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Key Findings

- In 2004 and 2004-05 HPAI outbreaks predominantly occurred in the Red and Mekong river deltas in the month preceding the Tet holiday period.
- This temporal and spatial pattern changed in 2005 after the implementation of systematic control measures and the number of outbreaks was greatly reduced.
- The occurrence of smaller outbreaks between the main epidemics supports the hypothesis of the presence of a fairly widespread infection reservoir in Viet Nam, possibly in domestic and wild waterbirds.

Controlling Avian Flu and Protecting People's Livelihoods in the Mekong Region

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Temporal and Spatial Patterns of HPAI in Viet Nam

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Highly pathogenic avian influenza of the pathotype H5N1 was first reported in Viet Nam at the end of 2003. Since then major epidemic waves occurred in poultry and the country has attempted to control the disease through a range of measures. To date, 100 humans have been reported with HPAI H5N1, of which 46 have died (December, 2007; http://www.who.int). These cases were attributed to exposure to infected poultry.

So far no human-to-human transmission appears to have occurred. The genetic changes necessary to produce a virus which would be capable of human-to-human transmission and that could then result in a human influenza pandemic are most likely to occur in epidemiological systems with frequent interaction between the various infection reservoirs and humans. Viet Nam provides such a system through its smallholder farming population, a large proportion of which keep chickens and waterbirds. A national livestock census in 2003 estimated the total domestic poultry population in Viet Nam as 261 million (192 million chicken and 69 million waterbirds).

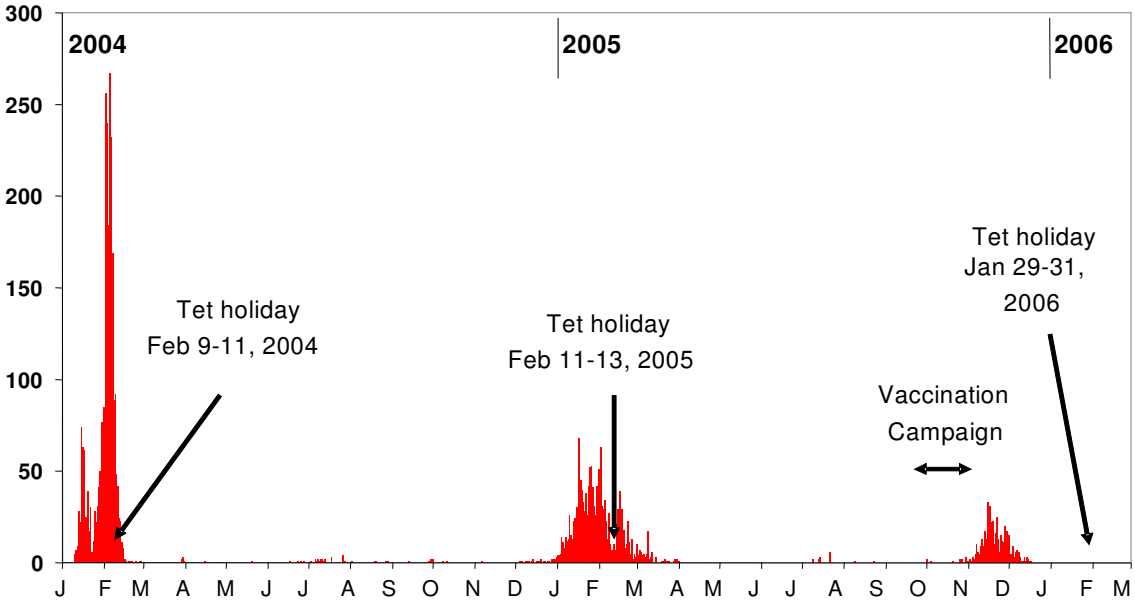
Many smallholder farmers are involved in rice production where domestic waterbirds are grazed on the paddy fields following harvest, which creates an opportunity for interaction with potentially infected domestic and wild waterbirds. In addition, many farmers trade their poultry at live bird markets which apart from mixing involves frequent movements of live animals. Consumers have a preference for fresh meat and therefore prefer birds to be slaughtered after purchase at the market or at home, a custom which creates further potential for HPAI transmission to humans.

The relative significance of the different components of this complex epidemiological system needs to be understood in order to identify critical control points to break the transmission cycle. Here, we investigate the relationship between several risk factors and the occurrence of HPAI outbreaks in poultry in Viet Nam during the period 2004 to early 2006.

Temporal Patterns of HPAI in Poultry in Viet Nam

The temporal pattern of the reported HPAI outbreaks in Viet Nam is shown in Figure 1.

Figure 1: Temporal pattern of the first three epidemic waves (outbreaks per day).



Three distinct epidemic waves can be identified, with the first two being closely associated with the Tet (Vietnamese New Year) holiday period, and the last finishing one month before Tet. A small number of outbreaks occurred between these two distinct peaks. According to official reporting data, the first (2004) epidemic wave in early 2004 involved 2,506 outbreaks and lasted from Jan 10 until Feb 28 (i.e. for at least 49 days – but this is an underestimate by at least 14 days due to the lack of official commune-level records before Jan 10). A total of 38.8 million birds were reported to have been culled during this period. The epidemic had two peaks, one in mid January and the other in early February 2004. The second (2004-5) epidemic wave commenced on Dec 4, 2004 and finished on April 1, 2005, i.e. it lasted for 118 days, involved 1,511 reported outbreaks, and 2.2 million birds we culled. It also had two peaks, one before the Tet festival and another just after. The third (2005) epidemic wave started on Oct 20, 2005 and lasted for 58 days until Dec 17, 2005 with a single peak in mid November. It involved 457 outbreaks, and 0.9 million birds were culled.

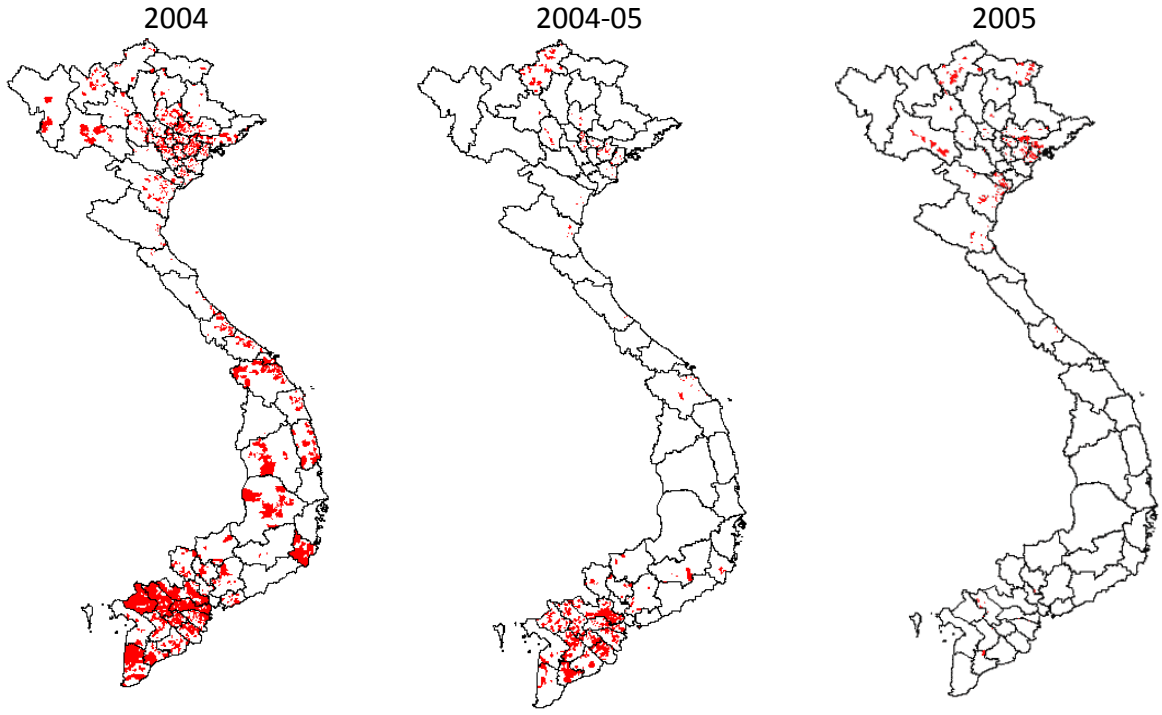
It is unlikely that the occurrence of the first two epidemic waves was associated with increased virus survival in the environment in winter, as the climatic conditions vary significantly between the north and south of Viet Nam. The south is tropical and remains hot all-year round (26-33C), with a wet season from May to October and a dry season from November to April. In contrast, the north has a distinct summer (June to August) and winter

period (November to April) with temperatures as low as 10C in January. It thus appears that increased movement of people and poultry prior to the Tet festival period was a significant factor for the disease spread during the first two epidemic waves in 2004 and 2004-5.

Spatial Patterns of HPAI in Poultry in Viet Nam

The spatial pattern for each of the three epidemic periods is presented in Figure 2.

Figure 2: Spatial patterns of first three HPAI epidemic waves in Viet Nam.



In the 2004 epidemic period, 23% (n=2,312) of communes reported at least one outbreak, in 2004-5 it was 6.3% (n=630) and in 2005 2.9% (n=293). A spatial cluster analysis revealed that there were three clusters of outbreaks in Viet Nam for the epidemic periods 2004 and 2004-5. The primary cluster was located in the Mekong delta south of Ho Chi Minh City. One secondary cluster was identified east of Hanoi and included the city Hai Phong and another secondary cluster was found around the city of Da Nang in the central part of the country.

Both, the 2004 and the 2004-5 epidemic waves occurred in similar geographic locations with the major foci being the Mekong and the Red river deltas. This suggests the presence of important risk factors for spread of infection in these areas, such as the high percentage of surface water which would support higher densities of domestic and wild waterbirds compared with other parts of the country. The number of communes affected in the 2004-5 outbreak period was less than a quarter of those affected in 2004. While the disease risk for a commune was reduced, the focus of infection broadly remained in the same geographical locations, suggesting the key risk factors remained the same. The situation changed in the third epidemic wave in 2005 when a smaller outbreak occurred with a single focus in the north of the country seemingly disconnected from the Tet festival. The change in terms of timing and geographical location of this wave compared with the two previous ones

indicates that the relative importance of the key risk factors changed between the 2004-5 and late 2005 outbreaks, a change probably associated with control measures implemented by Vietnamese authorities.

Control Measures and their Effect

The Vietnamese government implemented a range of measures during 2005. These included a large-scale vaccination campaign as well as some other measures, such as banning poultry keeping in some major cities, campaigns to educate the public about preventive measures, movement controls and closure of live poultry markets. Subsequent to two pilot vaccination campaigns in the provinces Tien Giang and Nam Dinh in August 2005, a systematic large-scale vaccination campaign was conducted from late September to the beginning of November 2005, which focussed mainly on the high risk areas in the Mekong and Red River deltas with around 85 million chickens and 79 million domestic waterbirds being vaccinated.

The duration of all three epidemic waves was between 2 and 4 months, but it should be recognised that the 2005 epidemic wave only involved comparatively limited spatial spread, even in the absence of vaccination. The 2005 epidemic wave commenced towards the end of the vaccination campaign, and occurred only in the north forming a cluster that had already been observed in 2004. These findings suggest that the combined effects of the government's measures had been effective at preventing an outbreak in 2005 in the southern and central parts of Viet Nam. The data analysed here do not allow unequivocally attributing this result to vaccination, since other control measures were applied at the same time. The 2005 epidemic wave in the north which commenced around the time of the completion of the vaccination campaign might have been caused either by poor vaccine efficacy or the movement of vaccinators between flocks resulting in spread of existing infection. It is unclear why a similar effect was not observed in the rest of the country, but it should be noted that there are likely to be differences in the delivery of control measures between the north and the south of Viet Nam.

Consistently across epidemic wave periods, however, risk decreased with increasing distance from higher density human population areas. This effect may be associated with decreased local trade of poultry, or less sensitive disease reporting. Also, Increasing values for proportion of land area used for rice paddy fields, density of domestic waterbirds and chickens were associated with a higher risk of outbreaks. These findings lend support to the hypothesis that the contact structure within poultry and particularly domestic duck populations within the rice paddy production system of the river delta areas is important for the maintenance and spread of HPAI virus. Assuming that the increased movement of people and live poultry prior to the Tet festival was a key risk factor for the first two epidemic waves, the occurrence of smaller outbreaks between the main epidemics supports the hypothesis of the presence of a fairly widespread infection reservoir in Viet Nam certainly up until the end of the third epidemic wave, possibly in domestic and wild waterbirds.

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