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RESEARCH

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Understanding international travelers' health risk perceptions, preferences, and decisions: a segmentation analysis

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Abstract

Background This study assesses international travelers' risk perceptions and travel decisions related to three recent emerging diseases. Travelers can facilitate the spread of emerging infectious diseases and their decision-making on where to travel is influenced by outbreaks. These feedback loops can potentially impact the tourism economy. Often, travelers' judgment and actions towards a risk are based on their perceptions.

Method We conducted two surveys, using constructs from the Health Belief Model, with 747 individuals who had recently traveled to selected Latin American countries, and who had heard about Zika virus, chikungunya, and/or COVID-19. Using segmentation analysis, the respondents were grouped based on their risk perception level (i.e., low, medium and high), and we tested the differences between groups for different constructs of the model.

Results We found a significant difference between the risk perception groups for most of the sociodemographic factors, as well as for the purpose of the trip, regarding travel preferences. Personal experience with a disease and perceived efficacy towards diverse protective measures also differed between groups. Higher risk perception was related to reporting more changes in past travel plans, and higher likelihood of future travel avoidance if facing different risk scenarios in a tourism destination.

Conclusions Including the concepts of risk perception, sociodemographic factors, previous experience, and efficacy can help better explain the individual behavior of international travelers. These findings can inform tailored and more effective mitigation and management strategies to promote safe travel and prevent disease spread in the event of a future outbreak.

Keywords Travel medicine, Destination management, Mosquito-borne disease, COVID-19, Emerging infectious diseases

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Background

The travel industry is intricately connected with the spread of emerging infectious diseases (EID). Since the mid-20th century, people across the world have experienced an increase in the occurrence of emerging and re-emerging disease events; this pattern is expected to continue, posing a challenge to global health [1, 2]. Given current global connectivity, travel and tourism have been identified as central contributors to disease spread [3]. The international tourism industry has been steadily recovering from the halt in global mobility caused by the COVID-19 pandemic restrictions in 2020, which is expected to reach and surpass pre-pandemic levels in 2024 [4, 5]. Although this global crisis caused unprecedented negative economic impacts on the tourism industry [6], previous epidemics have also disrupted travel activity in diverse destinations worldwide [7, 8]. In 2023, there were around 1,286 million international tourists recorded, a number that is expected to increase in the following years [5]. With these trends, the travel industry is likely to keep contributing to the spread of EID, and the burden of travel-associated infections will increase, along with the potential negative economic effects on destinations dealing with an epidemic [9, 10]. In this study, we conducted a segmentation analysis to explore and compare the characteristics, preferences, and behaviors of three different groups, based on their risk perception (RP) regarding outbreaks of emerging diseases when traveling. Ultimately, our findings provide practical information for the mitigation and management of future epidemics, through tailoring strategies based on travelers' characteristics, to promote safe travel from both travel medicine and tourism destination management perspectives.

In recent years, different EIDs have impacted distinct destinations worldwide (i.e., Ebola, SARS, MERS, H1N1) [7, 8, 11]. In this study, we focused on three diseases that represent the largest recent outbreaks in the Americas. Undoubtedly, the most disruptive one, impacting both public health and the tourism industry, was COVID-19 [6]. The first case of COVID-19 in the Americas was confirmed in the US in early 2020, later spreading to 50 countries and territories in the Americas and becoming endemic [12]. Prior to this pandemic, two mosquito-borne diseases (MBDs) emerged and became epidemics in the tropical and subtropical Americas: chikungunya (CHIKV) and Zika virus (ZIKV) [3]. Local transmission of CHIKV was first reported in the Caribbean in late 2013, and ZIKV first suspected case in South America was in December 2014. Quickly, both diseases spread and became endemic to most countries and territories of Latin America and the Caribbean, where the mosquito vectors, *Aedes aegypti* and *Aedes albopictus*, are widespread [3, 13–15]. Although there are ongoing public health efforts to contain the mosquito vectors and the reported infections decreased after the initial outbreaks, it is expected that epidemic cycles occur as the viruses are still present in the region [16]. At an individual level, actions to prevent the transmission of these two MBD rely primarily on personal protection measures [17]. At the time this study was conducted, only the US had recently approved a CHIKV vaccine for adults at increased risk of exposure and there are ongoing research trials for vaccine development [18, 19].

These three diseases can pose a risk of illness to travelers when visiting tourist destinations dealing with outbreaks. Previous studies have documented travel-related cases of ZIKV and CHIKV linked to outbreaks in tourism destinations where the disease was emerging or became endemic [20, 21]. As a consequence, there have been reports of sporadic CHIKV autochthonous transmission in countries where the vector is present, like the US, France, and Italy [21], and local transmission of ZIKV in southern US states. Travelers can be particularly vulnerable to infection since their immune system is not prepared for novel viruses and they might have low awareness due to limited information about these diseases [21, 22]. In addition to the potential health burden, these diseases could impact international travelers due to the need to seek health care services abroad or when returning to their home country [10, 17, 23].

Most individuals judge and make decisions based on RP, which are determined by diverse social, cultural, and psychological factors [24, 25]. One approach proposed to understand the relationship between how an individual perceives a risk of infection and their behavioral response to prevent, mitigate, or cure themselves is the Health Belief Model (HBM). According to the HBM, individuals assess a health risk based on their perceived susceptibility or the extent of feeling personally vulnerable to contracting a particular disease, and perceived severity, which entails their understanding of how serious being affected by an illness could be [26, 27]. Multiple studies have shown that health RP can drive the adoption of protective behaviors [28–30], and the likelihood of adoption depends on the benefits and barriers perceived by the individual [27]. Benefits refer both to actions that decrease the susceptibility or severity of getting a disease or condition and can be influenced by social norms. While an individual might believe certain behavior will help to prevent or treat a disease, they may also perceive that the same action is inconvenient, expensive, painful, or upsetting; these are considered barriers. Therefore, a behavior is likely to be adopted only if the benefits of adopting it outweigh the perceived barriers or consequences [27, 28].

Additionally, the HBM identifies other internal and external factors that can influence the perceptions of a risk and the adoption of actions, including cues to actions, sociodemographic factors, and structural variables. Cues to action can be varied, as this term refers to triggers that prompt decisions to adopt certain behaviors; cues can include interpersonal interactions, communication campaigns, and learning about the disease through a family member's experience. HBM acknowledges that sociodemographic factors and structural variables play a role in the decision-making process of an individual, referring to individual characteristics. These factors include age, sex, ethnicity, psychological profiles, cultural backgrounds, structural variables, like prior knowledge and experience with a disease [27]. Often, the concept of efficacy has been added to the HBM, which refers to the confidence an individual has of being able to adopt a coping behavior successfully. A higher level of efficacy has been related to a greater chance of behavioral change [31, 32]. Although research of risk perceptions in tourism has grown in the past decades [33], this research aim to contribute to the knowledge on the field, which faces many challenges given the complexity of how to measure risk perceptions [34], the variety of risks that travelers can face [35], the fact that risks are often evolving and not static situations [36], and that these concepts are not always integrated into more comprehensive crises management models [35, 37, 38].

Using constructs from the HBM, we conducted two surveys to assess US traveler risk perception towards contracting CHIKV, ZIKV, and COVID-19 during their travels to select Latin American countries. Our study explores if (a) differences in experiences, preferences, and sociodemographic factors exist among health risk perceptions traveler segments; and (b) whether traveler efficacy perceptions and travel behaviors vary based on the level of health risk perceptions. Given that the acceptance and adoption of prevention and treatment measures rely on individual perceptions and actions, this study aims to contribute to the complex understanding of the heterogeneity of international travelers [39, 40].

Methods

Sampling and data collection

We conducted two online surveys targeting US residents who had traveled to selected countries in Latin America during the CHIKV, ZIKV, and COVID-19 outbreaks (Fig. 1). We selected Brazil, Colombia, and Guatemala as the study destinations based on the following criteria: (a) tourism is an important contributor to the country's economy; (b) the US is among the top countries of origin for tourists, determined by data from the World Tourism Organization (WTO) and the World Travel and Tourism Council [41–43]; and (c) the country had CHIKV and ZIKV cases reported based on data from the Pan-American Health Organization (PAHO) [16, 44, 45]. The travel timeframe was defined based on when the outbreaks of each disease peaked in Latin America using data from PAHO [44, 45]. The sample size was estimated based on the number of US visitors to the destinations within the timeframe selected. We used the Raosoft online sample size calculator to estimate the sample number, applying the parameters of a confidence level of 95% and a margin of error of 5%.

Both surveys consisted of self-administered online questionnaires [46] distributed to panels of travelers acquired through Qualtrics [47], who conducted the data collection. There were two different sets of respondents, as they had to comply with each survey specific inclusion criteria (Fig. 1). We had two research questions guiding the surveys, (a) do sociodemographic, cognitive, experiential factors vary among different risk perceptions

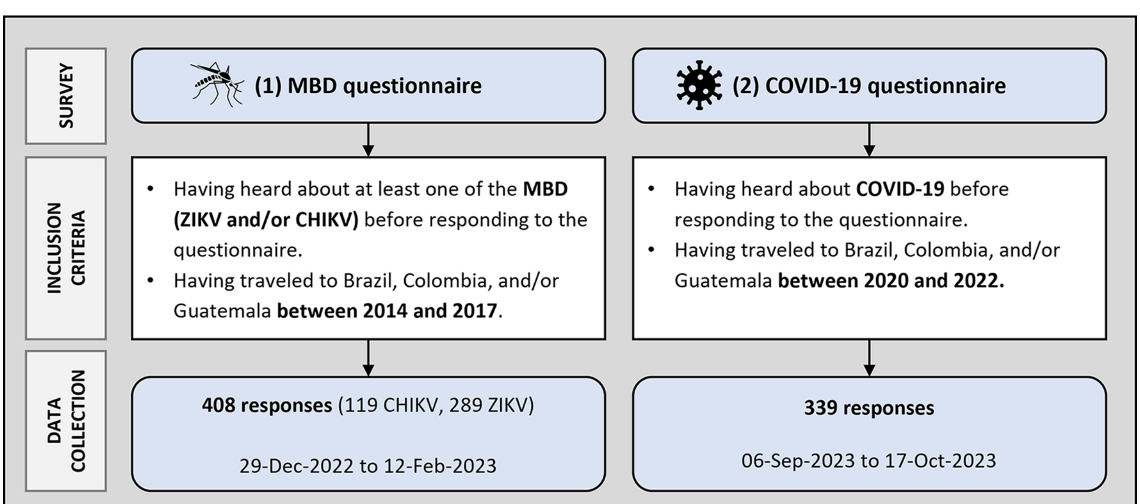

Fig. 1 Inclusion criteria, data collection dates, and total complete responses for each of the surveys conducted on US travelers to selected Latin American countries

segments of travelers? and, (b) do travelers with different levels of health risk perception have different efficacy perceptions, and protective and travel behaviors? Survey instruments consisted primarily of closed-ended questions and Likert-type scales, regarding: (a) travel information and preferences; (b) disease RP and adoption of preventive health behaviors; (c) future travel intentions, and (d) sociodemographic information. We conducted a pre-test with researchers and potential participants (international travelers) prior to data collection to reduce measurement error [46, 48].

Construct operationalization

Given the complexity that measuring RP entails, to develop the questionnaires we used constructs from the Health Belief Model (Fig. 2) as the overall framework [26, 27] and mainly relied on three studies that assessed RP and behavior adoption towards diverse EID [28, 29, 49]. Risk perception was defined as the perceived susceptibility and perceived severity of the disease. Perceived susceptibility and perceived severity were measured using four and five statements, respectively, both on a 5-point Likert scale (strongly disagree to strongly agree), adapted from Cahyanto et al. (2016).

Among the modifying factors assessed we included sociodemographics, which were measured by asking participants' age, gender, education level, ethnicity, annual household income, and political preference [29]. We assessed travel preferences through questions about the country where most time was spent, the main purpose of the trip, the traveling group, and the likelihood of seeking health information about the destination before traveling. Questions to assess past experiences with the disease were adapted from Dryhurst et al. (2020). We assessed response efficacy by using a modified six statement scale, measured on a 5-point Likert scale [49]. Five of the statements assessed the perceived effectiveness of specific protective measures for mosquito bites and COVID-19 infection, respectively, and one statement measured the belief that infection cannot be prevented.

Regarding the adoption of behaviors, we focused on travel avoidance, including two questions, one referring to past actions and one to the likelihood of future travel avoidance considering a variety of risks. Participants were asked if they had made any changes in their travel plans due to CHIKV, ZIKV, and COVID-19 outbreaks at their destination. To assess future travel avoidance, we adapted a question from Cahyanto et al. (2016), regarding the likelihood of avoiding traveling in the next 4 years to a destination, when facing a series of different potential risks. This was measured with a 5-point Likert scale ranging from extremely unlikely to extremely likely. Details of the constructs and scales utilized can be found in Additional File 1.

Data analysis

For the analysis, we combined the responses from the two surveys conducted, as, although they address different diseases, the COVID-19 survey replicated the questions from the MBD survey, adapting them, when needed, to the specific characteristic of the disease. We decided to merge the surveys, so the analysis focuses on trends beyond a disease, targeting mainly the RP construct. We evaluated the internal consistency of the two components of RP (Table 1) by using Cronbach's alpha (α) reliability test [50], which is considered acceptable if ranging from 0.70 to 0.95 [51]. We performed a k-means cluster analysis using SPSS 28 to group visitors into RP segments. To explore different options, various clustering techniques (two-step and k-means) were utilized to select the number of clusters, testing two, three, and four-cluster solutions. The k-means analysis resulted in good cluster quality, serving as base to select the three-cluster option [50] as the most appropriate to make the segmentation analysis, classifying the segments as low, medium, and high RP (Fig. 3).

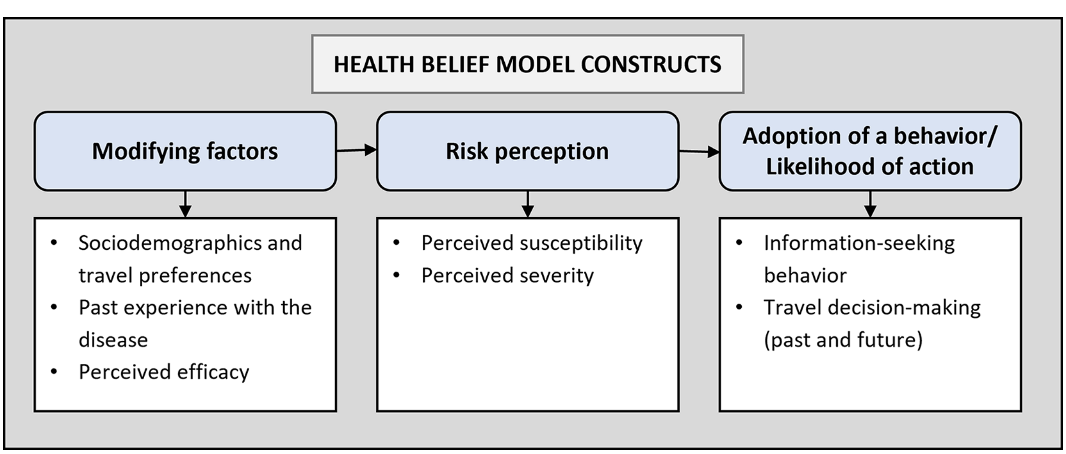

Fig. 2 Constructs from the Health Belief Model applied to develop the questionnaires

Table 1 Statements used to group visitors into segments based on their risk perception level, on a five-point scale (1 = strongly disagree to 5 = strongly agree)

Category	Statements	α
Perceived susceptibility	• My chances of being exposed to (chikungunya / Zika virus / COVID-19) were high during the trip(s). • It was likely that I was going to contract (chikungunya / Zika virus / COVID-19) during the trip(s). • It was likely that I was going to be exposed to (chikungunya / Zika virus / COVID-19) during the trip(s), but I was not going to get sick. • It was likely that I was going to contract (chikungunya / Zika virus / COVID-19) if I traveled internationally between 2014 and 2017*.	0.858
Perceived severity	• If I got sick from (chikungunya / Zika virus / COVID-19), I would have died. • I was afraid that I might die if I contracted (chikungunya / Zika virus / COVID-19) • If I tested positive for (chikungunya / Zika virus / COVID-19), I could have passed it to my family or friends who may have died. • I was at greater risk of dying if I contracted (chikungunya / Zika virus / COVID-19), because of my general health at the time. • Getting sick with (chikungunya / Zika virus / COVID-19) during my trip could have been serious.	0.844

Adapted from Cahyanto et al., 2016

*2020 and 2022 for COVID-19 respondents

We tested differences between the three RP segments for sociodemographics, travel preferences, previous experience with a disease infection, perceived efficacy, information-seeking behavior, and travel decision making. Chi-square tests were run with Cramer's V for categorical variables [50]. Levene's test was used to assess the homogeneity of variances. If variances were equal, ANOVA was used to identify differences between groups, and Bonferroni test was used as a post-hoc test; for unequal variances, we used Welch's ANOVA with a Games-Howell post-hoc test [50].

Results

Traveler segments

Travelers were segmented into three groups based on their health RP level (Table 2). The low RP group, comprising the smallest number ($n = 191$), perceived the severity of the diseases slightly higher ($\bar{x}$ = 2.11, range: 1.00-4.40) than the susceptibility ($\bar{x}$ = 1.91, range: 1.00-3.25). Next in size, the high RP group included about one third of the participants ($n = 250$) and showed a similar trend of having a higher perceived severity ($\bar{x}$ = 4.23, range: 3.00–5.00) than susceptibility ($\bar{x}$ = 4.06, range: 2.25-5.00). The medium RP group was the largest group ($n = 306$), which leaned towards the middle point, "neither agree nor disagree," could be interpreted as a neutral or unaware perception. Unlike the other two groups, travelers in this group exhibited lower perceived severity ($\bar{x}$ = 2.83, range: 1.00-4.20) towards the disease than susceptibility ($\bar{x}$ = 3.29, range: 1.75-5.00). The three diseases were distributed in all three RP segments, in percentages similar to the size of the segments. CHIKV received a

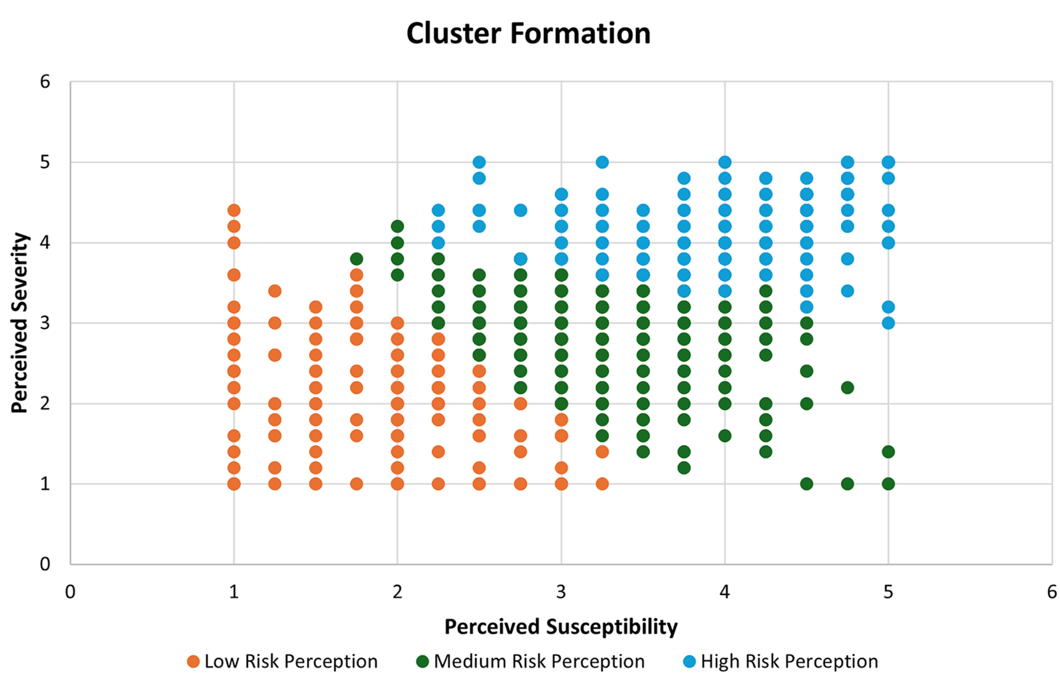

Fig. 3 Cluster formation graph showing the three risk perception level segments

Table 2 Description and characteristics of the three clusters ($n=747$). The input shows the mean by group, on a 5-point likert scale (1 = strongly disagree to 5 = strongly agree)

Cluster	1	2	3
Label	**Low risk perception level**	**Medium risk perception level**	**High risk perception level**
Segment size	26% ($n=191$)	41% ($n=306$)	34% ($n=250$)
Inputs	Perceived susceptibility: 1.91 (1.00-3.25) Perceived severity: 2.11 (1.00-4.40)	Perceived susceptibility: 3.29 (1.75-5.00) Perceived severity: 2.83 (1.00-4.20)	Perceived susceptibility: 4.06 (2.25-5.00) Perceived severity: 4.23 (3.00–5.00)
Segments by disease			
CHIKV ($n=119$)	19% (23/119)	40% (48/119)	40% (48/119)
ZIKV ($n=289$)	29% (84/289)	40% (117/289)	30% (88/289)
COVID-19 ($n=339$)	25% (84/339)	42% (141/339)	34% (114/339)

slightly higher percentage in the high RP questionnaire (40%), while ZIKV was more prevalent in the low RP (29%).

Traveler profile: sociodemographics and travel preferences

Most of the sociodemographic factors were significantly different between the segments, except for ethnicity (Table 3). Travelers were almost evenly distributed between females (51%) and males (47%), although the high RP group had a larger percentage of males (57.2%), while the mid RP group had of females (57.5%). In terms of age, respondents were mostly young adults ($\bar{x}$ = 35.1 years), and the low RP group had a slightly older mean (37.7 years old) and was significantly different than the other two groups. About half of the sample (49.8%) had completed a bachelor's degree or higher. The high RP group contained over half of these respondents who had a bachelor's degree or higher (56.8%), while a larger percentage of respondents with no degree were in the mid RP group (43.8%). The respondents' annual household income varied in range; 34.3% earned less than $50,000, 36.5% earned between $50,000 and $100,000, and 29% earned more than $100,000. The high RP group had a larger percentage of respondents (41.2%) earning over $100,000. Among the participants, the majority identified as White (58.5%), followed by Black or African American (16.9%) and Hispanic or Latin American (9.5%). The political preference of participants was varied, with more than a third considering themselves as independent (35.9%), and slightly less than a third as liberal or very liberal (31.9%) and conservative or very conservative (30.8%). The group with a larger percentage of independent was the mid RP (43.8%), while the high-RP had a larger percentage of liberals (38.8%).

Regaing their travel preferences, only the main purpose of the trip and the likelihood of seeking information before traveling were significantly different between groups (Table 3). The majority of respondents traveled to Brazil (54.8%), followed by Colombia (32.3%) and Guatemala (13.0%), respectively, which reflects the arrivals' data from the WTO. For the three countries, the main purpose of traveling was recreation, followed by visiting family and friends, and business trips. The low RP group had the largest recreation (55.0%) and humanitarian percentages, while the high and mid RP groups had the largest percentage for business travelers (28.0%) and visiting family and friends (31%), respectively. Most respondents traveled solo (24.2%), followed by individuals traveling with friends (19.9%). In the pre-traveling process, the overall mean of likelihood to seek health-related information about the destination was close to 4, which was somewhat likely ($\bar{x}$ = 3.76), and the high RP group was significantly different, higher than the other two groups.

Past experience with the disease

Participants were asked about their prior experience with a specific disease, including their own and those of their friends and family. Regarding CHIK and ZIKV, chi-squared analysis showed a significant difference between groups for respondents reporting having experienced the disease, both personally and through their friends or family (Table 4). Over three-quarters of respondents in the low RP group had not experienced or suspected having had ZIKV/CHIKV personally (78.5%) and through family or friends (77.6%). In contrast, one-quarter of the high RP group were certain of having had ZIKV/CHIKV personally (25.0%) and through family or friends (26.5%). Although the questions were slightly different for COVID-19, the trend was similar. Chi-squared analysis also showed a significant difference between groups, but only when experienced personally or through friends and not through family. The low RP group had the larger percentage (54.8%) of respondents who reported not having been infected with COVID-19 personally, while the high RP group had the larger percentage (68.4%) of individuals who had or might have had an infection. Regarding having a friend who experienced a COVID-19 infection, the lowest percentage was in the low RP group (56%). Over two-thirds of respondents overall had a family member who experienced COVID-19 (Table 4).

Perceived efficacy

Overall, most respondents reported having adopted some health preventive behaviors during their travels, with only 16 of the 408 respondents to the MBD questionnaire mentioning they had not adopted actions to

Table 3 Travelers profile broken down by group. Total and per group numbers are expressed as percentages, except for age (mean in years) and likelihood of information seeking (5-point likert scale, 1 = extremely unlikely to 5 = extremely likely)

Sociodemographic factors	Total (n = 747)	Risk perception level			Chi-square	ANOVA F / Welch's F
		Low (n = 191)	Medium (n = 306)	High (n = 250)		
Gender					20.490***	
Male	47.0	45.5	39.5	57.2		
Female	51.0	52.9	57.5	41.6		
Other [z]	1.6	1.6	2.6	0.4		
Age in years						5.072**
Mean	35.1	37.7 [a]	33.6 [b]	34.9 [b]		
Education					27.135**	
High school or less	20.3	16.8	23.2	19.6		
Some college, no degree	17.7	20.9	20.6	11.6		
Associate's degree	11.9	9.4	13.4	12.0		
Bachelor's degree	28.0	30.9	25.8	28.40		
Graduate degree	21.8	20.9	17.0	28.40		
Annual household income					45.467***	
Less than $24,999	7.9	5.8	10.1	6.8		
$25,000 to $34,999	13.4	16.8	13.1	11.2		
$35,000 to $49,999	13.0	16.8	14.1	8.8		
$50,000 to $74,999	17.9	16.8	19.9	16.4		
$75,000 to $99,999	18.6	21.5	19.3	15.6		
$100,000 to $149,999	16.2	11.5	15.0	21.2		
$150,000 to $200,000	8.7	5.2	4.9	16.0		
Greater than $200,000	4.1	5.2	3.6	4.0		
Ethnicity					15.162	
American Indian or Alaska Native	1.9	2.6	2.3	0.8		
Asian	3.9	4.7	2.6	4.8		
Black or African American	16.9	16.2	15.4	19.2		
Hispanic or Latin American	9.5	8.9	12.7	6.0		
Native Hawaiian or Pacific Islander	0.7	0.5	1.0	0.4		
White	58.5	59.2	55.9	61.2		
Other (two or more)	8.7	7.9	10.1	7.6		
Politics					52.401***	
Very conservative	13.1	9.9	8.5	21.2		
Conservative	17.7	24.1	18.0	12.4		
Independent	35.9	35.1	43.8	26.8		
Liberal	21.3	20.4	20.6	22.8		
Very liberal	10.6	7.9	7.8	16.0		
Country where most time was spent					6.435	
Brazil	54.8	50.3	53.6	59.6		
Colombia	32.3	34.0	32.0	31.2		
Guatemala	13.0	15.7	14.4	9.2		
Main purpose of the trip					30.676***	
Recreation	45.9	55.0	47.1	37.6		
Business trip	18.9	11.0	16.3	28.0		
Visiting family and friends	28.9	26.2	31.0	28.4		
Humanitarian	5.6	7.9	4.9	4.8		
Traveling group					25.670	
Solo traveler	24.2	29.3	20.9	24.4		
Young couple	11.9	14.1	12.1	10.0		
Mature couple	12.0	9.9	13.7	11.6		
Family with young children	15.9	9.4	15.7	21.2		
Family with older children	8.3	7.3	8.5	8.8		
Group of friends	18.1	19.9	19.0	15.6		

Table 3 (continued)

Sociodemographic factors	Total (n = 747)	Risk perception level			Chi-square	ANOVA F / Welch's F
		Low (n = 191)	Medium (n = 306)	High (n = 250)		
Part of a guided tour	2.8	2.6	3.6	2.0		
Part of a school tour	0.5	0.0	1.0	0.4		
Part of a group with humanitarian purposes	4.1	5.2	3.6	4.0		
Likelihood of health-related information seeking before traveling						
Mean	3.76	3.40 [a]	3.58 [a]	4.27 [b]		38.841***

Indicates * p-value ≤ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

[z] Includes non-binary, genderqueer, or genderfluid; transgender female/trans woman; transgender male/trans male

[abc] Means followed by different letters are statistically significant at α = 0.05 found using Bonferroni Post Hoc test for equal variances, and Games-Howell when variances were unequal

Table 4 Travelers' experiences with Zika virus, Chikungunya, and COVID-19 disease broken down by group. Total and per group numbers are expressed in percentages

Experience with MBD infection	Total	Risk perception level			Chi-square	df	Cramer's V
		Low	Med	High			
MBD questionnaire [z]	***(n = 408)***	***(n = 107)***	***(n = 165)***	***(n = 136)***			
Personal experience with MBD					***59.294******	***6***	***0.270***
I am sure I had ZIKV / CHIKV because it was confirmed by a test	12.3	4.7	6.7	25.0			
I think I might have had ZIKV / CHIKV in the past, but I was not tested	12.0	5.6	10.9	18.4			
No, I have not had or was suspected to have had ZIKV / CHIKV	57.4	78.5	61.2	36.0			
Friends or family experience with MBD					***50.204******	***6***	***0.248***
I am sure they had ZIKV / CHIKV because it was confirmed by a test	16.2	9.3	12.1	26.5			
I think they might have had ZIKV / CHIKV in the past, but they were not tested	16.4	4.7	17.6	24.3			
No, they had no suspicion of having ZIKV / CHIKV	54.2	77.6	52.7	37.5			
COVID-19 questionnaire[z]	**(n = 339)**	**(n = 84)**	**(n = 141)**	**(n = 114)**			
Personal experience with COVID-19					***19.533******	***4***	***0.170***
Yes - I have had, or think I may have had COVID-19	57.5	39.3	59.6	68.4			
No - I have had, or think I may have had COVID-19	36.3	54.8	32.6	27.2			
Friends or family experience with COVID-19							
Yes - Friends have had or think they have had COVID-19	72.6	56.0	79.4	75.4	19.888***	4	0.171
Yes - Immediate family have had or think they have had COVID-19	71.1	65.5	75.9	69.3	6.454	4	0.098
Yes - Extended family has had or thinks they have had COVID-19	65.2	60.7	69.5	63.2	5.787	4	0.092

Indicates * p-value ≤ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

[z] Sample numbers differ between MBD and COVID-19 questionnaires

prevent mosquito bites (3 for CHIKV, and 13 for ZIKV). The actions with a higher agreement in terms of perceived effectiveness to prevent transmission were using long sleeves and pants outdoors ($\bar{x}$ = 3.92), followed by using repellents outdoors ($\bar{x}$ = 3.80). The belief that mosquito bites cannot be prevented had the lowest mean scores ($\bar{x}$ = 3.33). All the actions were significantly different between groups, as well as the belief that mosquito bites cannot be prevented. According to the post hoc tests, the high RP group differed significantly from the other two groups, whereas the low and mid RP groups were more alike. The high RP group reported the highest perceived efficacy for all actions, as well as the highest agreement that mosquito bites cannot be prevented, which might seem contradictory (Table 5).

Respondents to the COVID-19 questionnaire also showed high adoption of protective measures, as only 15 of the 339 respondents mentioned that they did not adopt any action to prevent an infection. Maintaining social distancing ($\bar{x}$ = 3.92) and wearing a mask indoors ($\bar{x}$ = 3.87) were the two actions that had the highest agreement for perceived efficacy. The perceived effectiveness towards all the preventive actions was significantly different between groups, as well as the belief that a COVID-19 infection cannot be prevented. According to the post-hoc tests, the low RP group had the lowest mean scores for all the actions and was significantly different in all cases from the high RP group, which had the highest mean scores. The high RP group was different than the other two groups in the belief that a COVID-19 infection

Table 5 Travelers' perceived efficacy towards actions to prevent transmission of mosquito-borne diseases and COVID-19 broken down by group. Total and per group numbers show the mean, on a 5-point likert scale (1 = strongly disagree to 5 = strongly agree)

	Total	Risk perception level			Levene Stat (sig)	ANOVA F / Welch's F
		Low	Medium	High		
MBD questionnaire [z]	*(n = 408)*	*(n = 107)*	*(n = 165)*	*(n = 136)*		
Using ______ is an effective way to prevent MBD disease transmission						
Insecticides or repellents outdoors	3.80	3.65 [a]	3.53 [a]	4.25 [b]	2.407 (0.091)	20.156***
Bed or mosquito nets indoors	3.77	3.65 [a]	3.60 [a]	4.07 [b]	3.999 (0.019)	9.890***
Window or screen doors	3.72	3.69 [a]	3.55 [a, b]	3.94 [b]	1.883 (0.153)	4.560*
Insecticides or spatial repellents indoors	3.72	3.55 [a]	3.58 [a]	4.01 [b]	5.114 (0.006)	8.129***
Long sleeves and pants outdoors	3.92	3.80 [a]	3.78 [a]	4.20 [b]	0.000 (1.000)	7.176**
Lack of efficacy						
I believe that mosquito bites cannot be prevented	3.33	2.96 [a]	3.25 [a]	3.70 [b]	1.624 (0.198)	11.129***
COVID-19 questionnaire[z]	**(*n* = 339)**	**(*n* = 84)**	**(*n* = 141)**	**(*n* = 114)**		
_____ is an effective way to prevent a COVID-19 infection						
Wearing a mask outdoors	3.65	2.94 [a]	3.50 [b]	4.36 [c]	14.747 (0.000)	45.999***
Wearing a mask indoors	3.87	3.38 [a]	3.85 [b]	4.25 [c]	11.373 (0.000)	16.499***
Maintaining social distancing outdoors	3.78	3.24 [a]	3.77 [b]	4.19 [c]	14.242 (0.000)	17.624***
Maintaining social distancing indoors	3.92	3.54 [a]	3.89 [a]	4.25 [b]	9.133 (0.000)	10.282***
Getting the full dose of the vaccine	3.80	3.21 [a]	3.89 [b]	4.13 [b]	13.706 (0.000)	11.617***
Lack of efficacy						
I believe that an infection of COVID-19 cannot be prevented	3.14	2.63 [a]	3.02 [a]	3.65 [b]	1.455 (0.235)	16.629***

Indicates *p-value ≤ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

[abc] Means followed by different letters are statistically significant at α = 0.05 found using Bonferroni Post Hoc test for equal variances, and Games-Howell when variances were unequal

[z] Sample numbers differ between MBD and COVID-19 questionnaires

Table 6 Past changes in travel plans due to Zika virus, Chikungunya, and COVID-19 outbreaks in the destination, broken down by group. Total and per group numbers are expressed in percentages

Changes in travel plans due to:	Total	Risk perception level			Chi-square	df	Cramer's V
		Low	Med	High			
ZIKV outbreaks[z]	***n = 408***	***n = 107***	***n = 165***	***n = 136***	***41.678****	***2***	***0.320***
I have not changed plans	38.5	58.9	38.2	19.1			
I made one or more changes in the plans	61.3	40.2	58.8	80.9			
CHIKV outbreaks[z]	***n = 408***	***n = 107***	***n = 165***	***n = 136***	***47.215****	***2***	***0.341***
I have not changed plans	40.0	61.7	43.0	19.1			
I made one or more changes in the plans	59.8	37.4	57.0	80.9			
COVID-19 risk of infection[z]	***n = 747***	***n = 191***	***n = 306***	***n = 250***	***43.899****	***2***	***0.243***
I have not changed plans	43.0	58.1	46.1	27.6			
I made one or more changes in the plans	56.8	41.4	53.6	72.4			

Indicates * p-value ≤ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

[z] Sample numbers differ between MBD and COVID-19 questionnaires

cannot be prevented, showing a higher degree of agreement (Table 5).

Travel decision-making

Chi-squared analysis showed a significant difference between groups regarding participants' changes in past travel plans to Latin American countries due to ZIKV outbreaks, CHIKV outbreaks, and COVID-19 increased cases in the destination. The risk that triggered changes in a higher percentage of respondents was ZIKV outbreaks (61.3%). Most of the mid and high RP groups, over 50% and 70% respectively, reported having made one or more changes in their travel plans (e.g., canceled travel plans, changed travel dates, location, activity or mode) as a response to an increased risk of the three diseases in the destination. On the contrary, most of the low RP group, around two-thirds, reported not having changed plans as in response to the three diseases (Table 6).

When asked about the likelihood of avoiding traveling to Latin American countries currently and in the next

Table 7 Travelers' likelihood of future travel avoidance broken down by cluster. Numbers for the clusters show the mean (5-point likert scale, 1 = extremely unlikely to 5 = extremely likely that I would avoid international travel)

Likelihood of avoiding future travel due to ____ in the destination	Total sample ($n = 747$)	Risk perception level			Levene Stat (sig)	ANOVA F / Welch F
		Low ($n = 191$)	Medium ($n = 306$)	High ($n = 250$)		
Zika virus outbreaks	3.37	2.98 [a]	3.23 [a]	3.84 [b]	4.836 (0.008)	26.396***
Chikungunya outbreaks	3.33	2.79 [a]	3.21 [b]	3.90 [c]	4.727 (0.009)	46.531***
Dengue outbreaks	3.44	2.96 [a]	3.37 [b]	3.89 [c]	10.069 (0.000)	32.783***
COVID-19 increased cases	3.44	2.93 [a]	3.36 [b]	3.92 [c]	12.789 (0.000)	38.418***
Ebola outbreaks	3.70	3.44 [a]	3.59 [a]	4.04 [b]	26.479 (0.000)	15.268***
Disaster (natural)	3.73	3.46 [a]	3.63 [a]	4.07 [b]	20.118 (0.000)	15.977***
Political instability	3.62	3.47 [a]	3.46 [a]	3.93 [b]	9.233 (0.000)	12.794*
Petty crime increase	3.43	3.19 [a]	3.26 [a]	3.83 [b]	1.716 (0.181)	21.845***

Indicates * p-value ≤ 0.05, ** p-value ≤ 0.01, *** p-value ≤ 0.001

[abc] Means followed by different letters are statistically significant at α = 0.05 found using Bonferroni Post Hoc test for equal variances, and Games-Howell when variances were unequal

five years, there was a significant difference between all groups, although the responses slightly varied depending on the type of risk listed. Overall, a natural disaster in the destination ($\bar{x}$ = 3.73) was the risk with the highest travel avoidance level mean score, followed by Ebola outbreak ($\bar{x}$ = 3.70), and political instability ($\bar{x}$ = 3.62). When comparing groups, the post-hoc tests showed that the low and high RP groups were always different, while there was some overlap in certain risks between the low and mid RP groups. For all the risks, the high RP group leaned towards a higher likelihood of future travel avoidance (Table 7).

Discussion

This study aimed to compare the characteristics, preferences, and behaviors of international travelers who visited selected destinations in Latin America, based on their perception of risk when facing Zika virus, chikungunya, and COVID-19. Assessing and understanding travelers' risk perception is a complex multidimensional effort, as there is no standardized measure and it has been approached in a variety of ways [25, 38, 52]. We utilized constructs from the Health Belief Model (HBM), as this model has been widely used to understand the perceptions and the adoption, or lack of adoption, of preventive behaviors associated with a variety of health-related issues [53, 54]. Better understanding individual travelers is relevant as the success of identification, prevention, control, and treatment strategies partially depends on individual human behavior, especially when a disease is new [39], and those individual behaviors can also benefit or harm a tourism destination. Thus, our findings can serve to inform future management and mitigation strategies related to international tourism and infectious diseases, from both the travel medicine and the tourism destination management perspectives.

The results showed that the three RP groups were significantly different for most of the sociodemographic characteristics, including gender, age, education level, annual household income, and politics. There is consensus in previous studies that sociodemographic factors influence risk perceptions. Regarding gender, our finding of having more males in the high RP group contradicts other studies, as often males have been associated with having lower RP across different risks [55]. In a study conducted to assess RP of COVID-19 in ten different countries at the beginning of the pandemic, gender was the only sociodemographic factor showing some significant predictive importance for RP, and males displayed lower risk perceptions than females [29]. However, it might depend on the risk, as one study found a higher RP for male travelers for risks like malaria, mosquitoes, and rabies [56], while another one found that males perceived less concern than females towards health-related risks and encountering strange food when traveling internationally [57].

Regarding age, this same study found significant differences between age only for risks like terrorist attacks and STIs (sexually transmitted infections), with older participants (> 40 years) having a higher RP for the former one and younger participants for the latter one [56]. Another study found that international travelers who were male and older reported being more unlikely to change their travel plans if facing diverse risks, like infectious diseases, terrorist attacks, or natural disasters in their destination [58]. A study conducted to assess Australians' level of concern and likelihood of canceling traveling plans during an H1N1 outbreak found that respondents with a higher income and higher education level showed a lower concern about the disease when traveling and younger respondents were less likely to cancel travel plans [59]. Although many studies have focused on sociodemographics, Olofsson and Rashid (2011) propose that the RP might not be explained by these factors per se, but by how each of them situates in their own social context, specifically in relation to privilege and inequality [60].

Regarding travel preferences, in our findings only the main purpose of travel showed significant differences across risk RP level groups. Although we did not find significant differences across the segments based on the country they traveled to, previous studies have found that travelers have different RP towards different travel destinations [56, 58]. We found differences between RP groups regarding health information seeking behavior before traveling, which aligns with what a systematic review examining 56 studies found. In this case, the predominant reason found across studies for not seeking pre-travel advice nor complying with some of the suggested protective measures was the lack of perceived risk, which was even more relevant than cost or other barriers. This gap between knowledge and perceptions was found across individuals with different travel purposes, including business, visiting friends and relatives, military personnel, and humanitarian workers [61]. Furthermore, we found differences across the RP groups according to their past direct experience with a disease. Overall, a higher percentage of people who had experienced an infection with either MBD or COVID-19 tended to have a higher level of risk perception, which aligns with what previous studies have found for different diseases [29].

Our findings showed that the vast majority of participants (above 95%) reported having adopted one or more health preventive behaviors to protect themselves from both MBD and COVID-19 infection during travel. However, the three risk perception segments identified showed significant differences associated with perceived response efficacy. Mainly, the segment with the highest risk perception level showed higher efficacy perceptions for all the protective actions to prevent MBDs and COVID-19. A study conducted to better understand the risk perceptions and use of repellents to avoid chikungunya in a population of US resident tourists who visited Caribbean destinations found that individuals with higher perceived response efficacy, as well as higher self-efficacy, had a higher likelihood of using insect repellent as a protective action [49]. A study conducted with Australian outbound travelers found that travelers with higher risk perceptions were more likely to adopt a protective behavior. In this case, the risks were diverse, including health risks, crimes, epidemics, and natural disasters; and the protective behaviors included actions like seeking travel and health advice, and purchasing travel insurance [62]. Thus, our findings seem consistent with the idea that a higher RP is related with higher efficacy, potentially preceding the adoption of protective actions.

There was a significant difference between the risk perception levels and the travel avoidance behaviors reported. Regarding changes in past travel plans, the majority in the segment with the highest risk perception reported having made one or more changes, whether due to ZIKV outbreaks, CHIKV outbreaks, and/or COVID-19 risk of infection. This segment also reported a higher likelihood of future travel avoidance due to all the different risks posed in the questionnaire. Although our findings showed that the segment with higher RP tends to have a higher travel avoidance, some studies proposed that in the lack of travel restrictions, individuals will still travel despite being concerned, depending on the severity of the illness [59]. In the case of a survey conducted with Australians, about half of the respondents showed concern about H1N1 when traveling, but only one-third were willing to cancel a trip [59].

The intrinsic characteristics that each risk has (i.e., controllability, dreadfulness), influence how each risk is perceived [24]. In our findings, the risk with a higher likelihood of future travel avoidance across groups was a natural disaster, and among the health-related risks, an Ebola outbreak was rated higher than the other diseases. Fearing a natural disaster could appeal to the controllability characteristics, as it might be perceived as uncontrollable, while Ebola has a higher fatality rate than the others [63]. Interestingly, the mosquito-borne diseases did not rank among the highest risks to avoid future travel, which might be related to the fact that the majority of participants reported having adopted one or more protective actions, or because by being transmitted by a mosquito vector makes them less contagious than other airborne diseases [63]. Kozak et al. (2007) found that, although international travelers were found to be sensitive to any type of risk in a destination, infectious diseases and terrorist acts were the most important reasons to change travel plans, while natural disasters were the least important. Another study conducted with European frequent travelers found that when comparing facing infectious diseases and other risks at the destination like water shortages or forest fires, travelers also identified infectious diseases as the risk most negatively affecting their willingness to visit a destination [64]. Although each risk event might trigger different reactions, our findings suggest that higher risk perceptions relate to a higher likelihood of travel avoidance across diverse risks.

Conclusions and implications

This study contributes to understanding the complexity of international travelers' risk perceptions and behaviors towards emerging diseases. Recognizing the heterogeneity of international travelers can help inform the design and implementation of customized and appropriate strategies to mitigate and manage future epidemics in the tourism industry and travel medicine [65, 66]. From a destination managers' perspective, for example, utilizing concepts related to risk perceptions can shed light on a better understanding of how travelers perceive different diseases, and their characteristics, preferences, and related actions. This information can also be used to tailor specific marketing mix strategies to optimize safety in tourism products and services, and to mitigate risks for travelers [65, 66]. Additionally, considering risk perceptions is relevant as not all the emerging diseases outbreaks trigger obligatory international travel requirements (i.e., vaccination, prophylaxis), therefore, disease prevention and control often relies on individual adoption of protective actions [17]. From a travel medicine perspective, identifying higher risk sociodemographic factors, travel preferences, knowledge and efficacy perceptions, and other barriers that limit the adoption of actions can help public health officials target their education efforts to specific groups [59], aiming to obtain higher compliance and safer international travel practices [67]. Although risk perceptions were found applicable, as the Health Belief Model suggests, there are other factors that play a role in influencing perceptions and behaviors, which should be taken into consideration in the design of public health strategies [68]. Using the concept of efficacy in these strategies is also relevant, as it often precedes the adoption of actions, and needs to be balanced with a certain level of risk perception, so individuals not only fear a disease but adopt preventive actions to reduce an infection and to travel safely [29, 32, 69]. Overall, both the tourism and the public health sectors could benefit from a more integrated and collaborative approach to develop preemptive, preventive, and reactive strategies to address future epidemics. For example, ongoing research efforts using brief surveys (i.e., at airports, at tourism attractions) could serve to generate context specific knowledge to promote safe travel behaviors to prevent and respond to future outbreaks.

Limitations and future research

We found that using constructs from the Health Belief Model was useful for our research purpose; however, there is no standardized method to measure travelers' risk perception. Future studies can be strengthened by using theoretical constructs (i.e., combining complementary models from fields like psychology, anthropology, sociology, communication, or geography), as well as diverse statistical analysis (i.e., regression analysis, structural equation modeling), for a more comprehensive understanding [40]. In this study, we used a cross-sectional and retrospective approach, which provided valuable findings. Given the time gap between when the outbreaks happened and when the surveys were conducted, these findings might have been affected by recall bias due to alterations in the participants' memories towards not too recent events [70, 71]. Future research could longitudinally monitor health risk perceptions, since EIDs are continuously evolving, and travel behavior and risk perceptions are dynamic and change rapidly in response to new circumstances [36]. As in this analysis we are comparing different diseases, we acknowledge that the variability of how they were managed (i.e., mandatory protective measures vs. non-mandatory) could have influenced the respondents' adoption behaviors. However, this might not have significantly affected the results given that the majority of participants reported having adopted one or more preventive measures. Although this study targeted three different countries as tourism destinations, respondents were all US residents. Knowledge about the risk perceptions of international travelers would be greatly enriched with studies including diverse nationalities and cultures, as other cultures may perceive risk differently [58], and factors influencing and predicting risk perceptions vary across countries [29] and affect tourists' decisions [72]. Future research could include more countries or include a quota sampling strategy to ensure that more ethnicities and cultures are represented.

Supplementary Information

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Supplementary Material 1

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Author contributions
Conceptualization: EPR, SDUS, LNR, AC, LNE; data curation: EPR; formal analysis: EPR; funding acquisition: SDUS; investigation: EPR, SDUS; methodology: EPR, SDUS, LNR, AC, LNE; data visualization: EPR, AKC; project administration: SDUS; resources: SDUS; supervision: SDUS; validation: SDUS, AKC, JRS; writing – original draft: EPR; writing- review & editing: EPR, SDUS, LNR, AKC, JRS, AC, LNE.

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Data availability
The datasets used during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Review Board at the University of Maine (2018-06-12). A consent form was included at the beginning of each questionnaire and submitting the responses implied consent. The researchers did not have access to personal identifiable data from respondents, as Qualtrics conducted the data collection.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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