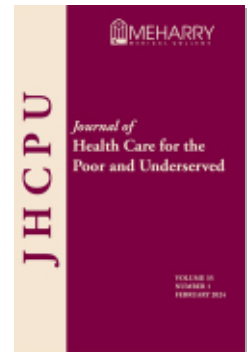# PROJECT MUSE®

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Former COVID-19 Hotspot

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Vaccine Attitudes and Uptake Among Latino Residents of a Former COVID-19 Hotspot

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Abstract: Early in the COVID-19 pandemic, the Centers for Disease Control and Prevention identified Prince William County (PWC), Va. as a hotspot with a high disease rate among Latinos. This study uses spatial, survey, and qualitative data to understand attitudes towards vaccine uptake among PWC Latinos. A quantitative analysis (n=266) estimates the association for vaccine acceptance among Latinos. Next, qualitative interviews with Latinos (n=37) examine vaccine attitudes. Finally, a spatial analysis identifies clusters of social vulnerability and low vaccine uptake in PWC and adjacent counties. Our findings show that a substantial proportion of PWC Latinos had low vaccination rates as of December 2022, two years after the vaccine's release. Side effects and safety and approval concerns were cited in both the quantitative and qualitative studies. Persistent vaccine disparities are concerning given the high hospitalization and mortality rates that prevailed among Latinos early in the pandemic.

Key words: COVID-19, COVID-19 Latinos, COVID-19 vaccines, vaccine hesitancy, mixed methods.

Compared with their White non-Latino counterparts, Latinos have 1.5 times the rate of COVID-19 cases, 1.9 times the rate of hospitalizations, and 1.8 times the rate of deaths, according to November 2022 data.[1] Early in the pandemic, 818 (26%) of the United States' 3,142 counties were classified as COVID-19 hotspots, defined by case rates of 212–234 cases per 100,000, which placed them in the nation's highest quartile.[2] Prince William County (PWC) Virginia was in the top 1% in case rates.[2]

In Prince William County, Latinos accounted for 55% of COVID-19 diagnoses despite constituting only 25% of its population.[3] High COVID-19 rates among PWC Latinos were explained by difficulty following prevention guidelines due to: 1. employment characteristics (hourly positions with no paid medical or other leave), 2. immigration enforcement-related fears, and 3. poor knowledge of and/or access to local COVID-19 resources.[3] A June 2020 mixed-methods study examining PWC case rates found that Latinos who lived in crowded households, worked outside the home, or had a family

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member who tested positive for COVID were more likely to test positive themselves.[3] The study revealed multiple concerns informing poor outcomes including fears of immigration enforcement. Survey data (n=177) showed that 25% of respondents experienced both food insecurity and mental health problems.[3]

Public health officials early in the pandemic noted that Latinos trailed others in vaccine receipt—a gap that closed by 2022 with 66% nationally receiving a vaccine, which compares favorably with non-Latino Whites at 56%.[4] Latinos, however, were about half as likely as non-Latino Whites to have received bivalent boosters that protect against omicron variants as of November 2022.[4] Case and hospitalization rates, as well as a lag in COVID-19 vaccine booster uptake, indicate that the question of vaccine hesitancy remains a concern for U.S. Latinos and could continue to exacerbate COVID-related health disparities.[5] Due to these disparities, research targeting vaccine hesitancy among Latinos is imperative.[6]

Latinos and vaccine hesitancy. Recent studies of Latinos and COVID-19 vaccine uptake reflect the escalating willingness of this population to receive vaccinations after initially trailing non-Latino Whites in vaccine receipt.[7–9] For example, a March 2020 to February 2021 study using a smartphone application (n=87,388) to collect vaccine hesitancy data showed that 16% of Latinos were vaccine-hesitant compared with 7% of non-Latino Whites.[7] In comparison, a study analyzing nationally representative data (n=1,936) conducted between February and March 2021 established no difference between Latino immigrants and non-Latino Whites with respect to COVID-19 vaccine hesitancy.[9] Reasons for COVID-19 vaccine hesitancy are complex and can be informed by a general distrust of the health care system, disinformation, fears about vaccine provenance,[10] and experiences of discrimination,[10–12] issues that may influence how some Latinos perceive COVID-19 vaccinations.[13] Low COVID-19 vaccine confidence among all racial and ethnic groups has been argued to stem from worries over ingredients, speed of development, and fears of long-term health effects.[14]

Several recent studies offer indications of attitudes as well as proximity to COVID-19-related demise that may inform Latino vaccine receipt.[9,15–16] A national online study of 3,029 adults assessed vaccine beliefs according to race and ethnicity.[9] The study found that 42% of all respondents believed that government could not be trusted to be honest about vaccine risks.[9] African Americans reported more distrust and vaccine hesitancy than non-Latino Whites and Latinos, with 47% of Blacks expressing hesitancy.[9] These were the only groups included in the analysis.[9] A scale used to assess vaccine hesitancy showed that non-Latino Whites and Latinos reported similar average levels of vaccine hesitancy regardless of nativity.[9] Fewer Latinos (29%) than Whites (33%) endorsed definite plans to receive vaccines; this fact is offset by Latinos (17%) who reported they were highly likely to be vaccinated compared with their non-Latino White counterparts (11%).[9] Foreign-born (75%) and U.S.-born (62%) Latinos were more likely to know someone who experienced COVID-19 or who died from the disease compared with 51% of African Americans and 42% of Whites.[9]

A study using data from the U.S. Census Bureau's Household Pulse Surveys (N = 60,492) found that worry about side effects (51%), a desire to wait and see if the vaccine is efficacious and safe (43%), and a general distrust of COVID-19 vaccines (34%) informed hesitancy.[16] The study showed that findings do not vary across racial and

ethnic groups.[16] Although severe allergic reactions are rare, Latinos who work in service industry jobs may be deterred by side effects such as tiredness and fever because many such jobs do not offer sick leave.[16] The questions of distrust and disinformation emerged as themes in two qualitative studies with Latino respondents.[11,15] A study that included Latina mothers (n=22) and youth ages 13–18 (n=24) found 45% expressed vaccine hesitancy based on the perceived role of politics in COVID-19 vaccine development, as well as fear of being used as guinea pigs.[11] Some Latinos may be inclined to resist vaccines because they have endured long histories of racism and problematic encounters with health care, including situations in which providers lacked cultural sensitivity, a history they share with other racial/ethnic populations.[17] Distrust based on historical factors may be amplified by social media and the spread of disinformation.[15] A qualitative study of Latino *promotoras* (community public health workers) in Los Angeles (n=22) found that many said that their work was hindered by COVID-19 misinformation spread by social media influencers, celebrities, and public officials via multiple media sources including television, radio, and social media.[15] The proliferation of information from multiple sources across competing media platforms rendered differentiation of facts from falsehoods challenging.[15]

Other recent studies have examined the relationship between immigration status and vaccine hesitancy, a serious concern given that immigrants might avoid contact with health care providers because of immigration enforcement fears amplified during the Trump Administration.[18–19] Residual fear from the Trump Administration's threats to deport people deemed to be a public charge because they accessed benefits such as Medicaid for children could still deter undocumented immigrants from accessing health care.[18,20–21] Other factors influence vaccine uptake among undocumented immigrants, as shown by a study conducted in Baltimore, Paris, Geneva and Milan (n=816) from February to May 2021.[19] This study found that women who were at high risk of severe COVID-19, who had a co-morbid medical condition, and who endorsed traditional media as their main source of health information were most likely to want the vaccine.[19] Women's healthier male counterparts and those who rely on social media for news were less likely to receive the vaccine.[19] Researchers concluded that more local studies are needed to understand vaccine hesitancy among immigrants.[19] "We found that factors associated with perceived availability of and demand for COVID-19 vaccination diverged across study sites, reflecting differences in samples, local health policies and cultural preferences. This highlights the importance of collecting data at local level in order to tailor responses."[19[p.7]]

Given the early concerns about high COVID-19 case positivity and hospitalizations in PWC, particularly the fact that this area was ranked by the CDC in the top 1% of areas affected by COVID-19, we designed a mixed-methods study to explore the health care-seeking experiences of Latino populations in that county.[3] An interdisciplinary team that included an epidemiologist, a geographer, and a social scientist used mixed methods to examine both social disadvantage and vaccine hesitancy. We sought to build from previous mixed methods research that identified the following concerns for Latinos: limited awareness of local COVID-19 resources; fears of immigration enforcement; declines in food security; and mental health issues by illuminating how this population perceived vaccines.[3] We examined perceived vaccine efficacy, poten-

tial side effects, access, as well as sources for health care information including social media and Spanish language television.[3] Finally, we discuss how social disadvantage may have depressed health locus of control, a construct found in other studies to lead to positive health behavior.[22–25]

Methods

Study design overview. The study occurred in three phases. First, between January and March 2021 a quantitative survey was conducted to learn about COVID-19 vaccine acceptance among English-speaking Latinos. Second, from June 2021 to December 2022, a qualitative study was conducted to delve into the experiences of Spanish-speaking populations given the results of the quantitative survey and the results of the CDC investigation into COVID-19 hotspots.[2] Last, a spatial analysis estimated COVID-19 vaccine uptake in locations with high Latino and socially vulnerable populations within PWC and neighboring counties by December 2021 and December 2022. Together the data provide an in-depth description of how Latino populations responded to the pandemic in a setting that was hit hard by COVID-19.

In this article, we focus on ethnic Latinos, a term that encompasses all races within that ethnic group. We use the term, Whites, to refer to the non-Latino White population. We acknowledge that Latinos are not a homogeneous group, although they are grouped as single ethnic subset for the purposes of this study.

This mixed methods study combines analysis at multiple scales. The quantitative analysis of survey (n=266) data and the qualitative analysis of interview (n=37) data examine COVID-19 vaccine uptake attitudes at the individual level. The analysis of spatial data at the census tract level characterizes Latino populations in PWC with respect to vaccine uptake and social vulnerability. The spatial analysis study site is in Northern Virginia, which comprises Arlington, Fairfax, Loudoun, and Prince William counties, and independent cities including Alexandria, Falls Church, Fairfax, Manassas, and Manassas Park.

Study populations. A quantitative survey was conducted in PWC from December 2020 to March 2021 to ascertain views of English-speaking Latino survey respondents on vaccine receipt. Qualitative research from June 2021 to December 2022 was conducted with Spanish-speaking Latinos seeking health care at a clinic in PWC serving uninsured patients. Spatial data at the census tract level were collected from various sources from 2018–2021, described further below.

Spatial analysis using multi-variate clustering. Open spatial data capturing six variables for each census tract in Virginia were acquired. Data for the variable *Latino population (%)* were acquired from the U.S. Census Bureau American Community Survey 5Y Estimate.[26] The variables indicating social vulnerability for this study included: *crowded housing (%), unemployment (%), uninsured (%), English as a second language (ESL) (%), and no high school diploma (HSD) with age 25 and older (%).* These variables are characteristic of communities that need additional support in circumstances such as the COVID-19 pandemic and were retrieved from the CDC/Agency for Toxic Substances and Disease Registry's Social Vulnerability Index.[27] Multi-variate clustering analysis using the k-means algorithm was used to detect groups of census tracts with

similar demographic characteristics based on the six variables. K-means partitions census tracts into k clusters so that the differences among the features in a cluster are minimized and the differences between clusters are maximized.[28] Using the optimized pseudo-f statistic, $k = 3$ was the most optimal. About 1% (n = 26) of census tracts had no data (these were such areas as airports and national parks) and thus were excluded from the analysis. Maps were generated using ArcGIS Pro version 3.0.1 (*ArcGIS Pro* [Computer software]. Version 3.0.1. Redlands, CA: Esri; 2023) to visualize the census tracts that belong to each cluster. Data capturing vaccine uptake as of December 31, 2021 at the census tract level for Virginia were obtained through the COVID-19 Vaccine Unit from the Virginia Department of Health. Vaccine uptake among the clusters was investigated.

Quantitative survey design and analysis. A quantitative online survey was distributed in PWC. The survey was developed to capture participants' demographic information, vaccine intent, concerns surrounding the vaccine, sources of information, and flu vaccine status. Survey questions were developed from the CDC vaccine confidence survey bank,[29] and after review of current literature on vaccine hesitancy questionnaires.[30] The survey was programed in Survey Monkey and the survey link was distributed through social media, email, local newspapers, the local radio, and with the help of community partners. Inclusion criteria were living in PWC and being 18 years of age or older. Responses were collected from December 17, 2020 until March 23, 2021 with the majority of the responses being collected in December and January, a time when the COVID-19 vaccine was first distributed to health care workers, under consideration for FDA authorization, and then authorized. Data were collected in English only during this phase of research given limited resources for this study and to facilitate rapid analysis. No compensation was provided to survey participants. The survey was conducted as part of a graduate student internship at the Prince William Health District. Data collected were deidentified before being sent to the investigators, and George Mason University Institutional Review Board determined that it was not human subject research.

Statistical analysis of survey data. The main outcome of interest was vaccine acceptance, which we define as a self-reported willingness to receive the vaccine. A nominal level variable: *Will you accept the COVID-19 vaccine when it is available?* was included. The explanatory variables included demographic variables (race, gender, education, income, and age), COVID-19 vaccine concerns (relating to safety, effectiveness, trust, side effects, production, and approval process), sources of COVID-19 vaccine information (federal and state websites, news, radio, family and friends, and social media), and history of influenza vaccination. Descriptive analysis provided counts (n) and frequencies (%) of all explanatory variables. Chi-square analyses assessed the association between all categorical explanatory variables and the outcome, vaccine acceptance. Unadjusted odds ratios were calculated to assess the relationship of each of the explanatory variables of interest and the outcome, vaccine acceptance. Multivariable logistic regression assessed the relationship between the variables of interest and vaccine acceptance. The data were visualized using bar graphs to display the relationships. For all analyses, statistical significance was set to $p < .05$. All analyses were conducted using STATA version 16 (StataCorp, LP, College Station, TX).

Qualitative methods. We used a phenomenological approach to conceptualize qualitative data gathering and to analyze how respondents understand and interpret the pandemic.[31–32] The qualitative research phase of the study (n=37) was conducted at a free university-run clinic serving uninsured patients who live in multiple neighborhoods in the PWC area. The clinic provides free vaccines and encourages all patients to receive them. Inclusion/Recruitment criteria included being a Spanish-speaker ages 18–65 years old who is paid informally (i.e., off the books, via cash or personal check, rather than receiving a paycheck reflecting Federal Insurance Contributions Act (FICA) and Social Security tax payments). We used this strategy to recruit immigrants who likely were undocumented and work in the residual economy. Institutional review board prohibitions included questions about immigration status; therefore, work in the secondary economy, defined by wages paid in cash or checks without payroll taxes, was used as a proxy for undocumented workers.

Two Spanish-fluent Latina research assistants were responsible for recruiting respondents, a process that began in June 2021, two months after completion of the quantitative sampling. The clinic-based sample was recruited at a table near the clinic's waiting room. Respondents were told that the study was optional and that declining to participate would not affect receipt of health care. Respondents were read a Spanish-language consent form onsite immediately after recruitment. The consent was read to respondents to avoid assuming literacy. Respondents received a $30 gift card for participation and were told during the consent that they were free to decline answering any questions or withdraw consent later without loss of the compensation.

A semi-structured interview focused on understanding how Latino respondents experienced COVID-19 in multiple domains, including attitudes towards the vaccine and how they secured health care information. Researchers allowed the respondents to lead and emphasize points of concern. All interviews were conducted via Zoom for COVID-19 safety. A research assistant fluent in Spanish assisted respondents in downloading and using the Zoom app on respondent smartphones onsite and in trouble-shooting the app during interviews. It is possible that a lack of familiarity with the app discouraged some respondents from participating, and we acknowledge this fact as a limitation of the study.

Qualitative analysis of open-ended interviews. Interviews were recorded and then transcribed verbatim by one of two native Spanish-speaking research assistants. The principal investigator responsible for the qualitative section of the study reads Spanish fluently and coded the data in that language. Line by line coding of the Spanish language texts was completed by the principal investigator with ATLAS.ti 9.1.3 (ATLAS.ti GmbH, Berlin, Germany). Consultation with the two native Spanish-speaking research assistants ensured that the translations of verbatim transcriptions were accurate. The goals for analysis included: 1. bracketing bias and assumptions, 2. developing themes while recognizing complexity, and 3. identifying exceptions to emerging patterns. Bracketing requires effort to suspend assumptions to understand respondents.[33] The goal was to stay close to words used to describe events, instead of reaching for an interpretation. Brief statements were coded using concrete terms such as "fearing side effects," "vaccine myths," and "vaccine strong support" to keep the analysis close to the raw information.[34] Such concrete codes reduce potential for over-reach in interpretation and help

prevent the changing of codes during data review, strategies recommended for ensuring reliability in analysis.[35] As recommended by Boyatzis,[34] literal codes described above supported bracketing, thus reducing the potential for bias in interpretation.

Integration of methods. The survey data provided a rapid analysis of determinants of vaccine hesitancy during the initial period when the COVID-19 vaccine was authorized. Qualitative analysis of interviews provides context to understand lingering vaccine hesitancy in PWC, despite highly problematic outcomes during the height of the pandemic in 2020–2021. Multivariate spatial analysis affords a broader contextualization of the population and the official vaccine uptake in the study area. By combining these three methods of analysis, we contextualize factors related to vaccine hesitancy including social disadvantage. Qualitative data afford access to Spanish-speaking respondents who could describe factors related to hesitancy that might not otherwise be captured. Qualitative methods alone are not designed to understand the prevalence of vaccine-related decisions and beliefs; quantitative methods alone may miss constructs that have not previously been captured in the literature.[36]

Results

Slightly more than 24% of the English-speaking Latino study population (n=266) reported that they did not plan to receive the vaccine. Among Latino survey respondents who reported concerns about the vaccine, 79% said they feared its side effects and 31% questioned its safety. These concerns were echoed in the Spanish-speaking qualitative sample that declined the vaccine (27%), despite this cohort having been recruited from a clinic that assertively encourages all patients to receive it. Our English and Spanish-speaking data show generally strong support for receiving the COVID-19 vaccine, with higher rates of receipt than documented nationally for English speakers, and only slightly lower uptake among Spanish speakers.

In addition, multivariate spatial analyses show that areas with high Latino populations exhibit characteristics of high social vulnerability including lack of high school diploma, crowded housing, speaking English as a second language, lack of health insurance, and unemployment. The census tracts identified as having high rates of Latinos as well as high rates of social vulnerability arguably render residents vulnerable to higher rates of COVID-19 infections, a concern given the potential for the virus to mutate[37] and the lack of uptake of bivalent boosters among Latinos.[38] Although we found a high rate of vaccine receipt, our results suggest that a lack of access to regular health care and interactions with medical providers could depress COVID-19 vaccine uptake, including for bivalent boosters.

Spatial analysis. The multivariate spatial analysis reveals three distinct clusters of similar census tracts where each cluster contains a set of census tracts with statistically similar population demographics based on the selected variables. Figure 1 maps the census tracts in Northern Virginia belonging to each cluster (A) and provides an inset for a region of interest (B). Based on statical comparison of the cluster variable mean to the overall variable mean for Virginia, we describe each cluster as follows: Cluster 1 (red) includes census tracts with a *high Latino population and high social vulnerability,* meaning a higher-than-average fraction of the population that lives in *crowded hous-*
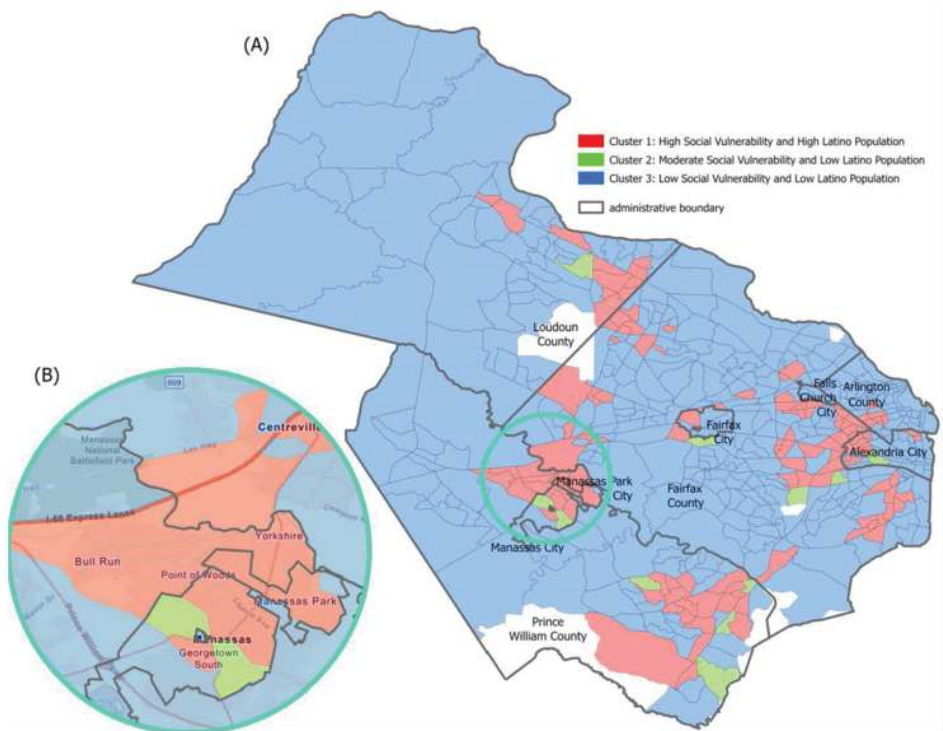
Figure 1. Map of census tracts in Virginia (A) grouped into three clusters based on the variables Latino population (%), crowded housing (%), unemployment (%), uninsured (%), no high school diploma (HSD) age 25+ (%), and English as a second language (ASL). Cluster 1 includes counties with high Latino population and high social vulnerability. Cluster 2 include counties with low Latino populaiton and moderate social vulnerability. Cluster 3 includes counties with low Latino population and low social vulnerability.

ing, has *no high school diploma (HSD) and is age 25 or older,* speaks *English as a second language (ESL),* is *uninsured,* and is *unemployed* (all five of the variables that indicate social vulnerability). Cluster 2 (green) includes census tracts with a *low Latino population and moderate social vulnerability*, meaning a higher-than-average fraction of the population with *no high school diploma (HSD) and is age 25 or older,* who is *uninsured,* and is *unemployed* (three variables that indicate social vulnerability). Cluster 3 (blue) includes census tracts that have a *low Latino population and low social vulnerability,* meaning a lower-than-average fraction of the population that lives in *crowded housing,* that has *no high school diploma (HSD) and is age 25 or older,* speaks *English as a second language (ESL),* is *uninsured,* and is *unemployed.* This analysis gives context to the Latino populations in PWC and the broader region and shows that census tracts that have a high Latino population also have characteristics corresponding to high social vulnerability. To further contextualize the study, we next examine vaccine uptake in census tracts that have high Latino and socially vulnerable populations as of December 31, 2021 and 2022 (Figure 2). We find that on average, vaccine uptake in these census tracts
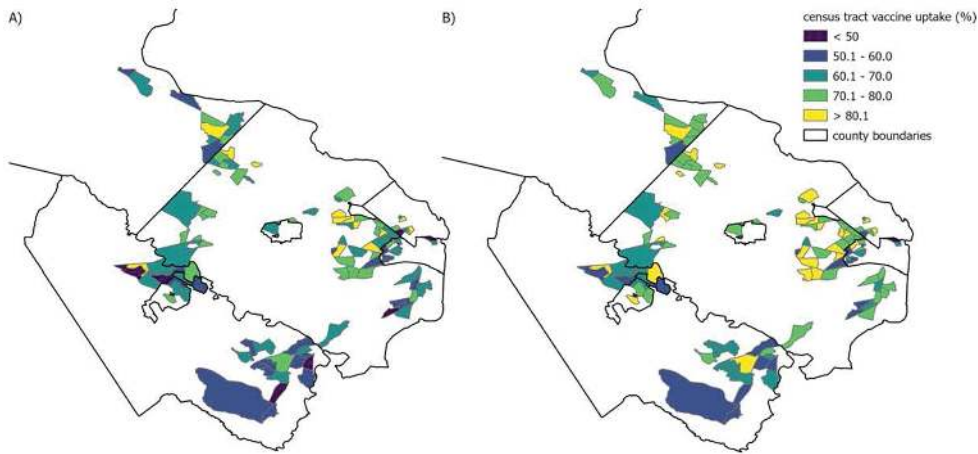
Figure 2. COVID-19 vaccine uptake for census tracts that have high Latino and socially vulnerable populations as of (A) December 31, 2021 and (B) December 31, 2022.

(66% by December 2021 and 72.18% by December 2022) trails slightly behind vaccine uptake for all census tracts in the region (71% and 76%, respectively). Additionally, there is a spatial disparity among these tracts—on average, census tracts with high Latino and socially vulnerable populations located in PWC, Manassas, and Manassas Park cities have lower vaccine uptake in December 2021 (60%) and 2022 (66%) than census tracts with similar population characteristics in Fairfax, Alexandria, Arlington, and Loudon (69% and 75%, respectively). This may partially explain PWC, Manassas and Manassas Park as a CDC designated COVID-19 hotspot. Finally, analysis shows that in general, vaccine uptake did not change significantly between December 2021 and December 2022 across all census tracts (+6%), including those with high Latino and socially vulnerable populations. This highlights the long-term impact of access and messaging on future vaccine behaviors.

Quantitative survey analysis. Where the spatial analysis provides context for the census tracts with high Latino populations and the associated COVID-19 vaccine uptake for those same census tracts, the quantitative survey provides individual-level insights. Most respondents are between 25 and 54 years of age (67%) and female (67%) and have less than a college degree (38%) or have completed college (27%) (Table 1). Slightly more than 24% of the study population (n=64) reported that they do not accept the COVID-19 vaccine (Table 2). There are significant differences in the distribution of age among those who do not accept the vaccine compared with those who do: For example, 80% of those who do not accept the vaccine are 25 to 54 years of age compared with 62% of those who accept it in the same age group (p=.012) (Table 3). More females did not accept the COVID-19 vaccine (73% compared with 65% who do accept it, p=.078) (Table 3). Among those who do not accept the vaccine, about half do not have a college degree (52% compared with 34% of those who do accept the vaccine in the same education group (p<.049) (Table 3). The proportion of acceptance of the vaccine was similar across income groups (Table 3).

TABLE 1.

SURVEY RESPONDENT CHARACTERISTICS (N=266) JANUARY 2021

TOTAL	Total Population	
	n	**%**
Latinos	266	100.0
Age		
18–24	15	5.6
25–54	177	66.5
55+	74	27.8
Gender		
Female	178	66.9
Male	85	32.0
Education		
Less than college	101	38.0
Bachelor's degree	73	27.4
Graduate school	91	34.2
Income		
$0–$49,999	50	18.8
$50,000–99,999	89	33.5
$100,000–149,999	58	21.8
$150,000 +	69	25.9
Occupation		
Government	63	23.7
Education	34	12.8
First responder	16	6.0
Health care	31	11.7
Building and construction	11	4.1
Food service and hospitality	12	4.5
Other	37	13.9
Retired	11	4.1
Unemployed	30	11.3

In the multivariable analysis of the survey data, individuals over the age of 54 years have significantly greater odds of accepting the vaccine (adjusted odds ratio [aOR]=2.30, 95% confidence internal [CI]: 1.06–4.98) compared with those younger than 55 years of age (Table 4). Those with a bachelor's degree or graduate degree have significantly greater odds of accepting the vaccine compared with those with less than a college degree (Table 4).

Of those PWC Latino respondents surveyed for this study 79% of those who report concerns about the vaccine report that they feared its side effects (Figure 3). Another

Table 2.

DEMOGRAPHIC CHARACTERISTICS AMONG LATINOS AND ACCEPTANCE OF COVID-19 VACCINATION IN PRINCE WILLIAM COUNTY, VIRGINIA–DECEMBER 2020–MARCH 2021[a]

Characteristics	Accept n (%)	Do not accept n (%)	CHI-2, p-value
	202 (75.9)	64 (24.1)	
Age			9.473, .024
18–24	12 (5.9)	3 (4.7)	
25–54	126 (62.4)	51 (79.7)	
55+	64 (31.7)	10 (15.6)	
Gender			2.449, .118
Female	131 (64.9)	47 (73.4)	
Male	70 (34.7)	15 (23.4)	
Education			6.313, .043
Less than college	69 (34.2)	33 (51.6)	
Bachelor's degree	60 (29.7)	13 (20.3)	
Graduate school	73 (36.1)	18 (28.1)	
Income			2.040, .564
$0–$49,999	39 (19.3)	11 (17.2)	
$50,000–99,999	64 (31.7)	25 (39.1)	
$100,000–149,999	43 (21.3)	15 (23.4)	
$150,000 +	56 (27.7)	13 (20.3)	
Occupation			9.678, .288
Government	48 (23.8)	15 (23.4)	
Education	23 (11.4)	11 (17.2)	
First responder	10 (5)	6 (9.4)	
Health care	26 (12.9)	5 (7.8)	
Building and construction	8 (4)	3 (4.7)	
Food service and hospitality	10 (5)	2 (3.1)	
Other	29 (14.4)	8 (12.5)	
Retired	28 (13.9)	2 (3.1)	
Unemployed	9 (4.5)	2 (3.1)	

Note
[a]Percentages may not add up to 100% due to missing data.

38% report concerns with the vaccines' effectiveness and 31% have concerns about its safety. Slightly more than 14% express concerns with the vaccines' production and approval, and another 3% have concerns about vaccines in general (Figure 3). Respondents report seeking information from federal websites (74%), state websites (59%) and local/national television (51%) (Figure 4).

Qualitative analysis of open-ended interviews. To better understand reasons for declining the COVID-19 vaccine, the qualitative study focused on Spanish-speaking

Table 3.

MULTIVARIABLE ANALYSIS OF THE OUTCOME ACCEPTANCE OF COVID-19 VACCINE AMONG LATINOS BY DEMOGRAPHIC CHARACTERISTICS IN PRINCE WILLIAM COUNTY, VIRGINIA— DECEMBER 2020 TO MARCH 2021

Characteristics	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Age		
18–54	1	1
55+	2.50 (1.20–5.23)	2.30 (1.06–4.98)
Gender		
Female	1	1
Male	1.67 (0.87–3.21)	1.31 (0.66–2.61)
Education		
Less than college	1	1
Bachelor's degree	2.21 (1.06–4.58)	2.60 (1.20–5.62)
Graduate school	1.94 (1.00–3.76)	2.23 (1.04–4.77)
Income		
$0–$49,999	1	1
$50,000–99,999	0.72 (0.32–1.63)	0.52 (0.22–1.26)
$100,000–149,999	0.81 (0.33–1.97)	0.56 (0.21–1.49)
$150,000 +	1.21 (0.49–2.99)	0.78 (0.28–2.17)

respondents recruited from the university-run free clinic to ask their beliefs and attitudes about the vaccine. Of 37 interviewed, 10 said they would not receive the vaccine, despite having been recruited from a clinic in which personnel assertively encourage people to receive the free vaccine at the site.

Qualitative sample characteristics. The qualitative data reflect concerns raised by the CDC in its designation of PWC as a COVID-19 hotspot, as well as our spatial analysis of the county.[38] High rates of adversity were reported by interviewees, especially in the domains of being in arrears (46%), experiencing unemployment (35%) and food bank reliance (79%), and almost all who experienced one of these forms of adversity suffered others. A slight majority of respondents reside in basement apartments, and another 24% rent other apartments. All interviewees described renting rather than owning their dwellings. With respect to occupations in our sample, Spanish-speaking Latinos are heavily represented in the service industry with almost half working as housecleaners (49%). Women were overrepresented in the sample, possibly because the university clinic where recruitment took place is frequently used by families needing immunizations for children to attend school as well as to address childhood illnesses. Everyone interviewed (n=37) acknowledged the gravity of COVID-19, with two describing deaths of coworkers from the virus prior to the vaccine, and another stating that she and her husband left a hospital against medical advice despite being so ill that a physi-

Table 4.

MULTIVARIABLE ANALYSIS OF THE SURVEY DATA

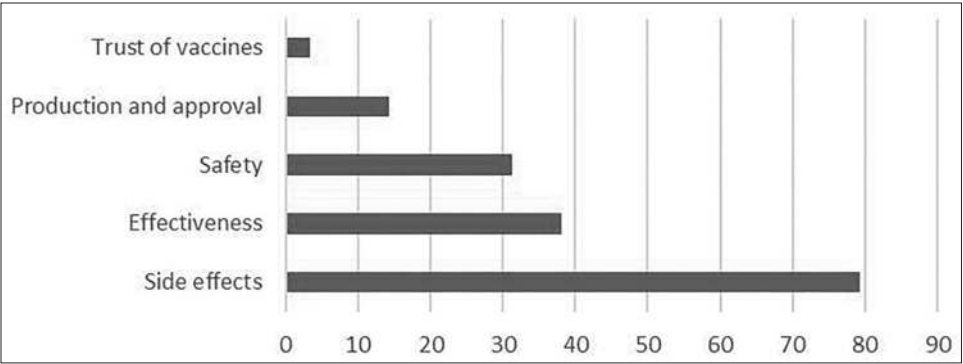| Characteristics	n (%)
Age	
21–29	15
30–39	8
40–49	12
50–65	2
Gender	
Female	31
Male	6
Country of Origin	
El Salvador	15
Guatemala	7
Honduras	6
Peru	4
Venezuela	2
Nicaragua	1
Ecuador	1
Bolivia	1
Occupations	
House cleaning	18
Construction	11
Landscaping	5
Hair stylist	1
Manicurist	1
Mechanic	1
Dwelling Type	
Basement	19
Apartment	9
House	4
Townhouse	2
Room	2
Mobile home	1
Experiences of adversity	
Behind on bills	17
A period of unemployment	13
Visited food banks	29
Forced to migrate due to COVID-19	3
Eviction	2

Figure 3. Percentage of Latino respondents with specified concerns about the vaccine in Prince William County, Virginia, December 2020 to March 2021.
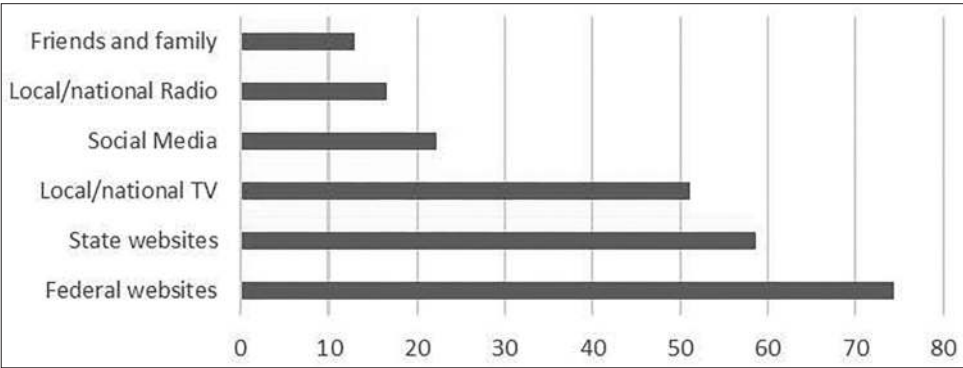

Figure 4. Percentage of Latino respondents reporting sources of information about the COVID-19 vaccine in Prince William County, Virdinia—December 2020 to March 2021.

cian recommended intubation. The woman and her husband feared medical expenses. Respondents described limiting errands and requiring that their children stay home to avoid contracting the virus.

The raw codes that emerged from analysis of vaccine data included: 1. fearing side effects, 2. fearing serious incident (such as death), 3. vaccine strong support, 4. encouraging others to receive the vaccine; 5. negative religious beliefs (vaccine violates respondent's religious ideology); 6. positive religious beliefs (e.g., conviction that God would protect them from adverse vaccine outcomes); 7. frustration with others (negative emotion about people who refused the vaccine); 8. vaccine rumors (includes hearing negative views of vaccine from friends, social media, or TV/radio); 9. believe vaccine unnecessary; and 10. vaccine myths (reports of hearing beliefs from others such as vaccine includes a chip or is deadly). The raw codes were grouped under brackets of positive views of vaccines and negative views. As we detail below, themes about fear and misinformation emerged from interviews as well as support for the vaccine and wiliness to receive it.

Most respondents (n=27) reported either having received the vaccine or having plans to receive it in the future and endorsed vaccination efforts. One woman who had received both a vaccine and a booster described efforts to ensure that family members and friends also received their shots: "Well, if doctors, nurses, everything that is on the front line here in the country have already been vaccinated and the control measures that are in place have already been passed, then why be afraid of a vaccine? But each time it is a world of different thinking. But I always try to make them aware and tell them to do it," said a 52-year-old woman from El Salvador, who migrated to the United States 16 years earlier.

Although 10 in the sample were unvaccinated, no one dismissed the gravity of the COVID-19 pandemic or argued that the disease is inconsequential. Five people had suffered COVID-19 themselves before the vaccine was available and one sought care in an emergency room. Three respondents knew someone who had died from the disease. A Peruvian immigrant said that she had attended funeral services for someone who had died of COVID-19. During a reception following the funeral, she argued with others who refused the vaccine because they feared it would be dangerous.

Of those not vaccinated, nine described fear as being the primary reason, citing safety as well as concerns about side effects. A woman said she had finally received her initial vaccine, but not without having to resolve fear initially. "We were afraid because of what people said—that they put a chip in you—that they put a virus in you, but well, none of that has happened," said a 37-year-old woman from El Salvador who worked as a cook. This respondent, interviewed in June 2021, had recently received her vaccine. Another Salvadoran woman who worked as a housekeeper said she had heard the vaccine causes side effects such as headaches and fever, and thus was disinclined to receive it. A Guatemalan man left a job because a coworker died from COVID-19 before the vaccine's availability. He was trying to avoid infection at his new workplace by wearing a mask and staying six feet away from others. He feared taking the vaccine because he thought it might make him seriously ill.

Three respondents described being angry about social media posts that they had seen attempting to dissuade people from receiving vaccines. Each described social media posts that implied the vaccine was linked with evil, including posts that invoked the idea of the devil. A 22-year-old Salvadoran who was unemployed when interviewed in March 2022 said she would not receive the vaccine for religious reasons. "We come from a very Catholic and religious family, so our family doesn't believe in that," she said, adding that the need for boosters also caused her to question the vaccine's efficacy. "It seemed like more of an experiment," she said. Other respondents described support for the vaccine as well as frustration with others who have yet to receive it. A sample of their comments is below.

> I have seen a lot, since I have my circle of friends at work, they are always posting things (on social media) . . . That the vaccine only had bad things, that it's seal of the beast. That we are going to die. . . . Only crazy things were said.—Respondent A

Respondent A was a 30-year old Salvadoran woman interviewed in September 2021 who said she was not influenced by these beliefs and had no reservations about receiving the

vaccine. She worked for a catering company that prepared food for large gatherings, an occupation that forced her to become unemployed during the worst of the pandemic. Her partner owned a cleaning company which helped them meet living expenses. She expressed frustration with coworkers who hadn't received the vaccine, as well as with having to work alongside people who didn't wear masks.

> There are people who have appeared on social networks saying that this is part of the anti-Christ, the anti-Christ, that I don't know what, that the chip and a lot of things. All the people who, I mean, are, are Latinos too. And well, they are. We come with a closed mind and well, honestly, we are like fools.—Respondent B

Respondent B was a 30-year-old Honduran construction worker who came to the United States after his fruit business collapsed during the pandemic. He was interviewed in April 2022 and noted he and his wife had their vaccines and were eager for their children to receive them.

Respondent C was 24-year-old Salvadoran who also complained about anti-vaccine attitudes she heard from acquaintances, noting that someone told her:

> According to the Bible, that mark is the one that people who are not going to be saved, so to speak . . . So, the people who have received the vaccine are the people who are not going to be saved, so to speak.—Respondent C

Respondent C was interviewed in May 2022. She shared a room in a house with her daughter and other immigrants who supported themselves with two jobs: cleaning a movie theater and working in a lunch truck. She expressed gratitude that she and her daughter could receive the vaccine and frustration with others who had not done so.

Respondent D was a 39-year-old Honduran woman interviewed in September 2022 who described seeing social media that invoked fear of deaths and illness related to receiving the vaccine.

> On Facebook I saw that 10 children had died . . . 10 children who were studying at school, whose parents had gone to give them the vaccines and who had caught COVID due to the vaccines. That scared me because they are getting vaccines to protect, I thought, how are they dying from getting vaccinated?—Respondent D

Despite her fears, Respondent D had received the vaccine.

Discussion

This study represents the first effort to comprehensively analyze COVID-19 vaccine hesitancy among Latino residents in one of the counties that the CDC classified as one the United States' COVID-19 hotspots during the worst of the pandemic, PWC.[2] This area was also the focus of a CDC investigation into areas with particularly sharp COVID-19 disparities. This study is the first to our knowledge to analyze the perspectives

of Latinos using mixed method approaches.[14,30,39–40] We argue this approach is necessary to capture the specific challenges faced by Latinos and thus constitutes a step towards understanding why part of the Latino population in an area of high social vulnerability to COVID-19 remains vaccine-hesitant. This is particularly important since all other studies compare Latino vaccine hesitancy with other racial and/or ethnic groups using single methodologies. We frame our analysis via the concept of health locus of control (HLOC), a concept used in previous research on vaccine hesitancy to understand factors informing vaccine attitudes.[41] Individuals with a high HLOC believe that they can influence personal health outcomes according to their own needs and concerns, part of a construct known as internal factors.[25,41] High HLOC has been positively linked to efforts to improve health outcomes via engagement in healthy eating, exercise, and medical treatment adherence.[22–25] In comparison, people with low HLOC often believe that their health is decided by external factors such as God, chance, or their doctors, and have been found to be less treatment-adherent to regimens such as regular mammograms, as they attribute health outcomes to factors beyond their control.[42–43] Recent research on pediatric vaccine adherence found that a high HLOC produced positive attitudes towards vaccine uptake compared with low HLOC.[41]

The spatial analysis shows that in general, vaccine uptake did not change significantly between December 2021 and December 2022 across all census tracts (+6%), including those with high Latino and socially vulnerable populations. This highlights the long-term impact of access and messaging to future vaccine behaviors. Vaccine hesitancy remains a concern, particularly among socially disadvantaged Latinos. The spatial analysis reveals areas of high vulnerability, particularly in Manassas, a city in PWC with a substantial Latino population and social vulnerability.

The qualitative data show that despite having been recruited from a free clinic where staff assertively promote and vaccines, 27% of the Spanish-speaking sample remained hesitant because of fears that the vaccine might be dangerous or because respondents had concerns about side effects. One cited religious belief as her reason for declining the vaccine, and others who had been vaccinated complained of social media posts linking it to the devil and the anti-Christ. This finding indicates that religious leaders in areas of high Latino residency and social disadvantage may need to explicitly address social media disinformation to protect the population, as social media may undermine HLOC. Qualitative data revealing deliberate misinformation passed through Spanish-language social media raise the issue of whether companies such as Facebook, the outlet most often described in our sample, are adequately vigilant in monitoring content. Deliberate efforts to dissuade Spanish speakers appeared to include rumors about deaths from the vaccine, including demise among children, as well as religious appeals invoking images of evil and the anti-Christ. Although one respondent denigrated Latinos when describing the negative social media appeals, it is necessary to note that similar disinformation may be spread among non-Latinos through social media.[44] The dissemination of disinformation via social media targeting religious beliefs may be especially pernicious during a global pandemic, as the disease coupled with attendant problems from protracted quarantine and job losses posed a threat sufficient to exacerbate mental health concerns globally.[45–48]

Our analysis also raises concerns about social disadvantage, which could arguably

reduce HLOC as low HLOC was found in one recent study to be associated with social disadvantage, although little research exists on socioeconomic status and its potential relationship with HLOC.[22] Our spatial analysis illustrates that census tracts with a high percentage of Latino populations are also the most socially vulnerable, according to the following domains: no high school diploma (HSD) and are age 25 or older, speak English as a second language (ESL), lack health insurance, are uninsured, and are unemployed. These factors arguably contributed to the disproportionate cases, hospitalizations, and deaths in PWC early in the pandemic[1] and may create barriers to vaccination receipt. In fact, based on the spatial analysis of vaccine uptake data obtained from the Virginia Department of Health, areas with both high Latino and socially vulnerable populations have slightly lower vaccine uptake on average when compared with all census tracts. These findings reflected the concerns raised in the qualitative analysis with many respondents being behind on bills (46%), experiencing unemployment (35%), lacking college education (38%), and living in crowded rental housing. No one in the Spanish-speaking qualitative sample had health insurance, which likely means less regular contact with providers who could address fears about the vaccine's safety. Given that the Spanish-speaking sample comprises people who are foreign-born, work in the residual economy, and have no health insurance, it is highly likely that many are undocumented individuals, which raises the question of how xenophobia and social exclusion affect this population's vaccine decision-making.[49–50] Our findings raise the question of whether unemployment, fears generated by the pandemic, and an inability to pay bills contribute to poor HLOC. It is possible that multiple dynamics of adversity coupled with a deadly pandemic might amplify fear and cause people to feel that they have less efficacy in making health decisions. Thus, future research is needed to better understand a potential relationship between HLOC and social disadvantage among Latinos, and to determine if this is a possible pathway to vaccine hesitancy among this population.

It is encouraging that our findings from both the English-speaking quantitative sample and Spanish-speaking qualitative cohort express support for COVID-19 vaccine use, and the rate of receipt (76% and 63% respectively) compares favorably with the national average for Latinos of 66%.[4] The rates observed in the quantitative sample are comparable to, although slightly higher than, those that are observed in the spatial analysis of vaccine uptake in PWC/Manassas/Manassas Park census tracts with high Latino and socially vulnerable populations (60% by December 2021 and 66% by December 2022). Our quantitative findings reveal more COVID-19 vaccine hesitancy among young, female, English-speaking Latina/os and those with less than a college education. Although most respondents in both the English-speaking quantitative sample and Spanish-speaking qualitative cohort express support for COVID-19 vaccine use and distribution (76% and 63% respectively), our findings indicate concern among almost a quarter of the population. Again, HLOC research is needed with this population to understand possible correlation between this construct and hesitancy among young, English-speaking Latinas.

Contrary to one recent web-based survey administered nationally (n= 7,678) which found associations between complacency about COVID-19 and vaccine hesitancy,[51] our qualitative findings show that all those interviewed believed the virus to be a grave health

threat. Those who had not received the vaccine described efforts to prevent contagion through changing jobs and social distancing, self-described behavior that indicates acknowledgment of the danger posed by COVID-19. With respect to the Spanish language sample, the vaccine uptake rate of 63% in our study is concerning, given the social location of Latinos in PWC. As we noted, Spanish speakers reported food bank reliance, spells of unemployment, being behind on bills, and eviction. A subset (n=3) migrated here from Central and South America because of business-related closures due to COVID-19 in their countries of origin. Slightly more than half of respondents reside in basement apartments which raises the question of how efficiently family members can isolate during a bout of an infectious disease such as COVID-19. These findings raise the question of whether pervasive hardship and pandemic-related fears could be informing decision-making about the vaccine. One study prior to the pandemic found that respondents who believed they had a high degree of health locus of control (HLOC) in influencing their own health outcomes had more positive attitudes towards pediatric vaccines than those with a low HLOC.[41] Thus, our findings raise the possibility that, especially among uninsured, Spanish-speaking Latinas, there may exist a low HLOC informed by an accretion of adversity, including unemployment, being in arrears, and having to rely on food banks. Future research is needed among Spanish-speaking Latino/as to understand the potential pathways between high levels of adversity and vaccine hesitancy. The spatial analysis identifies the locations in PWC and broader Northern Virginia that given their high Latino population and high social vulnerability, would benefit from additional support during the COVID-19 pandemic to avoid localized outbreaks.

Limitations. While our study provides an important assessment of Latino vaccine hesitancy in a former COVID-19 hotspot, there are limitations to our analysis. The spatial analysis is limited in that it uses data that only capture populations identified by the census, aggregated to the census-tract level. It is considered an ecological fallacy to make inferences about the individuals living in the census tracts based on what we observe at the census-tract level.[52] For example, while we observe that some census tracts have both a high Latino population and a socially vulnerable population, we cannot say for sure that it is the Latino individuals living in these census tracts who are also socially vulnerable. We overcome this limitation by combining quantitative and qualitative approaches that allow us to get a better understanding of the Latino population and their perspectives on the COVID-19 vaccine at the individual level. The quantitative survey was limited to English-speakers, which means that they are likely more advantaged than those who are unable to answer a written survey in English. However, this is the largest quantitative survey of its kind administered at a county level and provides some insight into determinants of COVID-19 vaccine acceptance among English-speaking members of the Latino/a population. Finally, the qualitative interviews were drawn from one free clinic in one part of PWC and the results cannot be generalized. However, this is not a true limitation since the purpose of qualitative research is to provide insight and help understand why and how certain health behaviors occur.[53]

Conclusion. Our findings show that a substantial proportion of Latino/as in a county formerly designated as a COVID-19 hotspot in 2020 remained vaccine hesitant in 2021 and 2022. Concerns about side effects, safety, production, and approval

were cited by both English and Spanish-speaking respondents, with English-speakers endorsing doubts about vaccine efficacy and reporting generalized doubts about vaccines. These results are concerning given the high hospitalization and mortality rates that prevailed among this population early in the pandemic, coupled with ongoing social disadvantage in employment, housing, and health care access. Future research among both Spanish-speaking and English-speaking Latinos is needed to identify causal pathways for vaccine hesitancy, with particular focus on identifying possible divergence in reasons for declining the vaccine.

Acknowledgments

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