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Association of death or illness from COVID-19 among family and friends on vaccine uptake within four months of the Emergency Use Authorization. Findings from a national survey in the United States

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ABSTRACT

Objective: To examine the relationship between knowing that a friend or family member became ill with, or died from, COVID-19 and receiving a vaccine dose within four months of the FDA's Emergency Use Authorization.
Methods: A national sample of 1,517 respondents were surveyed from April 7 to April 12, 2021, 1,193 of whom were eligible for the vaccine when the data were collected.
Results: Respondents who knew someone who became ill with COVID-19 (AOR = 2.32, 95 % CI 1.74–3.09) or knew someone who died (AOR = 2.29, 95 % CI 1.32–3.99) from COVID-19 were more likely to receive at least a single COVID-19 vaccine dose.
Conclusion: Encouraging people to share their COVID-19 illness and bereavement experiences with their local network such as friends, families, social-networks and via social media might help increase vaccine uptake.

1. Introduction

As 2022 draws to a close, COVID-19 has infected nearly 100 million individuals in the United States alone, resulting in more than one million deaths [1] and devastating economic consequences for individuals, families, and society [2]. Vaccines are effective, economical, and life-saving interventions [3], which is why the U.S. Food and Drug Administration (FDA) issued emergency use authorization (EUA) for Pfizer BioNTech and Moderna mRNA vaccines in December 2020 [4]. In theory, effective vaccines can successfully end pandemics, but not if uptake is sub-optimal.

Suboptimal COVID-19 vaccination has led to the emergence of newer variants with increased transmissibility [5–10]. Despite public health and media campaigns promoting vaccination, many vaccine-eligible individuals have not received a single dose of the vaccine in the United States [11]. Nearly-two years after the EUA, 16.0 % (n ~ 53.3 million) of the vaccine-eligible population (≥5 years old) remain unvaccinated, even though the U.S. has a stockpile of hundreds of millions of doses of three different WHO- and FDA-approved COVID-19 vaccines [1].

Vaccine uptake is a complex, socially-patterned behavior that is context-specific, and varies across time, place, and vaccines [12]. Identifying influences on early vaccine adoption could inform the development of public health interventions to increase vaccination. Most health behaviors, including vaccine uptake, are subject to peer influence [13–16]. Prior studies have evaluated the association of social influence and vaccination with mixed findings [17–22]. Exposure to vaccinated individuals may provide reassurance about the safety and effectiveness of the vaccine leading to increased uptake of vaccination. However, it may also motivate people to avoid getting vaccinated if they see the majority has already been vaccinated and herd immunity has been achieved [18,21–23]. Finding effective persuasive promotional strategies using social influence may help increase COVID-19 vaccine uptake [19,20].

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Prior studies of other infectious diseases have shown that vaccine uptake is more likely when people know someone who has been ill with the disease that the vaccine was designed to prevent [24–28]. One prior study showed that individuals who did not know anyone with COVID-19 were more likely to refuse the vaccine [24]. However, that study did not adjust for regional differences in vaccine uptake [29,30] and nearly 80 % of the sample was already vaccinated. Moreover, several demographic groups (men, younger individuals, college-educated respondents, full-time employees) were over-represented.

In our study, we attempted to address these weaknesses and tested the hypothesis that vaccine uptake within months of the EUA would be more common among individuals who personally knew someone who became ill with, or died, from COVID-19 [31]. Our hypothesis was informed by the Health Belief Model (HBM), which suggests that health promoting behavior is a product of several processes, including stimuli that prompt action (cues to action) [13]. The awareness about the experiences of friends and family members may motivate the early adoption of a vaccine, as it provides a cue to action [32].

2. Methods

2.1. Study Setting, data source, and study design

The survey was conducted from April 7 to April 12, 2021. Respondents were recruited using Qualtrics research panel service, which is a study participant recruitment service platform that is commonly used to conduct surveys in the United States. Qualtrics invites participants by distributing recruitment messages to potential participants using online platforms of registered and verified users. Qualtrics ensures that a diverse sample is collected across the country by randomly selecting survey respondents. Eligible participants are then provided access to the survey. Email invitations, in-app notifications, or SMS notifications are used to inform eligible participants that the survey is for research purposes only. Information about survey length and incentives are also provided. To avoid self-selection bias, survey invitations do not include specific details about the contents of the survey and are instead kept general. Rewards were given by Qualtrics that varied such as cash, airline miles, gift cards, redeemable points, charitable donations, sweepstakes entrance, and vouchers. Information on the specific rewards provided to participants in this study are unavailable.

To assess COVID-19 vaccination status, respondents were asked if they have received at least one dose of the COVID-19 vaccine. To assess social network experiences of respondents with people who had become ill or died from COVID-19, respondents were asked if they knew family members or friends who had been recovered, are still sick, or had died with COVID-19. Respondents were allowed to select multiple options as some may know family members or friends that may had been sick and later died with COVID-19. Responses were used to create binary independent variables of interest reflecting knowledge of sick/recovered or died family members or friends from COVID-19. Covariates included sex, age, race, ethnicity, marital status, income, employment (including essential-worker status), education, health insurance coverage, region, and perceived health status (5-point scale). We adjusted for essential-worker status because essential-workers had access to the COVID-19 vaccine earlier than the other population groups and were more likely to know individuals who had been exposed to COVID-19 [33]. Our survey had asked if respondents' occupation falls in the essential worker categories, such as frontline healthcare worker, grocery store personnel, mail and delivery personnel, first responder (firefighter, police officer, EMT, etc.), public transport personnel and the same was used to create a binary variable for essential-worker status. In addition, to account for local COVID-19 death rates, we linked the U.S. Census data for county population and COVID-19 deaths from CDC (Jan 2020 to March 2021) to our study data [34,35]. The study was approved by the Institutional Review Board, Rutgers University, New Brunswick.

2.2. Data analysis

Of the 1,517 survey respondents, 324 were excluded because they reported they were ineligible for the vaccine (n = 313) or they gave conflicting answers to the two social network items (n = 11), resulting in the final analytic sample of 1,193. We conducted descriptive analyses to characterize the sample and compare vaccine-eligible respondents who had (n = 698) and had not (n = 495) received at least one vaccine dose within the first few months of the EUA. The hypothesized associations between social network exposure and vaccination status (Vaccinated and Unvaccinated) were tested using multivariate logistic regression while accounting for covariates described above. Unadjusted logistic regressions to assess the impact of adjustment in multivariate modeling were also tested (Table S1 in the supplement materials).

In a sensitivity analysis we used multi-level modeling to account for census regional-level (ICC = 0.06) clustering in vaccine uptake [36,37]. We also tested for effect modification by essential worker status; no evidence for effect modification was observed. (Table S2 in the supplement materials). We analyzed data using STATA 16.1 (StataCorp).

3. Results

Table 1 shows the characteristics of the 1,193 adults in the sample (49.1 % men and 49.4 % women; median age, 40 years; interquartile range, 30–45 years). The sample had 36.4 % Non-Hispanic Whites, 21.0 % Non-Hispanic Blacks, 8.3 % American Indians or Alaskan Natives, 10.3 % were Asians or Native Hawaiians and, 24.0 % were Hispanic/Latinos. 23.8 % of the sample had no health insurance. Most (75.4 %) participants had more than 12 years of education, and most (63.5 %) were employed; 40.7 % of the study sample was employed in an essential occupation.

Table 2 details the independent variables that were evaluated in our logistic regression model to assess their association with COVID-19 vaccine acceptance. Respondents who knew someone in their close network who had been ill with (AOR 2.32, 95 % CI 1.74–3.09), or died from (AOR 2.29, 95 % CI 1.32–3.99), COVID-19 were more likely to have received a vaccine dose by April 12, 2021.

Essential workers and people with good or better health status were more likely to have received a vaccine dose within four months of the EUA. As shown in Table 2, older respondents and respondents with higher income and greater education were also more likely to receive at least one dose. Conversely, the uninsured, and Alaskan natives or American Indians were significantly less likely to receive the vaccine within four months of the EUA.

Sensitivity analyses yielded comparable findings for the hypothesized predictors. Respondents who had someone in their close network who had been ill with (AOR 2.25, 95 % CI 1.69–2.99), or died from (AOR 2.32, 95 % CI 1.34–4.02), COVID-19 were more likely to have received a vaccine dose by April 12, 2021.

4. Discussion

Increasing vaccine uptake has been an ongoing public health challenge [38–40] for more than 150 years since the United Kingdom introduced compulsory vaccination in 1871. In this large national survey administered in the United States in April 2021,

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Table 1
Descriptive Statistics of Survey Population, United States, April 2021.

Variables	All Respondents n = 1,193 (100 %)		Vaccinated for COVID-19 (at least one dose) n = 698 (58.5 %)		Unvaccinated for COVID-19 n = 495 (41.5 %)		*P* Value[1]
	N	%	N	%	N	%	
Sex: Male	586	49.1 %	376	53.9 %	210	42.4 %	<0.001
Female	589	49.4 %	311	44.6 %	278	56.2 %	
Others	18	1.5 %	11	1.6 %	7	1.4 %	
Age Group: 18–29 y	395	33.1 %	183	26.2 %	212	42.8 %	<0.001
30–45 y	388	32.5 %	224	32.1 %	164	33.1 %	
46–60 y	202	16.9 %	131	18.8 %	71	14.3 %	
61–74 y	170	14.3 %	130	18.6 %	40	8.1 %	
75 or older	38	3.2 %	30	4.3 %	8	1.6 %	
Race/Ethnicity Non-Hispanic White	434	36.4 %	289	41.4 %	145	29.3 %	<0.001
Black or African American	251	21.0 %	119	17.0 %	132	26.7 %	
American Indian or Alaska Native	99	8.3 %	41	5.9 %	58	11.7 %	
Asian or Native Hawaiian	123	10.3 %	81	11.6 %	42	8.5 %	
Hispan ic/Latinos	286	24.0 %	168	24.1 %	118	23.8 %	
Marriage: Married	610	51.1 %	392	56.2 %	218	44.0 %	<0.001
Single	410	34.4 %	200	28.7 %	210	42.4 %	
Separated	173	14.5 %	106	15.2 %	67	13.5 %	
Income Level: Less than $10,000	127	10.7 %	48	6.9 %	79	16.0 %	<0.001
$10,000 - $29,999	211	17.7 %	107	15.3 %	104	21.0 %	
$30,000 - $59,999	307	25.8 %	164	23.5 %	143	28.9 %	
$60,000 - $89,999	213	17.9 %	134	19.2 %	79	16.0 %	
$90,000 or more	334	28.0 %	245	35.1 %	89	18.0 %	
Education Attained: (<12y)	27	2.3 %	9	1.3 %	18	3.6 %	<0.001
12 y	266	22.3 %	112	16.0 %	154	31.1 %	
13 y or more	900	75.4 %	577	82.7 %	323	65.3 %	
Employment Status: Unemployed	435	36.5 %	238	34.1 %	197	39.8 %	0.04
Employed (Full/Part-time)	758	63.5 %	460	65.9 %	298	60.2 %	
Worker Type: Essential Worker	486	40.7 %	313	44.8 %	173	34.9 %	<0.001
Non-essential Worker	707	59.3 %	385	55.2 %	322	65.1 %	
Insurance Status: Uninsured	284	23.8 %	117	16.8 %	167	33.7 %	<0.001
Medicaid or Medicare	480	40.2 %	318	45.6 %	162	32.7 %	
Private Insurance	429	36.0 %	263	37.7 %	166	33.5 %	
Region: Northeast	229	19.2 %	150	21.5 %	79	16.0 %	<0.001
Midwest	211	17.7 %	118	16.9 %	93	18.8 %	
South	482	40.4 %	248	35.5 %	234	47.3 %	
West	271	22.7 %	182	26.1 %	89	18.0 %	
COVID-19 County Deaths per 1,000 people	1.67	0.73	1.69	0.76	1.64	0.69	<0.001
Perceived Health Status: Fair or Poor	147	12.3 %	73	10.5 %	74	14.9 %	0.02
Good, Very Good, or Excellent	1046	87.7 %	625	89.5 %	421	85.1 %	
Family or Friends Recovered/Sick from COVID-19	469	39.3 %	336	48.1 %	133	26.9 %	<0.001
Family or Friends Died from COVID-19	88	7.4 %	64	9.2 %	24	4.8 %	0.005

Note: [1] Statistics represents differences between group using chi-squared test of independence.
Data Source: Qualtrics Panel Service, United States.

we found that the likelihood of receiving the vaccine was significantly greater among those who knew someone who became ill with, or died from, COVID-19. This association was observed in two different analytic approaches, and was independent of established demographic, socioeconomic, and geographic correlates of vaccination.

Our results are consistent with one prior study on COVID vaccination [24], though our effect sizes were smaller, perhaps because our sample was more representative and we statistically adjusted for confounding factors such as county deaths, essential worker status, and regional variabilities [29]. Our hypothesis was derived from Rosenstock's Health Belief Model, namely, that individuals are more like to adopt preventive behaviors when they are exposed to a salient cue that prompts action. We can use this evidence in policy as well as practice by highlighting the role that cues to action from family members and friends can play in the acceptance of COVID-19 vaccines.

The public health implications of these findings are relatively straightforward. Health information, when shared by personal contacts, is likely a more potent cue to action than generic public health messages in media or print that focus on increasing the knowledge of benefits of vaccine uptake [41–44]. If more people share their COVID-19 illness and bereavement experiences with their friends, families, social-networks, either in-person or via social media, vaccine uptake could be increased. Our study results could help social workers, public health campaign managers, policymakers, political leaders, governments agencies, and clinics designing strategies in overcoming the pandemic faster and save lives. Identifying other salient cues to action could inform the development of public health interventions to increase vaccination.

We found younger adults, those with lower education, and individuals residing in lower income households were less likely to be vaccinated within four months of the EUA. In conjunction with similar findings [42], the current results highlight the need for focused efforts to increase vaccine uptake in these demographic groups [45]. For example, increased vaccination in younger adults can further help curb community spread of COVID-19, especially among the more vulnerable older adults. Older adults have the highest rate of complications and mortality from COVID-19 among all age groups [46–49].

Several limitations should be taken into account in interpreting the study results. The use of self-reported data is subject to biases and limitations, including socially desirable responding. Probability sampling was not used, so generalizability to the U.S. adult pop-

Table 2
Logistic Regression: Individual characteristics associated with COVID-19 vaccination status, United States (April 2021), n = 1,193.

Predictor Variables	AOR (95 % CI)
Sex: Male (Ref.)	1.00
Female	0.77 (0.58–1.02)
Others	1.79 (0.61–5.22)
Age Group: 18–29 y (Ref.)	1.00
30–45 y	1.21 (0.85–1.73)
46–60 y	2.50** (1.61–3.90)
61–74 y	5.76** (3.37–9.84)
75 or Older	9.01** (3.54–22.98)
Race/Ethnicity Non-Hispanic White (Ref.)	1.00
Black or African American	0.73 (0.50–1.07)
American Indian or Alaska Native	0.34** (0.20–0.57)
Asian or Native Hawaiian	1.42 (0.88–2.30)
Hispanic/Latinos	1.05 (0.72–1.53)
Marriage: Married (Ref.)	1.00
Single	1.13 (0.82–1.57)
Separated	0.91 (0.60–1.38)
Income Level: Less than $10,000 (Ref.)	1.00
$10,000 - $29,999	1.15 (0.69–1.91)
$30,000 - $59,999	1.07 (0.65–1.75)
$60,000 - $89,999	1.43 (0.83–2.48)
$90,000 or more	2.42** (1.41–4.16)
Education Attained: < 12 y (Ref.)	1.00
12 y	0.94 (0.37–2.39)
> 12 y	1.47 (0.59–3.70)
Employment Status: Employed (Full/Part-time) (Ref.)	1.00
Unemployed	1.13 (0.78–1.63)
Essential Workers	1.92** (1.37–2.69)
Insurance Status Before Pandemic Medicaid or Medicare (Ref.)	1.00
Private Insurance	0.85 (0.61–1.18)
Uninsured	0.60** (0.42–0.87)
Region: Northeast (Ref.)	1.00
Midwest	0.85 (0.56–1.31)
South	0.81 (0.54–1.22)
West	1.19 (0.75–1.88)
COVID-19 County Deaths per 1,000 people	1.17 (0.95–1.43)
Perceived Health Status: Fair or Poor (Ref.)	1.00
Good, Very Good, or Excellent	1.55* (1.02–2.33)
Family Members or Friends Recovered/Sick from COVID-19	2.32** (1.74–3.09)
Family Members or Friends Died from COVID-19	2.29** (1.32–3.99)

Note: *** p <.01, * p <.05, AOR Adjusted Odds Ratio, CI Confidence Intervals.*
Data Source: Qualtrics Panel Service, United States.

ulation is limited. The predictors and outcomes were simultaneously assessed in this cross-sectional study and therefore causal inferences cannot be established. Data on the temporal relationship between the predictor and outcome is unavailable, so it is unknown whether, for example, respondents who knew someone who died from COVID-19 received their vaccine prior to or subsequent to this knowledge. Data on COVID-19 illness severity is unavailable, so it is unknown, for example, if long-covid is a more potent cue to action. At the time of this study, roughly 39.4 % Americans had received at least one dose whereas 58.5 % of study participants had received at least one dose. Our results are from within four months of EUA, and cannot generalize to longer durations, such as after herd immunity has been established.

5. Conclusion

By encouraging individuals to share their COVID-related illness and bereavement experiences in their local-networks, public health practitioners could increase vaccine uptake. Ideally, any efforts to encourage COVID-related disclosure should empathically acknowledge that not all will be comfortable in sharing due, for example, to stigma, shame, or the desire for privacy. Local public health departments could facilitate public messaging campaigns with the help of public health non-profits organizations to share the experiences of people who have recovered or are sick, to increase vaccine acceptability. A timely vaccination to all eligible individuals worldwide is our only hope to end this pandemic prior to the emergence of newer variants that may make the current vaccinations ineffective.

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CRediT authorship contribution statement

Saurabh Kalra: Conceptualization, Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing. **Deepak Kalra:** Methodology, Writing – review & editing. **Irina Grafova:** Methodology, Writing – review & editing. **Julia Sass Rubin:** Investigation, Writing – review & editing. **Alan Monheit:** Methodology, Writing – review & editing. **Joel Cantor:** Investigation, Writing – review & editing. **Paul Duberstein:** Methodology, Supervision, Writing – review & editing. **Soumitra Bhuyan:** Investigation, Writing – review & editing.

Data availability

Data will be made available on request.

Declaration of Competing Interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2023.01.024.

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