Knowledge and Prevention Practices among U.S. Pregnant Immigrants from Zika Virus Outbreak Areas

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Abstract. We administered an anonymous survey to assess knowledge, attitudes, and prevention practices related to the Zika virus among pregnant women residing in Texas. Multivariate logistic regression models controlling for age, race/ethnicity, education, and number of years in the United States assessed differences between women born in outbreak areas ($N = 390$) versus those born in the United States ($N = 249$). Results demonstrated that most women wanted more information on the Zika virus and desired to obtain it from their physician. The majority did not know that the Zika virus could be spread through sex with an asymptomatic partner or how often those infected were symptomatic. Few women took precautions to avoid mosquito bites. Only 40% reported frequently using repellent; 21% stated that cost was problematic and almost half were concerned about use during pregnancy. Three-fourths stated they would agree to vaccination, if available. Compared with U.S.-born women, those born in outbreak areas were more likely to have already discussed the Zika virus with their doctor (adjusted odds ratio [aOR] = 1.86, 95% confidence interval [CI] = 1.27, 2.71) and identify microcephaly as the most common birth defect (aOR = 2.59, 95% CI = 1.78, 3.76). Moreover, women born in outbreak areas were less likely to desire to keep it a secret if they became infected (aOR = 0.47, 95% CI = 0.31, 0.71). This study found that, regardless of birthplace, pregnant women need more education on the Zika virus disease and assurance regarding the safety of using repellent during pregnancy. They also need financial assistance for repellent, especially if living in states where transmission by mosquitoes has been reported.

INTRODUCTION

An epidemic of the Zika virus (ZIKV) has been declared in many parts of Central and South America as well as the Caribbean.¹ After it was found that ZIKV infection was associated with microcephaly and other neurological birth defects among infants born to infected mothers in South America in early 2016, the World Health Organization declared a Public Health Emergency of International Concern.² In April of the same year, the Centers for Disease Control and Prevention (CDC) declared that ZIKV infection is a cause of microcephaly and other fetal brain defects.³ Although ZIKV is transmitted by mosquitoes, most cases in the United States have occurred as a result of individuals traveling to outbreak regions.⁴ There are also cases where transmission occurred through sexual intercourse with an infected person.⁵ As of December 7, 2016, there have been 185 mosquito-borne cases transmitted in the continental United States and 4,389 travel-associated cases reported.⁶

Even though ZIKV is now circulating in the United States, only a few studies have examined the knowledge level of pregnant women in America, including those at higher risk of exposure through their own travel or a partner who traveled to an outbreak area. Data from the currently published surveys are limited by their methodology and narrow scope and few have reported data for pregnant women. Moreover, most have not been published in peer-reviewed journals, but instead appeared in the lay press. These articles suggest low levels of knowledge in the United States. For example, a national poll of 1,004 households in March 2016 found that 40% of Americans had heard “only a little” or “nothing at all”

about the ZIKV. Only 57% of those aware of ZIKV knew it could be spread through sexual intercourse with an infected person.⁷ An online survey of 300 U.S. citizens showed that ZIKV concerns are not stopping Americans from traveling abroad.⁸ Analysis of a ZIKV twitter chat hosted by the CDC in February 2016 demonstrated that participants were most concerned about how the ZIKV spreads and ZIKV infection-related fetal abnormalities.⁹

Few of the studies on ZIKV have focused on pregnant women, even though they may be at risk of delivering a child with severe health problems if infected. The largest study that included pregnant women surveyed 1,275 households in which someone was pregnant or considering becoming pregnant in the next 12 months.¹⁰ About 25% were not aware of the link between ZIKV infection and microcephaly and had little knowledge about how it was transmitted, prevented, or what the risk of symptoms were in infected individuals.¹⁰ A second study of 99 pregnant women found that 31% were unaware of the U.S. advisory to avoid travel to active ZIKV outbreak regions and nearly half did not know there was active ZIKV transmission in areas where they had traveled.¹¹ Neither study included information on women's attitudes or their prevention practices other than limiting travel.

To address these gaps in the literature, we conducted a clinical survey of pregnant women attending prenatal clinics in southeast Texas in the summer of 2016, soon after the link between ZIKV infection and fetal brain defects was announced. These clinics serve a large number of women who immigrated to the United States from Central or South America and thus are at higher risk of ZIKV infection than women born in the United States as they are more likely to travel to countries with ongoing outbreaks or have partners who traveled there. The survey assessed knowledge, attitudes, and preventive practices related to ZIKV infection. By the time it was administered, the CDC had issued guidelines recommending that pregnant women limit their travel to

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countries with active outbreaks and that providers test pregnant women who did travel to one of these areas.³ To assess whether women originally born in countries with active ZIKV outbreaks had different views or practices that may affect their risk of infection, we stratified our findings by place of birth (born in an area with active ZIKV outbreak versus born in the United States). This information is needed to develop interventions that address the specific needs of high-risk groups.

MATERIALS AND METHODS

Pregnant women 18–50 years of age attending one of five reproductive health clinics in southeast Texas were invited to participate in an anonymous paper survey, which was available in English or Spanish, between June 14 and July 21, 2016. At the time of this study, information on ZIKV was not being actively distributed in the clinics. These clinics provide obstetric care to low-income women, almost 80% who have an annual family income < \$30,000. Research assistants approached women in the waiting room before their clinic visit who had been preidentified as being eligible on the clinic census (currently pregnant and between 18 and 50 years of age). After confirming their eligibility, their interest in completing the self-administered survey was assessed before it

was handed to them. Those who agreed to participate were allowed to select a gift for their baby valued at ≤ \$5 as reimbursement for their time and effort. To ensure that participants completed the survey only once, study personnel maintained a cumulative database containing the clinic numbers of all women who had previously been approached across all clinics and compared it daily to those scheduled for a visit; previously approached women were not asked to participate a second time. The University of Texas Medical Branch Institutional Review Board approved all procedures and protocols for this study, including a waiver of written consent.

Questions were adapted from those published in the World Health Organization's Resource Pack on ZIKV,¹² the National Health Interview Survey,¹³ the First Nations' Knowledge of and Protection from the West Nile virus survey,¹⁴ and the Ipsos poll on ZIKV conducted for Reuters.¹⁵ Reading level of English questions was a Flesch–Kincaid grade level of 7.4. Self-reported demographic information including age, ethnicity, education level, country of birth, and gestational age were collected. This survey assessed respondents' 1) knowledge of ZIKV, 2) past and future travel to outbreak regions, 3) exposure to mosquitoes, and 4) preventive practices against mosquito bites. We defined outbreak areas as any country in which local ZIKV transmission was declared as of July 2016 (when the survey was

FIGURE 1. Inclusion of pregnant women in a survey about Zika who attended a reproductive health clinic in southeast Texas from June 14 to July 21, 2016. Percentages in flowchart are based on the total number of eligible women invited to participate ($N = 876$). ZIKV outbreak areas included Mexico, all of Central America, Brazil, Colombia, Puerto Rico and the Caribbean Islands. ZIKV = Zika virus. This figure appears in color at www.ajtmh.org.

administered). Outbreak areas represented in our population included Mexico, all of Central America, Brazil, Colombia, Puerto Rico, and the Caribbean Islands.

Statistical analyses were conducted using Stata Statistical Software, release version 14.1 (StataCorp LP; College Station, TX). A two-sided P value < 0.05 was considered significant. Descriptive analyses included χ^2 and Fisher's exact tests for bivariate analyses of categorical data and two-tailed t -tests for comparison of continuous data. Multivariable logistic regression models that controlled for age, education, race/ethnicity, and number of years lived in the United States were used to compare all significant results found in bivariate analyses. For those born in the United States, the number of years in the United States was equal to their age.

RESULTS

A total of 639 women were included in the final analysis. Women were excluded if they declined to participate, had incomplete surveys, or if they were not born either in the United States or in areas with ZIKV outbreaks (Figure 1). Most of the women in this study were in their second or third trimester of pregnancy (Table 1). About two-thirds spoke Spanish at home and 79% self-identified as Hispanic or Latina. Differences in mean age, language spoken at home, race/ethnicity, and education levels were observed between U.S.-born women and those born in outbreak countries.

Data from this survey indicated that there were several gaps in knowledge about ZIKV, and that women wanted to know more about it. Almost all women reported they had heard of ZIKV, but more than half of all participants wanted more information on ZIKV symptoms (58%), prevention measures (49%), or consequences of infection during pregnancy (42%; results not shown in table). U.S.-born women most often reported they trusted their physician for ZIKV information, whereas those from ZIKV outbreak areas indicated they trusted their family (Table 2). However, more than half of U.S.

born and women born in ZIKV outbreak areas preferred to learn about ZIKV through face-to-face communication with their health provider.

A small proportion of women from outbreak areas thought there was a cure for ZIKV infection. About half of all women knew about the CDC's recommendation against traveling to outbreak areas during pregnancy, but had low knowledge about which regions had confirmed mosquito-borne outbreaks. Less than half had discussed travel restrictions with their health-care provider. Most women were aware that ZIKV was spread by mosquitoes and could be transmitted during pregnancy from a mother to her child. The majority did not know their risk of being infected by ZIKV or that it could be transmitted through sexual contact with an asymptomatic partner. Only half of the women understood the importance of using condoms to prevent transmission during pregnancy, with those born in the United States less likely to know this fact (55% versus 44%). Moreover, most did not know how often those infected by ZIKV were symptomatic. Few women knew the approximate risk of transmitting ZIKV to their fetus during pregnancy.

Almost half of surveyed women spent ≤ 2 hours a week outdoors, although a higher proportion of U.S.-born women spent ≥ 2 hours outdoors per week than women born in ZIKV outbreak countries (Table 3). The majority of women from both groups reported ≤ 2 known mosquito bites per day. Less than half of the sample reported they often used mosquito repellent. A little more than a quarter of U.S.-born women wore long-sleeved shirt or pants compared with more than a third of women born in ZIKV outbreak countries. Less than one-fourth of women reported using N,N-Diethyl-meta-toluamide (DEET)-based repellants with two-thirds reporting that they did not know what type of repellant they used. Almost all stated they would seek medical care if they experienced any signs or symptoms of ZIKV disease. However, 40% of U.S.-born women and 24% of those born

TABLE 1

Characteristics of participants by country of origin among pregnant who attended a reproductive health clinic in southwest Texas between June 14 and July 21, 2016

Characteristics	Whole sample (N = 639)		U.S. born (N = 249)		Born in countries with ZIKV (N = 390)		P value
	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)	
Gestational weeks							0.70
0–13	94	14.9%	34	13.9%	60	13.5%	
14–26	211	33.4%	79	32.4%	132	38.3%	
27–40	326	51.7%	131	53.7%	195	48.2%	
Age	639	27.6 (6.0)	249	25.3 (5.5)	390	29.0 (5.9)	< 0.001
Number of years in the United States	641	N/A	249	N/A	390	11.9 (7.2)	
Language spoken at home							< 0.001
English	217	33.8%	196	78.7%	21	5.6%	
Spanish	424	66.2%	53	21.3%	371	93.9%	
Race/ethnicity							< 0.001
Hispanic or Latina	500	78.7%	114	46.2%	386	97.9%	
Non-Hispanic White	71	11.2%	70	28.3%	1	0.3%	
Non-Hispanic Black	51	8.0%	50	20.2%	1	0.8%	
Others	13	2.0%	13	5.3%	0	1.0%	
Education							< 0.001
< High school	179	28.4%	38	15.3%	141	37.1%	
Completed high school/GED	451	71.6%	211	84.7%	240	62.9%	
Relationship status							0.162
Unmarried	196	30.9%	84	33.9%	112	28.9%	
Married/living with domestic partner	439	69.1%	164	66.1%	275	71.1%	

GED = general educational development; SD = standard deviation; ZIKV, Zika virus.

TABLE 2

Frequencies reflecting ZIKV knowledge among pregnant women born in outbreak areas vs. those born in the United States who attended a reproductive health clinic in southeast Texas between June 14 and July 21, 2016

	Whole sample (N = 639)		U.S. born (N = 249)		Born in countries with ZIKV (N = 390)		P value
	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)	
Heard of ZIKV	617	96.3%	228	91.6%	389	99.2%	< 0.001
Aware of CDC recommendation for travel	345	55.1%	123	49.8%	222	58.6%	0.08
Provider has talked about risks to pregnant women related to travel to ZIKV outbreak area	264	46.2%	83	35.6%	181	53.6%	< 0.001
Trusted source of accurate ZIKV information*							
Family	277	43.9	57	23.3%	220	57.0%	< 0.001
Friends/neighbors	101	16.0%	20	8.2%	81	21.0%	< 0.001
Doctor	442	70.0%	208	84.9%	234	60.6%	< 0.001
Internet	86	13.6%	43	17.6%	43	11.1%	0.02
Social media (Facebook, Twitter, etc.)	32	5.1%	11	4.5%	21	5.4%	0.60
Government announcement	86	13.6%	49	20.0%	37	9.6%	< 0.001
Health-care workers (nurse, etc.)	217	34.4%	117	47.8%	100	25.9%	< 0.001
Radio/TV/newspaper	83	13.2%	37	15.1%	46	11.9%	0.25
Risk of getting ZIKV in the next 6 months							0.10
Do not know	386	60.2%	139	55.8%	247	63.0%	
0–20%	230	35.9%	103	41.4%	127	32.4%	
21–40%	13	2.0%	3	1.2%	10	2.6%	
41+%	12	1.9%	4	1.6%	8	2.0%	
Knowledge of how ZIKV is transmitted*							
By sexual contact with an infected person	319	49.8%	98	39.4%	221	56.4%	< 0.001
By sexual contact with an infected person who has no symptoms	242	37.8%	83	33.3%	159	40.6%	0.17
By sharing air with in infected person	154	24.0%	67	26.9%	87	22.2%	0.32
By mosquito bites	502	78.3%	190	76.3%	312	79.6%	0.11
By blood transfusions	327	51.0%	119	47.8%	208	53.1%	0.02
From mother to baby during pregnancy	412	64.3%	156	62.6%	256	65.3%	0.20
Knowledge of countries/regions that have active Zika transmission by mosquitoes	641	1.6 (1.9)	249	1.6 (2.1)	392	1.7 (1.8)	0.81
Knowledge of possible ZIKV symptoms*							
Fever	412	64.3%	131	52.6%	281	71.7%	< 0.001
Rash	289	45.1%	102	41.0%	187	47.7%	0.071
Joint pain	293	45.7%	84	33.7%	209	53.3%	< 0.001
Conjunctivitis	188	29.3%	50	20.1%	138	35.2%	< 0.001
Muscle pain	321	50.1%	86	34.5%	235	60.0%	< 0.001
Headache	321	50.1%	97	39.0%	224	57.1%	< 0.001
Importance of using condoms with partner during pregnancy to prevent ZIKV transmission	316	50.6%	108	43.6%	208	55.2%	0.007
Is there a cure for ZIKV?	49	7.9%	11	4.5%	38	10.0%	0.022
Have birth defects been reported among pregnant women infected with ZIKV?	445	71.1%	162	65.8%	283	74.5%	0.03
Identified microcephaly as most common birth defect	382	62.0%	111	46.4%	271	71.9%	< 0.001
Percentage of children born to mothers who are infected with ZIKV							0.05
Do not know	466	72.7%	196	78.7%	270	68.9%	
0–20	16	2.5%	4	1.6%	12	3.1%	
21–40	12	1.9%	4	1.6%	8	2.0%	
41+	147	22.9%	45	18.1%	102	26.0%	
Percentage of ZIKV-infected people who have ≥ 1 symptom(s)							0.10
Do not know	513	80.0%	208	83.5%	305	77.8%	
0–20	15	2.3%	6	2.4%	9	2.3%	
21–40	27	4.2%	12	4.8%	15	3.8%	
41+	86	13.4%	23	9.2%	63	16.1%	

SD = standard deviation; ZIKV = Zika virus.

* Numbers do not total 100% because participants could select more than one response.

in outbreak areas reported they would want to keep it a secret if they or someone in their family contracted ZIKV. Other concerns included difficulty obtaining their preferred repellent or properly fitted screens.

More than half of pregnant women born in countries with ZIKV outbreaks were concerned about the safety of using repellent during pregnancy, whereas less than a third of U.S.-born women had this concern (Table 4). About three-fourths felt that ZIKV testing should be performed on all pregnant women and would agree to be vaccinated against ZIKV. We

found that a higher frequency of women from outbreak areas indicated they would be vaccinated compared with U.S.-born women, although willingness was high in both groups. Less than 20% of all women stated they would have an amniocentesis to find out if their baby was infected with ZIKV and only 6% would seek termination for a birth defect. A higher proportion of women born in ZIKV outbreak areas felt that it was important to avoid mosquito bites. A lower proportion of U.S.-born women felt that it was hard to get their preferred type of repellent compared with women born in countries

TABLE 3

Frequencies reflecting behaviors used to avoid ZIKV infection among pregnant women born in outbreak areas vs. those born in the US who attended a reproductive health clinic in southeast Texas between June 14 and July 21, 2016

	Whole sample (N = 639)		U.S. born (N = 249)		Born in countries with ZIKV (N = 390)		P value
	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)	
Time per week spent outside							0.002
Less than 2 hours	325	52.1%	109	44.0%	216	57.4%	
2–5 hours	213	34.1%	92	37.1%	121	32.2%	
6–10 hours	63	10.1%	36	14.5%	27	7.2%	
10+ hours	23	3.7%	11	4.4%	12	3.2%	
Frequency of mosquito bites while outside							0.08
Never	181	29.3%	61	25.0%	120	32.1%	
1–2 times per day	162	26.2%	68	27.9%	94	25.1%	
Several times per day	51	8.2%	27	11.1%	24	6.4%	
Only a few times per week/month	224	36.2%	88	36.1%	136	36.4%	
When outdoors in United States, frequency of use of mosquito repellent spray							0.07
Used often	241	40.4%	104	42.6%	137	38.8%	
Use occasionally	253	42.4%	95	38.9%	158	44.8%	
Did not use at all	90	15.1%	43	17.6%	47	13.3%	
Used, but not because of mosquitoes	13	2.2%	2	0.8%	11	3.1%	
When outdoors in United States, frequency of use of long sleeved shirts, long pants							0.006
Used often	179	31.2%	66	26.9%	113	34.4%	
Use occasionally	201	35.1%	77	31.4%	124	37.8%	
Did not use at all	153	26.7%	83	33.9%	70	21.3%	
Used, but not because of mosquitoes	40	7.0%	19	7.8%	21	6.4%	
When outdoors in U.S. frequency of treating clothing and gear with permethrin							0.001
Used often	58	10.9%	23	9.6%	35	12.1%	
Use occasionally	73	13.8%	20	8.3%	53	18.3%	
Did not use at all	376	70.9%	190	79.2%	186	64.1%	
Used, but not because of mosquitoes	23	4.3%	7	2.9%	16	5.5%	
Kind of mosquito repellent used							0.09
Do not know/not sure	384	66.4%	143	61.4%	241	69.9%	
Repellent with DEET as active ingredient	140	24.2%	64	27.5%	76	22.0%	
Repellent with Picardin as active ingredient	2	0.4%	0	0.0%	2	0.6%	
Natural repellent, e.g., citronella oil	52	9.0%	26	11.2%	26	7.5%	
Know someone who has had ZIKV	2	0.3%	0	0.0%	2	0.5%	0.52*
Remain private/secret if respondent or their family were to get ZIKV	178	30.4%	95	40.6%	83	23.6%	< 0.001
Would seek medical care if had ≥ 1 ZIKV symptom	590	92.0%	229	92.0%	361	92.1%	0.95

DEET = N,N-Diethyl-m-toluamide; SD = standard deviation; ZIKV = Zika virus.

* Fisher's exact test statistics used for comparison because cell size was less than 5.

affected by ZIKV. Affordability of repellent was an issue for only 20% of this low-income group. Women born in countries with ZIKV outbreaks felt that fitted screens were hard to get for their home, but a smaller proportion felt that there were a lot of mosquitoes around their home. Most homes in the United States use air conditioning (A/C), so the use of mosquito bed nets is not prominent, therefore the survey did not address this use in U.S. homes. However, we found that when traveling to outbreak areas, 16.7% of U.S. born and 17.9% of women born in outbreak countries stayed in places without A/C. Also when traveling, 94% of U.S.-born women and 67% of those born in outbreak areas did not sleep under a mosquito bed net, this difference was significant.

In multivariable models that controlled for age, education, and number of years that each participant spent in the United States, a number of significant differences were observed between women born in outbreak areas versus those born in the United States (Table 5). Women from outbreak areas were more likely to 1) have heard of ZIKV; 2) have discussed with their doctor risks of traveling to outbreak areas; 3) trust friends and family for accurate ZIKV information; 4) know that microcephaly was the most commonly reported birth defect among ZIKV-infected pregnant women;

and 5) be concerned about the safety of using mosquito repellent while pregnant. Women born in outbreak areas were less likely to trust doctors or health-care workers as a source of accurate ZIKV information compared with U.S.-born women and were less likely to want to keep it a secret if they or a family member were infected.

DISCUSSION

In this study, we found that women born in ZIKV outbreak areas had greater knowledge than those born in the United States of ZIKV's signs and symptoms and associated birth defects. This difference could also have been due to more extensive provider counseling, or due to discussions with family still living in their birth countries. However, women from outbreak areas still had a number of important knowledge gaps. Over half were not aware of several signs and symptoms of ZIKV infection or did not know that infection was usually asymptomatic. Furthermore, although they were more likely than U.S.-born women (44%) to know that condoms could prevent transmission of the virus, only 55% knew this fact. This has important implications as pregnant women may not take precautions if they have sexual

TABLE 4

Frequencies of attitudes and beliefs about ZIKV among pregnant women born in outbreak areas vs. those born in the United States who attended a reproductive health clinic in southeast Texas between June 14 and July 21, 2016

	Whole sample (N = 639)		U.S. born (N = 249)		Born in countries with ZIKV (N = 390)		P value
	N	% or mean (SD)	N	% or mean (SD)	N	% or mean (SD)	
Worried about safety of using mosquito repellent while pregnant	279	45.4%	77	31.8%	202	54.2%	< 0.001
Concern about ZIKV affecting their health (Very or extremely concerned)	275	45.6%	106	43.2%	169	47.2%	0.352
Concern about ZIKV affecting their baby's health (very or extremely concerned)	365	65.2%	157	64.6%	208	65.6%	0.832
All pregnant women should be tested for ZIKV	492	78.6%	189	76.5%	303	80.0%	0.58
Would get vaccine if available for ZIKV	463	74.3%	170	68.8%	293	77.9%	0.015
Would have an amniocentesis to find out if baby was infected with ZIKV	117	18.8%	45	18.2%	72	19.2%	0.36
Would terminate pregnancy if baby had a birth defect	38	6.1%	15	6.2%	23	6.1%	0.38
Mosquito bites do not bother them	114	19.2%	38	15.3%	76	21.9%	0.05
It is important to avoid getting mosquito bites	561	91.4%	215	87.4%	346	94.0%	0.004
It is hard to get the kind of insect repellent preferred	151	25.8%	43	17.6%	108	31.7%	0.001
Insect repellent is easy to find	511	84.7%	207	84.8%	304	84.7%	0.96
Insect repellent is too expensive	121	20.6%	49	20.1%	72	21.0%	0.77
Proper fitted screens are hard to get	121	20.1%	41	16.8%	80	24.0%	0.04
Proper fitted screens are too expensive	141	24.8%	50	20.7%	91	27.7%	0.06
There are a lot of mosquitoes around my home	209	35.5%	101	41.4%	108	31.4%	0.01
It is important for people to reduce number of mosquitoes around their homes	527	86.5%	206	83.7%	321	88.4%	0.10

SD = standard deviation; ZIKV = Zika virus.

intercourse with a partner who could be infected, but does not have symptoms.

We found that 40% of the sample that was born in the United States and 24% from outbreak areas would keep a ZIKV infection secret if they or a family member contracted it. This implies that the disease carries a perceived stigma for infected individuals and their families, particularly for those born in the United States. One possible reason for this finding could be the extreme negative reaction of the public to U.S. residents, who developed Ebola virus infections during their travel to Africa in 2014.¹⁶ Although stigma is associated with other infectious diseases, such as human immunodeficiency virus, concerns about newly emerging infectious

diseases are more comparable to each other as news about their outbreaks are often accompanied by controversy, scattered information about policy, and threats of isolation or quarantine.¹⁷ Education, particularly in U.S. states that are vulnerable to ZIKV outbreak, is needed to combat stigma of these types of diseases, as less educated people are at risk of failing to be diagnosed or may not share information with their sexual partners. This could be especially detrimental to a pregnant woman's fetus, if the infected individual engaged in unprotected sexual intercourse.

Many of the study participants stated they would agree to be vaccinated against ZIKV, if it becomes available. Women born in outbreak areas favored vaccination over those born

TABLE 5

The odds of pregnant women born in ZIKV outbreak countries compared with U.S.-born women's knowledge, beliefs, and behaviors who attended a reproductive health clinic in southeast Texas between June 14 and July 21, 2016

	aOR*	95% CI	P value
Heard of ZIKV	9.66	2.62, 35.64	< 0.001
Provider has talked about risks to pregnant women related to travel to ZIKV outbreak area	1.86	1.27, 2.71	0.001
Trusted source of accurate ZIKV information			
Family	3.55	2.37, 5.31	< 0.001
Friends/neighbors	2.74	1.38, 4.43	0.002
Doctor	0.33	0.21, 0.51	0.001
Health-care workers (nurse, etc.)	0.42	0.29, 0.62	< 0.001
Remain private/secret if respondent or their family were to get ZIKV	0.47	0.31, 0.71	< 0.001
Knowledge of possible ZIKV symptoms			
Fever	0.97	0.92, 1.08	0.95
Joint pain	0.80	0.71, 3.68	0.77
Conjunctivitis	2.40	0.52, 11.00	0.26
Muscle pain	2.56	0.84, 7.79	0.10
Headache	2.51	0.56, 11.24	0.23
Preventing ZIKV transmission by using condoms with partner during pregnancy	0.97	0.46, 2.07	0.94
Identify microcephaly as most commonly reported birth defect among pregnant women infected with ZIKV	2.59	1.78, 3.76	< 0.001
Worried about safety of using mosquito repellent while pregnant	2.48	1.69, 3.65	< 0.001
Frequency of treating clothes and gears with permethrin	1.68	0.27, 10.36	0.58
It is important to avoid getting mosquito bites	1.75	0.95, 3.24	0.07

aOR = adjusted odds ratio; CI = confidence interval; ZIKV, Zika virus. Binary multivariable logistic regression.

* Adjusted for age, education, and number of years lived in the United States.

in the United States, possibly because they were more aware of potential consequences for their infants, if infected. In addition, the majority agreed that pregnant women should be offered ZIKV testing, demonstrating they would want to know if their infant was at risk. However, few would agree to an amniocentesis (defined as a test that inserts a needle through your belly to find out if your baby was infected) to diagnose fetal ZIKV infection. Some may have felt that this would be of little benefit since they knew there was no treatment or cure. It is also possible that some respondents did not understand that an amniocentesis would not harm the infant. Our findings are consistent with prior reports that acceptance of amniocentesis is significantly lower in Hispanic than Caucasian populations.¹⁸ In contrast to a study conducted in Latin America, women receiving care in these Texas clinics stated they would not seek an abortion if diagnosed with ZIKV infection.¹⁹ This makes it even more critical to educate women who live in states that may experience an outbreak on how to avoid this infection, as the birth of an infant with severe, permanent disabilities would likely impact the entire family.

Women born in countries with ZIKV outbreak reported less frequent use of mosquito repellent. This is concerning, as repellent is one of the few ways available to prevent infection and mosquito-borne circulation. This may have resulted from their concerns about its cost or its safety during pregnancy as almost half of the women surveyed were concerned that repellent could harm their infant. Moreover, 20% stated that its cost was prohibitive, demonstrating a need for programs to help pregnant women easily obtain repellent at a reduced cost or free of charge. These programs could be offered at clinics that see a high proportion of underserved patients, such as those in which this study was conducted. In fact, Texas announced a program in November 2016 that includes a provision for Medicaid benefits for mosquito repellent as a direct consequence of the threat of a ZIKV outbreak.²⁰

We found that low-income Texan women also need education on the type of mosquito repellent to use. The CDC strongly recommends using repellents that contain DEET in addition to Picardin, IR3535, oil of lemon eucalyptus, and 2-undecanone during pregnancy to protect against ZIKV infection. However, most women in this study were not aware of the active ingredients in the repellent they used nor did they know that DEET is safe to use. In fact, the U.S. Environmental Protection Agency placed DEET in the second lowest of the agency's toxicity categories (Category III) and labeled it as a Group D carcinogen (not classifiable as a human carcinogen).²¹ Its safety during pregnancy has been echoed by the CDC and obstetrics/gynecology organizations.^{22,23} In addition, 71% of the sample did not use permethrin even though the CDC recommended that pregnant women treat their clothing with this repellent/insecticide.²¹ Thus, most pregnant women in this study infrequently used these two simple techniques recommended by the CDC to avoid mosquito bites during pregnancy. This demonstrates that education on the type, safety, and importance of mosquito repellents and avoidance methods is urgently needed for those attending clinics that serve low-income pregnant women.

Another concerning finding is that more women born in outbreak areas reported that their family and friends were

the source they trusted for accurate information on ZIKV, rather than doctors or the government. This has clinical implications as physicians and clinics are often the main provider of accurate information about diseases. However, women from both groups stated that their preferred method of learning about ZIKV was face-to-face communication with their health provider suggesting that they would accept physician education as a first-line technique to learn more about this particular disease. Women in these clinics may feel that it is most appropriate to learn about ZIKV directly from their provider.

Our study has some limitations. The sample was limited to low-income pregnant women in southeast Texas and was not representative of the general U.S. population. There was no information about whether the pregnant women had had previous visits for prenatal care, which limits the possibility that they had an opportunity to be exposed to their provider's information about the virus. In addition, a cross-sectional study cannot be used to infer causality. The strengths of this study include a large sample of pregnant women from diverse backgrounds. Furthermore, we were able to sample women born in countries with active outbreaks who may be at higher risk of this disease than those born in the United States.

Overall, our study has important implications for the medical community. We found that pregnant women have many misconceptions about ZIKV and need more information on how to recognize disease resulting from infection. Those from outbreak areas are in urgent need of education on prevention practices, including the use of condoms if their partner has traveled to an outbreak area and use of repellents containing DEET or other proven and safe ingredients whenever they are outdoors. Treating clothing with permethrin is also an underutilized practice. Finally, the stigma of ZIKV infection needs to be addressed to allow early diagnosis and decrease the risk of transmission.

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