



Identification of best outreach strategies and delivery modalities for population subgroups for COVID-19 vaccination[☆]

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ABSTRACT

This observational study examined which characteristics of vaccination events were associated with greater vaccination to help identify which event characteristics and targeted interventions could maximize vaccination participation. In partnership with local health departments, trained research staff attended 184 health department-sponsored vaccination events for an 8-month period from November 7, 2021 through July 1, 2022. Most events were strategically held in ZIP codes where vaccination rates lagged or were much lower than the rest of the county. Over 1400 vaccinated attendees were coded for categories of race (African-American, white, other), sex (male, female), and age (adult vs. child). Analyses compared vaccinations across different event characteristics and sites among these demographic subgroups. Having vaccination events at non-clinic sites, more vaccine stations, offering more incentives, and offering the first vaccine dose was associated with a higher rate of vaccination across sex, race, and age. Outdoor precipitation was associated with a lower rate of vaccination except for females. The rate of vaccination for males was higher at non-clinic sites and increasing vaccination frequency by one day; this was not the case for females. For African-Americans, the rate of vaccination was significantly higher with additional incentives, a relationship not seen with whites. The rate of vaccination for children was higher with each additional vaccination station. Identifying features and details of vaccination events that increase rates of vaccination will add to limited literature of the optimal length and features of future vaccination events.

1. Introduction

COVID-19 vaccination remains an important behavior for protection against hospitalization and death. Vaccination rates for African-Americans have lagged behind those of whites and especially in Missouri, which was ranked in March 2021 among the states with the lowest vaccination equity [1]. To engage communities with low COVID-19 vaccination rates, local health departments and healthcare organizations implemented a wide range of vaccination methods (e.g., mass vaccination, mobile pop-ups, homebound services, drive-up, walk-up,

door-to-door) and outreach strategies (e.g., neighborhood canvassing, church leaders, social service organizations, phone, mail, text).

Various incentive programs were also used to encourage vaccination, especially when rates became stagnant or declined. Research examining the effectiveness of incentives on COVID-19 vaccination rates is mixed. Some studies have shown no significant effects of financial incentives on intention to vaccinate [2,3], or on statewide vaccination rates [4]. Others found success with increasing vaccination or slowing vaccination declines, particularly among low-income and minority populations [5,6]. Brewer, et al. (2022) identified different types of incentives

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(guaranteed cash payments, non-cash rewards, or lottery with cash/non-cash prizes) and their relative effectiveness based on behavioral criteria (receipt is certain; delivered immediately; or valued by recipient) [7] to suggest that certain vaccination incentives would have greater impact [8].

COVID-19 vaccination opportunities have included one-time or recurring events, a variety of local, community-based venues (clinics, community centers, churches, libraries, schools and parks), and targeted different audiences (general population, youth, older adults). Each event also varied in its staffing resources and the number and types of incentives offered.

This observational study sought to determine which characteristics of vaccination events were associated with greater turnout among population subgroups in order to help identify which targeted interventions could maximize vaccination participation.

2. Methods

In partnership with the St. Louis City Department of Health (DOH) and St. Louis County Department of Public Health (DPH), trained research staff attended DOH- and DPH-sponsored vaccination events from November 7, 2021 through July 1, 2022. Most events were strategically held in ZIP codes where vaccination rates lagged or were much lower than the rest of the county. Certain events, such as those held at schools and senior centers, focused on children or older adults, respectively, though some events at schools vaccinated all ages as well. The remainder of events were open to all age groups.

Research team members obtained prior approval to attend by event sponsors, as well as a preferred arrival time. At the event site, trained coders were placed in a location that did not interfere with patient flow, and where sightlines to the vaccination stations were clear. Coders conducted in-person observations at each event for roughly 1–2 h.

Research team members directly observed and recorded on coding forms both event and vaccine recipient characteristics, including the number of people observed being vaccinated as well as key attributes of those who were vaccinated. Event details such as incentives offered were verified by event sponsors.

Vaccination event characteristics included the following:

- Outdoor weather (temperature and precipitation)
- Geographic location of the event
- Event location type
- Frequency of event
- Number of vaccination stations
- Number and types of incentives offered
- Doses being given (1st, 2nd, booster)

Using observational methods, vaccine recipients were coded on sex, race, and age (child vs. adult). Given the potential for imprecise coding on physical characteristics, coders could mark “unknown” for any vaccine recipient characteristic.

Statistical analysis was conducted using IBM SPSS Statistics v.31. Descriptive analyses were used to identify characteristics of events and incentive approaches as well as event attendees. Because the main outcome of interest, the number of people vaccinated, is a count variable, the multilevel structure of events and sites had potential for clustering by site. Since the within-group correlations are not the focus of this study, Huber-White (Robust) sandwich estimator of variance was used to produce valid standard errors [9]. As a result, we ran negative binomial regression models with generalized estimating equations (GEE) using the independence working correlation structure implemented via the GENLIMIXED procedure in IBM SPSS Statistics for the dependent variables: total number vaccinated, total males, total females, total Black/African American, and total kids vaccinated. The independent variables include outdoor precipitation during the event, event location type, frequency of events, number of vaccination stations,

incentives offered, and the first dose or not. The rate ratios were reported by exponentiating the corresponding coefficients to facilitate the interpretation of associations.

This study was approved by the Washington University Institutional Review Board, IRB #202108227.

3. Results

From November 7, 2021 through July 1, 2022, in-person observational coding was conducted at 184 events at 23 unique sites totaling over 329.5 observed hours. We observed a total of 1413 COVID-19 vaccinations administered (1st, 2nd or booster dose), of which 357 (25%) were to children.

3.1. Event characteristics

Table 1 displays vaccination events and characteristics. Each event

Table 1

Characteristics of vaccination events for 184 events at 23 sites, November 7, 2021 - July 1, 2022.

Event characteristic	Number of events (%)	
Total hours of event, Mean	7.57	(1.78)
Total number of hours coded per event, Mean	1.85	(0.55)
Outdoor temperature, °F, Mean	56.82	(16.98)
Precipitation		
Yes	21	(11.4)
No	148	(80.4)
Not recorded	15	(8.2)
Geographic location of event		
North city	10	(5.4)
South city	1	(0.5)
Central city	2	(1.1)
Central county	2	(1.1)
North county	169	(91.8)
Event location type		
Health clinic	134	(72.8)
Library	32	(17.4)
Church*	6	(3.3)
School*	5	(2.7)
Community center*	4	(2.2)
Other*	3	(1.5)
Frequency of events		
One-time/pop-up	17	(9.2)
One day recurring weekly	32	(17.4)
Four-five days recurring weekly	110	(59.8)
Six days recurring weekly	25	(13.6)
Start time of observation period		
8 am	9	(4.9)
9 am	20	(10.9)
10 am	36	(19.6)
11 am	25	(13.6)
12 pm	21	(11.4)
1 pm	25	(13.6)
2 pm	26	(14.1)
3 pm	16	(8.7)
4 pm	2	(1.1)
5 pm	4	(2.2)
Number of vaccination stations		
1 station	104	(56.5)
2 stations	32	(17.4)
3+ stations	47	(25.5)
Not recorded	1	(0.5)
Total number of incentives offered		
No incentives	104	(56.5)
1 incentive	12	(6.5)
2+ incentives	68	(37.05)
Doses offered		
First dose	78	(42.4)
Second dose	76	(41.3)
Booster dose	182	(98.9)

* Note: These event location types were collapsed into the Other category for Table 3.

ran an average of 7.6 h (SD = 1.78). Each event was attended and observed an average of 1.85 h (SD = 0.55). The average outdoor temperature was 57 degrees Fahrenheit (SD = 16.98) and most events (80%) had no precipitation during the observation period.

Most (92%) events were held in North county, consistent with our partners' goals and resources. Most (73%) events attended were held at public health clinics, followed by libraries (17%) and other locations.

Most (91%) events were recurring, i.e., held more than once at the same location, and the rest (9%) were held a single time or as a pop-up event. Of all recurring events, most (73%) were held every weekday or Monday thru Saturday. Approximately half (49%) of observation start times were before 12:00 pm. Over half (57%) of the events had a single vaccination station, but one quarter (25%) of events had three or more stations. Over half of events (57%) did not offer any incentives; when incentives were offered, most (85%) events provided two or more incentives. Incentives included \$100 Visa gift cards, \$100 grocery cards, \$50 gas cards, or a combination of these. The predominant dose offered at these events was a booster dose (99% of events).

3.2. Attendee characteristics

As shown in [Table 2](#), less than half of those vaccinated were observed to be male (44%). African-Americans comprised 66% of the vaccinated attendees, followed by whites (27%) and the rest (8%) coded as Asian, unknown, or other race. Most (75%) vaccinated were adults; 25% were children.

3.3. Event characteristics associated with vaccination

In Table 3, the rate of receiving vaccines is 29% lower among those at events with outdoor precipitation ($p < .01$). The rate of receiving vaccines is about 8 times higher at other sites compared to clinic locations after adjusting for other factors in the model ($p = .01$). Each additional vaccine station is associated with a 58% greater rate of people receiving vaccines ($p < .01$). The rate of receiving vaccines increases 41% for every additional incentive ($p < .01$), and the rate of receiving the first dose is 85% higher than those who received the second dose or booster vaccination ($p < .01$).

This pattern is also shown for the rates of receiving vaccines among males, females, African-Americans, Whites, and children in [Table 3](#). The rate of receiving vaccines is 37% lower among males at events with outdoor precipitation ($p = .02$), but the rate of receiving vaccines at events with precipitation was only 24% lower for females ($p = .01$). The rate of receiving vaccines among males is about 12 times higher at other sites compared to clinic sites after adjusting for other factors in the model ($p < .01$). Each 1-day increase offered per week is associated with a 1.44 times higher rate of males receiving vaccines ($p = .03$). Each additional vaccine station is associated with 61% higher rate of males ($p < .01$) and 54% higher rate of females ($p < .01$) receiving vaccines. The rate of receiving vaccines among males increases 50% for every additional incentive ($p < .01$), compared to the 38% increase among females

Table 2
Observed demographics of vaccinated attendees ($N = 1413$ individuals).

	Number vaccinated (%)	
Sex		
Male	628	(44.4)
Female	783	(55.4)
Unknown	2	(0.1)
Race		
African-American	927	(65.6)
White	379	(26.8)
Asian	20	(1.4)
Unknown or other	87	(6.2)
Age group		
Adult	1173	(74.7)
Child	357	(25.3)

Table 3
The negative binomial regression models of vaccinated people by sex, race, and children with generalized estimating equation (GEE).

	Total			Sex			Race						Children		
				Male			Female			African-American			White		
	Rate ratio	SE	P	Rate ratio	SE	P	Rate ratio	SE	P	Rate ratio	SE	P	Rate ratio	SE	P
Intercept	0.27	0.26	0.18	0.07	0.07	0.01	0.28	0.30	0.23	0.59	0.67	0.64	0.01	0.02	0.06
Precipitation	0.71	0.07	<0.01	0.63	0.12	0.02	0.76	0.12	0.08	0.85	0.07	0.05	0.40	0.08	0.17
Event location type															
Clinic	1.00														
Library	2.48	1.80	0.21	3.20	2.29	0.11	1.60	1.28	0.55	0.82	0.78	0.84	8.53	6.56	1.65
Other	8.22	7.05	0.01	11.98	10.00	<0.01	4.93	4.67	0.09	4.16	4.18	0.16	10.41	11.15	3.28
Frequency of events	1.35	0.26	0.12	1.44	1.35	0.03	1.22	0.27	0.35	1.12	0.26	0.61	1.56	0.34	0.30
Number of vaccine stations	1.58	0.15	<0.01	1.61	0.15	<0.01	1.54	0.17	<0.01	1.44	0.14	<0.01	2.06	0.23	0.61
Number of incentives	1.41	0.14	<0.01	1.50	0.18	<0.01	1.38	0.15	<0.01	1.53	0.16	<0.01	1.25	0.24	0.51
First dose offered	1.85	0.36	<0.01	1.96	0.70	0.06	1.78	0.26	<0.01	1.48	0.28	0.04	3.97	1.87	1.09

Note: SE = standard error.

($p < .01$). The rate of receiving vaccines among females for the first dose is 78% higher compared to the rate for the second dose or booster vaccination ($p < .01$).

This pattern is also shown for the rates of African-Americans and whites vaccinated. The rate of whites receiving vaccines is 60% lower among those at events with outdoor precipitation ($p < .01$). The rate of receiving vaccines among whites is about 8.5 times ($p = .01$) higher at library vaccination sites and 10 times ($p = .03$) higher at other sites compared to clinic sites after adjusting for other factors in the model. Each 1-day increase in vaccination offered per week is associated with a 1.56 times higher rate of whites ($p = .04$) receiving vaccines. Each additional vaccine station is associated with a 1.4 times higher rate of African-Americans ($p < .01$) and 2.1 times higher rate of receiving vaccines among whites ($p < .01$). The rate of receiving vaccines among African-Americans increases 53% for every additional incentive ($p < .01$). The rate of receiving vaccines among African-Americans who received the first dose is 1.5 times higher compared to those who received the second dose or booster vaccination ($p = .04$); this rate was 4 times higher for whites ($p < .01$).

The rate of receiving vaccines among children was significantly lower (69%) at events with outdoor precipitation ($p = .03$), and about two times higher with each additional vaccine station ($p < .01$).

4. Discussion

In general, the rate of vaccination was lower at events with outdoor precipitation (versus no participation), and higher at other sites (compared to clinics), with each additional vaccination station and incentive, and with a first dose (compared to second or booster doses). With regard to sex, the rate of vaccination for males was lower with precipitation, and higher at other sites, having additional vaccination stations, increasing frequency of vaccination by one day, and having additional incentives. The rates for females were also lower with precipitation and higher for additional vaccination stations, incentives, and with a first dose. For African-Americans, the rate of vaccination was lower with precipitation, and higher for having additional vaccination stations, increasing frequency of vaccination by one day, having additional incentives, and with a first dose. Rates for whites were higher at other sites, libraries, additional vaccination stations, increasing frequency of vaccination, and with a first dose. Rates for children were lower with precipitation, and higher with each additional vaccination station.

Non-clinic events included those held at churches and community centers, consistent with recommendations of partnering with faith-based and community partners for increased COVID-19 vaccination in Black communities [10]. Having more incentives was not significantly different than no incentives in the rates of vaccination among whites or children, but was statistically significant for males, females, and African-Americans. This is noteworthy for African-Americans as a population subgroup, who have had lower COVID-19 vaccination rates compared to the population in general [11,12].

While this study also sought to explore the influence of event characteristics, such as incentives, on vaccination participation, the incentive amounts offered in this current study were not nearly as large as other studies (\$50–\$100 incentives versus \$1000–2000 incentives) [3]. However, they were consistent with other studies finding higher COVID vaccine uptake with the use of incentives, especially among Hispanic or other non-white or lower-income groups [3]. The incentives distributed by the event hosts were similar in type (gift cards) and in cost, totaling around \$150 from a combination of \$50 and \$100 gift cards. We instead considered the total number of gift cards received, suggesting that getting two vs. one gift card might be considered “better”, even though the total amounts may be the same; and both of these options being better than no incentives. Additionally, prior studies have found that using monetary incentives to increase COVID-19 vaccine uptake was greater if receipt of the incentive was certain (vs. lottery) [13], as were the

incentive types and delivery process provided in the current study's vaccination events.

4.1. Limitations

As this was an observational, non-assessment-based study, the research team was limited in its accuracy of coding sex and race based on visible physical characteristics. In addition, demographic characteristics were coded by event as individual characteristics and not in combination, i.e., we cannot determine how many African-American males vs. African-American females vs. White males/females were vaccinated. While attending several of these events, demand for vaccinations was quite high, leading us to consider that coding combinations of demographic characteristics may be less reliable and more prone to error. As this is an initial attempt to identify observable demographic characteristics at vaccination events, we expect that future studies could build on the methods and demographic specificity assessed here.

This study was also limited in the events we had permission to attend, as such, we did not have access to vaccinations given at pharmacies, doctors' offices, and other community events that neither the St. Louis City DOH nor St. Louis County DPH co-sponsored. These different events also varied in the number of hours available for vaccinations (e.g., each health clinic event was available for vaccination for 8.5 h on average, compared to 4.0 h per event for community center events), though our coders spent a similar amount of time coding (1–2 h) across all events. Further analysis of the representation of the time during which coding occurred did not show differential time of day for coding at the types of venues, except for libraries, which were more often observed in the afternoons based on our partners' preferences. In addition, many of these sites could not offer their customers or patients the gift card incentives given by the health departments.

4.2. Future research and practice

The results found in this observational study provide preliminary insight as to what event characteristics might increase vaccination numbers, especially by sex, race, and children. Future studies would allow for assessment-based data collection to confirm age, sex, and race and other demographic and psychosocial factors on each of its vaccine recipients for more robust data analysis and consider other population subgroups for which vaccine uptake is more challenging, such as lower-income and higher-risk groups. Additionally, future studies might also consider what event characteristics are associated with vaccination for previously vaccine hesitant attendees, and to determine how event attendees are similar or different from those who do not attend. Doing so would offer more insight as to how and where we might further intervene or encourage vaccination.

The results of the analyses have interesting implications for vaccination event planners. Exploring non-clinic, non-library vaccination event locations might help increase vaccination numbers, as would ensuring there were plenty of vaccine stations and incentives. These strategies also seem particularly effective for males and African-Americans, consistent with the goals of the health departments to increase vaccination rates among African-American populations in the St. Louis area. Further examination of these findings has practical implications and will add to the currently limited literature of the ideal features of vaccination events for planning purposes.

CRediT authorship contribution statement

Charlene A. Caburnay: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Qiang John Fu:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Tyla Carter:** Writing – review & editing, Project administration,

Data curation. **Taylor Butler:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Data curation. **Damon E. Broadus:** Writing – review & editing, Project administration. **Matifadza Hlatshwayo Davis:** Writing – review & editing, Project administration. **Matthew W. Kreuter:** Writing – review & editing, Resources, Methodology, Investigation, Funding acquisition, Conceptualization.

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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.

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Data availability

Data will be made available on request.

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