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RESEARCH ARTICLE

Association Between the "We Can Do This" Campaign and COVID-19 Booster Uptake, U.S., 2021–2022

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Introduction: Monovalent COVID-19 boosters lower the risk of COVID-19 disease, infection, hospitalization, and death. This study examined associations between exposure to a booster public education campaign (the booster campaign) and the increases in booster uptake and reduced length of time until booster uptake among U.S. adults.

Methods: Data included a national survey panel of U.S. adults and booster campaign paid media (i.e., digital impressions and TV gross rating points) from September 2021 to May 2022. Multilevel logistic regression models examined the association between exposure to the booster campaign and the likelihood of booster uptake. A Cox proportional hazard model evaluated the association between the booster campaign and booster uptake timing. Interaction terms between the booster campaign media variables and first-dose COVID-19 vaccine date examined differential effects of the booster campaign based on when individuals received their first dose.

Results: Interactions between first-dose vaccination date and the booster campaign were statistically significant for cumulative digital impressions (ß=4.75e-08; 95% CIs=5.93e-09, 8.90e-08) and TV gross rating points (ß = 4.62e-05; 95% CIs=5.09e-06, 8.73e-05), suggesting that booster uptake was strongest among those who received their first-dose COVID-19 vaccine later. Booster campaign cumulative digital impressions and TV gross rating points were associated with accelerated booster uptake among those with later first-dose vaccination dates (digital: ß=9.98e-08; 95% CIs=2.70e-08, 1.73e-07; TV: ß=0.0001; 95% CIs=2.80e-05, 0.0002), relative to those with earlier first-dose vaccination dates.

Conclusions: The booster campaign may have increased monovalent booster uptake and reduced how long individuals waited until getting their booster. Public education campaigns show promise in stemming the tide of pandemic fatigue and increasing booster confidence.

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INTRODUCTION

More than 100 million cases and 1 million deaths in the U.S. have been attributed to the coronavirus disease 2019 (COVID-19).[1] Ongoing research suggests that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections are associated with acute and long-term health consequences, and subsequent reinfections increase the risk of negative health outcomes and death.[2] However, COVID-19 vaccine availability in December 2020 changed the pandemic's course, reducing disease incidence and severity, hospitalizations, and associated deaths.[3–6,i] A Commonwealth Fund analysis estimated thousands of infections, hospitalizations, and deaths would have been preventable if the majority of eligible Americans had been vaccinated by the end of 2022.[7]

In response to waning vaccine protection over time, emergences of new viral variants, and decreased motivation to follow recommended behaviors for protection against the virus (better known as pandemic fatigue),[8–11] U.S. public health officials recommended monovalent booster[ii] (boosters hereafter) doses[6] for adults at least 6 months after initial vaccination series completion, beginning in September 2021.[12] Research suggests boosters are safe[13–17] and associated with lower risks of SARS-CoV-2 infection, hospitalization,[18,19] and death.[6]

Despite COVID-19 booster availability and effectiveness, booster uptake in the U.S. was initially slow. As of May 2022, only 46.6% of eligible U.S. individuals had received at least 1 COVID-19 vaccine booster dose.[1] Extant research identified factors such as vaccine timing relative to eligibility,[20] demographic characteristics,[21] and community booster norms and COVID-19 cases among those in one's social network may have influenced one's likelihood of receiving a booster dose.[22]

The HHS launched the We Can Do This Campaign (the campaign) in April 2021 to educate U.S. adults on COVID-19 vaccine effectiveness and safety and the risk of severe COVID-19 to promote first-dose vaccine uptake.[23] Campaign messages were informed by health behavior theories and formative research with the target audience and were delivered across television, digital and social media platforms, radio, print, and out-of-home media (e.g., billboards).

Prior evaluation efforts suggest the campaign was effective at increasing COVID-19 first-dose vaccine uptake among U.S. adults.[24,25] In December 2021, the campaign's scope expanded to include COVID-19 Booster Promotion (the booster campaign) among those who had completed a primary vaccine but were hesitant about getting a booster. Booster confidence took longer to build than primary vaccination confidence, as evidenced by slower booster uptake among those who completed their primary vaccination. Indeed, as of May 2022, only 100.7 million of 221.4 million vaccinated people had received the monovalent booster.[26] This study assessed the relationship between exposure to the booster campaign and booster uptake and timing among U.S. adults, using the date of booster and first-dose primary vaccine uptake as more granular measures of vaccine hesitancy to answer the following research questions: (1) *What is the relationship between booster campaign exposure, measured by media dose, and COVID-19 booster uptake timing*? and (2) *Is the relationship between the booster campaign and booster uptake and timing conditional upon the timing of first-dose vaccinations*? The hypothesized relationship is that the booster campaign dose will be positively associated with booster uptake and getting a booster sooner, particularly among those who had delayed getting their first-dose primary vaccination.

METHODS

Study Sample

This study combined paid media delivery data from the booster campaign and weighted individual-level survey data from 5 waves of the COVID-19 Attitudes and Beliefs Survey (CABS).[iii] CABS details have been published elsewhere[23] and are available in the Appendix (available online). Briefly, CABS was a nationally representative, longitudinal study among U.S. adults (aged ≥18 years) recruited from NORC's AmeriSpeak panel.[27] Participants were surveyed online every 4 months. The analytic sample consisted of 1,587 CABS participants who participated in waves 1–5 from 186 designated market areas (DMAs).[28,iv] These participants had completed their initial COVID-19 vaccine series but had not received a booster dose as of September 2021, when

[i]U.S. eligibility expanded to include those 5 years and older in May 2022.

[ii]Monovalent booster doses were available for high-risk adults starting on September 24, 2021, and for all adults starting on November 19, 2021. Bivalent boosters became available in September 2022, outside of the study timeframe.

[iii]For more on the CABS, see Appendix (available online).

[iv]A DMA is a proprietary geographic region centered around one or more metropolitan areas, defined by Nielsen[28] and used for media buying. There are 210 DMAs in the United States.

booster doses first received an emergency use authorization.[29] The study timeframe was from September 2021 through May 2022. Appendix Figure 1 (available online) shows how the analytical sample was constructed. The unit of analysis was DMA-nested participant-broadcast week.

Measures

Dependent variable. The key dependent variable was a self-reported dichotomous indicator of weekly booster status from CABS Wave 5 (fielded May–July 2022), with the earliest booster uptake date of September 9, 2021, and the latest booster uptake date of May 28, 2022.[v] The week a participant reported receiving their first COVID-19 booster was coded as 1, preceding weeks were coded as 0, and subsequent weeks were dropped. The weekly count of booster doses is shown in Appendix Figure 2A (available online). Self-reported booster data were audited to ensure high data quality (see Appendix, available online).

Independent variables. Booster campaign paid media delivery was measured by booster campaign digital impressions and local TV gross rating points (GRPs) per DMA delivered from December 15, 2021, to May 31, 2022. Digital impressions are publishers' estimates of the number of times an ad was seen, read, or heard on a digital platform. TV GRPs are a composite measure of estimated audience reach and average per-person frequency multiplied by 100, wherein reaching 1% of the audience once is equivalent to 1 GRP.[vi]

Booster campaign delivery data were operationalized in 2 ways: (1) cumulative media delivery, conceptualized as aggregate advertising with influence decaying over time; and (2) weekly media delivery. Consistent with existing research on the impact of digital and TV paid media on COVID-19 vaccination,[24,25,vii] the cumulative media delivery measures account for current and past exposure to paid media using a 3-week half-life decay function. All measures were lagged by 1 week to account for the expected temporal ordering of media delivery prior to respondents' decisions to receive a booster.[viii]

Initial first-dose vaccination timing affected booster eligibility and might have proxy attitudinal factors such as vaccine hesitancy intensity or other issues such as first-dose vaccine access.[20,30] Self-reported first-dose vaccination date was collected in each wave,[ix] measured as a continuous variable in days, and normalized so that the first self-reported initial vaccination date (December 2, 2020)[x] was set to 1, and other dates were the number of days from that date until the last reported date (May 1, 2022).

Interaction terms between booster campaign paid media delivery variables and first-dose vaccine date examined whether the booster campaign had differential effects based on the date of first-dose vaccination.

Covariates. Models controlled for local TV GRPs from other COVID-19 vaccination campaigns, lagged DMA-level COVID-19 cases and deaths, and the lagged share of eligible adults who had received at least 1 booster dose in the DMA were all measured at the weekly level. Individual-level control variables included demographics, SES, and respondents' vaccine confidence in Wave 1 (defined as having had at least a first-dose vaccination as of January/February 2021 or indicating they were very likely to get vaccinated). More than half of the sample (53.0%) consisted of respondents who were very likely to get vaccinated at Wave 1 (Appendix Table 1, available online). Detailed covariate information is found in the Appendix (available online).

Statistical Analysis

Two types of models were estimated to show the different but complementary associations between booster campaign media delivery and booster uptake. Similar to other campaign studies,[24,25] a multilevel logistic regression model with random DMA-level intercepts and time-fixed effects was estimated to evaluate the association between cumulative booster campaign media delivery and the week-over-week probability of receiving a

[v]September 9, 2021, is prior to authorized use, but is included in the sample under the assumption this could be a trial participant. CABS weeks after May 2022 are dropped by the model because no respondents reported receiving a booster dose in those weeks, leaving no variation in the dependent variable.

[vi]Reach refers to the percentage of the targeted population that is estimated to have seen the advertisement; frequency refers to the number of times each individual is estimated to have seen the advertisement.

[vii]Unlike Denison et al.,[25] short-term changes in Campaign media delivery were not included in models, given differences in booster dose availability and Booster Campaign timing. A robustness check with these variables included confirms that this decision does not affect the result (Appendix Table 3).

[viii]Multiple lag structures confirm this decision does not impact results (see Appendix Table 3, available online).

[ix]First-dose dates were audited for accuracy as described in Denison and colleagues (2023).[25]

[x]Date may indicate vaccine clinical trial participation.

booster dose.[xi] Next, a Cox proportional hazard model was estimated to evaluate the association between weekly booster campaign media delivery and changes in the length of time to receiving a booster. Interaction variables examined whether the booster campaign had a differential effect on booster uptake based on the timing of first-dose vaccine. All analyses were conducted in Stata 17.[31]

RESULTS

Multilevel Logistic Regression: Cumulative Booster Campaign Paid Media Delivery Predicting Booster Uptake

Table 1 presents multilevel logistic regression model results. In both non-interactive and interactive models, neither cumulative digital impressions nor cumulative TV GRPs were significantly associated with booster uptake. In the interactive model, there is a significant association between both interaction terms (first-dose vaccination date × cumulative digital impressions and first-dose vaccination date × cumulative local TV GRPs) and booster uptake (ß=4.75e-08; 95% CIs=5.93e-09, 8.90e-08 and ß=4.62e-05; 95% CIs=5.09e-06, 8.73e-05, respectively), suggesting that the later the date of first-dose vaccination, the greater the impact of the booster campaign on increasing the likelihood of receiving a booster dose.

Both the non-interactive and interactive model results demonstrate a significant association between the date of first-dose vaccine and booster uptake (non-interactive: ß= −0.0091; 95% CIs= −0.0111, −0.0072; interactive: ß= −0.0106; 95% CIs= −0.0124, −0.0088), indicating that the later the first-dose vaccine date, the lower the likelihood of receiving a booster dose.

Predicted Probability of Booster Uptake by Cumulative Booster Campaign Paid Media Delivery and First-Dose Vaccination Date

Among the population that received a first-dose vaccination prior to May 1, 2021,[xii] the likelihood of receiving a booster dose decreased as cumulative booster campaign digital impressions increased (Figure 1[a]). For those with first-dose vaccination dates after May 1, 2021, greater cumulative levels of digital impressions increased the likelihood of receiving a booster. For instance, participants who received a late first-dose vaccination on August 9, 2021, had a 0.56% probability of receiving a booster in a given week when cumulative digital impressions were 0.[xiii] However, increasing cumulative digital booster campaign impressions to 1 SD above the mean to 100,000 increased the probability of receiving a booster to 0.9% in a given week, whereas a roughly 2 −SD increase from the mean to 150,000 more than doubled the initial probability to 1.14% in a given week.

The interactive association of cumulative booster campaign local TV GRPs is illustrated in Figure 1(b). Individuals with first-dose vaccination dates in April 2021 and later also benefited from increased TV GRPs.[xiv] For example, a participant with a first-dose vaccination date of August 9, 2021, had a 0.57% probability of receiving a booster dose in the current week when the cumulative local TV GRP was 0. However, an increase to 108 cumulative local TV GRPs, roughly a 1−SD increase from the mean, was associated with a 1.18% probability of receiving a booster dose. Furthermore, increasing local TV GRPs to 2 SDs above the mean to 165 was associated with a 1.72% probability of booster dose receipt, more than tripling the initial likelihood of booster receipt.

Cox Proportional Hazard Model: Weekly Level in Booster Campaign Paid Media Delivery Predicting Time to Booster Uptake

Owing to the methodology, the authors refer to the desired behavior—booster uptake—as a "hazard." Table 2 shows the non-interactive and interactive Cox proportional hazard model results predicting length of time to booster uptake. The interactive Cox model indicates that the relationship between weekly booster campaign digital impressions and booster uptake was significant and positive among those with later first-dose vaccination dates (ß=9.98e-08; 95% CIs=2.70e-08, 1.73e-07), meaning the effect of digital impressions on booster uptake is conditional on first-dose vaccination date. The significant, negative coefficient for level of digital impressions (ß= −1.8e-05; 95% CIs= −3.1e-05, −4.03e-06) refers to the impact of increased impressions when the first-dose vaccination date was December 2, 2020—if individuals with early first-dose vaccination dates did not receive a booster before the booster campaign began, then increased digital impressions decreased the hazard

[xi] These were operationalized as week dummies to control for time-related confounders such as the Delta and Omicron waves.

[xii] May 1, 2021, was inductively chosen based on the plot in Figure 1(a). The sample included one individual with a vaccination date prior to authorization.

[xiii] August 9, 2021, is a 1-SD increase from the mean vaccination date, May 5, 2021.

[xiv] April 1, 2021, was inductively chosen based on the plot in Figure 1(b).

Table 1. Multilevel Logistic Regression Predicting Booster Uptake in Current Week

Variables	Non-interactive model, parameter estimates (95% CIs)	Interactive model, parameter estimates (95% CIs)
Date-level variables		
First-dose vaccination date	**−0.0091*** ** (−0.0110, −0.0072)	**−0.0106*** ** (−0.0124, −0.0088)
First-dose vaccination date × cumulative HHS digital booster impressions		**4.75e-08*** (5.93e-09, 8.90e-08)
First-dose vaccination date × cumulative HHS local TV booster GRPs		**4.62e-05*** (5.09e-06, 8.73e-05)
Cumulative variables		
Cumulative ANONYMIZED digital booster impressions	−1.69e-06 (−5.52e-06, 2.15e-06)	−7.00e-06 (−1.55e-05, 1.55e-06)
Cumulative ANONYMIZED local TV booster GRPs	0.0017 (−0.0029, 0.0063)	−0.0047 (−0.0119, 0.0025)
Cumulative other TV GRPs	−0.0008 (−0.0023, 0.0007)	−0.0008 (−0.0023, 0.0007)
Individual CABS respondent level variables[a]		
Income	**0.1151*** (0.0219, 0.2084)	**0.1075*** (0.0137, 0.2013)
Sex	−0.1707 (−0.3448, 0.0033)	**−0.1809*** (−0.3540, −0.0077)
Age	**0.3138***** (0.1571, 0.4705)	**0.3053***** (0.1476, 0.4629)
Education	−0.0043 (−0.1378, 0.1292)	−0.0073 (−0.1403, 0.1256)
Essential worker status	**−0.2881*** (−0.5207, −0.0556)	**−0.2898*** (−0.5247; −0.0548)
Political ideology	**−0.5366***** (−0.6588, −0.4144)	**−0.5304***** (−0.6526, −0.4083)
Preexisting health condition	0.1834 (−0.0311, 0.3978)	0.1921 (−0.0242, 0.4084)
Rurality	−0.0177 (−0.1757, 0.1404)	−0.0209 (−0.1783, 0.1365)
Non-Hispanic Black	0.0083 (−0.4674; 0.4840)	−0.0114 (−0.4773; 0.4544)
Latino	0.1140 (−0.1294, 0.3574)	0.1062 (−0.1377, 0.3501)
Non-Hispanic Other	0.2369 (−0.0802, 0.5539)	0.2372 (−0.0763, 0.5507)
DMA-level variables[a]		
Share of DMA with booster dose	−0.0040 (−0.0262, 0.0181)	−0.0050 (−0.0270, 0.0169)
Initial vaccine confidence	**0.6476***** (0.4199, 0.8754)	**0.6414***** (0.4139, 0.8689)
Cases per 100,000 people	−0.0001 (−0.0005, 0.0002)	−0.0002 (−0.0005, 0.0002)
Deaths per 100,000 people	**−0.0285**** (−0.0468, −0.0101)	**−0.0295**** (−0.0479, −0.0111)
Week dummies (suppressed)		
Intercept	**-7.0157***** (−8.5738, −5.4576)	**-6.7976***** (−8.3468, −5.2484)
DMA variance	0.1467 (0.0787, 0.2733)	0.1406 (0.0746, 0.2649)
N	32,225	32,225
n(DMAs)	186	186

Note: Boldface indicates statistical significance (*$p<0.05$, **$p<0.01$, ***$p<0.001$). 95% confidence intervals in paraenthesis.
GRPs, gross rating points (the measurement of TV paid media delivery); DMA, designated market area (the geographic organization of media markets); *n*(DMAs), the number of DMAs the observations are nested in.
[a]Details on how these variables were coded are found in the Appendix (available online).

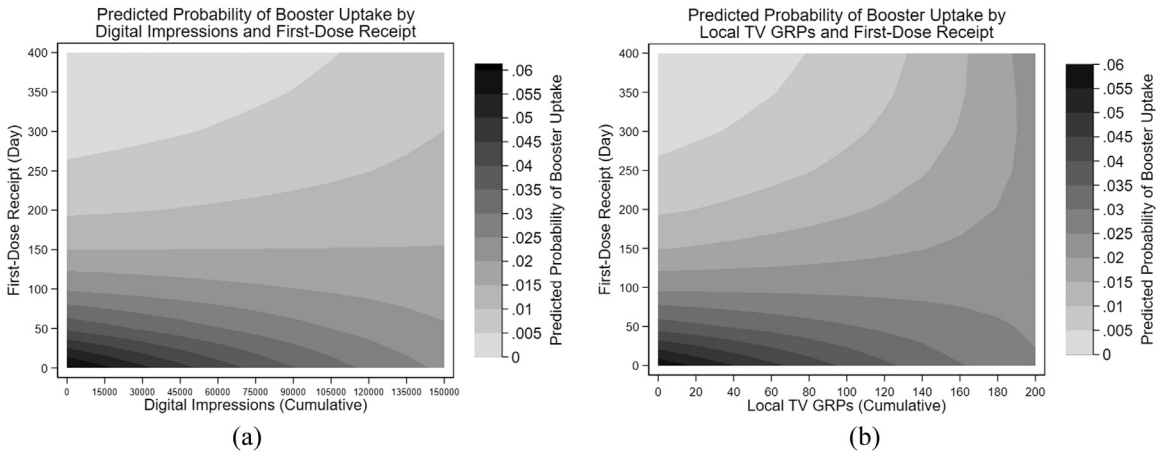

Figure 1. Predicted probability of booster uptake by booster campaign paid media delivery and first-dose vaccination date, U.S., September 06, 2021, to May 31, 2022; (a) cumulative booster digital impressions; (b) cumulative booster local TV GRPs.
Note: First-Dose Receipt (day) of 0 is December 2, 2020. First-Dose Receipt (day) of 120 is April 1, 2021. First-Dose Receipt (day) of 150 is May 1, 2021. GRP, gross rating point.

or overall likelihood of receiving a booster.[xv] This finding may suggest that once eligible individuals with early first-dose vaccination dates decided not to receive a booster, they became less likely to change their attitudes toward boosters.

The interaction term between first-dose vaccination date and weekly level of local TV booster campaign GRPs is significant (ß=0.0001; 95% CIs=2.80e-05, 0.0002), meaning that the effect of TV GRPs on booster uptake is conditional on first-dose vaccination date. Among those with later first-dose vaccination dates, greater levels of local TV GRPs in the previous week were associated with a shorter time to booster dose. The nonsignificant weekly level of local TV GRPs indicates that among those with earliest first-dose vaccination dates, the weekly level of local TV GRPs had no impact on the likelihood of receiving a booster.

Cumulative Hazard of Booster Uptake

Figure 2 illustrates the cumulative hazard functions of the interaction terms for first-dose vaccination date and weekly booster campaign digital impressions, as well as the first-dose vaccination date and weekly booster campaign local TV GRPs. The functions show the interactive associations between paid media delivery type and booster uptake timing. Representative dates for early and late vaccination times were chosen, and paid media delivery was split into low, medium, and high levels.[xvi]

Digital Impressions and First-Dose Vaccination Date

Among individuals with later first-dose vaccination dates, higher weekly levels of digital impressions increased the hazard of getting a booster over a 40-week period, suggesting the time to receive a booster was accelerated (Figure 2 [a]). Individuals with later first-dose vaccination dates who saw high levels of digital impressions were associated with a nearly 20% hazard of receiving a booster, whereas low levels of digital impressions were associated with an approximately 10% hazard of receiving a booster. For individuals with early first-dose vaccination dates, higher weekly levels of digital impressions led to lower hazards or overall likelihood of receiving a booster.

Local TV GRPs and First-Dose Vaccination Date

Among those with later first-dose vaccination dates, low weekly levels of TV GRPs were associated with a cumulative hazard of around 15% for receiving a booster, and high weekly levels of TV GRPs were associated with an approximate 40% cumulative hazard of receiving a booster (Figure 2[b]).[xvii] The cumulative hazard for those with early first-dose vaccination dates was similar, regardless of the level of

[xv]With alternative specifications, this coefficient is no longer significant, whereas the interaction term remains (see Appendix, available online).

[xvi]Digital impressions: low = 10,000, medium = 25,000, and high = 50,000. Early vaccine date is March 12, 2021, 100 days since the first reported first-dose vaccination date in the sample. The late vaccine date is September 28, 2021, 300 days since the first reported first-dose vaccination date in the sample.

[xvii]TV GRPs: low = 15, medium = 30, and high = 50.

Table 2. Cox Proportional Hazard Model Predicting Time to Booster Uptake

	Non-interactive model, parameter estimates (95% CIs)	Interactive model, parameter estimates (95% CIs)
Date-level variables		
First-dose vaccination date	**−0.0083*** ** (−0.0101, −0.0065)	**−0.0092*** ** (−0.0123, −0.0088)
First−dose vaccination date × weekly level of HHS digital booster impressions	–	**9.98e-08**** (2.70e-08, 1.73e-07)
First-dose vaccination date × weekly level of HHS local TV booster GRPs	–	**0.0001*** (2.80e-05, 0.0002)
Booster campaign paid media variables		
Weekly level of ANONYMIZED digital booster impressions	**−6.40e-06*** (−1.30e-05, −2.46e-07)	**−1.8e-05*** (−3.1e-05, −4.03e-06)
Weekly level of ANONYMIZED local TV booster GRPs	0.0043 (−0.0066, 0.0152)	−0.0124 (−0.0327, 0.0079)
Weekly level of other TV booster GRPs	**−0.0043*** (−0.0085, −0.0001)	−0.0041 (−0.0083, 2.50e-05)
Individual CABS respondent level variables[a]		
Income	**0.1105**** (0.0270, 0.1940)	**0.1061*** (0.0225, 0.1898)
Female	**−0.1809*** (−0.3375, −0.0244)	**−0.1854*** (−0.3409, −0.0298)
Age	**0.2848***** (0.1419, 0.4277)	**0.2814***** (0.1382, 0.4246)
Education	0.0066 (−0.1168, 0.1300)	0.00381 (−0.1189, 0.1265)
Essential worker status	**−0.2465*** (−0.4532; −0.0398)	**−0.2477*** (−0.4552; −0.0402)
Political ideology	**−0.4921***** (−0.6047, −0.3796)	**−0.4889***** (−0.6012, −0.3767)
Preexisting health condition	0.1558 (−0.0522, 0.3637)	0.1593 (−0.0494, 0.3681)
Rurality	−0.0076 (−0.1348, 0.1196)	−0.0097 (−0.1362, 0.1168)
Non-Hispanic Black	−0.0716 (−(0.4906, 0.3473)	−0.0803 (−0.4926, 0.3319)
Latino	0.0473 (−0.2098, 0.3044)	0.0456 (−0.2115, 0.3028)
Non-Hispanic other	0.2102 (−0.0569, 0.4772)	0.2141 (−0.0510, 0.4793)
DMA-level variables[a]		
Share of DMA with booster dose	−0.0031 (−0.0258, 0.0196)	−0.0036 (−0.0260, 0.0188)
Initial vaccine confidence	**0.5925***** (0.3798, 0.8053)	**0.5909***** (0.3784, 0.8034)
Deaths per 100,000 people	**−0.0313**** (−0.0502, (−0.0123)	**−0.0312***** (−0.0501, (−0.0124)
Cases per 100,000 people	−0.0001 (−0.0004, 0.0001)	−0.0001 (−0.0004, 0.0001)
N	32,932	32,932

Note: Boldface indicates statistical significance (*p<0.05, **p<0.01, ***p<0.001). 95% CIs in paraenthesis.
CABS, COVID-19 Attitudes and Beliefs Survey; GRPs, gross rating points (the measurement of TV paid media delivery); DMA, designated market area (the geographic organization of media markets).
[a]Details on how these variables were coded are in the Appendix (available online).

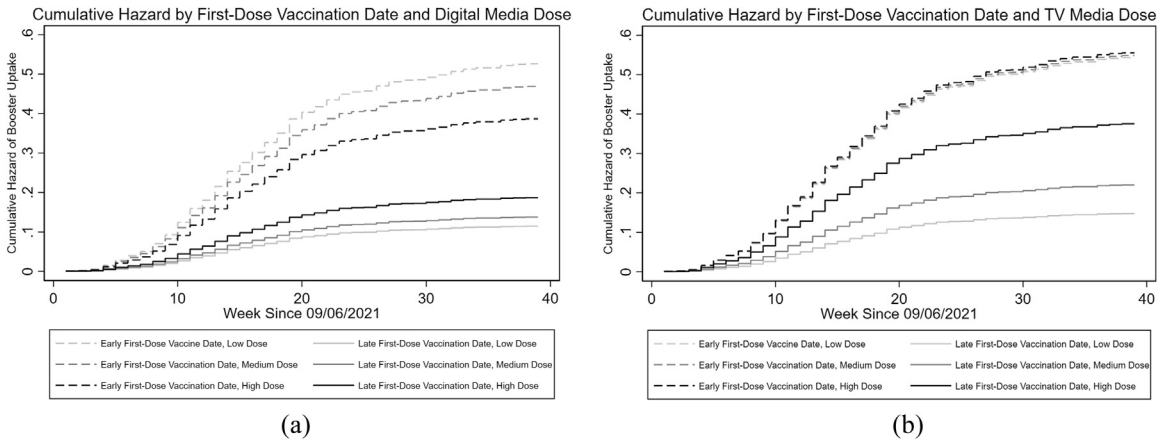

Figure 2. Cumulative hazard of booster uptake by booster campaign paid media delivery and first-dose vaccination date, U.S., September 06, 2021, to May 31, 2022; (a) cumulative booster campaign digital impressions; (b) cumulative booster campaign local TV GRPs. GRP, gross rating point.

weekly TV GRPs, indicating that paid booster campaign media delivery had a differential impact based on first-dose vaccination date and the booster campaign reached those vaccinated later.

Robustness checks validate the results using alternative specifications and provide details concerning significant associations between additional covariates and booster uptake (see Appendix, available online). Robustness checks included alternative operationalizations of booster eligibility based on changing U.S. Food and Drug Administration authorization, alternative lag structures and half-life decay functions for the media dose variables, the inclusion of short-term changes in media delivery, a DMA fixed effects model, and the inclusion of time-varying covariates in the Cox proportional hazard model.

DISCUSSION

This study builds upon prior evaluations in which campaign exposure was associated with increased first-dose vaccination uptake,[24,25] demonstrating a positive association between HHS's We Can Do This Booster Campaign and COVID-19 booster uptake as well as the speed at which individuals received their booster dose, relative to the timing of their first dose. In both the multilevel logistic regression and Cox proportional hazard models, results were consistent with multiple operationalizations of booster campaign exposure, indicating the campaign may have encouraged individuals with later first-dose vaccination dates to remain up-to-date with their COVID-19 vaccinations.[32]

Consistent with prior research, first-dose vaccination date was the strongest predictor of booster uptake in all models,[20] perhaps due to eligibility, booster campaign launch timing, booster hesitancy, and other contributing factors proxied by later first-dose timing. Booster doses were initially recommended 6 months after a first-dose vaccination, therefore, individuals with early first-dose vaccination dates would have been eligible for a booster before the booster campaign began. For instance, when using May 1, 2021, as the cut off for early first-dose vaccination, 76% of individuals with early first-dose vaccination dates received their booster doses prior to the launch of the booster campaign, whereas 31% of individuals with later vaccination dates received a booster dose before it began.[xviii]

Although the booster campaign provided more opportunity to influence individuals with later first-dose vaccination dates (because their booster eligibility began after it launched), early first-dose vaccination may serve as a proxy for vaccine confidence. Those with early first-dose vaccination dates were more likely to be vaccine and booster confident, absent campaign influence (Appendix Table 2, available online). This implies that those with early first-dose vaccination dates who had not received a booster dose at the start of the booster campaign were more likely to be booster hesitant and less likely to get a booster in response to booster

[xviii]Calculated as a crosstabulation of the number of respondents vaccinated before and after May 1, 2021, and the number of respondents who received a booster before and after the Campaign began. Note: Some of the 69% of respondents with later first-dose vaccine dates who had not received a booster may have been ineligible at the start of the Campaign, per FDA guidelines.

campaign messaging. Thus, it is important to recognize that the significant relationship between first-dose vaccination timing and booster uptake might be a reflection of evolving vaccine confidence rather than first-dose vaccination timing.

Additionally, results could reflect the effectiveness of the campaign strategy, which aimed to increase booster uptake among individuals who were hesitant to get a booster but open to change by delivering additional media dose in DMAs with higher booster hesitancy. As noted, a delay between first-dose vaccination eligibility and vaccine uptake could signal higher levels of vaccine hesitancy. Similarly, booster uptake delays could reflect greater booster hesitancy, such that the longer the delay, the less a person was open to getting a booster in response to booster messaging. As Appendix Table 2 (available online) shows, a higher percentage of individuals with later first-dose vaccination dates reported they were waiting to get a booster than the percentages of individuals with early first-dose vaccination dates who were waiting to get a booster, such that additional booster campaign dose was more likely to affect these respondents' decisions to receive a booster dose.

The first-dose vaccination date variable could also serve as a proxy for lower access to the vaccines and/or related information in initial periods of first-dose vaccination availability. Indeed, Appendix Table 2 (available online) shows that those with later first-dose vaccination dates were more likely to report having low income, no college degree, and being non-Hispanic Black and/or Hispanic—markers of marginalization and experienced discrimination. This implies it is possible that although access concerns affected first-dose vaccination timing, the booster campaign may have been effective in supporting these populations in overcoming barriers. More research could help to unpack the booster campaign influence among marginalized groups.

The interactive association of first-dose vaccine date with local TV GRPs was larger than the interactive association of first-dose vaccine date with digital impressions on booster uptake. TV GRPs' larger association is in line with previous research that finds cumulative TV GRPs are associated with moving individuals toward vaccine confidence in advance of first-dose vaccine decisions.[25,xix] Similarly, the larger TV effect for the booster campaign suggests increased TV GRPs move individuals with later first-dose vaccine dates toward booster confidence, when taking the lower initial vaccine confidence into account. Building upon first-dose uptake research,[24,25] digital impressions contribute by moving initially vaccine-hesitant individuals toward receiving a booster dose, proxied by later first-dose vaccine dates, but the effect is not as strong as that of TV GRPs.

These findings echo previous evaluations of the first-dose COVID-19 vaccination campaign but with some noteworthy differences. Evaluations of the first-dose vaccination campaign consistently demonstrated a positive association between short-term changes in campaign digital impressions and the likelihood of vaccine uptake. In evaluations that included campaign TV dose, the association between short-term campaign digital dose and the likelihood of vaccine uptake was larger in magnitude than the association between cumulative campaign local TV dose and vaccine uptake likelihood.[24,25] For the booster campaign, although there was an association between cumulative campaign digital dose and booster uptake among those with later first-dose vaccine dates, there was no association between short-term changes in campaign digital impressions and booster uptake, and the effect of cumulative local TV dose on booster uptake was larger in magnitude than the effect of cumulative digital dose on booster uptake. Higher, more entrenched booster hesitancy than first-dose vaccine hesitancy may be a factor, as booster hesitant people who remained so in December—3 months after boosters were authorized—may be less open to uptake than they were for their first-dose vaccination. This may be due to message fatigue; with each successive vaccination and booster, more people could become hesitant to the next recommended action, creating a higher barrier for future public education campaign impact.

Limitations

Results should be interpreted within the context of a few limitations. First, booster status was based on a self-reported measure susceptible to recall bias. However, prior research indicates a high correlation between self-reported measures of COVID-19 vaccine uptake and biological assessments of COVID-19 immune responses, suggesting the validity of self-reported measures.[30] Next, the use of exogenous measures of booster campaign exposure, such as digital impressions and TV GRPs, capture potential, not actual, booster campaign exposure. Lastly, this study assessed the monovalent COVID-19 booster dose prior to the introduction of the bivalent booster (September 2022) and the discontinuance of monovalent booster authorization for most people.

[xix] Appendix Table 3 (available online) includes a robustness check with short-term change variables from Denison et al.[25]-3. The nonsignificant results provide evidence that long-term cumulative effects from TV and digital Booster Campaign media impacted those with lower initial vaccine confidence.

Future research could evaluate the association between the campaign and bivalent booster uptake.

CONCLUSIONS

The booster campaign was associated with increasing monovalent booster uptake and reducing the length of time to receive a booster among COVID-19–vaccinated individuals. The results of this study provide evidence that public education campaigns play important roles in driving booster uptake in the context of COVID-19 pandemic fatigue among vaccinated populations.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.focus.2024.100183.

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