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Human Dimensions

Assessing Rabies Knowledge and Perceptions Among Ethnic Minorities in Greensboro, North Carolina

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ABSTRACT Human behaviors play a fundamental role in the epidemiology of urban wildlife diseases, and those behaviors are shaped by knowledge and ethnicity. We evaluated knowledge of rabies, transmission routes, vector species, and response to rabies exposure with a bilingual (English/Spanish) in-person survey in Greensboro, North Carolina. Ethnicity, gender, and education level were predictors of rabies knowledge. Latinos and African Americans had less rabies knowledge than non-Latino Whites. Non-Latino Whites and men had less knowledge than women. Only 41% of African American respondents identified animal bites as a route of rabies transmission to humans, and less than half of all respondents knew that washing a bite wound with soap and water was useful rabies prevention. Our knowledge scale was internally consistent (Cronbach's alpha = 0.73) and could be valuable for future studies of zoonotic disease knowledge. Future rabies educational campaigns should focus on developing culturally sensitive, language appropriate educational materials geared to minorities.

KEY WORDS African American, bilingual, education, gender, Hispanics, Latino, public health, rabies, urban, zoonotic disease.

Urban areas often provide ideal environments for the spread of zoonotic diseases from wildlife because they host high densities of humans, pets, and wildlife vectors (Van Druff et al. 1994). In fact, urban environments that include minimal amounts of green space can host greater population densities of wildlife species considered zoonotic disease vectors than rural environments by facilitating greater reproduction rates and increased survival (Prange et al. 2003). Raccoons (*Procyon lotor*) are widespread in North America, present in high densities in urban environments (Riley et al. 1998, Smith and Engeman 2002), and hosts for a large number of pathogens (e.g., *Leptospira interrogans*, canine distemper, rabies, and feline panleukopenia) that can infect other wildlife, pets, and humans (Junge et al. 2007). The current rabies epidemic in the Eastern United States is associated with a raccoon variant of the rabies virus and raccoons are believed to be the primary reservoir (Rupprecht et al. 1988).

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Humans play a fundamental role in the epidemiology of urban diseases by making personal decisions related to pet vaccination and feeding, trapping, and removing wildlife. Despite the critical role of these human behaviors, little information exists on urban residents' knowledge about rabies or other zoonotic diseases. Fontaine and Schantz (1989) noted that 63% of the residents in De Kalb County, Georgia, were not well informed about health hazards associated with animals regardless of education level. Also, Bingham et al. (2010) concluded that dog owners believed the most common way for people to get rabies was wild animal bites and only 59% of the respondents were aware that without treatment, rabies exposure leads to death. Less educated people and males may be less familiar with companion animal health and vaccination needs than more educated people and females, respectively (Ramón et al. 2010). Lack of rabies knowledge and pet vaccination compliance are not directly related to income level, but they are related to gender and education level (Ramón et al. 2010). Non-vaccinated pets present a serious risk to people because they are usually most likely to contact wildlife rabies reservoirs such as raccoons and coyotes (*Canis latrans*) exposing the people around them to rabies (Rupprecht et al. 1995).

Research from the public health discipline indicates that ethnicity may be a crucial factor shaping disease knowledge (Williams and Ekundayo 2001, Altschuler et al. 2008). Ethnic minority populations, particularly Latinos, are growing much faster than the general United States population and becoming critically important for wildlife management and outreach programs (Lopez et al. 2005). Understanding and engaging minorities in wildlife management and public health programs requires the development of bilingual (Spanish/English) and culturally sensitive educational materials. Developing these materials requires an understanding of how knowledge and perceptions of zoonoses differ among ethnically and culturally diverse publics. Although the association between cultural and ethnic background and knowledge of zoonotic diseases has not been thoroughly explored, disparities between the health knowledge of non-Latino Whites and minorities have been documented repeatedly in other public health areas, such as sexually transmitted diseases (STDs) and oral health (Altschuler et al. 2008). For example, minorities living in urban settings have less knowledge and greater incidence of diseases like acquired immunodeficiency syndrome (AIDS) and syphilis due in part to the lack of culturally sensitive educational materials targeted for the specific audience at risk (Williams and Ekundayo 2001, Altschuler et al. 2008). Research is needed to determine if similar ethnic disparities in zoonotic disease knowledge are emerging.

We began addressing this need with a bilingual (English/Spanish) survey of residents from Greensboro, North Carolina. In this survey, we assessed knowledge of rabies risk, transmission routes, vector species, and first response to rabies exposure. The city of Greensboro located in Guilford County, North Carolina, is a good case study because it is ethnically diverse with 6.5% of the total population being Hispanic/Latino and 37.3% African American (U.S. Census Bureau 2010 American Community Survey). Between 2006 and 2007, 57 cases of animal rabies were confirmed in Greensboro; 33 were from raccoons. To evaluate rabies knowledge among ethnically diverse groups in Greensboro, North Carolina, we created a rabies knowledge scale and compared scores by the demographic characteristics of the respondents.

STUDY AREA

For our study, we surveyed 4 neighborhoods in Greensboro, North Carolina. We selected the neighborhoods based on income distribution and included 1 higher income neighborhood, 1 middle income neighborhood, and 2 lower income neighborhoods (median household incomes for 2010 were $92,712, $53,860, and $31,995, respectively). The neighborhoods selected were located within the Northwest quadrant of the city of Greensboro because of the high number of rabies positive raccoon cases reported in 2006 and 2007 (Guilford county Environmental Health Department 2007).

METHODS

During October–November 2009, we administered a questionnaire to the adult (18 years or older) who answered the door of every third dwelling in 4 neighborhoods of Greensboro, North Carolina. Our face-to-face sampling strategy helped reduce sampling bias associated with telephone surveys because many households may not have land lines, especially in lower income neighborhoods (Nyhus et al. 2003, Peterson et al. 2008). We surveyed all selected neighborhoods on a weekday and a weekend day during mornings and afternoons to decrease bias associated with sampling during 1 time period. When no one was home or the person refused to answer the questionnaire in the selected house, we attempted to survey the next house and restarted the count. For survey administration, we hired 10 interviewers, 4 male, and 6 female, who worked in pairs. To ensure consistency, the primary author trained all the interviewers. Each interviewer had English and Spanish copies of the questionnaire and at least 2 bilingual interviewers were available during sampling days. The interviewers asked each respondent which language, English or Spanish, he or she preferred; if Spanish was chosen, the respondent was asked if he or she wanted a bilingual interviewer.

We designed a Spanish and English version of the questionnaire to assess knowledge of rabies transmission and symptoms, how people learned about rabies, and pet vaccination status. The questionnaire was initially developed in English, translated to Spanish by a native Spanish speaker, and translated back to English to check for accuracy and consistent meaning. We elicited information on the previous year's income divided in 9 categories (classified as: $0 \leq \$14,999$; $1 = \$15,000–\$19,999$; $2 = \$20,000–\$24,999$; $3 = \$25,000–\$29,999$; $4 = \$30,000–\$34,999$; $5 = \$35,000–\$39,999$; $6 = \$40,000–\$49,999$; $7 = \$50,000–\$59,999$; and $8 \geq \$60,000$), age, education divided in 5 categories (0 = completed grammar school, 1 = completed high school, 2 = incomplete college, 3 = completed college, and 4 = completed graduate level education), years of residence, number of household residents, gender, and ethnicity. We assessed ethnicity, as defined in United States Census Bureau (2010), by asking if they were Hispanic or Latino, followed by asking their race and gave the options of White, Asian, Black or African American, Native American, and Hawaiian or other Pacific Islander. Respondents could self-classify as Hispanic or Latino and then add race such as White or African American. All people that self-classified as Hispanic or Latino regardless of their race classification were considered Latino. When respondents did not self-classify as Hispanic or Latino and chose White for race, they were considered non-Latino Whites. Respondents that chose African American for race and did not self-classify as Hispanic or Latino were considered African American. Finally, we asked respondents if they would say they had no, some, or a lot of knowledge regarding rabies.

To help us understand the association between different ethnic and socio-economic groups and their knowledge of

Table 1. Rabies knowledge scale questions and frequency of correct answers (percentage) for each ethnic group, Greensboro, North Carolina, 2009.

Knowledge question	Percent correct (percent unsure[a]) Latino ($n = 33$)	African American ($n = 40$)	White ($n = 220$)
Do you think a house cat, dog or ferret can get INFECTED with RABIES in the ways listed below?			
(1) Being bitten by an animal that has rabies	97 (0)	85 (0)	98 (0)
(2) I do not think a house cat, dog or ferret can get infected with rabies	64 (9)	82 (5)	88 (4)
(3) Only wildlife can became infected with rabies	79 (6)	90 (3)	98 (2)
Do you think that the following animal behaviors are SYMPTOMS of RABIES?			
(4) The animal presents foam in the mouth, hyper salivation	88 (12)	82 (13)	95 (4)
(5) Displays slight or partial paralysis (i.e., loss of muscle control when walking)	39 (36)	41 (49)	74 (22)
(6) Strange behavior, such as walking in circles	64 (27)	59 (28)	80 (15)
(7) Aggressive behavior, such as eager to bite	91 (6)	84 (3)	94 (5)
Do you think a human can become INFECTED with RABIES in the ways listed below?			
(8) Being bitten by an animal that has rabies	67 (33)	41 (23)	74 (23)
(9) I do not think a human can become infected with rabies	52 (9)	77 (8)	89 (1)
Do you think humans can get rabies from the animals listed below?			
(10) Dogs	85 (3)	100 (0)	99 (0)
(11) Cats	73 (18)	85 (13)	95 (4)
(12) Raccoons	56 (31)	98 (3)	97 (2)
(13) Bats	58 (27)	85 (13)	92 (5)
Which of the following procedures are useful for preventing rabies in humans after they have been bitten by an animal?			
(14) Washing the wound with water and soap	45 (21)	40 (23)	49 (21)
If you were to encounter a large dog you suspect has rabies in your neighborhood, what you do?			
(15) Call someone who can take care of it	97	92	94

[a] Unsure answers were treated as incorrect because respondents did not know the correct answer.

rabies transmission, we created a knowledge scale (Table 1) that was based on the rabies information available at the Center for Disease Control and Prevention (CDC) webpage (http://www.cdc.gov/rabies/) and from the American Veterinary Medical Association rabies brochure (https://ebusiness.avma.org/EBusiness50/files/productdownloads/rabies_brochure.pdf). We generated 15 questions to assess knowledge needed to reduce risk of rabies exposure and infection (Table 1). For the first 14 questions, the answer choices available were "yes," "no," or "not sure;" we considered the "not sure" option to be incorrect (a person that did not know the answer to these specific questions is at higher risk of rabies exposure than one that knew the correct answer), and the correct answer could be yes or no, depending on the question (Table 1). For the last question, we considered the answer correct when the respondents choose the option "Call someone who can take care of it" (Table 1). Each respondent was given a knowledge score based on the number of correct answers to the 15 knowledge questions, the knowledge score values ranged from 0 to 15.

We used analysis of variance (ANOVA) or the Kruskal–Wallis test as appropriate to compare attributes of ethnic groups using SAS/STAT® software (SAS Institute, Cary, NC) and Minitab 15 software (Minitab, Inc., Taipei, China). We used Cronbach's alpha to determine the internal consistency of our knowledge scale. Finally, we used linear regression to identify variables predicting rabies knowledge.

RESULTS

We interviewed people in 301 households. Compliance rate was 79%. We identified respondents as non-Latino White (75%, $n = 220$), Latino (11%, $n = 33$), and African American (13%, $n = 40$; Table 1). Although we could not directly determine ethnicity of non-respondents, we compared neighborhood-level response rates between 2 neighborhoods, 1 that had 72% White residents, 17% African American, and 8% Latinos, and 1 that had 41% White, 50% African American, and 8% Latino residents (U.S. Census 2010). Response rates were 84% and 80%, respectively, indicating response rates did not differ based on the demographic composition of neighborhoods. Males accounted for 51% of all respondents, 50% of Latinos, 65% of African Americans, and 49% of non-Latino Whites. Latino and African American respondents were relatively younger and lived in the area for less time compared to Non-Latino Whites (Table 2). Latinos and African Americans had lower income levels than Non-Latino Whites (Table 2) and 65% of the Latino respondents said that their household income was less than $20,000 a year. Most (77%) of the non-Latino White respondents reported earning more than $35,000 year. Latinos had lower education levels than African Americans and non-Latino Whites (Table 2), with 39% of the Latino respondents having only completed grammar school. College completion was 8 times greater among White respondents (65%) than African Americans (8%). Latino and African American respondents had lower rabies knowledge scores than non-Latino Whites (Table 2).

When we asked respondents what they considered their level of rabies knowledge, 88% indicated they had some knowledge of rabies, 9% had no knowledge, and 3% had a lot of knowledge. Interestingly, 24% of Latinos, 15% of African Americans, and 5% of non-Latino Whites believed they had no knowledge of rabies. We detected a high degree of internal consistency for the knowledge scale (Cronbach's alpha = 0.73).

Table 2. Comparison of Latino ($n = 33$), African American ($n = 40$), and White ($n = 216$) respondents' demographic information and knowledge score, Greensboro, North Carolina, 2009.

Variable	Mean (SE)					
	Latinos	African Americans	Non-Latino Whites	χ^{2a}	F^{b}	P-value
Age	34.58 (2.36)A[c]	43.2 (2.19)A	52.92 (1.11)B		23.20	<0.001
Education	0.84 (0.15)A	1.76 (0.16)B	2.64 (0.06)C	71.96		<0.001
Income level	$18,696 (0.48)A	$27,823 (0.46)A	$51,694 (0.21)B	57.65		<0.001
Years resident	9.52 (1.51)A	17.53 (2.74)A	24.50 (1.19)B		13.02	<0.001
Rabies knowledge score	10.52 (0.47)A	11.20 (0.46)A	12.98 (0.14)B		20.05	<0.001

[a] Kruskal–Wallis Test.
[b] Analysis of variance.
[c] Comparisons significant at the 0.05 level are indicated with different letters (A, B, C).

The multivariate regression model suggested ethnicity, gender, and education level were the best predictors of rabies knowledge score (Table 3). Based on standardized coefficients, ethnicity was the most influential predictor, followed by education level and gender (Table 3). Latinos ($\bar{x} = 10.5$, SE $= 0.46$) and African Americans ($\bar{x} = 11.2$, SE $= 0.46$) had lower knowledge scores compared to non-Latino Whites ($\bar{x} = 13$, SE $= 0.15$). Women ($\bar{x} = 12.6$, SE $= 0.21$) had higher knowledge scores than men ($\bar{x} = 12.4$, SE $= 0.19$). Finally, respondents with graduate or professional degrees had higher ($\bar{x} = 13$, SE $= 0.19$) rabies knowledge scores than respondents who only finished grammar school ($\bar{x} = 10.37$, SE $= 0.6$).

DISCUSSION

The rabies knowledge differences among ethnicities detected in this case study may be explained by rabies epidemiology and the availability of rabies education materials. Differing epidemiology and outreach associated with rabies in the United States and Latin America may influence low rabies knowledge scores among Latinos. The majority of the non-United States born Latinos residing in Greensboro were originally from Mexico (U.S. Census Bureau 2010). In Mexico, dogs are the primary rabies vector for humans (Schneider et al. 2011) and public health campaigns focus on dogs (World Health Organization 2005). Mexico started a nationwide dog vaccination campaign in 1990 and more than 150 million vaccines were administered to dogs between that year and 2005 (Lucas et al. 2008). The number of dog-mediated human cases of rabies decreased from 60 in 1990 to 0 in 2000 thanks to this very successful mass vaccination campaign (Lucas et al. 2008). In our study, 85% of Latino respondents knew that dogs were carriers of rabies and could infect humans, but when asked about raccoons and bats as rabies vectors, the number of correct answers declined by 30%. Lower rabies knowledge scores among Latino residents (compared to non-Latino Whites) could be due in part to lack of access (language and cultural barriers) to educational efforts. At the time of this study, all educational materials related to rabies in North Carolina were in English. Educational materials are more likely to promote a behavioral change in Spanish speaking people when they are available in Spanish (Streit-Kaplan et al. 2011). Further, places where English education materials are distributed to the public (e.g., animal control organizations, environmental or public health departments, and CDC) are not typically frequented by Latinos (Essien et al. 2000). Officials in charge of rabies clinics in Guilford County showed some concern because they had not seen many Latinos at the clinics (personal communication with anonymous animal control official). Typically, the best way to reach Latinos is to disseminate information in forums they frequently attend such as churches, local Latino markets, and community groups and local non-governmental organizations with social action orientation (Livingston et al. 2008).

Although African Americans did not face a language barrier, they still had lower rabies knowledge scores than non-Latino Whites; African American scores were similar to Latinos in most cases. Notable differences occurred on questions about which species could be rabies vectors and whether humans could become infected, where African Americans scored higher. The higher scores among African Americans for these questions may reflect the aforementioned differences in rabies information campaigns in

Table 3. Linear regression model for prediction of rabies knowledge among survey respondents in Greensboro, North Carolina, 2009 ($n = 232$).

Variable	Age	Sex[a]	Latino[b]	African American[b]	Education level[c]	Income level[d]	Years resident	r^2
Coefficient (standardized coefficient)	0.001 (0.008)	0.460 (0.097)	−1.655 (−0.205)	−1.918 (−0.268)	0.356 (0.169)	0.009 (0.012)	0.009 (0.073)	0.203
P-value	0.905	0.105	0.005	0.000	0.032	0.873	0.290	

[a] Male = 0, female = 1.
[b] Hispanic = 0, African American = 1, compared to White = 2.
[c] Completed grammar school = 0, completed high school = 1, incomplete college = 2, completed college = 3, and completed graduate level education = 4.
[d] ≤14,999 = 0; $15,000–$19,999 = 1; $20,000–$24,999 = 2; $25,000–$29,999 = 3; $30,000–$34,000 = 4; $35,000–$39,999 = 5; $40,000–$49,000 = 6; $50,000–$59,999 = 7; and ≥60,000 = 8.

Mexico. The shared low knowledge scores on other questions, however, may reflect distrust of the public health sector among African Americans (Thomas and Crouse Quinn 1991, Corbie-Smith et al. 2002). Research focusing on human health suggested Latinos were more receptive to new educational materials than African Americans (Altschuler et al. 2008). African Americans are more receptive to public health educational materials when they know and trust the information source (Aruffo et al. 1991, Corbie-Smith et al. 2002). For instance, offering condoms and educational materials to African Americans at their local barber shop or hairdresser was an effective way of reducing high risk sexual activities (Lewis et al. 2002, Charania et al. 2010).

One option for addressing low rabies knowledge within the African American community would be building trust, but agencies associated with public health may face serious challenges associated with past abuses perpetrated against the African American community such as those associated with the Tuskegee syphilis experiment (Thomas and Crouse Quinn 1991, Corbie-Smith et al. 2002). Another option would be disseminating health messages through trusted outlets including community businesses and churches (Lieberman and Harris 2007, Charania et al. 2010). Future research should address the extent mistrust of the public health sector among African Americans explains their relatively low rabies disease knowledge.

Our results indicate that education level may predict knowledge of zoonotic diseases in ways similar to other public health and veterinary issues across ethnicities. For instance, people with higher education knew more about AIDS transmission risks, prevention, and sources for information than people with less education (Aruffo et al. 1991, Essien et al. 2000). Further, individuals that attended school longer may have an increased ability to apply knowledge about disease risk and response (Aruffo et al. 1991). Also, people with higher education levels know more about animal behavior and health needs including vaccinations (Ramón et al. 2010). Because education level seems to be an important factor in rabies knowledge, educational materials related to zoonotic disease management should be modified to convey information that can be understood by a less educated public.

The relatively weak gender effect detected in this study with women having more rabies knowledge than men, which differs from previous research on wildlife knowledge (Peterson et al. 2008), may be explained by this study's focus on health rather than wildlife identification. Although research assessing wildlife knowledge indicates that males have more wildlife knowledge than females (Kellert and Berry 1987, Kassilly 2006, Peterson et al. 2008), studies regarding pets have shown that women, especially mothers, are more knowledgeable about their pets' needs than males (Reisner and Shofer 2008). Our results suggesting women have more rabies knowledge than men may be explained by the tendency for women, even those who are employed full time, to take roles managing risk, and protecting the health of their children in United States households (Maume 2008). Generally, men take less time off work to manage the urgent care of their children (Maume 2008), which could lead to less contact with pediatricians and other sources of health information. Also, women are more likely to keep their pets longer (New et al. 2000) and show greater attachment to pets (Ramón et al. 2010), giving them more opportunities to encounter rabies information when they take their pets to the veterinarian or rabies clinics for vaccinations and checkups. In particular, Hispanic women are often responsible for domestic animals associated with a household (Peña 1998, Belknap and VandeVusse 2010), which indicates females may be a conduit for zoonotic disease related information. Future research should consider Latino women as outreach targets for education on zoonotic diseases and other public health issues; although, more research is needed in this area.

MANAGEMENT IMPLICATIONS

The knowledge scale developed for this study could be adapted and used for assessments of zoonotic disease knowledge in other areas and with other diseases to determine if the serious knowledge deficiencies associated with vectors, transmission, and first response occur for other diseases. This study highlighted key deficiencies in rabies knowledge that should be addressed. First, ethnic minorities need information highlighting potential for human infection by rabies. Similarly, less than half of the minority respondents knew humans could contract rabies through being bitten by an animal, a serious knowledge deficit that must be addressed by agencies charged with management of zoonotic diseases. Also, our results indicate need for emphasis on informing immigrant populations about local rabies vectors, as those populations may be encountering these wildlife species for the first time. Our results highlight educational needs that are independent of ethnicity; for example, fewer than half of respondents from all ethnic groups knew that washing a bite wound with soap and water was useful treatment for preventing rabies after being bitten by an animal. Even though educational campaigns should be careful not to suggest washing can replace post-exposure vaccination, the most efficient means of preventing rabies aside from vaccinations (http://www.cdc.gov/rabies/) should be relatively well known among the public. The high incidence of "not sure" answers in this study suggests education may be particularly effective in zoonotic disease education efforts because people are more receptive to outreach materials when they recognize they lack information about a health subject (Altschuler et al. 2008).

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