EXTERNAL SCIENTIFIC REPORT

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LPAI detection in wild birds and LPAI spread between European holdings in the period 2005-2015

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Abstract

The objective of this report is to describe the information provided from European Member States relating to LPAI detection in wild birds and LPAI spread between European holdings. Regarding LPAI outbreaks in poultry holdings in Europe, were collected for 272 LPAI outbreaks occurring in 13 Member States between 2006 and 2015. These consisted of 89 outbreaks of LPAI H5, 72 outbreaks of LPAI H7 and 111 outbreaks where the H subtype was not identified. Overall, France and Italy had the greatest number of LPAI H5 outbreaks between 2006 and 2015 (n=10 and 47, respectively). Most outbreaks from Italy were reported in 2011-2013 and 2015 Germany and Italy had the greatest number of LPAI H7 outbreaks across all years (n=17 and 30 respectively). Most outbreaks from Italy were reported in 2009-2011. Species affected by LPAI H5 and H7 were mostly chickens (n=15 and 34 respectively), ducks (n=17 and four respectively) and 'mixed' (n=16 and 20 respectively). Species affected by LPAI of undetermined H subtype were mostly turkeys (n=48), mixed species (n=25) and chickens (n=20). Regarding LPAI detection in wild birds between 2005 and 2015, there were 1159 records for wild birds with LPAI, of the H5 subtype (831), H7 subtype (216) or unreported subtype (112), from 20 EU member Member States. The majority of LPAI-positive birds were recorded from Sweden, Germany, and the Netherlands. The wild bird species in which LPAI was most frequently reported was the mallard. However, this species also was the most frequently sampled. Other species in which LPAI was frequently reported were gadwall, Eurasian wigeon, garganey, greylag goose, and greater white-fronted goose. Experimental infections in chickens, turkeys and mallards showed clear differences in replication kinetics and transmissibility of LPAI strains. Depending on LPAI-HPAI pair, the transmissibility of LPAI or HPAI in chickens was higher.

Key words: H5N1, H7N7, avian influenza, transmission, wild birds, poultry

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

This contract was awarded by EFSA to: Consortium leader Erasmus University Medical Centre (EMC, Rotterdam, the Netherlands).

Contractor/Beneficiary: EFSA

Contract title: Data collection, literature review and spatial models for virus spread in preparation to the mandate on avian influenza

Contract number: OC/EFSA/ALPHA/2015/01

Task 3.2 Review collected data/information provided by Member States and produce a report (report 2), about LPAI detection in wild birds and LPAI spread between European holdings. A report relating to LPAI detection in wild birds and LPAI spread between European holdings is produced in Microsoft Word, mainly through collaboration of partners 1 (EMC) and 3 (Animal and Plant Health Agency, APHA). This report includes a description of the whole process of data identification and selection as well as descriptive statistics of the collected data. The amendments to data from original versions to a final submission version have been tracked. Where automation has been used, the programming code is provided with the final deliverables. This report includes results from experimental transmission studies involving LPAI.

2. Data and Methodologies

2.1. Data

2.1.1. Sources of data for collation of EU AI poultry outbreak data

The following sources of data were used to create a collated dataset of EU AI poultry outbreak data:

1. Entries of notifiable avian influenza reported to the Animal Disease Notification System between 2005 and 2015 were used as the basis of the gathered dataset (Appendix A, fields 1-28).

2. Consortium partners, Germany, Italy, Netherlands and the United Kingdom, added information regarding species (field 34), reproduction type (field 35), local laboratory results (fields 39-44) and epidemiological data (fields 51-83) from internal epidemiological outbreak investigations, where available.

3. For all other Member States, details of the species and reproduction system affected by outbreaks was determined from official notification faxes received to the EURL for Avian Influenza (APHA Weybridge) (fields 34-35).

4. In addition, for all other Member States, local laboratory data (fields 39-44) and epidemiological data (fields 51-83) was gathered from presentations made by Member States to the Standing Committee on the Food Chain and Animal Health (SCoFCAH) at the European Commission.

5. Finally, laboratory data for samples handled by the EURL was added to the dataset (fields 45-50), including clades and accession numbers for sequences uploaded to online databases, where available.

Figure 1 describes the process by which European low pathogenic avian influenza (LPAI) data was collected for outbreaks occurring between 2005 and 2015. The design of the data model (Appendix A) was agreed with EFSA and five data sources were consulted in order to populate this model with as comprehensive coverage as was reasonably practicable.

Figure 1: LPAI Poultry Outbreak Data Collection Process

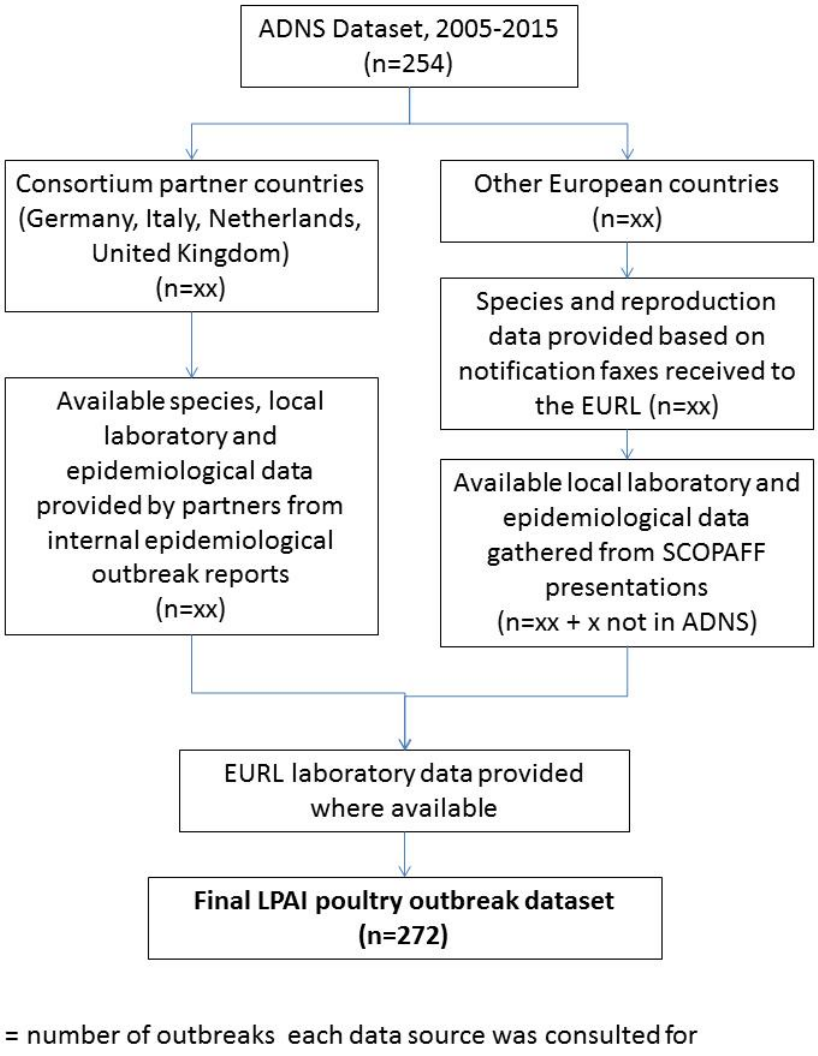

Figure 1: LPAI Poultry Outbreak Data Collection Process for the period 2005-2015

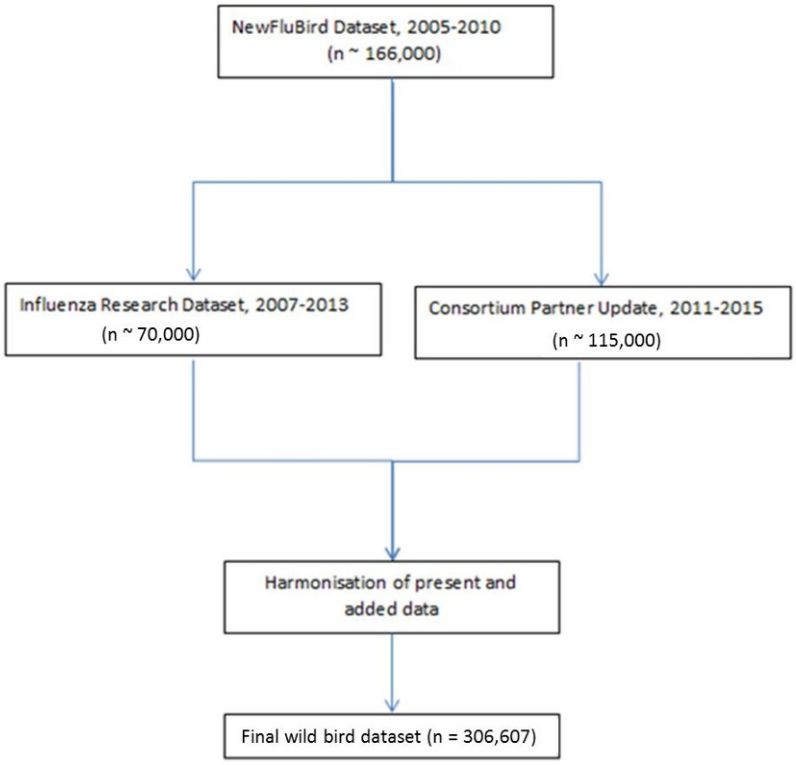

Figure 2: LPAI Wild Bird Data Collection process for the period 2005 to 2015. n = number of samples from wild birds.

2.1.2. Sources of data for LPAI detection in wild birds

The following sources of data were used to create a collated dataset of LPAI data in wild birds:

1. The basis of the dataset was the NewFluBird database, that contains >166,000 samples collected from wild birds between 2005 and 2010, the vast majority (>90%) of which was provided by participating institutes in this proposal (Germany, Netherlands, Sweden, Italy, United Kingdom).

2. Data were added from the Influenza Research Database (http://www.fludb.org/). This database has ~70,000 samples from wild birds in Europe collected between 2007 and 2013.

3. Data (~115,000) up to 2015 were added from consortium partners EMC, Central Veterinary Institute, APHA, Friedrich Loeffler Institute, Istituto Zooprofilattico Sperimentale delle Venezie, and Linnaeus University.

4. Added data were harmonized with the data already present.

2.1.3. Sources of data for experimental LPAI transmission studies

Results from transmission experiments involving LPAI were obtained from published studies selected by the consortium based on their relevance and included in the technical offer, not by a formal literature review.

The data used from experimental transmission studies were those scientific articles listed in the methodology section of the technical offer and listed below in the References section.

2.2. Methodologies

2.2.1. Poultry data cleaning

The merged poultry dataset was cleaned to facilitate harmonisation between outbreaks. This included ensuring that all country codes, poultry species and reproduction types conformed to a catalogue of entries. In addition, all dates submitted to the additional epidemiological information fields were formatted to follow the YYYYMMDD format requested by the data model.

NUTS 3 and latitude/longitude WGS84 data was added based on decimal/degrees/seconds co-ordinates submitted to the ADNS system.

The outbreak start date (startY, startM, startD) was populated using the 'firstInfectionDate' provided in ADNS, where available. Where this was not submitted to the ADNS system, the ADNS 'confirmationDate' was used as this is the first known date of infection for that holding.

2.2.2. Wild bird data methods

Data were collected on the basis of individual birds. For the purpose of the data collection, wild birds were defined as all birds that are free-living and do not qualify as "poultry" or "captive bird" according to Annex 7 of the Tender Specifications[1]. LPAIV was defined as any as any other type A influenza virus than H5 or H7 influenza A virus with an IVPI in 6-wk-old chickens > 1.2 and/or a multibasic cleavage site in the haemagglutinin protein. Avian species were identified by common name and scientific name, e.g., Eurasian wigeon, *Anas penelope*, to the extent possible. However, also lower level of specificity, e.g., Wild bird (not specified), Duck (not specified), Goose (not specified) were allowed, to allow maximum inclusion of surveillance data. Location of sample collection was specified to the maximum detail possible, but as a minimum should include country information. When available, also latitude-longitude and/or NUTS code and/or NUTS region and/or place (nearest village or town) were included. Please see Appendix 2 for fields included in the dataset. After collation and harmonisation of the dataset in the NewFluBird database, an export module was developed to allow transfer to EFSA of the LPAI positive cases.

2.2.3. Review of experimental transmission studies

Values of the following parameters, where available, were extracted from publications of experimental transmission studies: Group size, virus subtype, host species/breed/age, infectious period, transmission rate, clinical signs, mortality, and vaccination status.

[1] 'poultry' means all birds that are reared or kept in captivity for the production of meat or eggs for consumption, the production of other products, for restocking supplies of game birds or for the purposes of any breeding programme for the production of these categories of birds and 'captive bird' means any bird other than poultry that is kept in captivity for any reason other than those referred to in point 4 including those that are kept for shows, races, exhibitions, competitions, breeding or selling

3. Assessment/Results

3.1. LPAI outbreaks in poultry holdings in Europe

Data were collected for 272 LPAI outbreaks occurring in 13 Member States between 2006 and 2015. These consisted of 89 outbreaks of LPAI H5, 72 outbreaks of LPAI H7 and 111 outbreaks where the H subtype was not reported either to the ADNS system or in the other data sources consulted (Table 1). LPAI H5 outbreaks were identified throughout all years reported (except 2005). The highest number of LPAI H5 outbreaks were reported in 2012 (n=17) followed by 2015 (n=16). Outbreaks of LPAI H7 occurred across all years from 2006-2015, with the highest numbers identified in 2011 (n=26) and 2013 (n=13), all other years had fewer than ten outbreaks (Table 2).

Overall, France and Italy reported the greatest number of LPAI H5 outbreaks in the given timeframe (n=10 and 47, respectively). Most outbreaks from Italy were reported in 2011-2013 and 2015 (Figure 3). Germany and Italy reported the greatest number of LPAI H7 outbreaks across all years (n=17 and 30 respectively). Most outbreaks from Italy were reported in 2009-2011 (Figure 4).

Species affected by LPAI H5 and H7 were mostly chickens (n=15 and 34 respectively), ducks (n=17 and four respectively) and 'mixed' (n=16 and 20 respectively). Species affected by LPAI of undetermined H subtype were mostly turkeys (n=48), mixed species (n=25) and chickens (n=20) (Table 3).

Table 1: LPAI outbreaks by Member State and H subtype (where reported)

Member State	H5	H7	H subtype unreported	Total LPAI
Belgium	2			2
Bulgaria	6			6
Czech Republic	1	1		2
Germany	7	17	58	82
Denmark	3	4		7
Spain	1	1		2
France	10		1	11
United Kingdom		6		6
Ireland	1			1
Italy	47	30	51	128
Netherlands	6	13		19
Portugal	4			4
Romania	1		1	2
Total	**89**	**72**	**111**	**272**

Table 2: LPAI outbreaks by year and H subtype (where reported)

Year	H5	H7	H subtype unreported	Total LPAI
2006	3	4		7
2007	4	2	18	24
2008	2	1	35	38
2009	9	7	34	50
2010	3	9	5	17
2011	15	26	15	56
2012	17	2	3	22
2013	14	13		27
2014	6	3		9
2015	16	5	1	22
Total	**89**	**72**	**111**	**272**

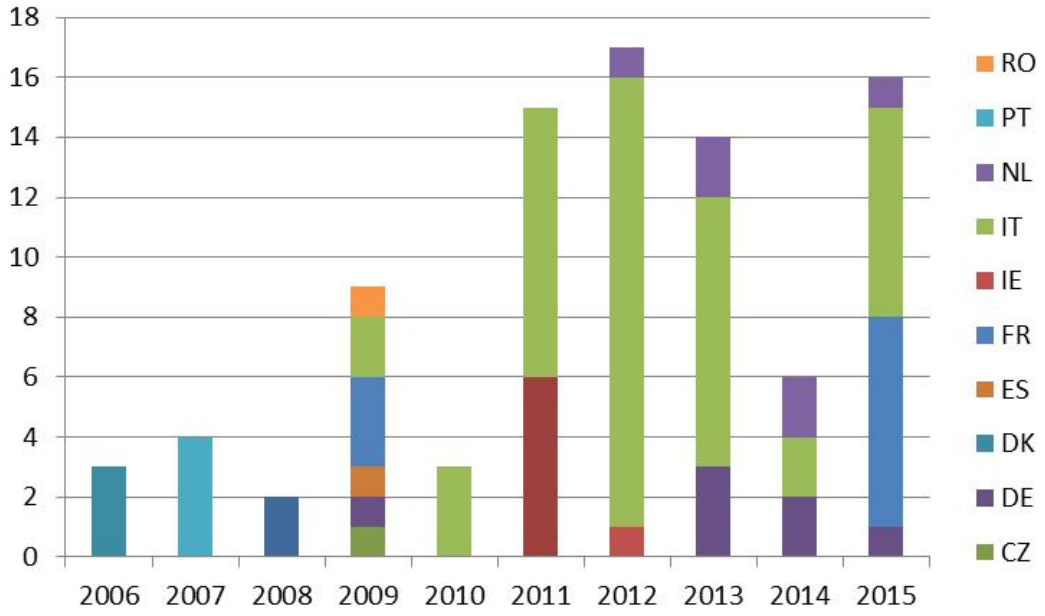

Figure 3: Number of LPAI H5 outbreaks reported on poultry holdings in EU Member States, by year

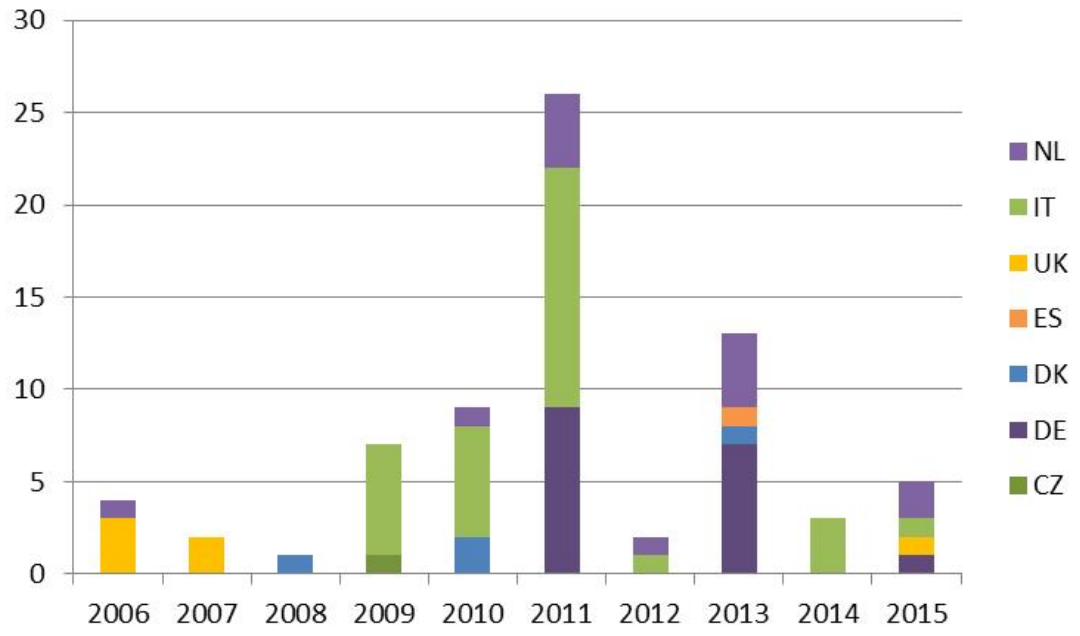

Figure 4: Number of LPAI H7 outbreaks reported on poultry holdings in EU Member States, by year

Table 3: LPAI outbreaks by species and H subtype (where reported)

Production system	Species	H5	H7	H subtype unreported	Total LPAI
Backyard		3		3	6
Commercial	Chickens		2	1	3
	Chickens / Ducks / Geese / Turkeys	15	34	20	69
	Chickens / Geese / Ducks / Quail	1		1	2
	Chickens / Ostrich		1	1	2
	Chickens / Turkey / Ducks	1			1
	Chickens / Turkey / Goose / Ducks / Quail			1	1
	Ducks	1			1
	Ducks / Chickens / Geese	17	4	5	26
	Ducks / Geese			2	2
	Game Birds	1	1		2
	Geese	5			5
	Geese / Chickens	2	1	2	5
	Guinea Fowl			1	1
	Farmed Mallard	1			1
	Mixed	6	1		7
	Ornamental	16	20	25	61
	Partridges	7	1	1	9
	Pheasants	2			2
	Turkeys	1			1
	Chickens	10	7	48	65
	Unknown	3		3	6
	Grand Total	**89**	**72**	**111**	**272**

3.2. LPAI detection in wild birds

Between 2005 and 2015, there were 1159 records for wild birds with LPAI, of the subtype H5 (831), H7 (216) or other subtype (112), from 20 EU Member States (Table 4). Most of these LPAI-infected birds were found in the years 2006 to 2010 (Figure 5), after which sampling wild birds for influenza decreased substantially due to lack of funding. The majority of LPAI-positive birds were recorded from Sweden, Germany, and the Netherlands (Figure 5), and consisted of more LPAI H5 than LPAI H7 reports each year (Figure 6). The wild bird species in which LPAI was most frequently reported was the mallard (*Anas platyrhynchos*); however, this species also was by far the most frequently sampled (Table 6). Other species in which LPAI was frequently reported were gadwall (*Anas crecca*), Eurasian wigeon (*Anas penelope*), garganey (*Anas querquedula*), greylag goose (*Anser anser*), and greater white-fronted goose (*Anser albifrons*). LPAI H5 and LPAI H7 were most frequently sampled from the mallard. Other species in which LPAI H5 was frequently reported were garganey, greater white-fronted goose, and mute swan (*Cygnus olor*). LPAI H7 was rarely reported in other species.

Table 4: LPAI detections in wild birds by Member State and H subtype, 2005-2015

Member State	LPAI H5	LPAI H7	LPAI HX	LPAI total
Austria	38	13	0	**51**
Belgium	8	4	0	**12**
Bulgaria	0	0	3	**3**
Czech Republic	17	1	0	**18**
Denmark	90	18	0	**108**
Finland	1	1	0	**2**
France	105	25	0	**130**
Germany	220	13	27	**260**
Greece	0	0	0	**0**
Hungary	22	1	0	**23**
Iceland	1	0	47	**48**
Ireland	2	0	0	**2**
Italy	1	9	19	**29**
Lithuania	0	9	0	**9**
Netherlands	124	108	0	**232**
Portugal	12	2	0	**14**
Poland	4	1	0	**5**
Romania	0	0	0	**0**
Slovakia	0	0	0	**0**
Slovenia	2	1	0	**3**
Spain	6	8	0	**14**
Sweden	160	9	16	**185**
Switzerland	0	0	0	**0**
United Kingdom	18	0	0	**18**
Total	**831**	**216**	**112**	**1159**

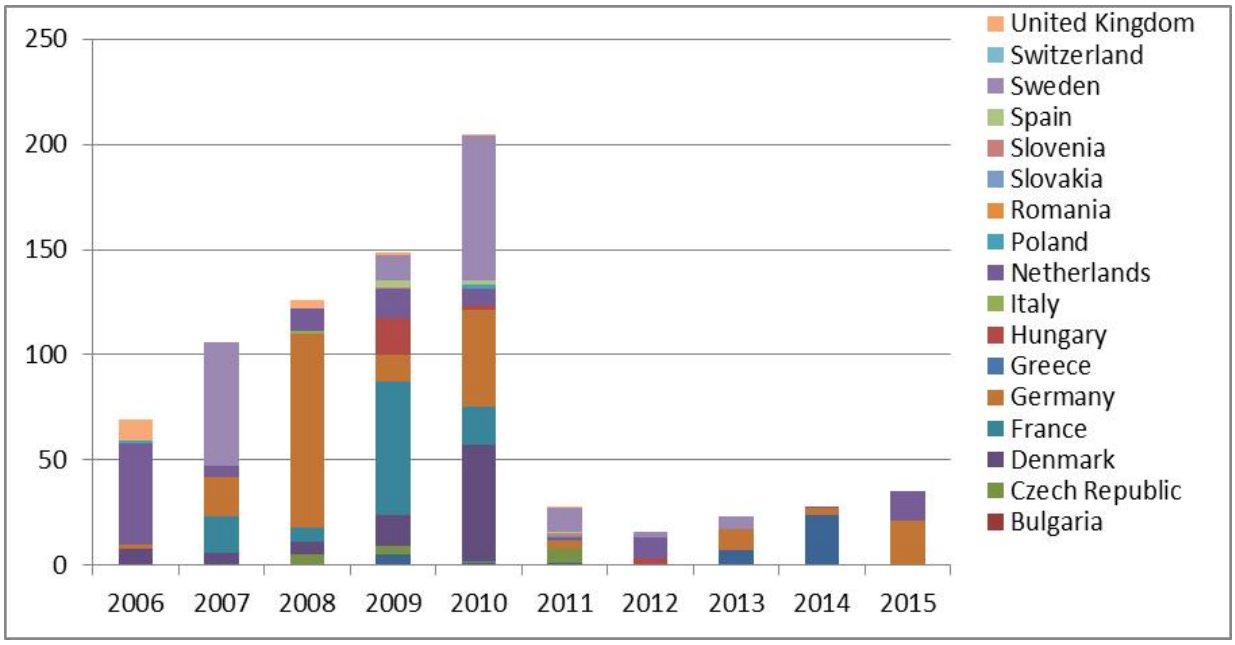

Figure 5: Number of LPAI virus detections reported in wild birds by Member State and by year, 2006 to 2015. (In 2005, LPAI viruses reported only in the Netherlands and Sweden.)

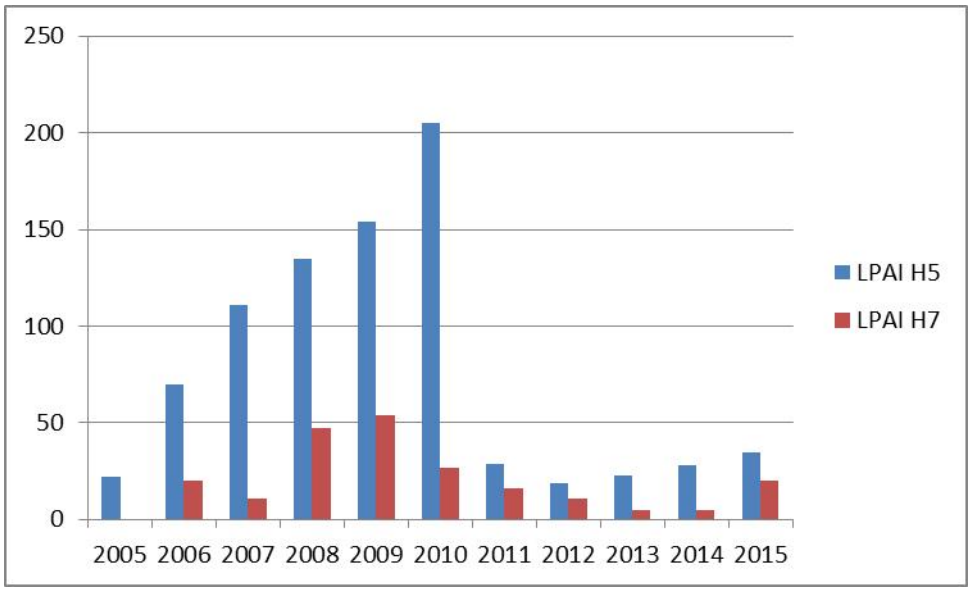

Figure 6: Number of H5 and H7 LPAI virus detections reported in wild birds by subtype and by year, 2005 to 2015.

Table 6: Number of LPAI virus detections by species and subtype

Order	Common name	Scientific name	LPAI H5	LPAI H7	LPAI HX	Total LPAI	Samples tested	Total LPAI/ samples tested
Anseriformes	Northern shoveler	*Anas clypeata*	1	5	1	7	776	0.9%
	Gadwall	*Anas crecca*	57	4	1	62	5,447	1.1%
	Eurasian wigeon	*Anas penelope*	12	6	1	19	14,812	0.1%
	Mallard	*Anas platyrhynchos*	623	165	36	824	144,806	0.6%
	Garganey	*Anas querquedula*	28	1	0	29	276	10.5%
	Gadwall	*Anas strepera*	1	2	0	3	2,570	0.1%
		Anas sp.	31	1	6	38	9,015	0.4%
	Eurasian pochard	*Aythya ferina*	3	2	0	5	396	1.3%
	Tufted duck	*Aythya fuligula*	0	1	0	1	969	0.1%
	Wood duck	*Aix sponsa*	0	1	0	1	74	1.4%
	Harlequin duck	*Histrionicus histrionicus*	0	1	0	1	2	50.0%
	Ruddy duck	*Oxyura jamaicensis*	2	0	0	2	2	100.0%
	Common shelduck	*Tadorna tadorna*	0	3	0	3	746	0.4%
	Greylag goose	*Anser anser*	3	0	12	15	20,032	0.1%

Order	Common name	Scientific name	LPAI H5	LPAI H7	LPAI HX	Total LPAI	Samples tested	Total LPAI/ samples tested
	Pink-footed goose	*Anser brachyrhynchus*	0	0	1	1	3,836	0.0%
	Swan goose	*Anser cygnoides*	0	0	1	1	2,076	0.0%
	Bean goose	*Anser fabalis*	4	8	0	12	3,635	0.3%
	Greater white-fronted goose	*Anser albifrons*	22	2	2	26	19,615	0.1%
	Lesser white-fronted goose	*Anser erythropus*	1	0	0	1	2	50.0%
		Anser sp.	3	1	2	6	4,473	0.1%
	Canada goose	*Branta canadensis*	0	1	0	1	3,449	0.0%
	Pink-footed goose	*Branta leucopsis*	0	0	2	2	5,453	0.0%
	Ashy-headed goose	*Chloephaga poliocephala*	1	1	0	2	1,849	0.1%
	Whooper swan	*Cygnus cygnus*	8	0	2	10	1,400	0.7%
	Mute swan	*Cygnus olor*	11	3	1	15	11,701	0.1%
		Cygnus sp.	5	2	0	7	5,791	0.1%
Charadriiformes	Black-headed gull	*Chroicocephalus ridibundus*	4	2	3	9	19,087	0.0%
	Herring gull	*Larus argentatus*	1	0	12	13	4,091	0.3%

Order	Common name	Scientific name	LPAI H5	LPAI H7	LPAI HX	Total LPAI	Samples tested	Total LPAI/ samples tested
	Lesser black-backed gull	*Larus fuscus*	0	0	11	11	1,608	0.7%
	Iceland gull	*Larus glaucoides*	0	0	1	1	26	3.8%
	Glaucous gull	*Larus hyperboreus*	0	0	2	2	140	1.4%
	Greater black-backed gull	*Larus marinus*	2	0	3	5	257	1.9%
		Larus sp.	0	0	3	3	1,520	0.2%
	Little tern	*Sternula albifrons*	0	0	0	0	50	0.0%
	Pied avocet	*Recurvirostra avosetta*	0	1	0	1	20	5.0%
	Common snipe	*Gallinago gallinago*	2	0	0	2	459	0.4%
	Ruddy turnstone	*Arenaria interpres*	0	0	1	1	1,307	0.1%
Accipitriformes		*Buteo sp.*	0	0	1	1	4,055	0.0%
Gruiformes	Common coot	*Fulica atra*	0	2	3	5	6,449	0.1%
	Eurasian moorhen	*Gallinula chloropus*	0	0	1	1	608	0.2%
Pelecaniformes	Black-crowned night heron	*Nycticorax nycticorax*	1	0	0	1	61	1.6%
Podicipediformes	Great crested grebe	*Podiceps cristatus*	0	0	0	0	470	0.0%

Order	Common name	Scientific name	LPAI H5	LPAI H7	LPAI HX	Total LPAI	Samples tested	Total LPAI/ samples tested
Passeriformes	Common grasshopper-warbler	*Locustella naevia*	0	1	0	1	35	2.9%
Strigiformes	Barn owl	*Tyto alba*	0	0	1	1	668	0.1%
Suliformes	Great cormorant	*Phalacrocorax carbo*	2	0	0	2	2,493	0.1%

3.3. Experimental transmission studies

Experimental studies were performed with chickens, turkeys and mallards (Appendix C). The main conclusions were:

-LPAI H2N3 (A/Mallard/New Brunswick/1/2006) and H13N6 (A/Gull/Ontario/680-6/2001) in mallards: Subtype H2N3 was better adapted to mallards than LPAI H13N6, causing productive infection. Although H13N6 could replicate in the lungs of mallards, a low level of virus would effectively be released into the environment, thus supporting the observation that this subtype has rarely been isolated from ducks. Larger quantities of H2N3 virus were detected in cloacal swabs than in pharyngeal swabs (Daoust et al., 2012).

-LPAI H7N1 (A/turkey/Italy/1067/99): Four group transmission experiments performed in chickens. Mean infectious period estimated at 7.7 days (95% CI 6.7-8.7). The transmission rate parameter was 0.49 (0.30-0.75) infections per infectious chicken per day, and the R0 was 3.8 (1.3-6.3) (Gonzales et al., 2011).

-LPAI H7N3: Field and experimental study for proof of principle that transmission parameters could be quantified using egg production data from commercial layer flocks (method best suited to flocks with litter (floor-reared) housing system. Experimental trials (two groups of ten birds, five contact and five inoculated) showed the infectious period was significantly greater in inoculated chickens compared to contact-infected chickens (Gonzales et al., 2012a).

-LPAI H7N7 and H5N7: Two transmission experiments were carried out in conventional layers. One chicken per pair was inoculated. With the LPAI H7N7 virus, the transmission rate was 0.10 (95% CI 0.04-0.18) day^{-1}. With the H5N7 virus, only 5/20 birds inoculated became infected and no transmission was observed, which highlights the differing transmission characteristics of LPAIV strains. This should be taken into account when designing surveillance programmes (Gonzales et al., 2012b).

-LPAI H7N1: Experimental infection of chickens and turkeys with alternative sites of glycosylation in the haemagglutinin (Italy/3466, Italy/4042 and Italy/1479). With a single variant virus, specific patterns of glycosylation near the receptor binding site were stable. With a mixed population of viruses, a specific variant was rapidly selected in the infected host (Iqbal et al., 2012).

-LP and HP H7N1: transmission rates for LP and HP were indistinguishable but the infectious period was far shorter for HP, which indicated a lower corresponding R0 (Saenz et al., 2012).

-HPAI H5N2 in chickens: In a model comparing A/Chicken/Pennsylvania/21525/83 (LPAI) and A/Chicken/Pennsylvania/1370/83 (HPAI), the reproduction ratio of the HPAI virus was significantly higher than that of LPAI (van der Goot et al., 2003b).

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Glossary and Abbreviations

Glossary

Poultry: All birds that are reared or kept in captivity for the production of meat or eggs for consumption, the production of other products, for restocking supplies of game birds or for the purposes of any breeding programme for the production of these categories of birds.

Captive bird: Any bird other than poultry (see above) that is kept in captivity for any reason other than those referred to for poultry, including those that are kept for shows, races, exhibitions, competitions, breeding or selling.

Wild bird: All birds that are free-living and do not qualify as poultry or captive bird (see above).

Abbreviations

ADNS: Animal Disease Notification System

APHA: Animal and Food Health Agency

EFSA: European Food Safety Authority

EMC: Erasmus University Medical Centre

EURL: European Union Reference Laboratory

H subtype: Haemagglutinin subtype

HPAI: Highly pathogenic avian influenza

LPAI: Low pathogenic avian influenza

NUTS: Nomenclature of Territorial Units for Statistics

SCoFCAH: Standing Committee on the Food Chain and Animal Health

Appendix A – Poultry data model

Field	Element name	Definition	Catalogue	Data source
1	country	Country reporting the disease notification		ADNS database
2	outbreakYear	Year in which the outbreak was reported		
3	adnsRef	Report reference number, unique to the outbreak year		
4	region	Region or province where the outbreak was reported		
5	outbreakType	Primary or secondary outbreak		
6	pathogenicity	HPAI or LPAI	HPAI/ LPAI	
7	hSubtype	H5 or H7, where available		
8	diseaseOrigin	Origin of the outbreak, if known		
9	relatedOutbreakYear	Year in which a related outbreak occurred, if relevant		
10	relatedAdnsRef	Reference number for related outbreak, if relevant		
11	latitude	Latitude either North (NO) or South (SO), if latitude given		
12	latitudeDecimal	Latitude co-ordinate- decimal figure		
13	latitudeMinute	Latitude co-ordinate- minute figure		
14	latitudeSecond	Latitude co-ordinate- second figure		
15	longitude	Longitude either East (EA) or West (WE), if longitude given		
16	longitudeDecimal	Longitude co-ordinate- decimal figure		
17	longitudeMinute	Longitude co-ordinate- minute figure		
18	longitudeSecond	Longitude co-ordinate- second figure		
19	suspicionDate	Date the suspicion of disease was reported		
20	confirmationDate	Date the disease event was confirmed		
21	firstInfectionDate	Date of first infection in the outbreak		
22	killedDate	Date the animals were slaughtered for control (or date animals died as a result of the infection)		
23	destructionDate	Date the destruction of animals for control was completed		
24	susceptible	Number of susceptible birds present		
25	cases	Number of cases reported		
26	deaths	Number of deaths reported		
27	destroyed	Number of birds destroyed		
28	depopulated	Number of birds depopulated (both deaths and those		

Field	Element name	Definition	Catalogue	Data source
		destroyed)		
29	countryCode	Country where the holding is located	COUNTRY	Populated according to the country code corresponding to ADNS country data (field 1)
30	NUTScode	Code for region where holding is located using Nomenclature for Territorial Units for Statistics	NUTS (for Europe)	Populated according to the NUTS 3 region relating to the decimal/ minutes/ seconds co-ordinates submitted to the ADNS system (fields 12-14)
31	NUTSregion	Text for region where holding is located using		
32	latitude	Latitude of site where sample was taken in WGS84 format		Populated according to the WGS84 latitude/ longitude data relating to the decimal/ minutes/ seconds co-ordinates submitted to the ADNS system (fields 12-14)
33	longitude	Longitude of site where sample was taken in WGS84 format		
34	species	Name of the species tested for AIV		For consortium outbreaks, details of the species and reproduction type was provided by partners; for outbreaks in other member states, details of the species and reproduction type were determined from official notification faxes received to the EURL for Avian Influenza (APHA Weybridge)
35	reproduction	reproduction for production of eggs, meat, mixed, breeding or other	MEAT/ EGG/ MIXED/ BREED/ OTHER	
36	startY	Year when the outbreak in the holding started		Derived from ADNS first infection date, or confirmation date where no first infection date was provided (fields 21 and 20, respectively)
37	startM	Month when the outbreak in the holding started		
38	startD	Day when the outbreak in the holding started		
39	labID	Identifier for laboratory performing test		For consortium outbreaks, local laboratory details were provided by partners, where available; for outbreaks in other member states, local laboratory details were gathered from presentations made to the European Commission's SCoFCAH, where available
40	tissueType	Type of tissue sampled	Carcass/ Faeces/ Environment	
41	localLabTest	Type of test	PCR/ ELISA/ Virus Isolation/ DFA/ Sequencing	
42	localLabPath	Sample pathotype		
43	localLabSubtype	Sample H and N subtype, i.e. H5N8		
44	nPos	Number of samples testing positive		
45	EURLID	Sample name given by the EURL		Details of EURL sample handling was added to the dataset where samples submitted to the EURL could be matched to an outbreak reported to ADNS
Field	Element name	Definition	Catalogue	Data source
46	EURLLabTest	Diagnostic tests performed by the EURL		Details of EURL sample handling was added to the dataset where samples

Field	Element name	Definition	Catalogue	Data source
				submitted to the EURL could be matched to an outbreak reported to ADNS
47	EURLClade	Clade of virus, where available		
48	sequenced	Was the virus sequenced	Y/N/U	
49	virusName	Name of the sequence generated		
50	sequenceID	Accession number of the sequence, if uploaded to Genbank or GISAID		
51	symptomatic	Were clinical signs observed on farm (mild respiratory disease, decreased egg production)	Y/N/U	For consortium outbreaks, the additional epidemiological information in fields 51-83 were provided by partners following a review of internal outbreak investigations, where available; for outbreaks in other member states, epidemiological information was gathered from presentations made to the European Commission's SCoFCAH, where available
52	housing	Describe the housing on the affected farm	Indoor controlled environment/ Indoor open to environment/ outdoor access	
53	deconVehicle	Does the farm operate decontamination procedures for vehicles entering the farm	Y/N/U	
54	deconPeople	Does the farm operate decontamination procedures people entering farm (shoes and clothing)	Y/N/U	
55	protectedFeed	Is the feed on the farm kept under controlled conditions which prevent access by wild birds	Y/N/U	
56	biosecurity	Level of biosecurity on farm	1/2/3/4	
57	travelAsia	Has anyone working on the farm travelled from Asia in the last month	Y/N/U	
58	travelDate	If yes, date of travel in format 20141101		
59	travelCountry	If yes, to which country	COUNTRY	
60	newWorker	Have any new workers joined the farm in the last month	Y/N/U	
61	startDate	If yes, date of the worker started employment in format 20141101		
62	nationality	If yes, which nationality	COUNTRY	
Field	Element name	Definition	Catalogue	Data source

Field	Element name	Definition	Catalogue	Data source
63	hobbies	Do any of the workers on the farm have hobbies which may result in exposure to wild or tropical birds (e.g. bird watching, breeding or pet birds)	Y/N/U	For consortium outbreaks, the additional epidemiological information in fields 51-83 were provided by partners following a review of internal outbreak investigations, where available; for outbreaks in other member states, epidemiological information was gathered from presentations made to the European Commission's SCoFCAH, where available
64	workerLinks	Do any of the workers have links to other poultry farms in area	Y/N/U	
65	farmLinks	Are there operational, financial, administrative or community links to other poultry farms (e.g. farm is one of a number of farms operating under a larger holding company)	Y/N/U	
66	importedFeed	Has imported feed or feed ingredients been used on the farm in the last month	Y/N/U	
67	feedDate	If yes, date when feed was used in format 20141101		
68	origin	If yes, country of origin	COUNTRY	
63	productName	If yes, name of feed product		
64	birdToFarm	Have live birds been moved onto the farm in the last month (including pet birds)	Y/N/U	
65	arrivalDateBird	If yes, date when birds arrived in format 20141101		
66	sourceLiveBird	If yes, the country the birds came from	COUNTRY	
67	sourceDetLiveBird	Text for region where the live birds came from	NUTS (for Europe)	
68	eggToFarm	Have bird eggs for hatching been moved onto the farm in the last month	Y/N/U	
69	arrivalDateEgg	If yes, date when the eggs arrived in format 20141101		
70	sourceEgg	If yes, the country the eggs came from	COUNTRY	
71	sourceDetEgg	Text for region where the live eggs came from	NUTS (for Europe)	
72	birdsFromFarm	Have live birds been moved out the farm in the last month	Y/N/U	
73	departDate	If yes, date when birds left the farm in format 20141101		
74	destinLiveBird	If yes, the destination of the live birds	COUNTRY	
75	destinDetLiveBird	Text for region of the destination of the live birds	NUTS (for Europe)	
Field	Element name	Definition	Catalogue	Data source
76	envSamp	Have environmental samples	Y/N/U	For consortium outbreaks, the

Field	Element name	Definition	Catalogue	Data source
		been taken from the farm (water, feed, manure etc)		additional epidemiological information in fields 51-83 were provided by partners following a review of internal outbreak investigations, where available; for outbreaks in other member states, epidemiological information was gathered from presentations made to the European Commission's SCoFCAH, where available
77	envSampType	Type of environmental samples taken on the farm		
78	NenvPos	Number of environmental samples positive for AIV		
79	contactWildBird	Indicate whether it is probable that indirect or direct contact with wild birds occurred, for example observations of large numbers of wild birds around the farm location	Y/N/U	
80	explanation	Describe how contact with wild birds may have occurred, or other route of infection suspected.		
81	oneKmHoldings	Number of holdings within 1km of the outbreak		
82	threeKmHoldings	Number of holdings within 3km of the outbreak		
83	tenKmHoldings	Number of holdings within 10km of the outbreak		

Appendix B – Wild bird data model

Data export from NewFluBird Database (NFB-DB): Pos.	Field name	Description
1	CountryCode	Country code according to „ISO 3166-1-alpha-2“.
2	Country	Country name.
3	BirdId	Non-ambiguous identifier of each single bird sampled at a unique location and date.
4	Organisation	Short name/key of corresponding organisation which provided the data to the NFB-DB. Possible values can be found on page 2!
5	Area	Area name, if available, for European geographical regions (equivalent to NUTS5). Area codes can be found in **NFB_DB_EU_nuts5.dbf.**
6	X	Longitude in WGS84 (decimal). If “Area” field has not the value “exact location”, this coordinate was randomly distributed within the spatial unit
7	Y	Latitude in WGS84 (decimal). If “Area” field has not the value “exact location”, this coordinate was randomly distributed within the spatial unit
8	XYInfo	Indicates whether the provided location is geo-referenced or not (e.g. missing information by the data provider).
9	Date	Bird localisation date.
10	SpcWbdb	Bird species WBDB (World Bird Database) code. See **NFB-DB_SpeciesList.xls**.
11	SpcEuring	Bird species EURING code.
12	SpcSciname	Bird species scientific name.
13	SpcCommonName	Bird species common name.
14	Specimen	Health status of the tested animal.
15	SurvStratification	Bird sampled by active or passive surveillance.

16	BodyScore	Rough body condition scoring.
17	Age	Age class.
18	Sex	Gender class.
19	Tag	Bird ring number.
20	SampleNr	Incrementing number of sample per bird; serves to implement one-to-many relationship to BirdId.
21	SampleType	Type of sample.
22	Infa	Result of the molecular Influenza-A screening assay (M-PCR).
23	Isolat	Virus isolation.
24	Haema	Hemagglutinin subtyping (molecular test).
25	Neura	Neuraminidase subtyping (molecular test).
26	Patho	Result of the pathotyping (molecular test: cleavage site sequencing in H5 and H7 subtypes).
27	HaemaS	Hemagglutinin subtyping (serological test).
28	NeuraS	Neuraminidase subtyping (serological test).
29	Remarks	Remarks / Comments about laboratory results etc.

Appendix C – Results from six experimental transmission studies listed in References

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
Daoust et al, 2012	Group 1: 1-8 (4 m, 4 f)	H2N3, H13N6	Mallards, captive bred			No clinical signs in any group	
	Group 2: 9-16						
	Group 3: 17-24						
	Group 4: 25-32						
	Four control ducks (2m, 2f)						
Gonzales at al., 2011	4 trials	LPAI H7N1	Six-week old specific pathogen free (SPF) white leghorn chickens	7.7 (6.7-8.7)	0.49 (0.30-0.75)		5 inoculated, 5 contact
Gonzales et al., 2012a	field trial and 2 experimental trials (x10 chickens)	LPAI H7N3					
		LPAI H7N3	SPF white leghorn chickens	13.32 days	Transmission rate 0.91 day-1, R0 9.1		Inoculated
		LPAI H7N3	SPF white leghorn chickens	10.03 days			Contact
Gonzales et al., 2012b	1	LPAI H7N7	Conventional layers	7.1 (6.5-7.8) days	0.10 (0.04-0.18), R0 0.7 (0.0-1.7)		30 pairs, one in each pair inoculated
	2	LPAI H5N7	Conventional layers			5/20 inoculated became infected but no transmission observed.	20 pairs, one in each pair inoculated

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
Iqbal et al., 2012		LPAI H7N1	Chickens and turkeys				
Saenz et al, 2012		HPAI/ LPAI H7N1	Turkeys (British United Turkeys)		(Density-dependent transmission - per bird, per day)		
	HP 1+10 (inoculated + contact turkeys)				3.34 (1.6-6.5) x10-1		
	HP 1+20				8.88 (5.2-14.0) x10-1		
	HP 1+40				5.09 (3.4-7.3) x10-1		
	combined				7.15 (5.4-9.3) x10-1		
	LP 1+40				3.85 (2.7-5.4) x10-1		
	LP 1+41				6.12 (4.4-8.3) x10-1		
	combined				4.84 (3.8-6.1) x10-1		
	HP			Mean infectious period (1.47 (1.3-1.7) days	2.04 (1.5-2.7) day-1		
	LP			Mean infectious period (7.65 (7.0-8.3) days	2.01 (1.6-2.5) day-1		

Author	Group	Virus	Species	Infectious period	Estimated transmission rate parameter (and 95% CI)	Virus shedding & disease symptoms and mortality	Vaccination status
van der Goot et al, 2003	Exp 1	LPAI	Six-week old specific pathogen free (SPF) chickens		R0 was 0.59 (CI includes 1)	0/5 contact animals seroconverted	5 inoculated, 5 contact
	Exp 2	LPAI				3/5 animals seroconverted	5 inoculated, 5 contact
	Exp 1	HPAI			∞	4/5 chickens seroconverted, 1/5 chickens died	5 inoculated, 5 contact
	Exp 2	HPAI				5/5 animals died (all could isolate virus)	5 inoculated, 5 contact