Make it easy: Lowering transaction costs substantially increases COVID-19 vaccinations

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Abstract

We examine the effect of reducing individuals' transaction costs for getting vaccinated against COVID-19 on vaccination decisions. In a field experiment, we sent mobile vaccination units (MVUs) to Swiss communities. Governments around the world use these types of mobile units to increase COVID-19 vaccination uptake. We found an increase by a factor of 3.4 (plus 9.0 percentage points) in the vaccination rate of the previously unvaccinated treatment group compared to the control group over a three-week period. The increase was present and highly statistically significant for women, men, and for all age groups. We found no evidence of cannibalization of vaccinations at other service locations. This suggests that MVUs did not just serve as a tool to reach people faster, but rather to vaccinate more people overall. Thus, the offer of mobile vaccination units is highly effective in raising vaccination rates.

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1 Introduction

Vaccination is the decisive factor in overcoming the COVID-19 pandemic (Lavine et al., 2021; WHO, 2022). Yet, despite the severe health and economic consequences of the pandemic, the vaccination curve in most high-income countries has flattened sharply since vaccines became widely available in the first half of 2021 (CDC, 2022; Federal Office of Public Health Switzerland, 2022). In response, governments around the globe have started programs to increase vaccination rates. However, thus far, these programs have not been sufficient to achieve government vaccination targets.

When considering an individual's decision to get vaccinated, the literature on vaccine uptake considers low transaction costs (i.e., the time needed to register before the vaccination appointment, the time to get the vaccination, and transportation costs) among the most important factors (Betsch et al., 2018; Machingaidze and Wiysonge, 2021), but causal evidence for this claim is scarce. The importance of keeping transaction costs low is also reflected in scientific advice for governments. For instance, Volpp et al. 2021 define five strategies, informed by insights from behavioral science, for the U.S. COVID-19 vaccine promotion program, with the first strategy being to make the vaccine free and easily accessible.

Research has proposed to compensate for transaction costs by paying people to get vaccinated. This has shown promising results (Campos-Mercade et al., 2021; Klüver et al., 2021; Serra-Garcia and Szech, 2021), and many governments have taken up the idea. To encourage vaccine uptake, they have paid moderate to high incentives (e.g., USD 25 in North Carolina (Wong et al., 2021), USD 100 in New York City (Oza, 2021), approximately USD 25 in Serbia (Holt, 2021), and approximately USD 180 in Greece (Reuters, 2021)). However, this has also led to heated debates on whether paying people to get vaccinated is ethically justifiable (Persad and Emanuel, 2021; Savulescu et al., 2021). In addition, there is a threat of crowding out intrinsic motivation for further vaccinations in the future (Loewenstein and Cryder, 2020).

Instead of compensation, in this paper, we consider the effect of a direct reduction of transaction costs by using mobile vaccination units (MVUs), which can be considered less controversial. Many countries rely on MVUs, which temporarily visit a community to vaccinate locally. For instance, MVUs are employed across the U.S. (Federal Emergency Management Agency, 2021), in 21 countries in the European Union (European Center for Disease Prevention and Control, 2022), and in both rural and urban settings in Asian countries (Panwar et al., 2021; Ministry of Health Singapore, 2022). Despite the popularity of MVUs, so far, no randomized controlled trial (RCT) has been reported to test their effectiveness. There is evidence coming from a setting where the visited communities were not assigned randomly that MVUs substantially increased COVID-19 vaccinations by 25% within three weeks (Zhang et al., 2022). This can give an indication of the effectiveness of MVUs; however, local authorities might have chosen those communities for the visits in which they expected the highest impact. Also beyond COVID-19, accessibility is seen as a key constraint on vaccination uptake, for instance in the case of influenza vaccinations (Betsch et al., 2018; MacDonald, 2015). There, the impact of on-site offerings on vaccination rates was investigated mainly in hospital settings (Burls et al., 2006; Lee and Fong, 2007; Harbarth et al., 1998). However, to the best of our knowledge, evidence from RCTs and evidence with the general population is also lacking in this area.

Here, we report the results of an RCT (N = 20,414 unvaccinated adults) in Switzerland. We examined the effect of sending MVUs to communities for four hours on a single day. We found that the vaccination rate for the previously unvaccinated in the treated communities was 9.0 percentage points higher than in the control communities (an increase by a factor of 3.4) for our time span of three weeks. We see no evidence for cannibalization of vaccinations at dedicated vaccination centers or at local doctors' offices and pharmacies (3.9% vaccination rate of the previously unvaccinated in the treated communities and 3.7% in the control communities). Accordingly, excluding vaccinations at MVUs, no difference in vaccination behavior can be seen over the whole three-week time span of the study. This suggests that the MVUs served not only as a tool to vaccinate people more quickly, but also to reach more people overall. The treatment effect is robust when age, gender, and community vaccination rates are controlled for. The increase is statistically significant for women, men, and all age groups.

The substantial effect of MVUs is notable because our study was conducted at a later point in the COVID-19 vaccination campaign when vaccines had been made widely available for several weeks, so that vaccination appointments were freely available for the general public the next day. People thus had enough time to contemplate their vaccination decisions and to plan for a convenient vaccination date. In contrast, several field experiments that aimed to increase COVID-19 vaccinations were conducted when vaccines first became available (Campos-Mercade et al., 2021; Dai et al., 2021; Santos et al., 2021). The timing might be relevant; for example, it could be that unvaccinated people grow more reluctant over time. Still, in this environment, we find a very large effect of the mobile vaccination unit being present for only four hours on a single day. Consequently, this study highlights the importance of keeping transaction costs as low as possible, even at a later stage in vaccination campaigns. As in most of the communities there was also an opportunity to get vaccinated at a local doctor's office or pharmacy, but with higher transaction costs (e.g., registering, scheduling an appointment), proximity alone is likely not the only driver of the effect.

Importantly, the substantial effect of MVUs is also present for people age 60 years and older, who had comparatively high vaccination rates before the intervention and constitute the group with the highest risk. Additionally, the data allow us to control for important factors, such as the community vaccination rate. Finally, the intervention represents a very cost-effective way of increasing vaccination uptake. The mobile team uses rooms available in the community and thus requires only staff to administer the vaccine. Taken together, our findings highlight the importance of accessibility and show how powerful MVUs are in increasing vaccination rates.

2 Experimental design

2.1 Field setting and intervention

We conducted the preregistered RCT in August 2021 with 10 treatment and 10 control communities in the Swiss canton of Solothurn.[1] Switzerland is divided into 26 cantons, which are mostly responsible for their own vaccination campaigns, including both the communication strategy and the implementation. Although the initial demand for COVID-19 vaccination was generally high in Switzerland, the vaccination rate began to stagnate from July 2021 onward, leading to many unfilled vaccination appointments at the time of our study (Federal Office of Public Health Switzerland, 2022).

The field partner was able to offer 10 slots for MVUs as part of the experiment. Due to the capacity of the MVUs, only communities with approximately 1,500–3,500 inhabitants older than 16 years were eligible; this ensured that a mobile vaccination team would be able to vaccinate everyone who would show up for the offering. In total, 32 communities in the canton of Solothurn fulfilled this criterion. We randomly picked 20 communities and assigned them to either the treatment or the control group, stratifying the assignment based on the community size and the estimated baseline vaccination rate available at the time. The remaining communities are not part of this study; they did not receive any type of intervention.

All 45,909 residents age 16 years and older in the 20 communities received personally addressed letters (see Appendix A Figures A1, A2, A3). Letters were sent to the entire population, including vaccinated individuals. All letters were framed as reminders to be vaccinated and provided a link to the appointment-scheduling website and the telephone number for making appointments at vaccination centers. The letters highlighted the importance of vaccination and, in the treatment communities, informed the recipients of the visit of an MVU in their community in the upcoming days. The MVU was present for a 4-hour interval on one weekday in each of the treatment communities. Irrespective of the treatment, adults in all communities could be vaccinated at a vaccination center or at their local doctors' offices and at pharmacies. Two-thirds of the letters in the control group and two-thirds of the letters in the treatment group included one of two types of supplementary social norm information: People were informed in either relative or absolute numbers about how many people in total and per age group had been vaccinated to instill the empirical social norm that vaccination is safe and has been chosen by others like themselves. The letter types were randomly assigned based on household information (apart from two communities where only address level information was given). This means that all people living in the same household received the same

[1] The details of the experiment were preregistered with the American Economic Association's registry for randomized controlled trials with the unique identifying number AEARCTR-0008070. The ethical standard of the study was approved by the Faculty of Business Administration, Economics, and Social Sciences of the University of Bern (July 14, 2021), serial number 172021. The data provision for the project was enabled through the cantonal data protection office, with data protection plans for sharing information between the involved communities and the canton of Solothurn in place (July 26, 2021). The data protection plans also regulated the sharing of anonymized data with the University of Bern project team.

type of letter. In each of the 20 communities, all three letter types were evenly distributed (see Appendix A Figure A4, p = 0.581, chi-square test). The letter type did not influence the effect of the MVUs (see Appendix B Table A1).

2.2 Data set and time frame

We received fully anonymized vaccination data for all citizens age 16 years or older, including basic demographic information (age and gender). At the onset of the study, more than 55.5% of people age 16 years and older in the 20 target communities had received at least one dose of a COVID-19 vaccine. The experimental sample thus consisted of all adults who had not received a COVID-19 vaccine before the intervention (N = 20,414). Before conducting the study, we received estimates on vaccination rates of the 20 communities from our field partner. Based on these, we estimated the unvaccinated population across the 20 communities to be at least 18,000 people (9,000 people in the MVU-treatment group and 9,000 in the control group). The vaccination rate for the control group during the intervention period was estimated at 3%, based on historical data from the weeks leading up to the intervention period and forecasts of the field partner. Thus, given an alpha-level of 5% and a power of 80%, we calculated the minimum detectable difference between the treatment and control group to be 0.8 percentage points (chi-square test). The actual numbers showed that the unvaccinated population was about 10% larger than our conservative estimate (20,414 people).

In the 20 communities, prior to the experimental intervention, 87.9% of all vaccinated inhabitants had been vaccinated at a vaccination center, 9.3% of all inhabitants had been vaccinated at a local doctor's office or pharmacy, and 2.8% had been vaccinated at an MVU. Until that time, the canton had not used MVUs for the general public, only for on-site vaccinations in retirement homes and similar institutions.

Our preregistered main outcome variable is the vaccination decision, which is the decision to be vaccinated against COVID-19.[2] We considered only first-time vaccinations. Second-dose appointments were automatically scheduled when the first appointment was made, and both vaccinations usually occurred at the same location. Thus, during the study period, mobile vaccination teams administered only first-dose vaccinations (the team returned four weeks later to administer the second-dose vaccinations). The rate of individuals who received their first vaccination at an MVU during the intervention period and later received their second dose was 94.1%, similar to the canton-wide average of 94.4% fully vaccinated (two doses), within the group of at least partially vaccinated individuals (status January 4, 2022).

Vaccinations at vaccination centers and by the mobile vaccination units were registered in a system that included information on vaccination dates, location, gender, age, community, and a unique identifier per household. Vaccinations administered at local doctors' offices and pharmacies were

[2]COVID-19 vaccinations in Switzerland are free of charge and, depending on local availability at the time of the study, either the Moderna or the Pfizer-BioNTech vaccine was administered.

registered in separate systems.[3] These systems captured the same information, except for the household identifier. Hence, for vaccinations administered at these service locations, we cannot identify the specific household of each vaccinated person. This household information is available for 86.8% of vaccinations administered during the study and only used for robustness analyses.

To measure the treatment effect, the period from Monday, August 16, 2021, to Monday, September 6, 2021, was considered. We included vaccinations as of August 16, as this was the first day when someone may have been vaccinated due to having read the information letter. In the treatment group, the MVUs visited the communities on either Thursday or Friday of the same week (August 19 or 20, 2021) or on the following Monday (August 23, 2021). The date and exact time of the visit of the MVU to the recipient's respective community was included in the letter. We included vaccinations up to September 6, 2021, two weeks after an MVU had visited the last community, to account for the potential spillover or cannibalization effects of having had an MVU in the community. This was approximately three weeks after the information letters were delivered.

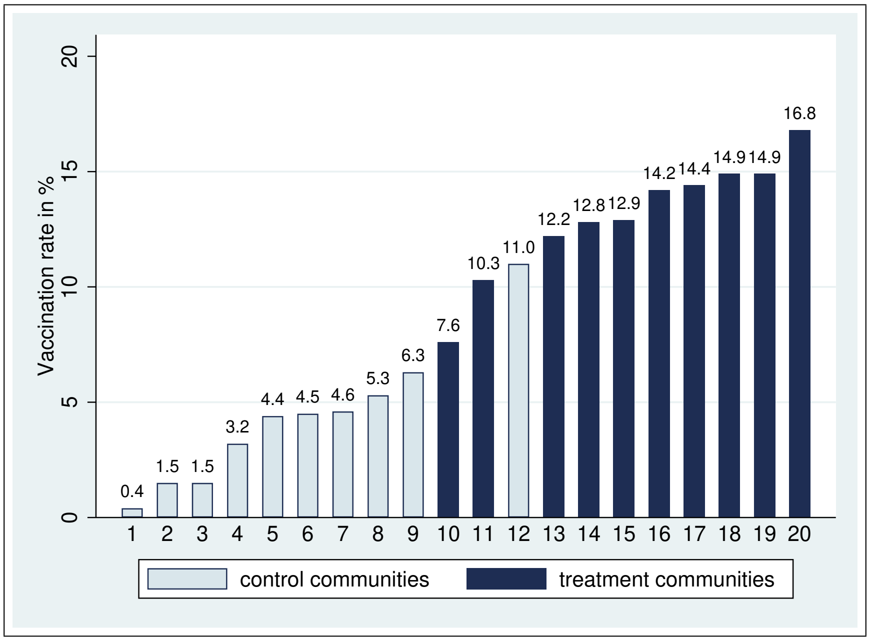
3 Results

Examining the vaccination rates during the intervention, we find a large and highly statistically significant difference of 9.0 percentage points between the control and treatment groups. Specifically, 3.8% of the citizens in the control sample and 12.8% in the treatment sample were vaccinated during the intervention period ($p < 0.001$, chi-square test.).[4] As illustrated in Figure 1, the vaccination rate of the previously unvaccinated population was higher in all but one of the treated communities than in the control communities.

[3] There was no significant difference between the share of people vaccinated during the intervention period at local doctors' offices and pharmacies between the control and the treatment group (1.0% and 1.1%, respectively).

[4] All p-values were derived from two-sided statistical tests.

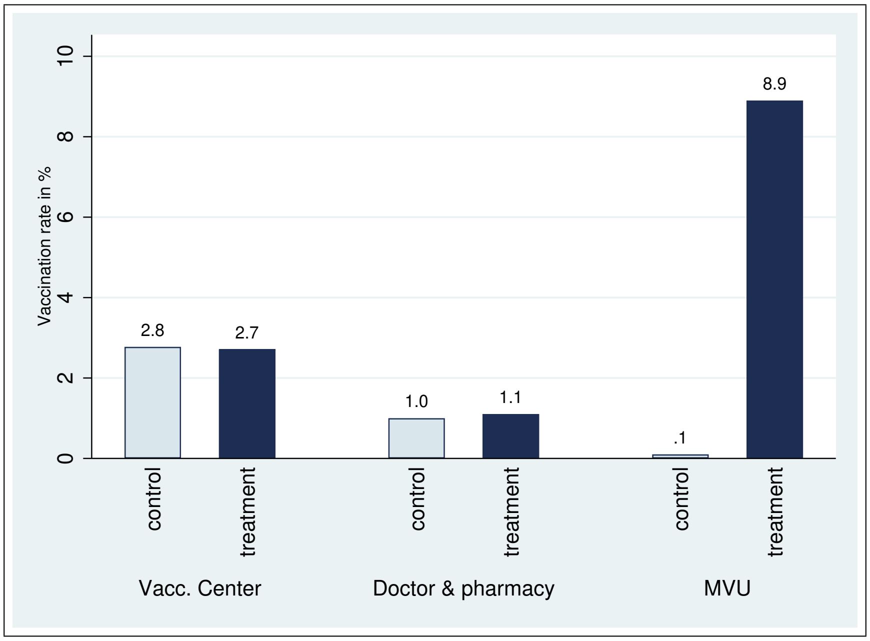
FIGURE 1: Vaccination rates by community.



Given that the communities differ in their pretreatment vaccination rates (see Appendix B Table A2), ranging from 47% to 69%, we compare the intervention period vaccination rate of each treated community with that of each control community (see Appendix B Table A3). Out of these 100 comparisons, the vaccination rate in the treated community is statistically significantly higher than in the control community in all but seven cases. Thus, the effect of the MVU is present for comparisons between communities with similar as well as unequal pretreatment vaccination rates.

Figure 2 shows that there is no evidence of cannibalization effects or spillover effects of MVUs on vaccinations at other service locations. There is no statistically significant difference between the treatment group and the control group in vaccination rates at vaccination centers (2.7% vs. 2.8%, $p = 0.809$, chi-square test) and at local doctors' offices and pharmacies (1.1% vs. 1.0%, $p = 0.214$, chi-square test). This shows that the difference in vaccination uptake is driven by MVUs and suggests that MVUs did not just motivate people to get their shot faster, but that actually more people were vaccinated overall.

Figure 2: Vaccination rates by treatment and service location.



The treatment effect is confirmed by the results of OLS regressions with robust standard errors clustered at the community level, as displayed in Table 1. We correct for the small number of clusters (20 communities) by using wild cluster bootstrapping (Porter and Serra, 2020; Cameron and Miller, 2015; Angrist and Pischke, 2008). The dependent variable in all models is the vaccination decision, which takes the value of 1 if an individual was vaccinated during the intervention period. All models show a highly statistically significant effect of MVU treatment on vaccination uptake. The magnitude of the effect remains stable when gender (specification 2), age (specification 3), and community baseline vaccination rate at the beginning of the intervention (specification 4) are controlled for. Results are robust with a stable effect size when we employ logistic regressions (see Appendix B Table A4).

Table 1: Vaccination behavior during the study, specifications 1-4.

	Vaccinated (1)	Vaccinated (2)	Vaccinated (3)	Vaccinated (4)
MVU-treat	0.090***	0.089***	0.089***	0.078***
	(0.013)	(0.013)	(0.013)	(0.013)
Female		-0.004	-0.004	-0.004
		(0.003)	(0.003)	(0.003)
Age			-0.000	-0.000
			(0.000)	(0.000)
Community vacc rate				0.287**
				(0.108)
Constant	0.038***	0.040***	0.042***	-0.109*
	(0.010)	(0.010)	(0.011)	(0.060)
Boot-p MVU-treat	0.000	0.000	0.000	0.000
Observations	20,414	20,414	20,414	20,414

Notes: The table presents estimates of ordinary least squares regressions. Robust standard errors clustered on the community level are in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Robustness checks with inclusion of letter type and household vaccination rate in the regression models in the partial sample[5] do not change the magnitude or significance of the effect of the MVUs observed in the full sample (see Appendix B Table A1). Further analyses show that the difference in vaccination rates compared to the control group is similar in magnitude and highly statistically significant for both genders, all age groups, and all gender-age group combinations ($p < 0.001$, chi-square tests; see Table 2). In line with Figure 2, when excluding vaccinations administered by the mobile vaccination team, there is no significant difference between treatment and control group during our study (see Appendix B Table A5).

[5]Given that we do not have information on these variables for those people vaccinated at local doctors' offices and pharmacies, we conducted this analysis only for those people vaccinated at vaccination centers and MVUs (86.8% of all vaccinations administered during our study).

Table 2: Vaccination rates by treatment group, age, and gender, during the intervention period.

		All (1) n = 20,414	Control (2) n = 10,923	MVU-treat (3) n = 9,491	p-value (2) vs. (3)
Agegroups					
All	(n = 20,414)	8.0	3.8	12.8	<0.001
16-30	(n = 5,091)	7.9	3.7	12.5	<0.001
30-39	(n = 4,400)	7.3	3.7	11.3	<0.001
40-49	(n = 3,361)	9.5	4.1	15.8	<0.001
50-59	(n = 3,653)	8.1	4.0	12.9	<0.001
60-69	(n = 2,345)	7.3	3.6	11.7	<0.001
70+	(n = 1,564)	7.5	3.7	12.6	<0.001
Female					
All	(n = 10,273)	7.7	3.7	12.5	<0.001
16-30	(n = 2,504)	7.7	3.3	12.6	<0.001
30-39	(n = 2,189)	7.9	4.4	11.9	<0.001
40-49	(n = 1,664)	9.8	4.5	16.4	<0.001
50-59	(n = 1,841)	7.1	3.3	11.3	<0.001
60-69	(n = 1,192)	6.4	2.8	10.8	<0.001
70+	(n = 883)	6.8	3.9	10.8	<0.001
Male					
All	(n = 10,141)	8.2	3.9	13.1	<0.001
16-30	(n = 2,587)	8.1	4.1	12.5	<0.001
30-39	(n = 2,211)	6.6	3.1	10.6	<0.001
40-49	(n = 1,697)	9.2	3.7	15.2	<0.001
50-59	(n = 1,812)	9.2	4.6	14.4	<0.001
60-69	(n = 1,153)	8.3	4.4	12.6	<0.001
70+	(n = 681)	8.5	3.4	14.8	<0.001

Notes: The table shows the vaccination rates within the group of individuals that were still unvaccinated at the beginning of the study by treatment, age, and gender. The table reports p-values from two-sided chi-square tests.

4 Discussion

Vaccinations are one of the most important measures in containing the COVID-19 pandemic (Jeyanathan et al., 2020; Skegg et al., 2021). They supplement other preventative measures such as distancing, staying at home, mask wearing, and hand hygiene (WHO, 2021). Over the course of the pandemic, most of these other measures have been assessed to gain a better understanding of what drives compliant behavior with preventative safety measures in the COVID-19 context. For instance, small monetary incentives increase uptake of digital contact tracing (Munzert et al., 2021), presidential messages affect the stated likelihood of wearing a mask (Cherry et al., 2021), mask wearing can serve as a social signal and therewith increase compliance with social distancing (Seres et al., 2021), and narrative public health messages affect intentions to practice social distancing (Lunn et al., 2020). In addition, research has examined the effect of the pandemic on health-unrelated outcome measures, such as between social distancing and partisan affiliation in the United States

(Allcott et al., 2020), major macroeconomic consequences (Baldwin and di Mauro, 2020), higher relative unemployment of women in the pandemic (Couch et al., 2020), and increased domestic violence due to more time at home (Leslie and Wilson, 2020).

Our research focuses on COVID-19 vaccine uptake and examines MVUs as part of the vaccine delivery strategy. Lowering the transaction costs of being inoculated for individuals is seen as an important way to increase vaccination rates (Volpp et al., 2021). We report the results of an RCT that tested the effect of MVUs and finds that they are an effective way to increase vaccinations. The RCT was conducted at a later stage of the vaccination campaign, when all individuals eligible for vaccination had had ample time to contemplate and discuss their own vaccination decisions. In addition, appointments at vaccination centers were in high supply, which kept transaction costs low because a convenient appointment date could be easily scheduled. Furthermore, in each community, a mobile vaccination unit was present for only four hours on a single day. The fact that we find such a substantial treatment effect in this type of environment highlights the importance of keeping transaction costs as low as possible, even in a situation that seems a priori not very affected by this type of cost.

In our study, we observed actual vaccination behavior. Many previous studies in the context of COVID-19 have focused on vaccination intentions and already provided significant insights to understand the drivers of COVID-19 vaccination decisions (Batteux et al., 2022; Keppeler et al., 2021; Klüver et al., 2021; Loomba et al., 2021; Pink et al., 2021; Serra-Garcia and Szech, 2021). While intentions are an important antecedent of behavior, researchers have also shown that there can be a gap between intentions and subsequent behavior (Ajzen, 1991; Ajzen and Czasch, 2009; Sheeran, 2002). Therefore, it is important to complement these findings with actual behavioral field data.

There are several potential reasons why the MVUs produced such a strong effect, in particular, the possibility of getting vaccinated without an appointment, the proximity, and the general setting (Batteux et al., 2022). Regarding proximity, the average one-way travel time to the vaccination centers from the communities participating in this study was approximately 12 minutes by car and approximately 24 minutes by public transportation. The mobile vaccination teams reduced this travel time to 5–10 minutes' walking distance. Table A6 in Appendix B shows the average commute times to vaccination centers for all communities. There is neither a significant difference between the treatment and control communities in terms of average travel time by public transport ($p=0.566$, Mann-Whitney rank sum test), nor in terms of average travel time by car ($p=0.897$, Mann-Whitney rank sum test). As in most communities there was also the opportunity to be vaccinated at a local doctor's office or pharmacy, but with more constraints (e.g., registering, scheduling an appointment), proximity alone is likely not the only driver of the effect. Another reason for our findings could be that having a specific "vaccination event" is driving the result. Although no specific event characteristics were present—for instance, no food or beverages were offered—we cannot rule out this explanation. Further research could examine whether offering several visits by an MVU would increase vaccination rates (due to increased flexibility) or decrease them (due to such visits being less-specific “events”).

The main limitation of our study is that it was conducted in one country at a specific point in time during the vaccination campaign. Our results cannot shed light on whether people in different countries and at different stages of the campaign would react differently to MVUs. However, it is encouraging that non-experimental research conducted in the UK also finds a substantial effect of MVUs (Zhang et al., 2022). Furthermore, although the MVUs in this study were a rather low-cost way of increasing vaccination uptake (using rooms available in the community and thus requiring only staff to administer the vaccine), there might still be more cost-effective ways.

The findings of this preregistered study can inform government vaccination strategies and provide a simple and rather low-cost way to increase vaccination uptake.

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Author contribution

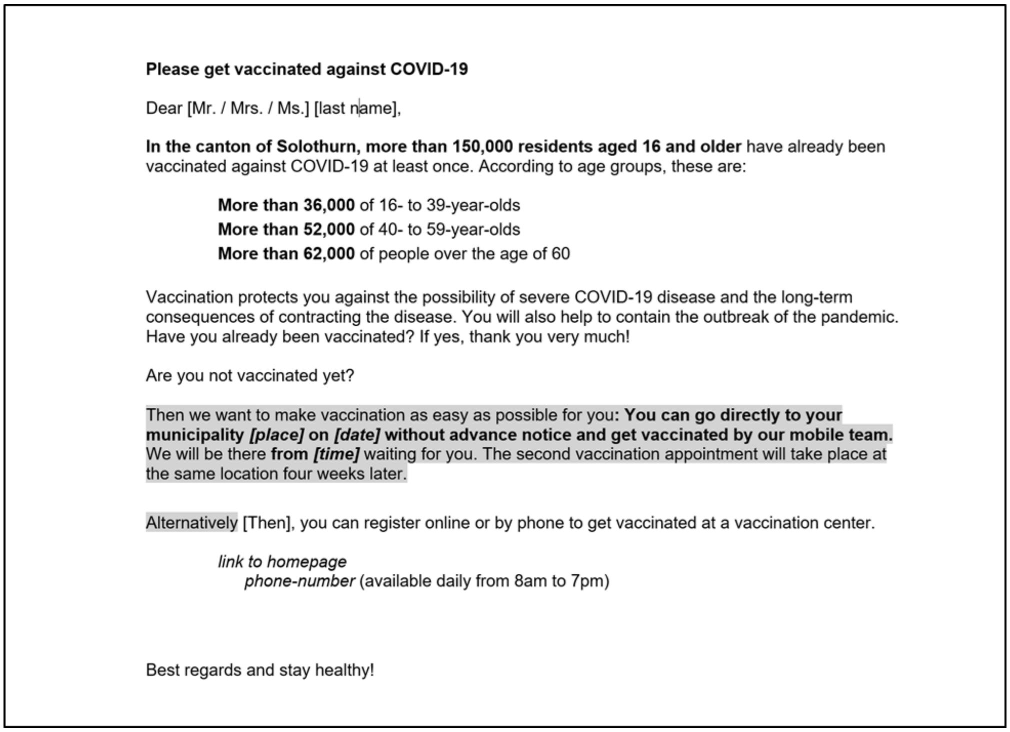
All authors conceived the idea. All authors were involved in conceptualization, methodology, investigation, project administration, and supervision. Data preparation, analysis, visualization, and drafting the manuscript were performed by A.-C.K. and S.S.. F.v.B. reviewed the data analysis and revised the manuscript. All authors approved the final version of the manuscript for submission.

Declaration of interest

The authors declare no conflict of interest.

Appendix A – Supplementary figures

FIGURE A1: Letter type "social norm 1" for MVU and control treatment.



Please get vaccinated against COVID-19

Dear [Mr. / Mrs. / Ms.] [last name],

In the canton of Solothurn, more than 150,000 residents aged 16 and older have already been vaccinated against COVID-19 at least once. According to age groups, these are:

More than 36,000 of 16- to 39-year-olds
More than 52,000 of 40- to 59-year-olds
More than 62,000 of people over the age of 60

Vaccination protects you against the possibility of severe COVID-19 disease and the long-term consequences of contracting the disease. You will also help to contain the outbreak of the pandemic. Have you already been vaccinated? If yes, thank you very much!

Are you not vaccinated yet?

Then we want to make vaccination as easy as possible for you**: You can go directly to your municipality *[place]* on *[date]* without advance notice and get vaccinated by our mobile team.** We will be there **from *[time]*** waiting for you. The second vaccination appointment will take place at the same location four weeks later.

Alternatively [Then], you can register online or by phone to get vaccinated at a vaccination center.

link to homepage
phone-number (available daily from 8am to 7pm)

Best regards and stay healthy!

Notes: The text in grey was only included in letters to residents of communities with mobile vaccination teams. All text is translated from German.

Figure A2: Letter type "social norm 2" for MVU and control treatment.

Please get vaccinated against COVID-19

Dear [Mr. / Mrs. / Ms.] [last name],

In the canton of Solothurn, more than 60 percent of residents aged 16 and older have already been vaccinated against COVID-19 at least once. According to age groups, these are:

More than 45% of 16- to 39-year-olds
More than 65% of 40- to 59-year-olds
More than 82% of people over the age of 60

Vaccination protects you against the possibility of severe COVID-19 disease and the long-term consequences of contracting the disease. You will also help to contain the outbreak of the pandemic. Have you already been vaccinated? If yes, thank you very much!

Are you not vaccinated yet?

Then we want to make vaccination as easy as possible for you**: You can go directly to your municipality *[place]* on *[date]* without advance notice and get vaccinated by our mobile team.** We will be there **from *[time]*** waiting for you. The second vaccination appointment will take place at the same location four weeks later.

Alternatively [Then], you can register online or by phone to get vaccinated at a vaccination center.

link to homepage
phone-number (available daily from 8am to 7pm)

Best regards and stay healthy!

Notes: The text in grey was only included in letters to residents of communities with mobile vaccination teams. All text is translated from German.

Figure A3: Letter type "no social norm" for MVU and control treatment.

Please get vaccinated against COVID-19

Dear [Mr. / Mrs. / Ms.] [last name],

Vaccination protects you against the possibility of severe COVID-19 disease and the long-term consequences of contracting the disease. You will also help to contain the outbreak of the pandemic. Have you already been vaccinated? If yes, thank you very much!

Are you not vaccinated yet?

Then we want to make vaccination as easy as possible for you**: You can go directly to your municipality *[place]* on *[date]* without advance notice and get vaccinated by our mobile team.** We will be there **from *[time]*** waiting for you. The second vaccination appointment will take place at the same location four weeks later.

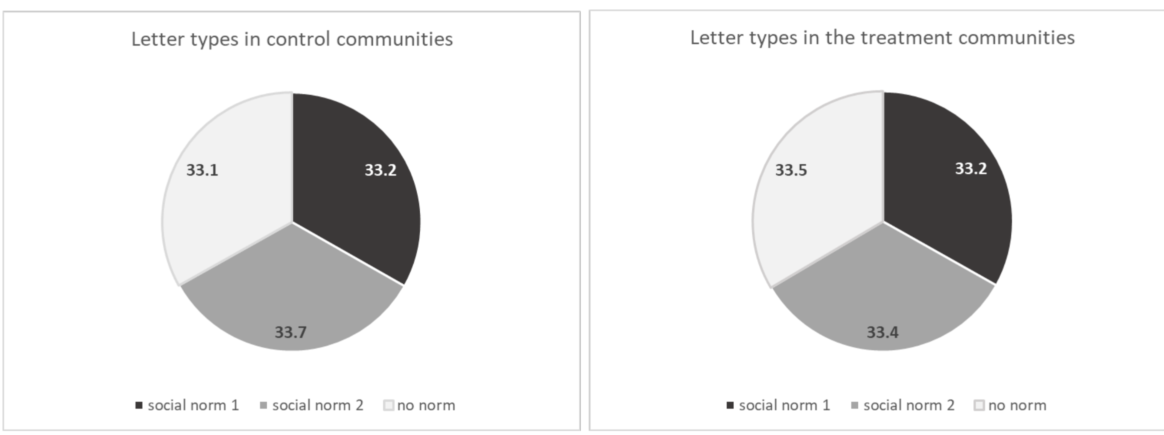
Alternatively [Then], you can register online or by phone to get vaccinated at a vaccination center.

link to homepage
phone-number (available daily from 8am to 7pm)

Best regards and stay healthy!

Notes: The text in grey was only included in letters to residents of communities with mobile vaccination teams. All text is translated from German.

Figure A4: Letter types across control and treatment communities.



Notes: In each of the 20 communities, all three letter types were evenly distributed (p = 0.581, chi-square test).

Appendix B – Supplementary tables

Table A1: Vaccination behavior during the study, including control for letter type and household size, partial sample missing vaccinations administered at local doctors and pharmacies.

	Vaccinated	Vaccinated	Vaccinated	Vaccinated	Vaccinated	Vaccinated
(excl. doc, pharma)	(1)	(2)	(3)	(4)	(5)	(6)
MVU-treat	0.075***	0.075***	0.075***	0.071***	0.073***	0.073***
	(0.011)	(0.011)	(0.011)	(0.012)	(0.014)	(0.015)
Female		-0.007***	-0.006**	-0.006**	-0.006**	-0.005**
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Age			-0.000***	-0.000***	-0.000***	-0.000**
			(0.000)	(0.000)	(0.000)	(0.000)
Community vacc rate				0.102	0.102	0.076
				(0.090)	(0.091)	(0.100)
Letter norm 1					-0.001	0.001
					(0.004)	(0.005)
Letter norm 2					0.001	0.002
					(0.002)	(0.002)
Letter norm 1 x MVU-treat					-0.004	-0.009
					(0.009)	(0.009)
Letter norm 2 x MVU-treat					-0.003	-0.008
					(0.009)	(0.009)
Household size						0.002
						(0.003)
Constant	0.026***	0.030***	0.050***	-0.003	-0.003	0.008
	(0.006)	(0.006)	(0.010)	(0.051)	(0.051)	(0.056)
Boot-p MVU-treat	0.000	0.000	0.000	0.000	0.000	0.000
Observations	22,792	22,792	22,792	22,792	22,792	19,658

Notes: The table presents estimates of ordinary least squares regressions. Robust standard errors clustered on the community level are in parentheses. This analysis is not using the full dataset, but only the dataset including vaccinations administered by vaccination centers and MVUs, as household information is not available for the other service locations (see details in Section 1.2.3). Individuals vaccinated at the missing service locations are therefore treated as "unvaccinated" in this analysis. In specification 6, the number of observations drops because of missing household information. For two communities, only address-level information was provided, and households across all other communities that count 10 or more adults are also treated as missing, as they mostly are communal care facilities that are recorded as households by the authorities. The results are stable to including and excluding any number of adult household sizes. Significance levels:
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2: Sample characteristics and balancing checks – all citizens aged 16 years or older.

		all	control	MVU-treat	p-value
Full sample		n = 45,909	n = 23,517	n = 22,392	
Unvaccinated sample		n = 20,414	n = 10,923	n = 9,491	
Communities	n =	20	10	10	
Full sample					
Community size	mean (S.D.)	2,295.5	2,351.7	2,239.2	0.853
		(741.0)	(775.5)	(742.2)	
Vaccination rate pre-intervention	in %	55.5	53.6	57.6	0.000
Female	in %	50.3	50.4	50.2	0.658
Age	mean (S.D.)	50.0	50.2	49.9	0.087
		(18.8)	(18.9)	(18.7)	
Unvaccinated sample					
Female	in %	50.3	50.8	49.8	0.176
Age	mean (S.D.)	43.5	43.8	43.1	0.004
		(17.3)	(17.5)	(17.2)	

Notes: The table shows the distribution of community size at the beginning of the intervention at the community level. On the individual level, the table shows the distribution of pre-intervention vaccination rate, gender and age, for the whole sample and for the control and mobile vaccination communities. The last column reports the p-value from a Mann-Whitney rank sum test for community size. For the other variables, the last column reports p-values of F-tests from regressions of the respective characteristics on individual treatment dummies.

Table A3: Pair-wise comparisons of vaccination rates between treatment and control communities (unvaccinated sample) during the intervention period.

		Treatment communities									
	Vacc rate (in %):	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	-pre-intervention	48.7	49.4	52.5	58.4	58.9	59.0	61.3	61.5	62.5	69.3
	-intervention	*7.6*	*12.2*	*16.8*	*14.4*	*14.9*	*14.9*	*14.2*	*10.3*	*12.8*	*12.9*
Control communities	**1** 46.8 *1.5*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	2 48.5 *3.2*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	3 49.8 *4.5*	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	4 50.3 *1.5*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	5 51.1 *0.4*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	6 54.4 *4.6*	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	7 55.6 *4.4*	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	8 57.6 *5.3*	**0.069**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	9 63.9 *11.0*	**0.007**	**0.331**	<0.001	0.015	0.006	0.015	0.038	**0.566**	**0.263**	**0.291**
	10 64.1 *6.3*	**0.340**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	<0.001	<0.001

Notes: The table reports p-values from chi-square tests. Each test compares the vaccination rate (*vacc rate intervention*) of the previously unvaccinated from a given control to a treatment community. Vacc rate pre-intervention reports the vaccination rate of the full population prior to our intervention period.

Table A4: Vaccination behavior during the study, log specifications 1-4.

	Vaccinated (1)	Vaccinated (2)	Vaccinated (3)	Vaccinated (4)
MVU-treat	1.307***	1.306***	1.306***	1.154***
	(0.287)	(0.287)	(0.286)	(0.263)
Female		-0.053	-0.053	-0.059
		(0.043)	(0.042)	(0.042)
Age			-0.001	-0.001
			(0.003)	(0.003)
Community vacc rate				3.885
				(1.813)
Constant	-3.229***	-3.202***	-3.170***	-5.225***
	(0.277)	(0.273)	(0.259)	(0.978)
Boot-p MVU-treat	0.000	0.000	0.000	0.000
Observations	20,414	20,414	20,414	20,414

Notes: The table presents estimates of logistic regressions. Robust standard errors clustered on the community level are in parentheses. Significance levels:
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Vaccination behavior during the study, excluding mobile team vaccinations, specifications 1-4.

	Vaccinated (1)	Vaccinated (2)	Vaccinated (3)	Vaccinated (4)
MVU-treat	0.005	0.005	0.005	-0.006
	(0.010)	(0.011)	(0.010)	(0.010)
Female		0.001	0.001	0.001
		(0.003)	(0.003)	(0.003)
Age			-0.000	-0.000
			(0.000)	(0.000)
Community vacc rate				0.276***
				(0.090)
Constant	0.037***	0.037***	0.043***	-0.103*
	(0.010)	(0.010)	(0.009)	(0.050)
Boot-p MVU-treat	0.175	0.185	0.162	0.481
Observations	19,563	19,563	19,563	19,563

Notes: The table presents estimates of ordinary least squares regressions. Robust standard errors clustered on the community level are in parentheses. The bootstrapped p-values are averaged across five runs to increase stability. Individual runs show variances of up to 0.05, not affecting the non-significance of the results. Significance levels:
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Average travel times to closest vaccination center from local communities.

	Group	Average time by bus/train (in min)	Average time by car (in min)
Community 1	MVU-treat	19	11
Community 2	MVU-treat	22	17
Community 3	MVU-treat	20	10
Community 4	MVU-treat	21	10
Community 5	MVU-treat	42	28
Community 6	MVU-treat	11	6
Community 7	MVU-treat	23	13
Community 8	MVU-treat	9	7
Community 9	MVU-treat	23	11
Community 10	MVU-treat	46	23
Community 11	control	37	20
Community 12	control	30	12
Community 13	control	13	9
Community 14	control	31	16
Community 15	control	42	16
Community 16	control	4	2
Community 17	control	18	9
Community 18	control	14	8
Community 19	control	22	9
Community 20	control	24	12

Notes: The table shows average travel times to the closest vaccination center based on google maps calculations, not accounting for potential rush hour traffic, construction work, and bus/train delays.