Article

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COVID-19 Conspiracy Beliefs and Vaccination Intentions among Social Media Users

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Abstract: More than a year after the introduction of vaccines against COVID-19, inoculation remains inconsistent and variable across countries. In this paper, we introduce a multi-item scale of COVID-19 related misinformation, skepticism, and conspiracy theories and investigate the effects of these beliefs on vaccine hesitancy. We report findings from a survey in Greece where participants were recruited via paid advertising on Facebook and the study sample was adjusted for demographic variables using a nationally representative reference sample. We show that the endorsement of COVID-19 conspiracy beliefs is the primary factor driving vaccine hesitancy, far exceeding the effect of all other demographic and attitudinal variables, including health status. Furthermore, a pre-registered randomized survey experiment showed that the effect cannot be attributed to respondents' exposure to the COVID-19 conspiracy theory questions of the survey. The paper concludes by discussing potential public policy implications for combating misinformation and promoting health literacy among social media users.

Keywords: COVID-19, Facebook, vaccine hesitancy, conspiracy beliefs

On December 12, 2019, the Chinese authorities announced that a novel coronavirus (SARS-CoV-2) was responsible for a highly contagious infectious human disease, which was named COVID-19. By March 11, 2020, the virus had spread to 114 countries prompting the World Health Organization (WHO) to characterize it as a global pandemic. The pandemic, which claimed the lives of more than six million people within the first two years, initiated a global health campaign for reducing COVID-19 infections by hand washing, physical distancing, and self-isolation, and

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motivated governments around the world to impose harsh containment measures that affected nearly every aspect of economic, social, and political life (Bonotti and Zech 2021, pp. 1–36).

The public health emergency took place parallel to an "infodemic" where rumors, misinformation, and conspiracy theories around COVID-19 spread rapidly through social media platforms which often serve as a source for health information for many internet users (Islam et al. 2020). Conspiracy beliefs can impede policy implementation and generate undesirable social outcomes when they hinder public compliance with government prescribed or mandated programs (Connolly et al. 2019). In the case of COVID-19, non-compliance with government policies, such as not following physical distancing guidelines or the use of masks, undermines public health. In this paper, we focus on the relationship between conspiracy beliefs and vaccine hesitancy. The focus on vaccine hesitancy was chosen for study as the most consequential rule compliance issue. As the lock-downs implemented in various countries were lifted, the public debate gradually shifted from "flattening the curve" via physical distancing and the use of masks, towards long-term policies. In particular, the rolling-out of several COVID-19 vaccines to the general population became the most relevant policy intervention against the pandemic from the beginning of 2021 onward.

In this paper we focus on social media users and employ data collected before the clinical trials were completed and the COVID-19 vaccines were made available to the general public. This way we are able to study vaccine hesitancy *per se* without our results being confounded by attitudes towards specific vaccine characteristics (Motta 2021). We argue that this is particularly important as the public debate since the introduction of the various COVID-19 vaccines was largely framed on the potential side effects, the effectiveness rate, and the national origins of the different vaccine brands, confounding the broader phenomenon of vaccine hesitancy.

In this context, as vaccine compliance remains inconsistent and variable, investigating the potential effects of conspiracy beliefs on vaccination attitudes attains particular importance. Given the social media's purported role in disseminating misinformation in the context of the COVID-19 pandemic, it is imperative to understand the role of conspiracy beliefs as drivers of anti-vaccination intentions among social media users. More generally, our study contributes to the better understanding of conspiracy driven rule non-compliance, with the aim of helping produce interventions that could mitigate behaviors that threaten public health.

1 Conspiracy Theories and Vaccine Hesitancy

Conspiracy theories are most commonly defined as "causal explanations of events or circumstances that posit a powerful group acting in secret for their own benefit and against the common good" (Connolly et al. 2019, p. 469). Despite ample evidence that the novel coronavirus had an animal origin before it became infectious among humans (Holmes et al. 2021), conspiracy theories around COVID-19 followed well-established narratives that characterized epidemics related to various viruses since the 1980s (see Earnshaw et al. 2019; Goertzel 1994; Klofstad et al. 2019; Setbon and Raude 2010). The most widespread conspiracy theories argued that the virus associated with COVID-19 was created in a laboratory with the intention to harm a particular country or group of people, and to help big pharmaceutical companies increase their profits. More imaginative conspiracy theories claimed that Bill Gates was conspiring to use the pandemic as an excuse to implant humans with microchips, or that the 5G network was responsible for spreading the virus.

Conspiracy beliefs have been associated with anti-vaccination attitudes (Hornsey, Harris, and Fielding 2018; Lewandowsky et al. 2012), and a range of health risk behaviours including a reduction in willingness to vaccinate even before the emergence of SARS-CoV-2 (Jolley and Douglas 2014; Quinn et al. 2017; Setbon and Raude 2010; Tomljenovic, Bubic, and Erceg 2020). This research has illustrated how anti-vaccination misinformation is spread through social media and social networking sites where the anti-vaccination movement that has a well-established presence (Featherstone, Bell, and Ruiz 2019; Mitra, Counts, and Pennebaker 2016; Smith and Graham 2019). Preexisting conspiratorial beliefs can interact with social media-fueled events and push newcomers into the anti-vaccination movement through exposure to misinformation and persuasion (Mitra, Counts, and Pennebaker 2016). Correspondingly, the literature has established the link between social media usage and vaccine hesitancy. For instance, a US study found that information exposure on social media where vaccines received negative representation was able to explain differences in vaccine coverage (Dunn et al. 2017). Similarly, a study in Italy found a correlation between vaccination coverage and internet search, tweets, and Facebook posts (Aquino et al. 2017). The COVID-19 pandemic is also a case in point as the misinformation campaign by anti-vaccination groups in Facebook outpaced public health messaging and hampered the roll-out of COVID-19 vaccines (Kalichman et al. 2022).

In addition to the observational studies, several recent randomized experiments that were conducted before the emergence of SARS-CoV-2, have demonstrated links between the vaccine misinformation and conspiracy theories

disseminated through social media on the one hand, and vaccine hesitancy on the other. In an experiment where American participants were exposed to Donald Trump's tweets that focused on his anti-vaccination views, there was a significant increase in vaccine concern compared to the control group that was exposed to Trump's tweets that focused on golf (Hornsey et al. 2020). In another experiment among US college students, exposure to a greater number of comments on Facebook expressing unfavorable opinions on the flu vaccine led to unfavorable attitude toward the vaccine through a change in perceived distribution of public opinions on the vaccination (Kim, Han, and Seo 2020). In yet another randomized experiment in the US, fact-checking labels attached to the conspiratorial misinformation Tweets significantly reduced vaccine conspiracy beliefs but did not affect vaccination intentions directly (Lee, Kim, and Yun Lee 2022). An experiment conducted in China, indicated that exposure to social media posts containing anti-vaccine conspiracy theories resulted in less favorable attitudes toward the HPV vaccine, less positive perceived norms regarding getting vaccinated, and weaker vaccination intentions (Chen et al. 2021). In a study in Italy, participants assigned to a message providing a false balance condition endorsed more conspiracy beliefs, which, in turn, reduced trust in vaccines compared with provaccine, anti-vaccine, and control messages (Salvador Casara, Suitner, and Bettinsoli 2019).

Moreover, in the case of COVID-19, a wealth of recent studies has illustrated the link between conspiracy beliefs and compliance with a range of government mandated containment policies. Two different studies among English-speaking social media users around the world found that belief in COVID-19 conspiracy theories was negatively associated with social distancing intentions both directly and indirectly through feelings of powerlessness (Biddlestone, Green, and Douglas 2020), and with compliance with COVID-19 prevention guidelines both directly and indirectly through trust in science (Plohl and Musil 2021) respectively. Furthermore, two different studies conducted in the US found that those who endorse COVID-19 conspiracy beliefs are more likely to distrust the claims made by the leading national public health institute in the country (Motta, Stecula, and Farhart 2020), and are less likely to take preventive measures and to be willing to get vaccinated (Romer and Jamieson 2020), while a third study found that those who endorse conspiratorial thinking about immunizations more generally were less likely to declare that they intended to get a COVID-19 vaccine (Ruiz and Bell 2021). Similarly, studies conducted in the UK found that rejection of conspiracy theories is associated with compliance with the mandated physical distancing (Swami and Barron 2021), a negative relationship between COVID-19 conspiracy beliefs and health-protective behavior (Allington et al. 2021), a polarizing relationship between COVID-19 conspiracy beliefs and compliant behaviour through opposing emotional pathways (Peitz et al. 2021), and that higher levels of COVID-19

conspiracy thinking were associated with less adherence to all government guidelines and less willingness to take diagnostic or antibody tests or to be vaccinated (Freeman et al. 2022). Further studies found that conspiracy beliefs describing the pandemic as a hoax were strongly associated with reduced containment-related behaviour in both the US and the UK (Imhoff and Lamberty 2020). More generally, a systematic review of studies conducted during the first year of the pandemic (Ripp and Röer 2022) found a largely consistent picture where the belief in COVID-19-related conspiracy narratives was negatively associated with vaccination willingness.

Given the available evidence linking conspiracy beliefs to (non-)compliance with government mandated rules surrounding the pandemic, we investigate the relationship between beliefs about COVID-19 related misinformation, skepticism, and conspiracy theories and vaccine hesitancy in the context of social media users. The research question we explore in this paper asks whether the explanatory power of conspiracy beliefs is higher compared to other possible explanations of vaccine hesitancy, such as one's health status considering that those who do not consider themselves vulnerable to COVID-19 will be less likely to get vaccinated. If indeed conspiracy beliefs is the most pertinent explanatory factor even beyond one's health status, it follows that governments should reconsider their vaccination information campaigns. Instead of emphasizing the need to vaccinate because of one's vulnerable health status, more emphasis can be placed in campaigns against vaccine misinformation.

2 Method

2.1 Participants

The data come from a web survey in Greece (fieldwork: 13–20 May 2020). Medical conspiracy theories have contributed to the development of the anti-vaccine movement in Greece that heightened during the H1N1 pandemic (Maltezou et al. 2015, p. 972) and in a survey among medical students, 16% believed in a H1N1 vaccine conspiracy theory (Mavros et al. 2011). As the COVID-19 pandemic unfolded, several conspiracy theories about COVID-19 circulated widely over the social media in Greece (Gemenis 2021). As Motta (2021) illustrated in a conjoint analysis, different COVID-19 vaccine properties influence vaccination intentions, so the fact that the data were collected before the COVID-19 vaccine roll-out to the general population allows us to study attitudes towards vaccination that are not confounded by the debate that unfolded among the different brands of vaccines. Moreover, as advised in a systematic review of the relevant literature (Ripp and

Röer 2022, p. 12), the current study introduces a more reliable measure of COVID-19-specific conspiracy beliefs that consists of multiple items, as compared to single items measures that have been typically used before.

To recruit respondents, we shared an invitation with a link to the survey on Facebook and Twitter, but most respondents (over 90%) came from paid advertising on Facebook (target: Greece, 18–65+), which is the largest social media platform in Greece with 6.3 million accounts according to its advertising platform. The Facebook ads (which were also featured on Instagram) were shown to 158,175 social media users leading to 7344 unique clicks. From those clicks, 4651 respondents reached the survey landing page and 3914 started the survey after the informed consent page. Out of those 3914 respondents, 2612 completed the survey (Supplementary Material, Table A1).

Facebook samples have been used to study social media effects and are known to generate valid measures of political attitudes (Munger et al. 2021; Schneider and Harknett 2022; Zhang et al. 2020). In the context of the pandemic, Perrotta et al. (2021) employed a cross-national Facebook sample to provide descriptive statistics of COVID-19 related beliefs and behaviors, arguing that the approach provided timely insights. However, since Facebook employs an algorithm to optimize ad delivery by favouring users who are most likely to click on the ad, we expect that the demographic characteristics of the end sample are likely to differ from the underlying population. Furthermore, a comparison between respondents who completed the survey and those who dropped out at any time after the demographic questions page, showed statistically significant differences in terms of political interest and the device used (results reported in the Supplementary Material, Table A1).

To address these and other possible sources of bias, we applied adjustments on the basis of auxiliary variables drawn from a nationally representative reference sample, an approach that has been used successfully to deal with selection bias and coverage error in non-probability samples (Schonlau and Couper 2017, pp. 285–288). The reference sample was a random digit dialing (70% landlines, 30% mobile phones) CATI survey conducted by the Metron Analysis polling company on behalf of *Dianeosis*, an Athens-based non-profit think-tank (fieldwork: 8–15 April 2020). The sample adjustment was achieved using entropy reweighting (Hainmueller 2012), a technique that adjusts the first three moments (mean, variance, skewness) of the auxiliary variables of the sample of interest to match those of the reference sample. The auxiliary variables used were age (recoded into five age groups), education (recoded into four levels), male/female, urban/rural, and the four NUTS1 regions (Supplementary Material, Table A3). The sample adjustment also took into account the previously computed weights of the CATI survey for age and gender. With this approach we were able to match the first three

moments of all auxiliary variables in our sample (often down to two decimal points) to those in the reference sample. Detailed results on the efficiency of entropy reweighting are reported in the Supplementary Material (Table A4).

2.2 Materials

The web survey was programmed in Limesurvey and the sampling method, study materials, and experimental design were pre-registered with the Center for Open Science (OSF) and are freely available online. In addition, the data will be made available in Harvard Dataverse. After an introductory informed consent page, respondents were directed to a page with six demographic questions following the wording of the European Social Survey (ESS): year of birth, gender, educational attainment (five levels), region of residence, domicile (five levels), and political interest (four levels).

2.2.1 COVID-19 Conspiracy Beliefs

The survey included a battery of 10 questions intending to measure conspiracy beliefs, skepticism, and misinformation relating to COVID-19 (e.g. "The coronavirus (COVID-19) was created in a laboratory as a biological weapon", the full list of questions translated in English is available in the pre-registration material). The use of multiple items was necessitated for constructing a reliable instrument, as also advised in a systematic review of the studies conducted during the first year of the pandemic (Ripp and Röer 2022, p. 12). All 10 questions appeared on the same web page and had a five point response scale (disagree/rather disagree/neither agree nor disagree/rather agree/agree) with an additional "no opinion" option. Mokken scale analysis indicated that nine of those questions formed a strong COVID-19 conspiracy beliefs scale (Loevinger's $h = 0.69$).

2.2.2 Vaccination Intentions

Vaccination intentions were measured through a single item asking respondents whether they would get vaccinated should a vaccine against the novel coronavirus is approved by the national regulatory authority in Greece (EOF). The response options were "Yes", "No", and "I don't know/Prefer not to say" coded as missing as per the pre-registration protocol. While it is well-established that stated intentions do not always translate to vaccine uptake, the question allows for studying vaccine

hesitancy and has also been used by the ESS in their COVID-19 module (Hanson et al. 2021).

In total 989 respondents answered positively (50.13%) and 984 negatively (49.87%). It is interesting to note that, for several months, the COVID-19 vaccine uptake in Greece remained consistently below the targets set by the government. By the time the vaccination rate reached the desirable levels, a booster dose was necessitated, which effectively put the country back to square one when it came to vaccine uptake. As of March 2022, the vaccine uptake (including the booster dose) is around 52% of the population, which is not far from the intentions recorded in our data nearly two years prior.

2.2.3 Health Literacy

Respondents were given three statements on virus related health information (e.g. "Antibiotics are effective against viruses") and asked to indicate whether they considered the statements to be correct or not. As per the pre-registration protocol, "don't know" answers and responses that took more than 30 s were coded as wrong, and the three questions were combined into a scale. Mokken scale analysis, however, indicated that only the first two questions could be combined into a weak strength scale (Loevinger's $h = 0.37$).

2.2.4 Political Knowledge

Four questions intending to measure political knowledge were given on individual web pages in random order. These questions asked respondents to match public figures at both national and European level to their political offices (health minister, development minister, Italian prime minister, head of the IMF). Each question had four possible answers in addition to "I don't know" and while only one of the answers was correct, the remaining answers were worded to sound plausible. The knowledge questions were not compulsory and respondents could simply move to the next web page using the pre-selected "no response" option. The responses to these questions were re-coded as either correct or incorrect (the latter including "I don't know" responses). Mokken scale analysis indicated that the four questions formed a medium strength political knowledge scale (Loevinger's $h = 0.43$).

2.2.5 Health and Socio-Economic Variables

Near the end of the survey, a transition page indicated to respondents that there were about to complete the survey and that there were only a few non-compulsory

questions left. These questions included a 0–10 left-right scale self-placement question (ESS wording with an additional "other" option), subjective income (ESS wording, four levels), and four yes/no questions asking respondents whether they considered themselves, or a family member to be to vulnerable in terms of their health, and whether their employment, or the employment of a family member has been affected negatively by the epidemic.

2.3 Experimental Design

While the study was observational, the web survey included a subtle experiment involving the order of the questions intended to test whether the relationship between conspiracy beliefs and vaccination intentions was fuelled by the conspiracy cues given in the aforementioned question battery. As per the pre-registration protocol, the treatment group received the battery of COVID-19 misinformation, skepticism, and conspiracy theories questions first, and the vaccination intention question afterwards. The control group received the question about vaccination intention first, and the battery of COVID-19, misinformation, skepticism, and conspiracy theories questions afterwards.

2.4 Procedure

The statistical analyses reported in the results included only the respondents who completed the survey ($N = 2612$). The sample adjustment also implies that the respondents who did not provide answers to either of the auxiliary variables as well as those who indicated that they live outside Greece were also excluded as no weights could be computed ($N = 177$). The conspiracy beliefs scale was constructed by taking the mean excluding "no opinion" and missing responses respectively. The health literacy and political knowledge scales were constructed by summing the correct responses. Further missing values were treated with listwise deletion. As per the pre-registration protocol, "don't know/prefer not to say" responses in the vaccination intention question were coded as missing, with additional analyses taking missing values into account reported in the Supplementary Material (Table A8). Ordinal variables (education, subjective income, political interest) were treated as continuous. A sensitivity analysis where ordinal variables were fully factorized is reported in the Supplementary Material (Table A5).

3 Results

To examine the impact of conspiracy beliefs on vaccination intentions, while controlling for the effect of other variables, we used multiple logistic regression. Table 1 summarizes the logistic regression results where the dependent variable is the intention to receive the COVID-19 vaccine. As evident by examining the 95% confidence intervals associated with the odd ratios in the table, only political knowledge, the perception of belonging to a group with vulnerable health, subjective income, and the conspiracy beliefs scale exert a statistically significant impact on the intention to get vaccinated. The associated odds ratios with these variables, however, vary considerably in terms of their size, so it is important to visualize the magnitude of these relationships to ascertain the primary drivers of vaccine hesitancy.

Since the interpretation of coefficients and odd ratios in logistic regression is not as straightforward as in linear models, we chose to report results based on predictive margins (also known as adjusted predictions and recycled predictions) which present a more intuitive comparison of the effect of different independent variables, especially when presented graphically (Graubard and Korn 1999). In our case, the predictive margin is a statistic computed from the predictions of the logistic regression model across all responses in the dataset where the values of the independent variables of interest are fixed at values different from what they really are. For ease of interpretation, we present the averaged vaccination intention

Table 1: Logistic regression results on the intention to get vaccinated.

	Odds ratio	95% CI
Age	1.01	[1.00, 1.03]
Female	1.03	[0.64, 1.64]
Education	1.03	[0.76, 1.39]
Political interest	1.22	[0.87, 1.70]
Political knowledge	0.81	[0.65, 1.00]
Health literacy	1.00	[0.77, 1.32]
COVID-19 conspiracy beliefs	0.14	[0.10, 0.18]
Vulnerable health (self)	2.77	[1.60, 4.82]
Vulnerable health (family)	1.02	[0.62, 1.70]
Affected employment (self)	0.89	[0.49, 1.64]
Affected employment (family)	1.16	[0.67, 2.03]
Subjective income	1.47	[1.08, 2.01]
Left-right self-placement	0.95	[0.86, 1.05]
Constant	19.88	[2.68, 147.77]

$N = 1033$. Sample adjusted using entropy reweighting.

predictions where the predictive margins have been calculated across the different values of political knowledge, vulnerable health status, subjective income, and conspiracy beliefs on vaccination intentions.

The predictive margins results are presented in Figure 1. The figure illustrates very eloquently that the effect of political knowledge, health status, and subjective income on the intention to receive the COVID-19 vaccine is negligible, despite appearing statistically significant on the basis of conventional levels of statistical significance in odd ratios. In contrast, the effect of endorsing different numbers of items of the conspiracy beliefs scale has a dramatic effect on the probability of vaccine uptake intentions. As evident in the bottom right panel of Figure 1, the effect runs the gamut of the vaccination intention probability. To interpret this effect in terms of predictive margins we can consider the following example. Had each and every respondent in the survey indicated that they disagreed with all of the conspiracy beliefs items in the scale while all other variables remained as they were, then the average probability of the intention to be vaccinated would be over 0.9. In practice, this would effectively translate to over 90% of the respondents in sample intending to get vaccinated. Conversely, had each and every respondent in the survey indicated that they agreed with all the conspiracy beliefs items in the scale while all other variables remained as they were, the average intention to be

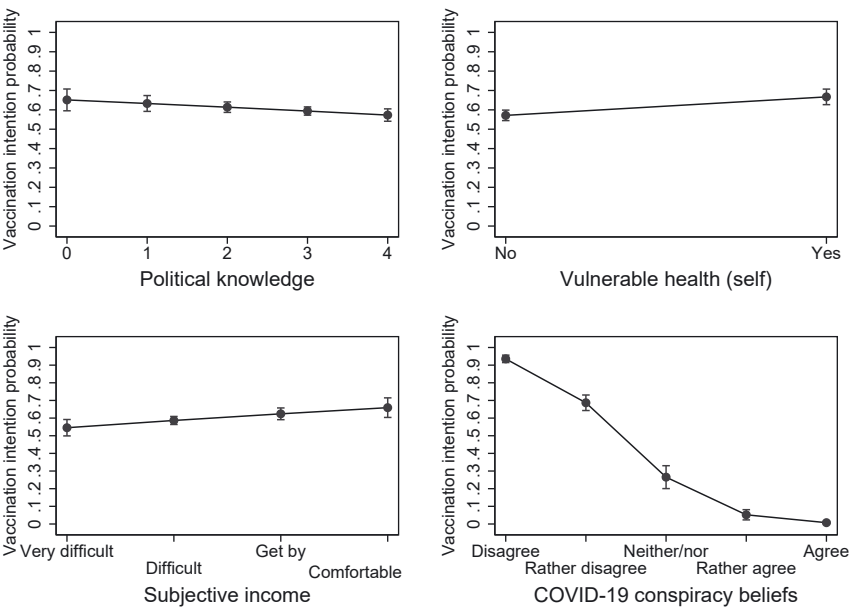

Figure 1: Predictive margins from logistic regression on vaccination intentions (Table 1).

vaccinated would be close to zero. We can therefore clearly see in Figure 1 that conspiracy beliefs is the only variable that leads to *substantially important* changes in the vaccination intentions. Moreover, this effect is robust to alternative specifications compared to the one presented in Table 1. Including fully factorized education, political interest, and subjective income variables and controlling for the respondent's overall assessment of the government's handling of the pandemic does not change the observed effect in a way which is statistically noticeable (the results are available in the Supplementary Material, Tables A5–A6).

Could the observed effect of conspiracy beliefs be an artefact of the design of the questionnaire? One could argue that there could be some "exposure effect" (Lyons, Merola, and Reifler 2019) since respondents were presented with not just one, but 10 different misinformation, skepticism, and conspiracy theory items with regards to the COVID-19 pandemic. To answer this question we turn to the randomized experiment in which respondents were randomly assigned to answer the vaccination intention question before (control) or after (treatment) being presented with the aforementioned battery of questions. The results presented in Table 2 confirm that there was no such exposure effect. According to the analysis plan that was pre-registerd with the OSF, the effect of this treatment is not statistically significant, nor conditional to the respondent's health literacy. This finding is consistent with previous survey experiments which illustrated that the negative consequences of exposure to conspiracy theories can be mitigated when respondents are asked to indicate their own beliefs about the conspiracy theories (Einstein and Glick 2015). Sensitivity analyses also confirmed the absence of an effect when control variables were included in the models. In addition, there was no effect on the respondents' choice between the yes/no options and the "not sure/do not know" answer option either (all sensitivity analyses are available in the Supplementary Material, Tables A7–A8).

Could the observed effect of conspiracy beliefs be endogenous to health status? One could argue that the statistical relationship between conspiracy beliefs and vaccination intentions presented in Table 1 is misspecified due to the

Table 2: Logistic regression results of the COVID-19 conspiracy questions exposure on the intention to get vaccinated.

	Odds ratio	95% CI	Odds ratio	95% CI
Treatment	1.03	[0.83, 1.28]	1.05	[0.75, 1.46]
Health literacy			1.16	[0.99, 1.37]
Treatment × health literacy			1.00	[0.79, 1.25]
Constant	1.08	[0.93, 1.26]	0.92	[0.72, 1.16]

$N = 1835$. Sample adjusted using entropy reweighting.

endogeneity between conspiracy beliefs and health status (and consequently the demographic variables that correlate with health status). Indeed, as expected, we observe that health status is a predictor of COVID-19 conspiracy beliefs, with those who responded having vulnerable health scoring lower on the conspiracy beliefs scale. Ideally, such endogeneity would be addressed using an experimental approach but given that health status is an observational variable that cannot be randomized, we resort to statistical matching. Since matching methods are typically employed for dichotomous endogenous variables, we dichotomize the COVID-19 conspiracy beliefs scale and match those who scored above the middle point of the scale ("conspiracy believers") to those who scored below the middle point of the scale ("conspiracy non-believers") on all variables that jointly affect conspiracy beliefs and vaccination intentions, namely health status (respondent and family) as well as the demographic variables that correlate with health status (age, sex, subjective income). For estimating the matching model we, once more, employ entropy reweighting (Hainmueller 2012) which has several advantages over other matching techniques such as propensity score matching (Gemenis 2018, pp. 169–170), and balance the "treated" (believers) and "non-treated" (non-believers) respondents on the aforementioned variables. The results of the matching approach (available in the Supplementary Material, Table A9, Figure A10) are practically indistinguishable from those presented in Table 1, indicating that the effect of conspiracy beliefs on vaccination intentions is robust to endogeneity concerns.

In all, the results indicate that conspiracy beliefs are by far the most important explanatory factor of hesitancy with regards to COVID-19 vaccination intentions among social media users in Greece, and that the presented effects are unlikely to be a methodological artefact due to an "exposure effect" or endogeneity between conspiracy beliefs and health status. Previous research has highlighted how conspiracy beliefs during the COVID-19 pandemic in Greece are likely to be deep rooted and independent to institutional trust which is a typical correlate of conspiracy beliefs (Gemenis 2021). These findings point to a number of implications for public policy which we discuss in the following section.

4 Discussion

Two years into the pandemic, and despite having implemented two strict and lengthy lock-downs, Greece found itself in the top 25 global list of countries in terms of COVID-19 related deaths in proportion to its population. While possible explanations to this troubling and puzzling finding include policy-related factors such as an over-reliance on lock-downs against other containment measures

(Ceron, Palermo, and Grechi 2021), as well as structural factors such the country's aging population and problems related to the hospitalization of COVID-19 patients, the findings of this paper point out that the role of conspiracy beliefs in fuelling vaccine hesitancy should not be underestimated.

While social media allow for the fast dissemination of conspiracy theories through their recommendation algorithms or coordinated bot spamming methods, we should not fail to recognize that traditional media can also act as carriers of conspiracy theories. Social media will often simply amplify what has already been disseminated by traditional media. In fact, those who ascribe to conspiracy beliefs will often cite stories in traditional media in order to legitimate their claims (Oliveira, Wang, and Xu 2022). While social media platforms attempt to contain the spread of misinformation by flagging misleading posts and removing accounts associated with spreading misinformation (Puri et al. 2020, p. 2589), the regulation of traditional media is typically left to national governments.

From a public policy perspective, the findings of this paper point to the importance of devising strategies to address the spread of misinformation (Puri et al. 2020). While those predisposed to conspiratorial thinking might be quick to believe in new conspiracy theories, it does not automatically follow that issuing corrections against misinformation is futile. For instance, the meta analysis by Walter et al. (2021) found that "interventions were more effective in cases where participants were involved with the health topic, as well as when misinformation was distributed by news organizations (vs. peers) and debunked by experts (vs. non-experts)." These findings imply that traditional media and the scientific community should address the flow of misinformation well before it reaches the stage of a social media "infodemic".

In the case of Greece, the government's decision to provide COVID-19 subsidies to all print, broadcast, and electronic media in the country prompted accusations about the handling of public funds. The proceedings of the parliamentary inquiry revealed that the funds were allocated to the different media outlets not only on the basis of their popularity (e.g. print circulation, Nielsen ratings, Alexa rankings) but also on the basis of their content. It became clear, however, that the evaluation of the media content was not performed in a systematic and informed way in order to filter out those outlets that had engaged in spreading misinformation, but decisions were made in an *ad hoc* manner that left much to be desired. Just prior to the start of the pandemic, in December 2019, the Greek government had announced a blanket distribution 20 million Euros in media subsidies. As a result, newspapers and other media outlets that had curved a niche by specializing on misinformation and conspiracy theories were able to receive government subsidies.

As it has been pointed out many times before, governments need to empower people to learn how to navigate through the information to pick out what is useful

and what is not. In the case of vaccines, this will undoubtedly necessitate widespread public educational campaigns regarding vaccine safety and efficacy. However, this cannot be effective when public money is spent in an uncoordinated manner that risks accusations of corruption and further fuels conspiratorial thinking. The scholarship has long been devising strategies to address the spread of misinformation, but it is also paramount that governments follow through these recommendations.

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