



Animal contact in public settings–risk awareness of enteric pathogens and hand hygiene behaviors

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ARTICLE INFO

Article history:

Available online 20 March 2018

Keywords:

Animal contact
Enteric pathogens
Risk awareness
Hand hygiene

ABSTRACT

Contact with animals in public settings can provide education and entertainment opportunities for both adults and children. However, outbreaks have been associated with human-animal interactions at state, region or county fairs, petting zoos, educational farms, etc. Those outbreaks not only raised a public health concern, but also had substantial medical, legal, and economic impacts. In this study, we assessed the risk awareness of enteric pathogens associated with animal contact in public settings. Participants were asked whether they recognize the risk of spreading enteric pathogens through specific animal contact behaviors such as petting animals with hands or eating around farm animals. The results showed that the self-reported risk awareness was 4.0 ± 1.2 out of a total score of 6, which indicated a poor risk awareness. We also assessed the hand hygiene behaviors including hand washing and hand sanitizer application. Most participants ($n = 177$, 78.0%) reported that they wash their hands immediately after contact with animals. Logistic regression results showed that risk awareness associated with animal contact was a reliable predictor of hand washing behaviors. Findings from this study serve as a needs assessment for future education to reduce risk of spreading enteric pathogens during animal contact in public settings.

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1. Introduction

Although contact with animals in public settings can provide education and entertainment opportunities, it also raises the risk to spread diseases (CDC, 2011a; Lejeune & Davis, 2004). Public settings include state/region/county fairs, petting zoos/farms, educational farms, school exhibitions, etc. Outbreaks related to animal contact in public settings have been reported to the Centers for Disease Control and Prevention (CDC) from as early as 1988 (CDC, 1988) to present. From 2000 to 2014, human-animal interactions at state, region or county fairs, petting zoos and educational farms have caused 30 gastroenteritis outbreaks in the United States. The Shiga toxin-producing *Escherichia coli* (STEC) outbreak linked to a petting zoo at the 2004 North Carolina State Fair resulted in 187 illnesses, 15 of which were complicated by Hemolytic Uremic Syndrome (HUS) (Goode & O'Reilly, 2005). This outbreak led to the

passage of Aedin's Law in North Carolina, which created regulations for exhibitions housing animals intended for physical contact with the public (2005). However, despite the new regulations, outbreaks associated with animal contact in public settings continues. In 2012, also in North Carolina, another *E. coli* O157:H7 outbreak caused 106 illnesses, including 1 death at the Cleveland County Fair petting zoo (CDC, 2012). A recent outbreak (Whatcom County Health Department, 2015) happened in Washington State and sickened 25 people. An investigation conducted by the Health Department of Whatcom County, WA, indicated that the source of this *Escherichia coli* O157:H7 outbreak was likely the dairy barn at the Northwest Washington Fairground. Ten people were hospitalized and 6 of them developed HUS which may eventually cause life-threatening kidney failure.

This public health issue is not just limited to the U.S., as animal contact in public settings has been causing outbreaks worldwide. Australia's largest outbreak of STEC infection occurred in Queensland during August 2013 associated with a petting zoo at the RNA (Ekka). There were 57 notified cases with the median age of 9 years

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(65% cases were children). Bloody diarrhea was reported among 41% cases but there were no reports of HUS (Queensland Health, 2014). An *E. coli* O157:H7 outbreak associated with Godstone Farm in the U.K. caused 93 illnesses (The Independent Investigation Committee, 2010) and the outbreak list goes on. The medical, public health, and economic impact of those outbreaks were substantial (CDC, 2011a).

Gastroenteritis outbreaks related to animal contact in public settings are caused by enteric pathogens that can transmit from animals and/or animal living environment to humans. A recent study estimated that 14% of all diseases in the United States by *Campylobacter* spp., *Cryptosporidium* spp., *E. coli* O157, non-O157 STECs, *Listeria monocytogenes*, non-typoidal *Salmonella enterica* and *Yersinia enterocolitica* were attributable to animal contact (Hale et al., 2012). Enteric pathogens can be carried by healthy animals without them having any illness. In fact, some animals serve as major reservoirs for specific pathogens. For example, ruminants such as cattle, sheep (Barlow, Gobius, & Desmarchelier, 2006), goats (Beutin, Geier, Zimmermann, & Karch, 1995), and deer (Cody et al., 1999) have been identified as the major reservoirs of *E. coli* O157:H7, with cattle being the most important source of human infections. Poultry are well-known for carrying *Salmonella* spp.. Animals harbor and shed enteric pathogens. Humans can be exposed and infected through direct or indirect contact with animals. Among all the identified sources associating with human-animal interaction, *E. coli* O157:H7 was the lead causative agent, followed by *Salmonella* spp.. *E. coli* O157:H7 is one of the most commonly identified STECs in North America. It has the ability to cause attaching and effacing (A/E) lesions on human intestinal epithelium and produce Shiga toxin which can be absorbed into the bloodstream and disseminated to other organs (Sandvig, 2001). Very young children and the elderly are identified as high-risk populations and are more likely to develop severe illness and HUS than others (CDC, 2011b). At the 2012 Cleveland County Fair outbreak in North Carolina, of the 106 people sickened, 65 were children (CDC, 2012). Not only are children's developing immune systems more susceptible to enteric pathogens, but they are also more likely to perform risk behaviors such as biting their nails during interaction with animals. The long term health consequences of *E. coli* O157:H7, especially for children, could be devastating, potentially leading to end-stage kidney disease, permanent brain damage, and insulin-dependent diabetes.

The objectives of this study were to describe urban, southeastern Louisiana participants in public events involving animal contact on the following characteristics: age, race, education level, and gender; to describe study participants' risk awareness of enteric pathogen associated with animal contact; to describe study participants' hand washing and hand sanitizer use behaviors; to describe study participants' past experiences with illness, allergy and animal bites at or after visiting livestock shows, petting zoos, or other places where they had contact with animals; and to determine the factors that may predict handwashing behaviors.

2. Material and methods

2.1. Questionnaire design

A questionnaire was designed to assess the participants' risk awareness of enteric pathogens and hand washing behavior after animal contact. A theory-driven approach to construct development was used. This approach involved a thorough review of the literature after which initial questions were developed by authors using the literature to also inform item development. The survey was reviewed for face validity by ten colleagues in the university who have children under five years old. Grammatical corrections

were made, and the wording of the questionnaire was modified based on the feedback. A pilot test was conducted with ten people, five of whom were males while the other five were females. Paper and electronic formats of the questionnaire were randomly used with the pilot group. Other than gender, no demographic information was taken into consideration when select the pilot group. The average time of completion was around 2 min. Feedback from participants in pilot test suggested that both the paper format as well as the electronic format of the questionnaire were acceptable modes of distribution. The survey instrument is under review at another journal.

Our questionnaire consisted of four sections including risk awareness, handwashing behavior, hand sanitizing behavior, and demographics. In the risk awareness section, seven items were developed to gauge participants' awareness of infectious disease risk associated with animal contact. An example item was "do you agree that petting farm animals with your hands is a risky behavior for enteric pathogen transferring." A six point Likert scale was used to capture participants' responses: strongly disagree, disagree, slightly disagree, slightly agree, agree, strongly agree. In the handwashing behavior section, seven response options were given based on how soon handwashing would occur after contact with farm animals in public settings. Response options included "immediately after contact", "within 30 min of contact", "within 1 h of contact", "when I think about it", "only before meals", "only after going to the restroom", and "I do not wash my hands." The rationale for this item was the assumption that the longer the time span between animal contact and handwashing, the higher the risk of passing the pathogens, if pathogens existed. In the hand sanitizing behavior section, two items were included regarding whether participants used hand sanitizer in place of handwashing or used hand sanitizer to supplement hand washing. A three-point, Likert-type scale was used: never, sometimes, and always. Demographic questions included age, race, education, gender, approximate number of visits to livestock shows, petting zoos, and other places of animal contact in the past year, whether the participant is a parent of young children, as well as their past experience (intestinal illness, animal bites, and allergies) after animal contact.

2.2. Questionnaire administration

The survey was distributed in southeastern Louisiana parishes in and around urbanized areas in 2016. A convenience sample of participants was selected at five events associated with animal contact, including one livestock show, three petting zoos and one agricultural education event. The only criteria for inclusion in the study was that participants had to be 18 years or older. The questionnaire was filled out by 231 adults who reside in Louisiana. Urbanized areas were chosen because people who live in those areas were normally away from nature. As part of bringing nature to the cities, petting zoos, educational farms, or other forms of animal-human interaction activities were popular in urbanized areas. This study received approval from the LSU AgCenter (HE 16-5) IRB board.

2.3. Data entry and analysis

Questionnaire responses were entered into Excel, and entry-validation checks were performed on all questionnaires by manually comparing the database and hard-copy versions.

For the risk awareness construct, answers were coded 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree, 6 = strongly agree. For each respondent, responses to the seven items were summed then divided by seven to create a mean value or average for the responses to the

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