Pre-analysis plan: COVID-19 Vaccination Take-Up in a County-Run Medicaid Managed Care Population

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1. **Have any data been collected for this study already?**

Yes, data collection began on May 24, 2021.

2. **What is the main question being asked or hypothesis being tested?**

Can messaging, financial incentives and highlighting a convenient scheduling tool increase take-up of COIVD-19 vaccines among the vaccine hesitant?

3. **Describe the key dependent variable(s) specifying how they will be measured.**

- Vaccine take-up at 1 month
- Vaccine intention

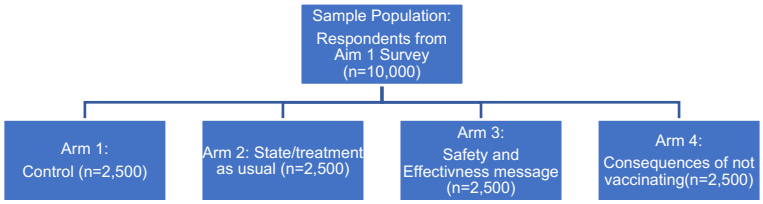
We will measure vaccinations at two points in time, first within one month of the treatment, and second about 6 months later. Vaccine intention, which is measured as the self-assessed probability of getting vaccinated in the next 30 days, is captured directly in the survey.

4. **How many and which conditions will participants be assigned to?**

We will aim to recruit 10,000 adult Medicaid enrollees. Stratifying based on race/ethnicity, language (Spanish or English) gender, and age group, we will randomize invited members to four arms. In brackets below we list sample sizes assuming we can recruit 10,000 members:

1. Control arm ([2,500]
2. Messaging/Information Arm 1: state message (treatment as usual) [N=2,500]
3. Messaging/Information Arm 2: safety and effectiveness information [N=2,500]
4. Messaging/Information Arm 3: information on consequences of going unvaccinated].

Figure. Randomization Design



The information arms have been designed with the experimental literature on vaccination intentions in mind (see Brewer et al. 2017 for a review). That literature finds, among other things, that messages aimed at clarifying the negative outcomes of not getting vaccinated are much more effective at changing intentions than messages that try to correct misperceptions about vaccine safety. Within the arm 3 and arm 4 message groups, we will further randomize participants to race/ethnicity concordant/discordant video messages and to gender concordant/discordant messages. This

intervention builds on recent evidence that race-concordant health care providers increase health screening take-up (Alsan et al. 2019).

Each of these four arms will be interacted with a financial incentive of $10 (N=2,500) or $50 (N=2,500) and, separately with a convenient link to the county public vaccine appointment scheduling system highlighted for participants (N=5,000).

The above treatments are designed to test the role of the following on vaccine take-up:

- Financial incentives [N=5,000] vs. no financial incentives [N=5,000]
    - 2,500 will be randomized to a $10 incentive and 2,500 to a $50 incentive
- Convenient scheduling link highlighted [N=5,000] vs. not [N=5,000]
- Messaging [N=7,500] vs not [2,500]
    - Message type: treatment as usual [N=2,500] vs. safety and effectiveness [N=2,500] vs. consequences of not vaccinating [N=2,500]
- Race concordant [N=2,500] vs. race discordant messenger [N=2,500]
- Gender concordant [N=2,500] vs. gender discordant messenger [N=2,500]

In practice, the randomization will divide the sample 40 possible conditions:

1. Control [N=625]
2. Control x financial [N=625]
3. Control x link [N=625]
4. Control x financial x link [N=625]
5. Treatment as usual (language concordant) [N=625]
6. Treatment as usual (language concordant) x financial [N=625]
7. Treatment as usual (language concordant) x link [N=625]
8. Treatment as usual (language concordant) x financial x link [N=625]
9. Safety and effectiveness (race concordant, male) [N=156.25]
10. Safety and effectiveness (race concordant, male) x financial incentive [N=156.25]
11. Safety and effectiveness (race concordant, male) x link [N=156.25]
12. Safety and effectiveness (race concordant, male) x financial incentive x link [N=156.25]
13. Safety and effectiveness (race concordant, female) [N=156.25]
14. Safety and effectiveness (race concordant, female) x financial incentive [N=156.25]
15. Safety and effectiveness (race concordant, female) x link [N=156.25]
16. Safety and effectiveness (race concordant, female) x financial incentive x link [N=156.25]
17. Safety and effectiveness (race discordant, male) [N=156.25]
18. Safety and effectiveness (race discordant, male) x financial incentive [N=156.25]
19. Safety and effectiveness (race discordant, male) x link [N=156.25]
20. Safety and effectiveness (race discordant, male) x financial incentive x link [N=156.25]
21. Safety and effectiveness (race discordant, female) [N=156.25]
22. Safety and effectiveness (race discordant, female) x financial incentive [N=156.25]
23. Safety and effectiveness (race discordant, female) x link [N=156.25]
24. Safety and effectiveness (race discordant, female) x financial incentive x link [N=156.25]
25. Consequences of going unvaccinated (race concordant, male) [N=156.25]
26. Consequences of going unvaccinated (race concordant, male) x financial incentive [N=156.25]
27. Consequences of going unvaccinated (race concordant, male) x link [N=156.25]
28. Consequences of going unvaccinated (race concordant, male) [N=156.25]
29. Consequences of going unvaccinated (race concordant, female) [N=156.25]

30. Consequences of going unvaccinated (race concordant, female) x financial incentive [N=156.25]
31. Consequences of going unvaccinated (race concordant, female) x link [N=156.25]
32. Consequences of going unvaccinated (race concordant, female) x financial incentive x link [N=156]
33. Consequences of going unvaccinated (race discordant, male) [N=156.25]
34. Consequences of going unvaccinated (race discordant, male) x financial incentive [N=156.25]
35. Consequences of going unvaccinated (race discordant, male) x link [N=156.25]
36. Consequences of going unvaccinated (race discordant, male) x financial incentive x link [N=156.25]
37. Consequences of going unvaccinated (race discordant, female) [N=156.25]
38. Consequences of going unvaccinated (race discordant, female) x financial incentive [N=156.25]
39. Consequences of going unvaccinated (race discordant, male) x link [N=156.25]
40. Consequences of going unvaccinated (race discordant, male) x financial incentive x link [N=156.25]

Additional messaging treatments may be conducted in round 2, at least one month after the first round of treatments. Specifically, round 2 will select individuals who have not been vaccinated, both from round 1 participants and from CCHP members not enrolled in round 1.

There are a total of 2 conditions in round 2:

i. Control [50%]
ii. Messaging [50%]

The messaging for round 2 will depend on evidence from round 1. If round 1 appears ineffective, we will test personalized celebrity messages. If round 2 messages appear effective, we will randomize further to these messages. Randomization for those who participated in round 1 but were not vaccinated will be stratified by treatment arm.

5. What are your main analyses?

Our main analysis will use the CCHS data infrastructure matched to our baseline sample to estimate the following equation:

$$(1) \qquad Vaccinated_i = \alpha + \beta_1 Financial_i + \mathrm{M}_i\theta + \beta_3 Link_i + \delta X_i + \gamma Z_i + \varepsilon_i$$

where $Vaccinated_i$ is an indicator for whether a respondent had a vaccination for COVID-19 in the month after the intervention and $Financial_i$ is an indicator for whether the individual received any financial incentive, M is a vector of indicators for each of the three message types and $Link_i$ is an indicator for whether the individual received the highlighted link. The excluded group, the control condition, will receive no extra prompting to get vaccinated. To raise statistical power, we will include X_i, a vector of predetermined characteristics such as age, race, gender and so on. Z_i represents the vector of indicators for randomization strata. Our main hypotheses are that these interventions increase vaccination rates, $\beta_1 > 0$, $\theta > 0$ and $\beta_3 > 0$. We further hypothesize, based on the literature on childhood vaccinations, that across message types, the consequences message will have the largest effect on take-up. In other words, we hypothesize that $\theta_3 > \theta_1$, $\text{and } \theta_3 > \theta_2$ where 3 denotes the message about the consequences of not getting vaccinated, 2, denotes the message about the safety and effectiveness of vaccines and 1 denotes the state/treatment as usual message.

To differentiate across the financial incentive amounts, we can expand on (1) to estimate:

$$(2)\ Vaccinated_i = \alpha + \beta_1 1_i^{\$10} + \beta_2 1_i^{\$50} + \delta X_i + \gamma Z_i + \varepsilon_i$$

where $1_v^{\$10}$ and $1_v^{\$50}$ are indicators for financial incentives of \$10 and \$50. Our hypothesis is that the magnitude of the effect is increasing in the incentive amount: $0 < \beta_1 < \beta_2$

Among the sample receiving message 2 and 3, we can also test the effects of having a race and/or gender concordant messenger:

$$(3)\ Vaccinated_i = \alpha + \alpha_1 R_i + \alpha_2 G_i + \alpha_3 GR_i + \delta X_i + \gamma Z_i + \varepsilon_i$$

We hypothesize that vaccine take-up is higher for those with race and/or gender concordant messengers, i.e., $\alpha_1 > 0$ and $\alpha_2 > 0$ and $\alpha_3 > 0$. We will further test whether these coefficients differ by race/ethnicity.

Vaccine intention is measured directly in the survey after respondents watch a video message (for those randomly assigned to videos) and prior to an offer of financial incentives or a highlighted scheduling link. Thus, our primary analysis of vaccine intentions is a modification of equation (1):

$$(4)\qquad Intention_i = \alpha + \mathrm{M}_i\theta + \delta X_i + \gamma Z_i + \varepsilon_i$$

where Intention is a respondent's self-assessed probability of getting vaccinated in the next 30 days and M is a vector of indicators for each of the three message types. The excluded group, the control condition, will receive no messaging. As above, we will include X_i, a vector of predetermined characteristics such as age, race, gender and so on. Z_i represents the vector of indicators for randomization strata. Our main hypotheses is that messaging increases vaccine intentions, $\theta > 0$. As with vaccine take-up, we further that across message types, the consequences message will have the largest effect on intentions. In other words, we hypothesize that $\theta_3 > \theta_1$, and $\theta_3 > \theta_2$ where 3 denotes the message about the consequences of not getting vaccinated, 2, denotes the message about the safety and effectiveness of vaccines and 1 denotes the state/treatment as usual message.

Among the sample receiving message 2 and 3, we can also test the effects of having a race and/or gender concordant messenger on intentions. For that we use equation (4) above with the same basic hypotheses, i.e., that race and/or gender concordant messengers increase vaccine intentions more than discordant messengers.

Because of administrative delays that led to a large pause in recruitment, we will analyze the data both overall and separately across recruitment waves.

6. Any secondary analysis?

Vaccine take-up at 6 months; vaccine take-up at 1-year.

Difference between vaccine intention and vaccination

Time to first vaccination

Full vaccination status

We will also study heterogeneous treatment effects by race, gender, age and other characteristics.

From administrative data, we may study health care utilization and COVID-19 testing.

7. **Sample size and power**

For the purposes of this power calculation, we assume that among the vaccine hesitant only 10% of the population will get vaccinated in the absence of our interventions. The table below shows the minimum detectable effects (MDE) for our main comparisons using standard assumptions of 80% power, 5% alpha. We show the MDE for the unadjusted mean comparisons as well as when we include controls to increase precision. We assume controls will modestly increase the R-squared on take-up to 0.25.

Power Calculation: Vaccination take-up			
Intervention	N: tx vs. control	MDE	MDE with controls
Financial incentives; scheduling link	5,000 vs. 5,000	0.0168	0.0146
Any message/information	7,500 vs. 2,500	0.0194	0.0168
Message type; race or gender concordance	2,500 vs. 2,500	0.0238	0.0206

In the unadjusted comparisons, we will be able to detect a change in vaccinations of 1.68 percentage points (16.8% off the mean) for our financial incentive (5,000) vs. control (5,000) or scheduling link vs. control. For any message (7,500) vs. no message (N=2,500) we can detect take-up changes of 1.94 percentage points (19.4% off the mean). For our 3-message type or race or gender concordance (N=2,500 each) comparisons we can detect take-up changes of 2.38 percentage points (23.8% off the mean). Accounting for statistical controls as well as our randomization strata, the MDEs decline to 1.46 percentage points for financial incentives/scheduling link, 1.68 percentage points for any message and 2.1 percentage points for message type or race or gender concordance comparisons.

To benchmark these comparisons, we note that Alsan et al. (2019) finds increases in flu shot take-up among African American men, a vaccine hesitant group, of about 22 percentage points for a $5 or $10 incentive. A key difference with our study is Alsan et al. (2019) provided vaccinations on site. Nonetheless, our study will be well-powered if our interventions have impacts even $1/10^{th}$ the size as those in Alsan et al. (2019).

For vaccine intention, we assume that the self-assessed likelihood of vaccination in the next 30 days is double the rate of actual vaccinations, i.e., 20%. We further assume a 20% standard deviation. For any message vs. no message we can detect take-up changes of 1.29 percentage points (6.5% off the mean). For our 3-message type or race or gender concordance (N=2,500 each) comparisons we can detect take-up changes of 1.59 percentage points (8% off the mean). Accounting for statistical controls as well as our randomization strata, the MDEs decline to 1.12 percentage points for any message and 1.37 percentage points for message type.

Power Calculation: Vaccine intention			
Intervention	N: tx vs. control	MDE	MDE with controls
Any message/information	7,500 vs. 2,500	0.0129	0.0112
Message type; race or gender concordance	2,500 vs. 2,500	0.0159	0.0137