PREVENTING AUSTRALIAN BAT LYSSAVIRUS: COMMUNITY KNOWLEDGE AND RISK
PERCEPTION OF BATS IN SOUTHEAST QUEENSLAND

Running title: Preventing Australian Bat Lyssavirus

M.K. Young^{1,2}

D. El Saadi³

B.J. McCall⁴

1. School of Medicine and GHI, Logan Campus, Griffith University

2. Moreton Bay Office, Metro North Public Health Unit, Metro North HHS

3. Communicable Diseases Unit, Queensland Health

4. Metro South Public Health Unit, Metro South HHS

Key words: Lyssavirus, Community-acquired infections, prevention and control

Abstract

Objectives: Ongoing potential exposure of members of the public to Australian bat lyssavirus (ABLV) in southeast Queensland, Australia prompted investigation of community knowledge, risk perception and intention to handle bats in order to inform future prevention efforts.

Methods: After pilot testing, a computer-assisted telephone survey of a representative sample of 700 adults without previous potential exposure to ABLV was undertaken in the defined geographic region.

Results: Twenty-four percent of eligible contacted individuals participated. Basic knowledge of bats and ABLV was generally high, with 65% of participants answering nine or more of 12 knowledge questions correctly. The perceived risk that bats pose to human health was also high, with 93% indicating some degree of risk. Although 88% of participants indicated they would handle bats in one or more of the scripted situations, overall intention to handle bats was low, with 59% indicating they would handle a bat in 4 or less of the 12 scenarios. Younger males with lower risk perception of bats most frequently indicated intention to handle bats in varying situations. Knowledge score was not associated with intention to handle bats on multivariate modeling.

Conclusions: Future public health prevention efforts, both in Australia and overseas, should focus further on conveying the *risk* to humans and to bats when non-trained, non-vaccinated people attempt to handle bats rather than attempting to purely convey knowledge about bats and ABLV or rabies. Suitable alternative measures to handling should be included. Younger adult males are a particular target group for prevention efforts.

Introduction

Bats are implicated in the transmission of a range of viruses around the world including rabies, Nipah, Hendra, and most notably in Australia, Australian bat lyssavirus (ABLV) (Calisher *et al.*, 2006). Bats may directly transmit ABLV if they are infectious and bite or scratch a human (Calisher *et al.*, 2006).

ABLV is closely related to rabies virus and human infection resembles classical rabies (Moore *et al.*, 2010). While Australia is otherwise rabies free, to date, there have been three fatal human cases of ABLV, all in the state of Queensland (CDNA, 2012, Allworth *et al.*, 1996, Hanna *et al.*, 2000, Brisbanetimes.com.au, 2013). The first case prompted recognition of ABLV as a disease of public health importance, with guidelines for prevention first published in 1996 (Hanna *et al.*, 2000). Human cases have been notifiable nationally in Australia since 2001 (Blumer *et al.*, 2003), but potential human exposures (notifiable in certain states including Queensland) are not nationally notifiable (Australian Government Department of Health and Ageing, 2004).

Some Australian states have reported on local surveillance of potential exposures over short periods (Fielding & Nayda, 2005, Torvaldsen & Watson, 1998). Surveillance in south-east Queensland has been ongoing and identified 385 notifications of potential exposure between November 1996 and October 2008 in a defined geographic area (Young & McCall, 2010). Of these, an average of 55% (around 14 people annually) required post exposure prophylaxis between 2000 and 2008. The majority of people potentially exposed (52%) were members of the public who attempted to rescue entrapped bats (Young & McCall, 2010).

Public health messages targeting community members in Queensland have been broadcast through local and state media at least annually since the late 1990s and are featured on the state government Department of Health and other websites (Queensland Health, 2011, Queensland Health, 2010, Queensland Government Department of Agriculture, 2012, Australasian Bat Society Inc and Queensland Government, Not dated). The messages warn people not to handle bats, but to call in vaccinated trained handlers if required. Despite these ongoing prevention efforts, notifications of potential exposures have failed to decline since the turn of the century (Young & McCall, 2010).

In light of this finding, this cross-sectional community survey aimed to measure the knowledge and risk perception of adults in south-east Queensland, and investigate reasons why people might handle bats, with the aim of informing future public health campaigns for preventing potential exposures to ABLV.

Participants and Methods

A social marketing company was contracted to administer a purpose-built computer assisted telephone interview (CATI) survey to 700 adults (aged 18 years +) from south-east Queensland (Figure 1) in May-June 2012. Age and gender quotas, based on the 2010 estimated-resident population, were applied to ensure the sample was representative in these respects.

Eligible phone numbers were randomly generated, then subject to validation as household numbers prior to use in the survey. Listed and unlisted numbers, but not mobile phone numbers, were therefore included.

Exclusion criteria were: residing outside the study geographic area; inability to respond to the telephone survey because of language difficulties; currently working with or handling bats (including flying foxes) whether as a professional or as a volunteer; and having been previously bitten or scratched by a bat.

The survey included both discrete-choice and open questions, and asked participants about their perceptions of the risk to human health from bats, whether they would attempt to handle a bat in a variety of situations, their knowledge of bats and disease transmission, and demographic information.

The survey was pilot tested with 39 adult members of the general public, and adjustments made to the wording of some questions to ensure clarity in communication before recruitment proper commenced. A total of 15 interviewers employed by the social marketing company conducted the interviews using the scripted questionnaire. The marketing company used project briefing and ongoing supervision to ensure consistency of interview technique.

Data analysis was performed on SPSS version 19.0, and epiInfo 6.0. Descriptive analysis compared proportions using the chi-squared test.

Twelve knowledge questions were coded: 1 = correct answer; and 0 = incorrect answer or don't know. The responses were summed to give an overall knowledge score, with a higher score indicating more correct answers.

The responses to ten risk perception questions were coded: 0 = no risk; 1 = low risk; 2 = moderate risk; and 3 = high risk. The responses were summed to give a risk perception score. To account for questions where individuals answered 'don't know', each raw score was divided by that individual's highest possible score. The result was a decimal between 0 and 1, with values closer to one indicating greater risk perception regarding bats.

Twelve questions about participants' intention to handle bats in different situations were coded: 0 = no intention to handle; and 1 = intention to handle. The small number of "don't know" responses to these questions (0.9%) were coded as 0.5 given both 0 and 1 are equally valid in this situation. The responses were summed to give an overall intention to handle bats score. The higher the score, the more situations in which an individual indicated they would handle a bat.

Knowledge, risk perception and intention to handle scores were categorised, as none of these approximated a normal distribution. Chi-squared tests compared score categories across the range of demographic variables and the relationship of scores to each other. Significant associations with the intention to handle bats were then included in a preliminary multivariate model. Backwards, stepwise, multinomial regression was applied with the criteria for removal of factors set at $p \geq 0.05$. As handling a bat that has been dead for greater than 4 hours does not pose a risk of

exposure to ABLV (CDNA, 2012), we undertook sensitivity analysis by recalculating the overall intention to handle score excluding the scenario involving a dead bat and rerunning univariate and multivariate analyses.

The responses to open questions about reasons for handling or not handling bats and the risks to human health from bats were entered verbatim into the database at the time of interview. We analysed the responses to these questions thematically. We adopted a realist method of thematic analysis using an inductive approach (Braun & Clarke, 2006). We initially coded the text transcripts at the level of the phrase, reviewing the preliminary codes to refine a set of concepts, and then considered the relationships between concepts to encode preliminary themes. We refined these in the context of the entire data set before concluding and reporting the key themes.

The study was approved by the Queensland Health Central Human Research Ethics Committee.

Results

To obtain the sample of 700 adults, 7970 unique phone numbers were called. Of these: 1503 (19%) were ineligible due to age-gender quotas, working with or being previously bitten by a bat, or language barriers; 1065 (13%) found the eligible person unavailable; 2522 (32%) were not answered; and 2180 (27%) refused participation. The participation rate was 24% (700/2880).

In accordance with the required quotas, 49% of participants were male, and more than half (53.6%) were aged less than 45 years. Sixty-three percent of participants were employed at the time of the survey. Seven percent had ever worked or volunteered in the animal health industry, and 20% had ever worked or volunteered in the human health services industry. Sixty percent had completed either a TAFE, trade or university qualification.

The majority of participants felt that bats were a danger to human health, with 20% indicating a high risk, 31% indicating a moderate risk, 42% indicating a low risk and 4% indicating no risk to human health. Three percent of participants did not have an opinion.

Participants were asked what they thought were the risks to human health from bats. While participants could not always be specific, disease transmission, including viruses and bacteria was a key theme. Participants were concerned about diseases transmitted via bat droppings, bites and scratches. Responses indicated knowledge and concern about Hendra virus more than other diseases, although ABLV and rabies were also frequently mentioned. Participants associated a variety of other viruses and bacteria with bats including: influenza and equine influenza, SARS, dengue, Listeria, and Salmonella.

Another theme was that participants felt bats' impact on the physical environment was a hazard to human health. The noise and smell of bat colonies were felt to be health risks. Bats eating fruit meant for human consumption was of concern, as was bat droppings around people's homes.

However, the other key theme in these data was uncertainty about the health risks posed by bats. While people felt there was a risk, they were uncertain what the risk might be, or could recall the name of one or more viruses they associated with bats, but did not know what the virus/es meant for human health.

Of the 700 participants, “lyssavirus” or some variety of this was mentioned by 67 (10%) as a human health risk posed by bats. “Hendra” was mentioned by 207 (30%).

However, when asked specifically about Australian bat lyssavirus, a further 327 participants (47%) had heard of the virus, and 24 (3%) felt they might have heard of it.

Participants were asked to rate a variety of situations in terms of the risk to human health (Table 1). Bats interacting with people and bats interacting with pets were identified as the most risky scenarios.

However, high proportions of people would still personally attempt to handle bats in a variety of situations (Table 2), including these ‘riskiest’ situations. The survey defined ‘handle’ as any type of contact, whether with hands, gloves or some type of implement.

Of relevance to the apparent discrepancy, 27% of participants incorrectly felt that wearing gloves nullified the risk from bat handling, 54% (correctly) thought that not all bats carry lyssavirus, and 11% incorrectly thought that only bats that appear sick are a risk to human health.

Participants were asked if there was any other situation (not specifically named in the previous scenarios) in which they would handle a bat. Fifteen per cent (n=107) indicated there was. These responses were coded. Of these participants 36% (n=39) would handle a bat if the bat was attacking them or a member of their family, and 37% (n=40) would handle the bat if it needed rescuing in other situations. The remainder gave other reasons such as removing the bat from their personal environment.

Eighty-six participants (12%) indicated they would not handle a bat in any situation. When asked why, the key theme was the potential adverse consequences to themselves. The potential transmission of lyssavirus was specifically detailed as a reason not to handle bats, although the fear of 'disease' transmission in general was predominant. Either with or without the fear of disease transmission, being bitten or scratched was a particular concern. Concern that handling a bat may damage it was a less dominant theme.

The other 624 participants were asked why they would handle a bat in the circumstances they'd indicated. A key theme was protection. People either wanted to protect their family, friends, pets and themselves from the bat, or wanted to protect the bat from harm. Even in situations where the person had indicated they would only handle a dead bat, people frequently felt that they would do so to prevent harm to pets and others, or to maintain the cleanliness of their environment. Children and pets were given priority over personal safety. Similarly, baby bats were sometimes felt to be in need of saving preferentially.

Another key theme was the perception of minimal or no risk. People felt that using an implement, gloves or a towel when handling a bat would protect them from injury and therefore minimise the risk from handling. This sentiment was applied to a variety of handling situations; for example, as a way of minimising the risk to self while protecting others, rescuing a bat or removing a bat from the house. Dead bats were not felt to pose a high risk, and using an implement or gloves during disposal was felt to eliminate any risk to health. In some cases, baby bats were seen to pose less of a risk of injury than adult bats. However, in some of these cases, and more generally there was an overlying theme of handling as a last resort. People expressed the need to act more quickly in some situations than trained handlers could attend the scene.

The final key theme was the perception that handling was necessary, though not emergent. It was felt that to remove a bat from your property, particularly a live bat entering your house, or a dead bat in your yard was required; that *not* handling was not an option.

When knowledge questions were summed, the median was 9 (possible range 0-12); interquartile range 8-10. Overall risk perception had a median of 0.667 (possible range 0-1); interquartile range 0.467-0.833. The median for overall intention to handle bats was 4 (possible range 0-12); interquartile range 1-6.

On univariate analyses (Table 3), there were a number of demographic associations with knowledge, risk perception and intention to handle bats. Notably, males were more likely than females to score in the lowest quartile of risk perception, and more

likely to indicate intention to handle bats. These relationships were unaltered when intention to handle was recalculated after excluding the scenario involving a dead bat.

Knowledge score did not predict risk perception ($p=0.065$) or intention to handle bats ($p=0.310$). However, risk perception was associated with overall intention to handle bats ($p<0.001$). Those in the lowest risk perception quartile were 2.47 times (95% CI 1.68; 3.62) more likely to score in the highest intention to handle quartile compared to those in the highest risk perception quartile. Again, this relationship was not altered when intention to handle was recalculated after excluding the scenario involving a dead bat.

On multivariate analysis, the final model included gender, age group and overall risk perception (Table 4). Being male, in a younger age group, and having a lower risk perception of bats increased the likelihood of indicating intent to handle bats in greater numbers of situations. The final model included the same variables and similar odds ratios when intent to handle was recalculated after excluding the scenario involving a dead bat.

Discussion

This cross-sectional telephone survey of community members without previous potential exposure to ABLV indicated high levels of basic knowledge about bats and ABLV, moderately high risk perception of bats in general, and overall low intentions to handle bats. However, the vast majority of participants felt that handling a bat might be necessary in some circumstances to protect themselves or others, or to assist a bat in distress.

Young adult males with lower risk perceptions of bats indicated more frequently that they would choose to handle a bat in different situations. This finding is consistent with a male predominance in potential exposure notifications from the general public in recent years (Young & McCall, 2010).

Using gloves or implements was often felt by survey participants to reduce or nullify any risk of injury from handling bats. Liesener et al (2006) telephone surveyed community members submitting bats for rabies testing to the Minnesota Health Department in 2003. They too found a low level of intentional handling overall, but identified 29 of 358 bat submissions where potential human exposure occurred whilst capturing the bat, usually with some sort of implement.

To our knowledge, no other general population surveys related to bats and ABLV have been undertaken. Markus and Blackshaw (1998) surveyed volunteer bat carers in Australia in 1997 about their motivations for volunteering. They asked whether ABLV and/or bat paramyxovirus was felt to be a potential threat to health. Forty one percent considered either or both of these viruses a threat to personal health, with many stressing the need for appropriate precautions. While not directly comparable, this might indicate a lower risk perception of bats in volunteer handlers at that time compared to participants in our survey where 96% felt that bats posed some risk to human health, with 51% indicating moderate to high risk.

Studies on rabies and bats have found varying levels of knowledge in different populations. Robertson et al (2011) interviewed a convenience sample of people at

high risk of interactions with bats in Thailand in 2009. They found a low level of awareness of bat-transmitted rabies and identified that more than a quarter of their participants had been bitten or scratched by a bat. Similar to our study, knowledge of rabies was not associated with potential exposure on multivariate modeling.

Piyaphanee et al (2010) surveyed a convenience sample of non-Southeast Asian backpackers in Bangkok, Thailand about rabies in general. Fifty-three per cent of their sample identified that rabies could be transmitted by bats. Kikuti et al (2011) surveyed school children and teachers in Brazil immediately after a 50-minute lecture on rabies and its prevention and found a high level of knowledge at this time point, including awareness that bats are able to transmit rabies.

Our findings may be limited by volunteer bias. Despite the statistical generalisability of our sample in terms of age and gender, it is likely that people with some interest in bats responded to the survey. The levels of knowledge and / or risk perception may therefore be over-estimated. However, this should not impact on the relationships between these variables and the intention to handle bats.

Some selection bias is possible because of the exclusion of participants without fixed household phones. While it is unlikely that excluding those who own a mobile phone only (as compared to our participants who owned a landline with or without a mobile phone as well) would introduce a significant amount of bias, excluding people who do not own a phone at all is likely to have selected those with higher socio-economic status than the general population. Indeed, the proportion of participants currently employed was higher than the general population (63 vs 53%) (Australian Bureau of Statistics, 2007). Knowledge and risk perception may therefore have been overestimated, but this

is unlikely to impact on their relationship with intention to handle bats. Certainly, employment and education, while demonstrating some significant relationships with the outcome variables on univariate analysis, were not associated with intention to handle on multivariate modeling, and were therefore not included in the final model.

A further limitation may have been imposed by the nature of the questionnaire. The knowledge, risk perception and intention to handle scores were likely to be dependent to some extent on the questions asked and the scenarios given. A spectrum of questions and scenarios were deliberately included, and aggregate measures calculated to avoid placing excess emphasis on single questions or scenarios, but the number of questions and scenarios were limited in order to restrict the length of the interview required to complete the questionnaire. This may have lead to some misclassification of the intended outcomes. However, thematic analysis of the open question responses did seem to validate the conclusions reached based on the risk perception and intention to handle scores.

Conclusions

Our findings that the adult population of southeast Queensland have a high basic knowledge of bats and ABLV, but that level of knowledge is not related to the intention to handle bats is important for the prevention of future potential exposures. We recommend that future public health campaigns in Australia particularly focus on strengthening the communication of risk to humans and to bats from handling by nonvaccinated, nontrained handlers, and that younger adult males be a particular target group for such messages. Suitable alternative measures to handling should be included. The intentional handling of bats by community members related to those circumstances

where people are unable to wait for the assistance of a trained and vaccinated handler should be given attention in these future campaigns, while recognising that potential exposure in these situations will not always be preventable.

While this study was undertaken in an Australian population with regards to ABLV, the results of community member surveys about bats and rabies in other countries (Robertson et al., 2011, Liesener et al., 2006) suggest our findings about the relationship between risk perception and intention to handle bats may be generalisable outside Australia.

Acknowledgements

Our thanks to the staff at “Enhance Research” for their expert advice on question wording and telephone questionnaire structure as well as data collection.

Our thanks to Ian Hunter for producing the maps included in the figure.

The Communicable Diseases Unit, Queensland Health, Australia funded the data collection for this study.

Author Disclosure Statement

The authors each work in communicable disease control services for Queensland Health.

References

2013: Boy dies after contracting Lyssa virus. *brisbanetimes.com.au*. Fairfax Media.
Allworth, A., K. Murray and J. Morgan, 1996: A human case of encephalitis due to lyssavirus recently identified in fruit bats. *Communicable Diseases Intelligence*, **20**, 504.

- Australasian Bat Society Inc and Queensland Government, Not dated: Living with flying foxes.
- Australian Bureau of Statistics, 2007: 2006 Census Tables, Cat. No. 2068.0. Commonwealth of Australia, Canberra.
- Australian Government Department of Health and Ageing, 2004: Australian national notifiable diseases case definitions: Australian bat lyssavirus case definition. Commonwealth of Australia, Canberra.
- Blumer, C., P. Roche, J. Spencer, M. Lin, A. Milton, C. Bunn, H. Gidding, J. Kaldor, M. Kirk, R. Hall, T. Della-Porta, R. Leader and P. Wright, 2003: Australia's notifiable diseases status, 2001. *Communicable Diseases Intelligence*, **27**, 1-78.
- Braun, V. and V. Clarke, 2006: Using thematic analysis in psychology. *Qualitative research in psychology*, **3**, 77-101.
- Calisher, C., J. Childs, H. Field, K. Holmes and T. Schountz, 2006: Bats: important reservoir hosts of emerging viruses. *Clinical Microbiology Reviews*, **19**, 531-545.
- CDNA, 2012: Rabies and Australian Bat Lyssavirus CDNA National Guidelines for Public Health Units. Commonwealth Department of Health and Ageing, Canberra.
- Fielding, J. and C. Nayda, 2005: Postexposure prophylaxis for Australian bat lyssavirus in South Australia, 1996 to 2003. *Australian Veterinary Journal*, **83**, 233-234.
- Hanna, J., I. Carney, G. Smith, A. Tannenber, J. Deverill, J. Botha, I. Serafin, B. Harrower, P. Fitzpatrick and J. Searle, 2000: Australian bat lyssavirus infection: a second human case, with a long incubation period. *Medical Journal of Australia*, **172**, 597-599.
- Kikuti, M., I. Paploski, M. Silva, E. de Oliveira, A. da Silva and A. Biondo, 2011: Prevention educational program of human rabies transmitted by bats in rain forest preserved area of southern Brazilian coast. *Zoonoses and Public Health*, **58**, 529-532.
- Liesener, A., K. Smith, R. Davis, J. Bender, R. Danila, D. Neitzel, G. Nordquist, S. Forsman and J. Scheftel, 2006: Circumstances of bat encounters and knowledge of rabies among Minnesota residents submitting bats for rabies testing. *Vector-Borne and Zoonotic Diseases*, **6**, 208-215.
- Markus, N. and J. Blackshaw, 1998: Motivations and characteristics of volunteer flying-fox rehabilitators in Australia. *Anthrozoos*, **11**, 203-209.
- Moore, P., C. Jansen, G. Graham, I. Smith and S. Craig, 2010: Emerging tropical diseases in Australia. Part 3. Australian bat lyssavirus. *Annals of Tropical Medicine & Parasitology*, **104**, 613-621.
- Piyaphanee, W., P. Shantavasinkul, W. Phumratanaprapin, P. Udomchaisakul, P. Wichianprasat, M. Benjavongkulchai, T. Ponam and T. Tantawichian, 2010: Rabies exposure risk among foreign backpackers in Southeast Asia. *American Journal of Tropical Medicine and Hygiene*, **82**, 1168-1171.
- Queensland Government Department of Agriculture, Fisheries and Forestry,, 2012: Australian bat lyssavirus. The State of Queensland, Brisbane.
- Queensland Health, 2010: Australian Bat Lyssavirus. The State of Queensland (Queensland Health), Brisbane.
- Queensland Health, 2011: Bats and human health. The State of Queensland (Queensland Health), Brisbane.
- Robertson, K., B. Lumlertdacha, R. Franka, B. Petersen, S. Bhengsri, S. Henchaichon, L. Peruski, H. Baggett, S. Maloney and C. Rupprecht, 2011: Rabies-related knowledge and practices among persons at risk of bat exposures in Thailand. *PLOS Neglected Tropical Diseases*, **5**, e1054.

Torvaldsen, S. and T. Watson, 1998: Rabies prophylaxis in Western Australia: the impact of Australian bat lyssavirus. *Communicable Diseases Intelligence*, **22**, 149-153.

Young, M. and B. McCall, 2010: Potential exposure to Australian Bat Lyssavirus in south east Queensland: what has changed in 12 years? *Communicable Diseases Intelligence*, **34**, 334-338.

Table 1. Participants' risk perception of bats in different scenarios, proportions and (numbers)

Scenario	High risk	Moderate risk	Low risk	No risk	Don't know
Bats interacting with people	52.1 (365)	30.1 (211)	14.4 (101)	2.9 (20)	0.4 (3)
Bats interacting with pets	46.7 (327)	29.9 (209)	17.9 (125)	3.4 (24)	2.1 (15)
Bats living in the ceiling of your house	43.3 (303)	29.4 (206)	19.3 (135)	6.6 (46)	1.4 (10)
Bat manure or droppings in a swimming pool	39.6 (277)	27.6 (193)	26.0 (182)	4.3 (30)	2.6 (18)
Live bats lying on the ground	33.3 (233)	28.1 (197)	29.0 (203)	7.3 (51)	2.3 (16)
Dead bats	31.1 (218)	30.0 (210)	28.9 (202)	7.3 (51)	2.7 (19)
Bat manure or droppings on your washing	31.0 (217)	29.7 (208)	30.4 (213)	6.7 (47)	2.1 (15)
Bats living in a tree in your backyard	27.3 (191)	34.3 (240)	31.4 (220)	6.6 (46)	0.4 (3)
Bat manure or droppings on your car	17.0 (119)	24.4 (171)	42.0 (294)	15.0 (105)	1.6 (11)

Table 2. Participants' indicating they would personally attempt to handle a bat in different scenarios; proportions and (numbers)

Scenario	Yes	No	Don't know
A dead bat on the ground in your backyard	70.0 (490)	29.4 (206)	0.6 (4)
A bat having come into your house	55.9 (391)	43.3 (303)	0.9 (6)
A child is about to pick up or touch a live bat	52.0 (364)	47.1 (330)	0.9 (6)
A pet directly touching or fighting a live bat	50.6 (354)	48.0 (336)	1.4 (10)
A live baby bat lying on the ground in your backyard	46.3 (324)	52.1 (365)	1.6 (11)
A live bat trapped in wire mesh fencing	29.9 (209)	68.9 (482)	1.3 (9)
A live bat lying on the ground in your backyard	29.7 (208)	69.7 (488)	0.6 (4)
A live bat trapped in a net over a fruit tree	24.3 (170)	74.9 (524)	0.9 (6)
A live bat lying in the street	14.6 (102)	85.0 (595)	0.4 (3)
Any other situation	15.3 (107)	84.4 (591)	0.3 (2)

Table 3. Univariate associations between knowledge, risk perception and intention to handle scores and demographic characteristics; relative risks (95% confidence interval)

	Knowledge score (9-12 vs 0-8)	Risk perception (Lowest vs highest quartile)	Intention to handle (Highest vs lowest quartile)
Gender			
Male	1.02 (0.91-1.14)	1.42 (1.15-1.75)	1.95 (1.55-2.44)
Female	1.0	1.0	1.0

Age			
18-24 years	1.32 (1.05-1.67)	2.44 (1.61-3.72)	2.45 (1.35-4.45)
25-44 years	1.32 (1.07-1.62)	2.08 (1.40-3.08)	3.01 (1.74-5.18)
45-64 years	1.33 (1.08-1.64)	1.33 (0.86-2.05)	2.39 (1.37-4.18)
65 years and over	1.0	1.0	1.0
Highest level of education			
TAFE/trade or university	1.16 (1.03-1.30)	1.42 (1.14-1.78)	1.43 (1.13-1.81)
High school or earlier	1.0	1.0	1.0
Worked in human health services			
Yes	1.09 (0.96-1.24)	0.91 (0.69-1.19)	0.66 (0.49-0.91)
No	1.0	1.0	1.0
Worked in animal health			
Yes	1.13 (0.94-1.36)	1.21 (0.91-1.61)	1.52 (1.16-1.99)
No	1.0	1.0	1.0
Current paid employment			
Yes	1.10 (0.98-1.24)	1.62 (1.27-2.07)	1.67 (1.28-2.16)
No	1.0	1.0	1.0
Knowledge score			
9-12		1.0 (0.82-1.22)	0.95 (0.57-1.43)
0-8		1.0	1.0
Risk perception			

Lowest quartile		2.47 (1.68-3.62)
Second quartile		1.83 (1.22-2.74)
Third quartile		1.82 (1.2-2.77)
Highest quartile		1.0

Table 4. Final adjusted model for the score representing frequency of intention to handle bats across a range of scenarios

	Odds ratio	95% confidence interval
Intention to Handle Highest quartile		
Gender		
Male	2.10	1.37 – 3.23
Female	1.0	
Age		
18-24 years of age	1.51	0.70 – 3.25
25-44 years of age	2.55	1.36 – 4.76
45-64 years of age	1.47	0.79 – 2.73
65+ years of age	1.0	
Risk perception		
Lowest quartile	2.34	1.27 – 4.32
Second quartile	1.28	0.74 – 2.23
Third quartile	1.08	0.58 – 1.99
Highest quartile	1.0	
Intention to Handle Third quartile		
Gender		

Male	2.49	1.49 – 4.14
Female	1.0	
Age		
18-24 years of age	1.42	0.61 – 3.32
25-44 years of age	1.60	0.77 – 3.30
45-64 years of age	0.85	0.41 – 1.79
65+ years of age	1.0	
Risk perception		
Lowest quartile	2.97	1.36 – 6.49
Second quartile	1.91	0.93 – 3.95
Third quartile	2.54	1.20 – 5.40
Highest quartile	1.0	
Intention to Handle Second quartile		
Gender		
Male	3.50	2.20 – 5.60
Female	1.0	
Age		
18-24 years of age	2.96	1.16 – 7.57
25-44 years of age	5.06	2.23 – 11.45
45-64 years of age	3.23	1.43 – 7.26
65+ years of age	1.0	
Risk perception		
Lowest quartile	3.99	1.96 – 8.10

Second quartile	2.08	1.07 – 4.04
Third quartile	2.59	1.29 – 5.22
Highest quartile	1.0	

Figure 1. Geographic area of survey in southeast Queensland, Australia