Vaccine: X 13 (2023) 100258

Contents lists available at ScienceDirect

Vaccine: X

journal homepage: www.elsevier.com/locate/jvacx

Zika virus knowledge and vaccine acceptance among undergraduate students in Guayaquil, Ecuador

Madison Searles [a], Ysai Jose Ronquillo Mora [b], Lorena Carlo [c,d], Naveed Heydari [a], Yaa Takyiwaa [a,e], Mercy J Borbor-Cordova [b,f], Christina D Campagna [a,g,*]

[a] Institute for Global Health and Translational Science, State University of New York Upstate Medical University, 505 Irving Avenue Suite 4200, Syracuse, NY, 13210, USA
[b] Facultad de Ingeniería Marítima y Ciencias del Mar, Escuela Superior Politécnica del Litoral, Guayaquil, Ecuador
[c] Department of Health Informatics, School of Health Professions, Rutgers University, Piscataway, NJ, 08854, USA
[d] Facultad de Ingeniería Electricidad y Computación, Escuela Superior Politécnica del Litoral, Guayaquil, Ecuador
[e] College of Medicine, State University of New York Upstate Medical University, 750 East Adams Street, Syracuse, NY, 13210, USA
[f] Pacific International Center for Disaster Risk Reduction (-RRD), ESPOL, Campus Gustavo Galindo Km. 30.5 Vía Perimetral, Guayaquil, Ecuador.
[g] Department of Public Health and Preventive Medicine, State University of New York Upstate Medical University, 750 East Adams Street, Syracuse, NY, 13210, USA

ARTICLE INFO

Article history:
Received 20 January 2022
Received in revised form 17 November 2022
Accepted 27 December 2022
Available online 28 December 2022

Keywords:
Zika virus
Infectious disease
Vaccine acceptability
Vaccine hesitancy

ABSTRACT

Purpose: Zika virus (ZIKV) was declared a Public Health Emergency of International Concern (PHEIC) in 2016. Concerns surrounding the effects of ZIKV persist today and several vaccine candidates are currently in various stages of development worldwide. There is limited research on ZIKV vaccine acceptability worldwide, and little research specific to Latin American countries. This research aims to identify the general beliefs and acceptance of a potential ZIKV vaccine in the undergraduate population at Escuela Superior Politécnica del Litoral (ESPOL) in Guayaquil, Ecuador.

Methods: Between January and November 2019, 429 undergraduate students at ESPOL responded anonymously to a ZIKV vaccine survey. Frequencies, percentages, simple correspondence analysis, and bivariate inferential analyses were conducted using Kendall's tau-b test. Tests explored associations between likelihood of receiving a ZIKV vaccine and demographic, ZIKV information seeking, ZIKV psychosocial variables, and ZIKV information source variables.

Results: Among the eligible participants, 241 (56.2%) were willing to receive a ZIKV vaccine if one was made commercially available. Most students were male (61.5%), age 20–25 (63.3%), and of mixed (Mestizo) race (95.3%). Results provided insight into student's knowledge on ZIKV, revealed television as the most common information source, and found most students were willing to receive a ZIKV vaccine were one to become available. Bivariate results revealed most respondents reported feeling neutral or likely to receive a ZIKV vaccine regardless of their agreeability with ZIKV information seeking behavior and psychosocial variables.

Conclusions: This study provides insight into ZIKV knowledge among ESPOL university students and reveals most respondents obtained ZIKV related information from television. The most common reason for not wanting to receive a hypothetical ZIKV vaccine was vaccine hesitancy. Likelihood of receiving a ZIKV vaccine was associated with several information seeking behavior and psychosocial variables. Public health campaigns should focus on comprehensive ZIKV education efforts in this population.

Introduction

Since 2007 there have been six Public Health Emergencies of International Concern (PHEIC) declared by the World Health Organization (WHO).[1] Among these, the declaration of Zika virus (ZIKV) in 2016 remains the only PHEIC for an arboviral disease. [1] The ZIKV outbreak prompting the WHO's PHEIC declaration began in Brazil and continued to spread to various parts of South America, including Ecuador. The main mode of transmission for ZIKV is through the bite of infected mosquitos although the virus can also be transmitted through sexual contact, blood transfusion, and from mother to child during pregnancy or through breastfeeding. [2] ZIKV is of major concern as it has been linked to serious

* Corresponding author.
E-mail addresses: SearlesM@upstate.edu (M. Searles), yronquil@espol.edu.ec (Y. Jose Ronquillo Mora), lorena.carlo@rutgers.edu (L. Carlo), NaveedHeydari@gmail.com (N. Heydari), takyiwya@gmail.com (Y. Takyiwaa), meborbor@espol.edu.ec (M.J Borbor-Cordova), luponec@upstate.edu (C.D Campagna).

https://doi.org/10.1016/j.jvacx.2022.100258
2590-1362/

neurological health outcomes for all ages. [3] Such concerns include microcephaly in infants and Guillain-Barré syndrome in children and adults, two conditions that can have severe negative impacts on quality of life. [3,4] While the ZIKV PHEIC declaration was only in effect for approximately-nine months, concerns surrounding the effects of ZIKV persist today. [5–7].

As of January 4th, 2018, 6,351 cases of Zika have been identified in Ecuador with 2,397 of those confirmed by Ministry of Health (MOH) laboratories. [8] Additionally, 14 cases of confirmed congenital syndrome associated with Zika have been reported in the country. [8] Mandatory MOH reporting of ZIKV in Ecuador is conducted through a passive surveillance system which is the standard for detecting mosquito borne diseases globally. [9] Passive surveillance systems only account for individuals who become sick with the virus and seek treatment. [10] Because of a high proportion of asymptomatic cases, Zika prevalence counts across the globe are likely underreported and underrepresented in MOH reports. [11] Other factors contributing to underrepresentation of ZIKV prevalence include limited diagnostic testing and reporting capabilities in-country, and non-specific symptoms of the disease that mimic other mosquito-borne illness like dengue and chikungunya. [11] Additionally, previous research on dengue from Ecuador notes that there are high levels of presumptive self-medication and people often delay seeking medical attention. [12].

As highlighted by previous global outbreaks and the recent COVID-19 pandemic, vaccines are vital in preventing and responding to global infectious disease outbreaks. [13,14] Globally, views on vaccines are highly polarized, making it important to allocate resources to effective outreach measures that help promote vaccine acceptance. [15] It is also valuable to understand specific population's general beliefs and acceptance of vaccines so effective public health outreach efforts can be implemented. [14,15] Currently, there is limited research on ZIKV vaccine acceptability worldwide, and little research specific to Latin American (LA) countries. [16] General vaccine acceptability can be influenced by factors such as education level, vaccine knowledge, perceived risk/benefit, health provider trust, and willingness to pay. [16–18] In Ecuador, ZIKV vaccine knowledge and attitudes have been examined but not vaccination interest, while one LA study found high interest in Arbovirus vaccines in a Guatemalan community. [16,19].

Presently, there are no approved commercial vaccines to protect against ZIKV. [5] Without a vaccine the main means of minimizing disease transmission is through prevention methods such as vector control, limiting travel to ZIKV endemic areas, practicing protected sex, and delaying pregnancy. [10] Several vaccine candidates are currently in various stages of development and are being evaluated in clinical trials in the United States and other countries. [5] Recently, the WHO provided a roadmap for vaccine researchers, funders and product developers which outlined a framework to target priority activities and address unmet medical needs related to ZIKV infection. [20] Currently ZIKV vaccine development is aimed primarily at women of reproductive age and pregnant women, the population at risk of the greatest harm from ZIKV infection. [21,22] It is possible that should a vaccine be approved, endemic use of the vaccine as part of routine immunizations would greatly benefit at-risk people living in countries heavily impacted by local transmissions, such as Ecuador and surrounding LA countries. [23,24].

In 2019 the WHO recognized vaccine hesitancy as one of the greatest threats to global health, noting there are many complex logistical barriers and psychosocial, political, and cultural factors contributing to vaccine hesitancy globally. [25] Considering the complicated and unique combination of factors influencing vaccine hesitancy in different communities, efforts to increase vaccine acceptance must be individual and suited to a community's specific needs. [25] There is an urgent need for more research on the unique barriers to vaccine uptake present in middle-income countries such as Ecuador considering historically, this topic has been mainly researched in high-income countries. [25] A recent study on demand for a COVID-19 vaccine in Ecuador found at least 97 % of study participants were willing to receive a COVID-19 vaccine and that perceived probability of being hospitalized due to disease complications was associated with willingness to pay. [26] Results suggest potential for mitigating vaccine hesitancy in this population through education that accurately portrays health risks and other disease information. [26].

Vaccine information source influences people's individual knowledge, beliefs, and attitudes toward vaccines, and ultimately their decision to receive a vaccine or not. [26–28] People who obtain information on infectious diseases from healthcare professionals and scientists have higher vaccine acceptance than those who seek out information from social media sources. [27,29,30] This highlights the importance of providing accurate and readily accessible information on vaccines as a means of increasing perceived acceptability and uptake. [27,29,30] Previous research with pregnant women in LA countries identified the importance of trained healthcare professionals in providing accurate information on vaccines to increase vaccine acceptability. [31] With potential approval of a ZIKV vaccine, it is important to assess ZIKV vaccine knowledge and acceptability in communities at risk for future ZIKV outbreaks.

The ESPOL university student population has been selected for its unique susceptibility to ZIKV and as a part of a research consortium's larger effort to build capacity on vector-borne disease control in Ecuador. [32,33] Geographically, ESPOL university is located in Guayaquil, Ecuador, a ZIKV endemic region where risk for contracting the virus is high. Undergraduate students in general represent an appropriate target population for a ZIKV vaccine due to being at risk for vertical transmission from mother to infant, potential for engaging in risky sexual behaviors that could increase risk of sexual transmission, and a lack of awareness of general risk and transmission. [34–36] Women of reproductive age are also being targeted in ZIKV vaccine development efforts, making their perceptions of ZIKV and a potential vaccine especially valuable. [21,22] Further, ZIKV vaccine acceptance is not known in this population, and a university provides an appropriate setting for potential public health outreach. A comprehensive understanding of vaccine acceptability in the ESPOL university student population will be beneficial for the development of targeted public health messaging, vaccine promotion, and educational interventions.

In this paper, we will describe results from an online survey looking at ZIKV related knowledge, information seeking behavior, vaccine acceptability (were a ZIKV vaccine to become commercially available), information sources, and reasons for not wanting to receive a ZIKV vaccine among students at ESPOL, a large public university. This research aims to answer the following five research questions, 1) What is the general knowledge of ZIKV among ESPOL university students, 2) Where are ESPOL university students obtaining information on ZIKV, 3) What are the reasons ESPOL university student report not wanting to receive a ZIKV vaccine, 4) Are sociodemographic variables, ZIKV information seeking behavior variables, ZIKV psychosocial variables, or ZIKV information source associated with likelihood of receiving a ZIKV vaccine.

Materials and methods

Study design

In 2019 ESPOL university had approximately 9,334 students in science, technology, engineering, and math (STEM) oriented under-

graduate programs. Undergraduate students from entry, intermediate and advanced level classes were invited to participate in the research study to include students of different ages. STEM classes were chosen to obtain responses of students from a variety of disciplines and minimize sampling bias. Professors of selected classes advertised and administered the Zika vaccine survey in paper or online format. As an incentive to complete the survey, a $10 gift card was raffled in each class. Between January 2019 and November 2019, the survey was applied to students in different sessions to increase the sample size. The sessions included part of the second semester of 2018 (January to February of 2019), the first semester of 2019 (May to September 2019), and part of the second semester of 2019 (October to November 2019). Classes were not in session in March and April of 2019. The study applied a convenience sample of 429 undergraduate students at ESPOL who responded to the non-probabilistic survey. The minimum sample size was calculated using the STATS software, considering the total number of ESPOL students, with a 95 % confidence interval (n = 370). Students voluntarily completed the survey online using class lab computers, though some surveys were collected in paper format for classes not held in a lab setting. Using both online and paper surveys maximized the response rate by allowing students in both computer labs and traditional classrooms to participate. Data collected in paper format were entered into the online survey database manually. All survey responses were anonymous. Data were downloaded from the online form for analysis.

Survey and variables

The four-part survey asked students questions on 1) demographics (age, sex, race, academic major, enrollment status, influenza vaccination history, yellow fever vaccine history, pregnancy status, and residency information), 2) ZIKV knowledge scale, 3) ZIKV information seeking behavior and psychosocial variables, and 4) ZIKV vaccine acceptability. Survey responses used as independent variables in the bivariate analyses were classified as follows. Age was categorical (<20, 20–25, or > 25 years). Sex was binary (Male or Female). Race/Ethnicity was categorical (Other Indigenous, Afro-Ecuadorian, Mixed (Mestizo), or White). Academic major was categorical (Social Sciences, Business, Engineering and Mathematics, Computer Science, Biology and Life Science, or Other). Enrollment status was binary (Full-time or Part-time). Influenza and yellow fever vaccination history were categorical (No, I don't know, or Yes). Pregnancy status was categorical (Pregnant or Planning to become pregnant in the next year).

ZIKV knowledge scale responses were categorical (Correct, I don't know, or Incorrect). ZIKV information seeking behavior and psychosocial variables were categorical as they were measured using a 4-point Likert scale (Strongly disagree, Disagree, Agree, Strongly agree). An open-ended question asking where students obtained ZIKV related information was categorized as Television, Community, Social Networks, Health Personnel, or University.

The outcome variable used in the bivariate analyses was ZIKV vaccine acceptability, measured on a 5-point Likert scale with categorical responses (Extremely unlikely, Unlikely, Neutral, Likely, or Extremely likely). If a student selected Extremely unlikely, Unlikely, or Neutral regarding receiving a ZIKV vaccine, they were then asked to select from a provided list one or more reasons for not wanting to obtain the vaccine. Reasons for not wanting the ZIKV vaccine were categorized as: My socio-cultural beliefs do not encourage vaccines, My religious beliefs do not promote vaccines, Vaccines have risks/adverse events, My experience with past vaccination is discouraging, Zika can still infect anybody (both vaccinated and unvaccinated), It is an injection and will cause pain, Others should receive it first to let me see the effect before receiving it myself, I am concerned about the competence of vaccinators, Zika vaccine should not be a top priority now, There is rumor that you can get infected through the vaccine, and Other.

Data analysis

Descriptive analyses included calculating frequencies and percentages for demographic variables, ZIKV knowledge scale variables, ZIKV information sources, and reasons for not wanting to receive a ZIKV vaccine. Bivariate inferential analyses were conducted using simple correspondence analysis and Kendall's tau test to explore what demographic, ZIKV information seeking, ZIKV psychosocial variables, and ZIKV information source variables were associated with likelihood of receiving a ZIKV vaccine. Studies suggest that Kendall's tau has many advantages over Pearson's and Spearman's, for example, a study by Arndt et al. (1999) suggested that when calculating correlations in psychiatric data, the tau adequately controlled for type I errors, was almost as powerful as Pearson's r, provided much tighter confidence intervals, and had a clear interpretation. [37] The response rate was high, likely because the survey was administered face to face. Cases and records with missing data (0.2 % of the sample) were excluded from the bivariate analyses. The dataset contained 429 records and 47 variables. All statistical analyses were conducted in RStudio software version 4.0.2 (2020–06-22) with a 0.05 significance level.

Results

Sample characteristics

As shown in Table 1, out of 429 respondents, most respondents reported being likely to receive a ZIKV vaccine (38.2 %) followed by neutral (33.6 %). For demographic sample characteristics, of all respondents (N = 429) most were 20–25 years old (63.3 %) and male (61.5 %). The most commonly reported race was combined Spaniard and Indigenous American descent known as Mixed (Mestizo) race (95.3 %). The majority of respondents had not received an influenza vaccine (77.2 %) and had received a yellow fever vaccine (48.0 %) within the last year. For academic major, the most commonly reported area of study was engineering and mathematics (71.3 %).

Table 1 also shows that since we compared low and high acceptance, many responses fell into the neutral category. There are also a few notable differences between those who reported being extremely unlikely to receive a ZIKV vaccine and those who reported being highly likely to receive a ZIKV vaccine. First, 0.0 % of those who were > 25 years old reported being extremely unlikely to receive a ZIKV vaccine, while 23.0 % reported being highly likely. For academic major, 6.1 % of those studying business reported they were extremely unlikely, and 36.4 % reported being highly likely to receive a ZIKV vaccine. See Table 1 for more detail.

Zika virus knowledge

Table 2 summarizes questions from the ZIKV Knowledge scale survey that were most commonly answered incorrectly. Survey responses revealed most students had an incomplete understanding of ZIKV characteristics such as contracting the disease, symptoms, populations at risk, potentially associated health conditions, and treatment. Most respondents did not know that females can contract ZIKV through sexual intercourse with an infected male. Participants incorrectly believed bloody diarrhea to be a common symptom and few participants understood ZIKV to be generally mild in adults. The majority of respondents also incorrectly thought ZIKV was mainly a concern for healthcare workers. Most respondents did not know ZIKV is thought to cause

Table 1
Demographic Sample Characteristics by Likelihood of Receiving a Zika Virus Vaccine (n = 429).

	Total n (%)	Extremely unlikely n (%)	Unlikely n (%)	Neutral n (%)	Likely n (%)	Highly likely n (%)
Likelihood of receiving a Zika virus vaccine	429 (100.0)	22 (5.1)	22 (5.1)	144 (33.6)	164 (38.2)	77 (17.9)
Age						
<20	144 (33.6)	5 (3.5)	3 (2.1)	53 (36.8)	61 (42.4)	22 (15.3)
20–25	271 (63.3)	17 (6.3)	19 (7.0)	85 (31.4)	98 (36.2)	52 (19.2)
>25	13 (3.0)	0 (0.0)	0 (0.0)	6 (46.2)	4 (30.8)	3 (23.0)
Sex						
Female	165 (38.5)	10 (6.1)	7 (4.2 %)	57 (34.5)	63 (38.2)	28 (17.0)
Male	264 (61.5)	12 (4.5)	15 (5.7 %)	87 (33.0)	101 (38.3)	49 (18.6)
Race						
Other	3 (0.0)	0 (0.0)	0 (0.0)	1 (33.3)	1 (33.3)	1 (33.3)
Indigenous	2 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)
Afro-Ecuadorean	5 (1.2)	1 (20.0)	0 (0.0)	1 (20.0)	2 (40.0)	1 (20.0)
Mixed (Mestizo)	409 (95.3)	20 (4.9)	22 (5.4)	137 (33.5)	158 (38.6)	72 (17.6)
White	10 (2.3)	1 (10.0)	0 (0.0)	5 (50.0)	1 (10.0)	3 (30.0)
Academic Major						
Social Sciences	41 (9.6)	3 (7.3)	2 (4.9)	13 (31.7)	16 (39.0)	7 (17.1)
Business	33 (7.7)	2 (6.1)	2 (6.1)	9 (27.3)	8 (24.2)	12 (36.4)
Engineering and Mathematics	306 (71.3)	11 (3.6)	17 (5.6)	107 (35.0)	122 (39.9)	49 (16.0)
Computer Science	9 (2.1)	2 (22.2)	0 (0.0)	4 (44.4)	2 (22.2)	1 (11.1)
Biology and Life Science	21 (4.9)	2 (9.5)	1 (4.8)	4 (19.1)	10 (47.6)	4 (19.1)
Other	19 (4.4)	2 (10.5)	0 (0.0)	7 (36.8)	6 (31.6)	4 (21.1)
Influenza vaccination status						
No	331 (77.2)	19 (5.7)	16 (4.8)	114 (34.4)	121 (36.6)	61 (18.4)
I don't know	39 (9.0)	1 (2.6)	3 (7.7)	17 (43.6)	14 (35.9)	4 (10.3)
Yes	59 (13.8)	2 (3.4)	3 (5.1)	13 (22.0)	29 (49.2)	12 (20.3)
Yellow fever vaccination status						
No	75 (17.5)	5 (6.7)	0 (0.0)	24 (32.0)	31 (41.3)	15 (20.0)
I do not know	148 (34.5)	9 (6.1)	11 (7.4)	62 (41.9)	48 (32.4)	18 (12.2)
Yes	206 (48.0)	8 (3.9)	11 (5.3)	58 (28.2)	85 (41.3)	44 (21.4)
Currently pregnant or planning to become pregnant for females						
No	162 (98.8)	9 (5.5)	7 (4.3)	57 (35.2)	63 (38.9)	26 (16.0)
Yes	2 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)

Table 2
ZIKV knowledge scale survey responses.

Question	Answered correctly	Answered incorrectly	Answered do not know
	n(%)	n(%)	n(%)
A person can get Zika virus from eating contaminated food	336 (78.3)	91 (21.2)	2 (0.5)
A person can get Zika virus from infected mosquitos	422 (98.4)	7 (1.6)	0 (0.0)
A woman can get Zika virus from having sexual intercourse with an infected man	122 (28.4)	302 (70.4)	5 (1.2)
Fever is a common symptom of Zika virus	420 (97.9)	9 (2.1)	0 (0.0)
Skin rash is a common symptom of Zika virus	326 (76.0)	100 (23.3)	3 (0.7)
Bloody diarrhea is a common symptom of Zika virus	157 (36.6)	268 (62.5)	4 (0.9)
Zika virus disease is generally mild in adults	55 (12.8)	371 (86.5)	3 (0.7)
Zika virus is mainly a problem for a pregnant woman's unborn child	360 (83.9)	68 (15.9)	1 (0.2)
Zika virus is mainly a problem for healthcare workers	162 (37.8)	266 (62.0)	1 (0.2)
Zika virus is thought to cause birth defects	276 (64.3)	152 (35.4)	1 (0.2)
Zika virus is thought to cause Guillain Barré Syndrome	137 (31.9)	284 (66.2)	8 (1.9)
Zika virus is thought to cause diabetes	407 (94.9)	17 (4.0)	5 (1.2)
Zika virus is spreading throughout South America	387 (90.2)	40 (9.3)	2 (0.5)
There is currently no treatment for Zika virus	135 (31.5)	291 (67.8)	3 (0.7)
There is currently no vaccine available for Zika virus	183 (42.7)	239 (55.7)	7 (1.6)
The best way to prevent Zika virus is to protect you and your family from mosquito bites	405 (94.4)	24 (5.6)	0 (0.0)
One in four people infected with Zika virus has symptoms	241 (56.2)	184 (42.9)	4 (0.9)
The Zika virus is transmitted by the bite of the same mosquito that transmits dengue, chikungunya and yellow fever	303 (70.6)	124 (28.9)	2 (0.5)
In Ecuador there are confirmed cases of congenital syndrome associated with Zika virus	301 (70.7)	121 (28.4)	4 (0.9)

Guillain Barré Syndrome, thought there was a treatment for ZIKV, and believed there was already a vaccine available. Although results are not shown here, knowledge scale survey items were also stratified by gender revealing that both males and females answered the same questions incorrectly.

Zika virus information sources

Fig. 1a shows results of descriptive statistics revealing the three most utilized sources for obtaining ZIKV information among ESPOL university students were television, social networks, and radio.

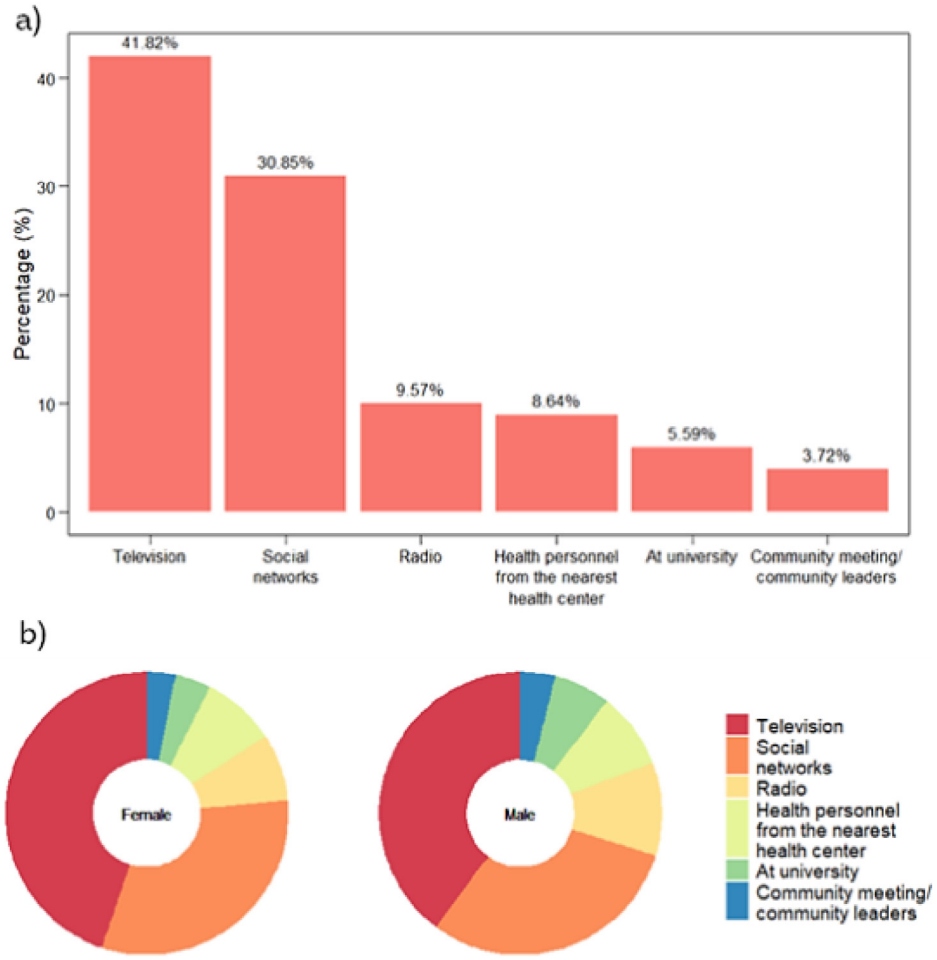

Fig. 1. A)Zika virus information sources reported by ESPOL university students. b) Zika virus information sources stratified by gender.

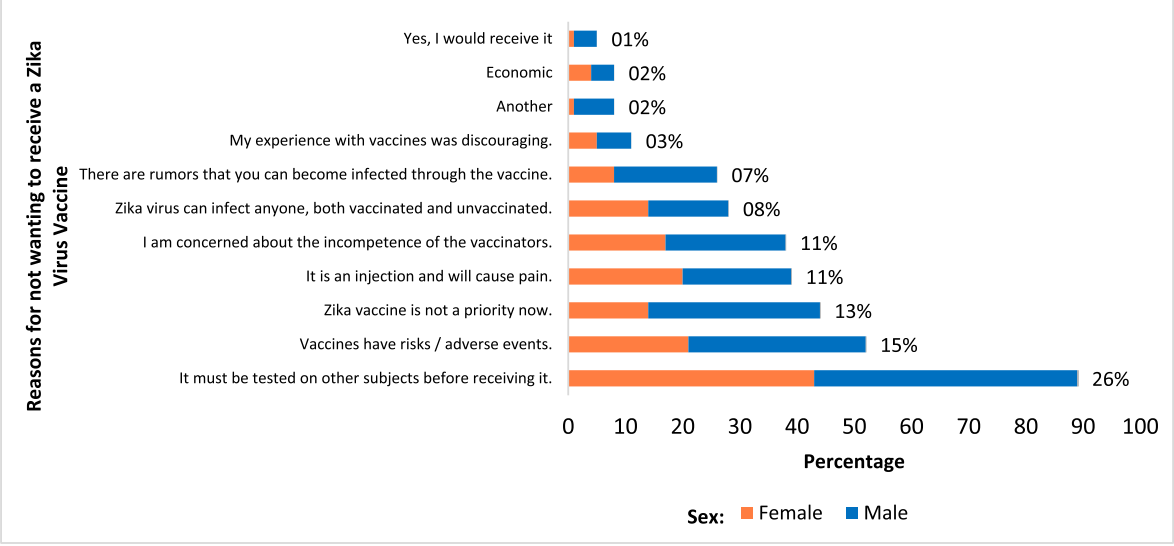

Fig. 2. Reason for not wanting to receive a Zika virus vaccine among ESPOL university students by sex.

Most students (72.0 %) obtained ZIKV information from television and social networks as indicated by the vertical line on the figure. As seen in Fig. 1b, stratifying results by gender reveals females and males generally obtain information from the same two sources, television and social networks.

Reasons for not wanting to receive a Zika virus vaccine

Fig. 2 illustrates participant's responses to a survey question asking to specify why they would not like to receive a ZIKV vaccine. Results indicate the three most common responses were that others should receive the vaccine first, vaccines have risks/adverse events, and ZIKV vaccine is not a priority now. Responses were similar among females and males.

Bivariate correlations

Likelihood of receiving a Zika virus vaccine

Table 3 shows significant results of exploratory bivariate analyses. We explored relationships between sociodemographic variables and likelihood of receiving a ZIKV vaccine. Kendall's tau revealed a correlation between pregnancy status in females and ZIKV vaccine acceptability ($p = 0.032$). As shown in Table 3, bivariate results for the association between information seeking behavior variables and likelihood of receiving the ZIKV vaccine revealed there was a statistically significant relationship between searching for accurate information on ZIKV and likelihood of receiving the ZIKV vaccine ($p < 0.001$). Knowing where to obtain up-to-date information on ZIKV was also significantly associated with likelihood of receiving a ZIKV vaccine ($p = 0.005$). Several psychosocial variables were significantly associated with likelihood of receiving a hypothetical ZIKV vaccine. Bivariate results indicated there was a statistically significant association between likelihood of receiving a ZIKV vaccine and concern about ZIKV ($p = 0.036$), thought of ZIKV inciting fear ($p = 0.014$), feeling personally threatened by ZIKV ($p = 0.011$), feeling the WHO is exaggerating ZIKV issues ($p = 0.032$), and that the Ecuadorian government should invest in treatment options ($p = 0.012$), and develop a ZIKV vaccine ($p < 0.001$).

Discussion

We found there were several misunderstandings among students regarding contracting ZIKV, populations at risk, potentially associated health conditions, and availability of treatment. Some

Table 3
Sample characteristics and significant bivariate results for likelihood of receiving a Zika virus vaccine by demographics and Zika virus information seeking.

Kendall rank correlation							
	Likelihood of receiving a Zika virus vaccine						
	Extremely unlikely n (%)	**Unlikely n (%)**	**Neutral n (%)**	**Likely n (%)**	**Highly likely n (%)**	**Tau statistic n (%)**	***p* value**
Currently pregnant or planning to become pregnant in females						**0.16**	**0.032**
No	9 (5.5)	7 (4.3)	57 (35.2)	63 (38.9)	26 (16.0)		
Yes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)		
I search for new information related to the Zika virus outbreak						**0.15**	**<0.001**
Strongly disagree	11 (10.6)	13 (12.5)	39 (37.5)	24 (23.1)	17 (16.3)		
Disagree	7 (3.4)	4 (1.9)	71 (34.5)	88 (42.7)	36 (17.5)		
Agree	4 (3.8)	4 (3.8)	31 (29.8)	45 (43.3)	20 (19.2)		
Strongly agree	0 (0.0)	1 (6.7)	3 (20.0)	7 (46.7)	4 (26.7)		
I know where to get up to date information about Zika virus						**0.12**	**0.005**
Strongly disagree	4 (14.8)	3 (11.1)	9 (33.3)	6 (22.2)	5 (18.5)		
Disagree	6 (3.6)	8 (4.8)	71 (42.3)	63 (37.5)	20 (11.9)		
Agree	4 (2.2)	7 (3.8)	57 (30.7)	79 (42.5)	39 (21.0)		
Strongly agree	8 (17)	4 (8.5)	7 (14.9)	15 (31.9)	13 (27.7)		
I am concerned about getting Zika virus						**0.09**	**0.036**
Strongly disagree	6 (11.5)	8 (15.4)	12 (23.1)	18 (34.6)	8 (15.4)		
Disagree	2 (1.6)	5 (4.0)	50 (40.3)	51 (41.1)	16 (12.9)		
Agree	7 (4.1)	7 (4.1)	60 (35.1)	64 (37.4)	33 (19.3)		
Strongly agree	7 (8.5)	2 (2.4)	22 (26.8)	31 (37.8)	20 (24.4)		
The thought of getting Zika virus scares me						**0.10**	**0.014**
Strongly disagree	2 (4.9)	5 (12.2)	10 (24.4)	19 (46.3)	5 (12.2)		
Disagree	3 (3.8)	6 (7.6)	34 (43.0)	27 (34.2)	9 (11.4)		
Agree	5 (2.5)	8 (4.0)	75 (37.7)	79 (39.7)	32 (16.1)		
Strongly agree	12 (10.9)	3 (2.7)	25 (22.7)	39 (35.5)	31 (28.2)		
Zika virus poses a threat to me personally						**0.11**	**0.011**
Strongly disagree	4 (10.3)	5 (12.8)	9 (23.1)	16 (41.0)	5 (12.8)		
Disagree	2 (1.7)	9 (7.6)	50 (42.0)	40 (33.6)	18 (15.1)		
Agree	7 (3.5)	7 (3.5)	72 (35.6)	83 (41.1)	33 (16.3)		
Strongly agree	9 (13.0)	1 (1.5)	13 (18.8)	25 (36.2)	21 (30.4)		
Zika virus is not as big of a problem as the World Health Organization (WHO) suggests						**0.09**	**0.032**
Strongly disagree	8 (6.6)	4 (3.3)	27 (22.1)	56 (45.9)	27 (22.1)		
Disagree	10 (4.6)	11 (5.1)	84 (38.5)	79 (36.2)	34 (15.6)		
Agree	2 (2.9)	7 (10.1)	27 (39.1)	25 (36.2)	8 (11.6)		
Strongly agree	2 (10.0)	0 (0.0)	6 (30.0)	4 (20.0)	8 (40.0)		
It is important for the Ecuadorian government to spend money conducting Zika virus research to develop treatments for people who are infected						**0.11**	**0.012**
Strongly disagree	0 (0.0)	1 (14.3)	1 (14.3)	4 (57.1)	1 (14.3)		
Disagree	2 (8.7)	3 (13.0)	8 (34.8)	10 (43.5)	0 (0.0)		
Agree	7 (2.9)	13 (5.5)	90 (37.8)	95 (39.9)	33 (13.9)		
Strongly agree	13 (8.0)	5 (3.1)	45 (28.0)	55 (34.2)	43 (26.7)		
It is important for the Ecuadorian government to spend money conducting Zika virus research to develop a vaccine						**0.15**	**<0.001**
Strongly disagree	1 (12.5)	2 (25.0)	1 (12.5)	2 (25.0)	2 (25.0)		
Disagree	1 (3.5)	7 (24.1)	12 (41.4)	6 (20.7)	3 (10.3)		
Agree	6 (2.6)	9 (3.9)	89 (38.9)	96 (41.9)	29 (12.7)		
Strongly agree	14 (8.6)	4 (2.5)	42 (25.8)	60 (36.8)	43 (26.4)		

experts recommend exploring how ZIKV knowledge varies by gender to better understand the relationship between gender and ZIKV perception, and to promote equitable research and development of vaccines. [38,39] In this study we analyzed the ZIKV knowledge scale survey by gender and found no significant difference between responses by gender. Analysis of ZIKV knowledge scale survey questions revealed an opportunity for improved infectious disease education initiatives among ESPOL university students. To combat misinformation and improve student's understanding of ZIKV, ESPOL university could implement a ZIKV education initiative for students using best practices for prevention and treatment method recommendations such as those outlined by the WHO and Centers for Disease Control and Prevention. [40].

Results also highlight an opportunity to improve sexual education for students. We found most respondents did not know that ZIKV can be sexually transmitted from males who have contracted the disease to females. Previous research indicates university students ages 20–24 who are less knowledgeable in practicing safe sex are more willing to engage in risky sexual behaviors when compared to those who are more knowledgeable. [34] Further, past research in Ecuador suggests young people want to learn more about sexual health and risk reduction. [41] Improved sexual education among ESPOL university students with a focus on practicing protected sex could be a component of a comprehensive effort to decrease the spread of ZIKV in this population. [42].

Information accuracy can vary between sources, leading to the spread of misinformation if people are learning about infectious diseases from substandard sources. [43] Research on the ZIKV outbreak has identified social media specifically as a common source of misinformation. [43,44] We found the majority of participating ESPOL university students reported learning about ZIKV from television and social networks. These findings suggest targeted public health messaging on television and social network platforms could improve engagement among ESPOL university students and increase spread of accurate information on ZIKV in this population. Healthcare professionals, researchers and governments should promote education on the appropriate use of social media and enhance online health literacy capacity. [45].

Student's hesitancy toward a hypothetical ZIKV vaccine mainly resulted from believing others should receive the vaccine first. The second and third most reported reasons for not wanting to receive a ZIKV vaccine were fear of risks/adverse events associated with a novel ZIKV vaccine and concern regarding vaccinator competency. Skepticism of novel vaccines is a timely concern as mistrust of new vaccines has recently been widespread. [46–48] The COVID-19 pandemic has brought to light a need for public health initiatives that promote the public's trust and understanding of the vaccine development process, safety, and effectiveness. [49] This is further supported by research on general vaccine hesitancy identifying concerns about adverse events as a driving factor in vaccine hesitancy. [50,51] Recent research on a novel vaccine in Ecuador found vaccine acceptance was associated with perceived susceptibility, education level, and belief in vaccines. [26,52] Future research should determine how education programs and ZIKV information accessibility can be optimized and suited to the ESPOL university student population to promote ZIKV vaccine acceptance.

When looking at information seeking behavior and psychosocial variables we found most respondents reported being neutral or likely to receive a ZIKV vaccine regardless of their agreeability with ZIKV information seeking behavior and psychosocial variables. Future research could focus on implementing surveys pre- and post-ZIKV education initiatives to ESPOL university students to provide more insight into these associations and to study whether ZIKV education initiatives influence likelihood of receiving a ZIKV vaccine in this population. [53] When considering ZIKV vaccine acceptance more broadly, expanding research to multiple locations across Ecuador could provide additional insight into the association of residence in low versus high disease burden areas with likelihood of receiving a ZIKV vaccine among university students.

This study has several limitations. First, a convenience sampling method was used, potentially contributing to selection bias. It was clear males were overrepresented in the study population due to the unique demographics of ESPOL university. The likelihood of receiving a ZIKV vaccine was hypothetical in nature due to a commercial ZIKV vaccine not yet being available. The likeliness of receiving a ZIKV vaccine could therefore change once a ZIKV vaccine is approved and available to the public. The use of online versus paper surveys was based on course location. Students in laboratory classes completed the online survey while students in non-laboratory classes completed the paper survey. The use of both survey forms was important to increase the sample size; however, some paper surveys were returned with missing responses while students who filled out the online survey were unable to skip questions. When looking at sociodemographic variables, we found females who were pregnant or planning to become pregnant in the next year were significantly more likely to receive a ZIKV vaccine. It's important to acknowledge that only two females in our study reported they were currently pregnant or planning to become pregnant in the next year. Additional research would be needed to better understand this association in our population.

Conclusions

Our research has several key findings. First, ESPOL university students had an incomplete understanding of ZIKV contraction, symptoms, populations at risk, potentially associated health conditions, and treatment. We also learned most students obtain ZIKV information from television. The most common reported reason for vaccine hesitancy among ESPOL students was skepticism of a novel vaccine. Lastly, we learned most respondents reported being neutral or likely to receive a ZIKV vaccine regardless of their agreeability with ZIKV information seeking behavior and psychosocial variables. Moving forward, population specific and accurate information on ZIKV should be provided to encourage the acceptance and uptake of a ZIKV vaccine if one is to become commercially available.

Ethics Statement.

The SUNY Upstate institutional review board (IRB) determined the project (1166606–1) to be exempt from IRB review according to federal regulations (category 2 exemption, research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior) in addition to a local Ecuador IRB Universidad San Francisco de Quito (project number 2017-174E). Informed consent was not required under this exemption.

CRediT authorship contribution statement

Madison Searles: Writing – original draft, Writing – review & editing. **Ysai Jose Ronquillo Mora:** Visualization, Formal analysis, Data curation. **Lorena Carlo:** Project administration, Writing – review & editing. **Naveed Heydari:** Conceptualization, Resources, Methodology. **Yaa Takyiwaa:** Writing – original draft. **Mercy J Borbor-Cordova:** Conceptualization, Resources, Methodology, Validation, Writing – review & editing, Project administration, Supervision. **Christina D Campagna:** Conceptualization, Methodology, Writing – review & editing, Validation, Project administration, Supervision.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Gift cards raffled for student survey participation was funded by the Escuela Superior Politécnica del Litoral (ESPOL).

Funding

Ysai J. Ronquillo was funded by the ESPOL project CIPRRD-03-2021.

References

[1] Wilder-Smith A, Osman S. Public health emergencies of international concern: a historic overview. J Travel Med 2020;27(8). https://doi.org/10.1093/jtm/taaa227. taaa227.
[2] Song BH, Yun SI, Woolley M, Lee YM. Zika virus: History, epidemiology, transmission, and clinical presentation. J Neuroimmunol 2017;308:50–64. https://doi.org/10.1016/j.jneuroim.2017.03.001.
[3] Barbi L, Coelho AVC, de Alencar LCA, Crovella S. Prevalence of Guillain-Barré syndrome among Zika virus infected cases: a systematic review and meta-analysis. Braz J Infect Dis 2018;22(2):137–41. https://doi.org/10.1016/j.bjid.2018.02.005.
[4] Costa PRL de A, Aragão FBA, Serra J do N, Andrade MS, Reis AD, Nascimento M do DSB. Quality Of Life Of Mothers Of Children With Congenital Syndrome Affected By Zika Virus. Rev paul pediatr. 2021;39:e2019231 10.1590/1984-0462/2021/39/2019231.
[5] Poland GA, Ovsyannikova IG, Kennedy RB. Zika vaccine development: current status. Mayo Clin Proc 2019;94(12):2572–86. https://doi.org/10.1016/j.mayocp.2019.05.016.
[6] WHO ends Zika as a Public Health Emergency of International Concern. European Centre for Disease Prevention and Control. Published November 23, 201Accessed November 4, 2021. https://www.ecdc.europa.eu/en/news-events/who-ends-zika-public-health-emergency-international-concern.
[7] Yufika A, Anwar S, Maulana R, et al. Attitude towards Zika among frontline physicians in a dengue-endemic country: a preliminary cross-sectional study in Indonesia. Narra J 2021;1(1). https://doi.org/10.52225/narraj.v1i1.32.
[8] Pan American Health Organization / World Health Organization. Zika cases and congenital syndrome associated with Zika virus reported by countries and territories in the Americas, 2015-2018 Cumulative cases, 2015-2017. Updated as of January 201Washington, D.C.:PAHO/WHO;2017;PAN American Health Organization, www.paho.org, © PAHO/WHO, 2017. Accessed November 29, 2021.
[9] World Health Organization. Global Strategy For Dengue Prevention And Control 2012-2020. 2012. https://apps.who.int/iris/bitstream/handle/10665/75303/9789241504034_eng.pdf. Accessed November 9, 2021.
[10] Piltch-Loeb R, Kraemer J, Lin KW, Stoto MA. Public Health Surveillance for Zika Virus: data interpretation and report validity. Am J Public Health 2018;108(10):1358–62. https://doi.org/10.2105/AJPH.2018.304525.
[11] Vitale M, Lupone C, Kenneson-Adams A, et al. Comparison of active and passive surveillance of dengue in machala, ecuador. In Review 2020. https://doi.org/10.21203/rs.3.rs-17173/v1.
[12] Handel AS, Ayala EB, Borbor-Cordova MJ, et al. Knowledge, attitudes, and practices regarding dengue infection among public sector healthcare providers in Machala, Ecuador. Trop Dis Travel Med Vaccines 2016;2(1):8. https://doi.org/10.1186/s40794-016-0024-y.
[13] Khan M, Adil SF, Alkhathlan HZ, et al. COVID-19: a global challenge with old history, epidemiology and progress so far. Molecules 2020;26(1):39. https://doi.org/10.3390/molecules26010039.
[14] McCloskey B, Endericks T. The rise of Zika infection and microcephaly: what can we learn from a public health emergency? Public Health 2017;150:87–92. https://doi.org/10.1016/j.puhe.2017.05.008.
[15] Kestenbaum LA, Feemster KA. Identifying and addressing vaccine hesitancy. Pediatr Ann 2015;44(4). https://doi.org/10.3928/00904481-20150410-07.
[16] Olson D, Rick AM, Krager S, Lamb M, Asturias EJ. Vaccine demand and willingness-to-pay for arbovirus vaccines: a cross-sectional survey in rural guatemala. Pediatric Infectious Dis J 2018;37(11):1184–9. https://doi.org/10.1097/INF.0000000000002169.
[17] Guzman-Holst A. Barriers to vaccination in Latin America: a systematic literature review. Vaccine 2020;38(3):470–81. https://doi.org/10.1016/j.vaccine.2019.10.088.
[18] Hassan W, Kazmi SK, Tahir MJ, et al. Global acceptance and hesitancy of COVID-19 vaccination: a narrative review. Narra J 2021;1(3). https://doi.org/10.52225/narra.v1i3.57.
[19] L, Casapulla S, Aidoo-Frimpong G, T.B, Basta et al. Zika virus knowledge and attitudes in Ecuador. AIMS Public Health. 2018;5 1 49-63. doi:10.3934/publichealth.2018.1.49.
[20] The World Health Organization. Zika Vaccine Development Technology Roadmap. 2019. https://www.who.int/publications/m/item/zika-vaccine-development-technology-roadmap. Accessed August 20, 2021.
[21] Goldfarb IT, Jaffe E, James K, Lyerly AD. Pregnant women's attitudes toward Zika virus vaccine trial participation. Vaccine 2018;36(45):6711–7. https://doi.org/10.1016/j.vaccine.2018.09.042.
[22] World Health Organization. WHO and experts prioritize vaccines, diagnostics and innovative vector control tools for Zika R&D. https://www.who.int/news/item/09-03-2016-who-and-experts-prioritize-vaccines-diagnostics-and-innovative-vector-control-tools-for-zika-r-d. Accessed August 25, 2021.
[23] E, Check Hayden, The race is on to develop Zika vaccine. Nature. Published online March 28, 2016:nature.2016.19634. doi:10.1038/nature.2016.19634.
[24] Shoukat A, Vilches T, Moghadas SM. Cost-effectiveness of Prophylactic. Emerg Infect Dis 2019;25(12):6.
[25] Attwell K, Betsch C, Dubé E, et al. Increasing vaccine acceptance using evidence-based approaches and policies: Insights from research on behavioural and social determinants presented at the 7th Annual Vaccine Acceptance Meeting. Int J Infect Dis 2021;105:188–93. https://doi.org/10.1016/j.ijid.2021.02.007.
[26] Sarasty O, Carpio CE, Hudson D, Guerrero-Ochoa PA, Borja I. The demand for a COVID-19 vaccine in Ecuador. Vaccine 2020;38(51):8090–8. https://doi.org/10.1016/j.vaccine.2020.11.013.
[27] AM, Jones, SB, Omer, RA, Bednarczyk, NA, Halsey, LH, Moulton, DA, Salmon, Parents' Source of Vaccine Information and Impact on Vaccine Attitudes, Beliefs, and Nonmedical Exemptions. Advances in Preventive Medicine. 2012;2012(Orit):1-8. doi:10.1155/2012/932741.
[28] Park S, Massey PM, Stimpson JP. Primary Source of Information About COVID-19 as a Determinant of Perception of COVID-19 Severity and Vaccine Uptake: source of Information and COVID-19. J Gen Intern Med 2021;36(10):3088–95. https://doi.org/10.1007/s11606-021-07080-1.
[29] Qiao S, Friedman DB, Tam CC, Zeng C, Li X. Vaccine acceptance among college students in south carolina: do information sources and trust in information make a difference? public and global. Health 2020. https://doi.org/10.1101/2020.12.02.20242982.
[30] Ortiz RR, Smith A, Coyne-Beasley T. A systematic literature review to examine the potential for social media to impact HPV vaccine uptake and awareness, knowledge, and attitudes about HPV and HPV vaccination. Human Vaccines & Immunotherapeutics 2019;15(7–8):1465–75. https://doi.org/10.1080/21645515.2019.1581543.
[31] Fauzia Malik A, Belizan M, Gutierrez M, et al. Pregnant women's perspectives about maternal immunization in Latin America. Vaccine 2021;39:B44–9. https://doi.org/10.1016/j.vaccine.2020.09.009.
[32] Stewart-Ibarra AM, Ryan SJ, Kenneson A, et al. The burden of dengue fever and chikungunya in southern coastal ecuador: epidemiology, clinical presentation, and phylogenetics from the first two years of a prospective study. Am J Trop Med Hyg 2018;98(5):1444–59. https://doi.org/10.4269/ajtmh.17-0762.
[33] Stewart-Ibarra AM, Henderson RR, Heydari N, Borbor-Cordova MJ, Fujii Y, Bardosh K. Tracking Aedes aegypti in a hotter, wetter, more urban world Capacity building, disease surveillance and epidemiological labour in Ecuador. In: In: Locating Zika Social Change and Governance in the Age of Mosquito Pandemics. London Imprint Routledge. p. 22.
[34] Reis M, Ramiro L, Gaspar Matos M, Alves DJ. Nationwide survey of contraceptive and sexually transmitted infection knowledge, attitudes and skills of university students in Portugal. Int J Clin Health Psychol 2013;13(2):127–37. https://doi.org/10.1016/S1697-2600(13)70016-4.
[35] Heitzinger K, Thoroughman DA, Porter KA. Knowledge, attitudes, and practices of women of childbearing age testing negative for Zika virus in Kentucky, 2016. Prev Med Rep 2018;10:20–3. https://doi.org/10.1016/j.pmedr.2018.01.002.
[36] Guerra-Reyes L, Fu T, chieh J, Williams D, et al. Knowledge of Zika and perception of risk among sexually-active adults in the United States of America: results from a nationally representative sample. Rev Panam Salud Publica 2018;42:e43. https://doi.org/10.26633/RPSP.2018.43.
[37] Arndt S, Turvey C, Andreasen NC. Correlating and predicting psychiatric symptom ratings: spearman's r versus Kendall's tau correlation. J Psychiatr Res 1999;33(2):97–104. https://doi.org/10.1016/s0022-3956(98)90046-2.
[38] Gurman T, Sara AB, Lorenzo FV, et al. The role of gender in Zika prevention behaviors in the Dominican Republic: findings and programmatic implications from a qualitative study. PLoS Negl Trop Dis 2020;14(3):e0007994.
[39] S, Heidari, T, Goodman, Critical Sex and Gender Considerations for Equitable Research, Development and Delivery of COVID-19 Vaccines. Accessed September 12, 2022. https://www.who.int/publications/m/item/critical-sex-and-gender-considerations-for-equitable-research-development-and-delivery-of-covid-19-vaccines. 2021. Accessed September 12, 2022.
[40] Towers VS, Goldsmith M, Goldsmith P. Zika Virus: patient education recommendations. Adv Neonatal Care 2018;18(5):360–5. https://doi.org/10.1097/ANC.0000000000000548.
[41] Reynolds C, Sutherland MA, Palacios I. Exploring the use of technology for sexual health risk-reduction among ecuadorean adolescents. Ann Glob Health 2019;85(1):57. https://doi.org/10.5334/aogh.35.
[42] K, Sáenz, P, Piñeiros, LF, Gómez, R. Monge, I, Tomo, Encuesta Nacional de Salud Y Nutrición de la población ecuatoriana de cero a 59 años. ENSANUT-ECU 2012. Ministerio de Salud Pública/Instituto Nacional de Estadísticas y Censos.

Quito-Ecuador. 2014. https://ensanut.insp.mx/encuestas/ensanut2012/doctos/informes/ENSANUT2012ResultadosNacionales.pdf. Accessed November 8, 2021.
[43] McBroom K. A Comparison of Zika Virus and COVID-19: Clinical Overview and Public Health Messaging. J Midwifery Womens Health 2021;66(3):334–42. https://doi.org/10.1111/jmwh.13230.
[44] Larson HJ. The biggest pandemic risk? Viral misinformation Nat 2018;562 (7727):309. https://doi.org/10.1038/d41586-018-07034-4.
[45] Hagg E, Dahinten VS, Currie LM. The emerging use of social media for health-related purposes in low and middle-income countries: A scoping review. Int J Med Inf 2018;115:92–105. https://doi.org/10.1016/j.ijmedinf.2018.04.010.
[46] Coustasse A, Kimble C, Maxik K. COVID-19 and Vaccine Hesitancy: a challenge the united states must overcome. J Ambulatory Care Manage 2021;44(1):71–5. https://doi.org/10.1097/JAC.0000000000000360.
[47] Dror AA, Eisenbach N, Taiber S, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. Eur J Epidemiol 2020;35(8):775–9. https://doi.org/10.1007/s10654-020-00671-y.
[48] Palamenghi L, Barello S, Boccia S, Graffigna G. Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy. Eur J Epidemiol 2020;35(8):785–8. https://doi.org/10.1007/s10654-020-00675-8.
[49] Vergara RJD, Sarmiento PJD, Lagman JDN. Building public trust: a response to COVID-19 vaccine hesitancy predicament. J Public Health 2021;43(2):e291–2. https://doi.org/10.1093/pubmed/fdaa282.
[50] Geoghegan S, O'Callaghan KP, Offit PA. Vaccine safety: myths and misinformation. Front Microbiol 2020;11:372. https://doi.org/10.3389/fmicb.2020.00372.
[51] Azarpanah H, Farhadloo M, Vahidov R, Pilote L. Vaccine hesitancy: evidence from an adverse events following immunization database, and the role of cognitive biases. BMC Public Health 2021;21(1):1686. https://doi.org/10.1186/s12889-021-11745-1.
[52] Jaramillo-Monge J, Obimpeh M, Vega B, et al. COVID-19 vaccine acceptance in azuay province, ecuador: a cross-sectional online survey. Vaccines 2021;9 (6):678. https://doi.org/10.3390/vaccines9060678.
[53] Kelkar AH, Blake JA, Cherabuddi K, Cornett H, McKee BL, Cogle CR. Vaccine enthusiasm and hesitancy in cancer patients and the impact of a webinar. Healthcare 2021;9(3):351. https://doi.org/10.3390/healthcare9030351.