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A National Study of US Bird Banders for Evidence of Avian Influenza Virus Infections

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Abstract

Background—Previously we have found that Midwestern US wildlife biologists, poultry farmers, veterinarians, and duck hunters have had evidence of avian influenza virus infections (AIVs).

Objectives—We sought to evaluate a national sample of US bird banders for previous evidence of AIV infection.

Study Design—Controlled, cross-sectional serological survey

Results—In 2009 and 2010 we enrolled 157 registered bird banders from 40 US states and compared their enrollment data and serological results with 78 adult age-group matched controls from Iowa. On average, the bird banders had 15 years of wild bird exposure, banded 20 days per year, worked chiefly in 1 of the 4 North American flyways, and banded 300 individual birds of 5 different species per season. While handling birds, only 15% of banders reported wearing gloves. Three bird banders and 1 control had evidence of previous infection (1 AIV each) with A/BWTE/Ohio/07/495762-6(H7N3), A/Ty/MN/38391-6/95(H9N2) or A/CK/NJ/7290-2/95(H11N3) by microneutralization assay. There was no evidence of previous infection with a representative sample H4, H5, H6, H8, or H10 AIVs. Participants were followed for influenza-like-illness for a median of 7 months and 4 (3 bird banders) submitted self-collected eye, nasal, and throat influenza-like-illness swab specimens, 1 of which collected in November of 2009, yielded a pandemic H1N1 influenza A virus.

Conclusion—Despite reports of conjunctivitis and upper respiratory symptoms while bird banding, we found sparse evidence that US bird banders had infections with AIVs.

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Key words//medical subject headings (MeSH)

influenza; influenza A virus, avian; zoonoses; occupational exposure; communicable diseases, emerging; agriculture; cohort studies; seroepidemiologic studies

BACKGROUND

In 2006, we found that 2 of 58 Iowan wildlife workers who self-reported contact with ducks had serologic evidence of previous infections with H11 avian influenza virus.¹ During interviews with such workers, we learned that few banders wear personal protective equipment (such as gloves, boots, gowns or safety glasses) and some routinely experience conjunctivitis after bird banding activities.

OBJECTIVES

In this study we sought to evaluate a national sample of US bird banders for evidence of previous infection with avian influenza viruses (AIVs).

STUDY DESIGN**Study Population**

Individuals were eligible to participate if they were >18 yrs and had participated in bird banding within the past 12 months. We used web-based and face-to-face enrollment strategies to recruit participants nationwide. Recruitments were made via 25 bird banding organizations, 10 bird banding periodicals, and displays at bird banding meetings. Participants signed an informed consent document and completed a questionnaire. After enrollment, participants were shipped two postal-ready, refrigerated specimen collection kits with instructions. The first kit was used to collect whole blood specimens for serological study. A second kit was used to collect an influenza-like illness (ILI) questionnaire, nasal, throat, and conjunctival swab specimens, and acute and 30-day convalescent sera during the follow-up period. Study specimens were collected by the participants' health care providers and shipped on blue ice to the University of Iowa. Study participants were compensated at enrollment and the participant's healthcare provider was reimbursed for their assistance in collecting study specimens.

Age-group matched, non-bird exposed controls were recruited from among the students and employees of the University of Iowa and followed in the same year as bird banders. These controls had never engaged in bird banding, bird hunting, or poultry farming and self-reported no immunocompromising conditions.

Laboratory Methods

Sera and study swabs in viral transport media were preserved at 80°C. Per our previous reports²⁻⁹ we used a hemagglutination inhibition assay using Guinea pig red blood cells to study human sera for antibodies against human viruses (Table 1) and a microneutralization assay performed with Madin-Darby Canine Kidney (MDCK) cells to study human sera for antibodies against avian viruses (Table 2). RNA was extracted from swab specimen using a QIAamp viral RNA extraction kit (Qiagen Inc., Valencia, CA) and screened via a proprietary real-time RT-PCR protocol developed and kindly provided by the CDC.¹⁰ The protocol was designed to first screen for influenza A, and then through separate reactions, to rapidly determine influenza HA subtype, including H5N1 and 2009 pandemic H1N1.

RESULTS

Bird banding organizations were very supportive in our requests to promote the study. The need to engage healthcare providers proved a challenge for a number of participants and likely inhibited participation by other eligible bird banders. Some healthcare providers refused due to our modest compensation for their support, others refused for liability reasons.

Of 235 participants, 157 (67%) were bird banders and 78 (33%) were non-bird exposed controls. Demographically, the exposed group was slightly older than the controls and much more likely to be male (Table 1). The controls were more likely to have been vaccinated against human influenza in the previous five years (76% vs. 53%) (Table 1). Bird banders reported 15 years of exposure to wild birds, with the most common exposures being to wild ducks (57%), wild geese (52%), and wild raptors (48%). Thirty-six percent of bird banders reported exposure to domestic chickens, ducks, or geese, and 24% reported exposure to pigs. Bird banders had contact with birds during all four seasons, but most worked only during one season and for a mean of 20 days per year. A higher percentage of banders (82%) were active in the summer than the fall (65%), spring (51%), or winter (32%). The banders reported homes in 40 states and captured birds in all four North American flyways with 48% banding in the Mississippi Flyway, 23% in the Central flyway, 20% in the Atlantic flyway, and only 17% in the Pacific flyway. Only 8% of the banders reported banding in more than one flyway. They reported banding an average of 5 species of birds (range 1–120), and an average of 300 (range 10–10,000) individual birds per season. While handling birds, only 15% of banders reported wearing gloves often or always, but 36% used eye protection and 78% washed their hands often or always while working with animals. More than half (53%) of the bird banders were government employees.

Sera was collected from 127 (81%) of the bird banders, and 69 (88%) of the controls. Bird banders who did not submit blood specimens did not differ from the other bird banders by age, gender, or region of enrollment. After adjusting for recent vaccination, there was no significant difference in the proportion of controls and exposed with elevated titers ($\geq 1:40$) against the 4 human viruses. Other demographic and health information was similar between the two groups (Table 1).

There were no participants with serological evidence of previous exposure to the H4N8, H5N2, H6N2, H8N4, or H10N4 AIVs (Table 2). Three bird banders and one control had an elevated titer against H7N3, H9N2, or H11N3 AIVs (Table 2). The three bird banders with elevated titers reported banding wild raptors in the Atlantic flyway. Three bird banders and 1 control reported an ILI during the follow-up period, and submitted swabs. One of the bird banders' swabs yielded an influenza strain that was very similar by molecular methods to the pandemic 2009 strain A/Mexico/4108/2009(H1N1).

DISCUSSION

Our findings validate those from our previous report.¹ Although the risk seems low, persons engaged in activities which put them in contact with wild birds may be at risk of acquiring AIV infection. Other groups occupationally exposed to avian influenza in birds have shown similar evidence for AIV infections. After a highly pathogenic avian influenza (HPAI) H5N1 outbreak occurred in 1997 in Hong Kong, 10% of 1525 poultry workers were shown to have elevated antibodies to the epizootic virus.¹¹ A retrospective study of Italian poultry workers found that 3.8% had elevated antibodies against avian H7 viruses that caused epidemics between 1999 and 2003.¹² After a 2003 HPAI H7N7 outbreak in the Netherlands, 50% of the 500 studied farmers or poultry cullers had serological evidence of infection.¹³

Recently, 2.6% or 700 rural Cambodians exposed to HPAI H5N1 outbreaks had elevated antibodies to that virus.¹⁴ We have found similar evidence of AIV infection among US farmers⁸ and turkey workers,¹⁵ but failed to find such evidence among Peruvian or US chicken workers.^{16, 17} Other teams have failed to find evidence of avian influenza virus infection after avian influenza outbreaks in Nigeria¹⁸ and Hong Kong.¹⁹

The US Ornithological Council (Washington, DC) recognizes this risk and has published informational guidelines for ornithologists and bird banders encouraging their use of rubber boots, eye protection, gloves, and hygiene methods.²⁰ Our study's finding that only 15% of banders reported using gloves and only 36% reporting using goggles is troubling and calls for further educational efforts by such leading wildlife organizations.

This study has a number of limitations. Seroreactivity in Table 2 could reflect cross-reacting antibody from participants' previous exposure to related human influenza virus or vaccines and represent false positives. Similarly, where no reactivity was detected for a specific AIV H-type, this could be falsely negative if the virus used in the serologic assays did not closely match circulating AIVs that had infected participants. Although the control group was matched by age-group to the exposed group, the groups differed by gender, occupation, and place of enrollment. Although our previous studies would not support this,^{7, 8, 17, 21} these demographic differences could have biased results. Finally, although we have participants from 40 states, our bird banding participants are a rather small sample and may not well represent the entire body of US bird banders.

In summary, these study data and previous reports of AIV infections among those occupationally exposed to wild birds suggest that bird banders may be at risk of infection from AIVs and should use personal protective equipment and good hygiene when handling such birds.

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Abbreviations

AIV	Avian influenza virus
RNA	RT-PCR
HPAI	highly pathogenic avian influenza
HI	hemagglutination inhibition

ORs odds ratios
ILI Influenza-like-illness

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Table 1

Characteristics of participants in the Bird Bander Study at enrollment, United States, 2009–2010. Odds ratios (ORs) reflect given a characteristic, the odds of being a bird bander vs. odds of being a control.

Variable	N	Control (n=78) N (%)	Exposed (n=157) N (%)	OR (95% CI)
Age group[*](yrs)				
21 – 30	36	18 (23.1)	18 (11.5)	0.7 (0.3–1.6)
31 – 40	43	9 (11.5)	34 (21.7)	2.6 (1.1–6.5)
41 – 50	56	23 (29.5)	33 (21.0)	Reference
51 – 60	64	19 (24.4)	45 (28.7)	1.7 (0.8–3.5)
> 60	36	9 (11.5)	27 (17.2)	2.1 (0.8–5.3)
Gender[*]				
Male	142	22 (28.2)	120 (76.4)	8.3 (4.5–15.3)
Female	93	56 (71.8)	37 (23.6)	
Chronic breathing problems[†]				
No	211	65 (83.3)	146 (93.0)	2.2 (0.9–5.7)
Yes	20	10 (12.8)	10 (6.4)	
Heart disease, hypertension, or stroke[†]				
Yes	34	11 (14.1)	23 (14.6)	1.0 (0.5–2.3)
No	199	66 (84.6)	133 (84.7)	
Other chronic medical problems[†]				
No	215	71 (91.0)	144 (91.7)	1.8 (0.5–10.4)
Yes	14	3 (3.8)	11 (7.0)	
Medications in the last 30 days[†]				
No	83	27 (34.6)	56 (35.7)	1.1 (0.6–1.9)
Yes	145	49 (62.8)	96 (61.1)	
Ever used tobacco products[†]				
No	178	56 (71.8)	122 (77.7)	1.5 (0.8–2.9)
Yes	51	21 (26.9)	30 (19.1)	
Vaccination for human influenza in last 5 years^{*†}				
No	85	18 (23.1)	67 (42.7)	4.6 (2.1–10.0)
Yes	142	59 (75.6)	83 (52.9)	
Developed a respiratory illness in last 12 months[†]				
No	147	46 (59.0)	101 (64.3)	1.3 (0.7–2.3)
Yes	81	30 (38.5)	51 (32.5)	
A/Brisbane/59/2007(H1N1), HI titer $\geq$ 1:40[†]				
Negative	169	55 (70.5)	114 (72.6)	2.1 (0.9–4.8)
Positive	26	13 (16.7)	13 (8.3)	
A/Brisbane/10/2007(H3N2), HI titer $\geq$ 1:40[†]				
Negative	132	41 (52.6)	91 (58.0)	1.7 (0.9–3.1)
Positive	63	27 (34.6)	36 (22.9)	

Variable	N	Control (n=78) N (%)	Exposed (n=157) N (%)	OR (95% CI)
A/Panama/2007/99(H3N2), HI titer ≥ 1:40 ^{†,‡}				
Negative	45	8 (10.3)	37 (23.6)	3.1 (1.3–7.1)
Positive	150	60 (76.9)	90 (57.3)	
A/Mexico/4108/2009(H1N1), HI titer ≥ 1:40 ^{†,‡}				
Negative	162	52 (66.7)	110 (70.1)	2.6 (1.1–5.8)
Positive	29	16 (20.5)	13 (8.3)	

HI = hemagglutination inhibition assay.

* Statistically significant with 95% confidence by Pearson's chi-square test.

[†] These covariates have missing values.

[‡] These unadjusted associations were statistically significant with 95% confidence by Pearson's chi-square test.

However, after adjusting for recent vaccination they were no longer statistically significant.

Table 2

Distribution of antibody titers against avian influenza viruses, by microneutralization assays

Virus & titer	Controls N (%)	Exposed N (%)
A/GF/NJ/14190-23/96(H4N8)		
<1:10	78 (100)	157 (100)
A/Nopi/Mn/07/462960-2(H5N2)		
<1:10	78 (100)	157 (100)
A/CK/CA/32213-1/00(H6N2)		
<1:10	78 (100)	157 (100)
A/BWTE/Ohio/07/495762-6(H7N3)		
<1:10	78 (100)	156 (99.4)
1:40	0 (0)	1 (0.6)
A/Ty/CO/173105/02(H8N4)		
<1:10	78 (100)	157 (100)
A/Ty/MN/38391-6/95(H9N2)		
<1:10	78 (100)	156 (99.4)
1:20	0 (0)	1 (0.6)
A/Rhea/MA/44017-12/94(H10N4)		
<1:10	78 (100)	157 (100)
A/CK/NJ/7290-2/95(H11N3)		
<1:10	77 (98.7)	156 (99.4)
1:10	1 (1.3)	0 (0)
1:20	0 (0)	1 (0.6)