



# Chikungunya Disease Awareness Among U.S. Travelers to Caribbean Destinations



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## Abstract

**Introduction:** This study investigated chikungunya disease awareness and its predictors, the level of adoption of recommended personal protective behaviors against chikungunya, and the health information-seeking behavior of U.S. travelers to Caribbean destinations.

**Methods:** A cross-sectional retrospective online survey of 653 adult U.S. international travelers who visited any one of 34 Caribbean destinations was conducted in October 2015. Study participants were recruited through Amazon<sup>®</sup> Mechanical Turk. Travelers who met the inclusion criteria and gave informed consent were subsequently redirected to complete the survey which was domiciled in Qualtrics<sup>®</sup>.

**Results:** Results regarding health information-seeking behavior indicated that 51% of study participants had never sought information about chikungunya or any vector-borne illnesses. Only thirty percent of study participants reported having heard of chikungunya disease before participating in this study. After adjusting for the presence of other variables in a logistic regression model, gender of female, higher levels of education, more time spent at the destination, and a higher number of hours spent engaging in outdoor activities were factors significantly associated with chikungunya disease awareness. Study results also showed that twenty-two percent of study participants did not engage in any of the three recommended personal protective behaviors under investigation.

**Conclusion:** Study findings highlighted a gap in existing approaches to health information dissemination vis-à-vis adoption of recommended personal protective behaviors, especially for U.S. travelers at risk for chikungunya and other emerging mosquito-borne infectious diseases in Caribbean destinations.

**Keywords:** Chikungunya awareness, U.S. travelers, Caribbean destination, Personal-protective behavior

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## Introduction

Chikungunya virus (CHIKV) is an alphavirus transmitted to humans through a bite from an infected *Aedes aegypti* or *Aedes albopictus* mosquito.<sup>1-4</sup> With an estimated 3.6 billion people living in 124 countries considered at risk for the disease, outbreaks are characterized by rapid spread and infection rates reported to be as high as 75%.<sup>3,5</sup> Although infection with the disease has been reported among travelers from different parts of the globe for decades,<sup>6</sup> the first known cases of local transmission of chikungunya in the Western hemisphere were reported in December 2013 on the Caribbean island of St. Martin. Within a period of four months, there were over 31 000 confirmed and probable cases reported from several

other Caribbean islands.<sup>3,7</sup>

Beginning in 2014, soon after the disease appeared at Caribbean destinations, cases were identified among U.S. travelers returning from that region, and nearly 8000 travel-related cases were reported across several U.S. states and territories.<sup>6</sup> It is expected that the number of U.S. travelers to and from Caribbean destinations will continue to increase, due in part to the close proximity of the region to the U.S., the short flight distance from the continental U.S., and the fact that several islands rank among the most tourism-developed islands in the world.<sup>8</sup>

Statistics from the Caribbean Tourism Organization indicate that approximately 10 million visitors from the U.S. arrived

in the Caribbean islands in 2014.<sup>9</sup> The evidence suggests that for U.S. travelers and tourists to Caribbean destinations, participation in outdoor activities – a major lifestyle activity in the region – is the foremost attraction, and these activities put them at risk of exposure to mosquitoes responsible for the transmission of chikungunya disease.<sup>10,11</sup>

Given the absence of licensed vaccines or specific drug treatments for chikungunya infection, the Centers for Disease Control and Prevention (CDC) has focused on, among other things, raising awareness among both healthcare providers and the traveling public.<sup>12</sup> Specifically, residents and travelers to areas in the tropics where chikungunya disease is prevalent were encouraged to adopt personal protective behaviors and mosquito avoidance strategies to prevent infection. Such strategies include using appropriate mosquito repellent on skin or clothing, wearing loosely-fitting long-sleeved shirts, pants, hats, and boots as weather permits when outdoors, sleeping under mosquito-repellent bed nets, using spatial repellents when indoors, staying in residences with air conditioning and screens on doors and windows,<sup>6,13</sup> and using other control efforts aimed at reducing mosquito abundance.<sup>12</sup>

In the absence of an existing vaccine or treatment for chikungunya, the goal is to increase adoption of the recommended personal protective behavior<sup>13,14</sup> among U.S. travelers to Caribbean destinations who constitute a population especially at risk. Although the U.S. CDC<sup>15,16</sup> has embarked on a chikungunya awareness campaign for U.S. travelers to and from Caribbean destinations, the level of chikungunya awareness and the extent to which travelers to Caribbean destinations adopt the recommended personal protective behaviors remain unknown. Equally unknown are the level of participation in outdoor activities and the health information-seeking behavior of U.S. travelers to Caribbean destinations. This knowledge should provide a snapshot of risk/protective factors for chikungunya infection among such travelers. Additionally, such information can serve as a basis for the evaluation of existing health promotion programs aimed at preventing chikungunya infection among vulnerable populations while providing baseline data that can be used to inform future interventions.

This study purposed to describe U.S. travelers to Caribbean destinations – a known endemic region for chikungunya in relation to (1) chikungunya disease awareness and its predictors, (2) level of adoption of recommended personal protective behaviors, (3) participation in outdoor activities, and (4) health information-seeking behavior for chikungunya. The 3 recommended personal protective behaviors of interest are (a) use of insecticides or repellents on skin or clothing, (b) wearing loosely-fitting long-sleeved shirts, long pants, hats, and boots as weather permits, and (c) sleeping under mosquito-repellent bed nets or using spatial repellents when indoors.<sup>13</sup>

## Methods

This cross-sectional retrospective survey was conducted on U.S. travelers/tourists to any one of 34 Caribbean destinations for leisure/business. “Caribbean destinations” as used in this discussion refers to the countries that are members of the CTO (see [Supplementary file 1](#) for a list of the countries).<sup>9</sup> Study participant inclusion criteria were an age greater than 18

years, currently living in the United States, and having traveled to one of the aforementioned Caribbean destinations in the last year for leisure/vacation. Exclusion criteria were reported travel in the past year, but not to one of the listed destinations; travel, but not currently living in the United States; and travel to the destination, but no reported participation in activities which might have led to exposure to mosquitoes. For this study, a “traveler/tourist” is defined as an individual who has traveled from the United States to one or more Caribbean island destinations and participated in recreation activities or rented or leased transient accommodations for a term of 6 months or less<sup>17</sup> within the previous year.

The survey instrument contained 2 screening questions, 5 general descriptive questions, and 2 attention-trap questions. The attention-trap questions were included for the purpose of identifying and screening out unengaged responses. An example of an attention-trap question is “Answer North America for this question, if you’re paying attention.” Respondents who did not select North America from the list of 5 options were dropped from further participation in the study. Thirty-two response options were used to measure respondents’ participation in outdoor activities (see [Supplementary file 1](#)). The list of outdoor activities was compiled based on the classifications of Hendee, Gale,<sup>18</sup> and Kil, Holland.<sup>19</sup> The awareness of study participants about chikungunya disease was measured as a dichotomous (Yes, No) variable using the question, “Have you heard about chikungunya disease before today?” Chikungunya awareness was dummy coded (1 = “Yes”, 0 = “No”) with the “No” responses used as the reference group in a multivariate logistic regression model. The 3 recommended personal protective behaviors (PPBs) were measured as dichotomous (Yes, No) variables using the following questions: “Which of the following behaviors did you practice on your last trip to the Caribbean destination(s) mentioned previously: (1) using insecticides and repellents on skin or clothing when outdoors at my primary Caribbean destination, (2) using bed nets, mosquito nets, insecticides or spatial repellents when indoors at my primary Caribbean destination(s), (3) Always wearing long pants, long-sleeved shirts, boots, or a hat when I was outdoors at my primary Caribbean destination(s).” All other survey items were pulled from existing instruments and research with known validity and reliability.<sup>19,20</sup>

The survey instrument was domiciled in Qualtrics (<http://www.Qualtrics.com>) and study participants were recruited through Amazon<sup>®</sup> Mechanical Turk ([MTurk], [www.mturk.amazon.com](http://www.mturk.amazon.com)), an online research participant recruitment platform. Participation in this study was completely voluntary. Those who elected to participate and provide signed informed consent were enrolled in the study. Data was subsequently collected after checking that participants had met the inclusion criteria. All data cleaning, processing, and statistical analyses were performed using Microsoft Excel<sup>®</sup> 2013 and SPSS<sup>®</sup> Statistics version 22.

## Results

A total of 734 qualified respondents participated in the online survey over a period of 5 days. Using multiple screening criteria such as deleting missing variables and unengaged responses, the final sample size decreased to 653 (89%).

The mean age of study participants was 32 years (SD=8.6). The mean duration of stay (in days) at the Caribbean destination was 9 (SD=8.8). The median number of hours spent engaging in outdoor activities was 25 (mean=37, SD=52.3, range=1-600 hours). Fifty-five percent (361) of study participants reported their gender as male, 38% (248) reported as females, and 7% (44) did not indicate their gender (Table 1). In all, 93% (606) of study participants said their purpose for travel to the Caribbean destination was for leisure, 4% (26) traveled for business, and 3% (19) traveled for both business and leisure, while only less than 1% (2) traveled for other reasons.

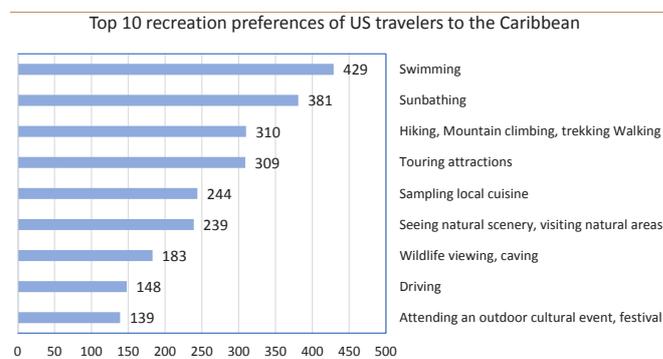
**Table 1.** Demographic Characteristics of Study Participants

Variable	No. (%)
<b>Gender</b>	
Male	361 (55)
Female	248 (38)
Unknown	44 (7)
<b>Race</b>	
White/European American	461 (71)
African American	957 (9)
Asian	55 (8)
Latino/Latina	37 (6)
Others	3 (< 1)
Missing	37 (6)
<b>Education</b>	
High School diploma	94 (14)
2-year college degree	114 (18)
4-year college degree	332 (51)
Graduate degree	76 (12)
Missing	37 (6)
<b>Annual Household Income</b>	
Less than \$25 000	69 (11)
\$25 001–\$50 000	197 (30)
\$50 001–\$75 000	184 (28)
\$75 001–\$100 000	90 (14)
\$100 001+	71 (11)
Missing	642 (6)
<b>Purpose of trip</b>	
Leisure	606 (93)
Business	26 (4)
Business and leisure	19 (3)
Others	2 (<1)
<b>Type of traveler</b>	
Solo traveler	167 (26)
Young couple	191 (29)
Group of friends	102 (16)
Mature couple	89 (14)
Family with young children	53 (8)
Family with older children	43 (7)
<b>Means of travel to destination</b>	
Cruise Ship	108 (16)
Air	410 (63)
Private smaller boat	112 (17)
Other (part cruise, etc.)	23 (4)

Results of study participants’ outdoor activity participation (Figure 1) indicated that 66% (429) engaged in swimming, 58% (381) in sunbathing, 47% (309) in tourist attractions, 46% (298) sat at an outdoor deck/patio/restaurant/bar, 39% (256) went hiking, 37% (244) sampled local cuisine, 36% (239) reported “seeing natural scenery” and visiting natural areas, 28% (183) went wildlife viewing or caving, and 23% (148) went driving. Activities with the least number of participants were hunting (1%), disc golf, boat racing, and horseshoes which saw approximately 3% participation. Scuba diving, zip lining, partying on the beach, modeling, and horseback riding were reported by 3% of study participants, even though these activities were not on the initial list of outdoor activities.

Results of the health information-seeking behavior of study participants revealed that only 21% (135) reported visiting the U.S. CDC’s website for information about vector-borne diseases at their primary destination (Table 2). Only 15% (100) reported visiting the U.S. CDC’s website for information about chikungunya disease in the past, while 35% (230) said they seek information about health risks present at a destination before visiting that destination. As regards seeking health information from the U.S. State Department’s website, 19% (124) of study participants reported looking at the website for information about mosquito-borne diseases in the Caribbean. Interestingly, about half (51%) of the study participants said they never sought information about chikungunya or any vector-borne illnesses in the past. When asked if they had heard of chikungunya (i.e. chikungunya disease awareness) before participating in this study, only 30% (196) of the respondents said yes, while 70% (457) said they had not (Table 3). Study participants’ records of the extent to which they adopted one or more of the recommended personal protective behaviors revealed that 74% (481) used insecticides and repellents on skin or clothing when outdoors at the destination, 36% (237) reported using bed nets, mosquito nets, insecticides, or spatial repellents, and 31% (202) reported wearing long pants, long-sleeved shirts, boots, or a hat when outdoors at the destination. Additionally, results of the analysis of study data showed that 22% (146) of study participants did not engage in any of the 3 recommended personal protective behaviors under investigation, 34% (225) engaged in only one of the recommended behaviors, 23% (151) engaged in two of the three behaviors, and 20% (131) engaged in all 3 recommended personal protective behaviors.

A chi-square test for independence (with Yates continuity



**Figure 1.** Recreation Preferences of a Sample of U.S. Travelers to Caribbean Destinations.

**Table 2.** Study Participants' Health Information-Seeking Behavior

Item	Statement	Yes (%)	No (%)
1.	I visited the U.S. CDC's website for information about vector-borne diseases at my primary destination(s) before the trip.	135 (21)	518 (79)
2.	I have visited the U.S. CDC's website for information about Chikungunya disease in the past.	100 (15)	553 (85)
3.	I seek information about health risks present at a destination before I visit that destination.	230 (35)	423 (65)
4.	I have looked at the U.S. State Department's website for information about mosquito-borne diseases in the Caribbean.	124 (19)	529 (81)
5.	I asked my doctor about strategies I could use to protect myself from mosquito-borne illnesses when traveling to the Caribbean.	122 (19)	531 (81)
6.	I have checked the Caribbean Tourism Organizations website for information to keep me safe from mosquito-borne illnesses.	116 (18)	537 (82)
7.	I have never sought information about chikungunya or any vector-borne illness in the past.	333 (51)	320 (49)

correction) showed a significant association between *gender* and respondent's chikungunya disease awareness ( $P = .005$ ), although the effect size ( $\phi = -0.12$ ) was small.<sup>30</sup> Chi-square tests also revealed significant associations between chikungunya disease awareness and *level of education* ( $P \leq .001$ ), ( $\phi = 0.12$ ); *number of days spent at the destination* ( $P < .001$ ), even though the effect size was small (Cramer's  $V = 0.17$ ); *purpose of travel* ( $P = .009$ ), (Cramer's  $V = 0.13$ ); and *number of hours spent engaging in outdoor activities* ( $P \leq .001$ ), (Cramer's  $V = 0.24$ ) (Table 4). No significant associations were found between study participants' chikungunya disease awareness and annual household income, race, employment status, and different age groups.

Unadjusted and adjusted logistic regression analyses were also performed to assess the impact of a number of factors on study participants' chikungunya disease awareness. The model contained 9 independent variables (Table 4). The adjusted logistic regression model was statistically significant ( $P < .0005$ ), indicating that the model was able to distinguish between respondents who reported and those who did not report chikungunya disease awareness. The model as a whole explained between 20% (Cox & Snell R squared) and 28% (Nagelkerke R squared) of the variance in chikungunya disease awareness and correctly classified 74% of cases.

As shown in Table 4, only 5 of the independent variables made a unique statistically significant contribution to the model at  $P < .05$  (*Gender, Level of education, Type of traveler, Purpose of trip, Number of days spend at the destination, and Number of hours spent engaging in outdoor activities*).

Compared to males, females were *two* times more likely to have heard about chikungunya disease before participating in this study (odds ratio [OR] = 2.4, 95% CI: 1.5–3.7). After adjusting for other variables in the model, respondents who had a 2-year college education (OR = 3.3, 95% CI: 1.4–8.2), a 4-year college education (OR = 6.4, 95% CI: 2.9–14.2), or a graduate degree (OR = 3.8, 95% CI: 1.5–10.2) were more likely to have chikungunya disease awareness than respondents with a high school diploma.

No statistically significant association was found between respondents' chikungunya disease awareness and annual household income, employment status, or purpose of trip. Race was not used as an independent variable in the logistic regression models, because the frequencies for the different racial groups participating in this study were not comparable (Table 4).

## Discussion

Chikungunya disease is endemic in the Caribbean region and poses significant public health risks to U.S. travelers and tourists to the region. This helps explain why relevant public health agencies such as the U.S. CDC have invested in various campaigns to raise awareness and adoption of recommended personal protective behaviors among U.S. travelers to the region. This study sought to investigate the level and predictors of chikungunya disease awareness among U.S. travelers to Caribbean destinations. Additionally, the extents to which travelers adopted 3 recommended personal protective behaviors, their outdoor activity participation, and

**Table 3.** Chikungunya Disease Awareness and Adoption of Recommended Personal Protective Behaviors Among Study Participants

Item	Statement	Yes (%)	No (%)
1.	Have you heard of chikungunya before today?	196 (30)	457 (70)
2.	I used insecticides and repellents on skin or clothing when outdoors at my primary Caribbean destination(s).	481 (74)	172 (26)
3.	I used bed nets, mosquito nets, insecticides or spatial repellents when indoors at my primary Caribbean destination(s).	237 (36)	416 (64)
4.	I always wore long pants, long-sleeved shirts, boots, or a hat when I was outdoors at my primary Caribbean destination(s).	202 (31)	449 (69)
5.	All 3 recommended personal protective behaviors		
	– I did not engage in any recommended protective behavior.	146 (22)	
	– I engaged in 1 recommended protective behavior.	225 (34)	
	– I engaged in 2 recommended protective behaviors.	151 (23)	
	– I engaged in all 3 recommended protective behaviors.	131 (20)	

**Table 4.** Predictors of Chikungunya Disease Awareness Among Study Participants

	Have You Heard About Chikungunya Disease Before Today?		P Value <sup>a</sup>	UOR	95% CI	AOR	95% CI
	Yes	No					
<b>Gender</b>							
Male	93 (26%)	268 (74%)	.004	1		1	
Female	91 (37%)	157 (63%)		1.7	1.18 – 2.37	2.4	1.50 – 3.73
<b>Level of education</b>							
High school diploma	13 (14%)	81 (86%)	<.001	1		1	
2-year college degree	29 (25%)	85 (75%)		2.1	1.03 – 4.37	3.3	1.35 – 8.18
4-year college degree	125 (38%)	207 (62%)		3.8	2.01 – 7.04	6.4	2.92 – 14.19
Graduate degree	20 (26%)	56 (74%)		2.5	1.02 – 4.84	3.8	1.45 – 10.18
<b>Income</b>							
Less than \$25 000	20 (29%)	49 (71%)	.132	1		1	
\$25 001–\$50 000	54 (27%)	143 (73%)		0.9	.50 – 1.70	0.5	.20 – 1.10
\$50 001–\$75,000	57 (31%)	127 (69%)		1.1	.60 – 2.02	0.8	.35 – 1.82
\$75 001–\$100 000	25 (28%)	65 (72%)		0.9	.47 – 1.89	0.6	.21 – 1.50
More than \$100 001	31 (44%)	40 (56%)		1.9	.94 – 3.83	0.9	.35 – 2.42
<b>Race</b>							
White/European American	129 (28%)	332 (72%)	.106				
African American	22 (39%)	35 (61%)					
Native American	0 (0%)	3 (100%)					
Latino/Latina	15 (41%)	22 (59%)					
Asian	21 (38%)	34 (62%)					
Other	0 (0%)	3 (100%)					
<b>Employment status</b>							
Employed (full-time)	159 (31%)	356 (69%)	.680	1		1	
Employed (part-time)	15 (31%)	34 (69%)		1.0	.52 – 1.87	0.5	.21 – 1.21
Not employed	13 (25%)	39 (75%)		0.8	.39 – 1.44	0.9	.40 – 2.27
<b>Age group (years)</b>							
20-25	42 (36%)	74 (64%)	.149	1		1	
26-30	51 (25%)	155 (75%)		0.6	.35 – .95	0.3	.15 – .55
31-35	43 (29%)	104 (71%)		0.7	.43 – 1.22	0.3	.15 – .61
36-40	19 (32%)	41 (68%)		0.8	.42 – 1.58	0.8	.33 – 1.86
41+	32 (37%)	55 (63%)		1.0	.58 – 1.83	0.9	.44 – 2.06
<b>Type of traveler</b>							
Solo traveler	56 (34%)	111 (66%)	.015	1		1	
Young couple	46 (24%)	145 (76%)		0.6	.40 – 1.00	0.5	.33 – 1.00
Mature couple	29 (33%)	60 (67%)		1.0	.55 – 1.66	0.8	.37 – 1.70
Family with young children	20 (38%)	33 (62%)		1.2	.63 – 2.28	0.5	.20 – 1.07
Family with older children	7 (16%)	36 (84%)		0.4	.16 – .92	0.1	.03 – .43
Group of friends	38 (37%)	64 (63%)		1.2	.70 – 1.97	1.0	.48 – 1.91
<b>Purpose of trip</b>							
Business	6 (23%)	20 (77%)	.009	1		1	
Leisure	178 (29%)	428 (71%)		1.4	.55 – 3.51	0.6	.21 – 1.75
Business and Leisure	12 (63%)	7 (37%)		5.7	1.55 – 21.06	2.1	.48 – 9.68
<b>No. of days spent at destination</b>							
1-5	35 (20%)	142 (80%)	<.001	1		1	
6-10	88 (29%)	211 (71%)		1.7	1.08 – 2.64	1.6	.91 – 2.72
11+	64 (41%)	94 (59%)		2.8	1.70 – 4.50	2.0	1.02 – 3.83
<b>No. of hours spent engaging in outdoor activities</b>							
0-20	64 (23%)	221 (73%)	<.001	1		1	
21-40	61 (33%)	126 (67%)		1.7	1.11 – 2.53	2.5	1.53 – 4.19
41-60	23 (25%)	71 (75%)		1.1	.64 – 1.93	0.9	.45 – 2.00
61-80	25 (53%)	22 (47%)		3.9	2.08 – 7.42	4.2	1.94 – 9.06
80+	23 (58%)	17 (42%)		4.8	2.35 – 9.28	2.6	1.04 – 6.46

Abbreviations: UOR, unadjusted odds ratio; AOR, adjusted odds ratio

<sup>a</sup>P value significant at ≤.05.

health information seeking behaviors were investigated.

Results of study participants' outdoor activity participation revealed that most visitors engaged in swimming, sunbathing, touring attractions, sitting at an outdoors deck/patio, hiking, sampling local cuisine, and visiting natural scenery. Conversely, the outdoor activities with the least number of participants were disc golf, boat racing, and horseshoes. These results further confirm previous evidence suggesting that outdoor activities remain a major attraction for U.S. travelers to Caribbean destinations.<sup>10</sup>

Results of study participants' health information-seeking behavior revealed that most visitors visited neither the U.S. CDC's nor the U.S. Department of State's websites for information about chikungunya disease or other health risks which might be present at the destination before traveling. In the same regard, more than 50% of study participants said they never sought information about chikungunya or any other vector-borne disease in the past. Of the large number of U.S. residents who travel each year to countries where certain infectious diseases are prevalent, Hamer and Connor<sup>22</sup> reported that only 36% of such travelers sought travel health advice, even though more than half planned the trip at least one month in advance. Given the relatively low health information-seeking behavior observed among participants of the current study, it was not surprising that only 30% reported previous awareness of chikungunya disease before participating in this study.

The finding of a positive association between participants' chikungunya disease awareness and female gender, college educated, more days spent at the destination, and more time spent outdoors suggests possible avenues for developing interventions aimed at increasing chikungunya disease awareness. Previous studies have reported lower overall intention to adopt vector-borne disease personal protective behavior in male subjects when compared to females.<sup>23</sup> Other studies that have reviewed gender differences in a wide variety of domains, including abilities, personality, social behavior, and memory, have produced conflicting results.<sup>24</sup> More studies are needed to validate whether gender differences contribute significantly to chikungunya disease awareness and eventual adoption of risk-reduction behavior. While no previous studies have documented associations between levels of education, number of days spent at the destination, and time spent outdoors with chikungunya disease awareness, studies have documented a positive association between levels of education and baseline knowledge of mosquito-borne diseases.<sup>25,26</sup> Nonetheless, Yasuoka et al<sup>25</sup> have suggested that, regardless of sociodemographic characteristics, educational interventions are effective in increasing understanding and active involvement in preventing mosquito-borne diseases.

Study findings also indicated that the use of insecticides and repellents on skin or clothing when outdoors was the most prevalent personal protective behavior among U.S. travelers to Caribbean destinations, while wearing long pants, long-sleeved shirts, boots, or a hat when outdoors was the least personal protective behaviors adopted. Previous studies have reported similar findings.<sup>23</sup> The finding of a very low rate of adopting appropriate clothing as a chikungunya risk-reduction behavior in study participants might not be unassociated with concerns about the discomfort associated with "dressing up,"

especially in the warm regions of most Caribbean destinations. In addition, "dressing up" may interfere with participation and enjoyment of various outdoor activities at the destination. Furthermore, about 22% of study participants did not engage in any of the 3 recommended personal protective behaviors, while 20% engaged in all 3 protective behaviors. The U.S. Department of Defense (DoD) recommends that individuals at risk of exposure to mosquito-borne diseases should use all elements of an insect repellent system (consists of wearing a permethrin treated uniform, applying DEET or picaridin to the skin, using properly worn clothing, and using a permethrin treated bed net) for maximum protection.<sup>14</sup> This is because all it takes for transmission of the disease is a single bite from an infected mosquito-vector. Since different components of an insect repellent system act synergistically to prevent mosquito bites, the goal should be to encourage members of an at-risk group, such as U.S. travelers to Caribbean destinations, to adopt multiple personal protective behaviors. In a study of outdoor recreationists at risk for another vector-borne disease, Omodior et al<sup>23</sup> reported a significant association between high overall intention to adopt 3 or more recommended personal protective behaviors and actual behavior. Given that intention is considered the largest predictor of behavior,<sup>27</sup> future studies should seek to investigate the predictors of intention vis-à-vis adoption of mosquito-borne disease personal protective behavior among U.S. travelers to Caribbean destinations.

Given the relatively low level of chikungunya disease awareness among the study participants, it is suggested that more novel approaches be considered. Carleton et al<sup>28</sup> reviewed the evidence for the relationship between exposure to health information, awareness, knowledge, skills to change behavior, changed risky behaviors, risk factor changes, and behavior modification; they found strong evidence in support of the relationship between awareness and behavior modification. Other studies have found similar relationships between cumulative exposure to health messages, awareness, and behavior modification in at-risk groups.<sup>29,30</sup> In a randomized controlled trial to evaluate the impact of an educational program on the prevention of tick-borne diseases, Daltroy et al<sup>31</sup> reported a 60% risk reduction in the intervention group compared with the control group. Additionally, they observed that members of the intervention group were significantly more likely to engage in the recommended personal protective behaviors compared with the control group. In this regard, novel approaches that could be adopted based on the results of this study may involve the provision of health information within the framework of the travel and activity experience to travelers at places such as airports, car rental agencies, hotels, motels, travel agencies, event locations, etc. This approach is premised on the notion that, while travelers may not visit the U.S. CDC or Department of State's websites for information but will be visiting the destination for leisure/business, providing health information using the means by which the travel experience will be planned (i.e. travel agencies), during their travel experience (airports), where they will be staying (hotels, motels, bed and breakfasts), by the means through which they move around at the destination (car rentals), and at the venues of activity participation (events) increases the likelihood of exposure to information, awareness, knowledge

and, ultimately, behavior modification.

The findings of this study are, however, limited to the average U.S. traveler/tourist to Caribbean destinations represented in the sample and cannot be generalized to a broader context. Another limitation of this study is that the data was collected using an online platform, which means that any segment of the population of interest without access to the internet and those not technologically savvy were missing from the sample frame. It is quite possible that a segment of the population not represented in this study (e.g., the elderly) are significantly different in some respect from the sampled population. Future studies should be designed in such a way as to sample a more representative population of U.S. travelers/tourists to Caribbean destinations. A third limitation is that this study did not adjust for variabilities that may be associated with different destinations within the Caribbean region. Future studies should also be designed to account for differences in the locations visited.

### Conclusion

Although the relationship between international travel, tourism and the global spread of emerging mosquito-borne infectious diseases are known, there is little information available on the level of awareness of international U.S. travelers regarding chikungunya disease. Additionally, little information is available on the predictors of chikungunya awareness, activity participation, and adoption of recommended personal protective behaviors. This is the first study to document chikungunya disease awareness and adoption of recommended personal protective behaviors among a sample of U.S. travelers to Caribbean destinations. The findings of this study revealed that swimming, sunbathing, and touring attractions topped the list of study participants' outdoor activity participation. The findings also revealed that there is relatively low level of chikungunya disease awareness among study participants who represent U.S. travelers to Caribbean destinations. Chikungunya disease awareness significantly differs by gender, level of education, type of traveler, purpose of trip, number of days spent at the destination, and number of hours spent engaging in outdoor activities. Furthermore, the current study revealed that the use of insecticides and repellents on skin or clothing when outdoors was the most prevalent PPBs, while wearing appropriate clothing was the least adopted PPBs. Finally, the current study found that the rate of visiting the U.S. CDC's or the U.S. Department of State's websites for travel health information was low among study participants.

In spite of the limitations of this study, the findings have practical value for the implementation of interventions aimed at increasing awareness and subsequent adoption of effective personal protective behaviors among U.S. travelers to Caribbean destinations where both incidence and prevalence of emerging mosquito-borne infectious diseases are on the rise. This study also reveals that more research is needed to identify additional factors associated with chikungunya disease awareness and the adoption of recommended chikungunya-risk reduction behaviors. From a theoretical and conceptual perspective, future studies should investigate whether certain theoretical constructs, such as perceived severity, perceived

### Research Highlights

#### What Is Already Known?

Evidence abounds for the relationship between international travel, tourism, and the global spread of emerging mosquito-borne infectious diseases, such as chikungunya. Infection usually results when tourists and other travelers who visit places where these infections are endemic or where outbreak events occur are bitten by infected mosquitoes. Although the U.S. CDC has embarked on a chikungunya awareness campaign for U.S. travelers to and from Caribbean destinations, the level of chikungunya awareness and the extent to which travelers to Caribbean destinations adopt the recommended personal protective behaviors remains unknown. Equally unknown is the rate of outdoor activity participation and health information-seeking behavior of U.S. travelers to Caribbean destinations.

#### What This Study Adds?

The current findings have practical value for the implementation of interventions aimed at increasing awareness and subsequent adoption of effective personal protective behaviors among U.S. travelers to Caribbean destinations where both incidence and prevalence of emerging mosquito-borne infectious diseases are on the rise. This study also reveals that more research is needed to identify additional factors associated with Chikungunya disease awareness and the adoption of recommended chikungunya-risk reduction behaviors.

vulnerability, response efficacy, self-efficacy, and behavioral intentions as contained in Rogers<sup>32</sup> Protection Motivation Theory, predict adoption of recommended PPBs among U.S. travelers to Caribbean destinations.

### Authors' Contributions

All authors contributed substantially to the conceptualization, writing, and review of this study.

### Conflict of Interest Disclosures

Authors state they have no conflicts of interest.

### Ethical Approval

The authors have addressed the relevant ethical issues. Informed consent was obtained from all participants before data collection, and the research protocol was approved by the University of Florida Institutional Review Board (IRB#: 2015-U-1040).

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### Supplementary Materials

Supplementary file 1 contains Member list of the Caribbean Tourism Organization and Study participants list of outdoor activity.

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