



Breakthrough infections and acceptance of COVID-19 vaccine boosters: A survey analysis

Christina W. Stevens^a, Stephen R. Neely^{a,*}, Joshua M. Scacco^b

^a University of South Florida, School of Public Affairs, United States of America

^b University of South Florida, Department of Communication, United States of America

ARTICLE INFO

Keywords:

COVID-19
Vaccine hesitancy
Booster shots
Breakthrough infections

ABSTRACT

Objective: This Short Communication explores the effect of COVID-19 breakthrough infections (defined as a COVID-19 diagnosis *after* vaccination) on the willingness of previously vaccinated individuals to receive ongoing vaccine boosters. Specifically, we examine unique effects for three different breakthrough infection experiences, including the participant themselves, a close member of their family, and a friend/coworker.

Methods: A representative, web-based survey of 600 adults in the state of Florida was fielded in March/April of 2022. Among the respondents, 455 had been vaccinated against COVID-19. Their responses were analyzed for this study using both descriptive and inferential statistical methods.

Results: Individuals who have experienced a personal breakthrough infection are two times less likely to receive annual vaccine boosters, *ceteris paribus*. However, there is not a statistically significant relationship between vaccine acceptance and breakthrough infections among close family members or friends/coworkers. We also found a very strong relationship between vaccine decisions and confidence in public health guidance.

Conclusion: Our findings show that confidence in public health guidelines is the most compelling determinant of vaccine acceptance, but breakthrough infections also have a significant impact on individual decision making when it comes to ongoing vaccination. Going forward, public health messaging should directly account for this correlation in order to effectively maintain vaccination levels.

Innovation: The COVID-19 pandemic marked a turning point in the development and deployment of mRNA vaccines. This study contributes to innovation in health communication research by examining how breakthrough infections in these vaccinated individuals impacts ongoing booster shot acceptance. The findings of this study contribute to the nascent and ongoing development of baseline research in this area.

1. Introduction

Despite messaging from public health officials and government leaders about the importance of receiving ongoing booster shots to maintain vaccination against COVID-19, rates of adoption have remained lower than desired among Americans. Currently, only 33% of United States adults between the ages of 18 and 64, and 65% of adults ages 65 and up have received a COVID-19 booster shot [1]. Booster shot hesitancy can be attributed to multiple factors, including politicization of the COVID-19 pandemic and declining trust in public health guidance [2,3]. More recently, it's also been suggested that news coverage of breakthrough infections (*i.e.* diagnosed cases of COVID-19 among vaccinated adults) may have undermined efforts to maintain ongoing vaccination against COVID-19. Critics of recent news coverage have pointed out that in many cases, popular reporting has made “breakthrough infections [to] seem like a new development rather than a statistical inevitability” [4]. Furthermore,

some have suggested that public health officials may have fallen short in communicating the fact that “breakthrough infections are not new” and that vaccine efficacy is likely to vary among individuals [5]. In the absence of clear and effective public health messaging around breakthrough infections, it's possible that these experiences could reduce public confidence in vaccine efficacy or lead those with mild breakthrough infections to believe that they are not in need of further vaccination.

In this short communication report, we examine how breakthrough infections impact booster shot hesitancy and acceptance among American adults. A representative sample of 600 adults in the state of Florida was collected in March of 2022. We asked vaccinated survey respondents ($n = 455$) if they had personally experienced a breakthrough COVID-19 infection (defined as a COVID-19 diagnosis *after* vaccination), or if they had experienced a breakthrough infection indirectly through a close family member or friend/coworker. Variables were also collected for factors known to influence vaccine hesitancy, including (1) trust in public health

* Corresponding author at: 412.335.5055, 4202 E. Fowler Ave., SOC 107, Tampa, FL, 33620, United States of America.
E-mail addresses: srneely@usf.edu (S.R. Neely), jscacco@usf.edu (J.M. Scacco).

officials, (2) personal demographics, (3) educational attainment, and (4) political affiliation. On August 31, 2022, the FDA announced emergency authorization for an ‘updated booster’ to provide protection against multiple strains of the virus, including the original strain of SARS-CoV-2, as well as the Omicron variant [6]. Consistent messaging and increased trust in public health officials will be necessary to increase booster vaccination rates among American adults, particularly those vaccinated individuals who have experienced breakthrough infections.

2. Methods

We conducted a web-based survey of 600 adults in the state of Florida between March 31 and April 12, 2022. The sample was purchased through an industry leading market research provider (Prodege MR), and respondents were identified using a stratified, quota sampling approach to ensure representativeness. Balanced quotas were determined (by region of the state) for gender, age, race, ethnicity, and political affiliation, each of which has been linked to vaccine acceptance in prior studies [2,7]. Given the focus of this analysis on booster shot acceptance, only 455 respondents who were previously vaccinated against COVID-19 are included in this current study. Consistent with prior research [8], participants were asked to share how likely they are to receive “annual” booster shots of the COVID-19 vaccine “if they are recommended by public health experts”. Response options included (1) “very likely”, (2) “somewhat likely”, (3) “not very likely”, and (4) “not at all likely”.

Additionally, in order to better understand how breakthrough infections are correlated with vaccination decisions, we asked three distinct questions to measure whether respondents had directly or indirectly experienced a breakthrough infection. The initial question asked whether the respondent themselves had been “diagnosed with COVID-19 after being vaccinated”. Subsequent questions asked the same about “a member of your family” and “any of your friends, coworkers, or acquaintances”, respectively. This approach allows for the measurement of unique relationships across varying degrees of proximity to the individual decision maker.

We employed a binary logistic regression model to examine the relationships between these breakthrough infection experiences and the likelihood of accepting regular booster shot injections. Given the focus of this analysis on vaccine acceptance, the model measures the likelihood of a respondent choosing “very likely” when asked about their willingness to receive additional COVID-19 booster shots. The model also included (1) a measure of confidence in the vaccine guidance offered by public health officials, (2) the three aforementioned measures of breakthrough infection experiences, (3) a vector of demographic control variables, (4) a measure of the respondent’s highest completed level of education, and (5) a measure of political affiliation.

3. Results

Among the survey respondents, 75.8% had received at least one dose of a COVID-19 vaccine. While the aim of this study was not to identify vaccination rates, it’s worth noting that this statistic is slightly higher than the 69.5% reported vaccination rate for Florida at the time of data collection [9]. Of these respondents, 53.6% indicated that they would be “very likely” to receive regular booster shots, while 25.1% indicated that they would be only “somewhat likely” (Table 1). A combined 21.3% indicated that they would be either “not very likely” or “not at all likely”.

Table 1
How likely will you be to receive regular booster shots of the COVID-19 vaccine if they are recommended by public health experts?

	Frequency	Percentage
Very Likely	244	53.6
Somewhat Likely	114	25.1
Not Very Likely	59	12.9
Not at All Likely	38	8.4

Question was only asked to those who have received at least one dose of a COVID-19 vaccine (N = 455).

Table 2
Breakthrough infection experiences.

	Frequency	Percentage
<i>Have you been diagnosed with COVID-19 after being vaccinated?*</i>		
Yes	60	13.2
No	395	86.8
<i>Has a member of your family been diagnosed with COVID-19 after being vaccinated?</i>		
Yes	173	28.8
No	427	71.2
<i>Have any of your friends or coworkers been diagnosed with COVID-19 after being vaccinated?</i>		
Yes	280	46.7
No	320	53.3

* Question was only asked to those who have received at least one dose of a COVID-19 vaccine (N = 455).

Only 13% of respondents (n = 60) reported having been diagnosed with a breakthrough infection themselves (Table 2). However, 29% (n = 173) reported that a member of their family had been diagnosed with a breakthrough infection, while 47% (n = 280) said that same about a friend or coworker. While the number of respondents who themselves experienced a breakthrough infection was relatively small (13%), the number of respondents in this category exceeds the “cell-size” expectations/assumptions of the logistic regression technique employed in this analysis.

The logit regression results – reported in Table 3 – show that individuals who have been diagnosed with breakthrough infections are less likely to accept subsequent vaccine booster shots. Specifically, those who experienced a breakthrough infection themselves were over two times less likely to say that they would receive annual vaccine boosters, *ceteris paribus* ($e^b = 0.472$). However, there were not statistically significant relationships between vaccine acceptance and the occurrence of breakthrough infections among family members or friends/coworkers. This suggests that individual

Table 3
Logistic regression: likelihood of booster shot hesitancy (n = 455).

	e^b	β	s.e.
<i>Confidence in public health guidance</i>			
Not at all confident	–	–	–
Not very confident	1.212	0.193	0.497
Somewhat confident	4.642***	1.535***	0.468
Very confident	21.449***	3.066***	0.528
<i>Breakthrough Infections (Yes)</i>			
Self	0.472**	–0.751**	0.377
Family Member	1.209	0.189	0.317
Friend, Coworker, or Acquaintance	0.762	–0.272	0.281
Gender (Female)	0.669	–0.401	0.250
<i>Age</i>			
18–24	–	–	–
25–44	1.517	0.417	0.509
45–64	3.876***	1.355***	0.498
65+	7.969***	2.075***	0.526
Hispanic (Yes)	1.069	0.067	0.274
<i>Race</i>			
White	–	–	–
African American	0.543*	–0.611*	0.322
Other	0.320*	–1.139*	0.657
<i>Education</i>			
<high school	–	–	–
High school/some college	0.554	–0.590	0.745
Four-year degree or higher	0.834	–0.182	0.768
<i>Political Affiliation</i>			
Non-voter	–	–	–
Democrat	6.027***	1.796***	0.507
Independent	2.592*	0.953*	0.515
Republican	1.762	0.566	0.509
Constant	0.074**	–2.598**	1.094
–2LL	–233.107	–	–
Pseudo R ²	0.258	–	–

* $p \leq 0.10$; ** $p \leq 0.05$; *** $p \leq 0.01$

experiences are more important than proximal one's when making vaccine decisions. This is perhaps unsurprising, as individual infections may give decision makers a sense of how their own bodies are likely to react to future COVID-19 infections, thus informing their vaccine intentions.

Confidence in public health experts was also highly predictive of booster shot acceptance. Those who reported being “very confident” in public health guidance were over 21 times more likely to choose “very likely” when asked about their willingness to receive annual vaccine booster shots ($e^b = 21.449$), as opposed to those who were “not at all confident”. Even those who were only “somewhat confident” in public health guidance were over 4 times more likely ($e^b = 4.642$) to say “very likely” than those who were “not at all confident”.

Several additional predictors were also related to booster shot acceptance. For example, those 65 and older were nearly 8 times more likely than those between 18 and 24 years of age ($e^b = 7.969$) to say that they would accept regular vaccine boosters, while those between 45 and 64 were nearly 4 times more likely ($e^b = 3.876$). Additionally, African American respondents were 1.84 times less likely than Whites to answer “very likely” ($1/e^b = 1.842$).

Finally, we found a significant relationship for some political affiliations but not others. Specifically, those who identified as registered Democrats were 6.027 times more likely to indicate vaccine acceptance than non-voters (reference category). Independent voters were 2.592 times more likely than non-voters to say the same, but there was not a significant relationship between Republican Party affiliation and booster shot acceptance.

4. Discussion and conclusion

4.1. Discussion

Just as the COVID-19 pandemic has continued to shift with viral variants, so too have public attitudes on how to mitigate pandemic effects. Consistent with prior research [9], we found that greater confidence in public health guidance and age contribute to an increased acceptance of booster shots. Additionally, partisan effects, particularly Democratic Party affiliation, also remain potent to pandemic attitudes. Yet, new pandemic developments associated with breakthrough infections may cut against booster shot acceptance. For example, in the current study, a combined 21.3% indicated that they would be either “not very likely” or “not at all likely” to receive regular COVID-19 booster shots. Notably, this represents a decline in likelihood from a prior study of the same population taken in 2021 [9]. In that study, 70% of previously vaccinated respondents said that they were very likely to receive regular booster shots, while only 7.4% were “not very likely” or “not at all likely” to do the same. While it's possible that this represents a temporal decline in the public's willingness to receive additional vaccine boosters, further analysis would be needed to confirm this suspicion.

The data presented above show that it is among previously vaccinated individuals who faced a breakthrough infection that future booster shot acceptance declined. Based on the current findings, these personal experiences with breakthrough infections may have slowed public acceptance for COVID booster shots. It's important to note that while personal experiences with breakthrough infections (*i.e.* breakthrough infections among the respondents themselves) were associated with a reduction in acceptance of vaccine boosters, indirect experiences (such as a family member or friend who suffered a breakthrough infection) were not. This distinction may reflect some belief on the part of respondents that having suffered a breakthrough infection will result in strengthened immunity without the need for additional booster shots. It may also be the case that having experienced a COVID-19 infection, some respondents are simply no longer concerned about contracting the virus in the future. In either case, additional research is needed to further explore and understand these relationships.

Given that previously vaccinated individuals initially accepted personal and communal mitigation approaches, such developments in booster hesitancy should shift attention to how public communication campaigns can blunt emerging attitudes. The importance of public health guidance, including confidence in public health professionals, to booster shot acceptance

could be integrated into future health communication efforts. The Centers for Disease Control and Prevention website includes dedicated information about “COVID-19 after Vaccination,” including explanations of key terminology and why infections still occur [10]. Attempting to meet potential audiences in more entertainment-focused spaces, Dr. Anthony Fauci appeared on “The Late Show with Stephen Colbert” to talk booster vaccination and receive a bivalent COVID shot in October 2022 [11]. Such efforts may need expansion ahead of future booster shot campaigns.

Prominent political elites, governmental organizations, and personal health professionals also are critical for signaling booster shot acceptance, even after a breakthrough infection [12]. President Joe Biden—who himself experienced a breakthrough COVID infection in July 2022—publicly received a booster shot in October 2022 [13]. Biden underscored that infection is still possible with the booster but coupled the message with the benefits obtained. “And if you get it, you'll be protected. And if you don't, you're putting yourself and other people at unnecessary risk.” Yet, such efforts may need renewed momentum amid the ongoing pandemic and continued risk of infections. Additionally, the personalized nature of the pandemic (as shown by personal infection contributing to booster shot hesitancy), places the locus of responsibility on conversations between primary care personnel and their patients about the benefits of booster mitigation [14].

Notably, the context considered for this study – including the communicative efforts discussed above – is unique to the United States, which has experienced high levels of politicization around the COVID-19 pandemic. However, it's likely that the underlying factors linking individual breakthrough infection experiences to reduced acceptance of vaccine boosters are relevant beyond the U.S. context. Additional studies considering this relationship in non-U.S. contexts would be helpful for advancing our understanding of this phenomenon.

This study shows a statistically and practically significant link between personal experiences with breakthrough infections and an individual's willingness to receive ongoing COVID-19 vaccine boosters. While this makes a valuable contribution to our evolving understanding of vaccine hesitancy – particularly as it relates to the COVID-19 pandemic – there are several important limitations to keep in mind when interpreting these results. First, and perhaps most importantly, the data collected in this study do not speak to a causal link between these phenomena. Several possible factors may underly this relationship – including (1) reduced concern over the severity of COVID-19 following a breakthrough infection, (2) reduced confidence in the efficacy of COVID-19 vaccines following a breakthrough infection, and/or (3) a belief that antibodies from their breakthrough infection results in future protection against the virus. Additional research is needed in order to develop a more nuanced and causal understanding of these factors.

Additionally, it's important to note that while the sample collected for this analysis was representative of the State's population, there are some inherent limitations associated with the methodology employed in this study. Notably, web-panel surveys are often under-representative of individuals with less than a high school diploma, as well as those who lack reliable internet access (particularly in the most rural areas of the state). As a result, the analysis may fail to adequately capture variation across these groups.

4.2. Innovation

While a significant body of research has explored the antecedents and consequences of vaccine hesitancy, considerably less attention has been paid to the idea of booster shot hesitancy among previously vaccinated populations. The relevance and immediacy of this issue has been heightened in the context of the COVID-19 pandemic, which led to the innovative development and deployment of mRNA vaccines. In this study, we seek to contribute to this small but important body of literature by considering a novel and innovative question: *how do breakthrough COVID-19 infections impact booster shot hesitancy?* Given both the sharp politicization of the COVID-19 pandemic and the fluid (often unreliable) information context in which the pandemic has unfolded, we consider this an important line of inquiry as the pandemic evolves.

5. Conclusion

While our findings show that trust and confidence in public health guidelines has the greatest impact on vaccine acceptance, there is also a statistically significant and non-trivial relationship between breakthrough infections and booster shot hesitancy. Specifically, previously vaccinated individuals who personally experience a breakthrough infection are two times less likely to say that they will accept annual vaccine booster shots when compared with those who did not experience a breakthrough infection. Going forward, this relationship requires further attention and consideration, as effective communication of vaccine booster guidance could be impacted by these experiences.

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.

References

- [1] New York Times. See how vaccinations are going in your county and state. Available at: <https://www.nytimes.com/interactive/2020/us/covid-19-vaccine-doses.html>. Accessed September 19, 2022.
- [2] Neely SR, Eldredge C, Ersing R, Remington C. Vaccine hesitancy and exposure to misinformation: a survey analysis. *J Gen Intern Med.* 2021. available "Online First" at: <https://doi.org/10.1007/s11606-021-07171-z>.
- [3] Wood S, Schulman K. Beyond politics – promoting Covid-19 vaccination in the United States. *N Engl J Med.* 2021.;384(7) e23(1)-e23(8). PMID: 33406324.
- [4] Allsop J. How major media outlets screwed up the vaccine 'breakthrough' story. *Columbia J Rev.* 2021(August 2):2021. Available at: https://www.cjr.org/the_media_today/cdc_date_media_coverage_vaccination.php.
- [5] Berg S. What doctors wish patients knew about breakthrough COVID infections. *American Medical Association: Public Health;* 2022. January 202, 2022. Available at: <https://www.ama-assn.org/delivering-care/public-health/what-doctors-wish-patients-knew-about-breakthrough-covid-infections>.
- [6] Healthline. By the numbers: COVID-19 vaccines and Omicron. Available at: <https://www.healthline.com/health-news/by-the-numbers-covid-19-vaccines-and-omicron>; 2022. Accessed September 19, 2022.
- [7] Momplaisir FM, Kuter BJ, Ghadimi F. Racial/ethnic differences in COVID-19 vaccine hesitancy among health care workers in 2 large academic hospitals. *JAMA Netw Open.* 2021;4(8):e2121931. <https://doi.org/10.1001/jamanetworkopen.2021.21931>.
- [8] Neely SR, Scacco JM. Receptiveness of American adults to COVID-10 vaccine booster: a survey analysis. *PEC Innov.* 2022;1:2022. <https://doi.org/10.1016/j.pecinn.2022.100019>.
- [9] Becker's Hospital Review. States ranked by percentage of population fully vaccinated. Available at: <https://www.beckershospitalreview.com/public-health/states-ranked-by-percentage-of-population-vaccinated-march-15.html>; 2022. Accessed March 23, 2023.
- [10] Centers for Disease Control and Prevention. 2022. COVID-19 after vaccination: possible breakthrough infection. June 23, 2022. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/effectiveness/why-measure-effectiveness/breakthrough-cases.html>. Accessed November 20, 2022.
- [11] Russo, E. 2022. Stephen Colbert takes Dr. Anthony Fauci for COVID booster at Walgreens *Walgreens Newsroom*, October 6, 2022. Available at: <https://news.walgreens.com/our-stories/stephen-colbert-dr-fauci-walgreens-covid-booster.htm>. Accessed November 20, 2022.
- [12] Gollust SE, Nagler RH, Fowler EF. The emergence of COVID-19 in the US: a public health and political communication crisis. *J Health Polit Policy Law.* 2020;45(6): 967–81.
- [13] Superville D, Boak J. Biden gets updated COVID booster shot: promotes vaccine. *AP News.* 2022. October 25, 2022. Available at: <https://apnews.com/article/biden-health-united-states-covid-94a1fbf9a35359fc9bf7954343a325c8>. Accessed November 20, 2022.
- [14] Wilkinson E, Jetty A, Petterson S, Jabbarpour Y, Westfall JM. Primary care's historic role in vaccination and potential role in COVID-19 immunization program. *Ann Family Med Jul-Aug 2021.* 2021;19(4):355. <https://doi.org/10.1370/afm.2679>. Epub 2021 Mar 11.