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ORIGINAL PAPER

University Students' Knowledge, Attitudes, and Sources of Information About Zika Virus

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Abstract
Colleges and universities are valuable partners for community health education outreach targeted to young adults. After the outbreak of Zika virus infection in the Americas was declared to be a Public Health Emergency of International Concern on February 1, 2016, postsecondary institutions played an important role in educating at-risk communities about health promotion and disease prevention strategies. In April 2016, we recruited 613 undergraduate students from a large public university to complete a survey about their Zika-related knowledge, attitudes, and information seeking behaviors. We standardized the results so that the participants' reports would be representative of the age, sex, major (course of study), and other characteristics of the university's student population. Most students knew that Zika virus is spread by mosquitoes (88.1%), but only about half knew that the virus could be transmitted through sexual intercourse (56.8%). Students perceived Zika to be a health risk for pregnant women in Zika-affected countries (83.0%), but did not personally feel at risk (12.1%). Many students (43.8%) reported not knowing where to get accurate information about Zika. Identifying gaps in scientific knowledge, misperceptions about personal susceptibility, and opportunities for behavioral risk reduction is an important foundation for designing community-based health interventions when future emerging infectious disease events occur.

Keywords Health knowledge · Attitudes · Practice · Health education · Student health services · Young adult · Zika virus infection

Introduction

Colleges and universities are important sites for community health promotion and disease prevention activities. Students pursuing tertiary education are likely to be open to receiving health education information and acting on it. In addition to the benefits that accrue to the individual students who adopt healthier behaviors as a result of community outreach, there may be multiplicative effects as those students share information with friends and family members who are not enrolled in institutions of higher education and as they take their informed perceptions and practices into the larger communities where they live and work.

Postsecondary schools are integral parts of the cities and towns where they are located. They are also part of a network of thousands of higher education institutions that interact with one another through associations, consortia, and other relationships. In the United States alone, there are more than 3000 degree-granting 4-year post-secondary schools and more than 1600 two-year institutions [1]. (Four-year colleges and universities award bachelor degrees and higher-level degrees, such as master and doctoral degrees. Two-year colleges award associate degrees.) Lessons learned at one institution are likely to be broadly applicable to other schools.

Higher education institutions are especially valuable places to reach young adult populations with critical health information. About 40% of 18–24 year-olds in the United States are enrolled in post-secondary educational programs [1]. Enrollment remains strong throughout many of

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reproductive years. In the United States, more than 12 million people younger than 25 years old are enrolled in a college or university along with nearly 2 million people aged 25–29 years, nearly 2 million people aged 30–39 years, and nearly 1 million people aged 40–49 years [1]. When the threat to fetal health posed by Zika virus became an international public health priority in 2016, there was a critical need to educate reproductive-aged women about how to reduce the risk of birth defects associated with Zika virus infection. Postsecondary schools were prime targets for community-based Zika education interventions. We acted quickly to gather data from university students early in the outbreak, so that we could identify gaps in knowledge and understand where students were accessing information about the emerging public health crisis. This type of information is a critical foundation for the design of health education interventions.

The outbreak of Zika virus infection in the Americas was declared by the World Health Organization (WHO) to be a Public Health Emergency of International Concern (PHEIC) between February 1 and November 18, 2016 [2, 3]. Although Zika virus is no longer classified as a PHEIC, the virus is still circulating, and the adverse health outcomes it can cause will likely remain a significant public health challenge until a safe, effective vaccine becomes available [3, 4]. Zika virus is associated with birth defects [5], most notably microcephaly [6], as well as Guillain–Barré syndrome (GBS) [7]. Because of the severe birth defects associated with infection, Zika virus poses a particular threat to pregnant woman and woman of child-bearing age.

Although the recent Zika virus outbreak disproportionately affected countries in Central and South America, the United States was also affected. In 2016, the United States experienced 5102 cases of symptomatic Zika virus [8]. The majority of these cases (4830) were diagnosed in travelers who had visited Zika-affected countries. Of the cases in non-travelers, 224 were attributed to vector-borne transmission in Florida and Texas, 46 were acquired through sexual intercourse, and 2 were contracted via other routes [8]. By the middle of 2017, more than 200 cases of Zika virus had been reported, with all but two cases occurring in travelers and the remaining 2 occurring in sexual partners of travelers [8]. Some of the women who tested positive for Zika virus later delivered babies with birth defects [9].

In the United States, undergraduate college and university students may represent a vulnerable, high-risk population for Zika virus infection. In 2017, approximately 21 million students were attending colleges and universities in the U.S., and more than half of these students were females of child-bearing age [1]. However, the risk of sexual transmission means that Zika is not merely a concern for women. Both males and females can contract Zika virus, and infected people may pass the virus on to pathogen-spreading mosquitoes or transmit the virus to partners through sexual activities and other forms of contact.

College students may engage in several behaviors that increase the risk of acquiring Zika virus. Many undergraduate students engage in travel-related activities such as international volunteer travel, study abroad programs, and spring-break trips. Popular travel destinations for students include both Zika virus-affected areas internationally and areas environmentally suited to Zika virus transmission domestically, including Florida and Texas [10–12]. Traveling to Zika-affected areas might render students susceptible to mosquito-borne transmission. In addition to mosquito-borne transmission, college students, including student travelers, may engage in sexual behaviors that could put them at risk of contracting or spreading Zika virus [10, 13]. Nearly 70% of college students are sexually active [14], and young people between the ages of 15–24 comprise almost half of the 20 million new sexually-transmitted infection (STI) cases diagnosed per year [15], demonstrating the potential for sexually-transmitted Zika virus to spread among this population. Additional factors, such as alcohol and drug use during sexual intercourse, might also increase Zika virus risk by reducing use of barriers and other STI prevention methods [10, 13, 16]. People who contract Zika virus can become unknowing carriers. Although symptoms often only last 2–7 days [17], if they occur at all, Zika virus RNA persists in serum for up to 8 weeks and in semen for up to 3 months [18].

The emergence of Zika virus created an opportunity to better understand how a diverse collegiate student body understands and responds to a WHO-declared global health emergency. This paper examines knowledge, attitudes, and information-seeking behaviors regarding Zika virus among undergraduate students. Studies of H1N1 influenza, Ebola, and other emerging infectious diseases have shown that knowledge and attitudes play a key role in in the adoption of healthy and risky behaviors, and they therefore have the potential to impact disease transmission. Low knowledge and widespread misperceptions among university students frequently occur during global health emergencies [19–21]. Although some students turn to the internet as a major information source during outbreaks [19, 20, 22], many students remain uninformed about or disengaged from these newsworthy happenings. Demographic and psychosocial factors are associated with significantly different knowledge levels, attitudes, and behaviors among university students during PHEIC events [21–26]. Taken together, these studies of previous PHEICs point toward the need to examine and address the knowledge, attitudes, and behaviors of at-risk populations during outbreaks, with attention paid to the different health education needs of various sub-populations within the study body.

Given the elevated risk of adverse outcomes from Zika infection among many American college students, an improved understanding the health beliefs and behaviors of undergraduates may provide insights into sustainable college-based interventions to promote the control and prevention of Zika virus. The aims of this study were to examine knowledge, attitudes, and information seeking behaviors among undergraduate students at a large public university in Virginia, and to examine differences in knowledge, attitudes, and information seeking behaviors among health and non-health majors.

Methods

We developed a quantitative online survey instrument to assess Zika virus-related knowledge, attitudes, and information-seeking behaviors among undergraduate students. Eligibility criteria included being enrolled as an undergraduate student at the large public university where the study was conducted; being at least 18 years old; and indicating consent for participation. A total of 708 individuals who began the survey met the eligibility criteria, and 619 of these individuals completed the entire survey. After excluding six participants who did not report a sex, a total of 613 individuals were included in statistical analyses.

We used a secure online survey assessment tool to collect data via the Qualtrics website (http://www.qualtrics.com/). A convenience sample of undergraduate students was recruited through multiple forms of outreach. We sent an email to all professors teaching undergraduate courses with more than 50 enrolled students. The email contained a PowerPoint slide about the study, a one-page flyer, and the survey link, along with a request to the professor to share the survey link with their students during class time or through the class email list. Flyers were also handed out on campus and posted in approved academic buildings to promote further participation in the survey. The flyers contained information concerning the purpose of the study, the incentives for participation, and instructions on how to access the online survey link. The survey link and contact information were provided as pull-off tabs on the flyers.

The survey was open to participants from April 8 through April 30, 2016. The first screen of the online survey showed an informed consent statement that described the purpose of the study, the procedures, the risks and benefits, and the steps that would be taken to assure the confidentiality of participants. Potential participants had to check boxes confirming their eligibility and indicating their consent to participate in the study before they could access the first survey questions. No names or other identifying information were collected. This waiver of a signature on the informed consent statement was approved by the institutional review board (IRB) because the research project presented no more than minimal risk of harm to participants and involved no procedure for which written consent would typically be required outside of the research context. Students who completed the entire survey were offered an opportunity to be connected to a separate secure website where they could enter a drawing to win one of four Amazon gift cards ($50, $100, $150, $200). The second form asked participants to provide an email address, but this identifiable information was not linked in any way to the original survey form. Of the 619 students who participated in the survey, more than 85% chose to provide an email address for the drawing. All protocols for this study, including the recruiting process, the data collection process, and the gift card drawing, were approved by the George Mason University IRB in Fairfax, Virginia (project #883062).

The survey instrument included questions about demographics, knowledge, perceived susceptibility, perceived severity, and information seeking. Demographic questions included age, sex, race, living on or off campus, being born in the United States or abroad, and undergraduate major. Students majoring in biology, community health, health administration, nursing, and chemistry were considered to be pursing health-related majors. All other students were considered to be non-health majors.

The "Knowledge" section included 15 questions with true and false answer choices. Answers were coded as either "correct" or "incorrect" based on consistency with information provided by the Centers for Disease Control and Prevention (CDC) and WHO websites. The items about attitudes included perceived severity by population (5 questions), perceived deadliness of Zika virus (3 questions), perceived susceptibility to Zika virus (4 questions), and Zika virus worry (2 questions). Questions about information seeking asked about sources of information about Zika virus and about self-efficacy for information seeking (4 questions). Responses to items about attitudes and self-efficacy for information seeking were reported on a five-point Likert scale ranging from 1 (strongly disagree or extremely unlikely) to 5 (strongly agree or extremely likely). For analysis, responses to Likert scale questions were dichotomized into likely or extremely likely (scores of 4 or 5) versus all other option choices (scores of 1, 2 or 3).

We analyzed the data using SPSS (version 24). Descriptive statistics were used to examine knowledge, attitudes, and information seeking behaviors overall and by major. Due to oversampling of students who were female and health majors, we calculated sex- and major-standardized percentages so that our results would be representative of the total student population at the university. Chi square tests were used to compare results among health majors compared to non-health majors.

Results

Demographics

There were a total of 613 total participants. The mean age was 21.5 years. By race/ethnicity, the participants were White (n = 272, 44.4%), Black (n = 70, 11.4%), Hispanic (n = 77, 12.6%), Asian (n = 119, 19.4%), or other (n = 75, 12.2%). A majority of participants lived off campus (n = 390, 63.6%), and were born in the United States (n = 482, 78.6%). The demographics of survey participants closely matched the demographics of the university where the survey was conducted (n = 21,575), with two exceptions. A majority of survey participants were female (n = 439, 71.6%) compared to around half of students at the university (n = 10,934, 50.7%). In terms of major, nearly half of survey participants were health majors (n = 253, 41.3%), compared to only 13.4% (n = 2896) of students at the university.

Knowledge

In sex- and major-standardized analyses, most participants were aware of the apparent link between Zika infections and birth defects (79.4%), but were uncertain of the symptoms associated with Zika virus (Table 1). Most participants correctly answered that Zika virus can be spread through infected mosquitoes (88.1%), however, only 56.8% correctly answered that a woman could get Zika virus from having sexual intercourse with an infected man. Students correctly identified Zika virus as mostly a problem for a pregnant woman's unborn child (73.3%), yet nearly half incorrectly thought that Zika virus is mainly a problem for health care workers (43.2%).

For almost all knowledge questions, health majors were significantly more likely to provide correct answers than non-health majors. The biggest differences in knowledge were that 70.4% of health majors correctly answered that there is currently no vaccine for Zika virus, compared to only 47.8% of non-health majors ($p < 0.001$); 68.8% of health majors correctly answered that Zika virus does not cause diabetes, compared to only 46.9% of non-health majors ($p < 0.001$); and 73.5% of health majors correctly answered that there is currently no cure for Zika virus, compared to only 54.4% of non-health majors ($p < 0.001$). Although health majors were overall more knowledgeable about Zika virus than their peers, less than half of health majors and less than a quarter of non-health majors correctly answered that Zika virus can cause Guillain–Barré syndrome.

Perceived Severity of Zika Virus

In sex- and major-standardized analyses, Zika virus was manly perceived as a health risk for pregnant woman in Zika-affected countries (83.0%), with fewer students considering Zika to be a risk for pregnant woman in the United States (61.8%) (Table 2). Approximately three-quarters of the participants agreed or strongly agreed that Zika virus is a serious health condition for women (71.3%) and children

Table 1 Percentage of undergraduate students who correctly answered Zika virus-related knowledge questions in April 2016, standardized by sex and major

Knowledge variables	Total	Standardized	Health and science majors	Other majors	p value
Number of respondents	613	613	253	360	–
A person can get Zika virus from infected mosquitoes (*True*)	90.2	88.1	94.9	86.9	0.001
Zika virus is thought to cause birth defects (*True*)	82.2	79.4	88.5	77.8	0.001
Zika virus is spreading through South America (*True*)	79.1	77.0	83.8	75.8	0.017
Zika virus is mainly a problem for a pregnant woman's unborn child (*True*)	77.7	73.3	87.4	70.8	< 0.001
Fever is a common symptom of Zika virus (*True*)	74.2	70.9	81.8	68.9	< 0.001
There is currently no cure for Zika virus (*True*)	62.3	57.3	73.5	54.4	< 0.001
A woman can get Zika virus from having sexual intercourse with an infected man (*True*)	60.4	56.8	68.4	54.7	0.001
A person can get Zika virus from eating contaminated food (*False*)	59.4	54.6	70.4	51.7	< 0.001
There is currently no vaccine for Zika virus (*True*)	57.1	51.3	70.4	47.8	< 0.001
Zika virus is thought to cause diabetes (*False*)	56.0	50.3	68.8	46.9	< 0.001
Skin rash is common symptom of Zika Virus (*True*)	47.6	46.0	51.4	45.0	0.119
Zika virus is mainly a problem for health care workers (*False*)	45.5	43.2	50.6	41.9	0.034
Zika Virus disease is generally mild in adults (*True*)	39.0	34.2	49.8	31.4	< 0.001
Zika virus is thought to cause Guillain–Barré syndrome (*True*)	31.0	26.1	41.9	23.3	< 0.001
Bloody diarrhea is common symptoms of Zika Virus (*False*)	22.8	19.3	30.8	17.2	< 0.001

Table 2 Percentage of undergraduate students who agree or strongly agree with various Zika virus-related statements in April 2016, standardized by sex and major

Attitude variables	Total	Standardized	Health and science majors	Other majors	p value
Number of respondents	613	613	253	360	–
Perceived severity by population					
Zika virus is a health risk for pregnant women in Zika-affected countries	84.8	83.0	88.9	81.9	0.018
Zika virus is a serious health condition for children	79.0	79.1	78.7	79.2	0.879
Zika virus is a serious health condition for women	73.1	71.3	77.1	70.3	0.062
Zika virus is a health risk for pregnant women in the United States	62.5	61.8	64.0	61.4	0.506
Zika virus is a serious health condition for men	29.0	30.0	26.9	30.6	0.016
Perceived deadliness of Zika virus					
Zika virus is more deadly than influenza (the flu)	27.2	27.9	25.7	28.3	0.038
If a person becomes infected with Zika virus, it is likely that he/she will die	9.6	9.0	11.1	8.6	0.003
Zika virus is more deadly than HIV/AIDS	9.0	9.8	7.1	10.3	0.050

(79.1%). Only one-third of the participants reported perceiving Zika virus as a serious health condition for men (30.0%). Few participants considered Zika virus to be deadly, although 9.0% thought that a person infected with Zika virus was likely to die.

In general, perceptions about the severity and deadliness of Zika virus among health-majors and non-health majors were similar. Health majors were significantly more likely than non-health majors to believe that Zika virus is a health risk for pregnant women in Zika virus-affected countries ($p=0.018$), but more than 80% of the respondents in both groups agreed or strongly agreed with this statement. Non-health majors were significantly more likely to believe that Zika virus is a serious health condition for men (30.6 vs. 26.9%, $p=0.016$). Non-health majors were also significantly more likely than health majors to believe that Zika virus is deadlier than influenza (28.3 vs. 25.7%, $p=0.038$) and HIV/AIDS (10.3 vs. 7.1%, $p=0.050$); however, across all participants, the overall percentage of respondents agreeing with these statements was low.

Perceived Susceptibility and Worry

In sex- and major-standardized analyses, perceived susceptibility to Zika virus varied based on geographical location (Table 3). More than two-thirds of participants perceived themselves to be at risk for Zika virus if they traveled to another country (68.4%), and over one-third of participants perceived themselves to be at risk for Zika virus as a result of sexual intercourse with someone who recently traveled to another country (40.7%). Comparatively, only 11.9% of participants perceived themselves to be at risk in the city where their university is located (in Virginia). Most participants did not feel personally threated by the disease (12.1%), and less than half were scared of becoming infected with the virus (46.0%).

Table 3 Percentage of undergraduate students who agree or strongly agree with various Zika virus-related statements in April 2016, standardized by sex and major

Attitude variables	Total	Standardized	Health and science majors	Other majors	p value
Number of respondents	613	613	253	360	–
Perceived susceptibility					
I am at risk for getting Zika virus if I travel to another country	70.5	68.4	75.1	67.2	< 0.001
I am at risk for getting Zika virus if I have sex with someone who recently traveled to another country	45.2	40.7	55.3	38.1	< 0.001
I am at risk for getting Zika virus in the city where my university is located	13.2	11.9	15.8	11.4	0.130
Zika virus poses a threat to me personally	12.7	12.1	14.2	11.7	0.613
Zika virus worry					
The thought of getting infected with Zika virus scares me	47.1	46.0	49.8	45.3	0.501
I would not travel to South or Central America because of Zika virus	36.1	33.1	42.7	31.4	0.012

Compared to non-health majors, health majors were significantly more likely to perceive themselves as being at risk for Zika virus as a result of traveling to another country (75.1 vs. 67.2%, $p < 0.001$), or having sex with someone who recently traveled to another country (55.3 vs. 38.1%, $p < 0.001$). Health majors were also significantly more likely than non-health majors to report that they would not travel to South or Central America because of Zika virus (42.7 vs. 31.4%, $p = 0.012$).

Sources of Information and Self-Efficacy for Information Seeking

In sex- and major-standardized analyses, most participants had sought information about Zika virus (86.6%). The most commonly reported source of information about Zika virus was newspapers and news websites (64.0%) (Table 4). Participants typically reported using information sources that did not involve direct interpersonal communication, such as social media (42.3%) and government websites (31.4%), rather than talking with friends (28.0%), family members (27.3%), or clinical care providers (10.7%). Only about half of the participants reported knowing where to get accurate (56.2%) and up-to-date (55.1%) information about Zika virus. Less than half of the participants agreed or strongly agreed that they were knowledgeable about Zika virus (33.0%) and only 23.1% were confident or very confident in relaying information about Zika virus to others.

Newspapers and news websites were the most prominent information source used by both health (62.8%) and non-health (64.2%) majors to obtain information about Zika virus. Compared to non-health majors, health majors were significantly more likely to report using government websites (such as the CDC's website) (54.9 vs. 27.2%, $p < 0.001$). More than half of health majors were able to access information about Zika virus from classroom instruction (52.6%), compared to only 33.3% of non-health majors ($p < 0.001$). Compared to health majors, non-health majors were significantly more likely to report that they had not obtained any sort of information about Zika virus (13.3 vs. 6.3%, $p = 0.005$).

Non-health majors were less informed than health majors about where to access accurate (53.6 vs. 70.4%, $p < 0.001$) and up-to-date (53.3 vs. 64.8%, $p < 0.001$) information about Zika virus. Health majors were significantly more likely than non-health majors to report being knowledgeable about Zika virus (54.2 vs. 29.2%, $p < 0.001$) and confident in relaying information about Zika virus to others (38.3 vs. 20.3%, $p < 0.001$). Almost half (47.1%) of health majors reported wanting more information about Zika virus to be provided by their university, compared to only 35.4% of non-health majors ($p = 0.005$).

Table 4 Percentage of undergraduate students reporting various types of information-seeking about Zika virus in April 2016, standardized by sex and major

Attitude variables	Total	Standardized	Health and science majors	Other majors	p value
Number of respondents	613	613	253	360	–
Which sources have you used to get information about Zika virus?					
Newspaper or news website	63.6	64.0	62.8	64.2	0.738
Social media website	42.4	42.3	42.7	42.2	0.909
Government website (like the CDC)	38.6	31.4	54.9	27.2	< 0.001
Friends	28.9	28.0	30.8	27.5	0.370
Family	28.4	27.3	30.8	26.7	0.260
University information (such as emails or flyers)	29.1	25.5	37.5	23.3	< 0.001
In-class instruction and/or conversations	33.2	24.7	52.6	19.7	< 0.001
Smart phone app	16.3	16.4	16.2	16.4	0.952
Doctor/nurse	11.4	10.7	13.0	10.3	0.289
Significant other/partner	7.8	8.3	6.7	8.6	0.391
None	10.4	12.2	6.3	13.3	0.005
Self-efficacy for information seeking (% who agree or strongly agree)					
I know where to go to get accurate information about Zika	60.5	56.2	70.4	53.6	< 0.001
I know where to get up-to-date information about Zika virus	58.0	55.1	64.8	53.3	< 0.001
I am knowledgeable about Zika virus	39.5	33.0	54.2	29.2	< 0.001
I am confident about my ability to relay information about Zika virus to others	27.7	23.1	38.3	20.3	< 0.001
I would like to have more information about Zika virus provided by my university	40.2	37.2	47.1	35.4	0.005

Discussion

This study is novel in its assessment of Zika-virus related knowledge, attitudes, and information seeking behaviors among a diverse group of university students. This study extends previous research about attitudes and beliefs toward emerging infectious diseases among student populations [19–26]. Since the young adults who make up the majority of the undergraduate student population may be at increased risk for Zika virus disease due to international travel and sexual behaviors—and since so many of these students are women of reproductive age—it is important for college and university health centers to be prepared to provide Zika education to their clients and encourage protective behaviors.

This study demonstrated that although many college students were aware of Zika virus, there were still considerable knowledge gaps. While most students were able to correctly identify infected mosquitoes as a route of transmission for Zika virus, only half of the participants knew that Zika virus could be spread by sexual transmission. Given that nearly 70% of college students are sexually active [14], lack of knowledge about sexual transmission could put students at risk of disease acquisition. Lack of knowledge and misperceptions about how diseases spread has been demonstrated among college populations for pandemic diseases (such as Ebola and H1N1 influenza) as well as infections transmitted through sexual contact (such as HIV and HPV). One recent study found that while most college students knew that Ebola could be spread through direct contact with bodily fluids, only one-quarter knew that Ebola could remain active in semen for several months after the patient was declared to be cleared of bloodstream infection [20]. Furthermore, more than one-third of the sample incorrectly thought that Ebola could be spread by mosquitoes [20]. Another study found that college students had numerous misperceptions about routes of transmission for the H1N1 strain of influenza, with many students believing that H1N1 could be spread by eating cooked pork, being bit by an insect, and drinking contaminated water [21]. Additional studies have demonstrated lack of knowledge among college students regarding diseases transmitted through sexual contact, including beliefs that HIV/AIDS can be transmitted by mosquitoes [27], and not knowing that HPV can be transmitted through skin-to-skin contact [28]. Understanding how infections are spread is a basic and critical component of understanding how to protect against infection. The gaps in knowledge in our study underscore the need for basic education about Zika virus disease among college and university students.

As expected, health majors were significantly more knowledgeable about Zika virus than non-health majors. This finding is consistent with previous research showing that biological science majors were more knowledgeable about Ebola than non-biological science majors [20], and that health-related majors were more likely to receive an HPV vaccine than non-health majors [29]. The disparity in knowledge between health majors and non-majors may be due to multiple factors. First, students with a strong interest in health might be more likely to major in a health-related subject and to seek knowledge about emerging infectious disease events. Second, health majors may have increased exposure to formal instruction and discussions about Zika virus disease in the classroom, which would increase their knowledge of the disease. The health majors in our study were significantly more likely than non-majors to report in-class instruction as a source of information about Zika virus. Third, because of their interest in health topics, health majors may be more likely to seek high-quality information about Zika virus outside of the classroom. In our study, health majors were more likely than classmates to report using government websites (like the CDC website) as a source of information about Zika virus. However, although health majors in our study were more knowledgeable about Zika virus than non-health majors, there were major gaps in knowledge among both groups. This highlights the need to disseminate accurate scientific information about future emerging infectious disease threats to all college students.

A large majority of students believed that Zika virus is a health risk for pregnant women in Zika-affected countries; a smaller majority of students perceived Zika virus to be a health risk for pregnant women in the United States; less than one-third of students preserved Zika virus to be a health risk for men; and very few considered Zika virus to be deadly. These perceptions were likely influenced by the media reporting around Zika virus at the time of the survey, which was conducted in April 2016, 2 months after the WHO declared Zika virus to be a PHEIC [2]. At this time, Zika virus was receiving a lot of media attention that featured the threat the virus posed to pregnant women in Brazil and in other countries in South and Central America [30–33]. Students reporting relying on news websites as their main source of information on Zika virus, which is consistent with findings from previous infectious disease outbreaks [34]. Although the CDC had documented both travel and sexual contact with travelers as exposures for Zika virus among pregnant women and women of childbearing age in the United States [35–37], these topics may have received less media attention because these aspects of the disease were less familiar to students. These findings highlight the important role that news media plays in shaping attitudes during public health emergencies.

In terms of personal risk, few participants considered Zika virus to be a personal threat, and most did not perceive

themselves to be at risk for Zika virus in the city where the university is located. Health majors were significantly more likely than their peers to consider themselves to be at risk for Zika virus as a result of traveling to another country or having sex with someone who recently traveled to another country. Health majors were also more likely to indicate that they would not travel to South or Central America because of Zika virus. These findings could possibly reflect increased knowledge about routes of transmission for Zika virus among health majors than non-health majors. Health majors also engaged in greater levels of health information seeking than their peers. The hope is that this increased knowledge among students majoring in health-related areas would translate into protective behaviors when engaging in travel or sexual risk behaviors. However, it is still important for these beliefs and practices to be reinforced by clinical care providers. All undergraduate students would benefit from counseling about Zika when visiting a clinic for a consultation about travel health, sexual and reproductive health, or general wellness.

Limitations

This study employed a convenience sample of college students at a single university in Northern Virginia, so the results may not be generalizable to a larger population. Women and health majors were over-represented among participants in the survey, but we adjusted for this discrepancy by standardizing the results by sex and major to represent the university as a whole. A limitation of the data collection process was that students were not proctored during participation, and they could have looked up answers to knowledge questions online. However, it is unlikely that participants in an anonymous survey would make this effort during the time they were answering questions. Finally, this study was conducted only two months after Zika virus was declared to be a PHEIC, and at the time data were collected no mosquito-borne cases had been reported in the United States even though cases had been found in other locations. Knowledge levels might have increased over time, and attitudes about Zika among college students might have changed in response to the evolution of the Zika virus outbreak.

Conclusions

Our survey of undergraduate students at a large university in the U.S. showed that most students had some basic knowledge of Zika virus. Although health majors were significantly more knowledgeable about Zika virus than non-majors, there were substantial limitations in Zika knowledge in both groups. Students perceived Zika virus to be a health risk for certain priority populations (such as pregnant women in heavily-affected countries), but they did not feel personally at risk for the disease. Given that college students are likely to engage in international travel and sexual intercourse, our results highlight the need to disseminate information about Zika virus to all college students. News websites were the most common source of information about Zika, demonstrating the importance of the media in shaping public health knowledge and attitudes among this population, with government websites (like the CDC website) and classroom instruction secondary sources of information. When future pandemic threats emerge, health education programs targeted towards all students may be beneficial for increasing knowledge, promoting realistic beliefs about personal risk, and encouraging health behaviors and risk prevention practices.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no competing interests.

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