Taylor & Francis
Taylor & Francis Group

RESEARCH PAPER

🔓 OPEN ACCESS Check for updates

Uncertainty and unwillingness to receive a COVID-19 vaccine in adults residing in Puerto Rico: Assessment of perceptions, attitudes, and behaviors

Andrea López-Cepero[a], Stephanie Cameron[b], Lyz E. Negrón[c], Vivian Colón-López[d], Uriyoán Colón-Ramos[e], Josiemer Mattei[a], Emma Fernández-Repollet[f], and Cynthia M. Pérez [iD][c]

[a]Department of Nutrition, T.H. Chan School of Public Health, Harvard University, Boston, Massachusetts, USA; [b]Department of Biology, University of Puerto Rico-Cayey, Cayey, Puerto Rico, USA; [c]Department of Biostatistics and Epidemiology, Graduate School of Public Health, Medical Sciences Campus, University of Puerto Rico-Medical Sciences Campus, San Juan, Puerto Rico, USA; [d]Health Services Administration - Evaluation Program, Graduate School of Public Health, University of Puerto Rico-Medical Sciences Campus, San Juan, Puerto Rico, USA; [e]Department of Global Health, Milken Institute School of Public Health, George Washington University, Washington, DC, USA; [f]Department of Pharmacology, School of Medicine, Center for Collaborative Research in Health Disparities, University of Puerto Rico-Medical Sciences Campus, San Juan, Puerto Rico, USA

ABSTRACT

Background: Widespread vaccination against COVID-19 is essential to control the pandemic. Estimates of unwillingness and uncertainty toward COVID-19 vaccination and factors associated with it remain unclear among adults in Puerto Rico (PR).
Objective: To examine factors associated with uncertainty and unwillingness of COVID-19 vaccination among adults in PR.
Methods: The Health Belief Model was used to develop an online survey. Analyses included adjusted logistic regressions (aOR). A total of 1,911 adults completed the survey from December 2020 to February 2021.
Results: Overall, 76.2% were females, 33.7% were aged 50 or older, and 82.7% reported an intent to get vaccinated. Individuals who did not perceive that their chances of getting COVID-19 were high (aOR = 2.94; 95%CI = 2.24–3.86), that getting COVID-19 was not a possibility for them (aOR = 2.86; 95% CI = 2.19–3.74), or unafraid of getting COVID-19 (aOR = 3.80; 95%CI = 2.76–5.23) had higher odds of uncertainty and unwillingness to get vaccinated against COVID-19. Participants who perceived that COVID-19 complications were not serious also had higher odds of uncertainty and unwillingness (aOR = 7.50; 95%CI = 3.94–14.3), whereas those who did not perceive that they would get very sick with COVID-19 had 89% increased odds. Those who agreed that they would only take the vaccine if many individuals took it had higher odds of uncertainty and unwillingness (aOR = 3.32; 95%CI = 2.49–4.43). The most reported reasons for uncertainty and unwillingness toward COVID-19 vaccination were vaccine safety (63.8%), efficacy (49.4%), and novelty (45.5%).
Discussion: Although COVID-19 vaccination intent was high, the study highlights concern over vaccine safety and efficacy that should be addressed by public health campaigns and interventions to enhance vaccine uptake.

Introduction

The coronavirus SARS-CoV-2 has been a global health emergency for more than one year, with approximately 95 million cases and over 2 million deaths reported worldwide.[1] In the United States (US), ethnic disparities in SARS-CoV-2 infections have been documented, with Hispanic communities (15.5%) having more than twice the positivity rate of non-Hispanic White communities (7.1%),[2] and being twice as likely to die from COVID-19 and three times more likely to be hospitalized with the virus.[3] Reasons for these disparities are due, in part, to inequities in healthcare access and exposure risk (i.e., population density) and higher prevalence of chronic conditions among Hispanics (i.e., obesity and type 2 diabetes).[4] In Puerto Rico (PR), as of February 15, 2021, there were 90,429 confirmed COVID-19 cases and 1,920 deaths.[5] Half of the cases are people between 20 and 49 years, whereas 80% of COVID-19 deaths are in individuals 60 years or older.[5]

The control of the COVID-19 pandemic largely relies on acquiring herd immunity, which is estimated to be 70%.[6] Thus, widespread vaccination against COVID-19 is essential to control the pandemic and recover from it. Although there are several vaccines available, there has been skepticism around these novel vaccines. A mixed-methods study in the US reported concerns about the vaccine, including its safety, rigor of testing, novelty, and lack of trust in the government.[7] Studies that have evaluated COVID-19 vaccination intent report rates between 54% to 86% of probable or a definite intent to get vaccinated.[7–14] In PR, a two-phased cross-sectional survey conducted first between November 20th to 23rd, 2020 and then during February 25th-28th, 2021 showed that vaccination intent against COVID-19 was 55% during the first time point and 83% in the second one.[15] However, another poll conducted on December 20 reported that the vast majority (91%) of teachers had an intent

to get vaccinated.[16] The wide range of vaccination intent reported by these studies warrants further investigation.

The Health Belief Model (HBM) was developed to help understand and predict health behaviors, including vaccination.[17] This model consists of several constructs, including perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action (a trigger to engage in the desired health behavior). Several studies have examined HBM constructs and COVID-19 vaccination intent.[11,12,18–20] For example, a study in Malaysia found that the strongest predictors of vaccination intent were perceived benefits and susceptibility.[18] This knowledge can help develop persuasive messages for public health campaigns to help reach the target immunization rate. This information is of utmost importance in PR given the high rates of comorbid chronic conditions in the population.[21] Additionally, at the time of writing, according to the Centers for Disease Control and Prevention, PR has the second-lowest overall COVID-19 vaccination rate nationwide.[22] Thus, given the research gaps and the vulnerability of the PR population, the objectives of this study were to document the uncertainty and unwillingness to receive a COVID-19 vaccine among adults in PR and to understand influencing factors to bolster vaccination intent in this population.

Methods

Study design and participants

A cross-sectional study was performed to collect data through a convenience sampling approach, using an anonymous web-based questionnaire, given that resources and pandemic restrictions limited the implementation island-wide sampling procedure. To calculate the sample size for this survey, we hypothesized that at a 95% confidence interval, 48% of the respondents intend to get vaccinated at a margin of error ± 3%. Thus, the minimum target sample size was found to be around 1065 respondents.

The online questionnaire was developed in Google Forms, and the link was distributed through institutional newsletters, academic groups, organizations, and social network pages. The web-based questionnaire was open to the public for participation from December 15, 2020, to February 15, 2021. Individuals were eligible for study participation if: 1) they were 18 years or older, 2) resided in PR, 3) had access to an electronic device (i.e., computer, phone, or tablet) to complete the online questionnaire, and 4) were able to answer the questionnaire in Spanish.

An online information sheet detailing the study was available for the public as part of the survey's first page. Interested individuals then completed eligibility questions on age and place of residence. If a person was not eligible, the survey notified them that they were ineligible and the platform automatically closed the survey. Eligible individuals proceeded to complete the study questionnaire, after which they received a note encouraging them to share the survey link with their contacts. Participants did not receive compensation for completing the survey. The Institutional Review Board of the University of Puerto Rico-Medical Sciences campus approved the study (IRB protocol number: 6050220).

Study measures

The web-based questionnaire was developed from a literature review. It contained sections from several scales used in previous studies,[7,18] which were translated to Spanish (the dominant language in business, education, and daily life in PR) by the first author, reviewed by an expert group (coauthors), and pilot tested in a small group of men and women (n = 7; men = 1; women = 6) of varying ages (20–58y) for comprehension. The survey was designed to collect data on intent to get vaccinated against COVID-19, and information on socio-demographic, behavioral, and clinical characteristics, health literacy, and beliefs about COVID-19 and vaccination against it.

Intent to get vaccinated against COVID-19

Similar to the study conducted by Fisher and colleagues,[7] vaccination intent was assessed, with the question: "When a vaccine for the coronavirus becomes available, will you get vaccinated?". Response options were "Yes", "No" and "Unsure". A fourth option stating "I already got the vaccine" was added given vaccine availability. Participants who responded "No" and "Unsure" were asked: "What makes you unwilling (or unsure) to get the vaccine?". Response options were abstracted from a previous study and include: Already got COVID-19, Safety, Efficacy, Cost, Lack of health insurance, Do not like needles/shots, Not in a high-risk group, Do not trust what the government says about COVID-19, Novelty of the vaccine, Rigor of testing, Religious beliefs, and Other (which were then specified in a text field).[7] For descriptive purposes, intent to get vaccinated was evaluated with the three possible response options (yes, no, and unsure).

Beliefs about COVID-19 and vaccination against it

HBM constructs were used to assess beliefs about COVID-19 and vaccination against it. As in Wong et al., three items were used to measure perceived COVID-19 susceptibility (i.e., My chance of getting COVID-19 in the next few months is high, I am worried about the likelihood of getting COVID-19, and Getting COVID-19 is currently a possibility for me) and severity (i.e., The complications from contracting COVID-19 are serious, I will be very sick if I get COVID-19, and I am afraid of getting COVID-19), two items for perceived benefits toward COVID-19 vaccination (i.e., Vaccination is a good idea because it makes me feel less worried about catching COVID-19, and Vaccination decreases my chances of getting COVID-19 or its complications) and cues to action for vaccination (i.e., I will only take the COVID-19 vaccine if I was given adequate information about it, and I will only take the COVID-19 vaccine if the vaccine is taken by many in the public), and three items for barriers for COVID-19 vaccination (i.e., I worry the possible side-effects of COVID-19 vaccination would interfere with my usual activities, I am concerned about the efficacy of the COVID-19 vaccination, and I am concerned about the safety of the COVID-19 vaccination). Response options to all items were "Agree" or "Disagree" to reduce participant burden.[18]

COVID-19 experience and socio-demographic, behavioral, and clinical characteristics

Socio-demographic characteristics collected included: age, sex, education, municipality of residence, annual household income, ethnicity, health insurance, smoking, employment status, and marital status. Municipalities were further categorized according to the regions of the PR Department of Health (Arecibo, Bayamón, Caguas, Fajardo, Mayagüez/Aguadilla, Metropolitan, and Ponce). We also collected data on smoking status, having received the influenza vaccine in the previous year, and overall trust in vaccines. Religiosity was assessed with one item that asked about the importance of religion in the person's life, with response options ranging from less important to very important.[23] Health literacy was measured with one item that asked about the person's confidence in filling out medical forms by themselves (range of response options: extremely uncomfortable to extremely comfortable).[24,25] Individuals rated their health status (with responses ranging from poor to excellent) and reported any existing health conditions or chronic diseases. Health conditions were categorized as respiratory, psychiatric, endocrine, cardiovascular, and other (i.e., cancer, autoimmune, rheumatic, neurological, kidney, and liver diseases). For multivariable models, these conditions were collapsed to create a variable that defined the presence of any condition. COVID-19 experience was assessed with two items that asked if the person knows someone who had COVID-19 and if they had to care for someone with the disease.

Statistical analysis

Sample characteristics and HBM constructs were contrasted by COVID-19 vaccination intent status using chi-square tests or Fisher's exact tests, when appropriate. For each HBM construct, a multivariable binary logistic regression was used to assess the odds of unwillingness or uncertainty to get vaccinated against COVID-19 (using the "yes" group as the reference category) due to small frequencies. As in previous studies,[7,18] models were adjusted for age, sex, education, income, health region, influenza vaccine, confidence in filling out medical records, religiosity, and disease history. Multicollinearity between the independent variables was checked with tolerance and variance inflation factors. Model fit was evaluated using the Hosmer and Lemeshow's goodness-of-fit test. Statistical analyses were conducted using STATA for Windows release 15.0 (StataCorp L.P., College Station, Texas).

Results

A total of 2,233 surveys were submitted. Of these, 21 responders declined to participate, 31 did not reside in PR, and 1 was under 18 years old. Of the remaining 2,180 surveys, 235 were eliminated due to duplicates (reporting the same set of responses for all items). Responders who reported being already vaccinated against COVID-19 (n = 34) were further excluded. Individuals who reported being vaccinated, compared to those who were unwilling, were more likely to be employed, gotten the flu vaccine, trusted vaccines, knew someone with COVID-19, and had to care for someone with

COVID-19 (data not shown). The final analytic sample consisted of 1,911 surveys.

Overall, three-fourths of the sample were female, the majority self-reported being Puerto Rican and having health insurance, approximately 65% had less than 50 years, and over half were married or living with their partner (Table 1). Almost half had a graduate degree and received the influenza vaccine in the previous year, and most were from the Metropolitan health region. Three-fourths self-reported having at least one chronic disease. Over 50% reported that religiosity was important for them and were very or extremely comfortable filling out medical forms by themselves. Lastly, approximately 80% knew someone who had COVID-19, but less than 1 in 10 had to care for someone with the disease. Compared to the estimated population of PR in 2019, our sample had a greater proportion of women (76.2% vs. 53.3%) and younger adults (less than 50 years: 66.3% vs. 49.7%) (Supplemental Table 1).

More than 80% of the sample reported an intent to get vaccinated against COVID-19, whereas 6.5% had no intent, and 11% were unsure. Survey responders who reported no intent to get vaccinated or being unsure were more likely to be female, between the ages of 30–39 years, had lower income and did not have a history of any disease (Table 1). Those who had not received the influenza vaccine in the previous year did not trust vaccines and were not extremely comfortable filling out medical forms by themselves reported no intent to get vaccinated or being unsure. Participants from the Fajardo health region had the lowest intent to get vaccinated. Lastly, those with lower perceived health and greater religiosity were more likely to be unsure about getting vaccinated.

Perceived susceptibility and severity to COVID-19 and benefits of vaccination against it were high among survey responders (Table 2). More than 80% reported that vaccines would make them feel less worried about getting COVID-19 and decrease complications of the illness. A substantial proportion reported vaccination barriers, with approximately 40% reporting concerns about the vaccine's safety, efficacy, and side effects. Lastly, the most reported cue to action was receiving enough information about the vaccine. In bivariate analyses, a greater proportion of individuals who had lower perceived susceptibility and severity to COVID-19, and lower perceived benefits of vaccination against it, reported vaccination unwillingness and uncertainty (Table 2). A larger proportion of individuals with barriers to getting vaccinated reported being less likely to get vaccinated. Lastly, individuals who reported only taking the vaccine if given enough information about it or if enough people get it were more likely to be unsure about getting vaccinated.

Table 3 shows the unadjusted and adjusted logistic regression models of HBM constructs associated with unwillingness or uncertainty to get vaccinated. After adjusting for covariates, participants who did not perceive that their chances of getting COVID-19 were high, that getting COVID-19 was not a possibility for them, or were unafraid of getting COVID-19 had about three times the odds of no intent to get vaccinated or being unsure about it. Similarly, compared to those who perceived that they would get very sick from COVID-19, those who perceived that they would not had more than twice the odds of not getting vaccinated or being unsure about it. In addition, participants who were not worried about getting COVID-19 or

Table 1. Sample characteristics by vaccination intent status from an online survey among adults residing in Puerto Rico (n = 1911).

Characteristic	Vaccination intent			
Total sample n = 1911 (%)	Yes n = 1577 (82.5%)	No n = 123 (6.5%)	Unsure n = 211 (11.0%)	p value
Sex[a]				<0.001
Female	1444 (76.2)	1171 (81.1)	100 (6.90)	173 (12.0)
Male	451 (23.8)	399 (88.5)	18 (4.00)	34 (7.50)
Ethnicity[b]				0.345
Puerto Rican	1788 (94.1)	1475 (82.5)	114 (6.40)	199 (11.1)
Other	113 (5.9)	99 (87.6)	6 (5.30)	8 (7.10)
Age group (years)				0.026
18–29	481 (25.1)	408 (84.8)	25 (5.20)	48 (10.0)
30–39	361 (18.9)	277 (76.7)	30 (8.30)	54 (15.0)
40–49	426 (22.3)	349 (81.9)	34 (8.00)	43 (10.1)
≥50	643 (33.7)	543 (84.5)	34 (5.30)	66 (10.2)
Health insurance				0.082
Yes	1847 (96.6)	1530 (82.8)	115 (6.30)	202 (10.9)
No	64 (3.4)	47 (73.4)	8 (12.5)	9 (14.1)
Marital status				0.418
Married/living with partner	1069 (55.9)	878 (82.1)	65 (6.10)	126 (11.8)
Divorced/single/separated/widowed	842 (44.1)	699 (83.0)	58 (6.90)	85 (10.1)
Highest education level				0.147
High school graduate or less	70 (3.7)	57 (81.4)	4 (5.70)	9 (12.9)
Associate degree	168 (8.8)	144 (85.7)	8 (4.80)	16 (9.50)
Some college	101 (5.3)	78 (77.2)	12 (11.9)	11 (10.9)
Undergraduate degree	691 (36.2)	559 (80.9)	44 (6.40)	88 (12.7)
Masters	537 (28.0)	439 (81.8)	36 (6.70)	62 (11.5)
Doctoral degree	344 (18.0)	300 (87.2)	19 (5.50)	25 (7.30)
Employment status				0.682
Working	1256 (65.7)	1042 (83.0)	81 (6.50)	
Not working	655 (34.3)	535 (81.7)	42 (6.40)	78 (11.9)
Annual household income				<0.001
≤$20,000	325 (17.0)	259 (79.7)	25 (7.70)	41 (12.6)
$20,001-$40,000	474 (24.8)	369 (77.8)	36 (7.60)	69 (14.6)
$40,001-$75,000	461 (24.1)	386 (83.7)	28 (6.10)	47 (10.2)
>$75,000	466 (24.4)	423 (90.8)	19 (4.10)	24 (5.20)
Prefer not to answer	185 (9.7)	140 (75.7)	15 (8.10)	30 (16.2)
History of at least one disease				0.045
Yes	1433 (75.0)	1196 (83.5)	81 (5.60)	156 (10.9)
No	478 (25.0)	381 (79.7)	42 (8.80)	55 (11.5)
Current smoker				0.605
Yes	110 (5.8)	87 (79.1)	8 (7.30)	15 (13.6)
No	1801 (94.2)	1490 (82.7)	115 (6.40)	196 (10.9)
Received influenza vaccine in the previous year				<0.001
Yes	966 (50.5)	904 (93.6)	11 (1.10)	51 (5.30)
No	945 (49.5)	655 (71.2)	112 (11.9)	160 (16.9)
Trust in vaccines (general trust)				<0.001
Yes	1739 (91.0)	1540 (88.6)	51 (2.90)	148 (8.50)
No	172 (9.0)	37 (21.5)	72 (41.9)	63 (36.6)
Knows someone who had COVID-19				0.118
Yes	1600 (83.7)	1333 (83.3)	98 (6.10)	169 (10.6)
No	311 (16.3)	244 (78.5)	25 (8.00)	42 (13.5)
Had to care for someone with COVID-19				0.881
Yes	168 (8.8)	141 (83.9)	10 (6.00)	17 (10.1)
No	1743 (91.2)	1436 (82.4)	113 (6.50)	194 (11.1)
Importance of religiosity				0.008
Less important	411 (21.5)	357 (86.8)	27 (6.60)	27 (6.60)
Somewhat important	338 (17.7)	274 (81.1)	23 (6.80)	41 (12.1)
Important	498 (26.1)	418 (83.9)	21 (4.20)	59 (11.9)
Very important	664 (34.7)	528 (79.5)	52 (7.80)	84 (12.7)
Perceived health				<0.001
Poor/regular	183 (9.5)	146 (79.8)	11 (6.00)	26 (14.2)
Good	483 (25.3)	404 (83.6)	17 (3.50)	62 (12.8)
Very good	796 (41.7)	655 (82.3)	47 (5.90)	94 (11.8)
Excellent	449 (23.5)	372 (82.9)	48 (10.7)	29 (6.50)
Confidence filling up medical forms				0.001
Extremely/a little uncomfortable	99 (5.2)	79 (79.8)	8 (8.10)	12 (12.1)
Neutral	404 (21.1)	311 (77.0)	26 (6.40)	67 (16.6)
Very comfortable	544 (28.5)	446 (82.0)	35 (6.40)	63 (11.6)
Extremely comfortable	864 (45.2)	741 (85.8)	54 (6.20)	69 (8.00)
Health region				0.009
Mayagüez/Aguadilla	229 (12.0)	183 (79.9)	22 (9.60)	24 (10.5)
Arecibo	112 (5.9)	88 (78.6)	7 (6.30)	17 (15.1)
Bayamón	289 (15.1)	241 (83.4)	19 (6.60)	29 (10.0)
Metropolitan	667 (34.9)	578 (86.7)	34 (5.10)	55 (8.20)
Fajardo	64 (3.4)	47 (73.4)	6 (9.40)	11 (17.2)

Table 1. (Continued).

Characteristic	Vaccination intent			
Total sample n = 1911 (%)	Yes n = 1577 (82.5%)	No n = 123 (6.5%)	Unsure n = 211 (11.0%)	p value
Caguas	260 (13.6)	203 (78.1)	23 (8.90)	34 (13.0)
Ponce	290 (15.1)	237 (81.7)	12 (4.10)	41 (14.2)

[a]16 participants reported "prefer not to answer". [b]10 had missing data. Row percentages are shown.

Table 2. Bivariate association between health belief model constructs and vaccination intent among adults in Puerto Rico.

Characteristic	Vaccination intent			
Total sample n = 1,911	Yes n = 1,577 (82.5%)	No n = 123 (6.5%)	Unsure n = 211 (11.0%)	p value
Perceived susceptibility				
My chance of getting COVID-19 in the next few months is high	1,094 (57.3)			<0.001
Agree	1,094 (57.3)	977 (89.3)	25 (2.30)	92 (8.40)
Disagree	817 (42.7)	600 (73.4)	98 (12.0)	119 (14.6)
I am worried about the likelihood of getting COVID-19				<0.001
Agree	1,784 (93.3)	1525 (85.5)	70 (3.90)	189 (10.6)
Disagree	127 (6.7)	52 (40.9)	53 (41.7)	22 (17.4)
Getting COVID-19 is currently a possibility for me				<0.001
Agree	1,315 (68.8)	1159 (88.1)	45 (3.40)	111 (8.50)
Disagree	596 (31.2)	418 (70.1)	78 (13.1)	100 (16.8)
What would you think will happen if you get COVID-19				<0.001
I do not think I will get COVID-19	251 (13.1)	183 (72.9)	40 (15.9)	28 (11.2)
I think I will get a mild case	1,002 (52.4)	831 (82.9)	61 (6.10)	110 (11.0)
I think I will get very sick	591 (30.9)	511 (86.5)	18 (3.10)	62 (10.4)
Does not apply (already got COVID-19)	67 (3.5)	52 (77.6)	4 (6.00)	11 (16.4)
Perceived severity				
The complications from contracting COVID-19 are serious				<0.001
Agree	1,854 (97.0)	1554 (83.8)	100 (5.40)	200 (10.8)
Disagree	57 (3.0)	23 (40.4)	23 (40.4)	11 (19.2)
I will be very sick if I get COVID-19				<0.001
Agree	1,212 (63.4)	1043 (86.1)	45 (3.70)	124 (10.2)
Disagree	699 (36.6)	534 (76.4)	78 (11.2)	87 (12.4)
I am afraid of getting COVID-19				<0.001
Agree	1,627 (85.1)	1400 (86.1)	58 (3.60)	169 (10.3)
Disagree	284 (14.7)	177 (62.3)	65 (22.9)	42 (14.8)
Perceived benefits				
Vaccination is a good idea because it makes me feel less worried about catching COVID-19				<0.001
Agree	1,591 (83.3)	1473 (92.6)	18 (1.10)	100 (6.30)
Disagree	320 (16.7)	104 (32.5)	105 (32.8)	111 (34.7)
Vaccination decreases my chances of getting COVID-19 or its complications				<0.001
Agree	1,686 (88.2)	1528 (90.6)	26 (1.60)	132 (7.80)
Disagree	225 (11.8)	49 (21.8)	97 (43.1)	79 (35.1)
Perceived barriers				
I worry the possible side-effects of COVID-19 vaccination would interfere with my usual activities				<0.001
Agree	733 (38.4)	445 (60.7)	104 (14.2)	184 (25.1)
Disagree	1,178 (61.6)	1132 (96.1)	19 (1.60)	27 (2.30)
I am concern about the efficacy of the COVID-19 vaccination				<0.001
Agree	807 (42.2)	516 (63.9)	108 (13.4)	183 (22.7)
Disagree	1,104 (57.8)	1061 (96.1)	15 (1.40)	28 (2.50)
I am concerned about the safety of the COVID-19 vaccination				<0.001
Agree	772 (40.4)	465 (60.2)	112 (14.5)	195 (25.3)
Disagree	1,139 (59.6)	1112 (97.6)	11 (1.00)	16 (1.40)
Cues to action				
I will only take the COVID-19 vaccine if I am given adequate information about it				<0.001
Agree	1,159 (60.7)	940 (81.1)	45 (3.90)	174 (15.0)
Disagree	752 (39.3)	637 (84.7)	78 (10.4)	37 (4.90)
I will only take the COVID-19 vaccine if the vaccine is taken by many in the public				<0.001
Agree	368 (19.3)	236 (64.1)	22 (6.00)	110 (29.9)
Disagree	1,543 (80.7)	1341 (86.8)	101 (6.60)	101 (6.60)

Row percentages are shown.

perceived that its complications were not serious had approximately eight times the odds of unwillingness and uncertainty. In contrast, those who did not perceive that they would get very sick with COVID-19 had 89% increased odds. Those who agreed that they would only take the vaccine if many in the public take it had three times the odds of unwillingness and uncertainty compared to those who did not agree. Lastly, barriers to get vaccinated were also associated with higher odds of unwillingness and uncertainty; however, these estimates are not reliable due to small cell size and wide confidence intervals.

We further explored reasons for unwillingness and uncertainty for getting vaccinated against COVID-19 (Table 4). Amongst the most reported reasons were: (1) vaccine safety (63.8%), (2) vaccine efficacy (49.4%), (3) novelty of the vaccine (45.5%), (4) rigor of vaccine testing (41.6%), and (5) lack of trust in the government (31.4%). Survey responders who had no intent to get vaccinated were more likely to report a lack of trust in the government, religious beliefs, and having a specific health condition or treatment as reasons not to get vaccinated. In contrast, responders who were unsure were more likely to report concerns over vaccine safety as a reason for being hesitant.

Discussion

To our knowledge, this study is the first to use the HBM to understand vaccination intent in adults in PR. Our results indicate that vaccination intent is high in this sample. However, low perceived disease susceptibility and severity and vaccination benefits were associated with unwillingness and uncertainty to get vaccinated. Additionally, vaccination barriers and not having enough information about the vaccine were associated with no intent or unsure to get vaccinated. Lastly, our study documented that vaccine safety, efficacy, novelty, rigor of testing, and government mistrust were the most common reasons for having no intent or unsure to get vaccinated.

The proportion of participants reporting an intent to get vaccinated (82.7%) is within the worldwide range of 54% to 86%.[7-14] Our study had a similar prevalence of vaccination intent as in the second time point (February 2021) of the Centers for Disease Control and Prevention Community Assessment for Public Health Emergency Response (CASPER) conducted in PR, which was reported to be at 83%. However, caution needs to be taken when comparing vaccination intent across studies and time points. As discussed in Kukreti et al, willingness to get vaccinated is influenced by the current status of COVID-19 cases in each country.[26] For example, in Taiwan, willingness to vaccinate during a period without community outbreaks and transmission was considerably low (23% among healthcare workers and 31% among outpatients).[26] Thus, although we cannot compare our results to studies in other countries and at earlier time points in PR, more research is needed to continue monitoring vaccination intent on the island as the pandemic evolves and vaccination becomes more readily available.

Our results of perceived disease susceptibility and severity, vaccination benefits, and barriers being associated with vaccination intent are in agreement with previous studies that have evaluated similar HBM constructs.[11-13,18-20] For example, an online survey performed in a sample of Malaysian adults

(n = 1,159; 66% female) found that those who believed that getting COVID-19 was a possibility (perceived disease susceptibility) were 36% more likely to report an intent to get vaccinated than those who did not.[18] This same study showed that those who believed that COVID-19 complications were serious (perceived severity) were 63% more likely to get vaccinated than those who did not. Similar associations with perceived vaccination benefits and barriers were reported. For instance, believing that vaccination decreases the chances of getting COVID-19 was associated with twice the odds of reporting an intent to get vaccinated. In contrast, concerns about the vaccine's side effects were linked with lower odds of vaccination intent. Other studies in Europe and China found that individuals with lower concerns about the vaccines' efficacy and safety were associated with greater vaccination intent,[12,20] further supporting our findings.

In our sample, several socio-demographic characteristics were linked with vaccination intent. For example, we found that women were more likely than men to report unwillingness or uncertainty toward vaccination. Other studies have also documented similar sex differences.[11,14] Although reasons for this disparity are still unknown, uncertainty on the vaccine's safety for pregnant and breastfeeding women, two reasons reported in our sample, may play a role given that pregnant women were excluded from vaccine trials.[27] Additionally, differences in hesitancy may be due to the higher rates of COVID-19 deaths in men than in women, and to the fact that men may engage more in risky behaviors than women.[28] Nonetheless, research exploring and documenting factors associated with women's COVID-19 vaccine hesitancy is critical to address concerns in this subgroup. As in previous studies,[29] our data also showed that survey responders who were not vaccinated against influenza were less likely to report an intent to get vaccinated. Additionally, our study documented lower vaccination intent among individuals with greater religiosity. This finding is consistent with a recent study that found that religiosity was negatively associated with the intention to vaccinate against COVID-19 and a person's belief that their health depended on external factors (external locus of health control; i.e., God) mediated this association.[29] Lastly, our data showed differences in vaccination intent by annual household income. Individuals with lower income were more likely to report no intent to get vaccinated or being unsure about it. Other studies have also documented similar socioeconomic status differences.[13,14] Israel has already documented lower COVID-19 vaccination rates in areas of low socioeconomic status,[30] citing lack of resources and the novelty of the vaccine as potential reasons for the disparity. In our sample, the Fajardo health region had the lowest vaccination intent. Although more research is needed to understand differences in vaccination intent by health region, individuals from this zone reported lower SES than others, such as the Bayamón and Metropolitan regions. Thus, future research needs to examine reasons for lower vaccination intent and vaccination rates in socioeconomically disadvantaged individuals to avoid exacerbating existing COVID-19 disparities.

In our sample, there were notable concerns about the novel vaccines. Approximately 40% reported being worried about the vaccines' side effects, safety, and efficacy. Our data shows that these were the top reasons for individuals reporting uncertainty and unwillingness to get vaccinated.

Table 3. Association of the Health Belief Model constructs with intent to get vaccinated against COVID-19 among adults in Puerto Rico.

HBM construct	No intent to get vaccinated or unsure			
	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Perceived susceptibility				
My chance of getting COVID-19 in the next few months is high				
Agree	1.00	1.00		
Disagree	3.02 (2.36, 3.87)	<0.001	2.94 (2.24, 3.86)	<0.001
I am worried about the likelihood of getting COVID-19				
Agree	1.00	1.00		
Disagree	8.49 (5.82, 12.4)	<0.001	7.87 (5.09, 12.1)	<0.001
Getting COVID-19 is currently a possibility for me				
Agree	1.00	1.00		
Disagree	3.16 (2.48, 4.02)	<0.001	2.86 (2.19, 3.74)	<0.001
What would you think will happen if you get COVID-19				
I do not think I will get COVID-19	2.37 (1.65, 3.41)	<0.001	2.29 (1.52, 3.44)	<0.001
I think I will get a mild case	1.31 (0.99, 1.75)	0.062	1.28 (0.92, 1.76)	0.142
I think I will get very sick	1.00	1.00		
Does not apply (already got COVID-19)	1.84 (0.99, 3.43)	0.054	1.61 (0.81, 3.23)	0.176
Perceived severity				
The complications from contracting COVID-19 are serious				
Agree	1.00	1.00		
Disagree	7.66 (4.45, 13.2)	<0.001	7.50 (3.94, 14.3)	<0.001
I will be very sick if I get COVID-19				
Agree	1.00	1.00		
Disagree	1.91 (1.50, 2.42)	<0.001	1.89 (1.43, 2.43)	<0.001
I am afraid of getting COVID-19				
Agree	1.00	1.00		
Disagree	3.72 (2.82, 4.92)	<0.001	3.80 (2.76, 5.23)	<0.001
Perceived benefits				
Vaccination is a good idea because it makes me feel less worried about catching COVID-19				
Agree	1.00	1.00		
Disagree	25.9 (19.2, 35.0)	<0.001	23.6 (16.9, 33.0)	<0.001
Vaccination decreases my chances of getting COVID-19 or its complications				
Agree	1.00	1.00		
Disagree	34.7 (24.3, 49.6)	<0.001	28.6 (19.3, 42.3)	<0.001
Perceived barriers				
I worry the possible side-effects of COVID-19 vaccination would interfere with my usual activities				
Agree	15.9 (11.5, 22.2)	<0.001	13.4 (9.5, 19.1)	<0.001
Disagree	1.00	1.00		
I am concern about the efficacy of the COVID-19 vaccination				
Agree	13.9 (9.93, 19.5)	<0.001	12.7 (8.83, 18.1)	<0.001
Disagree	1.00	1.00		
I am concerned about the safety of the COVID-19 vaccination				
Agree	27.2 (18.1, 40.9)	25.5 (16.6, 39.3)	<0.001	
Disagree	1.00	1.00		
Cues to action				
I will only take the COVID-19 vaccine if I was given adequate information about it				
Agree	1.29 (1.01, 1.65)	0.043	1.27 (0.97, 1.66)	0.085
Disagree	1.00	1.00		
I will only take the COVID-19 vaccine if the vaccine is taken by many in the public				
Agree	3.71 (2.86, 4.81)	<0.001	3.32 (2.49, 4.43)	<0.001
Disagree	1.00	1.00		

Intent to get vaccinated against COVID-19 used as the reference group. All models are adjusted for: sex, age, education, income, health region, history of flu vaccine, confidence in filling out medical records, importance of religion, having a disease.

Thus, although vaccination intent was considerably high, reported vaccine acceptance may not directly translate into actual behavior, and there is a need for existing education campaigns to address these concerns. Given that lack of trust in the government was among the top five reasons for not reporting an intent to get vaccinated, education messages and campaigns need to be delivered and implemented by other groups, such as community leaders, public health and professional organizations, and healthcare providers. Nonetheless, formative research is needed to identify effective public health campaign strategies.

Our findings have important public health implications. We showed that HBM constructs were strong predictors of COVID-19 vaccination intent, indicating a useful framework for public health campaigns and interventions to enhance COVID-19 vaccination confidence and uptake in adults in PR. In addition, the documented concerns on the vaccines' safety, efficacy, and side effects highlight the critical need for public health campaigns and interventions that focus on increasing the perceptions of vaccine benefits and decreasing the identified barriers. Differences in vaccination intent by socio-demographic factors underscore the importance of

Table 4. Reasons for being unsure or having no intent to get vaccinated among adults in Puerto Rico.

	Total sample (n = 334) n (%)	Vaccination intent		
		No (n = 123) n (%)	Unsure (n = 211) n (%)	p value
Reason				
Already got COVID-19	16 (4.8)	4 (3.30)	12 (5.70)	0.429
Vaccine safety	213 (63.8)	66 (53.7)	147 (69.7)	0.003
Vaccine efficacy	165 (49.4)	60 (48.8)	105 (49.8)	0.862
Lack of health insurance	4 (1.2)	0 (0.00)	4 (1.90)	0.301
Do not like needles/vaccines	24 (7.2)	7 (5.70)	17 (8.10)	0.419
Not in a high-risk group	40 (12.0)	20 (16.3)	20 (9.50)	0.066
Lack of trust in what the government says about COVID-19	105 (31.4)	54 (43.9)	51 (24.2)	<0.001
Novelty of the vaccine	152 (45.5)	53 (43.1)	99 (46.9)	0.498
Rigor of vaccine testing	139 (41.6)	57 (46.3)	82 (38.9)	0.181
Religious beliefs	15 (4.5)	12 (9.8)	3 (1.40)	0.001
Being pregnant	7 (2.1)	2 (1.60)	5 (2.40)	0.999
Allergies or adverse reaction	23 (6.9)	7 (5.70)	16 (7.60)	0.510
Side effects	18 (5.4)	7 (5.70)	11 (5.20)	0.852
Breastfeeding	10 (3.0)	3 (2.40)	7 (3.30)	0.751
Do not believe in vaccines	4 (1.2)	4 (3.30)	0 (0.00)	0.018
Health conditions or treatment	7 (2.1)	3 (2.40)	4 (1.90)	0.711
Other	15 (4.5)	8 (6.50)	7 (3.30)	0.175

Column percentages are shown.

tailoring public health campaigns' messages to specific subgroups of the population (women and underprivileged individuals). Such interventions need to incorporate non-government groups (i.e., community leaders, public health and professional organizations, and healthcare providers) for delivery and implementation, given the documented mistrust in the government to enhance COVID-19 vaccine uptake in PR.

Our findings need to be taken with certain limitations in mind. Given the pandemic's restrictions, our study relied on an online survey for data collection. This strategy may have introduced selection bias as documented by our large proportion of females, younger individuals, and individuals with higher education and income (a common source of bias occurring with online surveys).[31,32] Thus, our results may not be generalizable to the adult population in PR. Future studies in the island need to expand similar surveys to other population subgroups, including men, older age, and lower socioeconomic status. In addition, at the time the study was conducted there were no validated scales to measure COVID-19 vaccination intent. Currently, there are several validated scales available to measure vaccination intent and drivers of vaccination acceptance that future studies should to incorporate to have a better understanding of willingness to get vaccinated against COVID-19.[33,34] Additionally, the lack of validated scales and instruments in Spanish, and the limited resources and time constraints of the pandemic, did not allowed for standard translation procedures such as backtranslation, testing of the translated measures through cognitive interviews, and proper validation of the measures used. Thus, future studies are needed to test the translated materials and its psychometric properties. Despite these limitations, our study provides essential guidance to address COVID-19 vaccination confidence and uptake in PR. Additionally, our questionnaire was informed by the HBM, which is one of the most commonly used frameworks to understand health behaviors[17] and as such has already been used in other studies evaluating COVID-19 vaccination intent and its predictors.[12,13,18–20]

In conclusion, this study documented COVID-19 vaccination unwillingness and uncertainty in a sample of adults in PR and specific predictors associated with it, including perceived disease susceptibility, vaccination benefits, barriers, and specific cues to action. It also documented significant concerns over vaccine safety and efficacy that education campaigns and future interventions will need to address. Lastly, studies are required in order to understand vaccination intent and its predictors in specific subgroups.

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

ORCID

Cynthia M. Pérez http://orcid.org/0000-0003-2529-7042

References

1. Johns Hopkins University & Medicine. 2021. COVID-19 dashboard by the center for systems science and engineering. [accessed 2021 March 3]. https://coronavirus.jhu.edu/map.html

2. Kaufman H, Niles J, Nash D. Disparities in SARS-CoV-2 positivity rates: associations with race and ethnicity. Popul Health Manag. 2021;24(1):20–26. doi:10.1089/pop.2020.0163.

3. National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases. 2021. Cases, data, and surveillance. centers for disease control and prevention. [accessed 2021 March 3]. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html

4. Mackey K, Ayers CK, Kondo KK, Saha S, Advani SM, Young S, Spencer H, Rusek M, Anderson J, Veazie S, et al. Racial and ethnic disparities in COVID-19-related infections, hospitalizations, and deaths: a systematic review. Ann Intern Med. 2021;174(3):362–73. doi:10.7326/M20-6306.

5. Departamento de Salud de Puerto Rico. 2021. Dashboard COVID-19. [accessed 3 Mar 2021]. http://www.salud.gov.pr/Pages/coronavirus.aspx .

6. Randolph H, Barreiro L. Herd Immunity: understanding COVID-19. Immunity. 2020;52(5):737–41. doi:10.1016/j.immuni.2020.04.012.

7. Fisher K, Bloomstone S, Walder J, Crawford S, Fouayzi H, Mazor K. Attitudes toward a potential SARS-CoV-2 vaccine. Ann Intern Med. 2020;173(12):964–73. doi:10.7326/M20-3569.

8. Gagneux-Brunon A, Detoc M, Bruel S, Tardy B, Rozaire O, Frappe P, Botelho-Nevers E. Intention to get vaccinations against COVID-19 in French healthcare workers during the first pandemic wave: a cross-sectional survey. J Hosp Infect. 2021;108:168–73. doi:10.1016/j.jhin.2020.11.020.

9. Grüner S, Krüger F The intention to be vaccinated against COVID-19: stated preferences before vaccines were available. Applied Economics Letters. 2020; pp.1–5. [accessed 2021 Mar 3]. https://www.tandfonline.com/doi/full/10.1080/13504851.2020.1854445

10. Neumann-Böhme S, Varghese N, Sabat I, Barros P, Brouwer W, van Exel J, Schreyögg J, Stargardt T. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. Eur J Health Econ. 2020;21(7):977–82. doi:10.1007/s10198-020-01208-6.

11. Detoc M, Bruel S, Frappe P, Tardy B, Botelho-Nevers E, Gagneux-Brunon A. Intention to participate in a COVID-19 vaccine clinical trial and to get vaccinated against COVID-19 in France during the pandemic. Vaccine. 2020;38(45):7002–06. doi:10.1016/j.vaccine.2020.09.041.

12. Sherman S, Smith L, Sim J, Amlôt R, Cutts M, Dasch H, Rubin JG, Sevdalis N. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. Hum Vaccin Immunother. 2020;1–10. doi:10.1080/21645515.2020.1846397.

13. Dodd R, Cvejic E, Bonner C, Pickles K, McCaffery K, Ayre J, Batcup C, Copp T, Cornell S, Dakin T, et al. Willingness to vaccinate against COVID-19 in Australia. Lancet Infect Dis. 2021;21(3):318–19. doi:10.1016/S1473-3099(20)30559-4.

14. Daly M, Robinson E Willingness to vaccinate against COVID-19 in the US: longitudinal evidence from a nationally representative sample of adults from April–October 2020. 2020. doi:10.1101/2020.11.27.20239970.

15. Evaluación Comunitaria para la Respuesta a Emergencias de Salud Pública (CASPER). Proyecto CASPER. 2021. [accessed 2021 Mar 3]. https://sites.google.com/view/casperpr/inicio

16. Metro Puerto Rico. Más del 91 % empleados de Educación se vacunarían contra el COVID-19. Metro. 2021. [accessed 2021 Mar 3]. https://www.metro.pr/pr/noticias/2020/12/21/mas-del-91-empleados-de-educacion-se-vacunarian-contra-el-covid-19.html

17. Hochbaum G, Rosenstock I, Kegels S. Health belief model. Washington (DC): U.S. Public Health Service; 1952.

18. Wong L, Alias H, Wong P, Lee H, AbuBakar S. The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay. Hum Vaccin Immunother. 2020;16 (9):2204–14. doi:10.1080/21645515.2020.1790279.

19. Guidry J, Laestadius L, Vraga E, Miller C, Perrin P, Burton C, Ryan M, Fuemmeler BF, Carlyle KE. Willingness to get the COVID-19 vaccine with and without emergency use authorization. Am J Infect Control. 2021;49(2):137–42. doi:10.1016/j.ajic.2020.11.018.

20. Lin Y, Hu Z, Zhao Q, Alias H, Danaee M, Wong LP, Marques ETA. Understanding COVID-19 vaccine demand and hesitancy: a nationwide online survey in China. PLoS Negl Trop Dis. 2020;14(12):e0008961. doi:10.1371/journal.pntd.0008961.

21.. Centers for Disease Control and Prevention. 2019. National center for chronic disease prevention and health promotion, division of population health. BRFSS Prevalence & Trends Data. [accessed 2021 Mar 3]. https://www.cdc.gov/brfss/brfssprevalence/ .

22. Centers for Disease Control and Prevention. COVID Data Tracker. 2021. [accessed 2021 Mar 3]. https://covid.cdc.gov/covid-data-tracker/#vaccinations

23. Institute for Social Research at the University of Michigan. National institute of mental health collaborative psychiatric epidemiology. 2021. [accessed 2021 Mar 3]. https://www.icpsr.umich.edu/web/pages/ICPSR/index.html

24. Wallace L, Rogers E, Roskos S, Holiday D, Brief Report: WB. screening items to identify patients with limited health literacy skills. J Gen Intern Med. 2006;21(8):874–77. doi:10.1111/j.1525-1497.2006.00532.x.

25. Chew LD, Bradley KA, Boyko EJ. Brief questions to identify patients with inadequate health literacy. Fam Med. 2004;36:588–94. [accessed 2021 Mar 3]. https://pubmed.ncbi.nlm.nih.gov/15343421/ .

26. Kukreti S, Lu ML, Lin YH, Strong C, Lin CY, Ko NY, Chen PL, Ko WC. Willingness of Taiwan's healthcare workers and outpatients to vaccinate against COVID-19 during a period without community outbreaks. Vaccines. 2021;9:3. doi:10.3390/vaccines9030246.

27. Osborne-Crowley L There is a lot of distrust': why women in their 30s are hesitant about the Covid vaccine. The Guardian. 2021. [accessed 2021 Mar 3]. https://www.theguardian.com/society/2021/jan/31/there-is-a-lot-of-distrust-why-women-in-their-30s-are-hesitant-about-the-covid-vaccine

28. Griffith DM, Sharma G, Holliday CS, Enyia OK, Valliere M, Semlow AR, Stewart EC, Blumenthal RS. Men and COVID-19: a biopsychosocial approach to understanding sex differences in mortality and recommendations for practice and policy interventions. Prev Chronic Dis. 2020;17:200247. doi:10.5888/pcd17.200247.

29. Olagoke A, Olagoke O, Hughes A. Intention to vaccinate against the novel 2019 coronavirus disease: the role of health locus of control and religiosity. J Relig Health. 2020;60(1):65–80. doi:10.1007/s10943-020-01090-9.

30. Caspi G, Dayan A, Eshal Y, Liverant-Taub S, Twig G, Shalit U, Lewis Y, Shina A, Caspi O. Socioeconomic disparities and COVID-19 vaccination acceptance: experience from Israel. 2021. doi:10.1101/2021.01.28.21250716

31. Jang M, Socioeconomic Status VA. Racial or ethnic differences in participation: web-based survey. JMIR Res Protoc. 2019;8(4): e11865. doi:10.2196/11865.

32. Lefever S, Dal M, Matthíasdóttir Á. Online data collection in academic research: advantages and limitations. Br J Educ Technol. 2007;38(4):574–82. doi:10.1111/j.1467-8535.2006.00638.x.

33. Chen IH, Ahorsu DK, Ko NY, Yen CF, Lin C, Griffiths MD, Pakpour AH. The development and validation of the motors of COVID-19 vaccination acceptance scale: psychometric evaluation among mainland Chinese university students. PsyArXiv. 2021. doi:10.31234/osf.io/abfp6.

34. Yeh YC, Chen IH, Ahorsu DK, Ko NY, Chen KL, Li PC, Yen CF, Lin CY, Griffiths MD, Pakpour AH. Measurement invariance of the drivers of COVID-19 vaccination acceptance scale: comparison between Taiwanese and mainland Chinese-speaking populations. Vaccines. 2021;9(3):297. doi:10.3390/vaccines9030297.