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A path model of psychosocial constructs predicting future Zika vaccine uptake intent

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ABSTRACT

Objective: The recent Zika virus outbreak, while no longer an international public health emergency, is still a serious threat, particularly to pregnant women and babies born to pregnant women infected with the virus. This study examined the predictive effects of psychosocial constructs on self-reported intent to get a future Zika vaccine among women of reproductive age.

Methods: Data were collected using an online survey with a representative sample of 339 women ages 18–49 from the continental United States. The survey addressed variables originating with the Extended Parallel Processing Model (EPPM) as related to future Zika vaccine uptake intent.

Results: Three quarters of all respondents reported intention to get a future Zika vaccine. Path modeling revealed a direct effect of perceived susceptibility, self-efficacy, and response efficacy on future Zika vaccine uptake intent, as well as an indirect effect of perceived susceptibility through both self-efficacy and response efficacy. In addition, the final model showed an indirect effect of perceived severity on Zika vaccine uptake intent through self-efficacy and response efficacy and accounted for 54.6% of the variance in vaccination intent.

Conclusions: These findings have implications for future Zika vaccine promotion campaigns.

This study confirms the importance of perceived susceptibility, self-efficacy, and response efficacy for use in Zika vaccine uptake campaigns; in addition, when using perceived severity, both self-efficacy and response efficacy should be considered in message design.

1. Background

Until recently, the Zika virus was regarded as a rare, mosquito-borne, infectious disease with few, if any, serious symptoms [17]. However, since 2015, Zika has developed into an ongoing epidemic – to date it has affected 5139 persons in the United States and 38,188 persons in U.S. territories [11]. In addition to mosquito-based transmission, the disease can also spread through sexual contact [14,32], blood transfusions [38], and during pregnancy from mother to fetus [51,56]. Although most patients either have no or mild symptoms, Zika has been linked with Guillain-Barre syndrome [10] and with microcephaly in babies born to mothers infected with Zika during pregnancy [34,43]. Zika cases have been diagnosed in 84 countries, and although the World Health Organization (WHO) in late 2016 declared the Zika global health emergency to be over, they also determined it to be a dangerous mosquito-borne disease which should be viewed as an ongoing threat [56].

Currently, treatment for Zika is supportive only [20], and no vaccine is available to the public; however, a National Institutes of Health (NIH)-developed vaccine entered Phase 2 clinical trial testing in March 2017 [41]. In August of 2018, vaccinations started in a human trial with 28 healthy, non-pregnant adults ages 18–50 [41]. Once a Zika vaccine becomes available, it will be important to quickly promote vaccine uptake in women of reproductive age [30]. Increasing public concern about vaccines and vaccine safety is likely to play a role in Zika vaccine uptake decisions. The focus of this paper is to gain an understanding of what might encourage as well as deter the public from seeking out a future Zika vaccine.

2. Vaccines

Vaccines have contributed greatly to the remarkable decline in morbidity and mortality due to infectious diseases over the course of the past century [58,57]. Nevertheless, recent unsubstantiated concerns about vaccine safety have resulted in an increase in

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parents delaying their children's vaccinations or not vaccinating their children at all [42]. Although relatively few people refuse all vaccines outright, far larger numbers refuse some vaccines or delay them, or vaccinate their children but have questions about vaccinations' safety and effectiveness [31,42]. This phenomenon, vaccine hesitancy, is defined as expressing concern or doubt about vaccine uptake, either for oneself or one's children [31]. Reasons why people either refuse or delay vaccines include (1) fears that vaccines do harm, (2) vaccines do not work, and (3) vaccines will overload children's immune systems. Additional reasons include: (4) convictions that they or their children are not at risk for a specific disease, (5) that the disease the vaccine prevents itself is not dangerous, (6) lack of trust in pharmaceutical companies and government entities, and (7) the idea that it is preferable to build up one's immune system naturally as opposed to through vaccinations [6,25,31]. Given this, it is unsurprising that interventions targeting anti-vaccination attitudes are seldom effective—health communication specialists recommend instead to focus on those who are unsure about vaccines [5,44]. When placed in a theoretical framework, psychosocial constructs are important predictors of vaccine intentions and behavior. As such, it is critical to understand how psychosocial constructs drive Zika vaccine uptake intent and to develop health messages tailored to relevant segments of the at-risk population.

3. Health behavior theories

Numerous studies have examined psychosocial predictors of vaccine behavior through the lens of health behavior theory. For example, a study among female college-age students and their parents guided by the Extended Parallel Processing Model (EPPM) found that for young women, framing HPV vaccine promoting messages as preventing genital warts (as opposed to cancer prevention) was associated with significantly increased reported self-efficacy, which then increased response efficacy, and, subsequently, intent to get the HPV vaccine [26]. An HPV vaccine study focused on men also found that the genital warts frame was associated with increased fear and increased vaccine uptake intent [54]. In a H5N1 influenza vaccine related study, perceived threat was associated with fear arousal, which according to the EPPM is associated with decreased behavioral intent [47]. An influenza vaccine-related study among African-Americans found that accessibility and affordability, as well as perceived negative consequences of the vaccine, were associated with self-efficacy and response efficacy [9].

Similarly, within a Health Belief Model (HBM) framework, high vaccine uptake is associated with low perceived barriers to the seasonal influenza vaccine [35,46], the HPV vaccine [8], and the H1N1 vaccine [21]. In contrast, low vaccine uptake is associated with high perceived barriers to the H1N1 vaccine [15,18]. Common barriers to vaccination include (1) fear of perceived vaccine side effects, (2) pain associated with vaccination, as well as (3) conspiracy theories blaming government or medical authorities for intentionally creating a perceived faulty vaccine [15,46]. High vaccine uptake is also associated with high perceived susceptibility for seasonal influenza [23] and HPV infection [8]. In addition, influenza vaccine uptake is associated with higher perceived benefits (or, as the EPPM defines it, response efficacy) [23,46].

In addition, high perceived severity and high self-efficacy related to seasonal influenza are associated with higher uptake of the seasonal influenza vaccine [21], and high self-efficacy to get a vaccine is associated with greater uptake of the HPV vaccine [8,22].

A similar pattern of results is evident for vaccine uptake intent. The Theory of Planned Behavior (TPB) links health beliefs and intent to perform a health behavior. Vaccine uptake intent is associated with high perceived susceptibility in case of seasonal influenza [13], HPV [4], and H1N1 influenza [39]. High perceived vaccine benefits are positively associated with both high seasonal influenza vaccine uptake intent [13] and high H1N1 vaccine uptake intent [39]. In addition, higher perceived behavioral control (similar to self-efficacy) is associated with higher H1N1 vaccine uptake intent [39].

This study focuses on exploring associations between psychosocial determinants and intent to get a future Zika vaccine based on some of the most often-used health behavior theories: the EPPM, HBM, and the TPB. These theories—like many other health behavior theories—have several overlapping constructs [3]. Applied to vaccine uptake intent, both the EPPM and the HBM focus on attitudes and beliefs in the form of perceived threat (i.e., perceived severity of and perceived susceptibility to the disease) as well as on self-efficacy related to vaccine uptake [40,45]. The EPPM, however, adds response efficacy—in this case the perception or belief that a vaccine will actually accomplish its goal to protect against a specific disease. The TPB's primary constructs are attitudes toward vaccination, subjective norms, and perceived behavioral control (similar to self-efficacy), which together produce intentions that, in turn, are said to determine vaccine uptake intent [1,2,36]. According to Bandura [3], most HBM and TPB constructs are forms of outcome expectancies; this also holds for several EPPM constructs—HBM's and EPPM's perceived susceptibility and severity, for example, are negative expected outcomes. These constructs overlap with TPB's attitudes toward vaccination, which is measured by perceived outcomes and their accompanying value. In addition, both EPPM's and HBM's construct of self-efficacy has long been compared to TPB's perceived behavioral control. Finally, the TPB distinguishes between behavioral intent and behavior. For the current study, vaccine uptake intent is the most relevant construct since a Zika vaccine is not yet available to the public.

Since the Zika vaccine is not yet available at time of this writing, and considering the severity of some of Zika's consequences, such as microcephaly, it is important to know what effect these psychosocial constructs might have on a future Zika vaccine uptake intent. The first research question for this study is, therefore:

RQ1: Which psychosocial factors predict intent to get a future Zika vaccine?

3.1. Demographics and healthcare variables

Socio-economic status (SES) as operationalized by income has been identified in several studies as a factor affecting vaccine acceptance for childhood vaccines; interestingly both high and low income/SES are reported as both barriers to as well as promoters of vaccine acceptance [28,52]. Similarly, level of completed education is also reported as both as a barrier and a promoter of vaccine uptake—while several studies in India found caregivers' high education level to be a promoter of vaccine uptake [27], studies in China, the U.S., and Israel found it to be a barrier to vaccine uptake [37,49].

Considering adult vaccine uptake, there is a trend toward higher vaccine acceptance by non-Hispanic White women compared with women in other subgroups [16,18], and more specifically, that Black respondents were less likely than White or Asian respondents to report intent to get the H1N1 vaccine during the H1N1 outbreak [39]. The same dynamic is visible with the seasonal flu vaccine—African-Americans display significantly lower odds of getting the flu vaccine, even after correcting for other factors like SES and access to care [29]. In addition, a higher education is associated with higher acceptance of the H1N1 vaccine [39]. Having a regular primary care physician is also associated with higher

acceptance of this H1N1 vaccine [39], as is previously having gotten the seasonal flu vaccine [12,33,50].

A future Zika vaccine will be administered to women of reproductive age to protect both them and their potential future offspring. This direct impact on both mother and child makes direct comparisons with either other adult or childhood vaccines challenging. Given this and the conflicting findings within each of these literatures, we propose the second research question:

RQ2: How are demographic and healthcare-related factors related to psychosocial variables to get a future Zika vaccine?

4. Method

A survey of 339 women of reproductive age (18–49, as defined by the World Health Organization [55]) was conducted to explore the relationships of demographics, healthcare-related variables, and psychosocial factors with the intent to get a future Zika vaccine. The study was approved by the Institutional Review Board at Virginia Commonwealth University, a large research university in the Mid-Atlantic U.S.

4.1. Sample

Leading survey research firm Qualtrics was hired to recruit participants and administer the online survey. A national quota sample of 339 participants completed the study in March 2017. The recruitment process ensured that all participants were women of childbearing age (18–49 years). Because Zika's potential harmful side effects affect pregnant women and their fetuses most severely, public health authorities have designated women in this age group to be a priority target group for a future Zika vaccine. Qualtrics recruited participants from their existing database, using a double opt-in process. Potential respondents were sent an email invitation informing them that the survey was for research purposes only, how long the survey was expected to take, and the incentives offered (i.e., a variable number of Qualtrics "points," worth approximately $5.20, which participants can exchange for gift cards, certificates, and other goods). A total of 831 individuals initiated participation. Of those, 23 withheld consent and exited the survey. Another 23 were excluded per the study inclusion criteria. Three hundred and thirteen respondents were dropped from the survey through attention checks (questions inserted into the survey flow which require specific answers given in the question). An additional 133 were dropped because they finished less than one third of the survey, for a final sample of 339 (see Fig. 1). There were no differences in income, education, and declared racial/ethnic background between the good completes and the dropouts of the study.

4.2. Instrumentation

4.2.1. All of these were introduced in the survey by the following language

"The Zika virus (Zika) can be spread through mosquitos, through sexual transmission, and from a pregnant woman to her fetus. Most of the symptoms of Zika are mild, but the Zika infection during pregnancy can cause fetuses to have a serious birth defect of the brain called microcephaly – a medical condition in which the brain does not develop normally. Currently, no vaccine or treatment is available for Zika, but several versions of a vaccine are under development and could be available as early as sometime in 2017."

4.2.2. Perceived severity

Perceived severity of the Zika virus was determined using three items from the Myers and Goodwin study—for example, "Complications of Zika are serious." Cronbach's alpha for items on the scale was 0.76 [39]. In addition, two items were added relating specifically to perceived severity of Zika infection during pregnancy: "Complications of Zika for a pregnant woman and her fetus are serious," and "I am afraid to get pregnant because of Zika." The answers to all these questions ranged between "strongly disagree" to "strongly agree," on a seven-item Likert scale.

4.2.3. Perceived susceptibility

Perceived susceptibility to the Zika virus was measured using three items (e.g., "I am worried about the likelihood of getting Zika in the near future"). An additional question was added relating to the presence of mosquitos: "When in an area with a lot of mosquitoes, my chances of getting Zika are high." The answers to these questions ranged between "strongly disagree" to "strongly agree," measured on a seven-item Likert scale. Cronbach's alpha for items on the scale was 0.75[39].

4.2.4. Response efficacy

Response efficacy was measured using two items focused on the benefits of a future Zika vaccine: "Vaccination will decrease my chance of getting Zika or its complications" and "A future Zika vaccination will help me feel less worried about getting Zika." Since these two items measure separate benefits, no internal

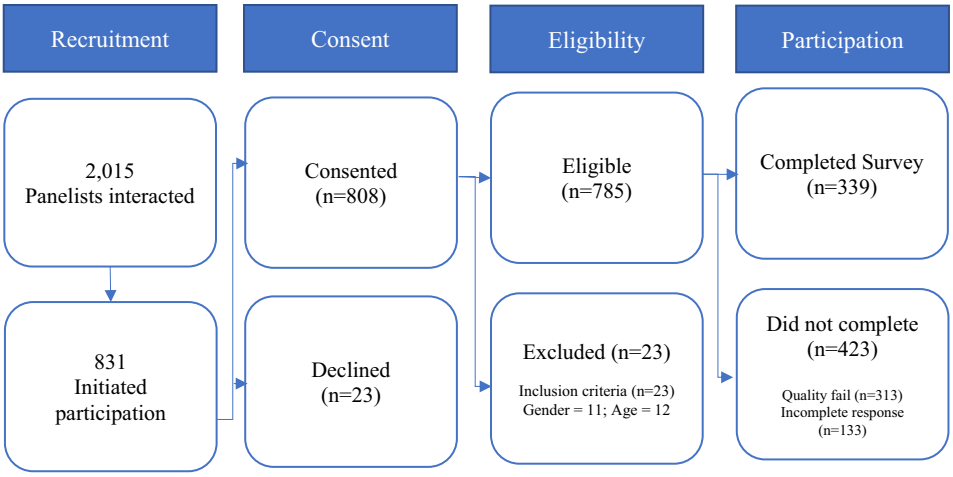

Fig. 1. Recruitment, consent, and completions.

reliability analysis was available [39]. Answers to these questions ranged between "strongly disagree" to "strongly agree" on a six-item Likert scale.

4.2.5. Self-efficacy

Self-efficacy was measured by two items: "How certain are you that you could get a future Zika vaccination?" with responses ranging from "very uncertain" to "very certain," and "If I wanted to, I am confident that I could get the future Zika vaccination," with responses ranging from "strongly disagree" to "strongly agree" on a six-item Likert scale. Cronbach's alpha for items on the scale was 0.89 [39].

4.2.6. Intention

Respondents' intention to get a future Zika vaccine was measured using a single item, "I intend to get the Zika vaccine when it becomes available," with responses ranging from "strongly disagree" to "strongly agree" on a six-item Likert scale (ADD SOURCE).

4.3. Statistical analyses

Normality was assessed for all study variables by visual inspection of normal Q-Q plots. A correlation matrix was constructed to examine the bivariate relationships among perceived severity of Zika, perceived susceptibility to Zika, self-efficacy to get a future Zika vaccine, response efficacy to get a future Zika vaccine, and intent to get a future Zika vaccine. Descriptive analyses were then performed for all primary study variables.

A path analysis procedure was conducted using AMOS 24.0 (Armonk, New York) to validate a hypothesized pattern of relations among the constructs leading from perceived severity of Zika and perceived susceptibility to Zika to self-efficacy and response efficacy related to getting a future Zika vaccine to intent to get a future Zika vaccine.

The criteria used to assess goodness of fit are listed in Table 1 [62]. For the goodness of fit index (GFI) and adjusted goodness of fit index (AGFI), the cutoff for adequate fit is 0.90 [59,61]. The normed fit index (NFI), incremental fit index (IFI), and Tucker-Lewis index (TLI) are relative fit indices and also use a cutoff of 0.90 for establishing adequate fit [59,61]. Finally, the Akaike information criterion (AIC) and Bayesian information criterion (BIC) assess improvement in successive models, and lower values indicate better fit [62]. Other indices to assess fit are a comparative fit index (CFI; [60]) of greater than 0.90 [59,61], and a root mean squared error of approximation (RMSEA) of 0.08 or lower [66].

Table 1
Fit indices of final path model (2).

Fit Index	Final Model
CMIN/DF	3.78
GFI	1.00
AGFI	0.93
NFI	0.99
RFI	0.93
IFI	1.00
TLI	0.95
CFI	1.00
RMSEA	0.09
AIC	31.78
BIC	85.35

Note. CMIN/DF = chi-squared to degrees of freedom ratio; GFI = Goodness of Fit Index; AGFI = Adjusted Goodness of Fit Index; NFI = Normed Fit Index; RFI = Relative Fit Index; IFI = Incremental Fit Index; TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root Mean Squared Error of Approximation; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

The path analysis procedure started with a saturated model in which all possible direct paths between variables were specified. Following trimming procedure outlined by [65], two consecutive models freed up the least statistically significant paths from the prior model until all non-significant paths were eliminated. Once a final model was retained, indirect effects and bias-corrected significance levels were calculated using 2000 bootstrap samples.

5. Results

Normality was assessed and confirmed for all study variables through visual inspection of Normal Q-Q Plots.

5.1. Participant characteristics

All participants resided in the U.S. and were English-speaking. The mean age of respondents was 33.9 years (SD = 7.88). Most participants were from the South[1] (38.9%), followed by the Western region[2] (24.5%), Midwest[3] (20.9%), and Northeast[4] (15.6%). In terms of education, 4.1% (n = 14) reported having some high school, 20.4% (n = 69) a high school diploma, 33.0% (n = 112) some college, 11.5% (n = 39) reported getting a 2-year degree, 22.4% (n = 76) a 4-year college degree, and 8.6% (n = 29) reported having a graduate degree. Finally, 9.4% (n = 32) were African-American, 1.2% (n = 4) American Indian, 5.0% (n = 17) Asian, 8.8% (n = 30) Hispanic, 73.5% (n = 249) Caucasian, and 2.1% (n = 7) other (see Table 2).

5.2. Intent to get the Zika vaccine

When asked to respond to the statement "I intend to get a future Zika vaccine when it becomes available," 6.8% (n = 23) responded they strongly disagreed, 8.6% (n = 29) reported they disagreed, 7.7% (n = 26) somewhat disagreed, 25.1% (n = 85) somewhat agreed, 26.5% (n = 90) agreed, and 25.3% (n = 86) strongly agreed. Breaking this down to a binary variable, 23.1% (n = 78) disagreed to some level with the vaccine intent statement, whereas 76.9% (n = 261) agreed to some level. An independent sample *t*-test was conducted to determine whether there were differences in reported intent to get the Zika vaccine between those who answered the attention checks correctly and those who were dropped from the study because of missed attention checks. There was no significant difference between the two groups, $t(858) = -1.040$, $p = .299$).

5.3. Correlation matrix

A correlation matrix was calculated showing the bivariate relationships among all primary study variables (Table 3). As would be expected, all variables were positively related to each other.

5.4. Path Model 1

The first path model (Fig. 2, Table 4) - the original model with all potential paths being specified - explained 20.0% of the variance in response efficacy, 8.5% of the variance in self-efficacy, and 55.1% of the variance in future Zika vaccine uptake intent. However, this was a fully saturated model with all possible paths being specified, so fit indices were invalid and will not be reported.

[1] AL, AR, DC, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV.
[2] AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY.
[3] IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI.
[4] CT, MA, ME, NH, NJ, NY, PA, RI, VT.

Table 2
Sample demographics.

Variable/Sub variable	Frequency
Geographical regions	
Northeast	15.6% (n = 53)
South	38.9% (n = 132)
West	24.5% (n = 83)
Midwest	20.9% (n = 71)
Education	
Some high school	4.1% (n = 14)
High school	20.4% (n = 69)
Some college	33.0% (n = 112)
Two-year degree	11.5% (n = 39)
Four-year college degree	22.4% (n = 76)
Graduate degree	8.6% (n = 29)
Race/ethnicity	
African-American	9.4% (n = 32)
American Indian	1.2% (n = 4)
Asian	5.0% (n = 17)
Hispanic	8.8% (n = 30)
Caucasian	73.5% (n = 249)
Other	2.1% (n = 7)

5.5. Path model 2

Following the trimming procedure outlined by [65], the second path model freed up the least statistically significant path from the first model, which was between perceived severity and Zika vaccine uptake intent. The fit indices for this model suggested adequate or good fit (Table 1). In the second path model, all path coefficients were statistically significant and are presented with their *p*-values in Table 5. As a result, the second model was retained as the final Zika vaccine uptake intent model (Fig. 3).

Perceived susceptibility yielded significant direct effects on self-efficacy ($\beta = 0.172$, $p = .004$) and response efficacy ($\beta = 0.212$, $p < .001$); Perceived severity also yielded significant direct effects on self-efficacy ($\beta = 0.168$, $p = .004$) and response efficacy ($\beta = 0.306$, $p < .001$).

Similarly, self-efficacy yielded a significant direct effect on Zika vaccine uptake intent ($\beta = 0.184$, $p < .001$), and response efficacy also yielded a significant direct effect on Zika vaccine uptake intent ($\beta = 0.555$, $p < .001$).

Table 4
Standardized β-weights and p-values of the original, saturated model (2).

Predictor	Criterion	β-weight	*p*-value
Perceived severity	Self-efficacy	0.168	0.004
Perceived susceptibility	Self-efficacy	0.172	0.004
Perceived susceptibility	Response efficacy	0.212	***
Perceived severity	Response efficacy	0.306	***
Self-efficacy	Zika vaccine uptake intent	0.181	***
Response efficacy	Zika vaccine uptake intent	0.533	***
Perceived susceptibility	Zika vaccine uptake intent	0.132	0.002
Perceived severity	Zika vaccine uptake intent	0.084	0.051

Note.
*** $p < .001$.

Table 5
Standardized β-weights and p-values of final model (2).

Predictor	Criterion	β-weight	*p*-value
Perceived severity	Self-efficacy	0.168	0.004
Perceived susceptibility	Self-efficacy	0.172	0.004
Perceived susceptibility	Response efficacy	0.212	***
Perceived severity	Response efficacy	0.306	***
Self-efficacy	Zika vaccine uptake intent	0.184	***
Response efficacy	Zika vaccine uptake intent	0.555	***
Perceived susceptibility	Zika vaccine uptake intent	0.163	***

Note.
*** $p < .001$.

Table 3
Correlation matrix.

Variable	1	2	3	4
1. Zika vaccine uptake intent				
2. Response efficacy	0.702*			
3. Self-efficacy	0.493*	0.484*		
4. Perceived susceptibility Zika	0.407*	0.356*	0.251*	
5. Perceived severity Zika	0.407*	0.406*	0.249*	0.469*

Note.
* $p < .01$.

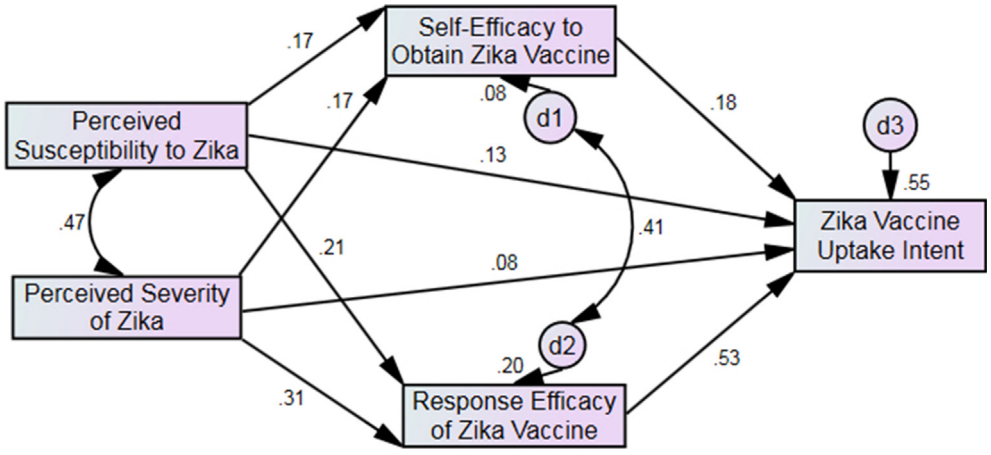

Fig. 2. Original, saturated model.

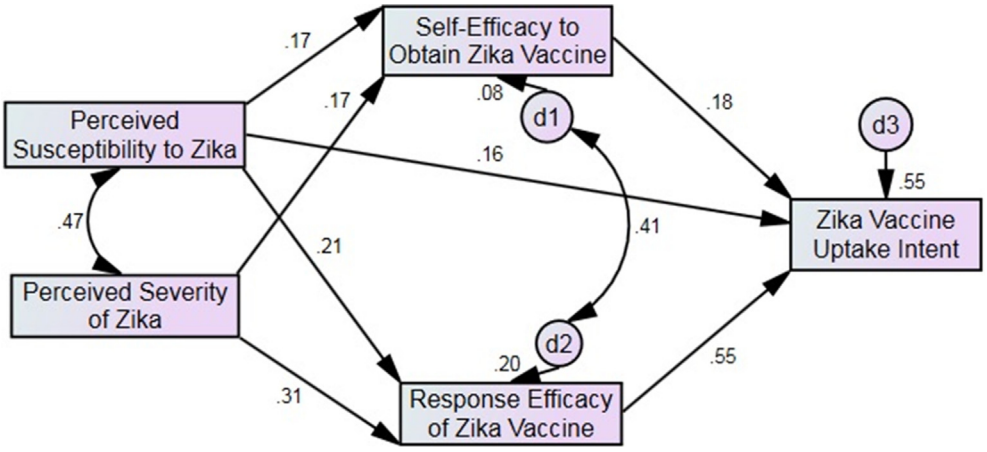

Fig. 3. Final model.

The relationship between perceived susceptibility to the Zika virus and Zika vaccine uptake intent was partially mediated by both self-efficacy to obtain the Zika vaccine and response efficacy of the Zika vaccine (β = 0.149, $p < .001$) (see Fig. 3). In addition, there was a direct relationship between perceived susceptibility and Zika vaccine uptake intent (β = 0.163, $p < .001$). The relationship between perceived severity to the Zika virus and Zika vaccine uptake intent was fully mediated by both self-efficacy to obtain the Zika vaccine and response efficacy of the Zika vaccine (β = 0.210, $p < .001$) (see Fig. 3). The final future Zika vaccine uptake intent model explained 20.0% of the variance in response efficacy, 8.5% of the variance in self-efficacy, and 54.6% of the variance in future Zika vaccine uptake intent.

Research question two focused on how demographic and healthcare-related factors are associated with a future Zika vaccine uptake intent.

First, a one-way ANOVA was conducted to determine if the intent to get a future Zika vaccine was different for participants living in different regions of the country [South (n = 53), West (n = 71), Midwest (n = 132), and Northeast (n = 83)]. The mean intent to get a future Zika vaccine was 4.08 (SD = 1.52) for those living in the South, 4.39 (SD = 1.54) for those living in the West, 4.36 (SD = 1.48) for those living in the Midwest, and 4.36 (SD = 1.45) for those living in the Northeast. The differences between these groups were not statistically significant, F(3339) = 0.582, p = .627.

A Pearson's product moment correlation was conducted to assess the relationship between plans to travel to areas with active Zika transmission and intent to get a future Zika vaccine. There was a statistically significant, positive correlation between travel plans to active Zika transmission areas and future Zika vaccine uptake intent, r(339) = 0.177, p = .001.

A multiple regression was conducted to predict future Zika vaccine uptake intent from age, race, education, pregnancy status, previous flu vaccine uptake, and healthcare provider contact about Zika. The multiple regression model statistically significantly predicted future Zika vaccine uptake intent, $F(11,302) = 7.334$, $p < .001$. Only previous flu vaccine uptake added statistically significantly to the prediction, $p < .001$ (see Table 6).

6. Discussion

This study investigated the predictive effects of attitudes and beliefs of women of reproductive age on intent to get a future Zika vaccine. Three quarters of the respondents reported agreement with intentions to get the Zika vaccine, while approximately one quarter reported some level of disagreement. This is encouraging because 76.9% agreed to some level, although few promotion efforts so far have taken place because the vaccine is not yet available. At the same time, it is discouraging because Zika is a disease and the devastating consequences of babies born with microcephaly have been widely publicized; yet almost a quarter of study participants reported they were not likely to get the vaccine once it becomes available. A potential reason for concern is that, while several studies carries out before the availability of the HPV vaccine found that a majority (in some cases upwards of the target vaccination rate of 80%) of parents reported intent to get their children vaccinated [7], the actual vaccination completion rate for the series was only 26% in 2016 [24].

Table 6
Multiple linear regression demographic and healthcare-related variables.

Variable	*B*	*SE B*	*β*	*(t)*	*p-value*
Constant	4.215	0.550		7.665	<0.001
Previous flu vaccine uptake	1.174	0.163	0.391	7.191	<0.001*
Primary Care Provider	0.337	0.213	0.084	1.581	0.115
Education: some college	−0.123	0.209	−0.039	−0.590	0.555
Education: 2 yr. college	0.027	0.279	0.006	0.097	0.923
Education: 4 yr. college	−0.087	0.228	−0.024	−0.382	0.702
Education: grad school	0.149	0.321	0.027	0.466	0.642
Race: Black	−0.119	0.275	−0.023	−0.433	0.665
Race: Hispanic	0.024	0.277	0.005	0.088	0.930
Age	−0.013	0.010	−0.070	−1.302	0.194
Pregnancy status: planning	0.120	0.475	0.030	0.252	0.801
Pregnancy status: not planning	−0.373	0.450	−0.099	−0.830	0.407

* Significant at p < .05.

In order to identify psychosocial factors associated with intent to get a future Zika vaccine, two path models were tested, and the second model was retained as it provided all adequate or good fit indices. Most of the results of this study appear to support findings from similar, previous studies focusing on the seasonal influenza, H1N1, and HPV vaccines. Specifically, this model found that perceived susceptibility was both directly and indirectly (through self-efficacy and response efficacy) associated with future Zika vaccine uptake intent; and that perceived severity yielded a significant indirect effect on vaccine uptake intent through both self-efficacy and response efficacy.

6.1. Direct and indirect effect of perceived susceptibility on Zika vaccine uptake intent

The final model suggests that perceived susceptibility is both directly and positively associated with intent to get a future Zika vaccine as well as indirectly through both self-efficacy and response efficacy. This finding is consistent with existing research showing that perceived high susceptibility is associated with high seasonal influenza vaccine uptake [23] as well as high HPV vaccine uptake [8]; as well as with high influenza vaccine uptake intent [13] and high HPV vaccine uptake intent [4].

6.2. Direct effect of self-efficacy and response efficacy on uptake intent

The final model also found that self-efficacy and response efficacy were directly associated with future Zika vaccine uptake intent. Previous studies have shown those with high self-efficacy related to the influenza vaccine are more likely to actually get the vaccine [21]; and similarly, those with high self-efficacy related to the HPV vaccine are more likely to get the HPV vaccine [8,22]. People with high response efficacy related to the seasonal influenza vaccine are more likely to get the vaccine [23]; those with high response efficacy related to the influenza vaccine and the H1N1 vaccine, respectively, also are more likely to report intent to get these vaccines [13,39]. These results add support for the utility of health behavior theory when designing vaccine-related messages.

6.3. Indirect effect of perceived severity on uptake intent

The final path model showed that perceived severity produced a significant effect on future vaccine uptake intent via both self-efficacy and response efficacy. Although previous research demonstrates a direct effect of perceived severity of the disease on seasonal influenza vaccine uptake [63] as well as on high H1N1 vaccine uptake intent [19] and HPV vaccine uptake intent [4], in the current study this relationship was fully mediated by self-efficacy and response efficacy. One possible explanation for the absence of a direct effect is the heavy use of microencephaly images in media messages about Zika. It is plausible that, in our population, the threat of microencephaly is much more severe that other vaccine-preventable diseases like the flu or HPV. The EPPM posits that very high threat in the absence of efficacy leads viewers to control their fear, rather than the danger posed by the threat. If someone's perceptions of severity were strong enough to directly affect intention beyond the indirect effects through efficacy, it is likely that they would be processing along the fear control path and the cognitive mechanisms used to control their fear would suppress any direct relationship between severity and intentions. Taken as a whole, the current study extends previous research by uncovering possible pathways by which perceived susceptibility to and severity of Zika lead through self-efficacy and response efficacy to vaccination intent.

6.4. Demographic and healthcare-related variables

In a multiple regression model, and in contrast to other vaccine-related studies [39,29,18,27,49], education and race did not significantly contribute to the model. [64] argue there may be differences in how people perceive a vaccine from one type of vaccination to another, depending either on the nature of the vaccine or on the condition the vaccine is supposed to prevent. In addition, while we could have anticipated a difference in future Zika vaccine uptake intent by respondents' geographic location, this variable did not significantly predict uptake intent. This could be explained by the fact that few places in the U.S. have experienced active local Zika transmission, and that preventative messaging so far has primarily focused on risks associated with traveling to Zika infected nations.

A recent study focused on mental models related to Zika virus awareness in Guatemala found a marked importance of the study participants' personal experiences with other mosquito-borne diseases. They primarily appeared to understand the threat of mosquitos spreading Zika but relatively few reported familiarity with the risk of sexual transmission. This may result in underestimating or even ignoring the threat of sexual transmission of the Zika virus. Since the study sample all originated in the contiguous United States, few of the survey participants will have first-hand experience with mosquito-borne diseases and they may not be easily able to evaluate that threat. However, they may be more likely to understand the risk of sexual transmission of the Zika virus [48]. This falls outside the scope of this study but should be considered for inclusion in future studies among this population.

Finally, seasonal influenza vaccine uptake history did contribute significantly to the regression model, with higher reported intent to get a future Zika vaccine associated with participants reporting that they received the seasonal influenza vaccine the previous season. This outcome indicates a possible relationship—confirmed by the literature [12,33,50]—between one of the most common vaccines for adults and the likelihood someone will decide to get a future Zika vaccine; convincing people to take one vaccine can help encourage them to get other vaccines, as well.

6.5. Implications

The study results confirm the importance of perceived susceptibility, self-efficacy, and response efficacy, and these all should be considered when designing future Zika vaccine messages. When using the perceived severity of Zika construct to communicate about future Zika vaccine uptake intent, public health communication professionals should consider including both response efficacy and self-efficacy in their message design. This is in line with the EPPM theoretical model: according to the EPPM, perceived threat will only be associated with actions to control the threat if both self-efficacy and response efficacy are present [53]. In practice, this could take the form of helping people develop self- and response efficacy related to the vaccine, possibly by developing and providing a clear step-by-step guide that can be distributed through healthcare practices as well as on social media, and that will include steps such as the number to call, clinics and other places where the vaccine will be available, and information about the effectiveness of the Zika vaccine. These guides and messages should be tailored to the geographical area for the target population.

In addition, previous influenza vaccine uptake appeared to predict future Zika vaccine uptake intent, providing public health communicators with a possible additional tactic to considering for future communication campaigns.

6.6. Strengths and limitations

A major limitation of this study is that the Zika vaccine is not available yet—so any questions about its uptake are addressing a hypothetical future situation at best. Because of this, there may well be discrepancies between intent and behavior, and constructs like response efficacy and self-efficacy related to the vaccine may function differently once the vaccine is available. In addition, while the Zika vaccine trials look promising as of September 2018, there is no guarantee a vaccine will ultimately become available.

Another limitation is this study's use of cross-sectional data, which makes it difficult to know whether the ordering of factors is accurate. Future studies should plan on using longitudinal data and look at longitudinal mediators to more appropriately determining causality in these relationships. A more specific limitation is that the response efficacy variables did not refer to direct protection of a fetus from the effects of Zika virus – this should be included in future studies. Moreover, for the sake of parsimony, this study did not include subjective norms in its models, and we encourage future studies to test alternative path models derived from these models and others.

Of further concern is that a relatively large number of survey respondents were excluded from the study for failing attention checks. This may be related to the length of the survey, but it is an issue that needs to be considered in future studies. Finally, because this study uses an Internet panel sample, the results of this study may not be generalizable.

This study has several strengths, despite its limitations. It takes a proactive approach in studying which psychosocial variables might be most important to target for future Zika vaccine messaging, allowing for results to be implemented as the vaccine becomes available. In addition, this study used a quota sample of women of reproductive age, focusing on one of the groups most vulnerable to devastating Zika consequences. Finally, this study investigated theoretically driven predictors of behavior, adding to the rigor of the design and the applicability.

7. Conclusion and future directions

The Extended Parallel Processing Model (EPPM) appears to be useful to inform future Zika vaccine uptake campaigns, which provides helpful guidance for public health professionals who will be focusing on these campaigns. Although several of this study results confirm previous results related to other vaccines in uptake and uptake intent, it adds the new dimension of a partially mediated relationship between perceived severity and vaccine uptake by both self-efficacy and response efficacy.

The Zika virus may not be designated as a global health emergency at this point, but it is an ongoing threat and it is of great importance that a future Zika vaccine be accepted quickly. Understanding the most effective psychosocial constructs for targeted messaging promoting a new Zika vaccine will be of vital importance for vaccine uptake to happen.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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