# Chapter 18

# The impact of vaccination on low pathogenicity avian influenza (LPAI) virus transmission between farms[*]

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## 1. Introduction

To control low pathogenicity avian influenza (LPAI) outbreaks many control measures are available. Italy has suffered multiple LPAI epidemics in the last decade and detailed data were collected. This provides the opportunity to study the impact of the (combinations of) various measures. The main interest of this study was to analyse the impact of vaccination on between-farm spread during these LPAI epidemics.

## 2. Material and methods

Data was available for four epidemics, during which six control measures were implemented: stamping out of infected flocks (1), controlled marketing (2), preventive culling (3), vaccination (4), homogenous areas (5) and reduced density (6), see Table 1. To estimate the reproduction ratio between herds ($R_h$) the data was transformed into a Susceptible-Infectious-Removed (SIR)-format with each week-record containing the number of S, I or R farms present per week. We used a generalized linear model with the number of new cases per week as the response variable with Poisson distribution and a log-link. The offset was log(S*I/N). This model yielded an estimate for the transmission rate parameter β, from which the $R_h$ was estimated by multiplying β with the mean infectious period per farm (5 weeks). Because various combinations of control measures were implemented, we studied the impact of vaccination both in a univariable and a multivariable model.

## 3. Results

The table shows the $R_h$ during different control periods of the four epidemics. After implementation of stamping out and controlled marketing the $R_h$ dropped from 2.15 to below 1 during the first epidemic. The second epidemic showed a reduction of Rh below 1 after vaccination started. Vaccination significantly reduced the $R_h$ in the multivariable model, and significantly below 1 in the univariable model.

## 4. Discussion

From the table it seems that vaccination reduces the $R_h$ below 1. Vaccination shows a clear between-farm spread reducing effect during the second epidemic. This effect is less clear during the first epidemic, where it seems that vaccination worsens the transmission. However, during period 4 there were only 2 cases. In the multivariable analysis (after correction for other measures), vaccination did not seem to reduce $R_h$ below 1, suggesting that vaccination alone is not a sufficient control measure. The analysis of observational studies where control measures are rarely implemented on their own is not straightforward, as opposed to clinical trials. Therefore it is necessary to analyse field data with a combination of multivariable and univariable techniques.

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Table 1. Data used in the analysis and control measures implemented.

| Epidemic | Period (# weeks) | # week-records | Vaccination | Control measures* | Cases | $R_h$ |
|---|---|---|---|---|---|---|
| 1 (H7N1) | 14/08/'00 – 20/03/'01 | | | | | |
| | *1 (7)* | *5* | - | - | *37* | *2.15* |
| | *2 (10)* | *10* | - | *1, 2* | *16* | *0.55* |
| | *3 (13)* | *13* | *Yes* | *1, 2* | *21* | *0.90* |
| | *4 (6)* | *6* | *Yes* | *1* | *2* | *1.25* |
| 2 (H7N3) | 20/06/'02 – 29/09/'03 | | | | | |
| | *5 (15)* | *7* | - | - | *18* | *1.65* |
| | *6 (1)* | *1* | - | *1* | *8* | *2.90* |
| | *7 (7)* | *7* | - | *1, 2* | *159* | *1.85* |
| | *8 (42)* | *42* | *Yes* | *1, 2, 3* | *188* | *0.65* |
| 3 (H7N3) | 15/09/'04 – 10/12/'04 | | | | | |
| | *9 (7)* | *6* | *Yes* | *5, 6* | *26* | *1.15* |
| | *10 (2)* | *2* | *Yes* | *2, 5, 6* | *0* | *0.00* |
| | *11 (6)* | *6* | *Yes* | *2, 5* | *2* | *0.30* |
| 4 (H5N2) | 11/04/'05 – 11/05/'05 | | | | | |
| | *12 (5)* | *4* | *Yes* | *5* | *15* | *0.90* |
| | *13 (3)* | *3* | *Yes* | *1, 5* | *0* | *0.00* |

* See text for explanation.