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ABSTRACT

In 2016 and 2017, South Florida was involved in an outbreak of locally-transmitted Zika virus. This questionnaire-based descriptive pilot study demonstrated the presence of behaviors that may be associated with increased risk of Zika transmission in a sample of respondents selected from an institution of higher education in the region. The majority of the 101 respondents living in Miami-Dade County reported inconsistent or no use of mosquito bite prevention methods, over one third (38.6%) traveled to local areas of active transmission, and almost two thirds (64.7%) of those reporting that their sexual partners traveled to local zones of viral transmission did not use barrier protection. The majority of all respondents reported awareness that the virus can be spread by mosquito-borne and sexual transmission (99.0%), and that infection can be avoided by preventing mosquito bites (98.0%) and sexual transmission (96.0%). Over half (52.5%) did not believe they were at risk of infection. South Florida remains at risk of outbreaks due to ongoing travel between the area and regions reporting continued Zika transmission, year-round presence of the vector, and the virus' ability transmit sexually. Further analysis is needed to determine whether findings are reproducible in the South Florida community.

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BACKGROUND

The Zika virus, a member of the genus *Flavivirus* first isolated in the Zika forest of Uganda in 1947, has geographically spread throughout the past decade, most recently into the Western Hemisphere (Petersen, Jamieson, Powers, & Honein, 2016). As of December 2, 2017, there were active outbreaks of the virus in 95 countries and territories across the globe, per the Centers for Disease Control and Prevention (CDC) (CDC, 2017g). The United States of America (USA) was previously listed among these countries due to detection of locally transmitted mosquito-borne cases in Florida and Texas during 2016 and 2017 (CDC, 2016a, CDC, 2017b; CDC, 2018a). So far in 2018, there has been no local transmission of Zika virus in the USA (CDC, 2018c).

The Zika virus is transmitted to humans via a mosquito vector, most commonly *Aedes aegypti*, as well as sexually and vertically (Petersen et al., 2016). It is the only arbovirus to be documented as being

sexually transmitted (Foy et al., 2011; Musso et al., 2015). There have been documented cases of spread via male to female, male to male, as well as female to male sexual activity (Petersen et al., 2016; Deckard et al., 2016; Davidson, Slavinsky, Komoto, Rakeman, & Weiss, 2016).

Many Zika infections are asymptomatic, however in approximately 19% of those infected, Zika virus causes a syndrome of fever, rash, joint pain, and conjunctivitis (CDC, 2016c; Duffy et al., 2009; Petersen et al., 2016). For most who experience the symptoms, the illness is mild, self-limited, and resolves without significant or lasting disability (CDC, 2016c). The concern with Zika infection arises due to links between the virus and congenital defects in infants of some women who are infected while pregnant as well as increased incidence of Guillain-Barré Syndrome (GBS) among certain infected individuals (Moore et al., 2017; Cao-Lormeau et al., 2016). Aside from microcephaly, there are several

anomalies associated with congenital viral infection including certain changes of the brain cortex, retinal and macular damage, congenital contractures, and early hypotonia; a collection of defects now known as “Congenital Zika Syndrome” (Moore et al., 2017). Although the specific rates of GBS and congenital defects associated with Zika infection are not completely understood, there is recognition that a rise in Zika infections may result in an increase of these health conditions, resulting in significant burden on the individuals and families affected, as well as on healthcare systems (Johansson, Mier-y-Teran-Romero, Reefhuis, Gilboa, & Hills, 2016; Florida Department of Health, 2016).

Since 2015, there have been 5,710 symptomatic cases of Zika virus reported in the continental USA and Hawaii (CDC, 2017a; CDC, 2017b; CDC, 2018a; CDC, 2018b). The majority of cases presented in travelers who are assumed to have contracted the disease while abroad in countries experiencing sustained local transmission of the virus (CDC, 2017a; CDC 2017b; CDC 2018a; CDC 2018b). Of these 5,710 cases, 231 were transmitted by local Zika-infected mosquitos in Texas and Florida, and 52 were deemed to be transmitted sexually (CDC, 2017a; CDC, 2017b). In the early summer of 2016, locally transmitted mosquito-borne cases were detected in South Florida (Likos et al., 2016). Throughout the fall of 2016 various areas of Miami-Dade County were designated as “red,” or zones of active transmission, due to detection of these locally transmitted cases (CDC, 2017f). In October 2016, all of Miami-Dade County was given a “yellow,” or cautionary, designation by the CDC with specific recommendations for screening and travel (CDC, 2017d; CDC, 2017c). A total of 220 locally transmitted mosquito-borne cases had been detected in Florida during 2016 and 2017 (CDC, 2017d; CDC, 2017c). In December 2016, the area around Brownsville, Texas was demarcated by CDC as a yellow zone after a case of local mosquito transmission was reported in late November 2016 (CDC, 2017c). A total of 11 locally transmitted mosquito-borne cases had been detected in Texas (CDC, 2017b; CDC, 2018a). All red and yellow zone designations in Florida and Texas have been lifted as of June 2017 and August 2017, respectively (CDC, 2017d; CDC, 2017c).

Despite the resolution of the Zika outbreak in South Florida, there remains the continued risk of further outbreaks due to the year-round and seasonal presence of *Aedes* mosquitos in the region, ongoing travel between the South Florida and other countries that have continued transmission of the virus, as well as the virus’ ability to be sexually transmitted independently

of the presence of a vector (Monaghan et al., 2016; Foy et al., 2011).

Purpose

The intent of this pilot study is to evaluate the presence of behaviors which may be associated with risk of Zika transmission via exposure to an infected vector or sexual partner within a population of students, faculty, and staff of an institution for higher education located in a region affected by active virus transmission, while simultaneously assessing respondents’ general knowledge and attitudes regarding Zika prevention and transmission.

METHODS

This pilot study was a cross-sectional questionnaire-based descriptive analysis. An electronic questionnaire of 28 questions was developed using Qualtrics Survey software and distributed to a convenience sample of faculty, staff, and students of an institution for higher education located in South Florida from May 23 until July 11, 2017.

The population

The study was conducted at an institution for higher education located in South Florida. This institution has a main campus in Miami-Dade County and several satellite campuses across the region, some of which are located in areas previously demarcated as red and yellow Zika transmission zones by the CDC. The student enrollment for this institution at the time of the study was 55,111 students. The student body is diverse with over 60% identifying as Hispanic or Latino and over half (56.8%) identifying as female (Burrows, 2016-2017). The majority (93%) of students live off of the campus (Burrows, 2016-2017). Data regarding faculty demographics could not be obtained by the time of the study.

The questionnaire

The questionnaire evaluated for behaviors that may be associated with increased risk for transmission of Zika virus including sexual activity, travel, and local mosquito bite prevention. Three questions investigating respondents’ general knowledge about Zika viral transmission and prevention were included, as was one question regarding attitudes towards transmission of the virus. Demographic data including age, gender, and zip code of residence were also gathered. Informed consent and inclusion criteria were integrated into the questionnaire.

To evaluate travel that may be associated with increased risk of Zika viral transmission, the respondents were first asked if they had traveled to any regions (The Americas, Oceania/Pacific Islands, Africa, Asia, and/or Downtown Miami or Miami Beach) that contain countries or zones that have reported active transmission of the virus. Based on the

respondents' answers, they were then directed to questions that allowed them to choose from a list of countries in each region that had reported active Zika transmission. Those who had traveled to one of the regions, but not to any of the countries reporting active viral transmission were provided with a choice of "no" or "none" for an answer. Local areas and countries listed in the questionnaire as zones of active transmission were based on information provided by the CDC and Florida Department of Health as of December 2, 2016, as this was when the questionnaire was written and granted IRB approval (CDC, 2016a; CDC, 2017f).

To evaluate for sexual activity that may be associated with increased risk for Zika transmission, respondents were first asked if they had been sexually active within the previous four weeks. Those who answered "yes" were then asked if they had participated in sexual activity with a partner who had been diagnosed with Zika infection or with a partner who had traveled to any areas of active Zika transmission (further inquiry of specific countries and zones of active transmission that the partner may have traveled to was made in the same manner as for the travel questions previously mentioned). Those respondents who answered "yes" to either of these questions were then asked if they had used barrier protection during sexual activity.

Regarding behaviors related to local mosquito bite prevention, respondents were asked to report their frequency of mosquito repellent and long sleeved clothing use as either "often," "sometimes," "rarely," or "none."

To evaluate personal knowledge of Zika transmission, one question inquired the respondent of their awareness of Zika transmission via mosquito bites and sexual activity. Two more asked if the respondent was aware that transmission could be prevented by avoiding mosquito bites and by preventing sexual transmission. One question relating to attitudes towards Zika transmission asked if the respondent felt at risk of infection (table 1).

The questionnaire was distributed electronically via four unofficial online social media pages dedicated to students associated with the institution (approximately 6,600 members at the time of the study) as well as via an employee newsletter which is distributed to the emails of subscribing faculty and staff on a monthly basis (approximately 250 subscribers at the time of the study). A post about the study was placed with a link to the questionnaire on each social media page and then reposted several times over the course of the study period. A brief statement about the study with a link to the questionnaire was placed in the employee newsletter for the months of June and July 2017. Within the questionnaire,

respondents were first asked to consent. They were then asked to confirm that they were faculty, staff, or students of the institution and that their age was at or above 18 years old.

To be included in the study, participants had to be current faculty, staff, or students of the institution and 18 years of age or older at the time of the study. Incomplete questionnaires were excluded from the study. Only one survey response was accepted per computer IP address. Data was analyzed using Qualtrics survey software licensed to Florida International University as well as Microsoft Excel version 16.8. This study was approved by the Health Sciences Institutional Review Board of Florida International University on April 18, 2017 (IRB protocol approval number IRB-17-0145). No funding was required or used for this study.

RESULTS

The questionnaire

A total of 109 individuals responded to the links posted on the social media site and newsletter, resulting in a response rate of 1.59%. All consented to the study. Eight respondents were excluded as they indicated that they were not faculty, staff, or students of the institution. Of the remaining 101 responses, 100% of the questionnaires were completed in entirety and were included in the study.

Demographics

The age of respondents ranged 18 to 69 years old with a median age of 26 years old. The majority of respondents were under the age of 30 years old (75.2%). The majority (83.1%) identified as female. Respondents reported living in zip codes located in the Florida counties of Miami-Dade, Broward, Palm Beach, Collier, and Hardee with the majority (80.2%) reporting a residence in Miami-Dade County (Table 2).

Knowledge and attitudes

Almost all respondents (99.0%) answered that they were knowledgeable about Zika's ability to spread via mosquito bites and sexual transmission. The majority also answered that they were aware Zika transmission could be prevented via personal measures to prevent mosquito bites (98.0%) as well as via practicing safe sex (96.0%). Over half of the respondents (52.5%) did not think that they were at risk of infection. Of those who reported that they were unfamiliar with Zika prevention measures either via prevention of mosquito bites (2 individuals) or practicing safe sex (4 individuals), all reported that they did not believe they were at risk of infection (Table 3).

Exposure to infected mosquitos via travel

Over two-thirds of respondents (65.3%) reported travel to Downtown Miami or Miami Beach during the study period, with thirty-nine of them reporting travel

to an area of Miami Beach previously recognized as a red transmission zone. Five respondents (5.0%) reported international travel (Table 4).

Of these individuals, three reported travel to the countries of Colombia, Dominican Republic, Guyana, and Fiji, which were designated as regions of active Zika transmission at the time of the conception of the study (CDC, 2016a) (Figure 1).

Eighty-one respondents (80.2%) reported a residence in Miami-Dade County, which was previously regarded as a yellow Zika transmission zone by the CDC. Two individuals reported living in a zip code which overlapped with a previously recognized red zone, one located in South Beach and one in the Wynwood district of Miami.

Sexual activity

A little over half (53.5%) of respondents reported being sexually active within the four weeks prior to the questionnaire. Seventeen respondents (16.8%) indicated that their sexual partner had traveled to an area of Miami Beach which had been designated a red zone, within the previous month. Eleven (64.7%) of these individuals reported either “no” or “sometimes” use of barrier protection during sexual activity with

their partner. None of the respondents reported knowledge of their sexual partners traveling to any international countries with active Zika transmission during the study period. Four reported being sexually active with an individual who had been diagnosed with Zika infection. Of those four respondents, only one used protection, a male of 20 years old. The three individuals who did not report using protection were females aged 19, 21, and 22 years old. Of the three respondents who reported personal travel to international Zika transmission zones, one reported sexual activity. This individual also reported use of barrier contraception during sexual activity.

Mosquito bite exposure

The majority of respondents reported either no or rare usage of mosquito bite prevention measures including both wearing of long-sleeved clothing (70.3%) and use of mosquito repellent on exposed skin (89.0%). (Table 5).

The majority (70.3%) of respondents reported that they had not used insect repellent at all in the previous week. Regarding use of long sleeved clothing, 50.0% denied using the measure at all during the previous week (Figure 2).

Table 1: Study questions

Question	Answer choices	
Are you currently a student, faculty, or staff member at Florida International University (FIU)?	<input type="radio"/> Yes	<input type="radio"/> No
Are you 18 or older?	<input type="radio"/> Yes	<input type="radio"/> No
Do you know that Zika virus is an infection which can be spread via mosquito bites or via sexual activity?	<input type="radio"/> Yes	<input type="radio"/> No
Do you think that you are at risk for Zika infection?	<input type="radio"/> Yes	<input type="radio"/> No
What is your age in years? (enter numbers only)	Free text answer	
With what gender do you identify?	<input type="radio"/> Female <input type="radio"/> Male	<input type="radio"/> Other
What is the ZIP code of the location where you live? (enter numbers only)	Free text answer	
Have you traveled to any of the following areas within the past 4 weeks? (select all that apply)	<input type="radio"/> Downtown Miami or Miami Beach <input type="radio"/> Americas (South America, Central America, Caribbean) <input type="radio"/> Oceania/Pacific Islands	<input type="radio"/> Africa <input type="radio"/> Asia <input type="radio"/> I haven't traveled
Did your travel to Downtown Miami or Miami Beach occur in any of these specific areas within the past 4 weeks? (select all that apply)	<input type="radio"/> Miami Beach within boundaries of 8th Street and 63rd Street	<input type="radio"/> No

Did your travel in the Americas (South America, Central America, or Caribbean) occur in any of these countries within the past 4 weeks? (select all that apply)	<input type="radio"/> Anguilla <input type="radio"/> Antigua and Barbuda <input type="radio"/> Argentina <input type="radio"/> Aruba <input type="radio"/> The Bahamas <input type="radio"/> Barbados <input type="radio"/> Belize <input type="radio"/> Bolivia <input type="radio"/> Bonaire <input type="radio"/> Brazil <input type="radio"/> British Virgin Islands <input type="radio"/> Cayman Islands <input type="radio"/> Colombia <input type="radio"/> Commonwealth of Puerto Rico, US Territory <input type="radio"/> Costa Rica <input type="radio"/> Cuba <input type="radio"/> Curacao <input type="radio"/> Dominica <input type="radio"/> Dominican Republic <input type="radio"/> Ecuador <input type="radio"/> El Salvador <input type="radio"/> French Guiana <input type="radio"/> Grenada <input type="radio"/> Guadeloupe <input type="radio"/> Guatemala	<input type="radio"/> Guyana <input type="radio"/> Haiti <input type="radio"/> Honduras <input type="radio"/> Jamaica <input type="radio"/> Martinique <input type="radio"/> Mexico <input type="radio"/> Nicaragua <input type="radio"/> Panama <input type="radio"/> Paraguay <input type="radio"/> Peru <input type="radio"/> Saba <input type="radio"/> Saint Barthélemy <input type="radio"/> Saint Lucia <input type="radio"/> Saint Martin <input type="radio"/> Saint Vincent and the Grenadines <input type="radio"/> Sint Eustatius <input type="radio"/> Sint Maarten <input type="radio"/> St. Kitts and Nevis <input type="radio"/> Suriname <input type="radio"/> Trinidad and Tobago <input type="radio"/> Turks and Caicos <input type="radio"/> U.S. Virgin Islands <input type="radio"/> Venezuela <input type="radio"/> NONE
Did your travel in Oceania/Pacific Islands within the past 4 weeks occur in any of these countries? (select all that apply)	<input type="radio"/> American Samoa <input type="radio"/> Fiji <input type="radio"/> Kosrae, Federated States of Micronesia <input type="radio"/> Marshall Islands <input type="radio"/> New Caledonia <input type="radio"/> Palau	<input type="radio"/> Papua New Guinea <input type="radio"/> Samoa <input type="radio"/> Tonga <input type="radio"/> None
Did your travel in Africa within the past 4 weeks occur in any of these countries?	<input type="radio"/> Cape Verde	<input type="radio"/> No
Did your travel in Asia within the past 4 weeks occur in any of these countries?	<input type="radio"/> Singapore	<input type="radio"/> No
Have you been sexually active within the past 4 weeks?	<input type="radio"/> Yes	<input type="radio"/> No
Within the past 4 weeks, have you had any sexual activity (vaginal, anal, oral, or sharing of sex toys) with an individual who has been diagnosed with Zika virus infection?*	<input type="radio"/> Yes <input type="radio"/> No	<input type="radio"/> I don't know
Did you use barrier protection (male condom, female condom, or dental dam)?**	<input type="radio"/> Yes <input type="radio"/> Sometimes	<input type="radio"/> No
Within the past 4 weeks, have you had any sexual activity (vaginal, anal, oral, or sharing of sex toys) with an individual who has traveled to any of the following areas? (select all that apply)*	<input type="radio"/> Downtown Miami or Miami Beach <input type="radio"/> Americas (South America, Central	<input type="radio"/> Asia <input type="radio"/> None <input type="radio"/> I don't know

	<ul style="list-style-type: none"> America, Caribbean) <input type="radio"/> Oceania/Pacific Islands <input type="radio"/> Africa 	
Did you use barrier protection (male condom, female condom, or dental dam)?**	<ul style="list-style-type: none"> <input type="radio"/> Yes <input type="radio"/> Sometimes 	<input type="radio"/> No
Did your sexual partner travel to either of these specific areas in Downtown Miami or Miami Beach within the past 4 weeks? (select all that apply)	<input type="radio"/> Miami Beach within boundaries of 8th Street and 63rd Street	<input type="radio"/> No
Did your sexual partner travel to any of these countries in the Americas (South America, Central America, Caribbean) within the past 4 weeks? (select all that apply)	<ul style="list-style-type: none"> <input type="radio"/> Anguilla <input type="radio"/> Antigua and Barbuda <input type="radio"/> Argentina <input type="radio"/> Aruba <input type="radio"/> The Bahamas <input type="radio"/> Barbados <input type="radio"/> Belize <input type="radio"/> Bolivia <input type="radio"/> Bonaire <input type="radio"/> Brazil <input type="radio"/> British Virgin Islands <input type="radio"/> Cayman Islands <input type="radio"/> Colombia <input type="radio"/> Commonwealth of Puerto Rico, US Territory <input type="radio"/> Costa Rica <input type="radio"/> Cuba <input type="radio"/> Curacao <input type="radio"/> Dominica <input type="radio"/> Dominican Republic <input type="radio"/> Ecuador <input type="radio"/> El Salvador <input type="radio"/> French Guiana <input type="radio"/> Grenada <input type="radio"/> Guadeloupe <input type="radio"/> Guatemala 	<ul style="list-style-type: none"> <input type="radio"/> Guyana <input type="radio"/> Haiti <input type="radio"/> Honduras <input type="radio"/> Jamaica <input type="radio"/> Martinique <input type="radio"/> Mexico <input type="radio"/> Nicaragua <input type="radio"/> Panama <input type="radio"/> Paraguay <input type="radio"/> Peru <input type="radio"/> Saba <input type="radio"/> Saint Barthélemy <input type="radio"/> Saint Lucia <input type="radio"/> Saint Martin <input type="radio"/> Saint Vincent and the Grenadines <input type="radio"/> Sint Eustatius <input type="radio"/> Sint Maarten <input type="radio"/> St. Kitts and Nevis <input type="radio"/> Suriname <input type="radio"/> Trinidad and Tobago <input type="radio"/> Turks and Caicos <input type="radio"/> U.S. Virgin Islands <input type="radio"/> Venezuela <input type="radio"/> None
Did your sexual partner travel to any of these countries in Oceania/Pacific Islands within the past 4 weeks? (select all that apply)	<ul style="list-style-type: none"> <input type="radio"/> American Samoa <input type="radio"/> Fiji <input type="radio"/> Kosrae, Federated States of Micronesia <input type="radio"/> Marshall Islands <input type="radio"/> New Caledonia <input type="radio"/> Palau 	<ul style="list-style-type: none"> <input type="radio"/> Papua New Guinea <input type="radio"/> Samoa <input type="radio"/> Tonga <input type="radio"/> None
Did your sexual partner travel to any of these countries in Africa within the past 4 weeks?	<input type="radio"/> Cape Verde	<input type="radio"/> No
Did your sexual partner travel to any of these countries in Asia within the past 4 weeks?	<input type="radio"/> Singapore	<input type="radio"/> No

How many times have you used insect repellent on your skin in order to prevent mosquito bites, during the past week?	<input type="radio"/> Often: 6 or more times per week <input type="radio"/> Sometimes: 3 - 5 times per week	<input type="radio"/> Rarely: 1 - 2 times per week <input type="radio"/> None
How many times have you worn long sleeve shirts or long pants in order to prevent mosquito bites, during the past week?	<input type="radio"/> Often: 6 or more times per week <input type="radio"/> Sometimes: 3 - 5 times per week	<input type="radio"/> Rarely: 1 - 2 times per week <input type="radio"/> None
Did you know that one way to prevent Zika virus infection is to prevent mosquito bites?(Prevention of mosquito bites includes wearing long sleeves/long pants and by using mosquito repellent on areas of exposed skin)	<input type="radio"/> Yes	<input type="radio"/> No
Did you know that one way to prevent Zika virus infection is to prevent sexual transmission?(prevention of sexual transmission includes using barrier protection -male condom, female condom, dental dam- during sex or avoiding sexual activity)	<input type="radio"/> Yes	<input type="radio"/> No

*These questions were only asked of the respondent if they answered that they had been sexually active within the previous 4 weeks

**These questions were only asked of the respondent if they answered that they had been sexually active with an individual who had been diagnosed with Zika virus or traveled to a region where Zika was known to be actively transmitted

Table 2: Demographics (n = 101)

Age (years)	
18 - 37	88 (87.1%)
38 - 57	11 (10.9%)
58 - 77	2 (2.0%)
Gender	
Female	84 (83.1%)
Male	17 (16.8%)
Residence (FL county)	
Miami-Dade	81 (80.2%)
Broward	14 (13.9%)
Palm Beach	2 (2.0%)
Collier	1 (1.0%)
Hardee	1 (1.0%)
Unknown	1 (1.0%)

Table 3: Knowledge and attitudes about Zika transmission (n = 101)

	Yes	No
Do you know that Zika virus is an infection which can be spread via mosquito bites or via sexual activity?	100 (99.0%)	1 (1.0%)
Do you think that you are at risk for Zika infection?	48 (47.5%)	53 (52.5%)
Did you know that one way to prevent Zika virus infection is to prevent mosquito bites?	99 (98.0%)	2 (2.0%)
Did you know that one way to prevent Zika virus infection is to prevent sexual transmission?	97 (96.0%)	4 (4.0%)

Table 4: Reported Travel Locations (n = 101*)

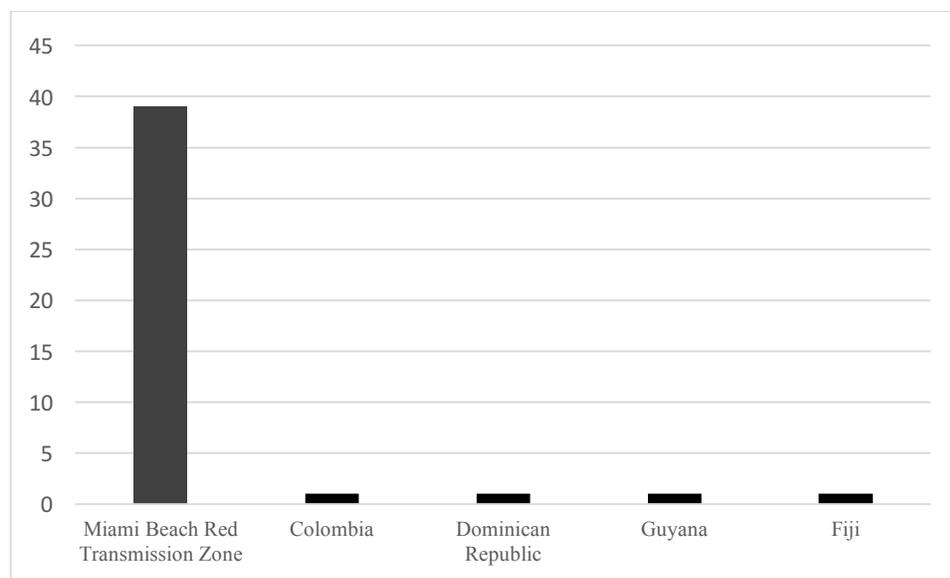
	Frequency
Downtown Miami or Miami Beach	67 (65.3%)
Americas (South America, Central America, Caribbean)	2 (2.0%)
Oceania/Pacific Islands	1 (1.0%)
Africa	0 (0%)
Asia	2 (2.0%)
I haven't traveled	36 (35.6%)

*Four respondents indicated travel to two regions each. Three indicated that they had traveled to “Downtown Miami or Miami Beach” as well as “I haven’t traveled”

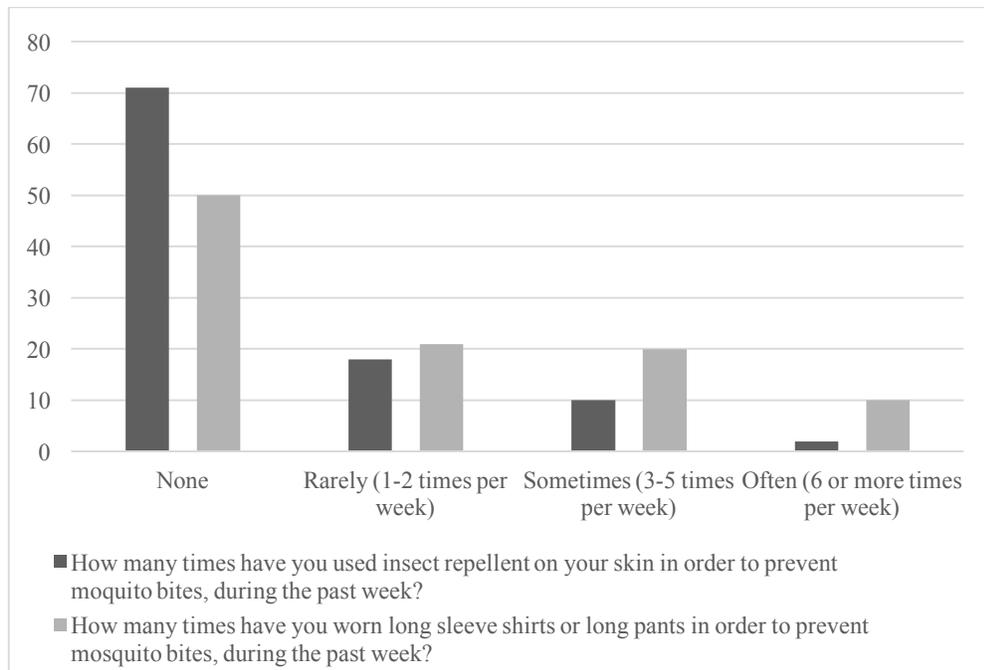
Table 5: Mosquito bite prevention (n = 101)

How many times have you used insect repellent on your skin in order to prevent mosquito bites, during the past week?	
Often: 6 or more times per week	2 (2.0%)
Sometimes: 3-5 times per week	10 (10.1%)
Rarely: 1-2 times per week	18 (17.8%)
None	71 (70.3%)
How many times have you worn long sleeve shirts or long pants in order to prevent mosquito bites, during the past week?	
Often: 6 or more times per week	10 (10.1%)
Sometimes: 3-5 times per week	20 (20.0%)
Rarely: 1-2 times per week	21 (20.8%)
None	50 (50.0%)

Figure 1: Travel to areas with increased risk of Zika viral transmission (n = 42*)



*One traveler reported travel to both Colombia and Dominican Republic

Figure 2: Reported use of personal measures to prevent mosquito bites

DISCUSSION

This pilot study demonstrates the presence of behaviors that may increase the risk of mosquito-borne and sexually transmitted Zika virus in a sample of respondents selected from an institution of higher education located in a region of South Florida affected by local transmission of the virus.

Travel to areas of active transmission

Only three respondents of this study recorded travel to overseas regions with active Zika transmission, while many more respondents (thirty-nine) reported travel to local red zones (only two individuals reported living in a zip code which overlapped with these zones). Data collected by the CDC indicates that the majority of Zika cases detected in the USA were in overseas travelers (CDC, 2017a; CDC 2017b; CDC 2018a; CDC 2018b), however in this study, the majority of travel to regions reporting Zika virus transmission was to local zones. Further study could reveal the degree to which travel to local versus overseas zones of Zika transmission may have contributed to the spread of the virus in South Florida.

Although the majority of respondents knew that the virus could be spread by mosquito bites, 38.6% of these individuals did not avoid local regions where there were reports of mosquito-borne Zika transmission. This study did not assess whether respondents attended classes or worked in zones of active viral transmission, which could account for the persistent travel, despite the CDC warnings. Future study should take this into account, as well as

frequency and length of travel to those zones. Another topic for future investigation should be whether those respondents who did not travel to these areas did so specifically to avoid viral transmission.

Sexual activity with Zika-infected partner

Ninety-six percent of respondents indicated they were aware that one way to prevent Zika virus infection is to take measures to prevent sexual transmission. Of the respondents who had sexual partners that had traveled to local red zones within the previous four weeks, 35.3% reported that they used barrier contraception. In a survey-based study conducted among students at the same university in the fall of 2016, 18.6% of respondents reported use of condoms for protection against sexual transmission and 7.1% reported abstaining from sexual activity (Darrow, Bhatt, Rene, & Thomas, 2018). A national survey published in 2017 revealed that 23.8% of women and 33.7% of men reported condom usage during sexual activity within the previous twelve months (Copen 2017). A higher rate of usage of barrier contraception was reported among those asked in this study, however the legitimacy of this result is challenged by recall and desirability bias. Further studies should be undertaken to confirm this finding, as well as determine whether those who used barrier contraception did so specifically to prevent Zika transmission. Further investigation should also determine why almost two thirds of the respondents who had partners that visited a zone of active Zika transmission chose not to use barrier contraception.

There remains the continued threat of sexual transmission from travelers coming to the USA from overseas regions where Zika virus remains active, and further study could focus on the use of barrier contraception by these travelers specifically to prevent spread of the virus.

The majority of respondents were female, 100% of whom reported that they knew Zika could be transmitted by mosquito bites and sexual activity. However, over half (51.2%) did not think they were at risk. A concerning finding was of four respondents who reported sexual activity with a known Zika case, three of whom were female and did not use barrier contraception. It is possible that these answers were errors made by the respondents, and further study could help explain this anomaly. Further study could determine whether males and females in South Florida were significantly different regarding the measures they took to prevent Zika, as well as their attitudes towards risk of the virus' transmission.

Exposure to local mosquito-bites

The majority of respondents took few or no measures to prevent local mosquito bites despite 98.0% reporting that they knew the virus could be prevented via mosquito bite prevention. Of those living in Miami-Dade, a yellow zone at the time, 98.8% reported "rare" or "no" use of insect repellent, and 95.1% reported "rare" or "no" use of long sleeved clothing to prevent mosquito bites. In another study conducted at the same university during the fall of 2016, 139 students were surveyed and only 37.4% reported that they had used repellent or wore long sleeves in order to prevent Zika infection (Darrow, Bhatt, Rene, & Thomas, 2018). As with the questions pertaining to sexual activity, there was the risk of recall bias. The use of environmental measures such as avoidance of outdoors, spraying outdoors, and emptying standing water from containers in the environment should be evaluated in further studies. A study dedicated to personal behaviors to deter mosquito bites could help elucidate the reason for low reports of preventative measures illustrated in this study.

Knowledge and perception of threat

Ninety-nine percent of respondents reported they were aware that Zika virus could be spread via mosquito bites or sexual activity. The majority of respondents also indicated they were aware that the virus can be prevented by avoiding mosquito-borne (93.0%) and sexual transmission (96.0%). This study was conducted approximately one year after locally-transmitted cases of Zika viruses were detected in the region, and public education campaigns had already been conducted by the local department of health, the CDC, and within the study institution, so respondents would have likely been exposed to educational

materials by the time they answered the study questionnaire.

Despite the majority of questionnaire respondents reporting awareness of how Zika virus is transmitted and how to prevent its spread, over half (52.5%) answered that they did not believe the virus posed a threat to them. About half (50.6%) of respondents who lived in Miami-Dade County believed that they were at risk of Zika infection. Over half of Broward County residents believed that they were not at risk, while all residents of other Florida counties represented did not believe they were at risk. Whether geography was resulted in significant differences in perception of risk and incorporation of Zika prevention behaviors between the residents of different counties remains to be investigated.

It is possible that, in this study, respondents may not have felt as high a risk for transmission as they may have experienced earlier in the outbreak, when case numbers were higher. By the time this study was conducted, detection of new infections had been decreasing (CDC, 2017a; CDC, 2017b; CDC, 2018a). Another possibility, is that some respondents may have been students enrolled exclusively in online courses and may not have been located in, or interacted with, any yellow or red transmission zones during the study period. It would be understandable that they did not feel that Zika posed any risk to themselves and did not take any precautions to prevent the virus. Future studies should take this issue into account.

Although the majority of respondents reported awareness of how Zika virus is spread and prevented, there appeared to be a lack of perceived threat, and many reported behaviors that may increase risk for infection. The majority of respondents living in Miami-Dade County reported inconsistent or no use of mosquito bite prevention methods, over one third of survey subjects traveled to local regions of active transmission, and almost two thirds of individuals who reported that their sexual partners traveled to local Zika transmission zones did not use barrier protection. It is possible that a lack of perceived threat may have contributed to lower than expected reports of personal measures taken to prevent transmission, however further study is required to determine if, and to what degree, threat perception played in respondents' behavior.

Survey and method limitations

As a cross-sectional study, this analysis cannot determine any cause-effect relationship between Zika virus transmission and the behaviors or attitudes that were assessed. The behaviors chosen for evaluation in this questionnaire were determined based on CDC recommendations for prevention of Zika transmission that were made at the time of the study's inception. Although an assumption could be made that activities

which result in increased exposure to Zika virus (exposure to infected mosquito bites and unprotected sexual activity with infected individuals) will result in increased Zika viral transmission, further study is required in order to determine to what degree these behavioral risk factors are, in fact, associated with spread of the virus.

The response rate of this particular survey was low, at 1.59%. The format of this questionnaire was electronic and distributed to four social media pages and an email newsletter. Individuals who did not have access to the internet or were not members of the social media pages or newsletter would not have been able to respond. If frequent enough, the posting of new materials to the social media pages might have resulted in the survey link being “buried” under newer posts, obscuring it from possible respondents. Another factor to consider would be the frequency and volume of social media page views. A page having lower traffic would result in fewer views of the link and fewer respondents. The use of an email newsletter for distribution of the link may have also contributed to the low response rate. Readers of the newsletter may not have seen the link, or might have been distracted from it by the articles. Also, the rate of newsletter views was unknown, and a low rate of readers would have limited exposure to the link. Another shortcoming of the study’s design was the opt-in nature of participation which resulted in the self-selection of respondents. This may limit the ability to apply the results of this study to other populations. Survey completion rate was 100%, however, indicating that factors such as questionnaire length, order, or display did not seem to have a substantial adverse effect on data collection in this study.

IMPLICATIONS FOR PUBLIC HEALTH

Despite its limitations, this pilot study reveals the presence of behaviors that may be associated with increased risk of Zika virus transmission within a sample of individuals who were present in an area of active transmission of the virus. In this pilot study, almost all respondents reported knowledge of how Zika virus can be spread, yet half believed that they were not at risk of infection. Of concern was the finding that half of the residents a county labeled as a yellow zone at that time did not believe they were at risk. Despite the threat, over one third of respondents did not avoid travel to local Zika zones. Almost all respondents reported that they were aware that Zika could be prevented by preventing mosquito bites, as well as by practicing safe sex with infected or possibly exposed partners, yet of those who reported sexual partners that had traveled to local Zika zones, over one third did not use barrier protection, and the majority of

Miami-Dade residents reported rare or no usage of mosquito bite prevention behaviors.

The Zika outbreak in South Florida has since resolved, however there remains the risk of future outbreaks in the region due to the year-round presence of the vector, the virus’ ability to be transmitted sexually independently of the vector, as well as continued international travel between South Florida and regions that continue to report active transmission of the infection. South Florida is a hub for international travel with Miami being listed among the top ten ports of departure for US citizens abroad as well as among the top forty ports of entry for residents arriving to the USA from abroad (US Department of Commerce, 2018; US National Travel and Tourism Office, 2018). There remains potential risk of infected travelers to spread the virus to local mosquito populations or directly to other individuals via unprotected sex, conceivably resulting in further sustained local outbreaks, particularly if residents and travelers to high risk zones do not take personal measures to prevent transmission.

Due to the limits in size and design of this study, results cannot be generalized to other universities or the region of South Florida, however it does illustrate the need for further analysis to determine whether any of the findings discussed are reproducible in the greater South Florida community. Particular concerns to explore include why over one third of respondents chose to travel to local regions of active Zika transmission, why over one third of those who denied using barrier contraception despite reporting sexual activity with a partner who had traveled to a local Zika zone, and why the majority of Miami-Dade residents did not use certain personal measures to prevent mosquito bites.

CONFLICT OF INTEREST

The authors whose names are listed certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

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