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# Media usage predicts intention to be vaccinated against SARS-CoV-2 in the US and the UK

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## Abstract

There is existing evidence of a relationship between media use and vaccine hesitancy. Four online questionnaires were completed by general population samples from the US and the UK in June 2020 (N = 1198, N = 3890, N = 1663, N = 2237). After controls, all four studies found a positive association between intention to be vaccinated and usage of broadcast and print media. The three studies which operationalised media usage in terms of frequency found no effect for social media. However, the study which operationalised media use in terms of informational reliance found a negative effect for social media.

Youth, low household income, female gender, below degree-level of education, and membership of other than white ethnic groups were each also found to be associated with lower intentions to be vaccinated in at least two of the four studies. In all four studies, intention to be vaccinated was positively associated with having voted either for Hillary Clinton in the 2016 US presidential elections or for Labour Party candidates in the 2019 UK general election. Neither of the UK studies found an association with having voted for Conservative Party candidates, but the two US studies found a negative association between intention to be vaccinated and having voted for Donald Trump.

The consistent finding of greater intention to be vaccinated among users of legacy media suggests that social media do not currently provide an adequate replacement for legacy media, at least in terms of public health communication. The finding of a negative association in the study which measured informational reliance rather than frequency is consistent with

the view that uncritical consumption of social media may be acting to promote vaccine hesitancy.

# Introduction

The Covid-19 pandemic, and the public health measures put in place to mitigate its worst effects, have exerted extraordinary costs. The death toll has been accompanied by significant levels of economic harm, [1, 2] while the population also experienced a substantial deterioration in mental health. [3, 4] Large-scale vaccination programmes against SARS-CoV-2, the virus that causes Covid-19, are an important part of global strategy for dealing with the pandemic. However, high rates of vaccination will be necessary before population benefits can be achieved. [5, 6] Acceptance of vaccination against SARS-Cov-2 is thus of urgent importance, both with regard to recruitment of clinical trial volunteers and with regard to future uptake of the vaccines themselves. [7]

An ‘infodemic’ of Covid-19 misinformation, especially online, has been identified as an obstacle to attempts to control the pandemic. [8-12] Conspiracy beliefs and misinformation regarding Covid-19 are widely-disseminated online, [13, 14] with 27.5% of the most popular YouTube videos on the subject, accruing over 60 million views between them, containing no factual information. [15] Furthermore, a large proportion of the most popular Covid-19 videos have been found to contain misinformation, [16] while misinformative and politically-slanted Covid-19 videos have been found to generate more interaction on YouTube than other Covid-19 videos. [17] One study has highlighted the reach of YouTube misinformation videos dealing with Covid-19, the slow rate at which YouTube takes action on such videos, and the rarity with which Facebook places warning labels on such videos when shared on its platform. [18] This problem is not new: similarly misleading content was popular even before the Covid-19 pandemic. A 2017 review of YouTube videos on vaccination found 65% to express anti-vaccination sentiment, [19] while studies looking at other platforms have found that posts expressing anti-vaccination sentiment are more likely to be re-circulated on Twitter, attract more likes on Instagram, and elicit considerably more engagement on Pinterest. [15, 20] However, the global emergency created by Covid-19 has sparked debate about the role and public responsibility of social media in the news ecosystem.[21] While coverage of vaccines and vaccination with more positive or neutral tones has been increasing on legacy media platforms over the past five years, [22, 23] a content analysis found that 75% of newspaper articles contained negative messages on vaccines and 83% lacked accurate information. [24]

More frequent social media use, and greater informational reliance on social media, have been found to be associated with higher levels of conspiracy beliefs regarding Covid-19, and both conspiracy beliefs and informational reliance on social media have been found to be associated

with lower levels of engagement in health-protective behaviour during the pandemic. [25] Moreover, the most vaccine-resistant in Ireland and the UK are more likely to consume relatively more media content from social rather than traditional media sources. [26] Such emerging findings are consistent with pre-pandemic studies of online social networks and vaccine hesitancy relating to parental vaccine hesitancy, [27] uptake of the HPV (Human Papilloma Virus) vaccine, [28-30] and variable uptake of annual influenza vaccines. [30-32]

The analyses reported in this article aim to measure the possible association between legacy and social media usage while controlling for possible effects associated with other factors. In particular, the research was designed with awareness of the likely importance of political ideology alongside information sources. At the national level, populist party vote share has been found to correlate with vaccine hesitancy in Western Europe, [33] and anti-vaccine attitudes have been found to be associated with the political right in the US, [34, 35]. Moreover, one study found a relationship between increased likelihood of believing vaccine conspiracies and both social media reliance and conservative political affiliation. [36] Reduced intentions to vaccinate have also been found to be associated with demographic characteristics, including low education, [37] age and African-American ethnicity in the US, [38, 39] and other than white ethnicity in the UK. [40] One study found HPV vaccination initiation to be lower among Black than White and Hispanic students in New York, [41] while a literature review suggests that initiation of HPV vaccination is lower among minority ethnic and low-income females in most high-income countries except for the US, where initial uptake may be higher but completion rates lower. [42]

# Hypotheses

The core hypotheses tested in the four studies are as follows:

| | |
|---|---|
| H1. | Usage of legacy media as a source of information about Covid-19 will have a positive association with vaccine intentions |
| H2. | Usage of social media as a source of information about Covid-19 will have a negative association with vaccine intentions |
| H3. | Voting history (as a proxy for political ideology) will have an association with vaccine intentions |

Additional hypotheses of effects for each of the following demographic variables were also tested: age, gender, ethnicity, education, and (except in Study 3, where this information was not collected) household income.

# Methods

## Data collection

Four online questionnaire surveys were conducted with stratified, nationally-representative samples from recruited panels, with Studies 1 and 2 being carried out in the US (N = 1198 and N = 3890), Study 3 being carried out in mainland Britain (N = 1663), and Study 4 being carried out in the UK as a whole (N = 2237). Fieldwork was carried out online from 24-25 June for Study 1 and Study 3, 20-25 August for Study 2, and from 17-20 June for Study 4. The second American study can be considered a direct replication of the first with a much larger sample, while the second British study should perhaps be considered a conceptual replication of the first, as it featured not only a larger sample but also a more detailed questionnaire: an additional demographic variable, i.e. household income, was measured (as in both US studies), and respondents were asked questions about individual social media platforms, as well as about both print and broadcast media, in contrast to the remaining three studies, which asked about social media and legacy media in aggregate.

Data for Studies 1-3 were collected by YouGov in partnership with the Center for Countering Digital Hate as part of YouGov's daily omnibus polling, and subsequently shared with the authors. Data collection followed ethical and data protection procedures at YouGov, and all participants were over the age of 18. Data for Study 4 were collected by Ipsos-MORI, as part of a bespoke survey commissioned by the Policy Institute at King's College London, with funding from King's College London and with data collection following ethical and data protection procedures both at Ipsos-MORI and at King's College London. All participants were over the age of 16, and informed consent was obtained after the nature and possible consequences of the studies had been fully explained. Table 1 contains summary statistics for demographic variables and voting history variables across all four samples. Income data were not collected for Study 3, and were banded differently for Studies 1-2 and Study 4. The voting history variable was coded with three levels: 'main right' (for those in the US who voted for Donald Trump in 2016 and for those in mainland Britain who voted for Conservative Party candidates in 2019), 'main left' (for those in the US who voted for Hillary Clinton in 2016 and for those in mainland Britain who voted for Labour Party candidates in 2019), and 'other/none' (for non-voters and for those who voted for independent or minor party candidates).

Studies 1-3 measured frequency and mode of media engagement with regard to Covid-19 with the following question:

> How often, if ever, do you get news and updates on the Coronavirus (Covid-19) outbreak from each of the following places?

Answers were required with regard to the following: 'Social media (e.g. Facebook, Twitter, YouTube, WhatsApp, etc)' and 'Mainstream/traditional

media, including through their websites and online (i.e. print, digital, radio and TV news)'. Answer options were 'Several times a day', 'Once a day', 'A few times a week', 'Less often than a few times a week', and 'Never'.

Study 4 assessed informational reliance on modes of media engagement with the following question:

> Please tell us how much of what you know about coronavirus, if anything, comes from …

Answers were required with regard to the following: 'TV and radio broadcasters (including through their websites and online)', 'Newspapers and magazines (including through their websites and online)', 'YouTube', 'Facebook', 'WhatsApp', and 'Twitter'. Answer options were 'A great deal', 'A fair amount', 'Not very much', 'Nothing at all', 'Don't know'. These variables were aggregated by grouping the first two and the last four, recoding as numeric variables, and taking the means.

Studies 1-3 measured vaccine intentions with regard to Covid-19 with the following question:

> When a Coronavirus (COVID-19) vaccine becomes available, do you think you will or will not get vaccinated?

Answer options were 'Definitely will get vaccinated', 'Probably will get vaccinated', 'Probably will not get vaccinated', and 'Definitely will not get vaccinated'.

Study 4 measured the same variable with the following question:

> If a vaccine for coronavirus becomes available, how likely or unlikely would you personally be to get the vaccine?

Answer options were 'Certain', 'Very likely', 'Fairly likely', 'Not very likely', 'Not at all likely', 'Definitely not', 'Don't know'.

Figure 1 visualises distributions of variables measuring media use and vaccine intentions for Studies 1-3, and Figure 2 visualises distributions of the equivalent variables for Study 4.

## Data analysis

Hypotheses were tested using cumulative logit models, with partial models and matrices of rank-order correlation coefficients being provided in the interests of transparency. Demographic weights were calculated by YouGov and Ipsos-MORI and employed in the cumulative logit models only; all other calculations reported in this article (including correlations) are treated as descriptive statistics and therefore unweighted. Both 95% confidence intervals and two-tailed p-values are reported for regression coefficients. (The hypotheses are directional but one-tailed tests could potentially have concealed relationships in the unexpected direction.) Cumulative logit models were fitted using the clm function from the *ordered* R package, version 2019.12-10, while rank-order correlation

coefficients were calculated using base R. Visualisations were created using *ggplot2*, version 3.3.3.

For the cumulative logit models, most nominal and ordinal predictor variables were recoded as dummy variables: female versus other, other than white ethnic group versus white ethnic group, lowest household income band versus higher household income bands, degree-level qualifications versus lower levels of qualifications. Voting history was the exception, with non-voting or voting for independent or minor party candidates being treated as the baseline. Media usage variables for Studies 1-3 were recoded as dummy variables indicating whether or not a respondent indicated that he or she received information on Covid-19 from each source '[a] few times a week', 'once a day', or 'several times a day'. All numeric variables (that is, age in Studies 1-4 and the aggregate media usage variables in Study 4) were standardised. For each study, two models were created: a partial model using demographic predictors only and a full model additionally using voting history and the media variables as predictors.

For the correlation matrices, nominal variables were re-coded as dummy variables: female versus other, other than white versus white ethnicity, having voted for candidates from the main Left-wing party versus other, and having voted for candidates from the main Right-wing party versus other.

# Results

## Study 1

Study 1 found that voting history and frequency of legacy media consumption are associated with SARS-CoV-2 vaccine intentions: see table 2 for cumulative logit model results and supplementary materials for correlations. Figure 3 (upper left) visualises coefficients from the full model. H1 was supported ($p = .027$), while H2 was not ($p = .738$). H3 was supported, with a negative effect found to be associated with having voted for Donald Trump ($p = .001$) and a positive effect found to be associated with having voted for Hillary Clinton ($p < .001$). In addition, vaccine intentions were positively associated with age ($p = .004$) and degree-level education ($p < .001$). Vaccine intentions were negatively associated with female status ($p = .002$). There was no association between vaccine intentions and household income ($p = .978$), although there was a non-significant negative association between vaccine intentions and other than white ethnic group ($p = .062$).

Of those effects associated with dummy variables, the largest were those associated with voting history. Note however that the coefficient for age is not directly comparable in any of the four sets of models, as it represents the effect of one standard deviation above the mean for this continuous variable.

## Study 2

Study 2 found that voting history and frequency of legacy media consumption are associated with SARS-CoV-2 vaccine intentions: see table 3 for cumulative logit models and supplementary materials for correlations. Figure 3 (upper right) visualises coefficients from the full model. H1 was supported ($p < .001$). H2 was not supported, although there was a small, non-significant negative association ($p = .363$). H3 was supported, with a negative effect found to be associated with having voted for Donald Trump ($p < .001$) and a positive effect found to be associated with having voted for Hillary Clinton ($p < .001$). In addition, vaccine intentions were positively associated with degree-level education ($p < .001$). Vaccine intentions were negatively associated with female status ($p < .001$), other than white ethnicity ($p < .001$), and low household income ($p = .012$). There was no association between vaccine intentions and age ($p = .696$).

Effects associated with most variables appeared very similar to those found in Study 1, with the exception of the effect associated with high legacy media usage, the largest coefficient in the model by a considerable margin. The finding for Study 2 could be considered more robust as the sample size was so much greater, although the weaker finding for Study 1 raises the possibility that the 'true' coefficient may be at the lower end of the 95% confidence interval for Study 2 (which would still leave it the largest coefficient in the model).

## Study 3

Study 3 found that voting history and frequency of legacy media consumption are associated with SARS-CoV-2 vaccine intentions: see table 4 for cumulative logit models and supplementary materials for correlations. Figure 3 (lower left) visualises coefficients from the full model. H1 was supported ($p < .001$) while H2 was not supported ($p = .754$). H3 was partially supported, with a positive effect found to be associated with having voted for Labour Party candidates ($p < .001$) and non-significant negative effect found to be associated with having voted for Conservative Party candidates ($p = .236$). In addition, vaccine intentions were positively-associated with age ($p < .001$) and negatively-associated with other than white ethnicity ($p = .017$). There was also a non-significant positive association between vaccine intentions and degree-level education ($p = .142$).

Effects associated with voting history were notably smaller than in both US-based studies, with the estimated effects of high legacy media usage, ethnicity, and having voted for candidates standing for the main left-wing party, i.e. the Labour Party, being about equal.

## Study 4

Study 4 found that voting history and informational reliance on both legacy and social media are associated with SARS-CoV-2 vaccine

intentions: see table 5 for cumulative logit models and supplementary materials for correlations. See figure 3 (lower right) for coefficients from the full model. H1 was supported ($p < .001$) and H2 was also supported ($p = .028$). H3 was partially supported, with a positive effect found to be associated with having voted for Labour Party candidates ($p = .010$) and no effect found to be associated with having voted for Conservative Party candidates ($p = .856$). In addition, vaccine intentions were positively associated with age ($p < .001$) and negatively associated with other than white ethnicity ($p < .001$) and low household income ($p = .009$). There was a non-significant positive association between vaccine intentions and degree-level education ($p = .114$) and a non-significant negative association between vaccine intentions and female status ($p = .087$).

Informational reliance on social media appears more closely correlated with vaccine intentions than informational reliance on legacy media (see supplementary materials). That this does not translate into a larger or more significant effect of social media on vaccine intentions in the full model is perhaps attributable to the mutual correlation with age. Further, informational reliance on YouTube and Facebook had a stronger negative correlation with vaccine intentions than informational reliance on WhatsApp and Twitter, while informational reliance on TV and radio had a stronger positive correlation with vaccine intentions than informational reliance on newspapers and magazines (which were virtually uncorrelated).

# Discussion

The four studies collectively provide evidence of a positive effect on vaccine intentions for usage of legacy media, whether measured in terms of frequency (Studies 1-3) or informational reliance (Study 4). Studies 1-3, which focused on frequency of media usage, did not find a relationship between social media usage and vaccine intentions, whether positive or negative. This suggests that usage of social media is not in itself a negative factor, as compared to non-usage of legacy media. If US and UK citizens use social media as an alternative to the legacy media, then relationships with vaccine attitudes may arise due not to heightened use of social media in itself but to reduced usage of legacy media, for which these findings suggest that social media are at best an inadequate replacement. (Frequency of use of social and of legacy media in receiving updates about Covid-19 were positively correlated in all three studies, but this may simply indicate mutual correlation with an un-measured variable such as health anxiety.) However, Study 4, which focused on informational reliance rather than frequency of use, found a significant negative effect associated with social media, which may indicate that problems arise from uncritical acceptance of claims found on social media, rather than arising from social media use *per se*.

The finding of a stronger negative correlation between vaccine intentions and informational reliance on YouTube and Facebook than for other social media platforms is consistent with earlier findings of a particularly strong association between informational reliance on those specific platforms and belief in Covid-19 conspiracy theories in the UK, [25] and also with the finding that Covid-19 misinformation videos on YouTube primarily reach their audience through Facebook shares. [18] However, one US-based study has found approximately equal negative correlations between knowledge of Covid-19 and trust in Facebook and Twitter as sources of information, [43] so it should not be assumed that the problem is confined to specific platforms.

A long-term solution to the problem highlighted here might be found in the promotion of information literacy, i.e. the learned ability to recognise and value verified and reliable information. [44, 45] Both in the short and in the longer terms, social media companies themselves could assist by preferentially directing users away from low-quality, hyper-partisan, and fake news sources, and towards sources of higher quality content, perhaps through partnerships with reputable content producers. There would appear to be some precedent for such a policy, as some social media companies already partner with news organisations, although not necessarily with the aim of diminishing the attention share held by hyper-partisan sources. [46] Moreover, there is evidence to suggest that an approach along these lines could potentially be effective, as studies have found that social media interventions such as links to sources can encourage vaccine uptake and reduce traffic to anti-vaccination content. [47-50]

Findings regarding significant negative associations between SARS-CoV-2 vaccine intentions and both minority ethnic group membership (Studies 2, 3, and 4) and low household income (Studies 2 and 4) are consistent with studies of intentions and uptake of HPV vaccination. Further research will be necessary to unpack the association between vaccination intentions and both age and female gender. In the meantime, these findings provide hints as to the sub-populations to which any future SARS-CoV-2 vaccination programme must be marketed most intensively.

Findings relating to voting history have a range of possible explanations. There is evidence that vaccination attitudes are bound up with broader political distrust and polarisation, and that individuals adhere to beliefs congruent with their identities even when they know and understand evidence against them. [51] It is plausible that political leadership in the US is itself driving attitudes to vaccinations: [34] a possibility that should be investigated further in the light of this study’s finding of a negative effect associated with having voted for Donald Trump but not with having voted for the UK Conservative Party. However, it is also plausible that these apparent political effects may originate in media effects, with the more politically-polarised US media landscape perhaps explaining the greater effects associated with voting history. Broadcast content is less

closely regulated in the US than in the UK, where long-standing political commitment to public service broadcasting informs the functioning of a statutory authority, Ofcom [52]. A range of studies have found that individuals tend to consume and interact with legacy and social media sources that confirm their political biases, and that technology may in some cases facilitate or worsen selective biases through ‘echo chambers’. [53-58] While the scale of the supposed ‘echo chamber’ problem is debatable, with some researchers arguing that the influence of technology on selective exposure – especially in relation to political information – is more subtle than popular accounts imply, [59] it remains plausible that overlaps exist between anti-scientific information sources with regard to vaccines and certain politically-focussed social media spaces, [60] which could also contribute to an explanation of the findings reported in this paper. If this conjecture is accepted, it would suggest that diversity of perspectives attended to within both legacy and social media could also be a relevant factor, although that was not measured in the studies reported here. In this connection, it is notable that existing US-based research has found a substantial negative correlation between knowledge about Covid-19 and trust in Trump-supporting media outlets Fox News and The Hill, while correlations with trust in left-leaning legacy media outlets were statistically insignificant. [43] However, there are likely to be hard limits to what can be discovered using voting history as a proxy for political values and identities, and it would be desirable for further research to be carried out which measures the underlying variables more directly.

The findings of the four studies presented here suggest that the timing of the political cycle, and the voice enjoyed by insurgent and populist politicians, should be considered as relevant variables for public health campaigns. They also highlight the importance of sustainable funding models for legacy media organisations, which may be fulfilling a hitherto under-appreciated public health function, and underscore the need to combat the problem of online misinformation, whether through information literacy, through voluntary action taken by internet companies, or through official regulation. Finally, they raise the question of whether we are now seeing negative public health consequences of the politicisation of domains that were formerly governed by expert practitioner knowledge.

# Endnotes


1. ONS, *Coronavirus and the impact on output in the UK economy: June 2020*. 2020.
2. BBC, *Coronavirus: US economy sees sharpest contraction in decades*, in *British Broadcasting Corporation*. 2020.
3. Pierce, M., et al., *Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population.* Lancet Psychiatry, 2020. **7**: p. 883-892.
4. Czeisler, M.E., et al., *Mental health, substance use, and suicidal ideation during the COVID-19 pandemic: United States, June 24-30, 2020.* Morbidity and Mortality Weekly Report, 2020. **69**(32): p. 1049-1057.
5. Sanche, S., et al., *High Contagiousness and Rapid Spread of Severe Acute Respiratory Syndrome Coronavirus 2.* Emerging Infectious Diseases, 2020. **26**(7): p. 1470-1477.
6. DeRoo, S.S., N.J. Pudalov, and L.Y. Fu, *Planning for a COVID-19 Vaccination Program.* JAMA, 2020. **323**(24): p. 2458-2459.
7. Detoc, M., et al., *Intention to Participate in a COVID-19 Vaccine Clinical Trial and to Get Vaccinated against COVID-19 in France during the Pandemic.* Vaccine, 2020. **38**(45): p. 7002-7006.
8. Chong, Y.Y., et al., *COVID-19 Pandemic, Infodemic and the Role of eHealth Literacy.* International Journal of Nursing Studies, 2020. **108**(103644).
9. Cornwall, W., *Officials Gird for a War on Vaccine Misinformation.* Science, 2020. **369**(6499): p. 14-15.
10. Biasio, L.R., et al., *Assessing COVID-19 Vaccine Literacy: A Preliminary Online Survey*. 2020.
11. Feleszko, W., et al., *Flattening the Curve of COVID-19 Vaccine Rejection: A Global Overview*, in *SSRN Scholarly Paper*. 2020: Rochester (NY).
12. Wang, Y., et al., *Systematic literature review on the spread of health-related misinformation on social media.* Social Science & Medicine, 2019. **240**: p. 112552.
13. Callaghan, T., et al., *Parent Psychology and the Decision to Delay Childhood Vaccination.* Social Science & Medicine, 2019. **238**: p. 112407.
14. Kata, A., *Anti-Vaccine Activists, Web 2.0, and the Postmodern Paradigm: An Overview of Tactics and Tropes Used Online by the Anti-Vaccination Movement.* Vaccine, 2012. **30**(25): p. 3778-3789.

15. Puri, N., et al., *Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases.* Human Vaccines & Immunotherapeutics, 2020. **16**(11): p. 2586-2593.

16. Oi-Yee Li, H., et al., *YouTube as a source of information on COVID-19: a pandemic of misinformation?* BMJ Global Health, 2020. **5**: p. e002604.

17. Marchal, N. and H. Au, *'Coronavirus EXPLAINED': YouTube, COVID-19, and the Socio-Technical Mediation of Expertise.* Social Media & Society, 2020(July-September): p. 1-4.

18. Knuutila, A., et al., *Covid-related misinformation on YouTube: the spread of misinformation videos on social media and the effectiveness of platform policies*, in *COMPROP Data Memo*. 2020: Oxford.

19. Basch, C.H., et al., *What do popular YouTube videos say about vaccines?* Child: care, health and development, 2017. **43**(4): p. 499-503.

20. Guidry, J.P., et al., *On pins and needles: how vaccines are portrayed on Pinterest.* Vaccine, 2015. **33**(39): p. 5051-5056.

21. Carlson, M., *Facebook in the news: social media, journalism, and public responsibility following the 2016 trending topics controversy.* Digital journalism, 2018. **6**(1): p. 4-20.

22. Catalan-Matamoros, D. and C. Peñafiel-Saiz, *Media and mistrust of vaccines: a content analysis of press headlines.* Revista Latina de Comunicación Social, 2019. **74**: p. 786-802.

23. Catalan-Matamoros, D. and C. Peñafiel-Saiz, *Exploring the relationship between newspaper coverage of vaccines and childhood vaccination rates in Spain.* Human Vaccines & Immunotherapeutics, 2020. **16**(5): p. 1055-1061.

24. Catalan-Matamoros, D. and C. Peñafiel-Saiz, *How is communication of vaccines in traditional media: a systematic review.* Perspectives in public health, 2019. **139**(1): p. 34-43.

25. Allington, D., et al., *Health-protective behaviour, social media usage and conspiracy belief during the COVID-19 public health emergency.* Psychological Medicine, 2020. **Published online first**.

26. Murphy, J., et al., *Preparing for a COVID-19 Vaccine: Identifying and Psychologically Profiling Those Who Are Vaccine Hesitant or Resistant in Two General Population Samples*. 2020: PsyArXiv Preprints.

27. Tomljenovic, H., A. Bubic, and N. Erceg, *It Just Doesn't Feel Right – the Relevance of Emotions and Intuition for Parental Vaccine Conspiracy Beliefs and Vaccination Uptake.* Psychology & Health, 2020. **35**(5): p. 538-554.

28. Dunn, A.G., et al., *Mapping Information Exposure on Social Media to Explain Differences in HPV Vaccine Coverage in the United States.* Vaccine, 2017. **35**(23): p. 3033-3040.

29. Dunn, A.G., et al., *Associations Between Exposure to and Expression of Negative Opinions About Human Papillomavirus Vaccines on Social Media: An Observational Study.* Journal of Medical Internet Research, 2015. **17**(6): p. e144.

30. Perez, S., et al., *Psychosocial Determinants of Parental Human Papillomavirus (HPV) Vaccine Decision-Making for Sons: Methodological Challenges and Initial Results of a Pan-Canadian Longitudinal Study.* BMC Public Health, 2016. **16**(1).

31. Ahmed, N., Sandra C. Quinn, Gregory R. Hancock, Vicki S. Freimuth, and Amelia Jamison, *Social Media Use and Influenza Vaccine Uptake among White and African American Adults.* Vaccine, 2018. **36**(49): p. 7556-7561.

32. Schmid, P., Dorothee Rauber, Cornelia Betsch, Gianni Lidolt, and Marie-Luisa Denker, *Barriers of Influenza Vaccination Intention and Behavior: A Systematic Review of Influenza Vaccine Hesitancy, 2005 – 2016.* PLoS ONE, 2017. **12**(1): p. e0170550.

33. Kennedy, J., *Populist Politics and Vaccine Hesitancy in Western Europe: An Analysis of National-Level Data.* European Journal of Public Health, 2019. **29**(3): p. 512-516.

34. Hornsey, M.J., et al., *Donald Trump and Vaccination: The Effect of Political Identity, Conspiracist Ideation and Presidential Tweets on Vaccine Hesitancy.* Journal of Experimental Social Psychology, 2020. **88**: p. 103947.

35. Lewandowsky, S., J.K. Woike, and K. Oberauer, *Genesis or Evolution of Gender Differences? Worldview-Based Dilemmas in The Processing of Scientific Information.* Journal of Cognition, 2020. **3**(1): p. 9.

36. Featherstone, J.D., R.A. Bell, and J.B. Ruiz, *Relationship of people's sources of health information and political ideology with acceptance of conspiratorial beliefs about vaccines.* Vaccine, 2019. **37**(23): p. 2993-2997.

37. Jylhä, K.M. and K. Hellmer, *Right-Wing Populism and Climate Change Denial: The Roles of Exclusionary and Anti-Egalitarian Preferences, Conservative Ideology, and Antiestablishment Attitudes.* Analyses of Social Issues and Public Policy, 2020. **Published online first**.

38. Fazekas, K.I., N.T. Brewer, and J.S. Smith, *HPV Vaccine Acceptability in a Rural Southern Area.* Journal of Women's Health, 2008. **17**(4).

39. Cates, J.R., et al., *Racial Differences in HPV Knowledge, HPV Vaccine Acceptability, and Related Beliefs Among Rural, Southern Women.* The Journal of Rural Health, 2009. **25**(1): p. 93-97.

40. Forster, A.S., et al., *Understanding adolescents' intentions to have the HPV vaccine.* Vaccine, 2010. **28**: p. 1673-1676.

41. Bednarczyk, R.A., et al., *Human papillomavirus vaccine uptake and barriers: Association with perceivedrisk, actual risk and race/ethnicity among female students at a New York State university, 2010.* Vaccine, 2011. **29**: p. 3138-3143.

42. Jeudin, P., et al., *Race, ethnicity and income as factors for HPV vaccine acceptance and use.* Human Vaccines & Immunotherapeutics, 2013. **9**(7): p. 1413-1420.

43. Fridman, I., et al., *Association between public knowledge about COVID-19, trust in information sources, and adherence to social distancing: cross-sectional survey.* JMIR Public Health and Surveillance, 2020. **6**(3): p. e22060.

44. Mason, L.E., D. Krutka, and J. Stoddard, *Media literacy, democracy, and the challenge of fake news.* Journal of Media Literacy Education, 2018. **10**(2): p. 1-10.

45. Jones-Jang, S.M., T. Mortensen, and J. Liu, *Does media literacy help identification of fake news? Information literacy helps, but other literacies don't.* American Behavioural Scientist, 2019. Published online first, DOI: https://doi.org/10.1177/0002764219869406.

46. Warzel, C., *Why will Breitbart be included in 'Facebook News'? Mark Zuckerberg can't be understood in terms of partisan politics. It's all about growth.*, in *The New York Times*. 2019.

47. Glanz, J.M., et al., *Web-Based Social Media Intervention to Increase Vaccine Acceptance: A Randomized Controlled Trial.* Pediatrics, 2017. **140**(6): p. e20171117.

48. Daley, M.F., et al., *Addressing Parents' Vaccine Concerns: A Randomized Trial of a Social Media Intervention.* American Journal of Preventative Medicine, 2018. **55**(1): p. 44-54.

49. Kim, S., et al., *The Effects of an Informational Intervention on Attention to Anti-Vaccination Content on YouTube.* Proceedings of the International AAAI Conference on Web and Social Media, 2020. **14**: p. 949-953.

50. Vraga, E.K. and L. Bode, *I do not believe you: how providing a source corrects health misperceptions across social media platforms.* Information, Communication and Society, 2018. **21**(10): p. 1-17.

51. Garrett, R.K., B.E. Weeks, and R.L. Neo, *Driving a wedge between evidence and beliefs: how online ideological news exposure*

*promotes political misperceptions.* Journal of Computer-Mediated Communication, 2016. **21**: p. 331-348.

52. Hitchens, L, *Broadcasting pluralism and diversity: a comparative study of policy and regulation*. 2006, Oxford and Portland: Hart Publishing.
53. Stroud, N.J., *Media use and political predispositions: revisiting the concept of selective exposure.* Political Behaviour, 2008. **30**: p. 341-366.
54. Wicks, R.H., J.L. Wicks, and S.A. Morimoto, *Partisan media selective exposure during the 2012 presidential election.* American Behavioural Scientist, 2014. **58**(9): p. 1131-1143.
55. Rodriguez, C.G., et al., *Partisan selective exposure: the role of party, ideology, and ideological extremity over time.* Translational Journal in Psychological Science, 2017. **3**(3): p. 254-271.
56. Bou-Hamad, I. and N.A. Yehya, *Partisan selective exposure in TV consumption patterns: a polarised developing country context.* Communication Research, 2016. **47**(1): p. 55-81.
57. Garimella, V.R.K. and I. Weber, *A long-term analysis of polarisation on Twitter*, in *ICWSM 17*. 2017: Montréal.
58. Yarchi, M., C. Baden, and N. Kligler-Vilenchik, *Political Polarization on the Digital Sphere: A Cross-platform, Over-time Analysis of Interactional, Positional, and Affective Polarization on Social Media.* Political Communication, 2020. Published online first, DOI: https://doi.org/10.1080/10584609.2020.1785067.
59. Guess, A., et al., *Avoiding the echo chamber about echo chambers: why selective exposure to like-minded political news is less prevalent than you think*. 2018, Miami: John S. and James L. Knight Foundations.
60. Schmidt, A.L., et al., *Polarization of the vaccination debate on Facebook.* Vaccine, 2018. **36**: p. 3606-3612.

# Tables

*Table 1: Descriptive statistics, all four samples*

| Study | N | Age (M) | Age (SD) | Female | Male | White | Other than white | Degree | Non-degree | Low income | High income | Vote: main left | Vote: main right |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1198 | 47.5 | 17.5 | 53.4 | 46.6 | 65.0 | 35.0 | 29.7 | 70.3 | 40.1 | 27.4 | 31.6 | 25.2 |
| 2 | 3890 | 47.9 | 17.9 | 53.6 | 46.4 | 64.2 | 35.8 | 28.9 | 71.1 | 41.5 | 26.2 | 30.4 | 27.1 |
| 3 | 1663 | 50.0 | 17.0 | 55.1 | 44.9 | 94.3 | 5.7 | 27.6 | 72.4 | | | 28.0 | 38.3 |
| 4 | 2237 | 44.5 | 16.6 | 49.7 | 49.3 | 89.7 | 10.3 | 41.8 | 58.2 | 30.1 | 15.8 | 28.8 | 28.4 |

Low income: Studies 1 & 2 = Under $40 000, Study 4 = Under £20 000
High income: Studies 1 & 2 = $80 000+, Study 4 = £55 000+

## *Table 2: Cumulative logit models, Study 1 (US sample I)*

| *Term* | *Est.* | *Low* | *High* | *SE* | *t* | *p* |
|---|---|---|---|---|---|---|
| *Model: CLM 1a* | | | | | | |
| *Definitely will not\|Probably will not* | *-1.62* | | | *0.14* | *-11.68* | *<.001* |
| *Probably will not\|Probably will* | *-0.99* | | | *0.13* | *-7.57* | *<.001* |
| *Probably will\|Definitely will* | *0.34* | | | *0.13* | *2.69* | *.007* |
| *Age* | *0.20* | *0.08* | *0.33* | *0.06* | *3.14* | *.002* |
| *Female* | *-0.35* | *-0.60* | *-0.10* | *0.13* | *-2.78* | *.005* |
| *Other than white* | *-0.18* | *-0.45* | *0.09* | *0.14* | *-1.29* | *.198* |
| *Degree* | *0.69* | *0.41* | *0.97* | *0.14* | *4.77* | *<.001* |
| *Low income* | *-0.04* | *-0.31* | *0.22* | *0.13* | *-0.33* | *.744* |
| *Residual DF: 873.11* | | | | | | |
| *Model: CLM 1b* | | | | | | |
| *Definitely will not\|Probably will not* | *-1.37* | | | *0.21* | *-6.39* | *<.001* |
| *Probably will not\|Probably will* | *-0.70* | | | *0.21* | *-3.32* | *.001* |
| *Probably will\|Definitely will* | *0.73* | | | *0.21* | *3.44* | *.001* |
| *Age* | *0.22* | *0.07* | *0.38* | *0.08* | *2.91* | *.004* |
| *Female* | *-0.40* | *-0.65* | *-0.15* | *0.13* | *-3.10* | *.002* |
| *Non-white* | *-0.26* | *-0.54* | *0.01* | *0.14* | *-1.87* | *.062* |
| *Degree* | *0.56* | *0.27* | *0.85* | *0.15* | *3.79* | *<.001* |
| *Low income* | *0.00* | *-0.27* | *0.26* | *0.14* | *-0.03* | *.978* |
| *Legacy Media: High* | *0.36* | *0.04* | *0.68* | *0.16* | *2.21* | *.027* |
| *Social Media: High* | *0.05* | *-0.24* | *0.33* | *0.15* | *0.33* | *.738* |
| *Vote: Left* | *0.77* | *0.44* | *1.10* | *0.17* | *4.57* | *<.001* |
| *Vote: Right* | *-0.59* | *-0.94* | *-0.23* | *0.18* | *-3.26* | *.001* |
| *Residual DF: 869.11* | | | | | | |

*Table 3: Cumulative logit models, Study 2 (US sample II)*

| *Term* | *Est.* | *Low* | *High* | *SE* | *t* | *p* |
|---|---|---|---|---|---|---|
| *Model: CLM 2a* | | | | | | |
| *Definitely will not\|Probably will not* | *-1.67* | | | *0.08* | *-21.45* | *<.001* |
| *Probably will not\|Probably will* | *-0.78* | | | *0.07* | *-10.87* | *<.001* |
| *Probably will\|Definitely will* | *0.60* | | | *0.07* | *8.50* | *<.001* |
| *Age* | *0.01* | *-0.06* | *0.08* | *0.04* | *0.34* | *.733* |
| *Female* | *-0.29* | *-0.43* | *-0.16* | *0.07* | *-4.27* | *<.001* |
| *Other than white* | *-0.23* | *-0.38* | *-0.09* | *0.08* | *-3.08* | *.002* |
| *Degree* | *0.56* | *0.41* | *0.72* | *0.08* | *7.27* | *<.001* |
| *Low income* | *-0.19* | *-0.34* | *-0.05* | *0.07* | *-2.63* | *.009* |
| *Residual DF: 2798.64* | | | | | | |
| *Model: CLM 2b* | | | | | | |
| *Definitely will not\|Probably will not* | *-1.08* | | | *0.12* | *-8.69* | *<.001* |
| *Probably will not\|Probably will* | *-0.11* | | | *0.12* | *-0.89* | *.373* |
| *Probably will\|Definitely will* | *1.39* | | | *0.12* | *11.16* | *<.001* |
| *Age* | *-0.02* | *-0.10* | *0.06* | *0.04* | *-0.39* | *.696* |
| *Female* | *-0.36* | *-0.50* | *-0.23* | *0.07* | *-5.16* | *<.001* |
| *Non-white* | *-0.40* | *-0.55* | *-0.24* | *0.08* | *-5.06* | *<.001* |
| *Degree* | *0.46* | *0.31* | *0.62* | *0.08* | *5.86* | *<.001* |
| *Low income* | *-0.19* | *-0.34* | *-0.04* | *0.08* | *-2.51* | *.012* |
| *Legacy Media: High* | *1.01* | *0.82* | *1.20* | *0.10* | *10.33* | *<.001* |
| *Social Media: High* | *-0.07* | *-0.22* | *0.08* | *0.08* | *-0.91* | *.363* |
| *Vote: Left* | *0.59* | *0.41* | *0.76* | *0.09* | *6.51* | *<.001* |
| *Vote: Right* | *-0.55* | *-0.74* | *-0.36* | *0.10* | *-5.75* | *<.001* |
| *Residual DF: 2794.64* | | | | | | |

## *Table 4: Cumulative logit models, Study 3 (UK sample I)*

| *Term* | *Est.* | *Low* | *High* | *SE* | *t* | *p* |
|---|---|---|---|---|---|---|
| *Model: CLM 3a* | | | | | | |
| *Definitely will not\|Probably will not* | *-2.59* | | | *0.12* | *-21.33* | *<.001* |
| *Probably will not\|Probably will* | *-1.43* | | | *0.09* | *-15.48* | *<.001* |
| *Probably will\|Definitely will* | *0.27* | | | *0.08* | *3.28* | *.001* |
| *Age* | *0.26* | *0.16* | *0.36* | *0.05* | *5.11* | *<.001* |
| *Female* | *-0.01* | *-0.21* | *0.18* | *0.10* | *-0.14* | *.891* |
| *Other than white* | *-0.44* | *-0.84* | *-0.03* | *0.20* | *-2.14* | *.033* |
| *Degree* | *0.32* | *0.10* | *0.54* | *0.11* | *2.80* | *.005* |
| *Residual DF: 1405.57* | | | | | | |
| *Model: CLM 3b* | | | | | | |
| *Definitely will not\|Probably will not* | *-2.10* | | | *0.19* | *-11.29* | *<.001* |
| *Probably will not\|Probably will* | *-0.94* | | | *0.17* | *-5.51* | *<.001* |
| *Probably will\|Definitely will* | *0.77* | | | *0.17* | *4.54* | *<.001* |
| *Age* | *0.31* | *0.20* | *0.42* | *0.06* | *5.52* | *<.001* |
| *Female* | *-0.04* | *-0.24* | *0.16* | *0.10* | *-0.35* | *.726* |
| *Non-white* | *-0.50* | *-0.92* | *-0.09* | *0.21* | *-2.40* | *.017* |
| *Degree* | *0.17* | *-0.06* | *0.40* | *0.12* | *1.47* | *.142* |
| *Legacy Media: High* | *0.54* | *0.24* | *0.84* | *0.15* | *3.53* | *<.001* |
| *Social Media: High* | *0.03* | *-0.18* | *0.24* | *0.11* | *0.31* | *.754* |
| *Vote: Left* | *0.49* | *0.23* | *0.75* | *0.13* | *3.71* | *<.001* |
| *Vote: Right* | *-0.15* | *-0.39* | *0.10* | *0.12* | *-1.19* | *.236* |
| *Residual DF: 1377.22* | | | | | | |

## *Table 5: Cumulative logit models, Study 4 (UK sample II)*

| *Term* | *Est.* | *Low* | *High* | *SE* | *t* | *p* |
|---|---|---|---|---|---|---|
| *Model: CLM 4a* | | | | | | |
| *Definitely not\|Not at all likely* | *-3.32* | | | *0.13* | *-25.37* | *<.001* |
| *Not at all likely\|Not very likely* | *-2.70* | | | *0.11* | *-24.92* | *<.001* |
| *Not very likely\|Fairly likely* | *-1.71* | | | *0.09* | *-19.52* | *<.001* |
| *Fairly likely\|Very likely* | *-0.55* | | | *0.08* | *-7.07* | *<.001* |
| *Very likely\|Certain* | *0.58* | | | *0.08* | *7.45* | *<.001* |
| *Age* | *0.39* | *0.30* | *0.48* | *0.04* | *8.61* | *<.001* |
| *Female* | *-0.15* | *-0.31* | *0.02* | *0.09* | *-1.71* | *.087* |
| *Other than white* | *-0.68* | *-0.97* | *-0.39* | *0.15* | *-4.61* | *<.001* |
| *Degree* | *0.21* | *0.03* | *0.40* | *0.09* | *2.27* | *.023* |
| *Low income* | *-0.28* | *-0.47* | *-0.10* | *0.09* | *-2.98* | *.003* |
| *Residual DF: 1792.78* | | | | | | |
| *Model: CLM 4b* | | | | | | |
| *Definitely not\|Not at all likely* | *-2.76* | | | *0.23* | *-12.08* | *<.001* |
| *Not at all likely\|Not very likely* | *-2.14* | | | *0.22* | *-9.88* | *<.001* |
| *Not very likely\|Fairly likely* | *-1.15* | | | *0.21* | *-5.51* | *<.001* |
| *Fairly likely\|Very likely* | *0.03* | | | *0.21* | *0.13* | *.898* |
| *Very likely\|Certain* | *1.17* | | | *0.21* | *5.64* | *<.001* |
| *Age* | *0.35* | *0.24* | *0.45* | *0.05* | *6.57* | *<.001* |
| *Female* | *-0.15* | *-0.32* | *0.02* | *0.09* | *-1.71* | *.087* |
| *Non-white* | *-0.73* | *-1.03* | *-0.43* | *0.15* | *-4.79* | *<.001* |
| *Degree* | *0.15* | *-0.04* | *0.34* | *0.09* | *1.58* | *.114* |
| *Low income* | *-0.25* | *-0.44* | *-0.06* | *0.10* | *-2.60* | *.009* |
| *Legacy Media* | *0.27* | *0.14* | *0.39* | *0.06* | *4.26* | *<.001* |
| *Social Media* | *-0.14* | *-0.27* | *-0.02* | *0.07* | *-2.20* | *.028* |
| *Vote: Left* | *0.27* | *0.07* | *0.48* | *0.11* | *2.58* | *.010* |
| *Vote: Right* | *-0.02* | *-0.23* | *0.19* | *0.11* | *-0.18* | *.856* |
| *Residual DF: 1779* | | | | | | |

# Figures

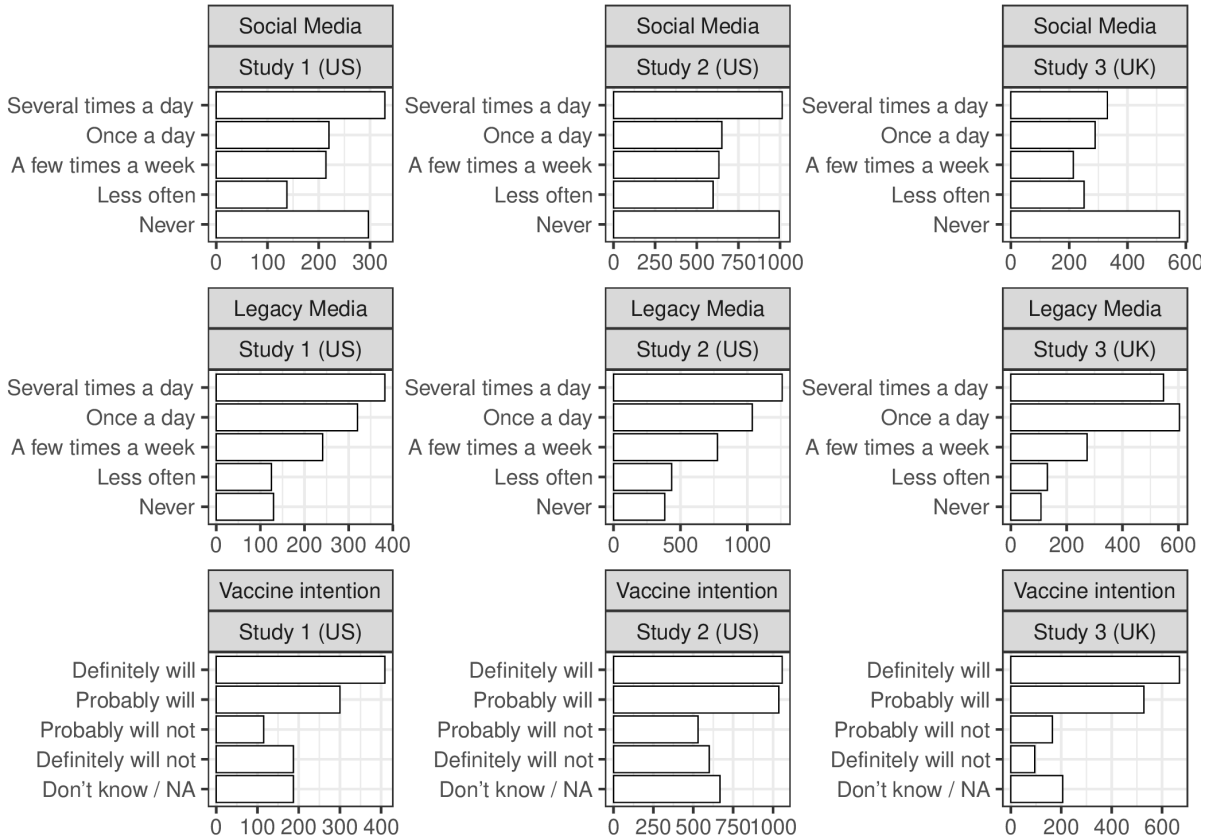


*Figure 1: Media usage and vaccine intentions: studies 1-3*

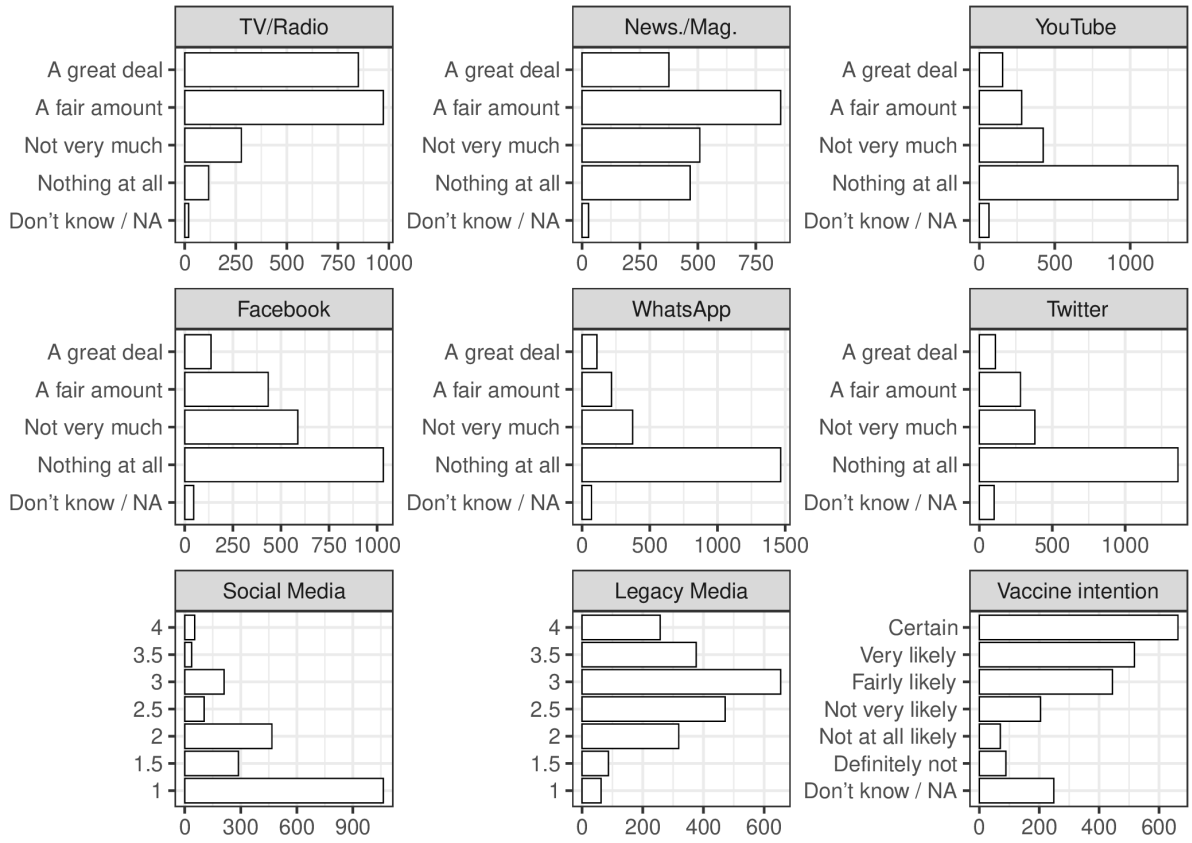


*Figure 2: Media usage and vaccine intentions: study 4*

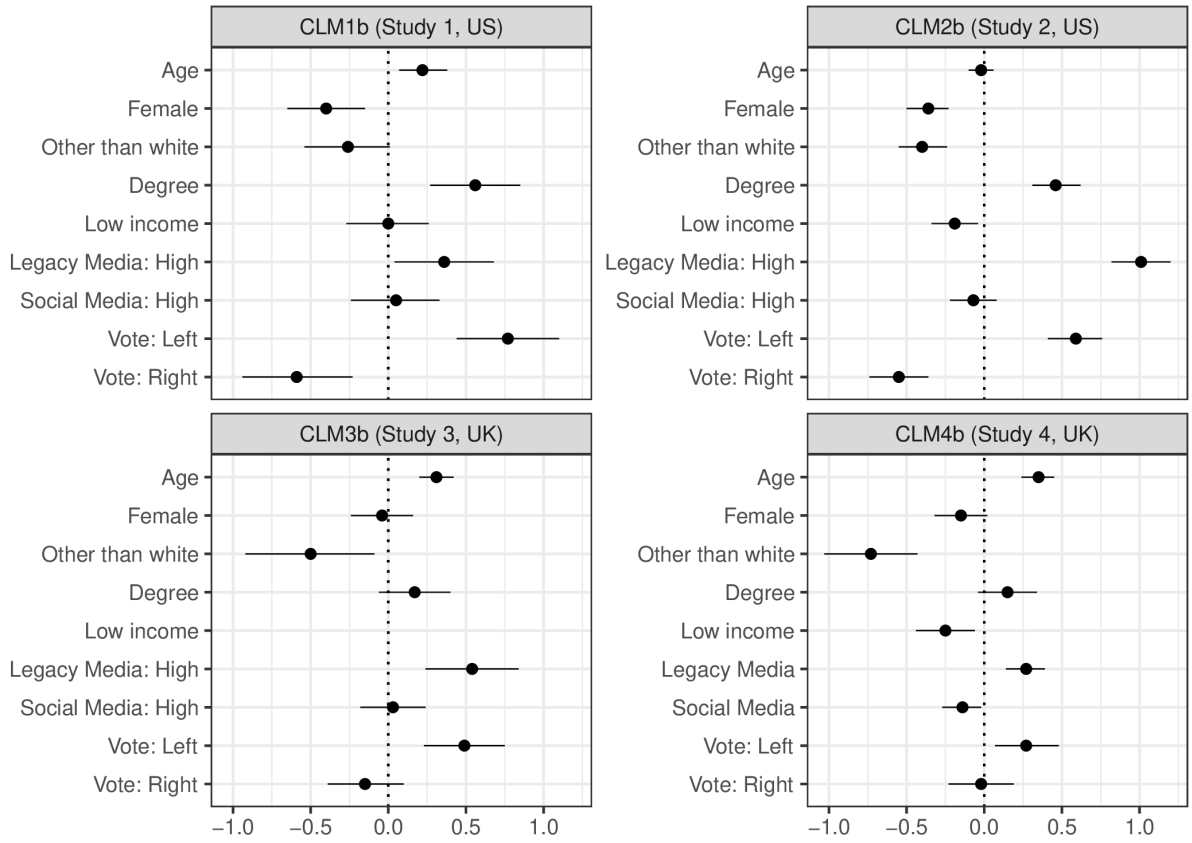


*Figure 3: Cumulative logit model coefficients, studies 1-4*