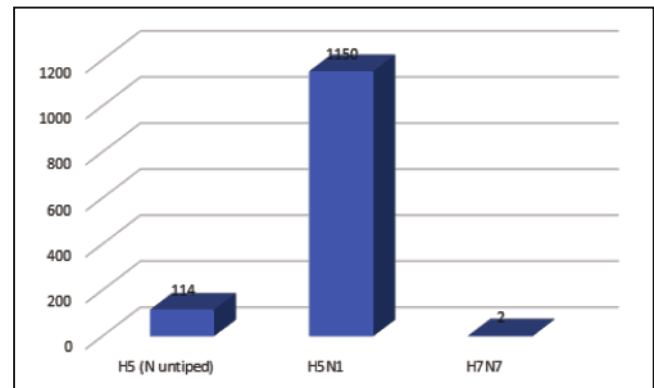


Fig. 1. Number of new outbreaks and subtypes of HPAI in poultry between 2005 and 2009 in European countries

In October 2005, the virus also spread to south-

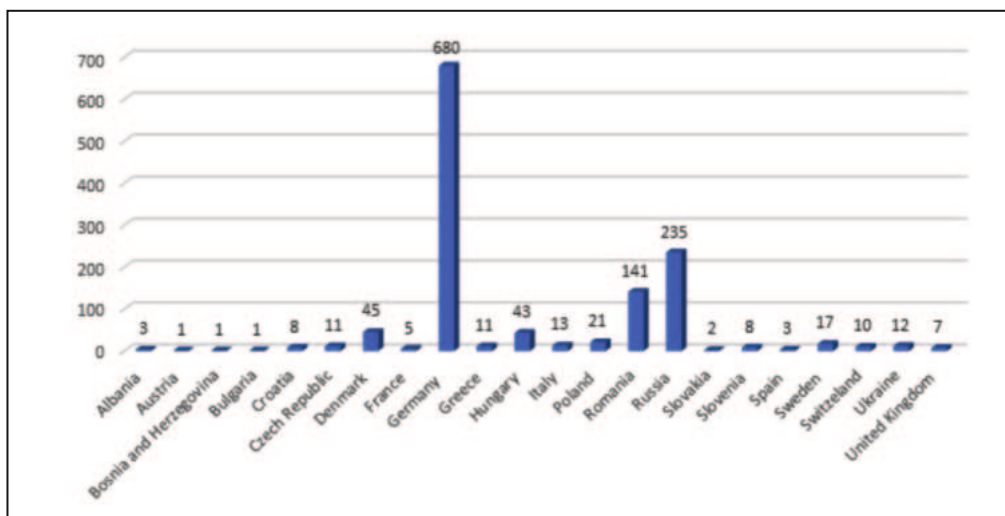


Fig. 2. Number of new outbreaks of HPAI in poultry between 2005 and 2009 in European countries

eastern Europe, with outbreaks of the H5N1 strain detected in Turkey, the Danube Delta (Romania), and Croatia, affecting both domestic and wild birds (10).

By the end of 2009, AI outbreaks had been identified in 22 European countries (Fig. 2), causing the loss of millions of birds, domestic and wild (22).

Second period: 2010-2014

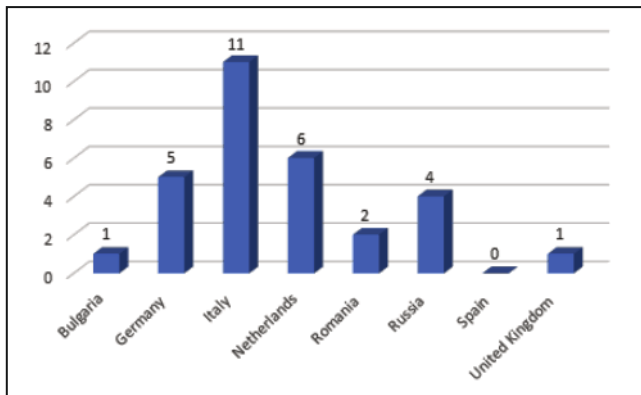


Fig. 3. Number of new outbreaks of HPAI in poultry between 2010 and 2014 in European countries

In early 2010, the first alert of a potential AI case was made in Tulcea County, Romania (Fig. 3).

Thus, during the post-mortem examination of two chickens reared in an extensive system, samples were taken for a certain diagnosis. Following reverse transcription polymerase chain reaction (RT-PCR), infection with HPAI of the H5N1 subtype was confirmed (Fig. 4). Unfortunately, full isolation of the outbreak was not achieved, and in two weeks, another outbreak was de-

tected in a flock 55 km away from the first one (19).

At the same time, AI was confirmed in Bulgaria in a dead common buzzard, *Buteo buteo* (14). Other cases of AI in poultry and wild birds were reported in Russia (13) and Romania at *Dalmatian pelicans* (21).

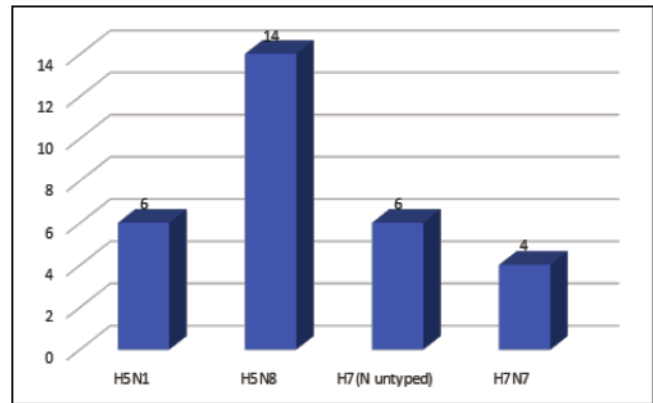


Fig. 4. Number of new outbreaks and subtypes of HPAI in poultry between 2010 and 2014 in European countries

Third period: 2015-2019

The third period when more AI outbreaks were detected at the European level was between 2014 and 2019. Thus, the first outbreak occurred in November 2014, when the HPAI H5N8 infection was confirmed in both poultry and wild birds. For the first time, cases were confirmed in a turkey farm in Germany (9), and the virus was later isolated in England (8) and the Netherlands (2, 26). Eurasian wigeons (*Anas penelope*) were the only species from which the virus was isola-

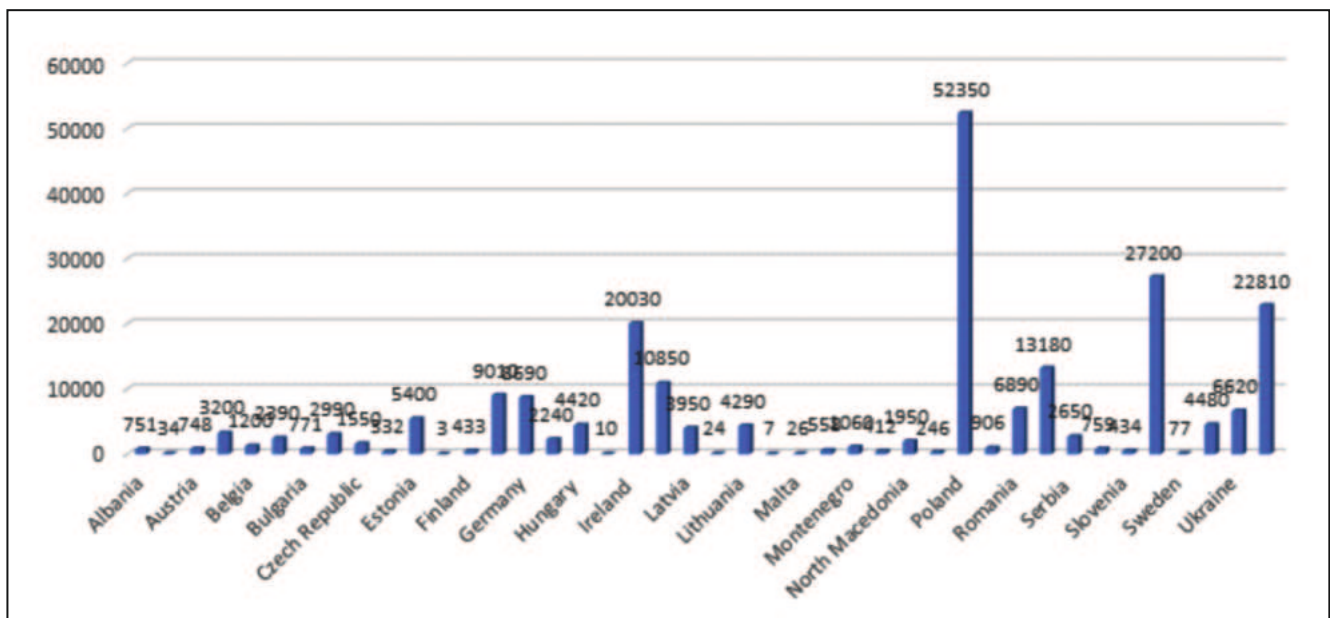


Fig. 5. Number of new outbreaks of HPAI in poultry between 2015 and 2019 in European countries

gary, Germany, the Czech Republic, and Poland, and detected in wild and domestic birds. On November 1, 2020, H5 HPAI was detected in chickens in the UK. Genetic analysis showed that this H5N8 virus was "Iraq-like". To date, no wild birds have been detected in the UK (15, 29).

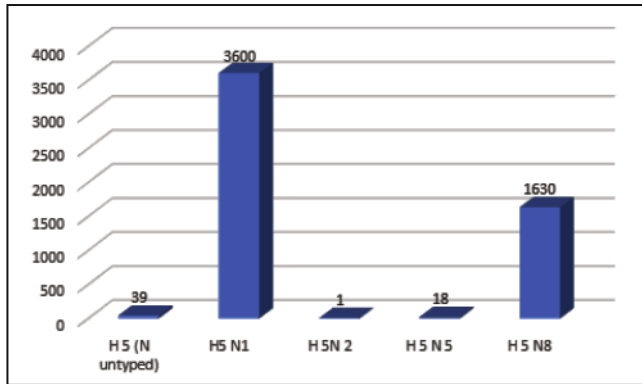


Fig. 8. Number of new outbreaks and type of HPAI in poultry between 2020 and 2023 in European countries

The emergence of these 2.3.4.4.4b H5 clade viruses in Eurasia has significant implications for the poultry sector in Europe, Central Asia, the Middle East, and Africa during the winter of 2020-2021 (23, 32).

Unfortunately, in the period 2020-2023, the virus continued to spread across several continents, causing substantial losses to both wild and domestic birds.

International collaborations and research initiatives, as well as the public availability of virus sequence data, are critical in advancing knowledge on HPAI virus emergence, evolution, and epidemiology.

The spread of AI-HPAI has been significantly facilitated by migratory wild birds (16, 22).

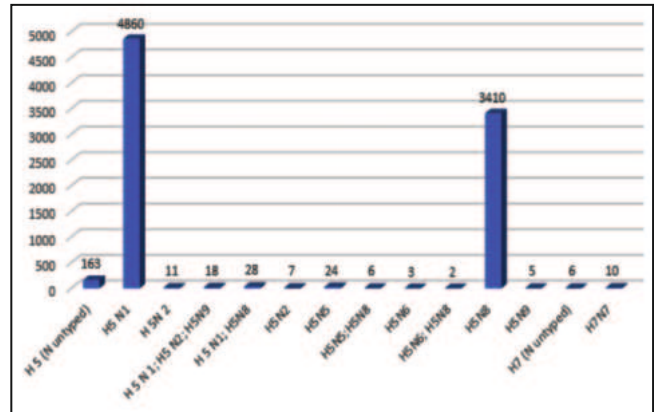


Fig. 9. Number of new outbreaks and type of HPAI in poultry between 2005 and 2023 in European countries

CONCLUSIONS

In the period 2005-2023, outbreaks of AI-HPAI, produced by H5 and H7 subtypes, were registered in many European countries. Annually, most outbreaks were produced by the H5N1 subtype, which was more prevalent in the analysed period with 4860 outbreaks, followed by the H5N8 subtype with 3410 outbreaks. It is crucial to understand the epidemiology of earlier HPAI incursions in Europe to detect new HPAI viruses early on and potentially stop them from spreading to humans as well as other bird populations. Due to the H5N1 virus's rapid spread throughout Europe, people, birds, and other animals all need to be closely moni-

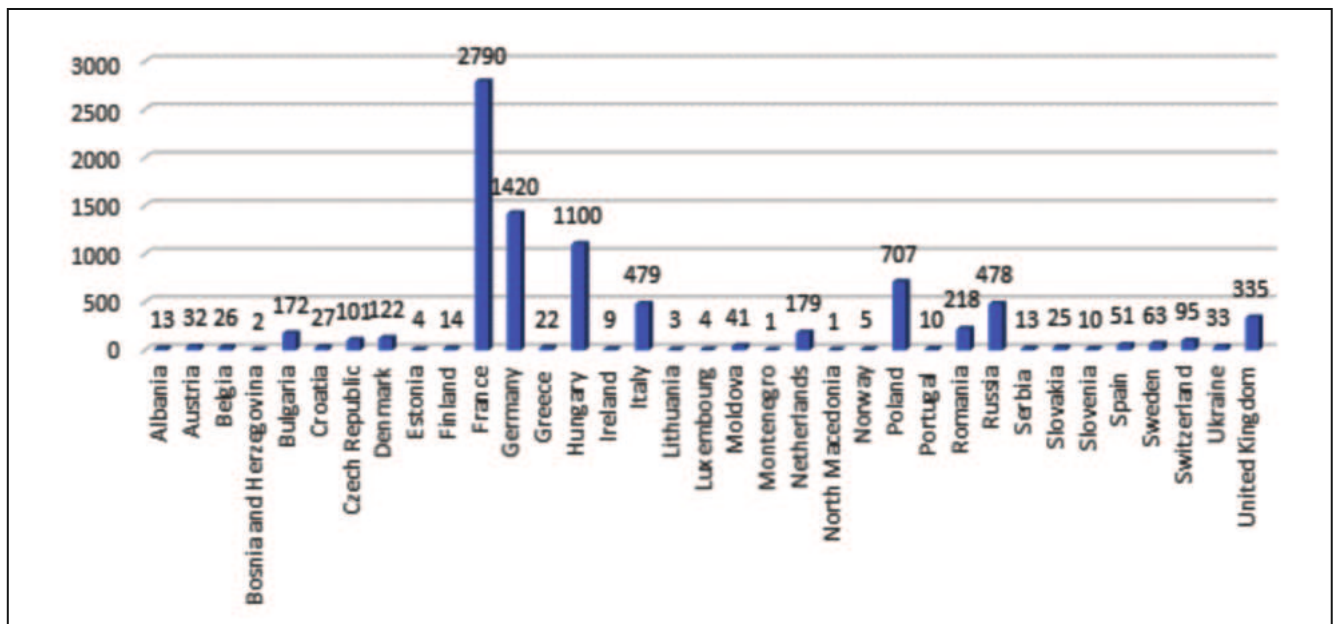


Fig. 10. Number of new outbreaks of HPAI in poultry between 2005 and 2023 in European countries

tored. Continuous monitoring of HPAI virus strains is necessary.

Acknowledgments:

This work was delivered by project ADER 10.1.2.

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