




A National Survey Assessing COVID-19 Vaccine Hesitancy Among Arab Americans

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Abstract

Background Arab Americans' experiences during the COVID-19 pandemic have been largely undocumented. Disparities in vaccine hesitancy between non-Hispanic Whites and minoritized groups have been observed, warranting exploration into the prevalence of COVID-19 vaccine hesitancy among Arab Americans.

Methods Data from the Survey of Arab Health in America (SAHA) ($n=638$), collected between May 2020 and September 2020, were analyzed to determine predictors for vaccine intention among Arab Americans. Chi-squared tests and logistic regression models were performed to determine the relationship between sociodemographic, immigration, acculturation, and COVID-19 risk variables and vaccine intention.

Results More than half (56.7%) of respondents reported an intention to be vaccinated with a COVID-19 vaccine, 35.7% reported uncertainty, and 7.5% reported being unlikely to receive a vaccine. Of those unlikely to receive the vaccine, 72.9% were women and 85.4% reported moderate to high religiosity ($p<0.01$). Arab American women had higher odds of being uncertain of their vaccine intention (OR = 1.68; 95% CI: 1.10, 2.57) or being unlikely to receive the vaccine (OR = 5.00; 95% CI: 1.95, 12.83) than men in this sample.

Discussion Factors such as high religiosity and gender were positively associated with being unlikely to receive a COVID-19 vaccine. Future studies should qualitatively assess the beliefs that undergird vaccine intention among Arab Americans.

Keywords Health disparities · COVID-19 · Vaccination · Arab Americans · Online survey

Introduction

The COVID-19 pandemic has highlighted and worsened many pre-existing health disparities in the USA, such as access to healthcare, mental health, and social support services. Many of these health disparities are rooted in the impacts of systemic racism on racialized or peripheralized populations in the USA [1]. Arab Americans, a growing minoritized population in the USA, have been categorized as White in government forms and data collection instruments; thus, little data currently exists on the impacts of the COVID-19 pandemic in this population [2–6]. Arab American health research has steadily gained interest among public health experts, especially since the early 2000s [7]. Research in this field has primarily relied on convenience samples and has not been able to engage nationally representative samples of Arab Americans. Limited Arab American participation in health research may be rooted in distrust and discomfort resulting from fear of surveillance, threats, and suspicion in post-9/11 America [8, 9].

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Additionally, Arab immigrants are often the subject of harmful discrimination that can lead to generational trauma, poor health outcomes, and a suboptimal quality of life [10, 11–13]. These challenges may pose inequitable public health outcomes and unique barriers to understanding the health needs of Arab Americans in the USA.

While there is a severe lack of data on COVID-19 prevalence among Arab American communities, the social determinants of health for Arab Americans, most prominently xenophobia, underlying comorbidities, and lack of social support, may put them at an increased risk for COVID-19 [14]. Moreover, Arab Americans tend to live in large multigenerational households, which is an established risk factor for contracting COVID-19 [15–18]. The largest Arab American communities are in states that have experienced some of the highest caseloads of COVID-19 in the USA, including California, New York, Michigan, and New Jersey [19]. In Michigan, 2.83% of all COVID-19 cases as of August 6, 2021, were of Arab ethnicity, despite this group only making up 1.55% of the state population [20]. These living conditions all qualify as at-risk COVID-19 indicators recognized by the CDC [21], thus suggesting the potential for increased risk of COVID-19 incidence, severe morbidity, and mortality among Arab Americans. Previous studies found lower influenza vaccine uptake among Arab Americans when compared to non-Hispanic Whites, as well as gender disparities associated with vaccine prevalence within the Arab American population [22, 23]. Other studies have found that COVID-19 vaccine hesitancy is higher among other minoritized groups compared to non-Hispanic Whites, including Black, Hispanic, and Asian racial groups [24, 25]. Additionally, a study in the UK found that, compared to White participants, those of Middle East/East Asian ethnic background were more hesitant about the COVID-19 vaccine [24]. These findings prompt the need for research on the vaccine intentions of Arab Americans during the COVID-19 pandemic.

As part of larger efforts to understand the health needs of Arab Americans in the USA, we conducted a national internet-based survey to assess COVID-19 experiences and vaccine hesitancy among Arab Americans. In the first study of its kind, we describe the predictors for COVID-19 vaccine intention among Arab Americans with a focus on sociodemographics, acculturation, immigration, and COVID-19 risk-related factors.

Methods

Study Population and Data Collection

The data for this analysis emerged from a larger study of health among Arab Americans in the USA, called the Survey

of Arab Health in America (SAHA). SAHA was an online survey administered between May 28, 2020, and September 30, 2020, targeted at Arab American adult participants across the USA. The survey was administered in both Arabic and English using Qualtrics. Informed consent was provided online through Qualtrics software. The SAHA survey had a number of questions about social determinants of health, health status, COVID-19 risk, and COVID-19 vaccine intention. Participants were recruited using social media advertisements on both Facebook and Instagram, through informal networks, such as with national religious and social organizations serving Arab communities, and through word-of-mouth. Participants were eligible if they self-identified as Arab American and were 18 years or older. The study was approved by Boston College's Institutional Review Board (#20.238.01e) and informed consent took place online.

Study Variables

Outcome

The main outcome of interest was COVID-19 vaccine intention. This was assessed with the participants' responses to the following statement: "*If a vaccine becomes available and is recommended for me, I would get it.*" Participants could respond on a Likert scale with options "Strongly agree," "Somewhat agree," "Neither agree nor disagree," "Somewhat disagree," and "Strongly disagree." Individuals who indicated "Strongly or Somewhat agree" were categorized as likely to get the vaccine. Individuals who indicated "Strongly or Somewhat disagree" were categorized as unlikely to get the vaccine. Individuals who selected "Neither agree nor disagree" were categorized as unsure about their intention to be vaccinated.

Predictors

Predictor variables were included based on prior work [23, 26, 27] and were categorized into one of the following groups: sociodemographics, immigration and acculturation related variables, and COVID-19 risk factors. Sociodemographic predictors included age (18–25, 26–34, 35–54, 55+), region of residence (West, Midwest, South, Northeast), education (high school or less, some college/associate's degree, college degree, graduate degree), religion (Christianity, Islam, Other), annual household income (\$0–5 K, \$5–45 K, \$46–99 K, > \$100 K), health insurance status (yes, no/don't know), and religiosity (extremely/very important, slightly/moderately important, not at all important).

Immigration and acculturation variables included participants' place of birth (USA vs. outside of the USA),

participants' parents' place of birth (USA vs. outside of the USA), years living in the USA (0–5, 6–20, and > 20 years), USA citizenship status (citizen vs. non-citizen), Arabic language proficiency (extremely/very good, moderately/slightly/not at all), and English language proficiency (extremely/very good, moderately/slightly/not at all).

COVID-19 risk factors included reporting a COVID-19 infection prior to the survey (yes/suspected, no/tested negative, prefer not to say), having a member of their immediate social environment infected with COVID-19 prior to the survey (yes/suspected, no/tested negative, prefer not to say), degree of adherence to COVID-19 recommendations (very much, a moderate amount, a little/not at all), and the participants' household size (living alone, 2, 3–4, 5, or more people).

Analysis

Descriptive statistics were produced for all Arab Americans with non-missing data on vaccine intention, age, gender, education, insurance, income, employment, citizenship, and religiosity, stratified by COVID-19 vaccine intention. Chi-squared tests were used to assess crude associations between the predictor variables for Arab Americans who would, would not, and were unsure about getting the COVID-19 vaccine when it became available to them. Statistical significance was considered at the $p < 0.05$ level.

The data analysis was completed using SAS software, version 9.4, of the SAS System for Windows (SAS Institute Inc. Cary, NC, USA). Logistic regression analyses were run sequentially using the *glogit* option in PROC LOGISTIC. Odds ratios for two different comparisons were calculated comparing individuals who were likely to get vaccinated to those who were unlikely to get vaccinated and comparing those who were unsure about vaccination to those who were likely to get vaccinated. Model 1 incorporated sociodemographic factors. Model 2 added acculturation and immigration variables to Model 1. Model 3 added COVID-19-related risk factors to Model 1. Model 4 incorporated all risk factors (sociodemographic, acculturation/immigration, and COVID-19 risk factors).

Results

A total of 4,242 individuals clicked on the SAHA survey link and initiated the survey with 1,550 (36.5%) completing 90% or more of the survey questions. A total of 638 individuals were included in this analysis with non-missing data on vaccine intention, age, gender, education, insurance, income, employment, citizenship, and religiosity. Data collection started on May 28, 2020, 50% of participants included in this

analysis completed the survey by July 1 and 75% completed the survey by August 4.

Sample Description

Over half (52.0%) of all respondents were female, most were between the ages of 18 and 25 (35.4%), and only 8.9% of survey participants were over 55 years of age (Table 1). Almost a third (30.4%) reported an annual household income of over \$100,000, and more than a quarter (25.1%) reported an income less than \$5,000.

More than half of respondents (53.1%) were born outside of the USA, and an even larger percentage (87.5%) had parents born outside of the USA. The majority of respondents (47.3%) have lived in the USA for 20 or more years, and 66.9% were US citizens. At the time of the survey, 10.7% of survey respondents had tested positive for COVID-19 or were suspected of having it, while 36.8% reported knowing someone in their immediate social environment who had been infected with COVID-19. Many respondents (33.2%) reported living in a household with five or more people, while only 11.3% reported living alone.

Vaccine Hesitancy and Bivariate Associations with Selected Variables

More than half ($N = 362$, 56.7%) of respondents reported they would likely receive a COVID-19 vaccine when it became available, 35.7% ($N = 228$) were unsure about their vaccine intention, and a small but considerable proportion ($N = 48$, 7.5%) did not intend to receive the vaccine. In bivariate analyses, age, gender, and religiosity were significantly associated with vaccine intention (Table 1). Those between the ages of 35 and 54 comprised 41.7% of those with no intention to receive a COVID-19 vaccine ($p = 0.04$). Women made up a large majority of those unlikely to receive a vaccine (72.9%, $p < 0.01$). Likewise, participants who reported religion as being very or extremely important to them comprised 85.4% of those who were unlikely to receive a vaccine ($p < 0.01$). More than three quarters (77.0%) of the sample had not been infected with COVID-19, and this group comprised 81.3% of those unlikely to receive the vaccine ($p < 0.01$). Those who lived in households of five or more people made up 33.2% of the sample, but comprised 45.8% of those who were unlikely to receive the vaccine ($p < 0.01$).

Model Results

In a logistic regression model adjusting for sociodemographic, immigration/acculturation, and COVID-19 risk variables, Arab American women had higher odds of reporting being unlikely to receive the vaccine compared to men (AOR: 5.00, 95% CI: 1.95, 12.83, Table 2). Those

Table 1 Bivariate associations between predictors and vaccine intention among Arab Americans surveyed between May 2020 and September 2020 in a national survey

	Likely to get vaccinated (<i>n</i> = 362)	Unsure about intention (<i>n</i> = 228)	Unlikely to get vaccinated (<i>n</i> = 48)	Total (<i>n</i> = 638)	<i>p</i> value
Demographics, <i>n</i> (%)					
Age					<i>p</i> = 0.04
18–25	142 (39.2)	72 (31.6)	12 (25.0)	226 (35.4)	
26–34	110 (30.4)	69 (30.3)	14 (29.2)	193 (30.3)	
35–54	78 (21.6)	64 (28.0)	20 (41.7)	162 (25.4)	
55+	32 (8.8)	23 (10.1)	2 (4.1)	57 (8.9)	
Region					<i>p</i> = 0.01
West	124 (43.2)	95 (51.0)	27 (73.0)	246 (48.2)	
Midwest	45 (15.7)	13 (7.0)	2 (5.4)	60 (11.8)	
South	60 (20.9)	42 (22.6)	5 (13.5)	107 (21.0)	
Northeast	58 (20.2)	36 (19.4)	3 (8.1)	97 (19.0)	
Education					<i>p</i> = 0.38
High school or less	81 (22.4)	42 (18.4)	11 (22.9)	134 (21.0)	
Some college or associate's degree	56 (15.5)	45 (19.7)	8 (16.7)	109 (17.1)	
College degree	116 (32.0)	87 (38.2)	17 (35.4)	220 (34.5)	
Graduate degree	109 (30.1)	54 (23.7)	12 (25.0)	175 (27.4)	
Religion					<i>p</i> = 0.19
Christianity	82 (22.7)	69 (30.3)	14 (29.2)	165 (25.9)	
Islam	240 (66.3)	143 (62.7)	30 (62.5)	413 (64.7)	
Other	40 (11.0)	16 (7.0)	4 (8.3)	60 (9.4)	
Gender					<i>p</i> < 0.01
Female	165 (45.6)	132 (57.9)	35 (72.9)	332 (52.0)	
Male	174 (48.0)	90 (39.5)	12 (25.0)	276 (43.3)	
Trans/other	23 (6.4)	6 (2.6)	1 (2.1)	30 (4.7)	
Income					<i>p</i> = 0.59
\$0–5 k	93 (25.7)	53 (23.3)	14 (29.2)	160 (25.1)	
\$5–45 k	76 (21.0)	52 (22.7)	5 (10.4)	133 (20.9)	
\$46–99 k	87 (24.0)	53 (23.3)	11 (22.9)	151 (23.7)	
>/\$100 k	106 (29.3)	70 (30.7)	18 (37.5)	194 (30.3)	
Insurance					<i>p</i> = 0.57
No/don't know	91 (25.1)	65 (28.5)	11 (22.9)	167 (26.2)	
Yes	271 (74.9)	163 (71.5)	37 (77.1)	471 (73.8)	
Religiosity					<i>p</i> < 0.01
Extremely/very important	235 (64.9)	176 (77.1)	41 (85.4)	452 (70.9)	
Slightly/moderately important	88 (24.3)	43 (18.9)	5 (10.4)	136 (21.3)	
Not at all important	39 (10.8)	9 (4.0)	2 (4.2)	50 (7.8)	
Immigration/acclimation, <i>n</i> (%)					
Born in the USA	179 (49.5)	94 (41.2)	26 (54.2)	299 (46.9)	<i>p</i> = 0.09
Parents born in the USA	46 (12.7)	28 (12.3)	6 (12.5)	80 (12.5)	<i>p</i> = 0.99
Years living in the USA					<i>p</i> = 0.50
0–5 years	117 (32.3)	68 (29.8)	13 (27.1)	198 (31.1)	
6–20 years	81 (22.4)	50 (21.9)	7 (14.6)	138 (21.6)	
20+ years	164 (45.3)	110 (48.3)	28 (58.3)	302 (47.3)	
US citizen					<i>p</i> = 0.82
Yes	240 (66.3)	153 (67.1)	34 (70.8)	427 (66.9)	
No/don't know	122 (33.7)	75 (32.9)	14 (29.2)	211 (33.1)	
Arabic language proficiency					<i>p</i> = 0.20
Extremely/very well	275 (76.0)	176 (77.2)	42 (87.5)	493 (77.3)	

Table 1 (continued)

	Likely to get vaccinated (<i>n</i> = 362)	Unsure about intention (<i>n</i> = 228)	Unlikely to get vaccinated (<i>n</i> = 48)	Total (<i>n</i> = 638)	<i>p</i> value
<i>Moderately/slightly/not at all</i>	87 (24.0)	52 (22.8)	6 (12.5)	145 (22.7)	<i>p</i> = 0.71
English language proficiency					
<i>Extremely/very well</i>	269 (74.3)	168 (73.7)	33 (68.8)	470 (73.7)	
<i>Moderately/slightly/not at all</i>	93 (25.7)	60 (26.3)	15 (31.2)	168 (26.3)	
COVID risk, <i>n</i> (%)					
Been infected with COVID					<i>p</i> < 0.01
<i>Yes/suspected</i>	49 (13.5)	12 (5.3)	7 (14.6)	68 (10.7)	
<i>Prefer not to say</i>	51 (14.1)	26 (11.4)	2 (4.2)	79 (12.3)	
<i>No/tested negative</i>	262 (72.4)	190 (83.3)	39 (81.2)	491 (77.0)	
Family member infected with COVID					<i>p</i> = 0.59
<i>Yes/suspected</i>	141 (39.0)	75 (32.9)	19 (39.6)	235 (36.8)	
<i>Prefer not to say</i>	21 (5.8)	12 (5.3)	2 (4.2)	35 (5.5)	
<i>No/tested negative</i>	200 (55.2)	141 (61.8)	27 (56.2)	368 (57.7)	
Follow COVID-19 recommendations					<i>p</i> < 0.01
<i>A little/not at all</i>	12 (6.9)	18 (17.5)	6 (31.6)	36 (12.1)	
<i>A moderate amount</i>	32 (18.2)	37 (35.9)	5 (26.3)	74 (24.9)	
<i>Very much so</i>	131 (74.9)	48 (46.6)	8 (42.1)	187 (63.0)	
Household size					<i>p</i> < 0.01
<i>Living alone</i>	54 (14.9)	15 (6.6)	3 (6.3)	72 (11.3)	
<i>2 people</i>	87 (24.1)	41 (18.0)	2 (4.2)	130 (20.4)	
<i>3–4 people</i>	112 (30.9)	91 (39.9)	21 (43.7)	224 (35.1)	
<i>5 or more</i>	109 (30.1)	81 (35.5)	22 (45.8)	212 (33.2)	

between the ages of 35 and 54 had higher odds of being unlikely to receive the vaccine when compared to those between the ages of 18 and 25 (AOR: 3.36; 95% CI: 1.34, 8.39). Arab Americans living in a household of two people had higher odds of being unlikely to receive the vaccine when compared to those living in a household of 5 or more people (AOR: 0.12, 95% CI: 0.03, 0.57).

Arab American women had twice the odds of reporting being unsure about receiving the COVID-19 vaccine compared to Arab American men (OR = 1.68; 95% CI: 1.10, 2.57, Table 3). Religiosity, previous COVID-19 infection, and household size were also significant predictors for vaccine hesitancy (Table 3). Participants who identified as being not at all religious were less likely to be unsure about the vaccine compared to those who identified as very or extremely religious (OR = 0.35; 95% CI: 0.16, 0.78). Additionally, respondents who had tested positive for COVID-19 or were suspected to have been infected were less likely to be unsure about their vaccine intention (OR = 0.40; 95% CI: 0.19, 0.83) when compared to those who had never been infected. Lastly, those living alone had lower odds of being unsure about receiving the COVID vaccine compared to participants living in households of five or more people (OR = 0.50, 95% CI = 0.25, 0.99).

Discussion

To our knowledge, this study is the first to explore COVID-19 vaccine intentions among Arab Americans. We used data from SAHA (conducted in the summer of 2020), to elucidate the predictors for COVID-19 vaccine intention among Arab Americans nationally. High religiosity, lack of previous COVID-19 infection, low annual household income, and being 35–54 years of age were positively associated with being unlikely to receive a COVID-19 vaccine. Arab American women had higher odds of being unsure about their COVID-19 vaccine intention and being unlikely to receive the COVID-19 vaccine.

Arab Americans who previously tested positive for COVID-19 or who had a suspected prior infection were less likely to be unsure about receiving the COVID-19 vaccine. No significant relationship was found between previous COVID-19 infection and intention to receive the COVID-19 vaccine in a survey conducted in June 2020 among a general population of US adults [27]. In this prior study, participants attributed their COVID-19 vaccine intention to (1) a preference to achieving COVID-19 immunity through previous infection and (2) already

Table 2 Logistic regression models comparing Arab Americans unlikely to get vaccinated for COVID-19 vs. those likely to get vaccinated for COVID-19 in a sample of Arab Americans surveyed nationally between May and September 2020

Odds ratio (95% CI)	Model 1: Demographics	Model 2: Model 1 + immigration/acculturation	Model 3: Model 1 + COVID risk	Model 4: Model 1 + immigration/acculturation + COVID risk
Demographics				
26–34 vs. 18–25	1.79 (0.75, 4.28)	1.73 (0.71, 4.25)	2.28 (0.93, 5.58)	2.44 (0.97, 6.14)
35–54 vs. 18–25	2.83 (1.24, 6.47)	2.94 (1.21, 7.11)	2.90 (1.25, 6.76)	3.36 (1.34, 8.39)
55+ vs. 18–25	0.83 (0.17, 4.13)	0.79 (0.15, 4.30)	1.28 (0.25, 6.63)	1.43 (0.25, 8.13)
Female vs. male	4.45 (1.91, 10.36)	5.34 (2.14, 13.35)	4.28 (1.80, 10.16)	5.00 (1.95, 12.83)
Trans/other vs. male	0.52 (0.06, 4.34)	0.51 (0.06, 4.30)	0.55 (0.06, 4.67)	0.55 (0.06, 4.76)
\$0–5 K vs. \$100 K+	1.06 (0.40, 2.78)	0.96 (0.31, 2.99)	1.02 (0.37, 2.84)	0.97 (0.29, 3.28)
\$5–45 K vs. \$100 K+	0.34 (0.11, 1.03)	0.31 (0.09, 1.01)	0.36 (0.12, 1.09)	0.32 (0.09, 1.09)
\$46–99 K vs. \$100 K+	0.61 (0.26, 1.43)	0.63 (0.27, 1.49)	0.69 (0.28, 1.68)	0.72 (0.29, 1.80)
High school or less vs. graduate	2.76 (0.90, 8.46)	2.56 (0.76, 8.63)	2.15 (0.67, 6.89)	2.09 (0.60, 7.28)
Some college or associate's vs. graduate	1.89 (0.67, 5.34)	1.88 (0.65, 2.36)	1.51 (0.53, 4.34)	1.46 (0.50, 4.31)
College degree vs. graduate	1.79 (0.77, 4.15)	1.71 (0.72, 4.07)	1.53 (0.64, 3.65)	1.50 (0.62, 3.64)
Uninsured vs. insured	1.14 (0.92, 2.30)	1.03 (0.41, 2.62)	1.27 (0.51, 3.14)	1.21 (0.46, 3.19)
Slightly/moderately vs. extremely/very religious	0.34 (0.13, 0.92)	0.32 (0.12, 0.88)	0.40 (0.15, 1.11)	0.36 (0.13, 1.02)
Not at all vs. extremely/very religious	0.40 (0.09, 1.81)	0.38 (0.08, 1.75)	0.41 (0.08, 1.95)	0.39 (0.08, 1.94)
Immigration/acculturation				
Not born in the USA vs. born in the USA		0.69 (0.36, 1.16)		0.59 (0.24, 1.47)
Parents not born in the USA vs. parents born in the USA		0.47 (0.16, 1.37)		0.44 (0.15, 1.34)
Living in the USA for 0–5 years vs. 20+ years		0.55 (0.15, 2.01)		0.63 (0.17, 2.38)
Living in the USA for 6–20 years vs. 20+ years		0.51 (0.19, 1.41)		0.51 (0.19, 1.40)
Not a citizen vs. a citizen		1.19 (0.34, 4.15)		1.04 (0.28, 3.90)
Moderate/slight/not well English vs. extremely well English		2.49 (0.79, 7.79)		2.36 (0.72, 7.77)
COVID risk				
Tested COVID+ or suspected vs. not tested for COVID/COVID-			1.39 (0.50, 3.88)	1.24 (0.43, 3.56)
Prefer not to say if tested vs. not tested for COVID/COVID-			0.32 (0.07, 1.43)	0.29 (0.06, 1.32)
Family tested COVID+ or suspected vs. family not tested for COVID/COVID-			1.03 (0.51, 2.10)	0.96 (0.47, 1.99)
Prefer not to say if family tested vs. family not tested for COVID/COVID-			1.17 (0.23, 5.84)	1.11 (0.22, 5.63)
Live alone vs. 5 or more in household			0.41 (0.11, 1.54)	0.33 (0.08, 1.30)
Two people vs. 5 or more in household			0.14 (0.03, 0.64)	0.12 (0.03, 0.57)
Three or four people vs. 5 or more in household			1.04 (0.50, 2.14)	0.98 (0.47, 2.05)

Note: Boldface indicates statistical significance

having immunity from a previous infection [27]. Individuals who are unsure or unlikely to receive the COVID-19 vaccine may therefore require increased education on

COVID-19 vaccine use, efficacy, and access despite prior infection.

Table 3 Logistic regression models comparing Arab Americans unsure about their COVID-19 vaccine intention vs. those likely to get vaccinated for COVID-19 in a sample of Arab Americans surveyed nationally between May and September 2020

Odds ratio (95% CI)	Model 1: Demographics	Model 2: Model 1 + immigration/acclturation	Model 3: Model 1 + COVID risk	Model 4: Model 1 + immigration/acclturation + COVID risk
Demographics				
26–34 vs. 18–25	1.36 (0.87, 2.13)	1.32 (0.84, 2.09)	1.52 (0.95, 2.42)	1.51 (0.94, 2.44)
35–54 vs. 18–25	1.62 (1.01, 2.60)	1.42 (0.86, 2.35)	1.56 (0.96, 2.52)	1.46 (0.87, 2.43)
55+ vs. 18–25	1.63 (0.86, 3.12)	1.22 (0.59, 2.51)	1.67 (0.86, 3.25)	1.36 (0.64, 2.88)
Female vs. male	1.67 (1.12, 2.48)	1.76 (1.16, 2.67)	1.56 (1.04, 2.34)	1.68 (1.10, 2.57)
Trans/other vs. male	0.50 (0.19, 1.30)	0.51 (0.20, 1.34)	0.50 (0.19, 1.32)	0.51 (0.19, 1.36)
\$0–5 K vs. \$100 K+	0.83 (0.51, 1.34)	0.85 (0.45, 1.59)	0.89 (0.50, 1.58)	0.93 (0.49, 1.77)
\$5–45 K vs. \$100 K+	0.97 (0.58, 1.62)	1.01 (0.58, 1.74)	1.04 (0.62, 1.76)	1.07 (0.61, 1.88)
\$46–99 K vs. \$100 K+	0.83 (0.51, 1.34)	0.83 (0.51, 1.35)	0.84 (0.52, 1.38)	0.84 (0.51, 1.38)
High school or less vs. graduate	1.38 (0.69, 2.37)	1.35 (0.71, 2.59)	1.25 (0.66, 2.34)	1.36 (0.70, 2.63)
Some college or associate's vs. graduate	1.72 (0.98, 3.02)	1.74 (0.98, 3.07)	1.66 (0.94, 2.95)	1.70 (0.95, 3.04)
College degree vs. graduate	1.59 (1.01, 2.52)	1.63 (1.03, 2.59)	1.52 (0.95, 2.41)	1.57 (0.98, 2.52)
Uninsured vs. insured	1.46 (0.92, 2.30)	1.45 (0.87, 2.36)	1.54 (0.96, 2.46)	1.57 (0.95, 2.59)
Slightly/moderately vs. extremely/very religious	0.64 (0.42, 0.99)	0.66 (0.43, 1.03)	0.67 (0.43, 1.05)	0.68 (0.43, 1.07)
Not at all vs. extremely/very religious	0.33 (0.15, 0.72)	0.34 (0.15, 0.73)	0.35 (0.16, 0.78)	0.35 (0.16, 0.78)
Immigration/acclturation				
Not born in the USA vs. born in the USA		1.70 (1.05, 2.77)		1.53 (0.93, 2.53)
Parents not born in the USA vs. parents born in the USA		0.65 (0.36, 1.16)		0.53 (0.29, 0.98)
Living in the USA for 0–5 years vs. 20+ years		0.69 (0.35, 1.37)		0.72 (0.35, 1.49)
Living in the USA for 6–20 years vs. 20+ years		0.84 (0.51, 1.38)		0.87 (0.52, 1.45)
Not a citizen vs. a citizen		0.93 (0.49, 1.76)		0.94 (0.49, 1.82)
Moderate/slight/not well English vs. Extremely well English		1.02 (0.58, 1.80)		0.95 (0.53, 1.71)
COVID risk				
Tested COVID+ or suspected vs. Not tested for COVID/COVID-			0.43 (0.21, 0.87)	0.40 (0.19, 0.83)
Prefer not to say if tested vs. not tested for COVID/COVID-			0.81 (0.47, 1.39)	0.83 (0.48, 1.43)
Family tested COVID+ or suspected vs. family not tested for COVID/COVID-			0.91 (0.62, 1.35)	0.90 (0.61, 1.33)
Prefer not to say if family tested vs. family not tested for COVID/COVID-			1.07 (0.48, 2.36)	1.15 (0.52, 2.56)
Live alone vs. 5 or more in household			0.49 (0.25, 0.98)	0.50 (0.25, 0.99)
Two people vs. 5 or more in household			0.66 (0.39, 1.11)	0.69 (0.40, 1.17)
Three or four people vs. 5 or more in household			1.16 (0.75, 1.79)	1.18 (0.76, 1.83)

Note: Boldface indicates statistical significance

Gender disparities in vaccine intention were apparent in our findings, with Arab American women being twice as likely as men to report being unsure about receiving the COVID-19 vaccine. Other studies in general US populations

have found greater vaccine intention in women with regard to both COVID-19 and non-COVID-19 vaccines [28]. Previous work has found that Arab American women have lower vaccination rates and preventive care engagement when

compared to non-Arab American women [22, 23]. Foreign-born Arab women have been found to have the lowest rates of vaccination in this community [22]. The disparity in vaccination rates among Arab and non-Arab American women may be rooted in the impact of being foreign-born on vaccine knowledge, access, and uptake. More than half of the respondents in our study were foreign-born; it may therefore be possible that being foreign-born impacts Arab American women's knowledge, trust, and intention to receive vaccines.

There is an indication that religiosity was associated with COVID-19 vaccine intention in our sample. Religiosity has been found to be correlated with low engagement in preventative health behaviors and vaccination in other studies [26, 29]. High religiosity was significantly associated with low intention to receive a COVID-19 vaccine in a survey conducted among a general population of US adults in March 2020 [26]. Additionally, high religiosity was significantly associated with a lack of adherence to shelter-in-place orders for the COVID-19 pandemic in a study conducted across 53 metropolitan cities in the USA [29]. Possible explanations for these findings include the use of religion as a coping mechanism during severe life events such as the COVID-19 pandemic, coupled with possible misinformation about COVID-19 vaccines informally spread throughout religious groups and communities [26]. High religiosity among Arab Americans has been found to serve as a hurdle to accessing cancer screening and treatment as well as a predictor for depression [7, 9]. Highly religious individuals and communities may need dedicated outreach during COVID-19 vaccine distribution as well as education on research-based information about vaccine efficacy and population-wide impacts of mass vaccination.

The interpretation of the findings should be contextualized within the study's limitations. First, convenience sampling was used to distribute the online SAHA survey, which makes it more likely that our respondents came from a subset of the Arab American community that is comfortable with online surveys and have a particular interest in health-related topics or COVID-19 in particular. This may account for the low numbers of participants in our survey that responded as unlikely to receive the vaccine. Second, the SAHA question on vaccine intention was asked prior to the availability of COVID-19 vaccinations in the general public and the Food and Drug Administration's (FDA) emergency approval. Public confidence in the research and development process of a safe and effective vaccine have increased considerably since the conclusion of this study in other populations [30]; follow-up is required to understand the current vaccine intentions of Arab American populations. Despite these limitations, this study had a number of strengths. The sample size for our study was larger than what is typical in Arab American research [7]. Additionally, there was notable geographic diversity represented in the SAHA

data, with representation of Arab Americans from the West, Midwest, South, and Northeast of the USA. The study sample's diversity increases the generalizability of these findings to other Arab American communities and minority populations in the USA.

Vaccine intention is a key epidemiological and socio-behavioral concept that can help contextualize and improve vaccine rollout campaigns. This quantitative study fills an important gap in our understanding of COVID-19 vaccine hesitancy among Arab Americans. It is important to note that our survey asked participants about their intention to receive the COVID-19 vaccine at a time when no vaccine was available, and that the survey did not ask participants about their reasons for intending to or not intending to receive the COVID-19 vaccine. Future research should engage Arab Americans communities in qualitative interviews to better understand their perspectives behind vaccination and include information about political and government relations as motivations for vaccination. The results from our study can also inform future interventions to improve vaccine uptake in Arab American communities.

Conclusion

With SARS-CoV-2's profound impact on communities all across the globe, the success of mass vaccination campaigns is crucial to achieving herd immunity and controlling the spread of COVID-19. Vaccine hesitancy among Arab Americans remains a largely understudied topic in public health research. The results from this study can inform public health policy and programming geared towards Arab Americans to increase vaccine confidence, as well as address structural barriers that may be impeding the success of vaccination efforts in these communities.

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Author Contribution SA and AH contributed to the conceptualization of the study and the writing of the manuscript. NNA led conceptualization of the study, data collection, and data analysis. MT, DJG, NZ, FH, FA, and NNA contributed to the writing and interpretation of findings. All authors read and approved the final manuscript.

Data Availability De-identified data used for the current study or additional statistics derived from the data are available from the corresponding author on reasonable request.

Declarations

Ethics Approval This study was approved by the Boston College Institutional Review Board. Respondents provided written consent using an online form.

Conflict of Interest The authors declare no competing interests.

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