

# A systematic approach to illuminate a new hot spot of avian influenza circulation in South Vietnam

Kien Le<sup>1</sup>, Mark Stevenson<sup>2</sup>, Norikazu Isoda<sup>1</sup>, Huy Chu<sup>3</sup>, Tien Nguyen<sup>3</sup>, Long Nguyen<sup>3</sup>, Tien Tien<sup>3</sup>, Trung Le<sup>3</sup>, Keita Matsuno<sup>1</sup>, Masatoshi Okamatsu<sup>1</sup>, and Yoshihiro Sakoda<sup>1</sup>

<sup>1</sup>Hokkaido Daigaku Juigakubu Daigakuin Juigaku Kenkyuka

<sup>2</sup>University of Melbourne

<sup>3</sup>Ministry of Agriculture and Rural Development

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## Abstract

In South Vietnam, live bird markets (LBMs) are key in the value chain of poultry products and spread of avian influenza virus (AIV) although they may not be the sole factor to determine avian influenza (AI) prevalence in the southern part. Therefore, a risk analysis of AIV spread was conducted by including all possible value chain factors. A cross-sectional study was performed in backyard farms, high-biosecurity farms (bio-farms), LBMs, and poultry delivery stations (PDSs) in the four districts of Vinh Long Province in December 2016 and August 2017. A total of 3 597 swab samples were collected from individual poultry at 101 backyard farms, 50 bio-farms, 58 sellers in LBMs, and 17 traders in PDSs and then investigated for AIV isolation. Concurrently, information related to participants and birds was collected and used to identify the fixed and random effects of factors in AIV infection. A total of 274 birds were positive for virus isolation, with a prevalence of 7.6% (95% confidence interval [CI]: 6.8–8.5) at the individual poultry level, and the adjusted prevalence based on the sampling weight was 7.9% (95% CI: 7.6–8.2). The significantly higher prevalence in PDSs (20.7%) and LBMs (14.2%) compared to backyard farms (3.0%) and bio-farms (0.6%) suggested that PDSs are another hot spot for AIV circulation. The high diversity in the seller and trader population characteristics was revealed using multiple-correspondence analysis to analyze the participants' demographic factors in LBM and PDS. The mixed-effect logistic regression model revealed that keeping duck at the sampling time and the owner's older age should be risk factors of AIV infection in PDS. Therefore, functional AI control efforts to monitor the PDS system should be emphasized to minimize AIV circulation risk in Vietnam.

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**Table 1.** Unconditional associations between the outcome (virus isolation positive) and the four explanatory variables

Variables	AIV positive	No. of sample	Prevalence (95% CI)	P-value
<b>Sector</b>				
Backyard	32	1,056	3 (2.1 - 4.3)	Reference
Bio-farm	7	1,200	0.6 (0.2 - 1.2)	<0.001
LBM	94	660	14.2 (11.7 - 17.1)	<0.001
PDS	141	681	20.7 (17.7 - 23.9)	<0.001
<b>Species sampling</b>				
Chicken	100	1,801	5.6 (4.5 - 6.7)	Reference
Duck	157	1,575	10 (8.5 - 11.6)	<0.001
Muscovy duck	16	189	8.5 (4.9 - 13.4)	0.106
Environment	0	18	0 (0 - 18.5)	0.97
Goose	1	14	7.1 (0.2 - 33.9)	0.266
<b>Round</b>				
1 (2016)	107	1,814	5.9 (4.9 - 7.1)	Reference
2 (2017)	167	1,783	9.4 (8.1 - 10.8)	<0.001
<b>District</b>				
Binh Minh	61	910	6.7 (5.2 - 8.5)	Reference
Long Ho	61	909	6.7 (5.2 - 8.5)	0.843
Mang Thit	53	867	6.1 (4.6 - 7.9)	0.612
Tam Binh	99	911	10.9 (8.9 - 13.1)	0.004

**Table 2.** Sampling weight of each category and the adjusted prevalence based on the sampling weight

Category	Population	Selected for sampling	Likelihood of being selected (%)	Sampling weight	AIV positive	No. of sample	The prevalence (95% CI)	The overall prevalence (95% CI)	The adjusted prevalence (95% CI)
Backyard farm	1,288	101	7.8	13	32	1,056	3 (2.1 - 4.3)		
Bio-farm	228	50	21.9	5	7	1,200	0.6 (0.2 - 1.2)	7.6 (6.8 - 8.5)	7.9 (7.6 - 8.2)
LBM	123	12	9.8	10	94	660	14.2 (11.7 - 17.1)		
PDS	98	13	13.3	8	141	681	20.7 (17.7 - 23.9)		

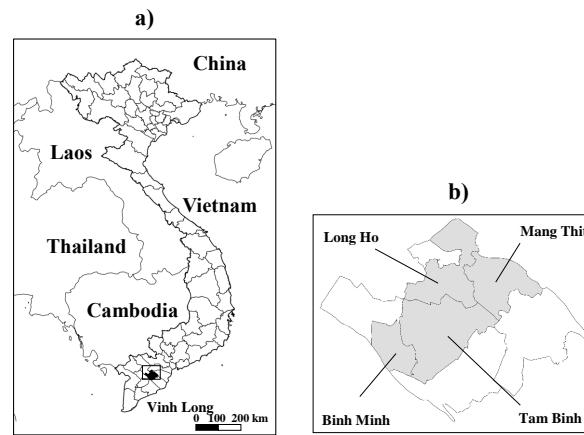
**Table 3.** Unconditional associations between the outcome variable (virus isolation positive) and the 11 explanatory variables in PDS

Variable	AIV positive	Bird	OR (95%CI)	P-value (ANOVA)
<b>District</b>				
Binh.Minh	25	164	Ref	<0.001
Long.Ho	35	189	1.26(0.72 - 2.22)	
Mang.Thit	6	150	0.23(0.09 - 0.58)	
Tam.Binh	75	178	4.05(2.41 - 6.81)	
<b>Species</b>				
Chicken	38	397	Ref	<0.001
Duck	103	196	10.46(6.76 - 16.19)	
Environment	0	18	NA	
Goose	0	3	NA	
Muscovy duck	0	67	NA	
<b>Mix species</b>				
No	2	40	Ref	0.004
Yes	139	641	5.26(1.25 - 22.08)	
<b>Gender</b>				
Female	139	551	Ref	<0.001
Male	2	130	0.05(0.01 - 0.19)	
<b>Year old</b>				
31-40	0	90		<0.001
41-50	2	128	Ref	
51-60	138	348	41.4(10.07 - 170.13)	
>60	1	115	0.55(0.05 - 6.18)	
<b>Career experience (year)</b>				
1-5	0	149	NA	<0.001
6-10	25	94	Ref	
>10	116	438	0.99(0.6 - 1.65)	
<b>Selling poultry meat</b>				
No	85	492	Ref	<0.001
Yes	56	189	2.02(1.36 - 2.98)	
<b>Working area</b>				
Within commune	0	30	NA	<0.001
Within district	6	120	Ref	
Within province	25	198	2.75(1.09 - 6.9)	
Interprovincial	110	333	9.37(4 - 21.97)	
<b>Working range (km)</b>				
<10	6	100	Ref	<0.001
10-50	0	104	NA	
51-100	27	213	2.27(0.91 - 5.7)	
101-200	0	75	NA	
201-500	108	189	20.89(8.72 - 50.07)	
<b>Frequency of poultry gathering</b>				
once per day	33	492	Ref	<0.001
twice per day	41	92	11.18(6.5 - 19.23)	
thrice per day	67	97	31.06(17.8 - 54.22)	
<b>Flock size (head)</b>				
<50	6	179	Ref	<0.001
50-100	2	40	1.52(0.29 - 7.81)	
101-500	2	124	0.47(0.09 - 2.38)	
501-1000	107	259	20.3(8.67 - 47.52)	
>1000	24	79	12.58(4.89 - 32.36)	

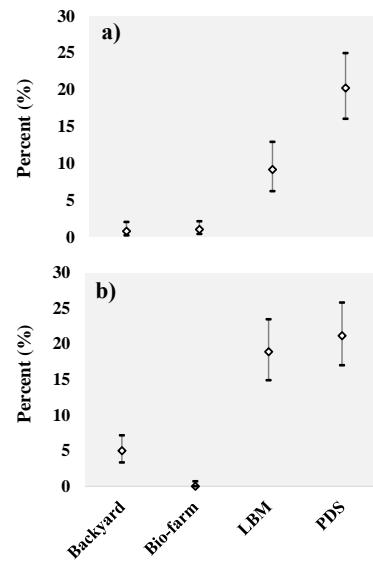
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**Fig. 1.**  
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**Fig. 2.**  
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**Fig. 3.**  
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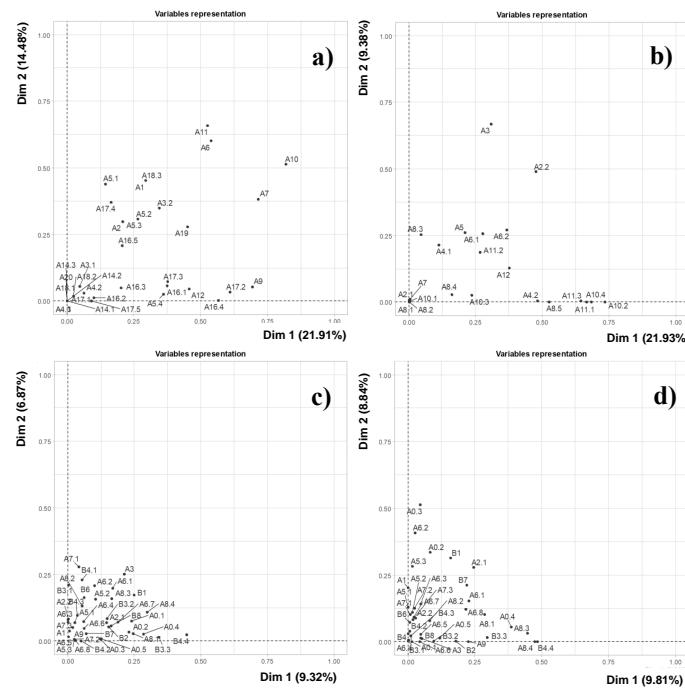
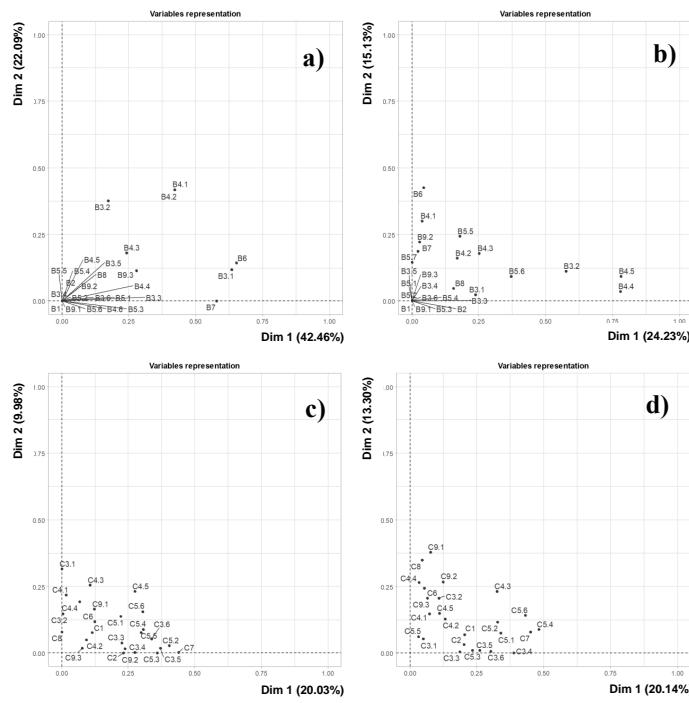
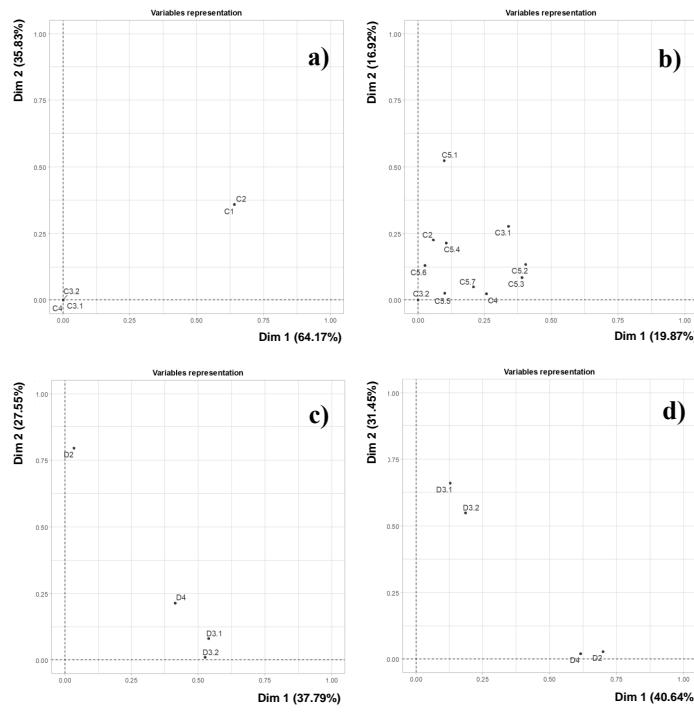


Fig. 4.  
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**Fig. 5.**  
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**Fig. 6.**  
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