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ARTICLE

# Encouraging vaccination against COVID-19 has no compensatory spillover effects

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**Abstract**
Effective communication is essential for delivering public health messages and enabling behaviour change. Little is known about possible backfiring, or spillover effects, of COVID-19 vaccine messaging. In a study with $n = 1{,}848$ United Kingdom (UK) adults, we assess whether communication strategies that target vaccine hesitancy have any unintended, positive or negative, spillover effects on people's intention to engage in protective, compliance and prosocial behaviours. In June–July 2021, we conducted an online experiment to assess the potential spillover effects of three messages, emphasising (a) the medical benefits of COVID-19 vaccination, (b) the non-medical collective benefits of vaccination or (c) the non-medical individual benefits of holding a vaccination certificate. Exposure to different messages did not significantly affect people's intention to engage in protective, compliance, or prosocial behaviours. Instead, vaccination status (being vaccinated vs not) was positively associated with intentions to engage in protective, compliance and prosocial behaviours. Our results suggest that communication strategies that aim to increase vaccination uptake do not have any unintended effects on other health behaviours and vaccination campaigns can be tailored to specific populations to increase uptake and compliance.

**Keywords:** behavioural spillovers; public health communication; risk compensation; COVID-19; vaccine hesitancy

## Introduction

Effective communication is a key non-pharmaceutical intervention (NPI) to protect people against health-related threats and misinformation about diseases (Islam *et al.*, 2020; Pennycook *et al.*, 2020; Lorna, 2021; World Health Organization, 2021). In the last few years, several frameworks have highlighted the importance of effective communication and the main elements that constitute such an intervention (European Centre for Disease Prevention and Control, 2012; World Health

Organization, 2017; Jones *et al.*, 2019; Hyland-Wood *et al.*, 2021). In the context of the COVID-19 pandemic, studies have tested the direct effects of different communication strategies on people's attitudes and behaviours, including vaccine hesitancy (Freeman *et al.*, 2021; Merkley and Loewen, 2021; Palm *et al.*, 2021; Steinert *et al.*, 2022), support of vaccination certificate (Sotis *et al.*, 2021), compliance (Kostopoulou and Schwartz, 2021; Krpan and Dolan, 2022), protective behaviours (Ahn *et al.*, 2021; Gantiva *et al.*, 2021; Heffner *et al.*, 2021; Vacondio *et al.*, 2021; Vereen *et al.*, 2021), psychological reactance (Krpan and Dolan, 2022) and perception of symptoms (Kostopoulou and Schwartz, 2021). However, the indirect spillover effects of vaccine communication strategies have not yet been systematically explored.

The present study attempts to systematically explore whether information campaigns about COVID-19 vaccination have any unintended spillover effects on other protective, compliance or prosocial behaviours, which are critical to avoiding infection even in vaccinated populations (Howard *et al.*, 2021; MacIntyre *et al.*, 2021). We study these questions by launching a second round of data collection in the UK during June–July 2021, immediately after the end of a randomised controlled experiment conducted in eight European countries, including the UK (Steinert *et al.*, 2022). Referred to as "wave 1" in our study, that initial experiment involved the provision of information related to COVID-19 vaccination in three messages, each emphasising different medical and non-medical benefits of vaccination.

The first message contained information about the health benefits and the efficacy of COVID-19 vaccines, such as a reduction in risk of death and hospitalisation. The second message contained information about the collective, non-medical, benefits of vaccination including access to leisure activities and social events. The last message emphasised the exclusive, non-medical, benefits of holding a vaccination certificate, such as the ability to travel to other countries. The results of wave 1 showed that vaccine hesitancy in the UK ranged from 8.27 to 10.03% for men and women, respectively. Furthermore, during the period of data collection (i.e., summer 2021), the UK had already rolled out a large vaccination programme, resulting in two-thirds of all UK adults being double vaccinated by the end of July 2021 (GOV.UK, 2022b), while restrictions were still in place. Critically, the study revealed that none of the three messages increased participants' willingness to get vaccinated consistently across the eight countries. In the present study, we investigate whether these communication strategies spill over to other behaviours.

Behavioural spillovers can be broadly defined as the effects of an intervention on a non-targeted behaviour (e.g., advertising a product can increase sales of another product) (Sahni, 2016). More specifically, behavioural spillovers refer to two sequential but different behaviours linked by an 'underlying motive' or a common purpose (e.g., environmental sustainability); they have been classified into four categories: permitting, promoting, purging and precipitating (Dolan and Galizzi, 2015; Galizzi and Whitmarsh, 2019). Briefly, permitting (or compensatory) spillovers refer to people's perceived entitlement to disengage from an initial motive, given that this motive has been already served (e.g., saving energy at home could 'licence' compensatory overconsumption of energy at work). Promoting spillovers refers to people's continuous engagement with a motive (e.g., saving energy at home could 'promote' energy saving at work). Purging spillovers refer to people's tendency to engage in a subsequent

behaviour to 'purge' themselves from a prior behaviour that did not serve the initial motive (e.g., overconsumption of energy at home could lead to energy saving at work). Finally, precipitating spillovers refer to people's disengagement from the initial motive all along (e.g., overconsumption of energy at home could perversely 'promote' the overconsumption of energy at work).

Besides the behavioural spillovers proposed by Dolan and Galizzi (2015), the lateral attitude change (LAC) framework has been proposed by Glaser *et al.* (2015) to explain how indirect attitudinal change happens. Briefly, the LAC framework suggests that a change in a focal attitude towards a topic or behaviour (e.g., vaccination) can be transferred (or 'generalised', in the authors' words) to other related attitudes (e.g., protective behaviours). Alternatively, the framework further suggests that (peripheral) attitudes related to a focal attitude can change, while the focal attitude remains stable (what the authors call 'displacement effect').

Before the first COVID-19 vaccines were approved, a few – including World Health Organization (2020) – hinted at potential negative spillover effects of mask-wearing on other protective behaviours, such as a reduction in people's compliance with other COVID-19 rules (Lazzarino *et al.*, 2020; Martin *et al.*, 2020; Trogen and Caplan, 2021), although other researchers challenged those concerns (Greenhalgh *et al.*, 2020; Mantzari *et al.*, 2020). Later in the pandemic, with vaccines publicly available, there were some concerns that vaccinated people could develop a sense of 'invulnerability' that would 'licence' them to engage in risky behaviours, such as large gatherings and regular travelling. These speculations were based on risk compensation, an instantiation of permitting spillover that posits that people tend to adapt their behaviour relative to their perceived level of risk (e.g., wearing a seatbelt can lead to speeding, as it could alter people's sense of safety or perceived risk of speeding) (Peltzman, 1975; Asch *et al.*, 1991; Evans and Graham, 1991; Houston and Richardson, 2007).

Evidence of risk compensation in the context of COVID-19 behaviours is scarce. A UK study showed that face mask usage led to reduced physical distancing (Luckman *et al.*, 2021). Likewise, a study in the United States (USA) showed that face mask mandates were associated with increased mobility in public places (Yan *et al.*, 2021). Similar results were found in France (Cartaud *et al.*, 2020; Aranguren, 2022) and Bangladesh (Wadud *et al.*, 2022). In contrast, studies in Germany and the UK showed that face mask usage *increased* physical distancing (Seres *et al.*, 2021) and other COVID-19 protective behaviours (Guenther *et al.*, 2021). Similar results were reported in Italy (Marchiori, 2020), China (Sun *et al.*, 2022) and the Netherlands (Liebst *et al.*, 2022), while a study in Denmark showed mixed results (Jørgensen *et al.*, 2021). Finally, a study looking at financial incentives to take the first dose of a COVID-19 vaccine in Sweden found no negative unintended consequences of financial incentives on future vaccination uptake, morals, trust and perceived safety (Schneider *et al.*, 2023). The same research further showed that not only financial incentives but also information regarding financial incentive programmes implemented in the USA had no unintended consequences on people's behaviours, including blood donation, further COVID-19 vaccine dose uptake, flu vaccination and trust in government (Schneider *et al.*, 2023).

There is also systematic evidence of the unintended effects of measures taken against COVID-19 on other, health-related, behaviours. For instance, restrictions related to the COVID-19 pandemic (e.g., lockdowns and working-from-home mandates) have been shown to negatively affect physical activity (López-Valenciano *et al.*, 2021; Runacres *et al.*, 2021; Stockwell *et al.*, 2021; Oliveira *et al.*, 2022; Strain *et al.*, 2022; Wunsch *et al.*, 2022), while there has been an increase in sedentary behaviours (López-Valenciano *et al.*, 2021; Runacres *et al.*, 2021; Stockwell *et al.*, 2021). Furthermore, dietary habits changed during the COVID-19 pandemic, with decreased adherence to healthy diets and increased consumption of alcohol and processed food (González-Monroy *et al.*, 2021; Khan *et al.*, 2022). In India, domestic violence incidents increased during strict COVID-19 lockdown measures (Ravindran and Shah, 2023).

There has also been research on the potential negative spillover effects of COVID-19 communication strategies. For instance, an experiment conducted in Sweden before vaccines were available found that participants, when exposed to information about the safety, effectiveness and availability of COVID-19 vaccines, became less willing to engage in protective behaviours (Andersson *et al.*, 2021). This phenomenon was termed 'vaccine anticipation effect', a type of anticipatory spillover also called behavioural 'spillunder' (Krpan *et al.*, 2019, 2021), suggesting that in the prospect of having a vaccine available, people tend to disengage from protective behaviours as the 'end' of the COVID-19 pandemic becomes more salient. On the other hand, providing information about the use of vaccination certificates in the past and people's opinions about the COVID-19 vaccination certificate had no spillover effects on people's willingness to get vaccinated in the USA (Sotis *et al.*, 2021). Likewise, commanding vs non-commanding messages about compliance with COVID-19 rules had no spillover effects on other unrelated behaviours, such as charitable giving in the UK (Krpan and Dolan, 2022).

Despite the recent interest in testing messaging strategies and their unintended effects on COVID-19 behaviours, to the best of our knowledge, the spillover effects of messages about COVID-19 vaccination on subsequent protective and compliance behaviours have not yet been systematically examined. The present study is an attempt to fill this gap. In particular, in our pre-analysis plan, we hypothesised that:

**H1: exposure to messages that encourage COVID-19 vaccine uptake does not have any spillover effects on subsequent intent to engage in protective, compliance or prosocial behaviours.** This is our main hypothesis based on previous research on COVID-19 messaging strategies (Sotis *et al.*, 2021; Krpan and Dolan, 2022).

**H2: previous participation in a survey about COVID-19 does not associate with participants' responses in a subsequent survey about COVID-19 protective, compliance or prosocial behaviours**. This hypothesis is based on previous research on 'survey' or 'mere-measurement' effects, a type of behavioural spillover, suggesting that prior survey participation can affect subsequent behaviour (Morwitz and Fitzsimons, 2004; Zwane *et al.*, 2011). For instance, asking people whether they intend to buy a car increased subsequent car purchase rates (Morwitz *et al.*, 1993). Likewise, asking people about their health behaviours increased subsequent uptake rates of health insurance (Zwane *et al.*, 2011). A potential mechanism via which this effect manifests is the increased salience of an underlying motive (e.g., owning a car) that serves as a reminder about people's intentions (e.g., buying a car)

(Bordalo *et al.*, 2012). In our study, we expect no such survey effects, given that the pandemic is already sufficiently salient in the respondents' minds.

**H3: being vaccinated does not associate with participants' intent to engage in protective, compliance and prosocial behaviours.** Specifically, we expect that vaccinated and unvaccinated participants would be equally likely to engage in protective behaviours and to comply with the rules in case of possible infection. The alternative hypothesis can, in principle, go in either direction. On the one hand, unvaccinated participants could be more likely to engage in prosocial behaviours, as they may perceive their choice not to get vaccinated as socially undesirable and try to restore this by donating and volunteering (purging spillover). It is also possible that vaccination against COVID-19 may reduce people's perceived risk and make them less compliant (risk compensation). On the other hand, self-selecting into COVID-19 vaccination could trigger a positive self-image, promote positive spillovers and make people more (rather than less) likely to engage in further protective, compliance or prosocial behaviours.

## Methods

### *Participants*

Participants were UK adults, aged from 18 to over 65 and recruited through Respondi, an online survey platform (www.respondi.com). The total sample size was 1,848 participants. About 51% of the participants were females (943/1,848). Data collection took place in June–July 2021, and participation was anonymous. The sample included participants who took part in both waves 1 (Steinert *et al.*, 2022) and 2 ($n = 1{,}205$), as well as participants who took part only in wave 2 ($n = 643$). Altogether, participants were allocated under six different conditions:

1. Unvaccinated participants who received no vaccination messages, that is, the control condition in wave 1 ($n = 299$).
2. Unvaccinated participants who received information about the medical efficacy of vaccines in wave 1 ($n = 304$).
3. Unvaccinated participants who received information about the collective benefits of vaccination in wave 1 ($n = 304$).
4. Unvaccinated participants who received information about the exclusive benefits of vaccination certificates in wave 1 ($n = 298$).
5. Vaccinated participants who only took part in wave 2 ($n = 332$).
6. Unvaccinated participants who only took part in wave 2 ($n = 311$).

The reason for allocating participants into six conditions was to test our three hypotheses described above. Specifically, to test H1, we compared participants who were exposed to different messages about COVID-19 vaccination (i.e., vaccine efficacy condition vs collective benefit condition vs vaccination certificate condition vs control). For H2, the comparison was between participants who took part in wave 1 vs unvaccinated participants who took part in both waves 1 and 2. Finally, to test H3, we compared vaccinated vs unvaccinated participants from wave 2 only. The vaccination messages that participants saw in each condition in wave 1 can be found in Supplementary Material S2.

The size of the sample of wave 2 was calculated based on the first wave of the study.

### Procedure

Participants initially took part in wave 1, which corresponds to the first four conditions described above. They were exposed to different messages about COVID-19 vaccination and asked about their willingness to get vaccinated (the procedure of the first wave is described in Supplementary Material S3). At the beginning of the first wave, and before being exposed to different experimental conditions, they provided their informed consent and were also asked to indicate their vaccination status and other sociodemographic information including age, gender, education, employment status and income. Subsequently, these participants, along with 643 participants recruited solely for wave 2, took part in wave 2 and conducted immediately after wave 1. Once they provided their informed consent, they were asked a number of questions about their intentions to engage in protective and prosocial behaviours related to COVID-19, as well as compliance behaviours in case of developing symptoms of illness. The full list of the dependent variables and scales of measurement can be found in Supplementary Material S4.

Participants were also asked whether they wished to donate 20%of the money they would receive for their participation in the survey. They were also provided with a hyperlink that would redirect them to the NHS Charities Together website, the umbrella organisation coordinating donations to the NHS (https://www.nhscharitiestogether.co.uk/be-there-for-them/). This was to measure participants' actual behaviour by tracking whether they clicked on the link. After completing the survey, participants were debriefed. The online platform Respondi arranged to distribute a voucher of £3 to participants who completed the survey in full. Participants who chose to donate to the NHS received only 80% of it. The rest 20% was donated to the NHS Charities Together through the online platform.

### Outcome measures

The main outcome measure was participants' intention to engage in protective and prosocial behaviours (discrete and dichotomous variables, respectively), as well as in compliance behaviours in case of developing symptoms of illness (discrete variables). Similar to Campos-Mercade *et al.* (2021), we also measured participants' decision to donate money to the NHS and whether they clicked on the link to the NHS charity (dichotomous variables).

### Predictors and control variables

We made three comparisons to test H1, H2 and H3 in separate regression models. The main predictors were message condition, participation in wave 1 and vaccination status for H1, H2 and H3, respectively. We used sociodemographic information, such as age (range 18–24 to 65+), gender (female, male and non-binary), education (range

primary to higher), employment status (employed and unemployed) and income (range £0–£13,000 to £55,000+) as control variables. Vaccination willingness (willing and not willing) was an additional explanatory variable for H1.

### *Analyses*

We initially used simple logistic regression models for dichotomous dependent variables and simple ordered probit regression models for discrete dependent variables. We subsequently controlled for sociodemographic factors such as gender, age, education, employment status and income (in one step). We also included vaccination willingness as another explanatory variable for H1. In this model, we also checked for interactions between vaccination willingness and the message condition. We also tested for interactions between participants' vaccination status and age and education for H3. Finally, we ran three subgroup analyses, dividing the sample by age (above vs below 45 years of age), gender (females vs males) and education (higher vs lower). For all the dependent variables, we ran additional regressions as robustness checks using linear regression models. In all regressions, we adjusted all the p-values for multiple hypotheses testing using Bonferroni correction (significance level was set to 0.0019: conventional significance level of 0.05 divided by 26 dependent variables). In line with our hypotheses and light of the existing literature, we articulate our three hypotheses as null hypotheses (i.e., no spillover effects of vaccination messages, no spillover effects of previous survey participation and no risk compensation: H1, H2 and H3, respectively). To rigorously test whether the absence of evidence corresponds to the evidence of absence for H1, H2 and H3 (i.e., the null hypothesis is not rejected), we conducted a series of 'equivalence tests' (Lakens, 2017; Harms and Lakens, 2018; Lakens *et al.*, 2018).

## Analysis and results

### *Comparison by the message condition (H1)*

In this comparison, we included 1,205 participants. A detailed summary of the sociodemographic characteristics of the sample can be found in Supplementary Material (S1). The regression models revealed no statistically significant association between any condition and any of the variables of interest, suggesting that none of the messages significantly changed participants' intentions to engage in protective, compliance or prosocial behaviours. The regression tables are available at https://osf.io/fy3ps.

We further excluded the presence of any effects by using Two One-Sided Equivalence Testing (TOST). The small effect size used in the TOST procedure was based on the expected effect size in wave 1 (https://osf.io/53zdk/), which was also the expected effect size in wave 2. A summary of the results of the TOST procedure is presented at https://osf.io/fy3ps. This, together with the fact that in the main analysis, we could not reject the null hypothesis that the spillover effect was not statistically significant from zero, provides rigorous evidence of statistical equivalence for

each of the spillover effects, that is, the evidence of the absence of spillover effects in our sample.

### *Comparison by survey participation (H2)*

We next looked at the potential spillover effects of having been exposed, more generally, to a survey, rather than to the specific messages about COVID-19 vaccination. In this comparison, we included 1,516 participants (1,205 unvaccinated participants who took part in both waves of the study vs 311 unvaccinated participants who took part only in wave 2). A detailed summary of participants' characteristics can be found in Supplementary Material S1. We found no statistically significant association between survey participation and any of the variables of interest, suggesting that having previously been surveyed about COVID-19 did not significantly change participants' intentions to engage in protective, compliance or prosocial behaviours. The regression tables are available at https://osf.io/fy3ps.

### *Comparison by vaccination status (H3)*

We finally focused on the potential effects of being vaccinated on intentions to engage in COVID-19 behaviours. In this comparison, we included only participants who took part in the second wave of the study ($n = 643$). A summary of participants' characteristics can be found in Supplementary Material S1. Unlike message condition and survey participation, vaccination status was found to be significantly associated with participants' intentions to engage in protective, compliance and prosocial behaviours. Contrary to our null hypothesis and also to the risk compensation hypothesis, the association between vaccination status and the variables of interest was a positive one, indicating that vaccinated participants were more likely than unvaccinated ones to engage in almost all the protective, compliance and prosocial behaviours, even after correcting for multiple hypotheses testing (Figures 1–3).

The results are presented in Table 1.

The results of the exploratory analyses, including further estimations looking at the role of sociodemographic factors, are reported in Supplementary Material S5. Subgroup analyses are reported at https://osf.io/fy3ps.

## Discussion

Our study revealed that messages about the medical and non-medical benefits of COVID-19 vaccination aiming to increase vaccine uptake did not affect people's intentions to subsequently engage in other COVID-19 or prosocial behaviours. Furthermore, being previously surveyed about COVID-19 vaccination was not associated with intention to engage in subsequent behaviours either. Self-reported vaccination status and vaccination intention were rather the factors associated with people's engagement in protective and prosocial behaviours and compliance with the COVID-19 rules.

The absence of behavioural spillovers of vaccination messages is in line with our null hypothesis, as well as with previous research on COVID-19 communication

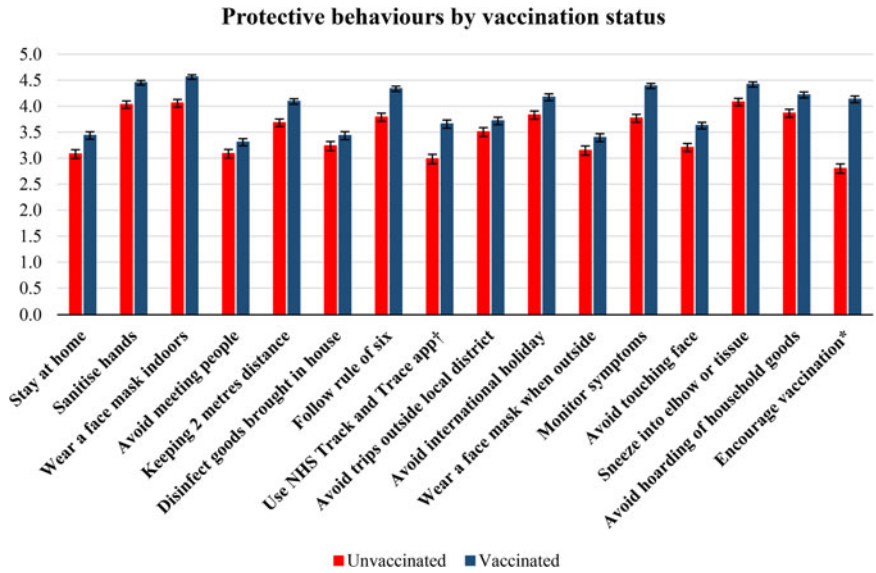


**Figure 1.** Means of intention to engage in protective behaviours by vaccination status.
*Notes*: This chart includes participants who took part only in wave 2. Protective behaviours were measured on a 1–5 scale with anchors from 'Never' to 'Always'. Higher values indicate higher engagement in protective behaviours. Error bars represent standard error. †The NHS Track and Trace app is a mobile app that has a number of different tools, including contact tracing and venue check-in (https://covid19.nhs.uk/). *Encouraging others to get vaccinated was classified as prosocial behaviour. Due to its measure (i.e., 1–5 scale), it has been included in this graph and not in the graph about prosocial behaviours (Figure 3), where results are presented in percentages.

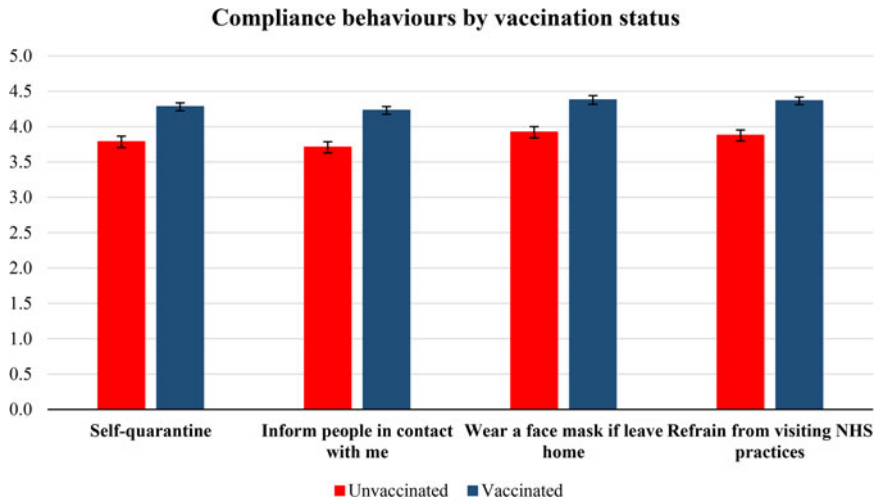


**Figure 2.** Means of intention to engage in compliance behaviours by vaccination status.
*Notes*: This chart includes participants who took part only in wave 2. Compliance was measured on a 1–5 scale with anchors from 'Never' to 'Always'. Higher values indicate higher engagement in compliance behaviours. Error bars represent standard error.

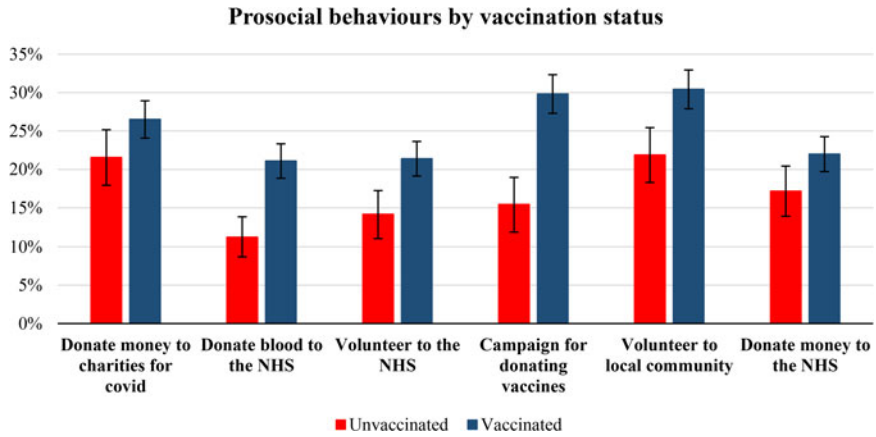


**Figure 3.** Percentages of intention to engage in prosocial behaviours by vaccination status.
*Notes*: This chart includes participants who took part only in wave 2. Prosocial behaviours were dichotomous variables with possible answers 'Yes' or 'No'. Results are presented in percentages. A higher percentage indicates higher engagement in prosocial behaviours. Error bars represent standard error.

strategies (Sotis *et al.*, 2021; Krpan and Dolan, 2022). However, our finding is not in line with previous evidence from Sweden (Andersson *et al.*, 2021). A possible reason for this discrepancy is related to the timing of the two studies. The experiment in Sweden was conducted at the end of 2020 when mass vaccination was only a hypothetical scenario, whereas the present study was conducted over the summer 2021 when the UK achieved one of the highest records of mass vaccinations in the world, while other restrictions such as mask-wearing and social distancing were still in place. Moreover, in the summer 2021, information about the 'Delta' variant also started circulating in the media. Both these new circumstances could have made respondents less likely to see the COVID-19 vaccine as the 'silver bullet' to conclude the pandemic and therefore less optimistic about the 'end' of the pandemic.

In addition to timing, motivation could also play a role. For instance, providing people with specific information about the various benefits of the vaccines (that were hardly available at the end of 2020) could increase their motivation for engaging in COVID-19 behaviours, their awareness of the pandemic and their sense of responsibility in contributing to combating the virus. This potential mechanism is not unambiguous, though, as specific information about vaccination could also create a false sense that the pandemic is reaching an end and therefore make people decrease their efforts.

The absence of behavioural spillovers of previous survey participation is in line with our null hypothesis but in contrast to the idea of a survey, or mere-measurement, effects (Morwitz *et al.*, 1993; Morwitz and Fitzsimons, 2004; Zwane *et al.*, 2011). A potential mechanism via which such an effect would be manifested is salience (Bordalo *et al.*, 2012). Previous, or repeated, participation in studies related to COVID-19 could be perceived as a reminder that the pandemic has not ended. However, since the study was run in June–July 2021, when the average daily infections in the UK were more than 20,000 (GOV.UK, 2022a), the pandemic was likely

**Table 1.** Main effects of vaccination status on protective behaviours

| Protective behaviour | Coefficient | Robust SE | *z* | p | 95% CI |
|---|---|---|---|---|---|
| Stay at home | 0.2682174 | 0.0838511 | 3.20 | 0.036 | 0.10–0.43 |
| Sanitise hands | 0.4207663 | 0.0896501 | 4.69 | 0.000 | 0.24–0.60 |
| Wear a face mask indoors | 0.5120604 | 0.0931685 | 5.50 | 0.000 | 0.33–0.69 |
| Avoid meeting people | 0.1696811 | 0.0836379 | 2.03 | 0.999 | 0.006–0.34 |
| Keeping 2 m distance | 0.3688893 | 0.0843639 | 4.37 | 0.000 | 0.20–0.53 |
| Disinfect goods brought in house | 0.1362125 | 0.0847862 | 1.61 | 0.999 | −0.03–0.30 |
| Follow the rule of six | 0.4669262 | 0.0879163 | 5.31 | 0.000 | 0.29–0.64 |
| Use the NHS Track and Trace app | 0.4715729 | 0.0863563 | 5.46 | 0.000 | 0.30–0.64 |
| Avoid trips outside the local district | 0.1486006 | 0.0855086 | 1.74 | 0.999 | −0.019–0.32 |
| Avoid international holiday | 0.3017277 | 0.0897476 | 3.36 | 0.021 | 0.12–0.48 |
| Wear a face mask when outside | 0.165154 | 0.0849394 | 1.94 | 0.999 | −0.001–0.33 |
| Monitor symptoms | 0.5885487 | 0.0889034 | 6.62 | 0.000 | 0.41–0.76 |
| Avoid touching face | 0.3351051 | 0.0836254 | 4.01 | 0.003 | 0.17–0.50 |
| Sneeze into the elbow or tissue | 0.3036731 | 0.0909745 | 3.34 | 0.021 | 0.12–0.48 |
| Avoid hoarding of household goods | 0.2928036 | 2928036 | 3.32 | 0.023 | 0.12–0.46 |
| Encourage friends to get vaccinated | 0.9838905[a] | 0.0903088 | 10.9 | 0.000 | 0.81–1.16 |
| **Compliance behaviour** | **Coefficient** | **Robust SE** | ***z*** | **p** | **95% CI** |
| Self-quarantine | 0.419554 | 0.0886115 | 4.73 | 0.000 | 0.24–0.59 |
| Inform people in contact with me | 0.4415602 | 0.0874744 | 5.05 | 0.000 | 0.27–0.61 |
| Wear a face mask if leave home | 0.4243657 | 0.0940856 | 4.51 | 0.000 | 0.24–0.61 |

| | | | | | |
|---|---|---|---|---|---|
| Refrain from visiting NHS practices | 0.4522094 | 0.089261 | 5.07 | 0.000 | 0.27–0.63 |
| **Prosocial behaviour** | **Odds ratio** | **Robust SE** | ***z*** | **p** | **95% CI** |
| Donate money to charities for COVID | 1.313433 | 0.2440988 | 1.47 | 0.999 | 0.91–1.89 |
| Donate blood to the NHS | 2.10687 | 0.4728761 | 3.32 | 0.023 | 1.35–3.27 |
| Volunteer to the NHS | 1.650731 | 0.3480565 | 2.38 | 0.452[b] | 1.09–2.49 |
| Campaign for donating vaccines | 2.328058 | 0.4602804 | 4.27 | 0.000 | 1.58–3.43 |
| Volunteer to the local community | 1.562452 | 0.2842744 | 2.45 | 0.369[b] | 1.09–2.23 |
| Donate money to the NHS | 1.360248 | 0.3603954 | 1.16 | 0.999 | 0.81–2.29 |

*Notes*: This regression table provides information about the size of the effect of vaccination status and its significance on all the behaviours of interest. Standard errors are robust. P-values are adjusted using Bonferroni correction for multiple hypotheses testing.

[a]As shown in Figure 1, the dependent variable 'Encourage friends to get vaccinated' was conceptualised as a prosocial behaviour. However, since it was treated as a discrete variable measured on a 1–5 scale, as opposed to the other prosocial behaviours treated as dichotomous variables, we used the ordered probit regression model to test the effects of vaccination status on it. For this reason, we included this variable in this table.

[b]The effect was significant before Bonferroni correction.

sufficiently salient in the respondents' minds. One could also argue that people's gradual disengagement from COVID-19 behaviours, possibly due to 'pandemic fatigue' (i.e., the alleged tendency to become tired of following COVID-19 rules) (Petherick *et al.*, 2021), would undermine potential survey effects and make people insensitive to previous exposure. However, neither our data nor the existing evidence, at least in the UK, support the idea of pandemic fatigue (Michie *et al.*, 2020).

Finally, being vaccinated was significantly associated with people's intention to engage in protective and prosocial behaviours and to comply with COVID-19 rules. This is not consistent with our null hypothesis nor with the risk compensation hypothesis (Luckman *et al.*, 2021; Yan *et al.*, 2021). Rather, it is in line with previous studies that revealed a reverse pattern, a positive or promoting spillover effect where a protective intervention increases subsequent protective behaviours (Kasting *et al.*, 2016; Guenther *et al.*, 2021; Seres *et al.*, 2021; Sun *et al.*, 2022). Therefore, this evidence speaks directly against the risk compensation hypothesis.

A potential explanation of this effect could be people's preference for, or tendency to maintain, cognitive consistency (Cialdini *et al.*, 1995). This is primarily based on Festinger's Cognitive Dissonance Theory that suggests that people tend to feel psychological discomfort when their beliefs and behaviours are not aligned (Festinger, 1957). To this extent, one could argue that people who protect themselves from COVID-19 infection through vaccination also protect themselves through other health behaviours, thus maintaining a consistent attitude towards the virus. It is also possible that people who protect themselves through vaccination might be driven by an underlying motive (e.g., the common good), which is served by both vaccination and engagement in protective behaviours. Heterogeneity in people's risk preferences (which, unfortunately, we were not able to control) could also contribute to such an attitudinal consistency towards vaccination and protective behaviours (Guenther *et al.*, 2021). Another potential interpretation of attitudinal consistency may be related to possible 'experimenter demand effects' (Zizzo, 2010; de Quidt *et al.*, 2018; Mummolo and Peterson, 2019; Haaland *et al.*, 2023); however, it is fair to note that, realistically, the likelihood of experimenter demand effects occurring in our case should have been limited by the temporal separation between wave 1 and wave 2 of data collection, together with the fact that wave 1 did not mention any reference to other health behaviours, which were only assessed in wave 2. This is confirmed by our finding, discussed above, of no significant survey effect (H2). Attitudinal consistency could also be related to the level of specificity between the attitudes and the behaviours, a key factor that, according to the Theory of Planned Behaviour, determines whether attitudes affect behaviours (Ajzen, 1991). Finally, people may opt for both vaccination and protective behaviours simply because both are required to mitigate infection.

Our study has three main limitations. First, the effect of vaccination status cannot be interpreted causally because respondents did self-select for COVID-19 vaccination, and the vaccination status could not be randomly assigned to different participants. Second, the study sample might not be fully representative of the UK population, given that during data collection for wave 1, older people were more likely to have been vaccinated and therefore could not be included in our sample. This is also reflected in participants' demographics, as approximately 90% of our sample were

between 18 and 44 years of age (see Supplementary Material S1). Finally, with the exception of the behavioural measure (i.e., participants' donation to the NHS), our results mainly rely on self-reported intentions, which may be susceptible to social desirability or self-reporting bias.

Despite these limitations, our study reveals some previously undocumented results, namely no spillover effects of vaccine communication strategies and no risk compensation for vaccinated participants. Future research could expand our work by measuring people's actual health behaviours or their interaction with health information through lab-field experiments (Galizzi and Navarro-Martinez, 2019). In addition, future studies could test communication strategies about protective behaviours (as opposed to vaccination), given that some people may be against vaccination and perceive the messages as too distant from their prior beliefs (Yaniv and Kleinberger, 2000; Yaniv, 2004). Finally, given the absence of behavioural spillovers, future policies could be less concerned about any unintended consequences when designing such messages. Instead, since vaccination status is associated with engagement in protective and compliance behaviours, policymakers could focus on vaccination campaigns to increase vaccine uptake that will, in turn, contribute to the engagement in compliance behaviours. Finally, since certain groups of our sample were found to be less willing to engage in health behaviours (e.g., males and unvaccinated), and given the importance of health-protective behaviours in tackling a pandemic, policymakers could try to design hybrid interventions that target specific populations and highlight the importance of protective behaviours, even when vaccination uptake in the population is generally high (Flemming, 2022).

**Supplementary material.** To view supplementary material for this article, please visit https://doi.org.10.1017/bpp.2024.1

**Data availability.** The dataset and code needed to reproduce the analyses can be found at osf.io/fy3ps.

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