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ARTICLE

Taking the Bite out of Mosquito Bites: The Role of Perceived Risk

Daryl G. Kroner[a], Pamela Plunkett[b] and Michael J. Lydy[c]

[a]Department of Criminology and Criminal Justice, Southern Illinois University Carbondale, Carbondale, IL, USA; [b]Harrisburg Middle School, Harrisburg, IL, USA; [c]Center for Fisheries, Aquaculture and Aquatic Sciences, and Department of Zoology, Southern Illinois University Carbondale, Life Science II, Carbondale, IL, USA

ABSTRACT
The present study examined how dimensions of perceived risk contributed to mosquito avoidance behaviors in a flood-prone area. Mosquito avoidance behaviors were classified into proactive (i.e. used repellant sources) and withdrawal/reactive (i.e. reduced outside activities) behaviors. After controlling for level of mosquito bites, increased scores for above normal perceived risk were associated with withdrawal/reactive avoidance behaviors; whereas, increased scores for normal perceived risk were associated with proactive avoidance behaviors. Efforts to improve mosquito avoidance behaviors should distinguish the type of perceived risk and the type of avoidance behavior. Greater congruence between perceived risk (i.e. normal risk of mosquito-borne illnesses) and avoidance behaviors (i.e. planning avoidance behaviors) will increase the effectiveness of education programs for disease prevention.

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Environmental health education; risk; rural; West Nile Virus

Interventions are often guided by risk levels. For example, preventative structures for flood risk areas, more security for vulnerable travel, and aggressive interventions for life-threatening medical events. Yet, the perceived risk of an adverse event can influence subsequent risk-related intervention and coping behaviors. Perceived risk of those in flood risk areas influences preparedness intentions (Terpstra 2011); perceived risk of an airline disaster influences future airline travel (Rose et al. 2017); and, the perceived risk of breast cancer influences accepting medical information from friends (Gerend et al. 2004). The present study examines if the perceived risk of mosquito-borne illness can make an additional contribution to the actual bite risk in predicting mosquito intervention and coping behavior. Understanding this relationship can result in better individual and policy strategies for coping and avoidance behaviors in high-density mosquito areas.

A relationship between perceived risk and subsequent behaviors has been demonstrated with reckless driving (Teese and Bradley 2008), smoking behavior (Hampson et al. 2000), criminal offending (Zimmerman 2008), and online shopping (Wu and Ke 2015). This same relationship is demonstrated in meta-analyses examining the perceived risk of stimulant misuse among students (Benson, Flory, Humphreys, and Lee 2015). Even after accounting for medical risk, a summary of the research suggests that disease risk perceptions are a determinant of health behavior (Ferrer and Klein 2015).

Applied to mosquito-related risk, community members' perceived risk of mosquito infection can be quite low with over half either having not heard of the main local mosquito virus, or they perceived a 'very unlikely' level of infection (Haenchen et al. 2016). With regard to the perceived risk of infection, perceived risk levels of 'unlikely to equally likely/unlikely' and 'likely to very likely'

CONTACT Daryl G. Kroner dkroner@siu.edu Department of Criminology and Criminal Justice, Southern Illinois University Carbondale, 1000 Faner Drive, Mailcode 4504, Carbondale, IL 62901, USA

did not differentiate mosquito avoidance strategies of repellent use and frequent checks for standing water after rainfall (Haenchen et al. 2016). Yet, other research has found that higher perceived risk of mosquito-related disease is associated with the use of additional control practices (Wong et al. 2017). These apparent differences between perceived risk and behaviors may be due to a lack of distinctions among perceived risks. Slovic and Peters (2006) highlighted the benefit of accounting for the level of perceived risk according to negative and positive effects. Similarly, Ferrer and Klein (2015) distinguished among logical, rule-based risk perceptions, affective risk perceptions, and integrated affect and deliberate risk perceptions. Drawing upon the benefit of making distinctions among perceived risks, the current paper uses two scales to measure the perceived risk of contracting mosquito-borne illnesses (Above Normal Risk and Normal Risk).

A more comprehensive measure of perceived risk might also include making a distinction between perceived risk to a broad referent as compared to a specific referent. For the current study, the broad referent is measured by 'mosquito-borne illnesses' and the specific referent is contact with the West Nile or Zika virus (labelled 'specific risk', see Methods section). This distinction may be a matter of degree, but may also be different according to the nature of the referent. Elevated risks to the more highly emotionally charged reference to West Nile or Zika virus may result in responses more similar to a fear response. To more fully understand perceived risks, studies frequently use multiple referents. Medical studies have used perceived risks of breast cancer, heart disease, and osteoporosis (Gerend et al. 2004). Perceived risk among adolescents has used substance abuse, driving with a drunk driver, getting into a fight, and having unprotected sexual intercourse (Haase and Silbereisen 2011). In a work safety study, perceived risks were examined across 17 referent areas (fall or slip, radiological contamination, hearing impairment, etc.; Kouabenan et al. 2015). With regard to vector-borne diseases, perceived risks of infection have been assessed through multiple referents of mosquitos, air, and body contact (Setbon and Raude 2009).

Mosquito avoidance behaviors can include use of insect repellant, mosquito nets, covering clothing, addition of insecticides to clothing, not going outside of residence at all, not going outside of residence during the night, removing nearby standing water, spraying insecticides outside of the residence, and adding screens on windows and doors (Corrin et al. 2017; Prue et al. 2017; Heitzinger et al. 2018). Haenchen et al. (2016) found the top three strategies were draining standing water, staying indoors, and spraying insecticides.

To capture potential differences in avoidance and coping behaviors, the current study examined differences among proactive (i.e. planning, additional activities) and reactive (i.e. reactions) behaviors. This distinction is used for three reasons. First, a theoretical model differentiates the two types of behavior, from which differential associations with other constructs can be expected. Proactive behavior typically involves more cognitive and planning processes, whereas reactive behavior involves emotional and reactive processes. Based on this distinction, associations with other constructs (i.e. risk intentions, perceived prevalence) can be expected. Second, the proactive and reactive distinction has been differentially related to perceived risk and emotionally charged risk, which are central to the current study (Rader et al. 2007). Finally, the application can be broad, as the ability of this distinction to differentiate related risk constructs can occur both at group levels (Dunn Butterfoss et al. 2008) and individually (Skeem et al. 2004; Miller and Lynam 2006). Given the above advantages of these proactive and reactive distinctions, the present study differentiated between proactive and withdrawal/reactive avoidance behaviors.

Research questions

The present study examined how the predictive factors of perceived risk and specific risk contributed to mosquito avoidance behaviors in a flood-prone area. Conducting this research in a flood-prone area gives the results strong contextual relevance for the inquiry into mosquito-borne illnesses and related behaviors. A focus was placed on the perceived risk measures of Above

Normal Risk and Normal Risk and their unique contributions to the outcome of mosquito avoidance behaviors (proactive and withdrawal/reactive). After controlling for the level of mosquito bites (actual risk), six statistical models were conducted examining the predictive factors (three with proactive behavior outcomes, and three with the withdrawal/reactive outcomes).

Materials and methods

Participants

The participants of the study were 85 residents from a rural Midwest county. The mean age was 48.1 (SD = 15.4), with 14 males and 71 females. Marital status was 60 (70.6%) married, 8 (9.4%) divorced, 11 (12.9%) single, 6 (7.0%) widowed, and 3 (3.5%) separated. With regard to employment, 56 (65.9%) worked full-time, 7 (8.2%) worked part-time, 4 (4.7%) were unemployed, 10 (8.5%) were retired, 2 (2.4%) were stay-at-home parents, and 6 (7.1%) were classified as other. All participants were White.

According to the 2010, United States Census (U.S. Census Bureau 2010) the median age of this county was 41.7 years; 48.8% males, 51.2% female; 57.0% were married, 10.3% divorced, 27.7% single, 3.4% widowed, and 1.5% separated; 54.7% were in the labor force, and 93.4% were White.

Location description

The location for the data collection was a county in southeastern Illinois. The average annual precipitation is 45.07 inches (1971–2000; Multi-Hazard Mitigation Plan, 2012). The majority of protocols were gathered form the central city (pop ~8,700) for the county. The main body of water for the county, which passes through this central city, lies between two drainage basins. In terms of hazards, a flood is listed as number 3, preceded by thunderstorms and tornados, and followed by dam or levee failure (13 dams in the county).

Reflecting a flood-prone area, the central city had significant flooding in 2008, 2011, and 2013. In 2008, nine homes were destroyed, and 30 homes and 44 businesses had water over the first floor (FEMA Disovery Report 2015). In 2014, proposed mitigation efforts involved buyouts of 40 homes and 6 businesses. The 2011 flood was declared a federal disaster. The county 100-year flood plain analyses included 907 buildings, including four critical facilities (Multi-harzard Mitigation Plan 2012).

Mosquito surveys used the Centers for Disease Control and Prevention (CDC) Gravid Trap, which actively attracts *Culex* females that attempt to lay eggs in organic water. There were 35 sample pools taken during the summer of 2016. There were no recorded occurrences of West Nile virus in the county. In two adjacent counties, one had two positive West Nile tests out of 30 pools tested, while the other had three positive tests out of 29 pools tested.

Self-report protocol package

Level of mosquito bites

The frequency of mosquito bites over the targeted three-month period measure had five response categories. The response categories for the current study were 'Never', '1 to 5 times', '6 to 10 times', '11 to 15 times', and 'More than 16 times.' For the analyses, these categories were coded '0' to '4.' This base-rate was the measure of actual risk.

Perceived risk of mosquito illness scales

Two scales were used to measure the perceived risk of contracting mosquito-borne illnesses. These scales differed in how risk was measured. For the Above Normal Risk scale, higher scores indicated that the risk was above an already evaluated risk level. For the Normal Risk scale, higher scores indicated the risk was above a normal risk level. Also, given that the majority of past research measured perceived risk with a single item (Grietens et al. 2010; Moro et al. 2010; Heitzinger et al. 2018), the current project used multiple-item scales. This approach has the advantage of measuring the scale's reliability in a more generalizable construct. Thus, placing mosquito-related risk in a context of daily routines, other insects, etc., provides a more robust measurement of perceived risk and may reduce outcome variability attributed to measurement issues.

For the **Above Normal Risk** scale (seven items, Appendix), participants were asked if their risk was above a normal risk level. Sample items were 'Compared to people like me, my risk of mosquito-borne illness is higher' and 'Compared to people where I live, my chance of mosquito-borne illness is greater.' The reliability for the scale, as indicated by Cronbach's coefficient alpha was 0.82. This demonstrates adequate reliability for the scale (Nunnally and Bernstein 1994).

For the **Normal Risk** scale (six items, Appendix), participants were asked if their risk was similar to other's risk level. Sample items were 'My chance of mosquito-borne illness is close to someone who is outside daily' and 'My risk of mosquito-borne illness is similar to those with difficulties with insects.' The reliability for the scale, as indicated by Cronbach's coefficient alpha was 0.68. This demonstrates modest reliability for the scale (Nunnally and Bernstein 1994).

Specific risk

A single item of 'My risk of contacting the West Nile or Zika virus is:', with the response category ranging from 0% to 100% in 5% increments was considered to be a measure of emotionally charged risk because of the direct asking of a potentially lethal threat. This contrasts the two perceived risk scales (Above Normal Risk and Normal Risk), in which the referent was a broad 'mosquito-borne illness' that would not be typically associated with a lethal threat.

Mosquito avoidance behavior scale

This measure consisted of two scales; **Proactive Behaviors** and **Withdrawal/Reactive Behaviors**, each of which had four items. Responses to these items were behaviors that actually occurred over a three-month period from June to August 2016, which was a high mosquito activity period. At the top of the page for these items, the following text was in bold 14-font, 'Past Summer questions. This section asked questions about behaviors that occurred this past summer (June to August 2016).'

The Proactive Behaviors scale focused on the frequency of activities that would assist in preventing the negative impact of mosquitos. The Proactive Behaviors scale items of; 'Used bug spray' and 'Discussed mosquito concerns with others' had the same five response levels used in the **Level of Mosquito Bites** measure. The other two items were; 'Changed outside area to reduce mosquitoes (i.e. empty standing water)' and 'Purchased yard repellant devices (i.e. sound, smoke, sent dispensers).' The response categories for these two items were; 'None', 'Once', 'Twice', 'Three', and 'Four', and 'Five or more.' For the analyses, these categories were coded '0' to '5.' The Cronbach's coefficient alpha for these four items was 0.84.

The Withdrawal/Reactive Behaviors scale focused on the frequency of withdrawal that would reduce the negative impact of mosquitos. The Withdrawal/Reactive Behaviors scale items of; 'Reduce time outdoors because of mosquitos' and 'Skipped outdoor event (party or concert) because of mosquitos' had the same five response levels as the Level of Mosquito Bites measure. The other two items were; 'Reduced outside social activity because of mosquitoes' and 'Changed behavior because of a chance of Zika or West Nile.' The response categories for these two items were; 'None', 'Once', 'Twice', 'Three', and 'Four', and 'Five or more.' For the analyses, these categories were coded '0' to '5.' The Cronbach's coefficient alpha for these four items was 0.85.

Procedure

The protocol package was distributed with a self-addressed envelope to Southern Illinois University. No personal identifying information was gathered. The package typically took 15–20 min for completion. A total of 120 packages were initially distributed for completion. Of the 89 returned protocols, four were unusable due to incomplete sections, resulting in a sample of 85. Of the 85 protocol packages, a total of 10 items were missing responses (total of 4,250 items). A nearest neighbor strategy was used to populate these items. Thirty percent of the protocols were distributed through an elementary school and the rest through community social groups. The data were collected between October 2016 and March 2017. As reported in the Participants section above, the demographics of the collected sample were close to the 2010 United States Census, except for the male/female composition. The current sample had considerably more female participants than the community distribution.

Analyses

The two measures of Proactive Behaviors and Withdrawal/Reactive Behaviors were the outcome (dependent variable) for each of the three statistical models, resulting in a total of six statistical models. The nearest neighbor strategy measure was a control variable entered into each of the six models. The three predictors (independent variables) were Above Normal Risk, Normal Risk, and Specific Risk.

Two **R**-based (R Core Team 2017) packages were used for the analyses. The coefficient alphas were computed in the **psych** package (Revelle 2017). Figure 1, which included a linear function, density plot, and correlations among the predictor variables, was developed with the package **ggally** (Schloerke et al. 2017). Following our research question to examine the unique contribution of the two perceived risk measures (Above Normal Risk and Normal Risk), three statistical models were conducted and compared for the Proactive and Withdrawal/Reactive outcomes. In each statistical model, the measure of Level of Mosquito Bites was entered as a control variable, as the amount of bites could vary among the samples. Not controlling for the amount of mosquito bites could result in a reduced ability to determine the independent contribution of perceived risk to avoidance behaviors (i.e. level of bites unknowingly determining the perceived risk and avoidance relationship). Thus, the amount of mosquito bites was statistically controlled for in each statistical model.

The first model focused on the unique contribution of Above Normal Risk and excluded the perceived risk measure of Normal Risk. The second model focused on the unique contribution of Normal Risk and excluded the perceived risk measure of Above Normal Risk. The third model included both perceived risk measures of Normal Risk and Above Normal Risk. The unique contributions of perceived risk measures of Normal Risk and Above Normal Risk to mosquito avoidance behaviors were determined by using a similar or dissimilar pattern of statistical significance in each of the three models.

Results

Figure 1 reports the relationship among the predictor measures. With the strongest zero-order correlation of 0.38, there were no multi-collinearity issues among the predictor measures. From the density plots, the endorsement percentages for the Level of Mosquito Bites variable were: 0 'Never' (2.4%), 1 '1 to 5 times' (20%), 2 '6 to 10 times' (23.5%), 3 '11 to 15 times' (12.9%), and 4 'More than 16 times' (41.2%). The Above Normal Risk and Normal Risk scales had dissimilar density plots, suggesting the distribution of the scale score data was different; the Above Normal Risk scale had its peak in the upper range of scores and the Normal Risk scale had its peak in the very low range (Figure 1). Therefore, the two scales did not have the same scale score ranges contributing to the total score. Of note, the zero-order correlations between Normal Risk and Specific Risk and Above Normal Risk and Specific Risk were 0.35 and 0.38. The correlation between the Proactive and Withdrawal/Reactive outcome measures was 0.70.

Overall comparisons between Tables 1 and 2 demonstrate some similarities with the Proactive and Withdrawal/Reactive outcome measures, after controlling for Level of Mosquito Bites. Without this control, the uniqueness of the other measures independent of the number of bites would not be known. The Specific Risk measure was statistically significant in all of the models.

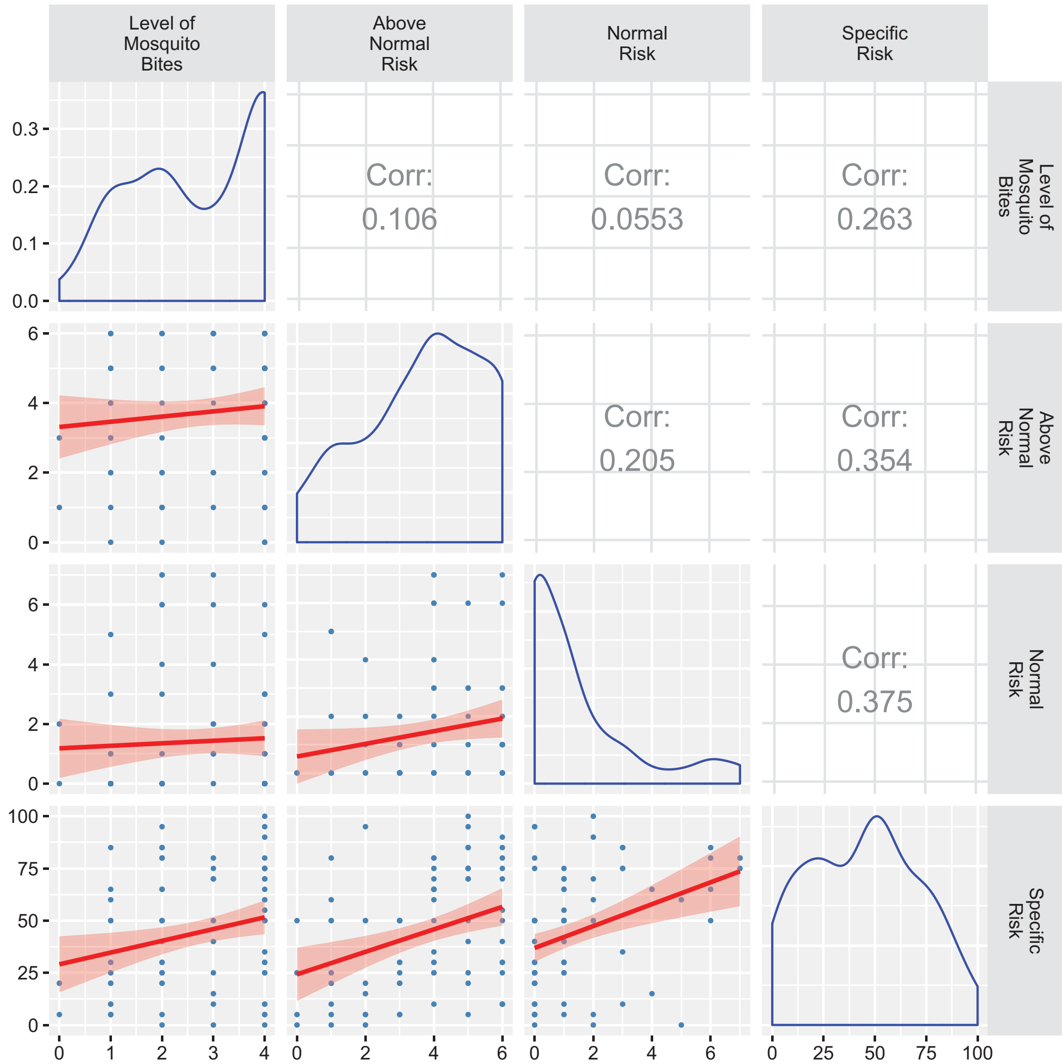

Figure 1. Regression model predictor variables.

The diagonal plots are density plots, indicating the shape of the occurrence frequency for each measure. The 95% confidence intervals are shaded around regression line in lower plots.

Table 1. Regression models predicting mosquito avoidance proactive behaviors.

	Model 1			Model 2			Model 3		
Predictors	Estimate	(SD)	95% CI	Estimate	(SD)	95% CI	Estimate	(SD)	95% CI
Level of Mosquito Bites[a]	2.23**	(0.37)	1.50, 2.97	2.19**	(0.37)	1.47, 2.92	2.21**	(0.36)	1.49, 2.94
Above Normal Risk	0.39	(0.25)	-0.11, 0.89	––	—	—	0.35	(0.25)	–0.14, 0.85
Normal Risk	—	––	—	0.56*	(0.27)	0.03, 1.10	0.53	(0.27)	0.00, 1.06
Specific Risk	0.07**	(0.02)	0.04, 0.11	0.07**	(0.02)	0.04, 0.11	0.06**	(0.02)	0.03, 0.10
R^2		0.51			0.52			0.53	

* $p < 0.05$, ** $p < 0.01$. [a]control measure. – = Predictor not entered into the model.

The two perceived risk measures of Above Normal Risk and Normal Risk were not additive for either outcome measure. Instead, these two measures were unique to the outcomes. The Normal Risk measure made a statistically significant contribution ($p < 0.05$) to the Proactive avoidance

Table 2. Regression models predicting mosquito avoidance withdrawal/reactive behaviors.

	Model 1			Model 2			Model 3		
Predictors	Estimate	(SD)	95% CI	Estimate	(SD)	95% CI	Estimate	(SD)	95% CI
Level of Mosquito Bites[a]	1.91**	(0.40)	1.12, 2.70	1.85**	(0.42)	1.05, 2.71	1.90**	(0.40)	1.14, 2.73
Above Normal Risk	0.74**	(0.27)	0.20, 1.27	—	—	––	0.72**	(0.27)	0.18, 1.27
Normal Risk	—	—	—	0.21	(0.41)	−0.39, 0.82	0.15	(0.29)	−0.44, 0.73
Specific Risk	0.05*	(0.02)	0.01, 0.90	0.07**	(0.20)	0.03, 0.11	0.05*	(0.02)	0.01, 0.09
R^2		0.41			0.36			0.42	

* $p < 0.05$, ** $p < 0.01$. [a]control measure. – = Predictor not entered into the model.

Table 3. Regression models predicting mosquito avoidance proactive and withdrawal/reactive behaviors combined.

	Model 1		
Predictors	Estimate	(SD)	95% CI
Level of Mosquito Bites[a]	4.12**	(0.65)	2.81, 5.42
Above Normal Risk	1.07**	(0.44)	0.19, 1.96
Normal Risk	0.68	(0.48)	−0.28, 1.64
Specific Risk	0.11**	(0.03)	0.04, 0.18
R^2		0.55	

* $p < 0.05$, ** $p < 0.01$. [a]control measure.

behavior outcome (Table 1). There was, though, no difference between the variance accounted for between Model #1 (Normal Risk excluded) and Model #3 (1%) and Model #2 (Normal Risk included) and Model #3 (1%). Thus, although statistically significant within Model #2, the overall additional contribution of Normal Risk was minimal.

The Above Normal Risk measure made a statistically significant contribution ($p < 0.01$) to the Withdrawal/Reactive avoidance behavior outcome (Table 2). There was no difference between the variance accounted for between Model #1 (Normal Risk included) and Model #3 (0%); whereas, the difference between Model #2 (Normal Risk included) and Model #3 was 5%. Model #1, with the absence of Normal Risk, accounted for the same amount of variance as Model #3 (including Above Normal Risk and Normal Risk). Thus, Above Normal Risk did make a statistically unique contribution to Withdrawal/Reactive avoidance behaviors.

A final model was ran with Proactive avoidance and Withdrawal/Reactive avoidance behaviors combined as the dependent variable (Table 3). In this model, the Normal Risk scale did not enter the model. Thus, overall, it appears that the Above Normal Risk scale may be of greater importance in predicting general avoidance behaviors.

Discussion

The current study found that perceived risk of mosquitoes had an additional contribution to predicting avoidance behaviors, above and beyond the actual occurrence of mosquito bites. Broadly, in addition to people acting on their actual risk (level of mosquito bites), they are influenced by their perceived risk. More specifically, this relationship was further refined by a matching of the type of perceived risk with the risk-related avoidance behavior. The perceived risk of Above Normal Risk was associated with Withdrawal/Reactive avoidance behaviors and perceived normal risk with proactive avoidance behaviors. Specific risk was associated with both Withdrawal/Reactive and proactive avoidance behaviors. In addition to these relationships, the different pattern of results for proactive and Withdrawal/Reactive outcomes suggest that these two types of avoidance behavior are fundamentally different. The applied relevance of these results are direct given that these data occurred within a flood-prone area, which is significantly related to increased mosquito counts (DeGroote et al. 2007).

Perceived mosquito risk levels may or may not be congruent with actual risk (Grietens et al. 2010; Corrin et al. 2017). Part of this lack of congruence may be due to an overly simplistic view of perceived risk, typically measured by a single item. Others have been critical of using a single frequency item to assess perceived risk (Nazareth et al. 2014). As noted in previous studies (Zielinski-Gutierrez and Hayden 2006; Zimmerman 2008), perceived risk can have multiple dimensions. In the present study, the above normal and normal scales had different density plots, a feature that would not be captured through a single item. Also, there was a minimal correlation ($r = 0.21$) between the two scales. Using two scales, each with multiple items, may have resulted in a more robust measurement of perceived risk. At a theoretical level, the current results suggest that perceived risk is not a unidimensional construct.

Above normal risk and normal risk levels were independently associated with specific features of mosquito avoidance behaviors. The above normal perceived levels of risk were associated with withdrawal/reactive avoidance behaviors. Thus, the reference point of 'above average' and making judgments against this 'above average' (i.e. greater endorsement, higher scores) resulted in avoidance behaviors that were a change in routine activities to avoid the negative impact of mosquitos. The contribution of above normal perceived risk levels to Withdrawal/Reactive avoidance behaviors occurred even after normal perceived risk level was added to the model.

Normal levels of perceived risk were associated with proactive avoidance behaviors. Thus, the reference point as 'average' (i.e. greater endorsement, higher scores) resulted in avoidance behaviors that were proactive in nature. This involved adding an activity (i.e. use of repellent) to avoid the negative impact of mosquitos. The contribution of normal perceived risk levels to proactive avoidance behaviors occurred even after the above normal perceived risk level was added to the model.

Specific risk was predictive of both withdrawal/reactive and preventative avoidance behaviors. This specific risk involving a threat was minimally related to above normal and normal perceived risk levels; thereby, allowing for an independent contribution to avoidance behaviors. Potential contributors to mosquito-related emotionally charged levels included the threat of infection, potential outbreak, severity of the disease, and past deaths (Moro et al. 2010; Bauch et al. 2013). The consistent role of specific risk across the two avoidance behaviors may be due to its assessed non-relative perceived risk. The Above Normal Risk and Normal Risk categories both measured relative-perceived risk, whereas the Specific Risk measured responses along a continuum.

A wide range of effective avoidance behaviors have been found in previous studies (Haenchen et al. 2016; Corrin et al. 2017). Also, the implementation of avoidance behaviors varied, even among high-risk contexts (Grietens et al. 2010; Patel et al. 2011). The present study provides evidence that avoidance behaviors can be classified, at minimum, into two categories. As demonstrated in other areas of research, such as aggression (Brugman et al. 2015), crime (Walters 2015), and health recruitment strategies (Carroll et al. 2018), there is support for a basic proactive/reactive dichotomy.

There are personal and policy implications associated with the proactive/reactive dichotomy. The benefits of these two types of avoidance behaviors are *not equal*. Proactive behaviors are less disruptive on a personal and social level, while outside activities can be sustained, or continued with a conscious acknowledgement of the perceived risk. Conversely, reactive avoidance behaviors involve withdrawal and will impact personal decisions concerning participation in outside activities. Not only is there a change, but the unique motivator for the reactive change is a reduction in well-being due to the withdraw behaviors associated with mosquitos.

In terms of prevention, proactive strategies should be framed within normal risk parameters, with a more cognitive approach. If withdrawal/reactive strategies are used, framing the intervention within an above normal risk parameter, with a more affective emphasis will be beneficial. With overall avoidance behaviors, it appears that above normal risk will be of greater importance.

Limitations

Although the actual avoidance behaviors of the participants were assessed, we did not check to see if participants believed that avoidance behaviors actually worked in reducing the level of mosquito bites. In other research, the perceived efficacy of avoidance behaviors was below 50% (Dhar-Chowdhury et al. 2016). The actual efficacy of avoidance behaviors would be informative to develop a more complete picture of the rationale for these types of decisions. With regard to the samples collected for the present study, it was a matter of convenience with a large portion of the respondent's being female. The other demographic characteristics, though, mirrored the local census data, but the proportion of females may limit the generalizability of the results.

The regression models assessed statistical prediction with cross-sectional data, not temporal-ordered prediction. The assessment of perceptions, then the base rate measure of bites, and then the assessment of the outcome behaviors in real-time would be needed to assess if the predictors actually predict the outcomes. Related to this is that the participant's perceived risk may have varied across the months of data collection (Fall, Winter, Spring).

Summary

Perceived risk is integral to the development of education efforts and polices to reduce the negative impact of mosquitos, yet is sometimes overlooked (Sedda et al. 2014). A more refined approach to perceived risk can increase our understanding of both proactive and withdrawal/reactive mosquito avoidance behaviors. If an effective proactive avoidance strategy is desired, then using normal risk perceptions in the framing of this strategy will be optimal. If an effective withdrawal/reactive avoidance strategy is desired, then using the above normal risk perceptions in the framing of this strategy will be optimal.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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Appendix

Above Normal Risk scale

Compared to people like me, my risk of mosquito-borne illness is higher.
Compared to people I know, my chance of mosquito-borne illness is greater.
Compared to people where I live, my chance of mosquito-borne illness is greater.
My chances of mosquito-borne illness are increased compared to others with a similar family history.
My risk of mosquito-borne illness is higher than people with similar personal characteristics.
I know my risk level of mosquito-borne illness is higher than those with like personal characteristics.
My chance of mosquito-borne illness is higher than it should be.

Normal Risk scale

My risk of mosquito-borne illness is similar to those with difficulties with insects.
My vulnerability to mosquito-borne illness is similar to one who is outside a lot.
My chance of mosquito-borne illness is close to someone who is outside daily.
I have a similar risk for mosquito-borne illness as someone who has difficulties with insects.
My risk of mosquito-borne illness is close to those in average risk situations.
Compared to others with one illness, my risk of mosquito-borne illness is the same.