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A national study of individuals who handle migratory birds for evidence of avian and swine-origin influenza virus infections

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Abstract

Background—Persons with occupational or recreational exposure to migratory birds may be at risk for infection with highly pathogenic avian influenza and other avian influenza viruses since wild birds are the natural reservoir of influenza A. Additionally, bird handlers may host avian and swine-origin influenza (pH1N1) virus co-infections, which generate reassortant viruses with high pathogenicity in mammals.

Objectives—We assessed the prevalence of avian and swine influenza viruses in US-based bird handlers and estimated their exposure to different orders of wild birds including waterfowl (Anseriformes), songbirds (Passeriformes), and shorebirds (Charadriiformes).

Study Design—Cross-sectional serologic survey accompanied by a questionnaire to estimate behavioral risk factors. This is first survey of US-based bird handlers who also work at international sites.

Results—401 participants were recruited and tested over the course of three years. One participant with occupational exposure to migratory birds had evidence of past infections with a H5N2 virus antigenically related to A/Nopi/MN/07/462960-02, which is the first case of this influenza subtype in a human host associated with exposure to wild rather than domestic birds. We detected no avian and swine-origin influenza virus co-infections. The exposure of bird handlers to songbirds was four times greater than to shorebirds or waterfowl.

Conclusions—Though rare, the transmission of avian influenza viruses from migratory birds to US-based bird handlers has potentially significant public health and economic consequences.

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Competing interests

None declared.

Ethical approval

Approval for this study was obtained from Medical IRB-2 at the University of California, Los Angeles.

1. Background

The Asian lineage of highly pathogenic avian influenza viruses of subtype H5N1 (hereafter HPAIV) was first detected in southern China in 1996 and subsequently has caused much concern among the medical and public health community. Prior to 2002, HPAIV was almost exclusively found in poultry, but since then the virus have been isolated from a number of different species of wild and migratory birds[1, 2]. Because HPAIV currently has low transmissibility but high case fatality, an outbreak in humans is an event with low probability but high potential for negative impact on human health. Since ornithologists and others who work occupationally or recreationally with migratory birds have substantial exposure to zoonotic reservoirs of HPAIV and other subtypes of avian influenza virus (AIV), this population is at risk for wildlife-to-human AIV transmission[3].

2. Objectives

Our goal was to examine the potential for AIV transmission from avian migrants to humans by conducting a serosurvey of individuals with significant and measurable contact with wild bird populations. By pairing serological analysis of blood samples for evidence of past infection with demographic and bird handling data collection from a questionnaire, we were able to identify subclinical cases of AIV infection that may have occurred and behavioral risk factors for the transmission of AIV from wild birds to the study participants. The study is unique in that we also screened participants for pandemic 2009 H1N1 (hereafter pH1N1) because co-infection with AIV and pH1N1 could lead to in vivo recombination, generating a reassortant strain with high pathogenicity in mammals[4].

Study Design

Participants were recruited for participation via convenience sampling at three annual meetings (2008–2010) of the American Ornithologist's Union. Anyone who fulfilled the inclusion criteria (at least 18 years of age, able to give informed consent in English, and affiliated with the wild bird handling community) was offered enrollment in the study. Following informed consent, all participants completed a comprehensive questionnaire about their basic demographic information and vaccination status. Participants were asked specific details about their bird handling habits as well as the locations and the duration of their handling.

A 10 ml venous blood sample was then collected from all willing participants. Antibody responses to AIV strains were detected by use of a microneutralization (MN) assay[5–8] (Table 1). We screened H5N2, H7N2, and H9N2 in 2008, H5N2 and H7N3 in 2009, and H5N2, H7N2, and pH1N1 in 2010 to test for avian and swine influenza co-infection. In each year, we selected antisera from different H5N2 and H7 viruses to match the H5N2 and H7 viruses detected in US poultry in the previous 12 months. For example, we used A/Chukar/Minnesota/14591-6/95 (H5N2) in 2008 because antibody positivity to this strain was detected in US poultry workers in the spring of 2008[9] thus we hypothesized that the strain might also circulate in persons exposed to wild birds due to spillover from poultry to wild birds. Sera were considered positive at a MN titer of ≥1: 40 since such titers are correlated with a reduction of 50% of the risk of contracting an influenza infection[9–12].

3. Results

In total, 401 participants were enrolled in the study. The majority of study participants (69.08%, *n*=277) had handled migratory birds for at least five years and most exposure to wild migratory birds occurred in the summer (Fig. 1). The most common handling activities were banding and measuring (91.52%, *n*=367) followed by bleeding (60.60%, *n*=243)

(Table 2). Exposure to avian migrants occurred primarily in the eastern or inland US, but 135 participants (33.67%) reported handling birds internationally, most often in the Americas and Caribbean (Table 3). Songbirds and perching birds were handled by 86% (*n*=344) of the participants whereas 22% (*n*=87) and 19% (*n*=77) were exposed to shorebirds and waterfowl, respectively. Additionally, 15 (3.7%) participants had occupational contact with poultry, while 11 (2.7%) had recreational contact with poultry (such as keeping backyard chickens). Even when using a very sensitive cut-off of 40 for the MN results[13], only one individual tested positive (0.25%) for any of the selected AIVs, which was an H5N2 virus antigenically related to A/Nopi/Minnesota/07/462960/02 (Table 1). There was no evidence of AIV and pH1N1 co-infection in this cohort.

4. Discussion

Although 1.4% of poultry workers in the eastern hemisphere are antibody positive for avian H5N1[14] and seropositivity to H5N2 has previously been detected in poultry workers in the US and Japan[5, 9, 15–17], this is the first evidence of H5N2 infection in a person exposed only to wild birds. The seropositive participant indicated no occupational or recreational contact with poultry and had worked exclusively with wild migratory birds in the eastern US, which is a region where H5N2 circulates in migratory waterfowl[18]. Furthermore, our questionnaire results indicate that the exposure of bird handlers to wild birds is greatest in the eastern US (Fig. 2), so the potential exists for wild bird-to-human transmission of H5N2 in this part of the country.

Among the shortcomings of the study is that we did not collect sera from any control subjects, which makes it difficult to determine whether the MN titer of 1:40 to the H5N2 virus actually reflects infection by an avian virus as opposed to cross-reactive antibody responses arising from seasonal influenza infection or vaccination. Our participant with evidence of H5N2 infection did report receiving the seasonal vaccine within the previous 12 months. The relationship between vaccination against seasonal influenza and H5N2 seropositivity requires further study insofar as the two are correlated in some cohorts with poultry exposure[15] but not others[5, 12]. Thus, additional serological surveys are needed to determine if putative H5N2 positivity represents reactivity to the neuraminidase antigen in the seasonal influenza vaccine. Furthermore, H5N2 antibody positivity increases with age in poultry workers[16], with highest prevalence among people older than 40, possibly due to cross-reactivity with seasonal influenza antibodies[19]. At 27 years of age, our seropositive subject was younger than 79% of the study participants, so H5N2 seropositivity in this individual is not likely due to age-related cross-reactivity.

From the data collected, that transmission of AIV to humans who handle wild birds appears to be a rare event, but one that has potentially significant public health and economic consequences. For example, an outbreak of highly pathogenic H5N2 in a live-bird market in Texas in 2004 led to export restrictions that cost the US poultry industry hundreds of millions of dollars[20]. Such poultry outbreaks along with the transmission of H5N1 from wild birds and poultry to humans in the eastern hemisphere underscore the importance of preventing the spread of avian H5 viruses. The US Ornithological Council recognizes this risk does exist and has published practice guidelines for ornithologists and bird banders[21] but compliance with these guidelines remains low[6]. For instance, at 30%, the seasonal influenza vaccination rate in our study participants was substantially lower than the US average of 43%[22]. In light of this, further efforts are needed to educate the ornithology community about the importance of influenza vaccination to protect the public from AIV or an avian and swine influenza reassortment event if it were to occur in a wild bird handler.

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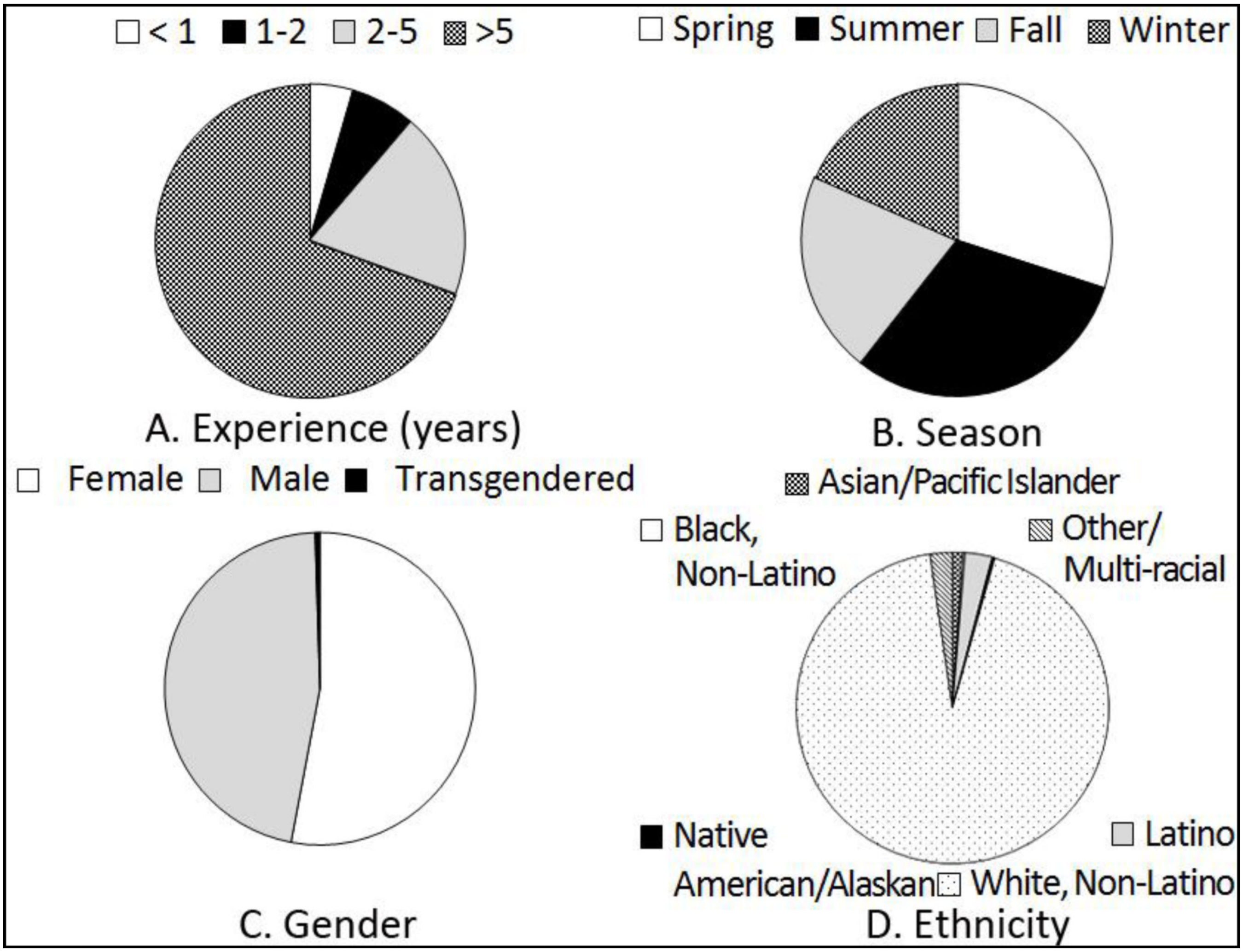

Fig. 1.
Participants' demographic and bird handling characteristics.

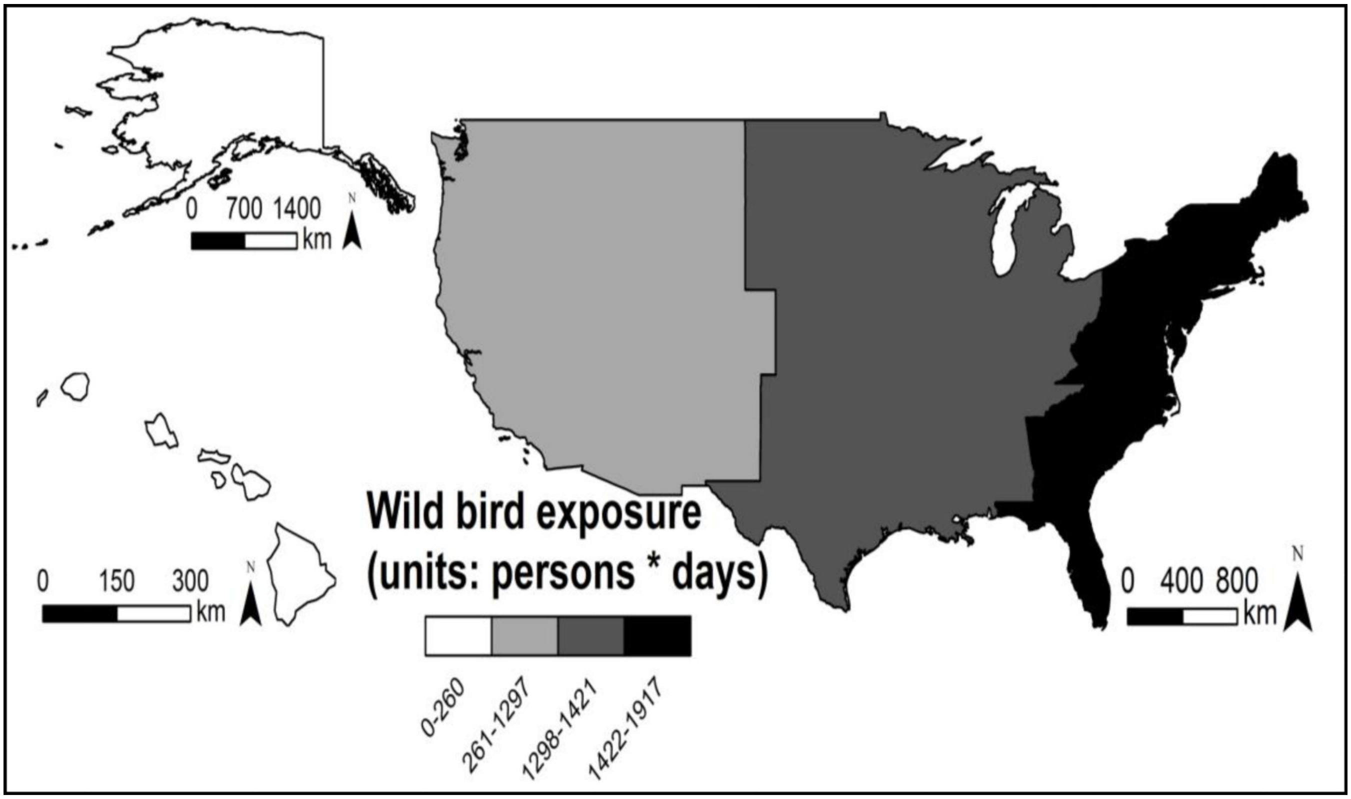

Fig. 2.

The exposure of bird handlers to avian migrants is greatest in the eastern US. Colors indicate person days of wild bird exposure per US region (2008–2010).

Table 1

Antibody titers against avian and swine influenza viruses determined by microneutralization assays.

Year	Virus and Titer	no. (%)
2008	A/Chukar/Minnesota/14191–7/98 (H5N2) <1:10 A/Turkey/Virginia/4569/02 (H7N2) <1:10 A/Turkey/Germany/49 (H9N2) <1:10	183 (100) 183 (100) 183 (100)
2009	A/Nopi/Minnesota/07/462960/02 (H5N2) <1:10 1:40 A/Blue-winged teal/Ohio/07 (H7N3) <1:10 1:10	122 (99.2) 1 (0.8) 122 (99.2) 1 (0.8)
2010	A/Mexico/4108/09 (H1N1) <1:10 1:10 1:20 1:40 1:80 1:160 1:320 1:640 A/Virginia/4529/02 (H7N2) <1:10 A/Turkey/Minnesota/38391-6/95 (H5N2) <1:10	47 (48.96) 11 (11.46) 11 (11.46) 5 (5.26) 10 (10.42) 8 (8.33) 3 (3.125) 1 (1.04) 96 (100%) 96 (100%)

Table 2

Songbirds and perching birds were the species most commonly handled by the study participants, whose most frequent exposure to avian migrants consisted of banding and measuring birds.

Handling Characteristics	no. (%)
Species Handled	
Passerines (songbirds and perching birds)	344 (85.79%)
Waterfowl	77 (19.20%)
Shorebirds	87 (21.70%)
Raptors	97 (24.19%)
Charadriiformes (auks, gulls, and waders)	21 (5.37%)
Piciformes (woodpeckers)	14 (3.58%)
Psittaciformes (parrots)	9 (2.30%)
Apodiformes (hummingbirds and swifts)	13 (3.32%)
Other	50 (12.79%)
Handling Activities	
Banding and measuring	367 (91.52%)
Cloacal swabbing	98 (24.44%)
Bleeding	243 (60.60%)
Specimen collection/preparation	86 (21.45%)
General care	17 (4.24%)
Surgery	8 (2%)
Other	14 (3.49%)

Table 3

Participants with contact with avian migrants outside the US most frequently worked with wild birds in the Americas and Caribbean.

Region	No. (%)
Africa	8 (2.0%)
Americas and the Caribbean	111 (27.68%)
Europe and the Mediterranean	12 (2.99%)
Western Pacific	17 (4.24%)