

# Cash versus lottery video messages: online COVID-19 vaccine incentives experiment

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## Abstract

During the COVID-19 pandemic, governments offered financial incentives to increase vaccine uptake. We evaluate the impact on COVID-19 vaccine uptake of cash equivalents versus being entered into lotteries. We randomly assign 1628 unvaccinated US participants into one of three 45-second informational videos promoting vaccination with messages about (a) health benefits of COVID-19 vaccines (control), (b) being entered into lotteries or (c) receiving cash equivalent vouchers. After seeing the control health information video, 16% of individuals wanted information on COVID-19 vaccination. This compared with 14% of those assigned to the lottery video (odds ratio of 0.82 relative to control: 95% credible interval, 0.58–1.17) and 22% of those assigned to the cash voucher video (odds ratio of 1.53 relative to control: 95% credible interval, 1.11–2.11). These results support greater use of cash vouchers to promote information seeking about COVID-19 vaccination and do not support the use of lottery incentives.

**Keywords:** vaccine, online, cash, experiments, incentives, COVID-19

## INTRODUCTION

Although the USA was one of the first countries to have access to COVID-19 vaccines, vaccine hesitancy was >25% in some areas, and this could have resulted in more than 200 000 vaccine-preventable deaths (Jia et al., 2023). With the 'emergency phase' of the pandemic ending in the US in May 2023 (Lancet, 2023) it would make sense to take stock of what are the most effective ways to reduce vaccine hesitancy. Financial and other incentives, particularly targeted at the hard-to-convince segments of the non-vaccinated population, are one of the policy measures that may contribute to being better prepared for future pandemics.

During 2021, many countries offered various types of monetary incentives for COVID-19 vaccination. In the USA, these were largely implemented at a state level, and typically, these involved either cash equivalents (e.g. online retail vouchers) or being entered into a lottery for a prize in the form of either cash or a high-value item such as a car (National Governors Association, 2021). A range of other countries implemented various types of vaccine incentives including vaccine lotteries in Canada (CBC News, 2021), cash incentives in Serbia (Holt, 2021) and shopping vouchers in the UK (BBC News, 2021).

These incentive schemes are typically accompanied by messaging campaigns informing the public that they can earn, or have a chance to earn, cash or cash equivalents if they get vaccinated. Such an approach builds on a wide range of experimental evidence on the use of financial incentives to promote vaccination and other preventive behaviours, with a recent review conclud-

ing that '[F]inancial incentives may be a useful addition to the behavioural change toolkit' (Giles et al., 2014). Survey evidence indicates that financial incentives may play a role in increasing rates of COVID-19 vaccination. Financial incentives, rather than information and appeals to the common good (or even personal advantage), convinced experimental subjects to subscribe to a COVID-19 contact tracing app. (Munzert et al., 2021). A Kaiser Family Foundation study found that about one in four would be more likely to get vaccinated if they were entered into a lottery with a chance to win US \$1 million. (Kaiser Family Foundation, 2021) Evidence from a German conjoint experiment suggests that a hypothetical financial incentive of 50 Euros, as part of a mass vaccination scenario, could increase vaccine uptake among the hesitant (Klüver et al., 2021). Although these schemes have garnered considerable enthusiasm amongst policy makers, a number of reservations have been raised regarding their morality, efficacy and possible negative consequences (Largent and Miller, 2021).

As new variants have emerged, there is a concern that control of COVID-19 will require both high vaccination coverage and the use of boosters to limit the risk of breakthrough infection (del Rio et al., 2022). Unfortunately, evidence on effectiveness of incentives to promote COVID-19 vaccine uptake is mixed (Batteux et al., 2022). For example, there have now been four evaluations of the Ohio vaccine lottery, with two studies finding that it produced a significant increase in adult COVID-19 vaccination rates (e.g. Barber and West, 2021), but two other studies finding no effect (e.g. Walkey et al., 2021). Similarly, there is conflicting evidence regarding cash incentives. A third of the unvaccinated

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respondents in a UCLA COVID-19 Health and Politics Project survey experiment indicated that cash payments would make them more likely to get vaccinated (Vavreck, 2021). Consistent with this, a recent online experiment reported in the journal *Science* found that modest monetary payments of US \$24 (200 Swedish kronor) increased vaccination rates by 4.2 percentage points (Campos-Mercade et al., 2021). In contrast, a recent experiment involving cash incentives of up to US \$50 in a Medicaid managed care plan in California did not show an effect on vaccination uptake (Jacobson et al., 2022). The somewhat fragmentary and conflicting evidence that has been summarized in a recent meta-analysis has concluded that ‘controversy [remains] over the effect of other incentives including other lotteries, low amount of cash, and messages on vaccination’ (Mardi et al., 2022).

Although we have abundant experimental clinical evidence on the effectiveness of COVID-19 vaccines, surprisingly, we have limited and somewhat conflicting evidence to inform policies designed to encourage COVID-19 vaccine uptake. An important element missing from the emerging literature is the lack of any head-to-head comparisons of cash and lottery incentives. Our randomized experiment set out to fill this knowledge gap by undertaking a head-to-head comparison of cash versus lottery incentives using an online US sample of non-vaccinated individuals to assess what messaging strategies encourage the non-vaccinated to seek information on COVID-19 vaccinations and the incentives that are being offered by states.

## METHODS

We conducted an online experiment of unvaccinated individuals in the United States to test the impacts of information about potential incentives on vaccine information-seeking behaviour. This involved randomly assigning one of three video messages: a standard Centers for Disease Control and Prevention (CDC)-inspired message that identifies the personal and public health benefits of COVID-19 vaccination (control), a message highlighting that those who get (first-time) vaccinated may have the chance of winning a lottery and a message that those who get vaccinated would receive a cash voucher (replication data, code and other supporting information are available on Dataverse: <https://doi.org/10.7910/DVN/XY4GCO>).

The outcome of the experiment was a behavioural response of clicking on a link to seek more information about the incentives that were on offer and where to get vaccinated. The survey experiment began on June 28, 2021 and ended on July 11, 2021 and coincided with a wide variety of incentives in different US states to promote COVID-19 vaccination (National Governors Association, 2021). After viewing the assigned video, participants were given the opportunity to consult additional information on being vaccinated in their state. We treat this digital expression of interest as our outcome. Our primary pre-registered hypotheses were that participants in the lottery message video and participants in the cash voucher message video would be more likely to click through to the vaccination information Web page than participants assigned to the control video (standard CDC-inspired health message). A secondary hypothesis was that there would be no difference in click-through rates between lottery message and cash voucher message treatments.

The sample size was determined with formal power calculations that were pre-registered. The pre-registration includes a detailed discussion of the basis for these calculations. Our target was to be able to detect a difference in treatment click-through rates of 10 percentage points with a one-sided 1% sig-

nificance level and a power of 80%. As we indicated in our pre-registration, this would require a total sample of ~1000 (roughly 350 respondents in each treatment group). Accordingly, we conservatively set our targeted samples sizes at 500 non-vaccinated respondents for each of the CDC health, cash voucher and lottery video treatments. At the outset of the study, approximately one-third of the US population had not yet had their first COVID-19 vaccine. To meet our target of 1500 non-vaccinated participants, we anticipated inviting ~4500 potential participants.

Figure 1 describes the details of the sampling and treatment assignment. A total of 3416 online participants were recruited to participate in the CANDOUR Incentive study. For the 1798 participants who indicated that they had received at least one COVID-19 vaccine, the Incentive survey terminated. The 1618 participants who indicated they had not had a COVID-19 vaccination were then invited to complete the online survey. The online participants were paid US \$2 for the experiment, which lasted less than 5 minutes. At the outset of the survey, participants were asked five brief demographic questions (the full survey is available in the Online Supplemental Materials). Participants were then randomly assigned to one of the three video messages. (The OSF Registries pre-registration is available at: [10.17605/OSF.IO/ADRW3](https://doi.org/10.17605/OSF.IO/ADRW3).)

A total of 4118 respondents were invited to participate in the online experiment. Primary recruitment was conducted from Cloud Research's Prime Panels—a total of 3551. The Cloud Research Prime Panels have a large and diverse pool of online respondents. Additional individuals were also recruited from online Facebook advertisements (297) (Zhang et al., 2020). The Lucid Fulcrum Exchange provided 364 participants—this is an online participant pool that matches the characteristics and attitudes of other online pools such as MTurk (Coppock and McClellan, 2019).

## Treatments

Each of the three information treatments were delivered in a short 45-second video.

### Treatment 1 (control)

Standard CDC-inspired COVID-19 vaccine promotional and information video (<https://youtu.be/V3DUCC8xD0>);

### Treatment 2

Lottery treatment—the first 30 seconds is identical to the control video; the last 15 seconds informs viewers that in some states, you can be entered into a lottery and win over US \$1 million if you get vaccinated ([https://youtu.be/QIm\\_vbpe\\_go](https://youtu.be/QIm_vbpe_go));

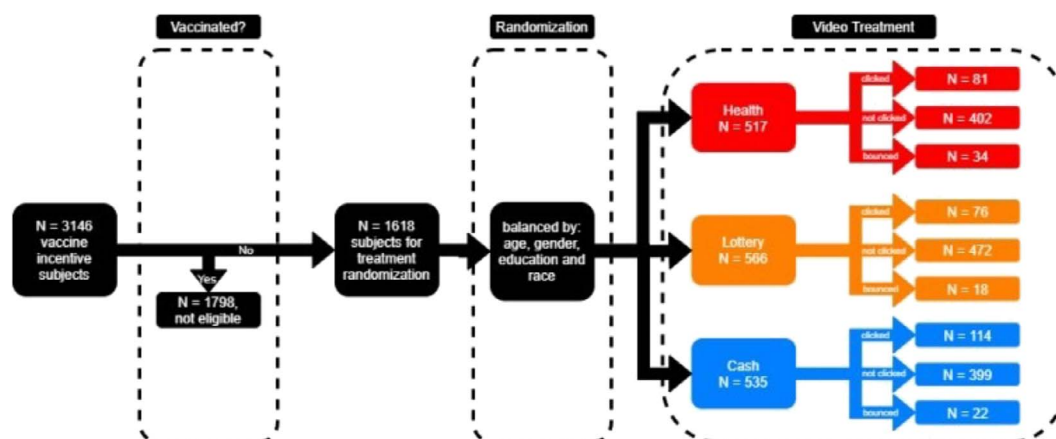
### Treatment 3

Cash voucher treatment—the first 30 seconds is identical to the control video; the last 15 seconds informs viewers that in some states, you can earn money or a money equivalent of up to \$100 that can be spent online or in stores (<https://youtu.be/gF045EaPj-o>).

Our treatment design simulates real-world decision-making situations in which videos play an increasingly important role in delivering public policy information. (Hopkins, 2015; Guess and Coppock, 2020; Mutz, 2021).

## Treatment assignment

Participants were randomly assigned to one of the three video treatments with the pre-registered objective of assigning approximately 500 participants per treatment. We implemented sequential covariate-adaptive randomization using the seqblock



**Figure 1.** Experiment flow diagram

algorithm in the blocktools R package. (Moore, 2012; Moore and Schnakenberg, 2016; Moore and Moore, 2017). We used the Qualtrics Web Service feature to run this covariate adaptive randomization remotely using an Application Programming Interface.

For each incoming respondent, we calculated the Mahalanobis distance for four key covariates to ensure that the random assignment resulted in balance across the three treatment videos (Moore and Schnakenberg, 2016): race, gender, age and education. As each new participant entered the online experiment, we adjusted the treatment assignment probabilities to ensure balance. Assignment probabilities changed based on the covariate profiles of units already in the three treatment groups. In practice, this procedure seeks to create similar covariate distributions in the treatment groups by biasing the current unit's treatment assignment in favor of treatment conditions with fewer units with similar profiles. This approach is especially adapted to online experiments such as ours, in which we do not know the precise characteristics of the respondents who will make up the final sample (Treasure and MacRae, 1998). At any point during the survey period, we only have information on participants who have already taken the survey and the subject that has just arrived.

## Outcome

We pre-specified a single primary outcome—the digital expression of further interest in vaccination information. After participants viewed the assigned treatment video, they were provided with a choice between 1) ending the survey or 2) obtaining further information about how they can get vaccinated in their state. The outcome is their response to this simple choice. If they clicked on the link for further information, they were directed to a Web page that we prepared ([www.didyougetcovidvaccine.com](http://www.didyougetcovidvaccine.com)), which points to vaccine information including the incentives on offer in each state.

This approach builds on online experimental designs that treat digital traces as outcome measures (Salganik, 2017; Cerina and Duch, 2020; Pennycook et al., 2021; Peterson et al., 2021). Their principal advantage is that individuals are not asked to give opinions, which can exaggerate experimenter demand effects.

## Covariates

In addition to age, gender, race and education, we asked participants for their county of residence. The percentage of each county's vote that was won by President Donald Trump in the 2020 presidential race was used to generate a county Trump vote

variable (MIT Election Data and Science Lab, 2017). To show the two continuous covariates (age and Trump vote) on a meaningful scale, we present them as per 10-year increase in age and per 10% increase in Trump vote because using the default one-unit increase could hide a meaningful change in odds.

## Multiple variable models

We summarize the treatment effects using a Bayesian logistic regression model with click-through as the dependent variable. We used a multiple variable model by including the treatment and potential predictors of click-through: age, gender, race, education and county Trump vote. We included random intercepts for each state and the three sample pools. We used vague priors for all parameters. In the heterogeneity analyses, we included interactions between the treatment effect and the four key variables of gender, race, education and county percentage Trump vote.

We present the estimates as odds ratios with 95% credible intervals and Bayesian P-values. The Bayesian P-values estimate the probability that the odds ratio is equal to one. We compared the model fit after adding additional covariates to the logistic regression model using the deviance information criterion (DIC) (Spiegelhalter et al., 2014).

A smaller DIC indicates a better fit, and a difference between models of 10 or more is a strong indicator of a better model. The Bayesian model was fitted in JAGS version 4.3.0. (Plummer, 2003).

We used two chains each with 5000 samples thinned by 5 with a burn-in of 5000. We visually checked the convergence and mixing of the two chains. The odds ratios with 95% credible intervals for the three models are presented in Table 2 (Supplemental Information). The Bayesian P-values for model 3 are presented in the last column of Table 2 (Supplemental Information).

## Ethics

The survey was conducted according to the University of Oxford's Policy for Human Participants Research and approved by the University of Oxford Research Ethics Committee (MS IDREC) (Approval ID: R72328/RE001). Informed consent was obtained from each participant at the beginning of the survey.

## RESULTS

Table 1 summarizes the distribution of the covariates for each of the three treatment groups. Generally, relative to the US population, the online convenience sample was younger, more White, more Black and disproportionately female. The distribution of

**Table 1.** Summary Statistics for US Vaccine Incentives Treatment Assignment

	CDC health message	Cash voucher	Lottery
<i>Education</i>			
High	91 (18%)	73 (14%)	93 (17%)
Medium	224 (43%)	238 (45%)	230 (41%)
Low	198 (38%)	219 (41%)	232 (41%)
Missing	3 (1%)	1 (0%)	7 (1%)
<i>Race</i>			
Black	98 (19%)	84 (16%)	101 (18%)
White	385 (75%)	409 (77%)	407 (72%)
Other	33 (6%)	38 (7%)	54 (10%)
<i>Gender</i>			
Female	359 (70%)	345 (65%)	363 (65%)
Male	157 (30%)	185 (35%)	198 (35%)
Other	0 (0%)	1 (0%)	1 (0%)
<i>Pool</i>			
CloudResearch	457 (89%)	472 (89%)	492 (88%)
Facebook	17 (3%)	16 (3%)	26 (5%)
Lucid	42 (8%)	43 (8%)	44 (8%)
<i>Continuous measures (Median and interquartile range)</i>			
Age	36 (29–49)	38 (29–46)	36 (29–46)
County % Trump vote	53 (40–65)	51 (39–65)	53 (40–67)
Outcome: click-through rates frequency	81 (16%)	114 (22%)	76 (14%)
Odds ratio (95% CI)	Reference	1.47 (1.07–2.02)	0.84 (0.60–1.18)
Total N	516	531	562

these covariates within each of the three treatment groups suggests that the participants were randomly allocated across the three treatments.

### Cash incentives, not lotteries, appeal to the non-vaccinated

Table 1 presents the click-through rates for participants assigned to the three treatments. Of the 516 participants assigned to the control, i.e. the CDC-inspired health video, 81 (16%) subsequently expressed interest in more vaccine information. A slightly lower 14% of those assigned to the lottery video subsequently clicked on the link for further information. The treatment odds ratio for this lottery video is 0.82 (95% credible interval of 0.58–1.17,  $P=0.28$ ). Hence, there is no compelling evidence that lottery incentives perform any better than a standard health message. Around 22% of participants assigned to the cash voucher video subsequently clicked through to the further information page, with an odds ratio of 1.53 (95% credible interval of 1.11–2.11,  $P=0.012$ ).

Table 2 in Supplemental Information presents the results for a basic specification with the cash and lottery treatment variables (model 1), a model 2 that includes the full set of covariates and a model 3 that adds random effects for states and participant pools. The estimated odds ratios for cash and lottery in model 1 are, respectively, 1.47 (95% credible interval of 1.07–2.02) and 0.84 (95% credible interval of 0.60–1.18), and they vary little across all three model specifications. Those in the lottery video treatment have an estimated odds ratio with a credible interval that encompasses 1—providing little evidence that the lottery had any benefit.

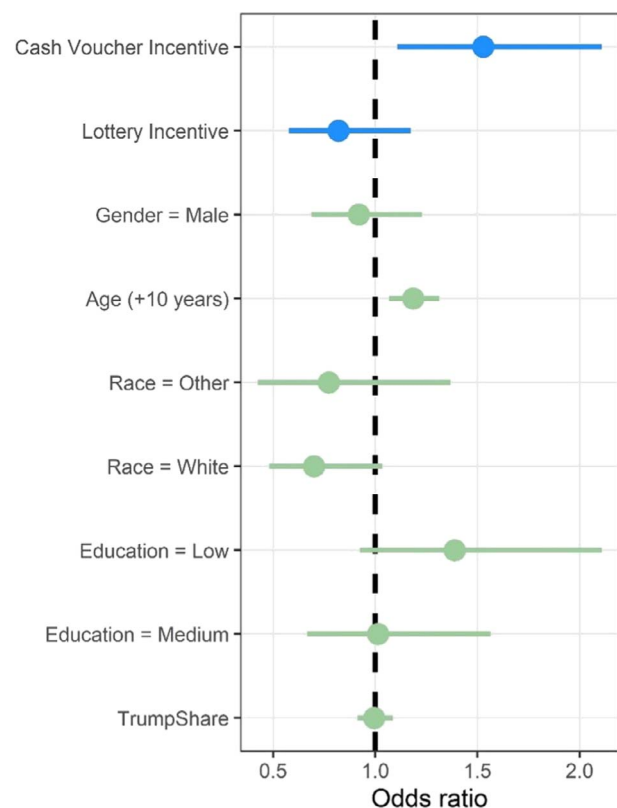
**Figure 2.** Bayesian logistic regression model of clicks to vaccine information. Odds ratios and 95% credible intervals

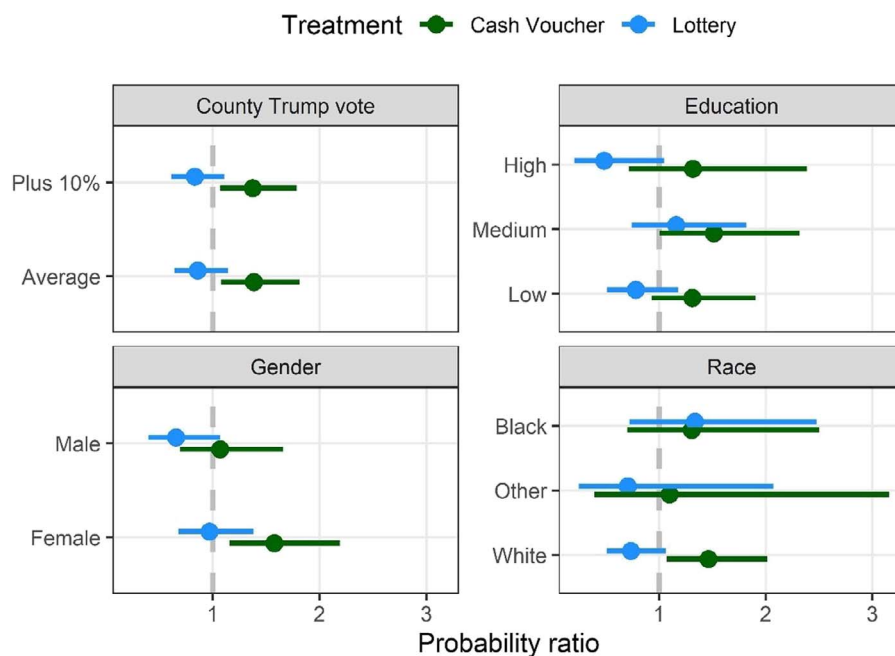
Figure 2 plots the odds ratios and their credible intervals for the fully specified model 3. Estimated odds ratios for the covariate adjustments from model 3 in Table 2 in Supplemental Information are also presented in Fig. 2. Two of the covariate adjustments show large differences in the odds of clicking through. White participants have an odds ratio of 0.69 (95% credible interval of 0.47–1.00), indicating they were less likely than Black respondents to click through for more information after the video treatment. Age has an odds ratio of 1.19 per 10-year increase (95% credible interval of 1.07–1.31), indicating that older participants were more likely to click through for more vaccine information.

### Heterogeneity

We specified heterogeneous treatment effects for three covariates: gender, race and education. The specifications are presented in equations 1 to 4 (Supplemental Information). The interaction terms in these models indicate whether exposure to one of the two treatments (cash or lottery) induces an increase in vaccination information interest relative to the control in that same subgroup. Hence, in the case of education, we present the relative effect of changing treatment within the same education level: high education and cash versus high education and control; medium education and cash versus medium education and control; and low education and cash versus low education and control. In Tables 3–6 (Supplemental Information), we present the estimated odds ratios with 95% credible intervals and Bayesian  $P$ -values. In Fig. 3, we present these estimated odds ratios along with their credible intervals for education, gender and race.

The set of three education and cash voucher odds ratios are similar to the overall cash odds ratio of 1.5. There is some evidence in Fig. 3 that the lottery treatment effect for the high-education





**Figure 3.** Estimated odds ratios and 95% credible intervals of the treatment effect interacted with gender, race, education and county Trump vote from the Bayesian logistic regression model

group is significantly lower than is the control treatment for this high-education group. There is a gender interaction. For female participants, the cash voucher odds ratio with respect to the control is  $\sim 1.8$  and quite precisely estimated, whereas for male participants the odds ratio is close to one.

The race interactions suggest interesting differences by ethnicity. For White participants, the cash voucher odds ratio is  $\sim 1.5$  and precisely estimated (they are the largest racial group in the sample). The lottery odds ratio for White participants is  $< 1.0$  and also precisely estimated. Relative to the control health video, White respondents are clearly more likely to click through for more information when they view the cash voucher information treatment and less likely when they view the lottery treatment. Black participants, on the other hand, seem to respond similarly to both the cash voucher and lottery treatments.

Figure 3 also estimates the odds ratios for cash versus control for respondents in a county with an average Trump vote share and cash versus control odds ratios for those in a county with a Trump vote share that is 10% above the average. County partisanship does not seem to interact with the treatment effects: participants in counties with a relatively high Trump 2020 vote share responded to the cash and lottery treatments similarly to those in counties with an average Trump 2020 vote share.

## DISCUSSION

We conducted an online randomized experiment with unvaccinated adults in the USA. Compared with a brief COVID-19 vaccine informational video message, information on the potential to receive a cash voucher (of up to US \$100) for being vaccinated increased the proportion of individuals seeking information (from 16 to 22%). Vaccine information-seeking behaviour in response to a lottery incentive was not significantly different from the non-incentivized COVID-19 health video. Our results suggest that monetary incentives to be vaccinated can be effective, but that the type of incentive matters—at least in the USA, cash is effective whereas lotteries are not.

The COVID-19 pandemic has highlighted the importance and challenges associated with ensuring regular cycles of vaccination. Experience with annual cycles of flu vaccines suggests that achieving and maintaining the recommended uptake will be challenging. For example, in the USA, the CDC recommends almost universal flu vaccination every season, yet only half the population follow these guidelines (Santibanez et al., 2020). Incentives can increase vaccine uptake, but the question remains as to which types work best. Randomized controlled experiments would seem to provide a way to systemically evaluate different policies. However, to date, there have been relatively few field experiments because they are both costly to conduct and often cannot be used to evaluate existing policies due to government reluctance to vary levels of benefits across the population.

The design we implemented in this study allows us to assess what incentives will increase the likelihood of the unvaccinated seeking information on how to get vaccinated. Seeking information is an intermediate outcome. It is, however, one of the first steps to changing behaviour and we note that ‘click-through rates’ are a widely used metric to test the effectiveness of advertising (Lewis et al., 2015). A recent meta-analysis of  $> 800$  social media experiments found that they are effective in shifting both self-reported beliefs and rates of vaccination, which provides some evidence that online information can impact COVID-19 vaccine uptake (Athey et al., 2023).

We see parallels between information and social media experiments that have intermediate outcomes and the testing of vaccines in randomized experiments that involve testing intermediate outcome indicators such as antibody response that are an important precursor to conducting large-scale trials of its efficacy in preventing disease (Mellet and Pepper, 2021).

Our online study recruited participants from across the USA, and we were able to explore heterogeneity in the treatment effect using a range of pre-specified covariates. Our results indicate that there is a significant difference between cash and lotteries among some subgroups. Given the disparities in COVID-19 vaccine

uptake, it would be useful to conduct further experiments to identify incentives that can help close these gaps.

Although the study provides evidence from an experimental design that tested different types of incentives, there is a need to build a much larger evidence base to inform policy choices regarding the rollout of vaccine booster shots. A potential strength of our study is the use of informational videos that summarize policies that are already in operation. Informational videos mimic the common sorts of media that individuals now routinely use to acquire information on which to base health decisions. Importantly, informational videos can also be rapidly implemented in any country. Furthermore, this type of experimental design allows direct comparisons of a wide variety of different types of incentives while ‘blinding’ the participant to the study hypothesis (Boutron et al., 2007).

Future experiments can be designed to identify the causal impact of a broad range of interventions other than cash and lotteries, including convenience and personal freedoms, on vaccine uptake in different populations. Such evidence represents an important first stage of a broader research agenda to find what works and in which populations. This could involve field experiments similar to the Swedish study referenced in our introduction that provided monetary incentives and ascertained the impact on vaccination within the next 30 days. Another possible design could be based on a recent ad experiment that tested the impact of a YouTube video (Larsen et al., 2022). This study was designed to test a video of Donald Trump advocating COVID-19 vaccination using random assignment of advertising at a county level and then examining the county-level variation in vaccination rates. The latter highlights the potential importance of advertising of any effective COVID-19 vaccine incentive strategy because a recent evaluation of various state initiatives showed that they were largely ineffective (Thirumurthy et al., 2022). Hence, future vaccine incentive initiatives need to find effective ways to reach the unvaccinated, and video messages on social media that can be tested via randomized experiments would be an evidence-based way to achieve this.

Another issue is whether incentives may have long-term effects such as reducing those offered propensity to use health care if they are not offered incentives. This would require long-term follow-up to understand long-term impacts on behaviour. This has recently been explored in a follow-up to the Swedish incentive experiments, which found no negative spillover effects in that there were no negative impacts of offering financial incentives for taking a first dose on the uptake of second or third dose of a COVID-19 vaccine (Schneider et al., 2023).

Finally, it is important to highlight a number of limitations. There are some minor wording differences between the cash versus lottery videos that may have had an influence on click-through rates. The impact of different aspects of the video messaging could be explored in future experiments. We used online panels such as the Lucid Fulcrum Exchange and provided a relatively high rate of compensation (\$2 for <5 minutes work). It is possible that such a mode of recruitment may produce a degree of sample selection (i.e. is more likely to be taken up by individuals who respond to incentives) and this may have an impact on the generalizability of the treatment effect. We have made all our videos, protocol and data available to encourage replication of our study in other populations.

Ensuring that COVID-19 levels remain low will require very high levels of vaccine coverage and will also likely require an ongoing cycle of vaccination for the global population. Incentive payments are likely to be a critical component to maximizing uptake

and ensuring efficient rollout, not only in developed countries, but also in low- and middle-income countries (Arezki, 2021). Our study has demonstrated that it is feasible to conduct pragmatic randomized experiments to measure which types of incentives are most likely to be effective. Obtaining future evidence from randomized experiments on what works should be a priority.

## Author Contributions

Concept and design: R.M.D., A.B., M.F., J.E.-B., L.S.J.R., M.V., P.M.C. Acquisition of data: R.M.D., M.F. Analysis and interpretation of data: R.M.D., A.B., M.F. Drafting of the manuscript: R.M.D., L.S.J.R. Critical revision of paper for important intellectual content: R.M.D., A.B., L.S.J.R., M.V., P.M.C. Statistical analysis: R.M.D., A.B. Provision of study materials or patients: R.M.D. Obtaining funding: R.M.D., P.M.C. Administrative, technical or logistical support: R.M.D., M.F., J.E.-B., M.V., P.M.C. Supervision: R.M.D.

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*Precis:* An online randomized experiment to compare cash and lottery incentives in promoting COVID-19 vaccine information-seeking behaviour.

## Conflict of Interest

None declared.

## Data Availability

Replication data, code and other supporting information are available on Dataverse: <https://doi.org/10.7910/DVN/XY4GC0>.

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