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Cross-Sectional Psychological and Demographic Associations of Zika Knowledge and Conspiracy Beliefs Before and After Local Zika Transmission

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Perceptions of infectious diseases are important predictors of whether people engage in disease-specific preventive behaviors. Having accurate beliefs about a given infectious disease has been found to be a necessary condition for engaging in appropriate preventive behaviors during an infectious disease outbreak, while endorsing conspiracy beliefs can inhibit preventive behaviors. Despite their seemingly opposing natures, knowledge and conspiracy beliefs may share some of the same psychological motivations, including a relationship with perceived risk and self-efficacy (i.e., control). The 2015–2016 Zika epidemic provided an opportunity to explore this. The current research provides some exploratory tests of this topic derived from two studies with similar measures, but different primary outcomes: one study that included knowledge of Zika as a key outcome and one that included conspiracy beliefs about Zika as a key outcome. Both studies involved cross-sectional data collections that occurred during the same two periods of the Zika outbreak: one data collection prior to the first cases of local Zika transmission in the United States (March–May 2016) and one just after the first cases of local transmission (July–August). Using ordinal logistic and linear regression analyses of data from two time points in both studies, the authors show an increase in relationship strength between greater perceived risk and self-efficacy with both increased knowledge and increased conspiracy beliefs after local Zika transmission in the United States. Although these results highlight that similar psychological motivations may lead to Zika knowledge and conspiracy beliefs, there was a divergence in demographic association.

KEY WORDS: Conspiracy belief; knowledge; perceived risk; Zika

1. BACKGROUND

People's knowledge, attitudes, and beliefs about an infectious disease are important predictors of whether they engage in disease-specific preventive behaviors. Having accurate knowledge about the causes, consequences, and prevention methods for an infectious disease has been found to be a necessary condition for engaging in appropriate protective behaviors during an infectious disease outbreak (Rosenstock, 1974; Taylor et al., 2009; Voeten et al., 2009). For example, increased knowledge about

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influenza has been associated with increased participation in flu-related preventive behaviors. (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic, Fischhoff, & Lichtenstein, 1979) Similarly, increased knowledge about the Zika virus has been positively associated with increased receptivity to both indoor and outdoor spraying to control mosquito populations (Abramson & Piltch-Loeb, 2016). In contrast, conspiracy beliefs—beliefs that run counter to the scientific evidence or consensus explanation—can inhibit preventive behaviors. For example, endorsement of medical conspiracy beliefs has been associated with decreased influenza vaccine uptake among adults (Oliver & Wood, 2014) and reduced parental intentions to vaccinate their children (Jolley & Douglas, 2014).

Despite their divergence as to which information sources are considered authoritative, those who endorse science-based knowledge and those who endorse conspiracy beliefs may share an underlying impulse to address uncertainty. Consistent with theoretical literature in this space, risk information processing can lead to the pursuit of further information and sense making (Griffin, Dunwoody, & Neuwirth, 1999). Previous research on infectious diseases with pandemic potential has demonstrated that increased infectious disease knowledge is associated with feeling at risk and trusting information sources about infectious diseases (Cheng & Ng, 2006; Tang & Wong, 2003; van der Weerd, Timmermans, Beaujean, Oudhoff, & van Steenbergen, 2011). Additionally, the broader literature on information seeking in response to a threat suggests that information is often sought to improve feelings of control or self-efficacy (Fischhoff et al., 1978; Griffin et al., 1999; Lucy, 2011; Rosenstock, 1974). Similarly, conspiracy beliefs are thought to emerge as a way of responding to feelings of uncertainty, risk, and loss of control that accompany events with high uncertainty about the reason for the event or are seemingly random (Douglas, Sutton, & Cichocka, 2017; van Prooijen & Douglas, 2017; van Prooijen & Jostmann, 2013). In other words, given the high degree of uncertainty that accompanies most infectious disease outbreaks (severity, mortality rates, contagiousness, etc.)—especially early in an outbreak—conspiracy beliefs about infectious diseases may emerge as a way to reduce anxiety from feeling at risk from the infectious disease or to increase feelings of control in response to the uncertainty or perceived randomness of the outbreak.

If true, then reducing anxiety from feelings of risk and increasing feelings of self-efficacy could be associated with increases in both knowledge and conspiracy belief endorsement. What may lead to a divergence between information seeking that leads to knowledge or information seeking that leads to conspiracy beliefs is the level of trust in the entities providing official information about the infectious disease outbreak. As described earlier, trust in information sources, such as the government, tends to be associated with infectious disease knowledge (Quinn et al., 2013; Taha, Matheson, & Anisman, 2013; van der Weerd et al., 2011). In contrast, individuals who endorse conspiracy theories are characterized by their distrust of conventional political institutions and scientific authorities (Douglas et al., 2017).

Understanding the psychological and demographic factors that may be related to knowledge or conspiracy beliefs is critical for designing effective public communication campaigns and interventions during an infectious disease outbreak. If individuals who are high in knowledge or conspiracy beliefs have different motivations or demographics, then the obvious approach would be to tailor messaging promoting preventive behaviors toward meeting the psychological needs of groups that are more likely to endorse conspiracy beliefs. However, if higher knowledge and conspiracy belief endorsement share similar demographic characteristics, then simply providing corrective information to individuals or groups who endorse infectious disease conspiracy beliefs would likely be ineffective, since these groups would also be the most informed. This outcome would suggest that additional research would need to be done to identify another approach to reach this subset of the population.

It is also important to explore shared demographic associations with both infectious disease knowledge and conspiracy beliefs, as these associations can help to guide targeting of communication efforts. We are aware of only two studies comparing associations with infectious disease knowledge and conspiracy beliefs (Hogg et al., 2017). Hogg and his colleagues examined demographic associations with HIV knowledge and conspiracy beliefs in an adolescent sample of South Africans. Being male or unemployed was positively associated with both HIV knowledge and conspiracy beliefs. In contrast, other demographic variables were uniquely associated with only one or the other. A recent study by Earnshaw, Bogart, Klompas, and Katz (2019) demonstrated that there is a relationship between knowledge and conspiracy beliefs, with lower knowledge of Ebola found to be related to an increase in conspiracy beliefs, but the study did not compare the factors associated with each outcome independently. Other research examining both infectious disease knowledge and conspiracy beliefs has used qualitative methods, such as focus groups, preventing statistical inferences from being made (Abramowitz et al., 2017; Friedman & Shepeard, 2007; Lohiniva, Barakat, Dueger, Restrepo, & El Aouad, 2014). Studies that have exclusively explored demographic factors associated with disease knowledge have found women and older adults are more likely to be knowledgeable (Brewer et al., 2007). Demographic associations with infectious-disease-related conspiracy beliefs are rarely reported. There is some evidence that women and older adults are less likely to endorse infectious-disease-related conspiracies (Galliford & Furnham, 2017; Hogg et al., 2017), but other research has found no associations with age and gender (Jolley & Douglas, 2014).

The Zika epidemic in 2015–2016 provided the most recent global infectious disease epidemic to explore the psychological and demographic factors associated with infectious disease knowledge and conspiracy beliefs. The current research provides some exploratory tests of this topic derived from two studies with similar measures, but different primary outcomes: one study with knowledge of Zika as a key outcome and one with conspiracy beliefs about Zika as a key outcome. Both studies involved cross-sectional data collection conducted during the same two periods of the Zika outbreak: one data collection prior to the first cases of local Zika transmission in the United States (March–May 2016) and one just after the first cases of local transmission (July–August). Local transmission of Zika in Miami-Dade County, Florida was a pivotal event for the United States during the Zika epidemic. Physical proximity to a health threat like Zika is associated with increased perceived risk and concern (Johnson, 2018) and the content and frequency of Zika coverage in the United States shifted after local transmission. Specifically, there was a relatively greater emphasis on messages to heighten perceived risk and highlighting factual information about Zika prior to local transmission, and a relatively greater emphasis on governmental efforts to control Zika and the controversies surrounding Zika prevention and response efforts after local transmission (Sell et al., 2018). As a result of this shift in psychological and media responses following local Zika transmission, it would be important to see whether the associations with Zika knowledge and conspiracy beliefs remain constant or change before and after local transmission.

As highlighted earlier, understanding the similarities and differences in the factors that contribute to Zika knowledge and conspiracy beliefs has implications for Zika messaging development. As a result, we have combined analyses from our two studies to answer three questions related to the factors that contribute to both Zika knowledge and conspiracy beliefs:

(1) What psychological motivations are associated with increased Zika knowledge and conspiracy beliefs?
(2) What demographic traits are associated with both increased Zika knowledge and conspiracy beliefs?
(3) Are any observed *psychological* or *demographic* associations with Zika knowledge and conspiracy beliefs static or do the associations change at different points in the epidemic?

We first report the methods of both studies, the statistical analysis plan used by the authors, and then the results relevant for each research question.

2. METHODS

2.1. Study 1: Knowledge

2.1.1. Participants and Setting

Two cross-sectional samples were collected that included Zika-related knowledge, which we will refer to as knowledge Samples 1 and 2. To obtain nationally representative samples, both knowledge samples were collected using a fully replicated, single-stage, random-digit-dialing (RDD) U.S. sample of landline telephone households, and supplemented by a list of randomly generated cell phone numbers, conducted on behalf of the research team by Social Science Research Solutions. The sample frame also included an oversampling of women of childbearing age between 18 and 45 years living in the southern tier states of Florida, Alabama, Mississippi, Louisiana, and Texas, where Zika was most prevalent. Weighting procedures for this sampling method have been described previously (Piltch-Loeb, Abramson, & Merdjanoff, 2017). Data collection occurred in April/May 2016 ($N = 1{,}233$) for knowledge Sample 1 and July/August 2016 ($N = 1{,}231$) for knowledge Sample 2. As noted earlier, these two data collection periods correspond to pre- and postlocal Zika transmission in the United

States. Participants were not given an incentive for participation. Identical sampling procedures were conducted at each time point. Questions focused on knowledge, risk perception, and sources of information regarding the Zika virus, in addition to demographic questions. This design was granted exempt status from New York University's institutional review board.

2.1.2. Measures

Knowledge. Participants were asked three questions with dichotomous response options regarding characteristics of the Zika virus: (1) Can Zika virus be sexually transmitted? (2) Can individuals without Zika symptoms pass on Zika virus? (3) Can Zika cause birth defects?

Demographics. Participants indicated their age, gender, race and ethnicity, education level, and pregnancy status (whether they or their partner were currently pregnant or trying to conceive [TTC]), and political party affiliation.

Perceived risk. Participants indicated "not at risk" (0) or "at risk" (1) to the question "Do you think your family could be directly affected by the Zika virus?"

Self-efficacy. Participants indicated "yes" (1) or "no" (0) to the following statement: "I feel that I have a lot of control over whether or not I become infected with the Zika virus."

Trust in government. Participants were asked: "How confident are you that the government can address problems associated with the Zika virus? Would you say very confident (4), somewhat confident (3), not very confident (2), or not at all confident (1)?"

2.2. Study 2: Conspiracy Beliefs

2.2.1. Participants and Setting

Two distinct cross-sectional samples were collected that included Zika-related conspiracy beliefs, which we will refer to as conspiracy Sample 1 and Sample 2. The two conspiracy samples were composed of adults in the United States who participate in a panel administered by Survey Sampling International (SSI). SSI panel members are initially recruited using strategies such as ads, emails, and online banners. Data collection occurred in March 2016 ($N = 543$) for conspiracy Sample 1 and August 2016 ($N = 644$) for conspiracy Sample 2. As noted earlier, these two data collection periods correspond to pre- and postlocal Zika transmission in the United States. Survey links were distributed to panel members through SSI's platform, using an algorithm that determines participant demographics and needs of the survey, to match appropriate participation. Quotas were established for age, gender, and race/ethnicity to reflect the distribution of these characteristics in the U.S. population. Qualtrics® software was used to design and program the survey. Distribution of the survey link was administered by SSI until all quotas were filled. Participants who completed the survey received points that could be redeemed for cash or gift cards, along with an entry for a quarterly drawing for a larger cash prize. Participants read a short description of Zika, which was excerpted from the Centers for Disease Control and Prevention's Zika website. After reading the short description, participants responded to a variety of questions about their beliefs and attitudes about Zika. Participants also provided demographic information at the end of the survey. This design was granted exempt status from the University of Michigan IRBMED Institutional Review Board.

2.2.2. Measures

Conspiracy beliefs. Participants were asked five items related to conspiracy beliefs regarding Zika, with responses on a seven-point Likert scale ranging from "not at all likely (1)" to "extremely likely (7)." Conspiracy beliefs included the likelihood that Zika was: (1) caused by the release of genetically modified mosquitoes, (2) a biological weapon used against the South American population, (3) a form of population control, (4) the result of a bad or expired batch of vaccines, and (5) caused by pesticides being added to the water to kill mosquitoes. These conspiracies were selected based on their appearance in news articles highlighting misperceptions among the general public of countries affected by the Zika outbreak, particularly in Brazil (Bode & Vraga, 2018; Sharma, Yadav, Yadav, & Ferdinand, 2017; Vraga & Bode, 2017).

Demographics. Participants indicated their age, gender, race and ethnicity, education level, pregnancy status (whether they or their partner were currently pregnant or TTC), and political party affiliation.

Perceived risk. Participants were asked how likely they thought it was that they would get the

Zika virus within the next month, with responses ranging from "very unlikely (1)" to "very likely (7)."

Self-efficacy. Participants were asked how much control they thought they had over whether or not they contracted the Zika virus or not, with responses on a seven-point Likert scale ranging from "no control at all (1)" to "complete control (7)."

Trust in government. Participants were asked "How confident are you that the Centers for Disease Control and Prevention (CDC) is responding *effectively* to protect the health of the public against Zika?" on a seven-point Likert scale with "not at all confident (1)" and "very confident (7)" as the scale anchor labels.

2.3. Data Analysis

2.3.1. Response/Completion Rates

The American Association for Public Opinion Research (AAPOR) response rate for the two knowledge samples was approximately 4%. Response rates were unable to be calculated for the conspiracy samples. Completion rates were 95.4% (518/543) for conspiracy Sample 1 and 94.1% (606/644) for Sample 2.

2.3.2. Demographic Characteristics

Participant characteristics for the knowledge and conspiracy samples are presented in Table I. Both samples are predominantly non-Hispanic white and middle aged (30–64) and skewed toward a more educated demographic. There were no significant differences in demographics pre- and postlocal transmission with the exception of a higher portion of Republicans and independents in knowledge Sample 2, and slightly higher education in conspiracy Sample 2 compared to Sample 1.

2.3.3. Treatment of Dependent Variables

A knowledge score (count variable) was the sum of the number of knowledge items a participant answered correctly, ranging from 0 to 3. Responses to the conspiracy beliefs were highly correlated (Cronbach's $\alpha = 0.93$), so responses were combined into a single aggregate measure of conspiracy beliefs.

2.3.4. Statistical Analyses

Descriptive statistics were calculated for participant demographics, Zika knowledge and conspiracy beliefs, and psychological beliefs and pairwise correlations were calculated to test for simple associations between our key measures. We also conducted order logistic regression analyses for the knowledge samples and linear regression analyses for the conspiracy samples. All analyses were done in Stata SE version 14.

3. RESULTS

Percentages and average responses for Zika knowledge, conspiracy beliefs, perceived risk, self-efficacy, and trust in the government are presented in Fig. 1. Knowledge was significantly positively associated with trust in government in Sample 1 and was significantly positively associated with perceived risk, perceived control, and trust in government in Sample 2 (Table II). There were statistically significant increases in conspiracy beliefs, perceived risk, and self-efficacy from Sample 2 to Sample 1 (Fig. 1). Conspiracy beliefs had significant, positive correlations with perceived risk and self-efficacy in conspiracy Sample 1, and a significant, positive correlation with perceived risk, self-efficacy, and trust in government in conspiracy Sample 2 (Table II).

To answer our three research questions, we examined the associations of the psychological and demographic factors with Zika knowledge and conspiracy beliefs separately for the data collected prelocal Zika transmission and the data collected postlocal Zika transmission to see if the effects were consistent or different across the two time points; these results are shown in Table III.

Our first research question pertained to determine the psychological motivations that are associated with knowledge and conspiracy beliefs before and after local transmission of Zika.

Prior to the local Zika transmission in the United States, there were no significant associations (ps > 0.323) between any of the psychological motivations with Zika knowledge (Table III). However, after the first cases of local transmission, perceived risk ($p = 0.003$) and self-efficacy ($p = 0.034$) were associated with increased knowledge, but trust in government was not ($p = 0.959$). In contrast, perceived risk and self-efficacy were associated with increased Zika conspiracy belief endorsement prior to local Zika transmission (ps < 0.01), while trust in government was associated with decreased Zika conspiracy beliefs ($p = 0.043$). After local Zika transmission, trust in the government was no longer significantly associated with conspiracy beliefs ($p = 0.778$), but perceived risk and

Table I. Summary Statistics of All Variables and Respondent Characteristics for Each Sample

Characteristic	Knowledge Sample 1 Frequency (Weighted %)	Knowledge Sample 2 Frequency (Weighted %)	Conspiracy Sample 1 Frequency (%)	Conspiracy Sample 2 Frequency (%)
Age[a]				
18–29	264 (21.7%)	239 (21.6%)	103 (20.2%)	81 (13.7%)
30–45	303 (21.4%)	312 (26.4%)	138 (27.1%)	204 (34.6%)
46–64	340 (31.8%)	351 (33.1%)	181 (35.6%)	181 (30.7%)
65+	290 (19.2%)	305 (18.9%)	87 (17.1%)	124 (21.0%)
	$X^2(3) = 0.61$	$p = 0.939$	$t(1{,}116) = -1.04$	$p = 0.301$
Gender				
Male	513 (48.5%)	501 (48.6%)	248 (48.1%)	301 (49.9%)
Female	720 (51.5%)	730 (51.4%)	268 (51.9%)	302 (50.1%)
	$X^2(1) = 0.01$	$p = 0.962$	$X^2(1) = 0.38$	$p = 0.536$
Race[b]				
Non-Hispanic white	779 (65.2%)	769 (65.2%)	347 (67.0%)	416 (68.8%)
Non-Hispanic black	154 (11.6%)	157 (11.4%)	65 (12.6%)	87 (14.4%)
Hispanic	188 (15.2%)	201 (15.6%)	68 (13.1%)	76 (12.6%)
Other	92 (8.1%)	79 (7.9%)	38 (7.3%)	26 (4.3%)
	$X^2(3) = 0.012$	$p = 0.997$	$X^2(3) = 5.41$	$p = 0.144$
Education				
<High school	126 (12.0%)	119 (12.3%)	11 (2.1%)	9 (1.5%)
High school diploma/GED	300 (33.3%)	315 (33.4%)	91 (17.6%)	106 (17.6%)
Some college/two-year degree	360 (24.6%)	331 (24.6%)	197 (38.0%)	182 (30.1%)
Four-year college degree or more	443 (30.2%)	460 (29.8%)	219 (42.3%)	307 (50.8%)
	$X^2(3) = 0.012$	$p = 0.997$	$X^2(3) = 10.13$	$p = 0.018$
Political party				
Republican	269 (21.5%)	300 (26.8%)	121 (21.4%)	135 (22.5%)
Democrat	421 (38.1%)	381(30.6%)	193 (37.3%)	256 (42.6%)
Independent/other	434 (40.4%)	458 (42.6%)	203 (39.3%)	210 (34.9%)
	$X^2(2) = 16.46$	$p = 0.005$	$X^2(2) = 3.43$	$p = 0.180$
Pregnancy status				
Not pregnant or TTC	1,148 (94.3%)	1,154 (93.5%)	451 (87.6%)	477 (79.8%)
Pregnant or TTC	69 (5.7%)	66 (6.5%)	64 (12.4%)	121 (20.2%)
	$X^2(1) = 0.769$	$p = 0.503$	$X^2(1) = 0.38$	$p = 0.536$

Note: Reports result only for those respondents who responded to the item. Percentages weighted for knowledge samples.
[a]Two-sample *t*-test comparing average age across samples, rather than differences in age categories.
[b]Respondents could mark more than one race.
TTC = trying to conceive.

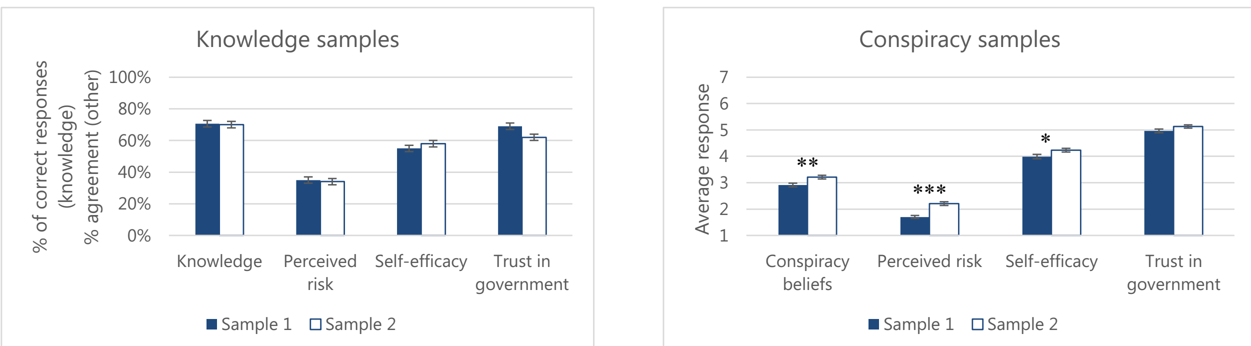

Fig. 1. Summary statistics for knowledge, conspiracy beliefs, perceived risk, self-efficacy, and trust in government for two knowledge and two conspiracy samples.
Note: Error bars are standard errors. Asterisks indicate differences between Sample 1 and Sample 2 based on chi-square analyses (knowledge samples) or *t*-tests (conspiracy samples). $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

Table II. Summary Statistics and Pairwise Correlations for Knowledge and Conspiracy Samples

	Knowledge	Perceived Risk	Self-Efficacy	Trust in Government
Knowledge samples				
Knowledge	–	**0.08 (0.012)**	**0.08 (0.013)**	**0.06 (0.040)**
Perceived risk	0.05 (0.163)	–	**−0.13 (<0.001)**	**−0.08 (0.011)**
Self-efficacy	0.02 (0.489)	**−0.15 (<0.001)**	–	**0.08 (0.008)**
Trust in government	**0.08 (0.016)**	−0.03 (0.437)	**0.13 (<0.001)**	–

	Conspiracy Beliefs	Perceived Risk	Self-Efficacy	Trust in Government
Conspiracy samples				
Conspiracy beliefs	–	**0.50 (<0.001)**	**0.31 (<0.001)**	**0.09 (0.020)**
Perceived risk	**0.35 (<0.001)**	–	**0.22 (<0.001)**	**0.13 (0.002)**
Self-efficacy	**0.10 (0.018)**	0.06 (0.192)	–	**0.26 (<0.001)**
Trust in government	−0.02 (0.616)	**0.10 (0.028)**	**0.25 (<0.001)**	–

Note: Pairwise correlations (p-values) for each Sample 1 are shown below the diagonal and above the diagonal for each Sample 2. Pairwise correlations in bold indicated significance at $p < 0.05$.

self-efficacy were still significantly associated with increased conspiracy belief endorsement (ps < 0.001).

Our second research question was concerned with determining the demographic traits that are associated with Zika knowledge and conspiracy beliefs before and after local transmission. Similar to the psychological motivation results, there were no significant associations between demographic traits with Zika knowledge prior to local Zika transmission (ps > 0.106; Table III). However, after the first cases of local transmission, identifying as female ($p = 0.025$) or a Democrat ($p = 0.002$) were associated with increased knowledge. Prior to local Zika transmission in the United States, identifying as nonwhite (ps < 0.02) or currently pregnant or TTC ($p = 0.033$) were associated with increased conspiracy belief endorsement, while being aged 29 or older was associated with decreased conspiracy beliefs (ps $<$ 0.02). After local cases of Zika transmission, identifying as a non-Hispanic black was the only significant racial/ethnic group associated with increased conspiracy beliefs ($p < 0.001$) and currently pregnant or TTC was still significantly associated with increased conspiracy belief endorsement ($p < 0.001$), while being aged 46 or older was associated with decreased conspiracy beliefs (ps < 0.001)

Our third research question was whether the observed *psychological* or *demographic* associations with Zika knowledge and conspiracy beliefs were static or dynamic. As highlighted by the results we have just described, there were marked differences in observed psychological and demographic associations with Zika knowledge and conspiracy beliefs based on whether the data were collected prior to local Zika transmission or after. For Zika knowledge, there were no significant associations prior to local Zika transmission, but two of the three psychological motivations (perceived risk; self-efficacy) and two demographic characteristics (identifying as female or a Democrat) became significantly associated with increased Zika knowledge following local transmission. In contrast, one of the three psychological motivations (trust in government) and three demographic characteristics (aged 30–45, identifying as Hispanic, or being in the "other" racial/ethnic group) that were associated with Zika conspiracy beliefs prior to local transmission had nonsignificant associations after local transmission.

4. DISCUSSION

The purpose of the current research was to examine the existence and stability of psychological and demographic associations with knowledge and conspiracy beliefs during two time points of the recent Zika epidemic. Overall, the results of our studies highlight that while there may be similar psychological motivations related to Zika knowledge and conspiracy beliefs, the divergence in demographic associations suggests that differential information seeking by different demographic groups could lead to increased knowledge in some groups (e.g., females) and increased conspiracy beliefs in others (e.g., younger people). Surprisingly, education did not have a significant association with Zika knowledge or conspiracy beliefs, suggesting that simply

Table III. Psychological and Demographic Associations with Knowledge and Conspiracy Beliefs for Each Sample

Characteristic	Knowledge Sample 1 Coefficient (95% CI)	Knowledge Sample 2 Coefficient (95% CI)	Conspiracy Sample 1 Coefficient (95% CI)	Conspiracy Sample 2 Coefficient (95% CI)
Perceived risk	0.05 (−0.30 to 0.40)	0.50 (0.17 to 0.82)	0.36 (0.27 to 0.46)	0.35 (0.27 to 0.43)
Self-efficacy	−0.11 (−0.45 to 0.23)	0.35 (0.03 to 0.68)	0.11 (0.04 to 0.18)	0.18 (0.11 to 0.25)
Trust in government	0.19 (−0.19 to 0.58)	0.01 (−0.31 to 0.33)	−0.08 (−0.17 to −0.00)	−0.01 (−0.09 to 0.06)
Age				
18–29	Reference	Reference	Reference	Reference
30–45	0.01 (−0.53 to 0.54)	−0.10 (−0.62 to 0.42)	−0.44 (−0.80 to −0.08)	0.05 (−0.32 to 0.42)
46–64	0.22 (−0.27 to 0.72)	−0.16 (−0.56 to 0.25)	−0.76 (−1.10 to −0.41)	−0.71 (−1.10 to −0.31)
65+	0.19 (−0.30 to 0.69)	0.05 (−0.40 to 0.50)	−0.70 (−1.11 to −0.29)	−0.93 (−1.36 to −0.51)
Gender				
Male	Reference	Reference	Reference	Reference
Female	0.18 (–0.15 to 0.51)	0.37 (0.05 to 0.69)	0.22 (−0.02 to 0.46)	−0.07 (−0.31 to 0.16)
Race				
Non-Hispanic white	Reference	Reference	Reference	Reference
Non-Hispanic black	−0.09 (−0.63 to 0.44)	−0.54 (−1.13 to 0.04)	0.81 (0.42 to 1.20)	0.79 (0.44 to 1.14)
Hispanic	0.24 (−0.35 to 0.84)	−0.04 (−0.53 to 0.45)	0.47 (0.09 to 0.84)	0.16 (−0.19 to 0.51)
Other	−0.19 (−0.91 to 0.52)	−0.06 (−0.59 to 0.48)	0.77 (0.29 to 1.24)	0.14 (−0.44 to 0.72)
Education				
<High school	Reference	Reference	Reference	Reference
High school/GED	−0.16 (−0.85 to 0.54)	0.16 (−0.55 to 0.87)	−0.21 (−1.06 to 0.63)	0.80 (−0.19 to 1.79)
Some college	0.09 (−0.60 to 0.79)	0.57 (−0.18 to 1.32)	−0.28 (−1.11 to 0.54)	0.60 (−0.38 to 1.57)
Four-year college+	0.57 (−0.12 to 1.26)	−0.06 (−0.60 to 0.48)	−0.53 (−1.35 to 0.30)	0.46 (−0.51 to 1.43)
Political party				
Republican	Reference	Reference	Reference	Reference
Democrat	0.31 (−0.12 to 0.73)	0.66 (0.24 to 1.09)	0.05 (−0.28 to 0.38)	−0.03 (−0.34 to 0.27)
Independent/other	0.04 (−0.37 to 0.45)	0.09 (−0.31 to 0.49)	0.11 (−0.20 to 0.43)	0.10 (−0.20 to 0.41)
Pregnancy status				
Not pregnant or TTC	Reference	Reference	Reference	Reference
Pregnant or TTC	−0.08 (−0.78 to 0.63)	0.19 (−0.54 to 0.93)	0.43 (0.04 to 0.82)	0.76 (0.44 to 1.09)
Constant			2.30 (1.26 to 3.33)	0.51 (−0.69 to 1.71)

Note: Cells in gray indicate statistical significance at $p < 0.05$. Results from weighted ordinal regression for knowledge samples (R^2 not calculated) and from linear regression analyses for conspiracy samples. Model fit statistics are $F(16, 803) = 1.42$, $p > 0.05$ for knowledge Sample 1 and $F(16, 889) = 2.24$, $p = 0.003$ for knowledge Sample 2. Model fit statistics are $F(16, 479) = 10.79$, $p < 0.001$, $R^2 = 0.26$ for conspiracy Sample 1 and $F(16, 550) = 23.19$, $p < 0.001$, $R^2 = 0.40$ for conspiracy Sample 2.
TTC = trying to conceive.

being educated may not make one more or less equipped to seek out quality information about an infectious disease during an outbreak. Examining demographic differences in information seeking could be an important area of inquiry to continue in future epidemics to develop better interventions to promote infectious disease knowledge and reduce conspiracy beliefs.

We also observed changes in the associations with Zika knowledge and conspiracy beliefs across the two points in the epidemic, with changes in opposite temporal directions for Zika knowledge and conspiracy beliefs. There were no significant associations with Zika knowledge, but many significant associations with conspiracy beliefs, prior to the first cases of local Zika transmission in the United States. After the first cases of local transmission, a number of significant associations with Zika knowledge emerged and, while there were still a number of significant associations with Zika conspiracy beliefs, the number of associations decreased.

We can only speculate about the causes of these shifts, but these patterns may be the result of the inherent nature of scientific knowledge and conspiracies. Scientific information is often sparse at the beginning of an epidemic and grows as more data are accumulated throughout the epidemic (Loewenstein & Mather, 1990). In contrast, conspiracy theories about the "true" cause of the disease can be created and promulgated faster than the infectious disease. As a result of the limited scientific information about an infectious disease at the beginning of an outbreak, resulting in universal ignorance about the disease, knowledge differences between groups may only emerge as more information becomes available during the course of the outbreak or health information seeking (Epstein, 1996; Manierre, 2015). Meanwhile, the rapid emergence of full-blown conspiracy theories at the beginning of an outbreak may allow different demographic groups the ability to adopt or reject conspiracy theories early in an outbreak, with some changes in conspiracy beliefs across different demographics as the knowledge base changes (Bode & Vraga, 2018; Dredze, Broniatowski, & Hilyard, 2016; Sharma et al., 2017). Once again, more research on information seeking over the course of an outbreak among different demographic groups may prove useful in determining how or why some groups are more likely to adopt conspiracy beliefs than others.

In the case of Zika, this is an especially interesting phenomenon in the context of the media environment before and after local transmission. Prior to local transmission (Samples 1), message content highlighting factual information about Zika was more frequent compared to after local transmission (Samples 2) (Sell et al., 2018). Despite this, it appears local transmission was a pivotal event that strengthened the relationship between psychological constructs and knowledge of Zika. This suggests there is not a direct connection between frequency of media coverage and the generation of beliefs, but rather something about the increase in perceived risk, proximity, and occurrence of the event that shifted factual information gathering and drove the significant relationships seen in knowledge Sample 2 and the decreasing associations seen between conspiracy Sample 1 and conspiracy Sample 2 (Johnson, 2018). Further exploration is needed to understand the specific types of information seeking (sources, channels, and content) that occurs at different time points in an epidemic.

There were some limitations to the current research. Although the samples measured the same constructs, they did so in different ways. Despite this, the constructs with the greatest differences in how they were measured—perceived risk, self-efficacy, and trust in government—produced the most similar patterns of associations with Zika knowledge and conspiracy beliefs and this explanation is unlikely to account for the differences in demographic associations. Another limitation is that the conspiracy belief samples were not representative samples, which could limit the generalizability of the results. It is worth noting that the quotas set during data recruitment for these samples provided demographic distributions that reflected national population distributions, which should minimize concerns about limited generalizability. The cross-sectional nature of the data also prevented us from making causal inferences. Although we were interested in the associations between psychological motivations and demographic characteristics with Zika knowledge and conspiracy beliefs, it will be important to conduct longitudinal research to determine whether the personal characteristics impact knowledge and conspiracy beliefs, knowledge and conspiracy beliefs impact the psychological motivations, or whether the sources of influence are bidirectional. The limitations of this exploratory research point to the need for researchers to measure both infectious disease knowledge and conspiracy beliefs within the same individuals in future research.

Beliefs about disease have previously been found to be strongly associated with health behavior, and are seen as a precursor to health behavior change (de Zwart et al., 2009; Rosenstock, 1974; Seale et al., 2010). During an emerging disease outbreak, individuals often must take protective health actions rapidly to control the spread of disease (Jiang et al., 2009; Paek, Hilyard, Freimuth, Barge, & Mindlin, 2008; U.S. Government Accountability Office, 2017). Both information and misinformation can shape the likelihood of action. Therefore, it is critical to understand the factors associated with knowledge of a threat and conspiracy beliefs of an emerging disease to counter maladaptive beliefs. Our results contribute to the limited literature on factors related to knowledge and conspiracy beliefs of the Zika virus and infectious diseases more broadly (Piltch-Loeb et al., 2017; Sharma et al., 2017; Vraga & Bode, 2017).

Using data from two independent studies, we have demonstrated that as an infectious disease threat emerges, the same psychological factors are associated with both increased knowledge and conspiracy beliefs about Zika. However, we have also demonstrated that pivotal disease-related events—in this case, local transmission—can shift both knowledge and conspiracy beliefs in not wholly understood ways. Given the exploratory nature of these findings, the authors encourage researchers to attempt to replicate our findings in a more rigorous fashion during future infectious disease outbreaks. These results highlight the potential importance of measuring knowledge and conspiracy beliefs/misinformation together, to better understand the factors that might contribute to both, to design better interventions to improve knowledge and decrease misinformation during an infectious disease outbreak.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table A1. Weighted Ordinal Regression for Psychological Factors (Model 1), Demographic Factors (Model 2), and Both (Model 3) for Knowledge Sample 1

Table A2. Weighted Ordinal Regression for Psychological Factors (Model 1), Demographic Factors (Model 2), and Both (Model 3) for Knowledge Sample 2

Table A3. Weighted Ordinal Regression for Psychological Factors (Model 1), Demographic Factors (Model 2), and Both (Model 3) for Conspiracy Sample 1

Table A4. Weighted Ordinal Regression for Psychological Factors (Model 1), Demographic Factors (Model 2), and Both (Model 3) for Conspiracy Sample 2