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Influenza vaccination in the time of COVID-19: A national U.S. survey of adults

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ABSTRACT

Introduction: Decisions about influenza vaccination for fall-winter 2020 were made against the backdrop of the COVID-19 pandemic. During May 2020, the authors examined intended vaccination in the next 12 months in relationship to demographic variables, healthcare attitudes, and personal COVID-19 experiences for two samples of adults--those who did not receive influenza vaccine during the prior 12 months, and those who did.

Methods: In May 2020, a cross-sectional online survey was conducted with a national US sample. Participants reported prior influenza vaccination (yes/no during prior 12 months) and anticipated vaccination (yes/no during next 12 months). Covariates included demographic characteristics (e.g., gender, race-ethnicity, political ideology), general beliefs (e.g., benefits of vaccines, altruistic attitudes), and COVID-19 health beliefs and experiences (COVID-19 worry and severity, perception of COVID-19 as a community threat, knowing someone with COVID-19). For each group, hierarchical multivariable logistic regression was conducted with intent to vaccinate as the outcome.

Results: Among participants (n = 3502), 47% did not receive influenza vaccine in the prior 12 months and 53% had; 25.5% of non-vaccinators and 91.9% of vaccinators intended future vaccination. For non-vaccinators, odds of intending vaccination was associated with race/ethnicity (Hispanics were more likely to intend than white-NH; AOR = 1.74; 95% CI = 1.23–2.4), greater perceived benefits of vaccination (AOR = 2.19; 95% CI = 1.88–2.54), and perception of COVID-19 as a community threat (AOR = 1.91; 95% CI = 1.49–2.45). For vaccinators, odds of intending vaccination was associated with age (AOR = 1.04; 95% CI = 1.03–1.05), race/ethnicity (Black-NH and Other-NH were less likely to intend than white-NH, AOR = 0.60; 95% CI = 0.36–0.999; and AOR = 0.45; 95% CI = 0.24–0.84, respectively), greater perceived benefits of vaccination (AOR = 1.88; 95% CI = 1.45–2.45) and greater perception of collective benefits of vaccines (AOR = 1.48; 95% CI = 1.15–1.90).

Conclusions: The COVID-19 pandemic may have served as a cue to action for influenza vaccination intention among some prior non-vaccinators whereas intention among prior vaccinators is more related to positive attitudes toward vaccination.

1. Introduction

The CDC estimated that from October 1, 2019 through April 4, 2020 there were 410,000–740,000 influenza-related hospitalizations and 24,000–62,000 influenza deaths in the United States [1]. High influenza vaccine coverage can reduce related mortality, but influenza vaccine coverage is routinely low for adults with only 45% receiving a vaccination for the 2018–2019 influenza season [2]. Such coverage rates stem in part from the public's worries about lower efficacy, the need for yearly vaccination, and more potential side effects than other vaccines [3]. Views of influenza vaccine as different from other vaccines apply to adults and children [3–5]. Anticipating co-circulation of COVID-19 and influenza in fall-winter 2020–2021, [6,7] public health experts advocated for high influenza vaccine coverage to both help reduce morbidity

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and mortality from influenza (and potentially from concurrent influenza and COVID-19 illnesses), and to preserve health system capacity for responding to the pandemic [6].

Prior influenza vaccination behavior is a strong predictor of future influenza vaccine acceptance [8,9] which did not bode well for increased coverage in the 2020–2021 influenza season. Indeed, vaccine uptake among the general population during the worldwide H1N1 pandemic in 2009 was very low, with many countries reporting less than 50% of expected coverage. However, individuals who received influenza vaccine in the prior season had higher vaccine uptake during the pandemic [8].

The public's decision-making about influenza vaccination for the 2020–21 influenza season was necessarily made in the context of the ongoing COVID-19 pandemic. Given that COVID-19 is a respiratory illness, some of whose symptoms and mode of transmission resemble those of influenza [7], the public's perceptions of COVID-19 may have impacted their willingness to vaccinate against influenza. This project examined two groups of adults: those who did not receive an influenza vaccine in the past twelve months (prior to the COVID-19 pandemic) and those who did receive the vaccine, and assessed their intentions prior to the 2020–2021 influenza season to receive an influenza vaccine in the upcoming twelve months (concurrent with the COVID-19 pandemic). We also explored whether intention to vaccinate in the upcoming year was associated in each group with different demographic variables, health-related beliefs and attitudes, and reports and perceptions of ongoing experiences with COVID-19.

2. Methods

2.1. Study sample

An online survey assessing knowledge, beliefs and behaviors related to the COVID-19 pandemic was programmed using the survey program Qualtrics. It was distributed to participants through Dynata, a market research firm that manages recruitment of survey respondents from panels which include 31 million volunteer survey respondents throughout North America. Data were collected from May 4 to May 11, 2020, and analyzed in June 2020. Panel members receive monetary incentives from Dynata for participation. Email invitations were sent to members of the U.S. panel who fit study eligibility criteria of being 18 years or older and able to read English. Dynata balanced recruitment to be reflective of national census data with respect to age, gender, race/ethnicity, and state of residence. This study was granted exempt status by Indiana University's Institutional Review Board.

2.2. Measures

A single item measured participants' reports of influenza vaccine receipt during the prior 12 months, with response options yes and no. A separate single item measured participants' intention to receive the influenza vaccine in the next 12 months, with response options yes and no.

Regarding demographic characteristics, respondents provided information about their age, gender, educational attainment, household income, race/ethnicity, U.S. region of residence, and political ideology. Political ideology was a single item question, "In general, how would you describe your political views?", with response options of very liberal, liberal, moderate/middle of the road, conservative, and very conservative. For purposes of analysis, we collapsed responses into three categories: liberal, moderate/middle of the road, and conservative.

General belief measures included attitudes about vaccines and altruistic attitudes that might predispose a respondent to decide to engage in vaccination. Benefits of vaccination was a four-item scale assessing positive regard for vaccines (e.g., "Vaccines are a way to take good care of myself now and in the future"; "Vaccines are effective") adapted from prior research on attitudes about vaccination [10,11]. Items were rated with a Likert-type response scale ranging from 1 = strongly disagree to 5 = strongly agree. Items were summed and averaged to create a single score (coefficient alpha = 0.92). Collective benefits of vaccines reflected the potential for personal vaccination to benefit the collective community. This measure consisted of two items, i.e., "I get vaccinated because I can also protect people with a weaker immunity"; and "Vaccination is a collective action to prevent spread of diseases"; which were adapted from prior research (coefficient alpha = 0.81) [12]. These items also were rated with a Likert-type response scale ranging from 1 = strongly disagree to 5 = strongly agree.

A previously validated 18-item altruism scale [13] was modified and consisted of 18 questions assessing how frequently the participant engaged in various altruistic activities (e.g., helping a stranger push their car out of the snow or mud) on a Likert-type scale from 1 = never to 5 = very often. A principal components exploratory factor analysis extracted two factors which we labeled high commitment altruism and low commitment altruism. High commitment altruism consisted of five items (Cronbach alpha = 0.83) and included behaviors that necessitated a high level of personal involvement (e.g., "I have helped carry a stranger's belongings (books, packages, groceries, etc.)"). Low commitment altruism consisted of four items (Cronbach alpha = 0.81) and involved behaviors requiring a low level of personal involvement (e.g., "I have given money to charity"). A mean score was calculated for each subscale.

COVID-19 health beliefs included COVID-related worry, perceived severity of COVID-19, knowing someone who has been infected, and perceived threat of COVID-19 in their community. During pretesting of the survey, and in line with the more common usage of COVID-19 being used by the lay public, all questions included the phrase COVID-19 rather than SARS-CoV-2 when asking about both the virus and disease. COVID-19-related worry was measured with a three-item scale that probed worry about becoming infected with COVID-19 (e.g., "The possibility of getting infected in the future with COVID-19 concerns me"). These items were adapted from previous research on worries about HIV infection [14,15]. Response options ranged from 1 = strongly disagree to 5 = strongly agree. The three items were summed and averaged into a single scale score, with higher scores indicating higher COVID-19-related worry (Cronbach alpha = 0.82). Perceived severity of COVID-19 was assessed using a four-item scale adapted from the literature on the Ebola outbreak [16] which assessed participants' perceptions of the severity of COVID-19 disease (e.g., "I am afraid that I may die if I contract COVID-19"). Response options ranged from 1 = strongly disagree to 5 = strongly agree. The four items were summed and averaged to derive a single perceived severity score (Cronbach alpha = 0.71), with higher scores reflecting higher perceived severity. Knowing someone infected was assessed with a single item "Do you know anyone who has had COVID-19?" Response options were: yes; I believe so but awaiting results; and no. Perceived community threat consisted of a single item "Do you think COVID-19 infection is a major problem in your community?" with a binary yes/no response option.

2.3. Analysis

We first distinguished between participants who had and had not received the influenza vaccination in the past twelve months. Using means and standard deviations or percentages, we described the sample characteristics of the non-vaccinator and vaccinator subsamples. Sample sizes vary across variables due to some respondents declining to answer specific items. For this study,

we were interested in intention to get influenza vaccine in the next 12 months (yes/no). For both subsamples, vaccinators and non-vaccinators, we initially used bivariate logistic regression to examine the association of demographic variables, vaccine attitudes, altruism, and COVID-19-specific experiences and health beliefs with intent to be vaccinated. Any variable that was significant at $p < .01$ in bivariate comparisons was included in a subsequent hierarchical multivariable regression model with intent to vaccinate in the next 12 months as the outcome. This threshold for significance was chosen because a cutoff of $p < .05$ would have led to the inclusion of covariates with very small effect sizes due the relatively large sample size. Variables entered in step 1 were demographic and background variables. Variables entered in step 2 were general beliefs and vaccine attitudes that might predispose a respondent to vaccinate, including doing so on behalf of others' wellbeing. Variables entered in step 3 were COVID-19-specific experiences and beliefs. We then created a reduced model with $p < .05$ needed for a variable to remain in the model.

3. Results

A total of 4,042 respondents opened the survey, 351 declined participation, and 42 were younger than 18 years old and excluded. The survey was completed by 3,586 participants, and of these, 3,502 answered all the questions about both prior influenza vaccination and future influenza vaccine intention and were included in the statistical analyses. The past non-vaccinator group consisted of 1,652 respondents (47% of total sample); the majority (74.5%) of these past non-vaccinators did not intend to get the vaccine in the next 12 months (non-intender subsample) but 25.5% did intend (intender subsample). Of the prior vaccinators (n = 1850, 53% of total sample), 91.9% intended to be vaccinated and 8.1% did not intend to get vaccinated. Overall, those who received the influenza vaccine in the past year were significantly more likely to intend vaccination in the upcoming year (chi-square = 1,608.8 6, $p < .001$). The remainder of analyses focus on the non-vaccinator and vaccinator subsamples separately.

3.1. Non-vaccinators

Table 1 summarizes sample characteristics and bivariate comparisons, including percentages intending to receive an influenza vaccine in the next 12 months (for categorical variables) and point bi-serial correlations (for continuous variables). The mean sample age was 42.9 years and there were more females than males (53.6%, 45.9%, respectively). The majority (62%) were white non-Hispanic (NH), 17.4% were Black NH, 7.3% other-NH and 13.3% Hispanic. Most participants (71.2%) had some post-high school education, and 28.8% had high school completion or less. Geographic location spanned the US with slightly more residing in the Southeast (26.9%) and Midwest (22.2%) than in the Northeast (17.9%) or Southwest (11.1%) areas. Nearly 40% of respondents self-identified as having moderate political leanings (39.9%), with 30.8% identifying as liberals and 29.3% identifying as conservatives. The majority of this sample (68.8%) reported not knowing someone infected with COVID-19 and slightly more than half (52.2%) considered COVID-19 to be a major problem in their community.

In bivariate comparisons, two demographic characteristics differed at $p < .01$ between intenders and non-intenders: race/ethnicity and political ideology. Compared to white-NH respondents, Hispanic respondents had increased odds of future vaccination intention (OR = 1.89; 95%CI = 1.38–2.58). Compared to self-identified liberals, conservatives had about half the odds of intending future vaccination (OR = 0.51; 95% CI = 0.38-0.69). Age, education, and household income were significant at the $p < .05$ level but did not meet the $p < .01$ significance threshold for inclusion in the subsequent hierarchical logistic regression analysis (see Table 1 for complete bivariate results).

All general vaccine beliefs were positively associated with intention for future vaccination at the $p < .01$ level: benefits of vaccination (OR = 2.18; 95%CI = 1.90–2.51), collective benefits of vaccines (OR = 1.82; 95%CI = 1.60–2.07), high commitment altruism (OR = 1.29; 95%CI = 1.15–1.46), and low commitment altruism (OR = 1.34; 95%CI = 1.18–1.52). COVID-19 specific measures were also predictive: higher levels of COVID-19 worry (OR = 1.52; 95% CI = 1.35–1.70) and COVID-19 severity (OR = 1.48; 95%CI = 1.29–1.70) were both related to intention to vaccinate. Compared to those who did not know someone infected with COVID-19, those who reported yes or not sure had higher odds of intending to get vaccinated (OR = 1.37; 95%CI = 1.05–1.79; and OR = 1.89; 95% CI = 1.32–2.70, respectively). Compared to participants who did not perceive COVID-19 to be a problem in their community, those who did report this perception had greater odds of intending future vaccination (OR = 2.37; 95%CI = 1.87–3.00).

Table 2 summarizes the multivariable hierarchical logistic regression analysis and the reduced model. In Step 1, the demographic and background variables, race/ethnicity and political ideology were entered and remained significant covariates. In Step 2, the general beliefs, perceived benefits of vaccination, collective benefits of vaccines, high commitment altruism, and low commitment altruism were entered. Of these, only perceived benefits of vaccination remained significant and political ideology became non-significant. In Step 3, the COVID-19-related measures, perceived community threat, COVID-19 worry, COVID-19 severity, and knowing someone infected were entered. Of these, only perceived community threat of COVID-19 remained significant. For the reduced model, odds of being in the intender group was associated with race/ethnicity, benefits of vaccination, and perceived community threat. Specifically, compared to White respondents, Hispanic respondents had increased odds of being in the intender group (AOR = 1.74; 95%CI = 1.23–2.44, $p < .01$). Higher perceived benefits of vaccination (AOR = 2.19; 95%CI = 1.88–2.54) and perceived community threat (AOR = 1.91; 95%CI = 1.49–2.45) were both associated with greater odds of being an intender.

3.2. Vaccinators

Table 3 summarizes sample characteristics and bivariate comparisons, including percentages intending to receive an influenza vaccine in the next 12 months (for categorical variables) and point bi-serial correlations (for continuous variables). The mean sample age was 48.2 years and there was an equal split between males and females (49.2% and 50.7%). The majority (64.9%) were white-NH, 14.3% were Hispanic, 13.1% were Black-NH and 7.7% were Other-NH. Educational attainment was fairly evenly distributed, with the least number (19%) reporting high school completion or less. Household income was evenly distributed across the four categories, with a smaller percentage reporting more than $150,000 per year. Geographic location spanned the United States, with slightly fewer participants residing in the Southwest (10.7%). Respondents slightly more often self-identified as having moderate political leanings (36.7%) and there was a comparable representation of liberals (32.6%) and conservatives (30.7%) The majority of this sample (62.2%) reported not knowing someone infected with COVID-19 and a similar proportion (62.7%) felt that COVID-19 was a major problem in their community.

In bivariate comparisons, three demographic characteristics differed at $p < .01$ between intenders and non-intenders: age, race/ethnicity and education. As age increased, the odds of intending future vaccination increased (r = 0.246, OR = 1.06 ;95% CI = 1.05–1.07). Odds of future vaccination also increased with any level of

Table 1
Intention to Receive Influenza Vaccine among **Prior Non-Vaccinators**: Descriptive Statistics and Binary Logistic Regression Results.

	% (n) Or Mean (SD)	Intention to get Flu Vaccine in Next 12 Months: Percentages (categorical variables) and point-biserial correlations (continuous variables)	OR (95%CI)
Flu Vacc Next 12 Mos			
No	74.5% (1,230)		
Yes	25.5% (422)		
Demographic & Background:			
Age	42.94 (15.18)	r = -0.06	0.99 (0.98–0.99)*
Sex			
Female	53.6% (882)	25.9%	Ref
Male	45.9% (754)	24.7%	0.94 (0.75–1.18)
Other	0.5% (8)		
Race/Ethnicity			
White-NH	62.0% (1,011)	23.6%	Ref
Black-NH	17.4% (283)	23.0%	0.96 (0.70–1.32)
Other-NH	7.0.3% (119)	27.7%	1.24 (0.81–1.90)
Hispanic	13.3% (217)	36.9%	1.89 (1.38–2.58)**
Education			
HS Grad or Less	28.8% (469)	23.7%	Ref
Some College	30.7% (501)	23.0%	0.96 (0.71–1.29)
Bachelor's	26.2% (427)	30.0%	1.38 (1.03–1.86)*
Grad School	14.3% (234)	26.5%	1.16 (0.81–1.67)
Income			
< $25,000	38.2% (612)	23.4%	Ref
$25,000-$75,000	30.0% (482)	24.5%	1.06 (0.80–1.41)
$75,000-$150,000	23.6% (378)	29.4%	1.36 (1.02–1.82)*
>$150,000	8.2% (132)	28.8%	1.33 (0.87–2.02)
US Region			
Northeast	17.9% (293)	27.0%	Ref
Southeast	26.9% (441)	25.4%	0.92 (0.66–1.29)
Midwest	22.2% (364)	21.7%	0.75 (0.52–1.08)
Southwest	11.1% (181)	31.5%	1.24 (0.83–1.87)
West	21.9% (359)	24.2%	0.87 (0.61–1.23)
Political Leanings			
Liberal	30.8% (471)	32.3%	Ref
Moderate	39.9% (610)	25.7%	0.73 (0.56–0.95)*
Conservative	29.3% (448)	19.6%	0.51 (0.38–0.69)**
General Beliefs:			
Benefits of Vaccination	3.54 (0.99)	r = 0.28	2.18 (1.90–2.51)**
Collective Benefits of Vaccines	3.55 (1.03)	r = 0.23	1.82 (1.60–2.07)**
High Commitment Altruism	2.44 (0.92)	r = 0.10	1.29 (1.15–1.46)**
Low Commitment Altruism	3.20 (0.93)	r = 0.11	1.34 (1.18–1.52)**
COVID-19 Measures:			
COVID-19 Worry	3.29 (1.10)	r = 0.18	1.52 (1.35–1.70)**
COVID-19 Severity	2.90 (0.86)	r = 0.14	1.48 (1.29–1.70)**
Know Someone Infected			
No	68.8% (1,127)	22.9%	Ref
Yes	21.9% (359)	29.0%	1.37 (1.05–1.79)*
Not Sure	9.3% (153)	35.9%	1.89 (1.32–2.70)**
COVID-19 a Problem in your Community			
No	47.8% (779)	17.1%	Ref
Yes	52.2% (851)	32.8%	2.37 (1.87–3.00)**

*p < .05, **p < .01.

education beyond high school completion (OR = 2.21; 95% CI = 1. 39–3.50 for some college; OR = 2.68 ;95% CI = 1.69–4.24 for Bachelor's degree; OR = 2.46; 95% CI = 1.51–4.03 for graduate education.) Compared to white respondents, all other groups had decreased odds of vaccination intention (Black-NH OR = 0.24; 95% CI = 0.16-0.037; Other-NH OR = 0.28; 95% CI = 0.16–0.48; Hispanic OR = 0.32; 95%CI = 0.20–0.51).

Of the general beliefs, higher levels of benefits of vaccination (r = 0.33; OR = 3.05; 95%CI = 2.55–3.66), collective benefits of vaccines (r = 0.29, OR = 2.44; 95% CI = 2.08–2.88), and low commitment altruism (r = 0.12, OR = 1.61; 95% CI = 1.34–1.93) predicted greater vaccination intention. Of the COVID-19 measures, higher levels of COVID-19 worry and severity were related to greater vaccination intention (r = 0.10, OR = 1.39; 95%CI = 1.17–1.64 and r = 0.05, OR = 1.26; 95%CI = 1.02–1.56, respectively). Compared to those who did not know someone infected with COVID-19, those who reported yes or not sure were less likely to intend vaccination (OR = 0.64; 95%CI = 0.44–0.93 and OR = 0.49; 95%CI = 0.30–0.80, respectively).

Table 4 summarizes the multivariable hierarchical logistic regression analysis and the reduced model. In Step 1, the demographic and background variables were entered, and age, race/ethnicity, and education remained significant covariates. In Step 2, the general beliefs were entered, and benefits of vaccination and collective benefits of vaccines were significant. In Step 3, three COVID-19-related measures, COVID-19 worry, perceived community threat, and knowing someone infected were entered and none were significant. For the reduced model, odds of being in the intender group was associated with age, race/ethnicity, benefits of vaccination, and collective benefits of vaccines. Specifically, greater

Table 2
Intention to Receive Influenza Vaccine among **Prior Vaccinators**: Descriptive Statistics and Binary Logistic Regression Results.

	% (n) Or Mean (SD)	Intention to get Flu Vaccine in Next 12 Months: Percentages (categorical variables) and point-biserial correlations (continuous variables)	OR (95%CI)
Flu Vacc Next 12 Mos			
No	8.1% (150)		
Yes	91.9% (1,700)		
Demographic & Background:			
Age	48.2 (17.9)	r = 0.246	1.06 (1.05–1.07)**
Sex			
Female	50.7% (934)	91.4%	Ref
Male	49.2% (907)	92.5%	1.16 (0.82–1.62)
Other	0.1% (2)		
Race/Ethnicity			
White-NH	64.9% (239)	95.5%	Ref
Black-NH	13.1% (1,186)	83.7%	0.24 (0.16–0.37)**
Other-NH	7.7% (140)	85.7%	0.28 (0.16–0.48)**
Hispanic	14.3% (262)	87.4%	0.32 (0.20–0.51)**
Education			
HS Grad or Less	19.0% (347)	85.6%	Ref
Some College	26.3% (480)	92.9%	2.21 (1.39–3.50)**
Bachelor's	31.5% (575)	94.1%	2.68 (1.69–4.24)**
Grad School	23.1% (422)	93.6%	2.46 (1.51–4.03)**
Income			
< $25,000	25.6% (462)	90.3%	Ref
$25,000-$75,000	31.1% (561)	91.3%	1.13 (0.74–1.72)
$75,000-$150,000	30.9% (558)	93.4%	1.52 (0.96–2.39)
>$150,000	12.5% (225)	93.3%	1.51 (0.82–2.77)
US Region			
Northeast	22.8% (417)	92.1%	Ref
Southeast	25.5% (466)	94.2%	1.40 (0.82–2.37)
Midwest	21.5% (393)	90.3%	0.80 (0.49–1.31)
Southwest	10.7% (196)	88.8%	0.68 (0.38–1.20)
West	19.6% (359)	92.8%	1.10 (0.64–1.88)
Political Leanings			
Liberal	32.6% (574)	91.5%	Ref
Moderate	36.7% (645)	93.2%	1.28 (0.84–1.95)
Conservative	30.7% (540)	93.3%	1.31 (0.84–2.04)
General Beliefs:			
Benefits of Vaccination	4.18 (0.85)	r = 0.33	3.05 (2.55–3.66)**
Collective Benefits of Vaccines	4.16 (0.90)	r = 0.29	2.44 (2.08–2.878)**
High Commitment Altruism	2.61 (0.96)	r = -0.02	0.93 (0.78–1.10)
Low Commitment Altruism	3.56 (0.86)	r = 0.12	1.61 (1.34–1.93)**
COVID-19 Measures:			
COVID-19 Worry	3.63 (1.05)	r = 0.10	1.39 (1.17–1.64)**
COVID-19 Severity	3.14 (0.88)	r = 0.05	1.26 (1.02–1.56)*
Know Someone Infected			
No	62.2% (1,132)	93.5%	Ref
Yes	27.7% (505)	90.1%	0.64 (0.44–0.93)*
Not Sure	10.1% (184)	87.5%	0.49 (0.30–0.80)**
COVID_19 a Problem in your Community			
No	37.3% (679)	90.9%	Ref
Yes	62.7% (1,142)	92.8%	1.30 (0.92–1.83)

*p < .05, **p < .01.

age was associated with greater odds for intending vaccination (AOR = 1.04; 95% CI = 1.03–1.05). Compared to White respondents, Black-NH and Other-NH respondents had decreased odds of being in the intender group (AOR = 0.60; 95%CI = 0.36-0.999, p < .05 and AOR = 0.45; 95%CI = 0.24-0.84, respectively). Higher perceived benefits of vaccination (AOR = 1.88; 95%CI = 1.45–2.45) and perceived community threat (AOR = 1.48; 95%CI = 1.15–1.90) were both associated with greater odds of intending vaccination.

4. Discussion

The purpose of this study was to assess the relationship between individuals' past influenza vaccination behavior and their current intentions to receive the influenza shot in the next twelve months, as well as to assess the relationship between intention, health-related beliefs and attitudes, and perceptions of ongoing experiences with COVID-19. Of participants who were not vaccinated against influenza in the prior year, 25.5% shifted their stance to intend vaccination in the upcoming 12 months; the overwhelming majority of prior vaccinators (91.9%) planned to be vaccinated again and a small subgroup (8.1%) no longer intended to vaccinate. Considering this subgroup who "flipped" from prior vaccinator to non-intender, additional qualitative studies (e.g., individual interviews or focus groups) may identify the reasons for refusals. It is possible that a certain percentage may have vaccinated in the past because it was a condition of their employment (e.g., in health care settings), but may have lost their jobs and no longer felt a need to vaccinate. Our finding that a subgroup of non-vaccinators intend to vaccinate is consistent with a recent multi-country study of parents' intention to vaccinate their children against influenza in the upcoming season: 28.6% of prior non-vaccinators intended to vaccinate in the upcoming year [17]. Together, our findings-- that a sizeable proportion of adults who had not been vaccinated in the prior year and most prior vaccinators intended to be vaccinated

Table 3
Hierarchical Logistic Regression for Influenza Vaccination Intention for **Prior Non-Vaccinators**.

	Step 1 AOR (95%CI)	Step 2 AOR (95%CI)	Step 3 AOR (95%CI)	Reduced Model AOR (95%CI)
Demographic & Background:				
Race/Ethnicity				
White-NH	Ref	Ref	Ref	Ref
Black-NH	0.93 (0.66–1.33)	1.34 (0.92–1.96)	1.28 (0.88–1.88)	1.13 (0.80–1.59)
Other-NH	1.26 (0.78–2.02)	1.75 (1.06–2.89)*	1.66 (1.004–2.75)*	1.51 (0.96–2.39)
Hispanic	1.77 (1.23–2.54)**	2.12 (1.44–3.14)**	1.96 (1.32–2.91)**	1.74 (1.23–2.44)**
Political Leanings				
Liberal	Ref	Ref	Ref	
Moderate	0.85 (0.63–1.13)	1.06 (0.78–1.44)	1.13 (0.83–1.54)	
Conservative	0.57 (0.40–0.79)**	0.77 (0.54–1.11)	0.90 (0.62–1.30)	
General Beliefs:				
Benefits of Vaccination		2.01 (1.61–2.51)**	1.98 (1.58–2.47)**	2.19 (1.88–2.54)**
Collective Benefits of Vaccines		1.16 (0.95–1.42)	1.10 (0.90–1.35)	
High Commitment Altruism		1.13 (0.95–1.34)	1.09 (0.92–1.30)	
Low Commitment Altruism		1.17 (0.97–1.41)	1.18 (0.97–1.43)	
COVID-19 Measures:				
COVID-19 Worry			1.07 (0.90–1.27)	
COVID-19 Severity			1.15 (0.95–1.39)	
Know Someone Infected				
No			Ref	
Yes			0.93 (0.67–1.30)	
Not Sure			1.57 (0.98–2.50)	
COVID-19 a Problem in your Community				
No			Ref	Ref
Yes			1.47 (1.10–1.97)**	1.91 (1.49–2.45)**

*p < .05, **p < .01.

Table 4
Hierarchical Logistic Regression for Influenza Vaccination Intention among **Prior Vaccinators.**

	Step 1 AOR (95%CI)	Step 2 AOR (95%CI)	Step 3 AOR (95%CI)	Reduced Model AOR (95%CI)
Demographic & Background:				
Age	1.05 (1.04–1.07)**	1.04 (1.02–1.06)**	1.04 (1.02–1.06)**	1.04 (1.03–1.05)**
Race/Ethnicity				
White- NH	Ref	Ref	Ref	Ref
Black-NH	0.42 (0.25–0.73)**	0.54 (0.30–0.99)*	0.56 (0.30–1.02)	0.60 (0.36–0.999)*
Other-NH	0.42 (0.22–0.80)**	0.42 (0.21–0.87)*	0.43 (0.21–0.89)*	0.45 (0.24–0.84)*
Hispanic	0.69 (0.38–1.25)	0.82 (0.43–1.56)	0.79 (0.41–1.52)	0.92 (0.54–1.57)
Education				
HS Grad or Less	Ref	Ref	Ref	
Some College	1.49 (0.85–2.61)	1.75 (0.96–3.21)	1.81 (0.98–3.34)	1.54 (0.91–2.61)
Bachelor's	2.52 (1.38–4.63)**	2.57 (1.32–5.01)**	2.62 (1.34–5.12)**	1.67 (0.99–2.81)
Grad School	1.44 (0.81–2.56)	1.45 (0.76–2.76)	1.44 (0.76–2.73)	1.62 (0.93–2.85)
General Beliefs:				
Benefits of Vaccination		2.54 (1.84–3.50)**	2.52 (1.82–3.50)**	1.88 (1.45–2.45)**
Collective Benefits of Vaccines		1.47 (1.08–2.01)*	1.47 (1.08–2.01)*	1.48 (1.15–1.90)**
Low Commitment Altruism		0.92 (0.70–1.20)	0.93 (0.71–1.22)	
COVID-19 Measures:				
COVID-19 Worry			0.92 (0.72–1.17)	
Know Someone Infected				
No			Ref	
Yes			0.86 (0.50–1.49)	
Not Sure			0.92 (0.45–1.87)	
COVID_19 a Problem in your Community				
No			Ref	
Yes			1.31 (0.80–2.15)	

*p < .05, **p < .01.

in the next year-- are cause for cautious optimism for improving influenza vaccination uptake during future influenza seasons that coincide with a viral pandemic.

4.1. Attitudes, beliefs, and COVID-19 related experiences

Some differences between the two sets of predictive analyses emerged. For prior non-vaccinators, positive attitudes about benefits of vaccination and perceiving COVID-19 to be a problem in their community increased the odds of future vaccination intention. Perceiving COVID-19 as a problem in one's community may represent perceived threat from the infection that is proximal to the respondent's community, in contrast to more distal perceived threat to the "nation" as a whole. Drawing on the Health Belief Model [18], we hypothesize that for some adults who previously did not vaccinate for influenza, the current COVID-19 health crisis may serve as a "cue to action" for influenza vaccination. Cues to action comprise both internal and environmental triggers that acti-

vate individuals to engage in health promoting behaviors. For prior non-vaccinators the perception of COVID-19 being a major problem in their community may have served as such a trigger. Designing public health messages that brings the COVID-19 threat "closer to home" and/or appeal to the public's attachment to their community may be a direction for future health communication research that targets prior non-vaccinators.

For prior vaccinators, intention was unrelated to COVID-19 related experiences and attitudes and it was related to positive attitudes about benefits of vaccination and vaccination's collective benefits. Interestingly, compared to those who did not know someone infected with COVID-19, those who reported yes or not sure were less likely to intend vaccination. In future research it will be important to query the severity of symptoms of the individuals whom respondents identified as having COVID-19 (or were not sure about). Familiarity with non-symptomatic cases and/or mildly symptomatic cases (e.g., did not require hospitalization) may have dampened any "cue to action" effect of COVID-19 related experience. Overall, public health messages that target general benefits of vaccination may appeal to both non-vaccinators and vaccinators alike. Prior vaccinators may also respond to messages reminding them of the collective benefits of vaccination.

4.2. Sociodemographic analyses

Among past non-vaccinators, compared to white respondents, being Hispanic increased the odds of being in the intender group; among vaccinators, Black-NH and Other-NH adults were less likely than white-NH adults to intend vaccination and older respondents were more likely than their younger counterparts. Our findings suggest that the pandemic may have shifted the racial distribution in influenza vaccination intention [19–21]. For Hispanic respondents who did not vaccinate in the prior year, the current COVID-19 pandemic may have served as a "cue to action" that activated intent to vaccinate against influenza. As Schmid et al. (2017) note, ethnicity variables are most likely "carrier variables" of more complex explanatory factors that may help identify target groups for intervention but not the content of the interventions themselves [8]. Further investigation is needed to unpack factors underlying the ethnic difference findings in this study.

The COVID-19 pandemic is not over, and the start of another influenza season is less than a year away. Understanding how the COVID-19 pandemic influences influenza vaccination continues to be important for planning for future public health campaigns. The combination of influenza and a pandemic virus such as COVID-19 may pose an unprecedented challenge for the health of the public and a strain on health care systems, including hospital capacity [6]. As the public may vary in their awareness of the potential for influenza to intersect with viruses such as COVID-19, public health messaging should include basic education about such potential "perfect storms". Ongoing public health monitoring of US adults' intentions to receive the influenza vaccine during a pandemic is important, given the potential for changes in perceptions of both specific pandemic-related vaccines under development and existing vaccines for influenza and other pathogens. Public health professionals must work to alleviate strain on the healthcare system while they work to keep individuals healthy with known measures like an influenza vaccine. The work presented here offers practical starting points for potential intervention strategies to ensure high influenza vaccine coverage in seasons to come.

4.3. Limitations

Several limitations to this study are acknowledged. The question about COVID-19 being a problem in the respondent's community did not define "community"; thus, geographic and/or neighborhood referents may vary across respondents. Better delineation of what "community" means to respondents (e.g., immediate neighborhood, circle of family/friends, city, county, state, etc.) may provide ideas for tailoring health messages about immunization. An additional limitation of the design was the necessary reliance on intention rather than vaccination behavior; data was collected in May 2020, prior to the fall-winter influenza vaccination season. Similarly, like other self-report measures of health behavior, self-report of past influenza vaccination status is subject to recall and social desirability biases. However, there are robust findings that self-report of influenza vaccination status is quite accurate for adults [22–24]. Lastly, intention for future influenza vaccination may not necessarily translate into actual vaccination and may be sensitive to such changes as fluctuations in the status of a viral pandemic, as well as other factors (e.g., the severity of the influenza season).

5. Conclusions

In an online survey, 53% of participants had received the flu vaccine in the prior year and 47% had not. Looking to the future, a significant subset (25.5%) of participants who had not vaccinated against influenza in the prior 12 months endorsed an intention to vaccinate in the upcoming 12 months. In this subset, Hispanic participants (compared to whites) and individuals who perceived general benefits from vaccination and COVID-19 as a threat in their community had increased odds of intending to vaccinate. Among prior vaccinators, the majority intended to vaccinate again. For some adults, the COVID-19 pandemic may have served as a "cue to action" to intend to vaccinate against influenza. Public health appeals about influenza vaccination that include community-referent messages and highlight the potential benefits of vaccination, including those to the community, may be a useful direction for further research.

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Lynne Sturm: Conceptualization, Methodology, Formal analysis, Writing - original draft. **Monica L. Kasting:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Katharine J. Head:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Jane A. Hartsock:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Gregory D. Zimet:** Conceptualization, Methodology, Formal analysis, Writing - review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Gregory D. Zimet has served as a paid consultant to Sanofi Pasteur for work on the Adolescent Immunization Initiative, to Merck for work on HPV vaccination, and to Moderna for work on COVID-19 vaccination.

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