Hunting Dogs as Sentinels for Avian Influenza:

Examining Zoonotic Disease Transmission Risk and Human-Canine Interactions

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Abstract

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As identification of H5N1 highly pathogenic avian influenza virus (HPAIV) outbreaks in mammals increase, there is a growing concern that the virus will spill over into the human population. H5N1 HPAIV has been a panzootic and public health concern since 1996. Although few cases of H5N1 HPAIV have been reported in dogs, hunting dogs that retrieve waterfowl are a high-risk group due to their physical contact with the environment, wildlife, and human handlers as well as previously documented infections with other influenza strains. This study is a combination of a primary cross-sectional study and secondary national study. In the primary study completed in 2023, blood serum was collected from Washington State hunting dogs and analyzed for H5 and N1 subtypes of HPAIV. Surveys completed by dog owners detailed the dogs' retrieving activities and health background. A secondary national survey of hunters from

January to mid-March 2024 characterized the types of interactions and relationship humans maintained with their hunting dogs along with contact between hunting dogs and other dogs. Descriptive analyses of the primary study (n=192) revealed 57.3% of participants did not have their hunting dogs vaccinated for CIVs and 18.8% did not know if their dog had a history of CIV infection. Descriptive statistical analysis of the secondary national survey (n=112) indicated that a majority of participants considered their hunting dog as part of the family (93.8%), but not as a pet (57.1%). Of dogs that lived inside the home and slept in the same room as their owners, 67.5% also slept in the bed. When considering the use of personal protective equipment (PPE), 96.4% of respondents did not utilize PPE when handling a sick dog and 81.3% did not use PPE when handling harvested birds. An exploratory analysis of the primary study utilized logistic regression models to determine the risk factors associated with H5N1 HPAIV infection in hunting dogs. From the exploratory analysis, the odds of a hunting dog infected with H5N1 HPAIV was 20.28 times greater for dogs that retrieved sick birds in the past 12 months compared to dogs that did not retrieve any sick birds (95% CI: 3.15, 217.30). Findings from this research demonstrate the complex, sustained physical and personal connections between individuals and their hunting dogs. Additional research utilizing a One Health approach is necessary to ascertain the risk factors associated with H5N1 HPAIV infection in hunting dogs and to enhance our understanding of the environment's role in the transmission of H5N1 HPAIV. Results from this study provide a unique understanding of the interactions between humans and their hunting dogs, and the potential to leverage the well-being of hunting dogs to protect public health as well by identifying opportunities to introduce preventative measures to reduce the risk of zoonotic disease transmission events.

Background

In a world where the next pandemic threat is constantly on the horizon, public health surveillance frequently concentrates on animals, especially wildlife, as reservoirs and sources of exposure in human and domestic animal disease events, including rabies, plague, zoonotic influenza, and severe acute respiratory syndrome (SARS). With more than 60% of infectious diseases known to affect humans spreading from animals and approximately 75% of emerging infectious diseases in people classified as zoonotic diseases,[1] hunting dogs, who reside at the interface between wildlife and humans, represent potential sentinels for zoonotic diseases. Hunting dogs may also act as sources of pathogen exposure to humans due to their position as a bridge between wildlife and humans. In 1996, the A/goose/Guangdong/1/1996 (Gs/Gd) lineage of highly pathogenic avian influenza virus (HPAIV; H5N1) was first identified[2] and has subsequently led to a panzootic that continues to affect domestic animals, wildlife, and human health. The Gs/Gd H5 lineage subclade 2.3.4.4b HPAIVs emerged in 2020, spreading across the globe and resulting in significant outbreaks and mortality in poultry, as well as other wild and domestic birds and mammals.[3] The current H5N1 HPAIV outbreak has been unprecedented in duration, global geographic distribution, mortality in poultry, economic impact, and diversity of species affected.[4–7] With increasing identification of H5N1 HPAIV in mammals, including sea lions (*Otariinae*), foxes (*Vulpes)*, seals (*Pinnipedia)*, skunks (*Mephitidae*), and mink (*Neovison vison*), there have been escalating concerns that the virus may be evolving towards mammals.[8]

For many years, the Gs/Gd H5 HPAIV has been a significant global disease and detected in a variety of mammals; however, morbidity or mortality in dogs has been rare. A report in 2004 observed a domestic dog in Thailand who died from H5N1 HPAIV, which was linked to the dog consuming a duck carcass during a time of outbreak.[9] In April 2023, another domestic dog in Canada contracted and later died from H5N1 HPAIV due to chewing on a wild goose.[10] Although there have been a limited number of documented cases of dogs infected with H5N1 HPAIV, experimental studies that exposed beagles to avian influenza (H5N1) indicate that dogs are susceptible to H5N1 HPAIV and may serve as potential bridges between infected birds and humans that enable viral transmission to occur.[11–13] H5N1 HPAIV has also been documented in a variety of wild canid species such as red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), gray foxes (*Urocyon cinereoargenteus),* South American bush dogs (*Speothos venaticus*), and raccoon dogs (*Nyctereutes procyonoides*).[7,14–16] Previous experimental and field research has demonstrated that red foxes appear considerably susceptible to H5N1 HPAIV.[15–17]

The United States includes four flyways utilized by migratory birds (Pacific, Central, Mississippi, and Atlantic Flyways).[18] These flyways encompass a wide range of environments with varying resources and climates. Since the initial detection of H5N1 HPAIV in January 2022, there have been 9,254 confirmed detections of H5N1 HPAIV in wild birds (Fig. 1), 82,048,886 poultry affected, and 214 confirmed cases in wild mammals in the United States (US) (referenced April 4, 2024).[14,19] H5N1 HPAIV has been identified in a variety of mammal species including domestic animals and humans. In March 2024, H5N1 HPAIV was detected in domestic livestock including goats and cows.[20] On March 25, 2024, H5N1 HPAIV infections in dairy cattle and domestic cats were confirmed, suggesting potential mammal-to-mammal transmission between cows and cross-species transmission from dairy cattle to cats through the consumption of unpasteurized milk or colostrum.[21] There have been 2 reported cases of humans infected with H5N1 HPAIV in the US. The first US human case occurred in April 2022 in Colorado, where a person had direct contact with poultry and reported experiencing fatigue for a few days. The second human case in Texas was confirmed on April 1, 2024 where the person had direct exposure to dairy cattle and experienced eye redness.[19,20] This was considered the first mammal to human transmission of H5N1 HPAIV (dairy cow to human) in the world.[20]

Mirroring the national trends, Washington State has had a large number of H5N1 HPAIV cases in wild birds along with four different wild mammal species impacted. Washington State consists of diverse landscapes, which support thirty-five species of waterfowl and more than twelve types of gamebirds that people and their dogs may hunt.[22] The first case of H5N1 HPAIV detected in the state occurred in May 2022. Since the first detection of H5N1 HPAIV in Washington State, there have been 327 confirmed cases of the disease in wild birds[23] (See Appendix-Table A), 46 confirmed cases in domestic birds consisting of 1 commercial flock and 45 backyard flocks,[24] and 16 confirmed detections in wild mammals.[14]

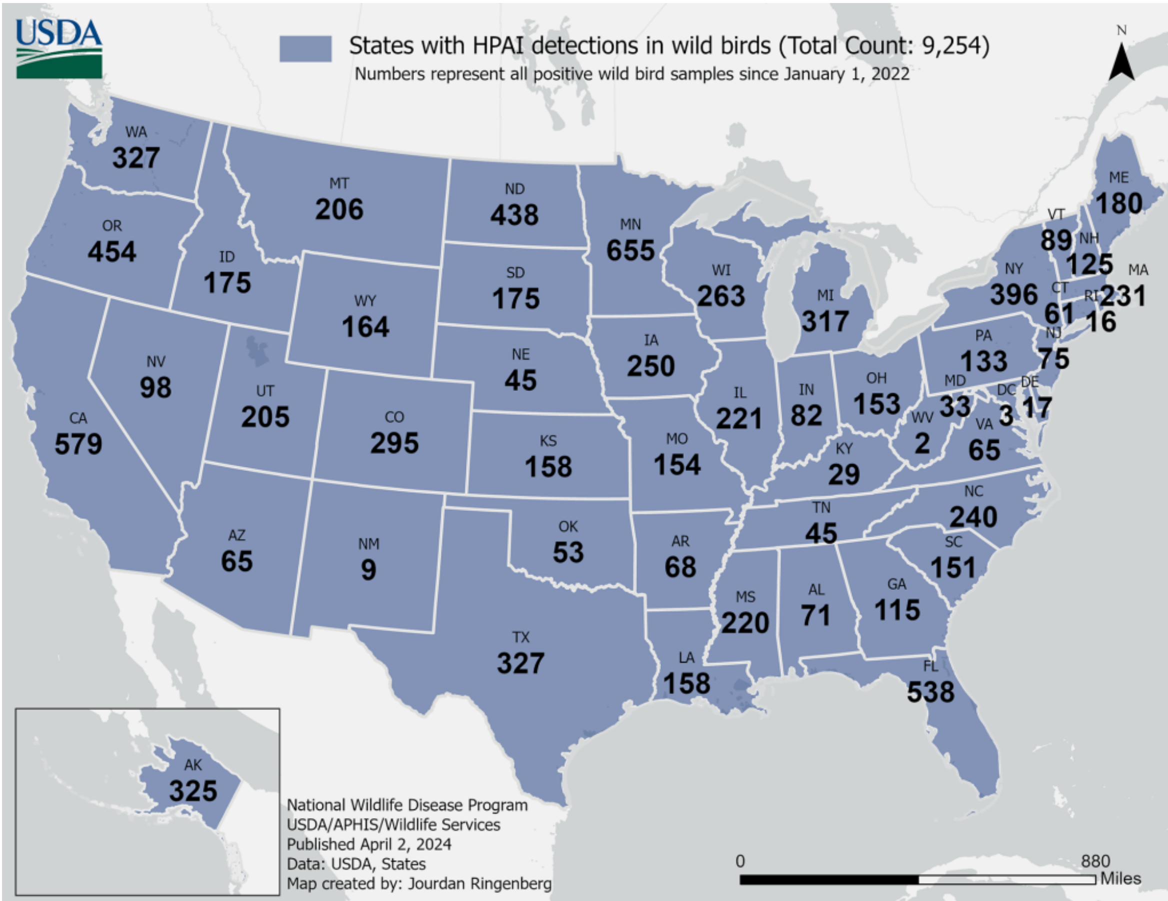

Fig. 1. Total H5N1 HPAIV detections in wild birds in the United States as of April 4, 2024.

Canine Influenza Viruses

Despite a relatively low number of cases of Gs/Gd H5 HPAIV in domestic dogs, distinct influenza A viruses originating from other host species such as canine influenza viruses (CIVs) H3N8 and H3N2 have been documented in dogs.[25] Both subtypes of CIVs generally result in the dog experiencing moderate to severe upper respiratory tract disease, which may involve a fever and frequent coughing.[26] The H3N8 CIV, an equine influenza virus transmitted to dogs, first appeared around 1999, but was not identified until 2004 in racing greyhounds in Florida.[27] H3N8 CIV appears to have a limited host range with low reports of the virus recorded after 2016.[26,28] H3N2 CIV originated from an AIV transferred to dogs around 2005 in Asia and was first introduced to the US in 2015 in Chicago, Illinois, presumably in dogs imported from South Korea.[26] Unlike H3N8 CIV, H3N2 CIV appears to infect a variety of species other than dogs, including cats, ferrets, and guinea pigs, with multiple outbreaks reported since the virus was first recognized.[25] Vaccines for CIVs are available and recommended for dogs that are at increased risk of exposure, including those that frequent kennels, daycare facilities, or who travel extensively. Although there have been no reported cases of humans infected by CIVs, dogs may become infected by seasonal human influenza A viruses, allowing for potential reassortment between human and dog viruses to occur.[26,28] Extended, continuous contact between humans and their dogs may enable CIVs or reassorted CIVs to pass back into the human population.[25] In South Korea, a surveillance study found a new H3N1 CIV, which was considered a reassortment between H3N2 CIV and the human influenza virus associated with the H1N1 pandemic.[29]

Hunting Dogs

Hunting dogs are at an increased risk for becoming infected with various diseases due to exposure to a multitude of pathogens. Compared to companion dogs, hunting dogs spend a greater amount of time in environments shared with wildlife that can harbor various pathogens.[30] Increased time in natural areas expose these dogs both directly and indirectly to wildlife, which may act as reservoirs or vectors for diseases. Humans often share the same environments with their hunting dogs and wildlife, and therefore may be at risk for diseases transmitted to them from their dogs or the environment.[31,32] Dogs that hunt may also be exposed to infectious diseases by ingesting infected raw meat in their daily diet or while game is being processed in the field.[31] Hunting dogs may travel long distances to numerous hunting regions, exposing them to pathogens not found in their home environment.[31] Dogs that retrieve waterfowl such as ducks, which are important reservoirs for H5N1 HPAIV and can be infected without displaying clinical signs of the disease, may be at an increased risk for H5N1 HPAIV. This unique group of dogs has direct physical contact with the environment and birds which may both act as sources of H5N1 HPAIV[33,34] as well as frequent interactions with their human handlers, which could enable disease spillover. Hunting dogs may be prime candidates to monitor and assess the possible health risk of H5N1 HPAIV to human populations due to their increased risk of acquiring the virus through direct transmission from infected wild birds or the aquatic habitat combined with their sustained proximity to people. The dogs also tend to travel to multiple locations throughout the hunting season, increasing their exposure to a variety of migratory bird species and other potentially infected wild birds, while also facilitating the spread of infectious diseases to different areas and animals.

Previous research has considered hunting dogs as sentinels for human health[35–37]; however, few studies have evaluated hunting dogs as public health indicators for Gs/Gd H5 HPAIV. Currently, there are no cases of dog-to-human transmission of H5N1 HPAIV. However, reports have documented dogs becoming infected with human strains of influenza A viruses such as H3N2, pandemic H1N1 2009, or co-infected with different strains of influenza viruses, allowing for reassortment of viruses to occur and causing concern for transmission back to people.[25,38,39] Transmission of influenza A viruses between dogs and humans may occur due to close contact or through aerosols.[40,41]

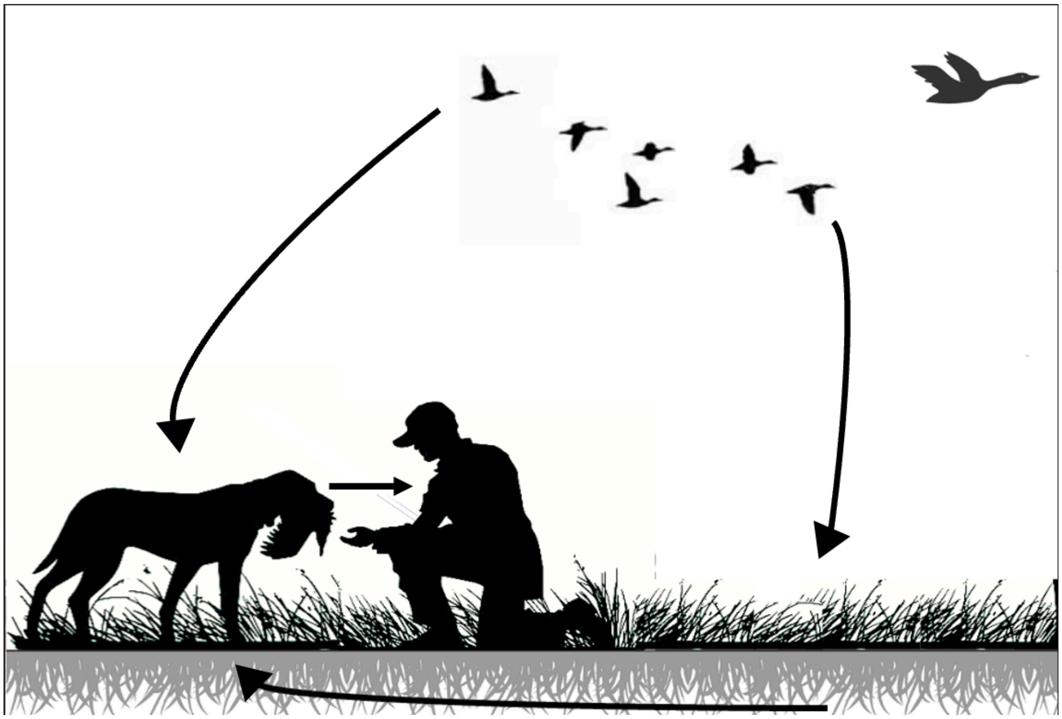

Fig. 2. Transmission routes of avian influenza from wild birds and the environment to hunting dogs and humans.

Due to the continued H5N1 HPAIV outbreak in the US affecting an increasing number of wild and domestic animals along with the emerging case of mammal to human transmission of the disease, hunting dogs and their owners appear as an important group to consider when investigating the risk of H5N1 HPAIV to animal and human populations. This study seeks to define factors that may be associated with an increased risk of Washington State hunting dogs being infected with H5N1 HPAIV. Additionally, using a national survey, we aim to identify possible preventative measures that may be implemented during people's interactions with their dogs to reduce the potential for infectious disease transmission.

Methods

Study Design

This study combines previous cross-sectional data collected from 194 Washington State hunting dogs (primary study) with a secondary nationwide survey to assess hunter-canine interactions. The goal of this study is to examine potential risk factors associated with H5N1 HPAIV infection in hunting dogs and identify opportunities to introduce preventative measures to mitigate the risk of zoonotic disease transmission between hunting dogs and humans. The primary study cross-sectional data were collected from March 2023 to June 2023 and consisted of a blood sample collection and a questionnaire completed by the owner outlining the dog's basic medical history and their bird hunting and retrieving activities. A voluntary subset of 19 dog-owners from the primary study along with an additional 93 new hunters participated in a secondary survey that characterized the interactions between hunters and their hunting dogs. This study design could provide the baseline assessment for monitoring H5N1 HPAIV in a high-risk population of animals, which could then be applied to longitudinal surveillance.

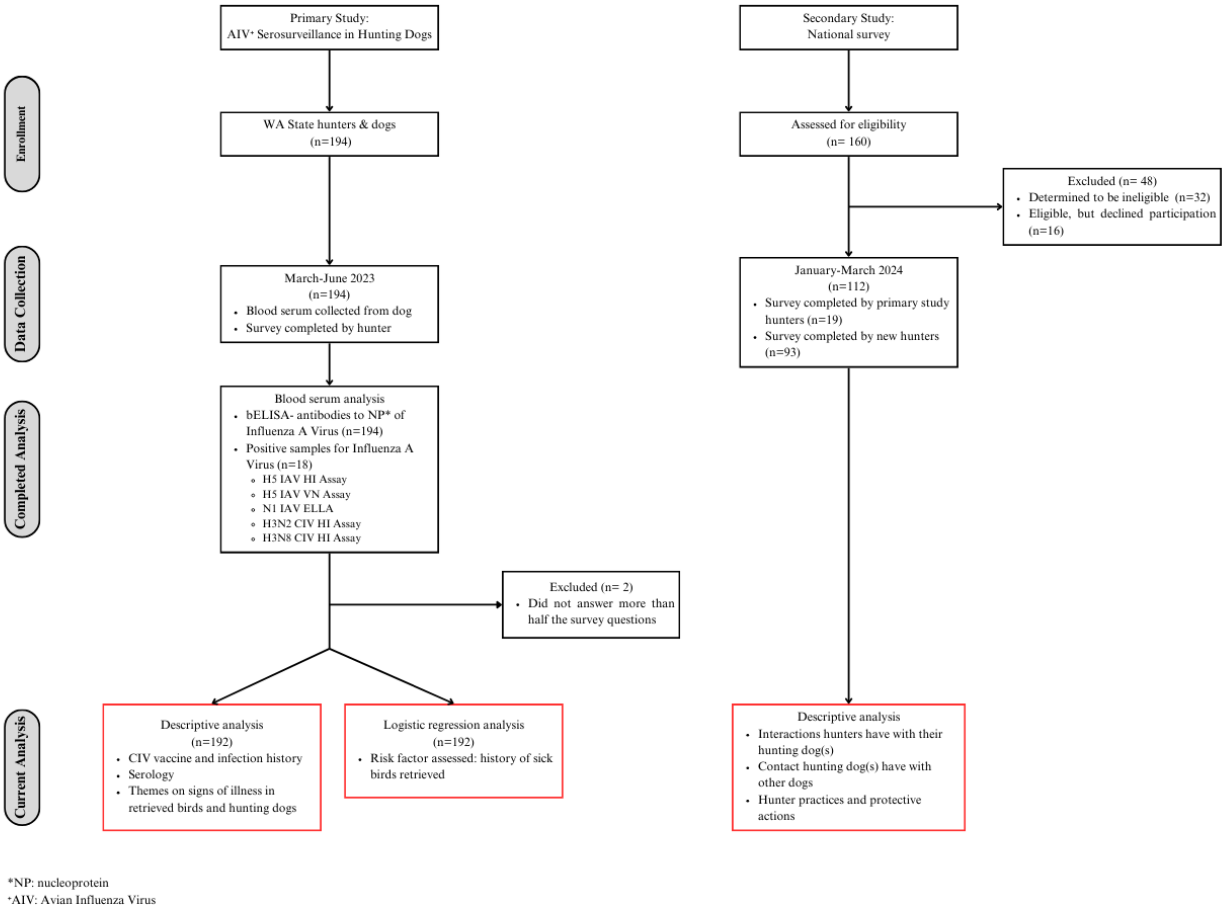

Fig. 3. Flow diagram of the study design

Study Population

Primary Study: 194 hunting dogs and their owners from Washington State were recruited into the primary study through a combination of direct connections, snowball sampling, self-recruitment, correspondence through hunting retriever clubs, national organizations with an interest in hunting dogs, and opportunistic sampling at hunt test or training events. Eligible participants were defined as any dog that had participated in bird hunting or bird hunt tests or training within the past 12 months.

Secondary National Study: For the national survey, 112 individuals participated, comprised of a combination of 19 dog-owner pairs from the primary study and 93 new participants from across the United States. Recruitment flyers describing the purpose and goals of the national survey were distributed electronically via email and social media to recruit participants who could then self-recruit into the survey any time between January 2024 through mid-March 2024. Participants were eligible to complete the national survey after confirming they had a hunting dog, hunted birds within the previous 12 months (including hunting, hunt tests, and/or field trials), were fluent in English, 18 years or older, and a US resident.

Data Collection

Primary Study: Dog-owner paired data consisting of a blood sample from the hunting dog and a questionnaire completed by the owner at the time of sampling, were collected at hunting club training and test locations, private residences, and public areas throughout Washington State from March 2023 to June 2023. Samples were collected approximately 1-4 months after the end of the Washington State waterfowl hunting season, which occurred from mid-October 2022 to February 2023. A veterinarian obtained an approximately 3 mL blood sample via the jugular vein. At the same time, a paper questionnaire was completed by the dog's owner with information about the dog's age, canine influenza virus (CIV) vaccination and infection history, and bird hunting and/or training activities within the past 12 months (See Appendix-Fig. A for a copy of the survey).[42]

Secondary National Study: From January 2024 through mid-March 2024, participants from the primary study along with new participants had the opportunity to participate in a nationwide online survey. The national survey was developed, administered, and completed electronically by participants using REDCap (See Appendix-Fig. B for a copy of the survey).[43–45] Questions in the national survey included information about the types of interactions the owner had with their hunting dog(s), personal protective practices employed when handling a sick dog and during hunting activities, and interactions that their hunting dog had with dogs from outside their household.

Blood Sample Processing

Blood samples (n=194) collected in the primary study were centrifuged upon collection, and the serum was aliquoted and stored on ice packs in the field. After field collection, serum samples were stored at -20°C at Penn State University (University Park, PA, USA) until antibody testing was completed. Based on the manufacturer's instructions, a commercial blocking Enzyme Linked Immunosorbent Assay (bELISA; MultiS-Screen AB Test, IDEXX, Westbrook, ME, USA) was used to screen the serum samples for antibodies to IAV (influenza A virus) nucleoprotein, which was conducted at Penn State University. Eleven of the serum samples that were negative on the bELISA were used as negative field controls. Samples that were IAV antibody-positive on the bELISA were tested for sub-type specific antibodies to H5N1 (H5N1 HPAIV) and H3N2 and H3N8 (canine influenza). The H5 and N1 serologic testing was performed at the Southeastern Cooperative Wildlife Disease Study (University of Georgia, Athens, GA, USA) using a hemagglutinin inhibition (HI) assay and virus neutralization (VN) to test serum samples for antibodies to H5 along with an enzyme-linked lectin assay (ELLA) to test for antibodies to N1 based on previously documented protocols.[46,47] When determining if serum samples were antibody-positive during the additional subtype-specific testing stage, we utilized the following conservative threshold titers: H5 HI (>1:32), H5 VN (>1:20), and N1 ELLA (>1:80). A sample was considered seropositive for H5 and N1 IAV, if it was positive for both H5 using the HI assay or VN and N1 using the ELLA. Serologic testing for the H3N2 and H3N8 subtypes were performed at Cornell University (Ithaca, NY, USA). Any titer ≥8 was considered positive. Full methods have been previously published by Brown et al. (2024).[42]

Secondary National Survey Development

Questions for the national survey were designed to establish the types of interactions that hunters engage in with their hunting dogs and to ascertain actions that may increase a person's risk for disease exposure or transmission. Additional questions regarding the hunting dog's contact with other dogs, both hunting and non-hunting dogs, were developed to determine possible events for animal-to-animal disease transmission. The survey questions were informed by previous surveys conducted by the Center for One Health Research (University of Washington, Seattle, WA, USA), experts in the field, and veterinarians. The survey was piloted by individuals (n=5) with knowledge of the field and/or who were active bird hunters with dogs. Revisions to the survey were completed based on feedback from the pilot group.

Data Analysis

Descriptive Analysis

Primary Study: Two survey records with less than half the questions completed were removed before any analyses were performed. Data cleaning included rounding the ages of the dogs to the nearest whole number. From the primary survey, descriptive statistics on hunting dogs were compiled regarding signalment data, CIV vaccination status, CIV infection, and seropositivity results from blood samples. We used conservative estimate parameters when determining cases of H5N1 HPAIV. Based on questionnaire responses and serology results, hunting dogs that were CIV vaccinated or tested positive for either H3N2 or H3N8, were not considered as potential cases of H5N1 HPAIV infection. Themes were identified based on reports provided by participants about signs of disease, atypical behavior, or death in retrieved birds and signs of illness in their hunting dogs.

Secondary National Study: Descriptive analyses for the national survey were performed. Summary statistics were computed to evaluate the frequency in which people engaged in various activities with their hunting dogs along with contact that hunting dogs had with dogs outside their household.

Exploratory Analysis

Due to the small number of H5N1 antibody-positive cases in the primary cross-sectional study, we undertook an exploratory analysis utilizing Firth's Bias-Reduced logistic regression[48,49] to analyze the association between retrieving a sick bird and H5N1 HPAIV infection in hunting dogs. Covariates were chosen *a priori* based on previous literature, assumed confounders, and included frequency of hunting and training activities. Before any computations were completed, data cleaning was performed, which included combining variable response categories due to a lack of data and based on the response distribution. Survey responses for the twelve types of birds retrieved were reduced into three broad categories based on hunting classification and differing risks for H5N1 HPAIV exposure and infection based on historic data[50]: Waterfowl (dabbling ducks, diving ducks, sea ducks, geese, and coots), Upland Game (pheasants, quail, grouse, chukars, and Hungarian partridge), and Other (doves and pigeons). Areas where hunting occurred were categorized into three regions: Pacific Northwest (PNW) including British Columbia, Canada, and Other states. Canada was defined as any province other than British

Columbia and Other states comprised of any US state not considered part of the PNW (Washington, Oregon, Idaho, and British Columbia). For the survey responses corresponding to the number of times the dog hunted and the number of times the dog trained, both variables were recategorized based on if the dog hunted or trained ≤ 20 times or > 20 times. A univariate Firth-type logistic regression model was completed with the retrieval of sick birds as the predictor variable (Model 1). An adjusted multivariate logistic regression (Model 2) was then calculated with the same predictor variable. In Model 2, the number of times the dog hunted over the previous 12 months and the number of times the dog trained with live or dead birds over the previous 12 months were adjusted for to address potential confounding. All data analysis was conducted in R version 4.2.2.[51] Firth-type logistic regression analyses were completed using the logistf package 1.26.0.[52]

Ethics Statement

This study was approved through the University of Washington Institutional Review Board (IRB) for human subjects research (STUDY00000042). The primary study was approved through the Pennsylvania State University Institutional Animal Care and Use Committee (IACUC) for animal research (#202302394). Participants in the primary study also completed a consent form from Pennsylvania State University allowing permission for their dog to be included in the research. Before participating in the national secondary study, human participants were informed that their participation was voluntary and that all information collected would remain confidential. Participants could withdraw from the study at any time.

Results

Descriptive Analysis

Primary Study: Table 1 summarizes data originally published by Brown et al. (2024),[42] which was used for this study. Records were only included in our analysis if they completed at least half of the survey; therefore, our dataset included a total of 192 records instead of 194 records and n=17 IAV antibody-positive bELISA samples instead of n=18 as described in Brown et al. (2024). The average age of these hunting dogs was 4.52 years old with most dogs (n=44) being 2 years old. A majority of the CIV vaccinated dogs were between the ages of 2-8 years old. As published by Brown et al. (2024), four dogs were seropositive for H5 and N1 antibodies.[42] Three of the four hunting dogs considered infected with H5N1 HPAIV were 6 years or older.

Table 1. Descriptive statistics of the primary study population and serology results for dogs in this study

	Overall (N=192)
Sex	n (%)
Male	87 (45.3%)
Female	105 (54.7%)
Age	
Mean (SD)	4.52 (2.9)
Median [IQR]	4 [2, 6]
CIV Vaccinated	
Yes	41 (21.4%)
No	110 (57.3%)
Unknown	39 (20.3%)
Did not answer	2 (1.0%)
CIV Infection History	
No	154 (80.2%)
Unknown	36 (18.8%)
Did not answer	2 (1.0%)
bELISA	17 (8.95%)
Further Serology Testing	**Positive Samples (N=17)**
H3N2	14 (82.4%)
H3N8	13 (76.5%)
HI-BWT H5N2	2 (11.8%)*
HI-AST H5N8	2 (11.8%)
VN AST H5N8	3 (17.6%)
ELLA N1	7 (41.2%)+

*Were not considered H5N1 cases due to testing positive for H3N2 and H3N8

+3 of 7 were not considered H5N1 cases due to testing positive for H3N2 and H3N8

NOTE: Data based on questionnaires with more than 50% completetion

Twenty-two of the 192 individuals reported their hunting dogs retrieved sick birds within the past 12 months. Participants with dogs that retrieved sick birds voluntarily self-reported these birds as displaying signs of abnormal behaviors such as flying or spinning in circles, swimming backwards, wobbling when approaching decoys, crash landing, and an unwillingness or inability to fly. Other reports included birds that appeared lethargic, dazed or confused, sickly, or dead.

Regarding illness displayed by hunting dogs, 5.2% of participants reported their dogs presented signs of illness within the past 12 months including respiratory diseases such as pneumonia and kennel cough, weight loss, kidney infection, and gastrointestinal issues including vomiting and diarrhea (Table 2).

Table 2. Themes of indicators of sick birds retrieved and illness displayed by hunting dogs reported by owners

	Total
Indicators of sick birds retrieved (n=22)[+]	**n (%)**[^]
Dying/Dead	11 (50.0%)
Appeared sickly	7 (31.8%)
Lethargic	5 (22.7%)
Unwilling/unable to fly	3 (13.6%)
Abnormal flight	2 (9.1%)
Dazed or confused	2 (9.1%)
Abnormal swimming	1 (4.5%)
Signs of illness displayed by dog (n=192)	**n (%)**
GI issues[1]	5 (2.6%)
Respiratory[*]	3 (1.56%)
Weight loss	1 (0.52%)
Kidney Infection	1 (0.52%)

[^]Responses may not equal total since participants could report multiple signs of illness
[+]Participants voluntarily self-reported
[1]Includes vomiting and diarrhea
[*]Includes kennel cough and pneumonia

Secondary National Study: We had 112 participants that completed the secondary questionnaire. Descriptive statistics about the study population are provided in Table 3.

Table 3. Descriptive characteristics of secondary national study population (total n=112)

	n (%)
State of Residence	
Washington	28 (25.0%)
California	26 (23.2%)
Michigan	9 (8.0%)
Wisconsin	8 (7.1%)
Minnesota	6 (5.4%)
Texas	5 (4.5%)
Oregon	5 (4.5%)
Other[+]	25 (22.3%)
Number of Dogs Owned	
Mean (SD[1])	2.32 (1.57)
Median [IQR[2]]	2 [1, 3]
Hunting Activity	
Hunting	54 (48.2%)
Hunt Tests/Trials	9 (8.0%)
Both	49 (43.8%)
Participated in AIV Serosurveillance study	19 (17.0%)
CIV[*] Vaccinated	
Yes	43 (38.4%)
No	51 (45.5%)
Do Not Know	18 (16.1%)
Has Pet Insurance	37 (33.0%)

[1]SD: Standard Deviation
[2]IQR: Interquartile Range
[*]CIV: Canine Influenza Virus
[+]Other states include Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Louisiana, Maryland, Massachusetts, Missouri, Montana, Nevada, New York, North Carolina, Ohio, Pennsylvania, and South Dakota

Hunters from 24 states were represented with the majority of respondents from Washington State (25%). In this population, 48.2% of individuals reported engaging in hunting with their dogs, 8.0% participated in hunt tests and/or trials, and 43.8% participated in both. Nineteen of the 112 individuals (17%) participated in the primary seropositivity study. Most participants (n=37) had neither pet insurance nor had their dog vaccinated for CIVs. Descriptive statistics for how individuals perceived their hunting dogs and locations where they had contact with their dogs are presented in Table 4. The majority of respondents indicated that they considered their dog a part of the family (93.8%), but 57.1% did not consider their dog a pet. Additionally, 49.1% of participants perceived their dogs as working dogs while 45.5% recognized their dogs as a tool for hunting. A majority of individuals indicated that their dogs slept inside at night (91.8%) and of those dogs, 83% slept in the person's room. Of the dogs that slept in a person's room, 67.5% slept in the individual's bed with them. Most participants (n=51) that reported allowing their dog to sleep in the bed with them also considered their dog part of the family. More than half the respondents (59.8%) reported that they kissed their dogs.

Table 4. Hunter perceptions and contact with their hunting dogs (total n=112)*

	Total (n=112)
I consider my dog:[1]	**n (%)**
Part of the family	105 (93.8%)
Working dog	55 (49.1%)
Tool for hunting	51 (45.5%)
Pet	48 (42.9%)
Dog lives:	
Inside	64 (57.1%)
Inside/Outside	47 (42.0%)
Outside	2 (1.8%)
Of dogs that live inside, dog sleeps:	
In the home	101 (91.8%)
Indoors, not in the home	8 (7.3%)
Outside	1 (0.9%)
Of dogs that sleep in the home, dog sleeps in my room	83 (83.0%)
Of dogs that sleep in my room, dog sleeps in my bed	52 (67.5%)
Kiss my dog	67 (59.8%)

[1]Responses may not equal total since participants were asked to select all that applied
[*]Responses may not equal total since some human-canine contact may not have been applicable

When participants were asked how they respond to their dog displaying signs of illness such as diarrhea, lethargy, or a lack of appetite, 50% of individuals reported keeping their dogs in the home to monitor them, 27.7% washed their hands after interacting with a potentially sick dog, 18.8% separated the sick dog from other animals, 0.9% separated themselves from the dog, 26.8% disinfected the dog's living area, 17.9% disinfected training equipment or dog gear, 3.6% used personal protective equipment (PPE), and 3.6% reported performing other actions such as taking their dog to the vet. All individuals that reported using PPE, indicated utilizing gloves (n=3). However, 42.0% of respondents expressed that their dog had never shown any of these signs of illness (Table 5).

Table 5. Descriptive statistics of hunters' responses to dogs who display signs of illness (total n=112)*

If my dog has shown signs of illness, I[+]:	**n (%)**
Keep at home to monitor	56 (50%)
Wash hands	31 (27.7%)
Separate from other animals	21 (18.8 %)
Separate self from dog	1 (0.9%)
Disinfect dog's living space	30 (26.8%)
Disinfect training equipment or dog gear	20 (17.9%)
Wear PPE	4 (3.6%)
Other	4 (3.6%)
Dog has never shown signs of illness	47 (42.0%)

[*]Responses may not equal total since participants were asked to select all that applied
[+]Signs of illness include diarrhea, lethargy, lack of appetite

When considering conditions where contact between individuals, hunting dogs, and birds occurred, 91 respondents (81.3%) did not use PPE when handling birds in the field. In addition, 74.1% of individuals did not process birds in the field, 17.9% sometimes processed birds in the field, while 8.0% processed birds in the field a majority of the time. Only 26.8% of hunters reported feeding parts of hunted birds to their dogs, while 73.2% did not feed any bird parts to their dogs (Table 6). A majority of individuals (n=88) did not use any type of PPE when handling either a dog that displayed signs of illness or birds in the field. In this study, 15.2% of participants reported experiencing undiagnosed flu-like symptoms such as fever, chills, coughing, or trouble breathing within the past year.

Table 6. Descriptive Statistics of contact between humans, dogs, and birds (total n=112)

Do you:	Total (n=112)
Process birds in the field	n (%)
Yes	9 (8.0%)
Sometimes	20 (17.9%)
No	83 (74.1%)
Feed parts of bird to dog	30 (26.8%)
Use PPE use when handling birds	21 (18.8%)

Information regarding the types of contact a participant's dog had with dogs outside their immediate household are exhibited in Table 7. When considering contact at boarding facilities, 14.3% of individuals boarded their dog at a general boarding facility within the previous 12 months while 20.7% boarded their dog at a training facility. Eighty-four of 112 of participants reported that their dog had contact with non-hunting dogs in the past 12 months with a majority of average contact between their dog and non-hunting dogs occurring on a monthly basis

(40.5%). Most individuals (89.3%) indicated their dog had contact with other hunting dogs, where a majority of average contact occurred monthly (44%). Most respondents (n=81) indicated that their dog had contact with both non-hunting and hunting dogs outside their household.

Table 7. Descriptive statistics of contact between hunting dogs and dogs outside the household

	Overall (N=112)*
Where do you board your dog?	**n (%)**
General boarding	16 (14.3%)
Boarding at a training facility	23 (20.7%)
Any contact with non-hunting dogs	84 (75.7%)
Frequency of contact with non-hunting dogs	
Daily	7 (8.3%)
Weekly	28 (33.3%)
Monthly	34 (40.5%)
Yearly	15 (17.9%)
Any contact with other hunting dogs	100 (89.3%)
Frequency of contact with other hunting dogs	
Daily	6 (6.0%)
Weekly	40 (40.0%)
Monthly	44 (44.0%)
Yearly	10 (10.0%)

*Responses may not equal total since some hunting dogs may not have had contact with any non-hunting or hunting dogs outside their household

Exploratory Analysis

Exploratory logistic regression results for the association between retrieiving sick birds and testing positive for H5N1 HPAIV antibodies from the primary study are presented in Table 8. In Model 1 (unadjusted model), we estimated that the odds of a hunting dog infected with H5N1 HPAIV was 20.28 times greater for dogs that retrieved sick birds in the past 12 months compared to dogs that did not retrieve any sick birds (95% CI: 3.15, 217.30). In Model 2 (adjusted model), we estimated that the odds of a hunting dog being infected with H5N1 HPAIV was 11.39 times greater for dogs that retrieved sick birds within the past 12 months compared to dogs that hunted and trained the same number of times who did not retrieve any sick birds (95% CI: 1.56, 158.91).

Table 8. Logistic Regression Models

	OR[1]	95% CI[+]
Model 1 (n=192)		
Retrieved sick bird	20.28	**3.15, 217.30**[*]
Model 2 (n=192)		
Retrieved sick bird	11.39	**1.56, 158.91***
Hunted > 20 times[#]	3.21	0.33, 48.86
Trained > 20 times[#]	0.40	0.03, 5.15

[1]OR: Odds Ratio
[+]CI: Confidence Interval
[#]Refers to within the past 12 months
[*]Considered statistically significant at $p < 0.05$ level

Discussion

This study of the characteristics of hunting dogs in the primary study and their interactions with humans and other dogs in the secondary national study provides valuable insight about a population at high-risk for infectious zoonotic diseases such as H5N1 HPAIV. Data from the primary study indicated that there were hunting dogs seropositive for antibodies to H5N1 HPAIV. Results from the secondary national survey revealed the types of relations between participants and their hunting dogs along with contact between their dogs and other dogs, providing critical insight into instances where disease transmission could occur including transmission between dogs and humans and between dogs. The limited number of H5N1 HPAIV cases identified in the primary study (n=4) only allowed for an exploratory analysis of the risk factors for H5N1 HPAIV infection in hunting dogs, and results should be interpreted cautiously.

Risk Mitigation Recommendations

A majority of respondents to the secondary national survey reported using no PPE when handling birds or interacting with a sick dog. Few individuals in the national survey reported experiencing any undiagnosed flu-like symptoms, yet we should still be cautious about the potential for H5N1 HPAIV or other infectious diseases to move between humans and animals, specifically mammal to mammal transmission. In April 2024, the CDC reported the first likely case of mammal to human transmission of H5N1 HPAIV.[20] Although the public health risk remains low for H5N1 HPAIV, the increasing number and diversity of mammal cases suggest the virus may be adapting to infect various mammal species. Despite the currently low threat to the public's health, preventive precautions are warranted. The use of PPE appears as an easy and cost-efficient approach to assist in preventing some disease transmission between humans and animals. Gloves or eyewear may be used to prevent contact with infected bodily fluids and specimens. Utilizing masks during activities such as processing birds or treating a sick dog can reduce the risk of inhaling infectious aerosols. Changing clothes immediately after potential contact with a sick or infected animal may also aid in preventing unnecessary prolonged exposure to infectious materials or decrease the risk of exposing other humans and animals to disease. Although PPE use may be the easiest control method to employ, it is also considered the least effective hazard control strategy when referencing the hierarchy of controls as PPE only protects the individual user and is only effective if the person consistently utilizes it properly; similarly it wouldn't prevent animal to animal transmission.[53] Implementing other forms of controls such as engineering and administrative controls that address biosafety measures alongside PPE is crucial to increase the effectiveness of risk management strategies, while reducing the risk of disease transmission to the public.

Besides PPE use, thorough handwashing with soap or disinfectant after handling birds or dogs can mitigate a person's risk of becoming infected with a disease. Tools used to process birds should be disinfected after use to prevent future contamination. Hunters should also consider disinfecting a sick dog's living space, equipment, and training gear to prevent the spread of disease to themselves or other animals. In the secondary national survey, only 18.8% of respondents separated their sick hunting dog from other animals. Isolating a sick dog from other animals in the household would assist in preventing the potential spread of a disease between animals; however, this action may not be feasible for some individuals. Furthermore, since a majority of hunting dogs that live indoors also live in the home (91.8%), owners may want to consider improving indoor air quality to reduce disease transmission within the indoor environment by upgrading ventilation and air filtration systems and using air purifiers.

Hunting organizations and licensing departments could also consider providing educational materials and required trainings to hunters, especially those with hunting dogs, regarding disease exposure, transmission, and proper preventative actions. A combination of different levels of control and preventative measures are essential to reduce the opportunities for H5N1 HPAIV to jump between animal and human populations and are applicable to other infectious diseases that are spread between the two groups as well. Furthermore, implementing these safety measures protects both animal and human health by preventing animals from becoming infected with human diseases. Previous research has established that dogs may become infected with human influenza A viruses,[26,28] viruses within the same family as H5N1 HPAIV, which may then allow for reassortment within dogs into a novel CIV,[29] which is also an influenza A virus.

Another factor to consider when addressing disease prevention in both animals and humans includes vaccines. In both the primary and secondary national studies, most participants did not vaccinate their dogs against CIVs, with only 21.4% and 38.4% reporting vaccinating, respectively. However, a high proportion of respondents (75.7%) in the secondary national survey indicated their dogs had contact with non-hunting dogs and 89.3% had contact with other hunting dogs. A lack of owner education regarding recommended vaccines for dogs that travel or who are exposed to places/events where dogs assemble along with vaccine shortages in the United States may have contributed to a decreased number of CIV vaccinated hunting dogs. The high proportion of contact between hunting dogs and dogs outside their household combined with the low number of CIV vaccinated dogs may promote conditions that facilitate the spread of CIVs between animals. By vaccinating hunting dogs for CIVs, participants have the opportunity to protect their hunting dogs whom many reported as being a part of their family and a working dog. In addition to vaccines, employing the use of other preventative dog care such as flea and tick prentatives and dewormers may reduce the risk of disease spillover to humans. Vaccines and other preventative care applied to hunting dogs not only benefits the health of the animal, but also human health by decreasing pathogen exposure to owners either directly or indirectly through contaminated environments. Although no vaccine currently exists to protect dogs against H5N1 HPAIV, a complete preventative care program supports the general health of hunting dogs as well as other animals and humans that reside in the same household together.

In the exploratory analysis, retrieval of a sick bird was determined to be statistically significant ($p<0.05$), indicating this activity may increase a hunting dog’s potential risk of becoming infected with H5N1 HPAIV. This finding aligns with previous literature of dogs testing positive for the virus after handling or ingesting an infected bird.[9,10] Other mammalian or avian species besides dogs who have had contact and consumed infected birds have also been reported positive for H5N1 HPAIV.[16,54,55] The low overall number (n=4) of positive H5N1 HPAIV cases from the primary study as reported by Brown et al. (2024),[42] may indicate that the virus is not yet well-adapted to domestic dogs. The lack of adaptation suggests that dog to dog transmission was unlikely, which was supported by the few H5N1 seropositive hunting dogs and lack evidence for transmission to other dogs in their household.[41] Despite the lack of adaptation, individual dogs may still be able to be infected if the viral exposure is high and the route is appropriate. A dog may also need to ingest large amounts of an infected bird or have prolonged contact while retrieving the bird, to become infected or have a detectable viral load. A group of individuals from the national survey (26.8%) reported feeding parts of the birds they hunted to their hunting dogs. Avoiding feeding uncooked bird parts and preventing dogs from scavenging dropped pieces during processing is another control method hunters can use to prevent their hunting dogs from being exposed to H5N1 HPAIV infected meat. Hunters may also protect themselves from potential infection by thoroughly cooking harvested meat to an internal temperature of 165°F, which will inactivate H5N1 HPAIV within or on the meat.[56]

Although many waterfowl species do not display outward signs of H5N1 HPAIV infection, any bird that displays signs of illness or abnormal behavior or sites with multiple sick or dead birds present should be avoided during hunting activities and reported to the proper local agency. To limit a hunting dog and hunter’s exposures to potentially infected birds, individuals may wish to check local and state wildlife resources before they select an area for hunting activities to determine if there have been any recent reports of birds infected with H5N1 HPAIV detected in the region. Furthermore, clubs that host hunt tests or trials should only use outwardly healthy birds from a reliable source.

A One Health Issue

The risk of H5N1 HPAIV appears as a One Health concern. One Health is an integrated approach that recognizes the interconnectedness of humans, animals, and the environment including ecosystems, to address a wide range of health issues and generate holistic solutions.[57] In this work, we investigated human and animal populations, but this study did not include any environmental sampling. However, previous studies have demonstrated that the environment acts as an important source/risk factor for H5N1 HPAIV.[33,34] Climate change is a major environmental element that may impact the epidemiology of H5N1 HPAIV through changes in environmental conditions and bird biology and movements. Increasing temperatures may alter the survival and viability of H5N1 HPAIV in aquatic habitats.[58] Furthermore, changes in temperature and seasonality may affect the abundance, migratory patterns, and geographic range of various bird species[59–61] that act as reservoirs for H5N1 HPAIV. This shift in avian populations has the potential to introduce new or extended contact between bird species, allowing for increased risk of transmission of H5N1 HPAIV between species or opportunities for the virus to mutate. Additionally, an environment shared by multiple species of birds affected by H5N1 HPAIV could impact the environmental load of H5N1 HPAIV in that habitat. Alterations in migration patterns and ranges may shift the regions that are at an increased risk of H5N1 HPAIV[62] due to exposure of domestic birds and humans to migratory species. Future studies may wish to incorporate water and soil sampling to screen for the presence of H5N1 HPAIV in the environment along with weather data such as temperature, humidity, pH, and rainfall to identify associations or trends between climate indicators and H5N1 HPAIV. Collecting environmental samples would allow for a comparison of those samples to animal and humans that share that location, providing an opportunity for disease surveillance.

Limitations

Since the primary study was a cross-sectional study, we were not able to establish the temporality of events. We cannot determine if the retrieved sick birds were directly connected to a dog displaying signs of illness since participants were asked to report any sick birds retrieved or signs of illness in their hunting dogs within the past 12 months. Mild signs of illness are also considered common in hunting or working dogs, thus not all signs of illness may have been connected to potential H5N1 HPAIV infection. Additionally, participants self-reported outward signs of disease, abnormal behavior, or dead birds that were retrieved. Clinical diagnostics were not completed on these birds; therefore, we cannot ascertain if the birds were infected with H5N1 HPAIV, which would impact the reliability of the exploratory logistic regression models. Results from the secondary national survey may not be generalizable since many of the participants were from either Washington State or California. Individuals from these states may not be representative of all hunters in the United States and there may also be regional differences in the risk of H5N1 HPAIV infection for hunting dogs in those states and preventative measures utilized. Furthermore, an atypical outbreak of canine infectious respiratory disease complex (CIRDC) appeared in Oregon in August 2023 and spread across multiple states,[63] which may have affected participants' travel to other states or hunting events, the amount of contact hunting dogs were permitted with other dogs, or the proportion of CIV vaccinated dogs. A central limitation of this study was the small number of positive H5N1 HPAIV samples from the primary study. Due to this limitation, only exploratory analyses could be completed, and they must be interpreted extremely cautiously. An exploratory analysis does not enable us to provide any conclusive inferences or findings. Models 1 and 2, where statistical significance was determined, display an appropriate development of logistic regression models. However, a lack of study power prevents these logistic regression models from having wider public health applications. To improve these models, an increased number of samples or more robust information are required to create effective predictive models. With a greater sample size, we could develop models that are more relevant and accurate to investigate the determinants of H5N1 HPAIV risk. This exploratory analysis does provide the basis for future research assessments of the risk factors of H5N1 HPAIV in hunting dogs or other important mammal species and may be useful for future surveillance and monitoring.

Conclusion

Examining hunting dogs as potential sentinels of H5N1 HPAIV provides us with the opportunity to determine the unique risks to the health of these dogs who share our living space and act as links between humans and wildlife reservoirs. Characterizing the interactions humans have with their hunting dogs provides an increased understanding of routes for the virus to enter the human population or for the introduction of human diseases to dogs. Findings from this research suggest the need for continued surveillance and investigation to better understand the risk factors for hunting dogs becoming infected with H5N1 HPAIV. The limited number of H5N1 HPAIV positive cases from the primary study indicate that it is likely not necessary to recommend cessation of hunting activities. However, cases were identified in hunting dogs, revealing that infection does occur, and that we should monitor and continue surveillance within this population of animals. If cases were to increase in hunting dogs, this may act as a signal that the virus is changing. Results also illustrate the close connections, both physical and mental, this population has with their hunting dogs. The continuous forms of contact humans maintain with their hunting dogs supports the concern for the potential of disease transmission between humans and animals as well as the importance of implementing protective practices to reduce disease risk and prevent spillover. By leveraging the desire to preserve the health of hunting dogs, we may simultaneously safeguard public health. This study provides the foundation for future research into understanding opportunities for disease transmission events between humans and a group of dogs that are both companions and coworkers. The study also demonstrates a surveillance method for H5N1 HPAIV and the capacity of hunting dogs as warning signals for population health. Since H5N1 HPAIV is not currently a human pandemic, we are situated in a position that enables us to achieve prevention of the disease rather than merely response to events or public health disasters. Overall, this research provides the basis for future studies seeking to understand the intricate relationship between hunting dogs and their owners, and the intermediate connection of domestic animals in the potential spread of infectious diseases between humans and animals.

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Appendix

Table A. Identified cases of H5N1 HPAIV in wild birds in Washington State as of April 4, 2024

Bird Species	Total
American Crow (*Corvus brachyrhynchos*)	3
American green-winged teal (*Anas carolinensis*)	7
American white pelican (*Pelecanus erythrorhynchos*)	1
American wigeon (*Mareca americana*)	8
Bald eagle (*Haliaeetus leucocephalus*)	24
Barn owl (*Tyto alba*)	1
Black turnstone (*Arenaria melanocephala*)	1
Bufflehead (*Bucephala albeola*)	1
Cackling goose (*Branta hutchinsii*)	6
Canada goose (*Branta canadensis*)	37
Caspian tern (*Hydroprogne caspia*)	12
Common raven (*Corvus corax*)	1
Cooper's hawk (*Accipiter cooperii*)	1
Crow* (*Corvus*)	3
Dunlin (*Calidris alpina*)	2
Gadwall (*Mareca strepera*)	2
Glaucous gull (*Larus hyperboreus*)	2
Glaucous-winged gull (*Larus glaucescens*)	2
Goose* (*Anser*)	1
Great blue heron (*Ardea herodias*)	1
Great horned owl (*Bubo virginianus*)	5
Gull* (*Larus*)	1
Hawk* (*Buteo*)	1
Hooded merganser (*Lophodytes cucullatus*)	1
Mallard (*Anas platyrhynchos*)	132
Northern pintail (*Anas acuta*)	3
Northern shoveler (*Spatula clypeata*)	29
Peregrine falcon (*Falco peregrinus*)	5
Red-tailed hawk (*Buteo jamaicensis*)	6
Ross's goose (*Anser rossii*)	1

Sanderling (*Calidris alba*)	3
Sandhill crane (*Grus canadensis*)	2
Short-eared owl (*Asio flammeus*)	1
Snow goose (*Anser caerulescens*)	8
Swan* (*Cygnus*)	1
Trumpeter swan (*Cygnus buccinator*)	3
Tundra swan (*Cygnus columbianus*)	1
Turkey vulture (*Cathartes aura*)	3
Western sandpiper (*Calidris mauri*)	1
Western screech owl (*Megascops kennicottii*)	1
Wood duck (*Aix sponsa*)	3

*Unidentified

Fig. A. Primary survey completed by hunters from Washington State to understand hunting dog retrieving activities, CIV vaccination, and health history.

Owner name & contact information (phone or email, whichever is preferable for results notification):

Name of dog: Date of sampling: Dog age (years):

Dog breed: Sex: □Male □Female

-Has your dog been vaccinated for canine influenza? □ Yes □No □Unknown

If yes, approximately what year (if known):________________

-Has your dog been infected with canine influenza virus? □ Yes □ No □Unknown

If yes, approximately what year (if known):________________

-Approximately, how many times did this dog <u>hunt</u> over the previous 12 months?

□0-5 □5-10 □10-15 □15-20 □20+

-Approximately, how many times did this dog <u>train with live or dead birds</u> over the previous 12 months?

□0-5 □5-10 □10-15 □15-20 □20+

-In what states has your dog hunted/trained over the previous year (list additional states on back page)

1)____________________ general area(s) ____

2)____________________ general area(s) ____

3)____________________ general area(s) ____

-What species groups have your dog retrieved (hunted or trained) over the previous calendar year?

□dabbling ducks □diving ducks □sea ducks □ geese □ coots □pheasants

□quail □grouse □doves □pigeons □chukars □ Hungarian partridge

□other______________________

-To your knowledge, were any of the birds your dog retrieved showing outward signs of disease, exhibiting odd behavior, or found dead? □Yes □No

If yes, please list what the signs were:

-Has your dog exhibited any signs of illness over the last calendar year? □Yes □No

If yes, please list what the signs were and approximately when:

Fig. B. Secondary national survey completed by hunters to assess the interactions between humans and hunting dogs.

Hunting Dog Interactions

As a graduate student at the University of Washington with a background in animal behavior and wildlife conservation, I am interested in identifying events where human-wildlife contact may occur along with the associated health impacts for both animals and humans. These questions will provide a better understanding of indirect human-wildlife interactions, mediated by hunting dogs. Understanding the connection and contact you have with your dog may enable us to determine different factors that influence the risk of exposure to disease for both your dog as well as yourself along with opportunities for prevention of disease transmission. Your insight and participation are greatly appreciated.

When answering these questions, please consider all of your hunting dogs.

Name

____

What state do you live in?

- ○ Alabama
- ○ Alaska
- ○ Arizona
- ○ Arkansas
- ○ California
- ○ Colorado
- ○ Connecticut
- ○ Delaware
- ○ Florida
- ○ Georgia
- ○ Hawaii
- ○ Idaho
- ○ Illinois
- ○ Indiana
- ○ Iowa
- ○ Kansas
- ○ Kentucky
- ○ Louisiana
- ○ Maine
- ○ Maryland
- ○ Massachusetts
- ○ Michigan
- ○ Minnesota
- ○ Mississippi
- ○ Missouri
- ○ Montana
- ○ Nebraska
- ○ Nevada
- ○ New Hampshire
- ○ New Jersey
- ○ New Mexico
- ○ New York
- ○ North Carolina
- ○ North Dakota
- ○ Ohio
- ○ Oklahoma
- ○ Oregon
- ○ Pennsylvania
- ○ Rhode Island
- ○ South Carolina
- ○ South Dakota
- ○ Tennessee
- ○ Texas
- ○ Utah
- ○ Vermont
- ○ Virginia
- ○ Washington
- ○ West Virginia
- ○ Wisconsin
- ○ Wyoming

Did you participate in the Surveillance for Antibodies to H5 Avian Influenza Virus in Hunting Dogs study?

- ○ Yes
- ○ No

Which of these do you and your dog(s) participate in?

- ○ Hunting
- ○ Hunt tests or trials
- ○ Both

How many dogs do you have (both hunting and non-hunting dogs)?

____

______

Do your dog(s) live indoor, outdoor, or indoor/outdoor? Check all that apply.	☐ Indoor ☐ Indoor/Outdoor ☐ Outdoor
Where do your dog(s) sleep at night?	○ In the home ○ Indoors, not in the home (e.g. barn, kennel) ○ Outside
Do your dog(s) sleep in your room?	○ Yes ○ No
Do the dog(s) sleep in your bed?	○ Yes ○ No
I consider my dog(s): Check all that apply.	☐ Part of the family ☐ A pet ☐ A working dog ☐ A tool for hunting
How do you transport your dog(s) to different locations?	○ Inside the vehicle with you (e.g. backseat, passenger seat) ○ Separate from you (e.g. trailer, pick-up bed)
If your dog(s) have shown any signs of illness (e.g. diarrhea, lethargy, lack of appetite), have you ever done any of the following? Check all that apply.	☐ Kept them in the home to monitor them ☐ Handwashing after interacting with potentially sick dog ☐ Separate dog from other animal ☐ Separate yourself from the dog (e.g. put the dog in isolation, do not bring into the house) ☐ Disinfect area where dog lives ☐ Disinfect training equipment or dog gear ☐ Wear PPE (personal protective equipment) when working with the dogs (e.g. gloves, mask, etc.) ☐ Other ☐ My dog has never shown any of these signs of illness
What type of PPE do you wear? Check all that apply.	☐ Gloves ☐ Mask ☐ Respirator ☐ Other
Please list or describe other PPE used.	____
Please list or describe any other precautions you take if your dog shows any signs of illness.	____
Do you process the birds in the field a majority of the time (leaving any parts of the bird in the field)?	○ Yes ○ Sometimes ○ No
Do you feed your dog(s) parts from the animals they retrieve?	○ Yes ○ No
Do you wear PPE (personal protective equipment) when handling birds (e.g. mask, gloves, etc.) in the field?	○ Yes ○ No

What do you wear? Check all that apply.

☐ Gloves
☐ Mask
☐ Eyewear
☐ Other

Please list or describe any other PPE that you wear when handling the birds in the field.

____

Did you board your dog(s) at a facility (e.g. daycare) within the last 12 months?

○ Yes ○ No

Did you board your dog(s) at a training facility within the last 12 months?

○ Yes ○ No

Have your dog(s) been in contact with any non-hunting dogs outside of your household within the last 12 months?

○ Yes ○ No

How often on average are your dog(s) in contact with these non-hunting dogs?

○ Daily
○ Weekly
○ Monthly
○ Yearly

Have your dog(s) been in contact with any hunting dogs outside of your household within the last 12 months?

○ Yes ○ No

How often on average are your dog(s) in contact with these hunting dogs?

○ Daily
○ Weekly
○ Monthly
○ Yearly

Do you have pet insurance for your dog(s)?

○ Yes ○ No

Did your dog(s) receive a canine influenza virus (CIV) vaccination in 2023?

○ Yes
○ No
○ Do not know

Do you kiss your dog?

○ Yes ○ No

In the last 12 months, have YOU experienced any undiagnosed flu-like symptoms (e.g. fever, chills, coughing, trouble breathing)?

○ Yes ○ No

Would you like to be contacted for future studies?

○ Yes
○ No

Please enter your email address.

____