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Salmonella Knowledge, Attitudes, and Practices: A Survey of Backyard Poultry Owners Residing in Seattle, Washington, and the Surrounding Metropolitan Area

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SUMMARY

Raising poultry flocks in urban backyard settings is becoming increasingly popular across the United States., but carries a risk of zoonotic infection. In the US from 1990–2014, 53 outbreaks of human salmonellosis linked to live poultry have been documented resulting in 2611 known illnesses, 387 known hospitalizations, and 5 known deaths. (CDC 2015a). A cross-sectional descriptive study was developed to better understand knowledge, attitudes, and practices of urban backyard poultry owners regarding *Salmonella* risk and prevention. The study included a survey of bird health, animal husbandry and hygiene practices, and knowledge, attitudes, and practices relating to *Salmonella* risk. Participants were videotaped while caring for their birds, and the recordings were transcribed using notational analysis to determine if reported practices differed from observed practices. The results indicated that while a large proportion of participants knew that exposure to *Salmonella* is an inherent risk associated with raising poultry and harvesting eggs, their reported and observed practices would not consistently reduce risk of transmission of *Salmonella* and other zoonotic diseases. Approximately 1 in 4 participants reported performing practices that increase risk of inoculation, such as snuggling and kissing birds or eating/drinking near them. None of the participants were observed kissing their birds on video; however, snuggling (holding birds to clothes) or touching their face during routine care was observed in approximately two-thirds of the video recordings. The video data provided a unique opportunity to compare reported practices with actions recorded during site visits. While the differences were not statistically significant, findings from our study suggest that flock owners may not accurately report the frequency with which risky practices are performed during routine animal care. Education and outreach targeting backyard flock owners should aim to improve husbandry and hygiene practices and reduce risk of zoonotic diseases associated with raising poultry in the backyard setting.

Keywords

Salmonella; poultry; backyard chickens; husbandry practices

1. INTRODUCTION

Raising backyard poultry creates a scenario where production animals are returning to the city after decades of moving them out into more rural areas; reintroducing the concept of “farm fresh eggs” has its benefits but also raises concerns related to public health. In the US from 1990–2014, 53 outbreaks of human salmonellosis linked to live poultry have been documented resulting in 2611 known illnesses, 387 known hospitalizations, and 5 known deaths (CDC 2015a). In addition, backyard poultry ownership by inexperienced individuals increases the likelihood of zoonotic disease transfer related to poor husbandry and hygiene practices (Scallan et al. 2011).

While there is not a standard definition used to describe backyard poultry flocks (Elkhoraihi et al. 2014; Beam et al. 2013; Pollock et al. 2012) and flock size may be limited by specific city ordinances, the term is usually used to describe privately-owned, non-commercial flocks of domesticated poultry species. In our study area, the Seattle Municipal Code (SKC MCP 23.42.052) allows for up to eight domestic fowl (chickens, ducks, turkeys, geese), excluding roosters, within the city limits of Seattle, WA and in Bellevue, Washington, only six chickens are allowed on a city lot (City of Bellevue, Ordinance 3413). King County Code, which is in effect in unincorporated areas, allows for varying flock sizes depending on the size of the animal housing structure (King County Code Section 21A.30.020).

Raising backyard poultry in an urban setting is increasing in popularity in many areas across the country (Elkhoraihi et al. 2014). As people are becoming more health conscious and aware of food sourcing, the movement towards sustainable farming and local foods has influenced the rise of urban farming. Raising chickens in the city not only provides fresh eggs but also companionship to their caregivers. From a public health perspective, there is inherent risk associated with zoonotic transmission of pathogens commonly associated with poultry husbandry and production. Common pathogens of interest include avian influenza and enteric bacteria, particularly *Salmonella enterica* and *Campylobacter jejuni* (Reed et al. 2003). These two bacteria are the leading causes of diarrhea caused by foodborne illness due to consumption of, or contact with, poultry products (Scallan et al. 2011). Transmission of *Salmonella* as a foodborne illness occurs when a product is contaminated with bacteria or due to inadequate heating or cooking of food (e.g. salmonellosis associated with undercooked eggs or chicken meat). Other routes of transmission of *Salmonella* may involve direct contact with poultry, or indirect contact with contaminated surfaces such as eggs, bedding, structures, or the environment.

Salmonella enterica can cause severe gastroenteritis and septicemia in humans and is generally the type implicated in cases of human salmonellosis (Beam et al. 2013). While *Salmonella* infections in young poultry can sometimes cause diarrhea, inappetence, weight loss and death, most of the time infection is subclinical (Beam et al. 2013). With subclinical infections, birds can shed the bacteria without any noticeable signs or symptoms of disease.

Since birds may carry *Salmonella* but not show outward signs of illness, it is important that poultry owners and handlers are aware of potential subclinical infection and consistently practice risk-reducing practices. Literature examining risks associated with *Salmonella* in flocks is largely focused on commercial operations and is not directly transferable to the backyard setting (Pollock et al. 2012). Prevalence of *Salmonella* occurring in backyard poultry flocks is largely unknown and likely variable depending on geographical location, husbandry and hygiene practices, hatchery source, and risk awareness of the owner (Pollock et al. 2012).

Contact with live poultry, including chickens, ducks, geese and turkeys, has long been a public health concern (CDC 2012ab; Behraves et al. 2014). Salmonellosis cases linked to contact with backyard poultry have been reported since 1955 (Loharikar et al 2009). In a report from the Centers for Disease Control and Prevention (CDC), an estimated 50 million chicks are sold each year, and since the 1990's there have been 53 reported outbreaks of human Salmonellosis linked to live poultry (CDC 2012a, 2014). An increased number of *Salmonella* outbreaks associated with backyard flocks really began to take off in 2007 with two unrelated *Salmonella* Montevideo multi-state outbreaks that were traced back to contact with poultry sold by feed stores or mail-order hatcheries (CDC 2009). Contact with baby poultry in backyard settings has been implicated in *Salmonella* outbreaks in the US, namely associated with chicks from mail-order hatcheries, each year from 2011 to 2014 (CDC 2012a, 2014a, 2015a; Behraves et al. 2014). In 2011 there were two outbreaks of *Salmonella* associated with 96 cases in 24 states that were traced back to contact with live poultry within weeks of purchasing chicks (CDC 2012ab). In 2012 three poultry-related outbreaks resulted in 334 cases, and in 2013 there two outbreaks and a total of 514 cases traced back to live poultry exposure (CDC 2015b). In 2014, there was one outbreak with 363 cases directly related to contact with live poultry located at the homes of the infected persons (CDC 2014, 2015b). As of December 2015, there had been four outbreaks associated with backyard poultry with 252 cases, 63 of which had been hospitalized (25%) (CDC 2015b). While it is widely known that salmonellosis can be acquired from consuming undercooked poultry and eggs or through cross-contamination in the kitchen, it is unclear if risk associated with raising chickens and handling eggs is acknowledged by those raising poultry in a backyard setting.

A multi-state study in 2010 targeting poultry owners at feed stores in Denver, Miami and Los Angeles analyzed *Salmonella* awareness and related practices utilizing written surveys. The study findings suggested there was limited awareness of risk associated with contact with live birds (Beam et al. 2013). In 2013, Elkhoraibi et al conducted a survey of owners of backyard flocks through feed stores in California, Colorado, and Florida to study general biosecurity and knowledge of poultry husbandry. This study also indicated a lack of awareness of poultry diseases and potential zoonotic risks associated with keeping poultry (Elkhoraibi et al. 2014). Both of these studies involved written surveys, relying on responses from participants that may include substantial response bias (Mazengia et al. 2015). In a study assessing cross-contamination during raw poultry handling in kitchens performed by researchers at the University of Washington in 2012, a combination study design using direct observation and a survey was used to reduce response bias and to compare observed versus reported behaviors (Mazengia et al. 2015).

The purpose of this cross-sectional study was to assess, among owners of backyard flocks in Seattle and the surrounding metropolitan area, the level of knowledge of *Salmonella* and risk of infection in maintaining poultry, and to also assess through survey and observation attitudes and practices that may influence exposure. The outcomes of this study may help direct future educational efforts to increase awareness and promote better husbandry and hygiene practices to reduce the risk of zoonotic disease among flock owners and those who come into contact with their flocks.

2. METHODS AND ANALYSIS

Potential participants responded to recruitment flyers that were posted at local feed stores, local veterinary clinics, online backyard poultry posting forums, and Facebook group pages, and by word of mouth. Participants were recruited from June 2014 through October 2014 until 50 households, who met the criteria for selection, were scheduled for site visits. Selection criteria required participants to be at least 18 years old, own at least one chicken and live in the Seattle metropolitan area. Participants were videotaped while they cared for their birds to record specific activities owners perform during routine animal care. Following observation of caretaking practices, a sixty-one item survey was administered orally to study participants that focused on bird health; general *Salmonella* knowledge; attitudes about *Salmonella* risk; and biosecurity, husbandry, and hygiene practices. Survey responses were compared to observed practices from the video recordings. Specific flock characteristics collected included type of poultry, flock size, number of birds owned currently and over past year, and duration of production cycle in weeks/months/years. Bird age was not directly collected.

Flock owners' routine care of birds, which included feeding, watering, harvesting eggs, cleaning the coop and bird handling were recorded using Flip Video Cameras (Cisco Systems, San Jose, CA). Recording began following the collection of a pre-avian contact hand swab, and ended after flock owners washed their hands following the completion of flock care. The video recordings were analyzed to assess whether certain practices like kissing or snuggling chickens or touching the face occurred during the 5 to 15 minute caregiving routine observed during the site visit. Video recordings of subjects were analyzed by two members of the research team to identify the number of hand contamination, cross-contamination, and self-inoculation events.

Hand contamination was defined as touching a coop surface and/or birds directly. Cross contamination was defined as touching bird to mouth (representative of kiss in survey), holding bird close to body making contact with clothes (representative of snuggle in survey), bare hand contact with surfaces likely to be contaminated by bird droppings, and improper personal protective equipment (PPE) use, such as wearing "flock shoes" in the house. Finally, self-inoculation was defined as any hand-to-face, including hand-to-mouth, activity. Each recording was reviewed by two researchers and their observations recorded on separate forms and the total number of events averaged across the two.

Questions on the survey were derived from public health guidelines for husbandry and hygiene practices and designed to collect information on how often certain risky and risk-

reducing practices are performed, using a Likert Scale to assess frequency. These data were re-categorized into two categories. Participants who responded to the survey as performing an activity *always*, *usually* or *sometimes* were considered to perform the practice often enough to be categorized as performing the practice, while those who responded *never* or *rarely* were categorized as not performing the practice. Responses of *not applicable* were excluded from the analysis. Participants were asked to self-report whether or not they had experienced symptoms or illness attributable to contact with or consumption of eggs from their flock, and what types of symptoms they had experienced.

Participants were pre-screened prior to scheduling site visits to ensure they met the selection criteria. Each survey site was given a unique code and data were entered into a database system excluding identifiable subject information. Missing data due to unanswered questions were infrequent, and non-responses were excluded from analysis. One video was lost due to technology transfer error resulting in a sample size of 49 for analysis of video and survey results. Descriptive analysis was used to describe survey results. Chi-square analysis was used to test for association between reported practices and gender, age and education status, using SPSS version 19. The University of Washington's Institutional Review Board approved this study.

3. RESULTS

The study participants were predominantly White (94%), female (74%), and well-educated (Table 1). Over one-third (36%) of participants had a 4-year college degree and more than one-half (54%) had a graduate degree or higher. Only 10% of participants had less than 4 years of post-high school education. No significant association between performing certain practices and demographic factors using chi square analyses were found.

The average layer flock size was 5 hens, with a range of 2 to 21 adult birds; the majority of flocks (45/50, 90%) were comprised of 8 or fewer birds. Two participants (4%) had other domestic poultry species living on the premises in addition to chickens, including waterfowl and turkeys. More than half (30/50, 60%) of participants reported that they kept birds for their entire life cycle; 32% (16/50) indicated that they have a set production cycle of 2–5 years, and 8% (4/50) did not specify a production cycle length. There was only one household with chicks on site during the site visits. At this location, the chicks were kept inside the home, while adult chickens were housed in an outdoor coop.

A total of 80% of participants knew that *Salmonella* is a bacterium, while 10% responded that that it is a virus, and 10% reported that they did not know. A total of 40% of participants understood that chickens could have symptoms of disease caused by *Salmonella*, 20% responded that chickens could not have disease caused by *Salmonella*, and 40% reported they did not know. Almost all participants (98%) reported that they were aware *Salmonella* could cause significant disease in humans (Table 2).

When asked how often participants washed their hands with soap and water or used hand sanitizer after direct contact with live poultry or their environment, almost all (98%) responded that they perform this practice (Table 3). Two-thirds (66%) of participants

responded that they do not wash poultry-related equipment in the house or in areas where food is prepared. Three-quarters (76%) of owners reported that they either rarely (10%) or never (66%) let live poultry inside their house, in bathrooms, or in areas where food or drink is prepared or stored.

One-quarter of participants reported that they snuggle, kiss, touch their mouth or eat/drink around chicks (26%) or adult chickens (22%). One-half (51%) of participants responded that they eat raw or undercooked eggs, including restaurant dishes. When asked if participants eat eggs from their chickens that were dirty or cracked, almost one-half (42%) responded that they had; however, most participants clarified that their answer applied only to dirty eggs and not to eggs that were cracked when collected. Over one-half (57%) of respondents indicated that they allow children younger than 5 years of age to have direct contact with chickens, especially chicks. When asked if participants wear personal protective equipment while cleaning the chicken coop, almost three-quarters (72%) responded that they do not wear a mask and almost one-half (43%) that they do not wear gloves.

In some videos young children, suspected to be less than five years old, were observed in the chicken enclosure area, petting chickens and collecting eggs. There were also observations of children playing barefoot in the yard where chickens were foraging. Entering the home with flock shoes and touching doorknobs with dirty hands were also observed.

Self-reported illness due to contact with coop and/or consumption of meals prepared with eggs from the coop occurred in approximately one-eighth of participants (6/50, 12%). The range of reported symptoms included diarrhea, vomiting, fever, abdominal cramping; however, information regarding clinical diagnosis and testing was not obtained from the participants.

For the purpose of consistent video analysis, we defined “snuggling” as participants holding birds close against the upper body making contact with clothes. None of the participants were observed eating/drinking near birds or kissing their birds on video. Touching the face was the practice performed most often and was observed in one-half (25/49, 51%) of the video recordings. Almost one-quarter of participants were observed snuggling birds (11/49, 22%). Overall, almost two-thirds of the video recordings identified participants touching their face and/or snuggling birds while performing their daily care routine (32/49, 65%).

Video observations were compared with individual participant survey responses to assess if there were differences between those who responded that they did or did not perform practices that involved close contact or higher risk exposure, defined as kissing or snuggling birds, touching their mouth, or eating or drinking near adult chickens. Most participants who reported that they do have close/higher risk exposure contact were in fact observed on video touching their face or snuggling birds during the site visit (10/11, 91%). A smaller proportion of participants had discordant responses and observations (Table 4, $p=0.071$); slightly more than one-half (22/38, 58%) of participants who reported that they do not have close/higher risk exposure contact were observed on video snuggling birds or touching their face.

4. DISCUSSION

Findings from this study suggest that flock owners often participate in risky practices while caring for their birds though they may not always be aware of or accurately report doing so. Health psychology theories, such as the Health Belief Model, suggest that perceived risk drives health-protecting behaviors (Brewer et al. 2004; Ibuka et al. 2010). Precautionary behavior can change over time depending on many factors including media attention to outbreaks, household composition and perceived risk to oneself and family members (Ibuka et al. 2010).

About one-fourth of participants reported that they kiss and snuggle live chicks or chickens, touch their mouth, or eat/drink near poultry (24% vs. 26%). This type of close contact increases the risk of ingesting material that could be contaminated with pathogens such as *Salmonella*. Although CDC recommends that young children are at higher risk of illness related to salmonellosis, over one-half (54%) of participants reported that they do allow children younger than five years old to have direct contact with poultry. Prior studies indicate ‘educational experience for kids’ as a main reason for owning backyard poultry (Beam et al. 2013). From the observed practices, it was not uncommon for participants with children in the home to allow supervised interaction with the poultry and some allowed young children to help with chores such as collecting eggs. It is important that parents are aware of risks associated with hand-mouth exposure during routine care and that children are more susceptible to illness so that they can supervise contact and promote risk-reducing practices like hand hygiene.

CDC guidelines and literature produced by the Washington State Department of Health (WSDOH) promoting proper poultry husbandry and hygiene highlight certain high-risk practices to avoid. The guidelines recommend washing hands with soap and water, or using hand sanitizer, after handling poultry or anything in their environment. CDC recommends cleaning all poultry equipment or materials associated with raising poultry outside the home, including feed and water containers and cages. Guidelines advise not allowing children under the age of five years or adults with weakened immune systems to have contact with or handle chicks or other live poultry. Avoiding hand to mouth contact is advised, specifically not kissing or snuggling adult or baby poultry, as well as not eating or drinking around poultry. Keeping poultry out of the house including bathrooms and kitchens, and away from areas where food and drink is served, including patios, is also recommended.

The video recordings allowed a unique opportunity to compare reported practices with those observed during the site visit. Specifically, comparing how participants responded to the question, “*How often do you kiss/snuggle, touch your mouth, eat or drink near adult birds?*” versus videotaped observation, differences were noted on how participants may respond to questions about perceived “risky” practices. Those who responded that they did perform the practice were commonly observed on video performing this practice, while those who responded that they did not perform the practice were observed on video performing the practice over 50% of the time. This indicates that participants may be likely to underreport risky practices and practices.

Limitations of this study include lack of diversity of the study population. The self-selected group of participants was predominantly White, female and well-educated. Ownership of backyard poultry in Seattle and the surrounding area does not require a permit, so there is no traceable source of data available to better understand the demographics of the owner population.

Survey questions were read to the participants and a research associate was able to help clarify questions as needed to minimize misinterpretation or lack of understanding of survey questions. Administering the survey orally may have created response bias, and participants may be less likely to report risky practices to a research associate than if a written survey had been filled out individually. Also, since participants were videotaped taking care of their birds prior to answering survey questions, they then may have been more aware of how researchers would interpret their survey responses (positively or negatively).

Education to reduce exposure to *Salmonella* has been implemented by Public Health- Seattle & King County at all poultry retail businesses in King County, Washington. Poultry retail businesses in King County are permitted and inspected by Public Health- Seattle & King County and are required to maintain a written infection control plan, post signs encouraging hand washing, provide hand washing facilities or hand sanitizer, and post signs about and distribute *Salmonella* educational information to customers at the time of sale (King County Board of Health Chapter 8.03 Pet Business Regulations). Signage and flyers describing *Salmonella* risk and CDC recommendations were adapted by the Washington State Department of Health; these and other resources are made available to poultry retail businesses by Public Health – Seattle & King County. Additional educational information, including best husbandry practices and information on other diseases associated with live poultry contact, should be distributed at the time of sale to increase awareness. Owners' experience with animal husbandry is variable, and the feed store setting would be an ideal place to reach owners for best practice recommendations as this is a point of contact people trust and visit frequently for feed and husbandry supplies. Proper egg processing and use of personal protective equipment (mask and gloves) when cleaning the coop are important husbandry practices that flock owners should improve. These practices not only reduce transmission of *Salmonella* but also protect flock owners from other zoonotic diseases related to poultry. Educational programs should be pretested and adjusted to fit the target population.

5. CONCLUSION

The data from this survey reveal that backyard poultry owners are aware of the association between *Salmonella* and poultry, but that they do not consistently perform risk-reducing husbandry and hygiene practices as recommended by CDC and the State department of health to help prevent infection with *Salmonella*. There is a need for better education to effectively communicate the risk of potential for zoonotic disease transmission and provide recommendations for husbandry and hygiene practices. While *Salmonella* knowledge, attitudes and practices were the focus of this particular study it is not the only relevant zoonotic exposure owners should be made aware. Flock owners should understand that there

is risk of disease transmission, but that good husbandry and hygiene practices can reduce risk and help to keep their poultry, themselves and their family healthy.

Future areas of study should include assessing factors that influence the detection of *Salmonella* in backyard flocks and the rates at which adult chickens shed *Salmonella* to help determine the risk associated with keeping backyard flocks. To better understand measurable risks associated with raising backyard poultry there should also be further study to assess how long chicks shed *Salmonella*. Since increased risk of salmonellosis is associated with chicks, assessment of husbandry/hygiene practices of owners caring for chicks may identify behaviors and practices that could be targeted to reduce risk of transmission. Evaluation of feed store and other poultry retail business educational messaging and advice on husbandry practices to customers would help to determine effective ways to influence and improve husbandry and hygiene practices among poultry owners. Consideration should be given to ways to encourage appropriate signage and education at point of sale. Public health and/or state departments of agriculture can play a key role in such educational efforts to increase risk awareness of store management, and educate on appropriate husbandry practices in-store, the need for accessible hand-washing and distribution of educational information for customers.

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IMPACTS

- *Salmonella* outbreaks associated with poultry contact occur every year. Understanding how backyard owners care for their birds and identifying gaps can help target educational outreach by health departments, departments of agriculture, mail-order hatcheries, veterinarians and feed stores to help flock owners safeguard their health.
- Notational analysis of video recordings from site visits allowed for comparison of observed versus reported practices. Results suggest that owners may not be aware of how often they perform risky/risk-reducing practices while caring for their birds.
- Future education outreach should focus on husbandry and hygiene practices at point of sale of chicks, and ongoing industry wide outreach through feed stores and other partners.

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Table 1

Demographics of Primary Caregiver

	No. (%) n=50
Sex	
Female	37 (74)
Male	13 (26)
Race	
White	47 (94)
Non-White	3 (6)
Education	
2- year college	5 (10)
4- year college	18 (36)
Graduate school	24 (48)
Professional school	3 (6)
Age Mean (Range)	44.5 (30–75)

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Table 2General *Salmonella* Knowledge

Survey Questions	Frequency No. (%) n=50
Salmonella is a	
Bacteria	40 (80)
Virus	5 (10)
Don't know	5 (10)
Salmonella can cause severe disease in poultry	
Yes	20 (40)
No	10 (20)
Don't know	20 (40)
Salmonella can cause severe disease in humans	
Yes	49 (98)
No	1 (2)
Salmonella is only found in poultry and poultry products	
Yes	2 (4)
No	43 (86)
Don't know	5 (10)
Salmonella can be found on which part of the egg	
Egg white (albumin)	30 (60)
Egg Yolk	29 (58)
External egg shell	44 (88)
Selected ALL Parts of the Egg	27 (54)
Salmonella can be transmitted by	
Eating undercooked/raw eggs	50 (100)
Handling chicks/chickens	49 (98)
Eating a dish made with raw eggs	49 (98)
Contact with eggs	50 (100)
Contaminated surfaces	49 (98)
Not washing hands	49 (98)
Selected all of the above transmissions	47 (94)

Table 3

Public Health Practices: Dichotomized for Behavior Trends

	Always/Often/Sometimes No. (%)	Rarely or Never No. (%)	n
a. Wash hands after touching chickens or ducks or anything in the area where they live, using soap and water or hand sanitizer if soap and water are not available	49 (98)	1 (2)	50
b. Wash clean cages, feed or water containers, or other poultry related equipment inside your house or in areas where food is prepared	16 (32)	33 (66)	49
c. Let live poultry inside your house, in bathrooms, or in areas where food or drink is prepared, served, or stored, such as kitchens, or outdoor patios	12 (24)	38 (76)	50
d. Snuggle or kiss baby chicks, touch your mouth or eat or drink or smoke around baby chicks	13 (26)	37 (74)	50
e. Snuggle or kiss (adult) chickens, touch your mouth or eat or drink or smoke around chickens	11 (22)	39 (78)	50
f. Eat raw or undercooked eggs, including restaurant dishes	25 (51)	24 (49)	49
g. Eat eggs from your chickens that were dirty or cracked **	20 (42)	28 (58)	48
h. Thoroughly wash hands and all food contact surfaces with soap and water after contact with raw eggs	43 (86)	7 (14)	50
i. Allow children younger than 5 years of age to handle (or have other contact with) your chickens, especially chicks	27 (57)	20 (43)	47
j. Wear a mask when cleaning the chicken coop	13 (28)	34 (72)	47

** Applies to dirty eggs, cracked eggs were reported as not being eaten in most surveys.

Table 4

Survey Reported vs. Video Observed Husbandry Practices

	Behaviors Observed in Video	
	Yes No. (%)	No No. (%)
Reported close or higher risk exposure contact[*] with adult birds	Yes 10 (20)	1 (2)
	No 22 (45)	16 (33)

Note: P-value= 0.071 (Fisher's exact test), n=49

* Close or higher risk exposure contact includes: kiss, snuggle, touching mouth, eating/drinking around chickens

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