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Political network composition predicts vaccination attitudes

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Abstract

Political polarization is growing rapidly in the United States and has been linked to politicized public health issues including vaccination. Political homogeneity among one's interpersonal relationships may predict polarization levels and partisan bias. In this study, we analyzed if political network structure predicted partisan beliefs about the COVID-19 vaccine, beliefs about vaccines in general, and COVID-19 vaccine uptake. Personal networks were measured by whom the respondent discussed "important matters" with to obtain a list of individuals who are close to the respondent. The number of associates listed who share the political identity or vaccine status with the respondent was calculated as a measure of homogeneity. We find that having more Republicans and unvaccinated individuals in one's network predicted lower vaccine confidence whereas having more Democrats and vaccinated individuals in one's network predicted higher vaccine confidence. Exploratory network analyses revealed that non-kin others are especially impactful on vaccine attitudes when those network connections are also Republican and unvaccinated.

1. Introduction

What is the relationship between the political homogeneity of our close associates and politicized beliefs about vaccination? Political polarization between Democrats and Republicans continues to grow in the United States (Pew Research Center, 2016a,b; Wilson et al., 2020). Partisanship has also been linked to attitudes toward COVID-19 vaccination and even vaccination in general (Estep et al., 2022). Exposure to vaccine misinformation has been linked to vaccine hesitancy (Jolley and Douglas, 2014; Pierri et al., 2022; Neely et al., 2022), creating a public health issue. The present study investigates how social network composition may influence vaccine beliefs and vaccination uptake.

Sociologists have long theorized how belief strength is associated with social feedback from important others (Berger, 1967). Individuals who are especially close to someone may have a particularly strong influence on their ideological beliefs (Smith et al., 1998). Prior research

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2023.116004.

has shown that greater ideological diversity within meaningful social connections has been linked to a reduction in polarized beliefs (Facciani and Brashears, 2019). Earlier studies report that an individual's vaccine attitudes positively correlate with the vaccine attitudes of their social network (Brunson, 2013; Konstantinou et al., 2021). However, studies have typically combined all close ties together instead of separating influences from different relationship types (i.e. partner, friend, family, non-kin others).

Using original ego network data, the results of this study show that measuring ego network ties as to whom the participant discusses "important matters" with accounts for political polarization and attitudes towards vaccination. This particular list of associates provides meaningful social connection, but also enough comfort to discuss politics, which could bolster partisanship and vaccine attitudes. The current study finds that having more Republicans in one's network predicted lower vaccine confidence while having more Democrats and vaccinated individuals in one's network predicted higher vaccine confidence.

Additionally, we also found that non-kin others are especially impactful on vaccine attitudes when those network connections are also Republican and unvaccinated. Republicans' reduced likelihood of getting the COVID-19 vaccine was associated with a significantly higher death rate than Democrats' once the vaccine was widely available (Wallace, Goldsmith-Pinkham and Schwartz, 2022). With political polarization and subsequent vaccine hesitancy growing at such alarming rates while also creating serious public health challenges, it is particularly important to understand how network structure can predict such attitudes.

1.1. Political polarization

Both ideological (Pew Research Center, 2016a,b) as well as affective polarization (Wilson et al., 2020) are growing in the United States (but see Leonard et al., 2021). Ideological polarization captures the strength of partisan's liberalism or conservativism towards social and fiscal issues (Shor and McCarty, 2011). Affective polarization is "the tendency of people identifying as Republicans or Democrats to view opposing partisans negatively and co-partisans positively" (Iyengar and Westwood, 2015 p. 691). As an illustration, while only 30% of Democrats and Republicans reported having negative feelings toward their political outgroup in 1964, this number ballooned to nearly 80% in 2012 (Pew Research Center, 2016a,b). Beyond negative feelings, about 42% of Democrats and Republicans agreed that their outgroup was "not just worse for politics – they are downright evil" (Kalmoe and Mason, 2018 p.17). Furthermore, about 20% of Democrats and 16% of Republicans admitted thinking occasionally that the United States would be better if large numbers of the outgroup died.

People's political views and feelings towards political groups shape how they navigate the world (e.g., hiring choices, Gift and Gift, 2015; requesting wages, McConnell et al., 2018; electoral choices, Graham and Svolik, 2020). Political beliefs also affect issues of health and medicine. One study found that patients' political affiliations influence the advice doctors provide (Hersh and Goldenberg, 2016). Political ideology also significantly impacted many aspects of the COVID-19 pandemic, including vaccine uptake.

1.2. COVID-19 vaccines and political polarization

The COVID-19 pandemic became politicized due to existing political polarization and fueled strong differences in vaccine acceptance. Beginning with the first public health measures to reduce COVID-19 transmission, partisanship significantly determined how likely people were to take the pandemic seriously and modify their behavior (Gadarian, Goodman and Pepinsky, 2020). Decisions regarding masking and social distancing became heavily partisan, with Democrats advocating more precautions than Republicans, including masking and social distancing behaviors (Allcott et al., 2020; Clinton et al., 2021; Pew Research Center, 2020). In a context of growing partisan legislation on childhood immunizations (Estep et al., 2022), it is unsurprising that COVID-19 vaccination measures and requirements were also quickly subsumed by partisan discourse (Dolman et al., 2022; Krupenkin, 2021; Xinyuan, 2021). Messages from political elites can also influence public perception as one study found that vaccine endorsement by Republican elites increased vaccine acceptance among unvaccinated Republicans. Additionally, the unvaccinated Republican participants decreased their vaccine acceptance when they saw messages from Democratic elites endorsing the vaccine (Pink et al., 2021).

After COVID-19 vaccines were developed and tested, evidence of partisan attitudes was visible in the general public as 72% of Democrats, 51% of Independents and 39% of Republicans said they would get (or had already gotten) the COVID-19 vaccine in a February 2021 poll (Monmouth, 2021). Additionally, 42% of Republicans explicitly said they would avoid getting the vaccine as long as they can compared to just 10% of Democrats. Independents often had COVID-19 vaccine attitudes in between Democrats and Republicans. For example, 54% of Independents agreed with vaccine mandates for university students compared to 85% of Democrats and 27% of Republicans (Hamel et al., 2021). Additionally, 18% of Independents wanted to wait for a vaccine before returning to normalcy compared to 30% of Democrats and 7% of Republicans (McCarthy, 2022). KFF Polling's concluded that partisanship was "the strongest single identifying predictor of vaccine uptake" (Kirzinger et al., 2021).

The politicization of vaccines was further exacerbated by political media and public figures. Fox News had more negative news coverage regarding the COVID-19 vaccine compared to other cable news shows and those who watched Fox News also were more likely to have negative views towards the vaccine (Motta and Stecula, 2023). Following conservative public figures on social media predicted lower confidence in the COVID-19 vaccine as well (Rathje et al., 2022). Other research has shown that mere exposure to COVID-19 vaccine misinformation may not have a significant impact on vaccine uptake (de Saint Laurent et al., 2022), which further highlights the importance of partisanship shaping initial attitudes. During the period of January to August 2021, when vaccines first became widely available, Republican counties had consistently lower vaccination rates than Democratic counties (Xe, 2021). There is evidence that the uptake of the influenza vaccine is becoming a partisan issue as well (Leuchter et al., 2022), which could result in more flu infections and deaths over time (Fine et al., 2011).

Given the impact vaccine hesitancy can have on public health, it is important to understand what factors contribute to increased partisanship and how such polarization influences

public health attitudes. Social network composition is one factor that can help explain politicized attitudes toward vaccination. While psychological variables such as higher analytic reasoning (Pennycook and Rand, 2021) and education (Georgiou, Delfabbro & Balzan, 2020) predict less susceptibility to COVID-19 misinformation, other research suggests that identity and identity-based networks may have a larger or an even larger influence on susceptibility to misinformation (Van Bavel et al., 2021; Batailler, 2022). Thus, it is important to understand in greater detail what types of networks influence vaccine attitudes and uptake.

1.3. How network homogeneity influences political polarization and vaccine beliefs

People prefer homogenous social networks (e.g., Christakis and Fowler, 2009; Kramer et al., 2014; McPherson et al., 2001). Both Democrats and Republicans prefer to associate with those who share their politics (Jost et al., 2018) and avoid information that challenges their political identity (Collins et al., 2017; Ditto et al., 2019). For example, 35% of Democrats and 50% of Republicans prefer to live in places with others who share their political beliefs (Pew Research Center, 2014). Greater political homogeneity in the personal networks predicted more extreme political beliefs for both Democrats and Republicans (Facciani and Brashears, 2019). A longitudinal study found that some individuals change their political beliefs to match those in their networks (Lazer et al., 2010). Others may adjust their networks when new social and political challenges arise (Facciani and McKay, 2022). Blanchar and Norris (2021) found that political homogeneity in one's network predicted attitudes toward voter fraud and this association between networks and attitudes grew stronger over time. Finally, researchers have demonstrated positive associations between network homogeneity and stronger political beliefs (Facciani and Brashears, 2019) as well as negative feelings for the outgroup (Parsons, 2015).

Homogeneity among those who provide meaningful social support may have a unique impact on political beliefs. Individuals are motivated to maintain consistency between the values associated with their identities and their actions (Burke and Stets, 2009). These identity-protective actions motivate us to process information in a biased fashion that supports our own political group (Ditto et al., 2019). When individuals surround ourselves with people who share the same identity as them, this may further bolster such identity-supporting actions through a process of mutual identity verification (Stets et al., 2021).

Families and friends transmit vaccine attitudes and behaviors through their relationships, including whether or not to vaccinate (Konstantinou et al., 2021; Sato and Takasaki, 2019; Brunson, 2013). As compared to other network members, such as healthcare providers, politicians, and colleagues, family and friends/peers exerted the greatest influence on vaccination attitudes and uptake (Konstantinou et al., 2021). Interestingly, a survey of parental decisions regarding vaccination for their children found that vaccine-hesitant parents relied more on the opinions of friends, family, doulas, lactation consultants, and midwives compared with vaccine-non hesitant parents who relied more on OB/GYNs and pediatricians (Nowak et al., 2021). Several experimental studies tested if exposing people to the vaccination status of their peers could influence vaccine hesitancy. Some of these studies did find that the knowledge of most of one's peers being vaccinated influenced vaccine

attitudes (Belle and Cantarelli, 2021; Hershey et al., 1994; Palm et al., 2021; Romley et al., 2016), while others did not (Clayton et al., 2021; Lazić et al., 2021; Ryoo and Kim, 2021; Sinclair and Agerström, 2021; Xiao and Borah, 2020). Social influence appears to matter, but the specific type of association and context of exposure are crucial elements as well.

The COVID-19 vaccine also demonstrates a similar pattern of social network influence. A 2021 study by Cordina and colleagues found that the opinions of family, friends, and health professionals had a significant impact on a person's willingness to take the COVID-19 vaccine (Cordina et al., 2021). These authors concluded that positive attitudes toward the COVID-19 vaccine are associated with positive attitudes toward vaccination generally (Cordina et al., 2021). Hao and Shao (2022) found that a greater percentage of COVID-19-vaccinated friends and family predicted a higher likelihood of vaccine uptake. The likelihood of getting vaccinated increases with frequent conversations about vaccines, positive attitudes toward vaccines among those around you, and following peer behavior (Konstantinou et al., 2021). Furthermore, friends and family members may be more likely to dissuade one another from accepting COVID-19 vaccines if their anti-vaccine attitudes are similar (Latkin et al., 2022). In addition, Larkin and colleagues suggest that when people have a negative attitude toward vaccination, they seek out information and others who confirm their viewpoint (Latkin et al., 2022). The homophily of social networks observed by Konstantinou et al. (2021) in their review may confound some of the findings since people tend to surround themselves with like-minded individuals. Furthermore, the majority of studies about the influence of social networks on individuals' decisions about vaccination categorize family and friends together in one group (Konstantinou et al., 2021: Casillas et al., 2011; Fu et al., 2019; Nyhan et al., 2012).

Family and close friends may not always be the center of influence over our beliefs, especially in a complex, highly politicized context like the COVID-19 pandemic. During the COVID-19 pandemic, polarization and politicization of vaccine beliefs were linked to substantial disruptions in friend ties in a national poll (Elizade, 2021). In this context, drawing on the Social Convoy Model offers additional flexibility and nuance when considering how social ties and network characteristics may have differentially affected COVID-19 vaccine attitudes. The Social Convoy Model posits that the value, function, and influence of different social relationships vary not only over the life course, but also across different contexts (Antonucci et al., 2014). Adopting this model, Merz and Huxhold (2010) found that, although both kin and non-kin relationships provided important support for older adults, well-being was negatively associated with low-quality kin relationships but was not negatively associated with any non-kin relationships. Merz and Huxhold conclude that non-kin ties are more likely to provide help entirely voluntarily, which changes how older adults perceive support from these individuals. Additionally, non-kin ties may have an outsized influence on individuals who hold opinions or identities that are different from their families of origin. Broadly, individuals are less likely to bring up particular topics with their networks when they feel it will cause conflict (Cowan and Baldassarri, 2018). Furthermore, individuals from marginalized identity groups, including LGBTQ individuals who are less likely to be supported by family members (Hull and Ortyl, 2019), may also rely more heavily on non-kin friends and others for certain kinds of support, information, and advice. In the context of COVID-19, coworkers and other more peripheral

network members (e.g., service providers, paid help, neighbors, supervisors) may play an outsized role in the provision of vaccine-related information and influence given both the substantial impacts of the COVID-19 pandemic on workplace environment and culture and increased time at home for most Americans. Thus, regarding discussions of COVID-19 vaccines, close and influential people in one's network may be kin, but among those who perceived or anticipated conflict, friends or others may have been more influential. For many, non-kin others who shared some characteristics with the respondent (gender, age, party, occupation, location) may have provided additional sounding boards or sources of influence. Additionally, the well-known influence of social media and news media platforms on COVID-19 related misinformation and beliefs is likely to have contributed to the outsized role that others (e.g., high profile individuals, individuals with extreme opinions) had on vaccine-related beliefs in the context of the pandemic. Improving on prior work in this space, the present study allows for a more granular evaluation of network composition by asking participants to categorize their relationship to social network members so we can analyze if a particular type of relationship has more or less social influence.

1.4. Present study and hypotheses

The above literature finds that political network homogeneity predicts higher polarization and that vaccine beliefs correlate with the beliefs found in our social networks. Given that the COVID-19 vaccine and vaccines, in general, have been politicized, the present study analyzed if political network composition predicts vaccination attitudes and behavior. We evaluated if the network composition of both political affiliations as well as having received the COVID-19 vaccine predicted attitudes toward both the COVID-19 vaccine and vaccines in general. Specifically, we conceptualized vaccine confidence within three domains: the belief that the COVID-19 vaccine is safe, trust in general vaccines, and support of COVID-19 vaccine mandates. We also measured the self-reported behavior of getting the COVID-19 vaccine in addition to one's beliefs towards vaccines. Because Democrats have consistently been in favor of the COVID-19 vaccine and vaccines in general we predict:

H1.—The percentage of Democrats in personal network will positively predict vaccine confidence & likelihood of getting COVID-19 shot

Conversely, we predict that having more Republicans in one's network will reduce the likelihood of getting a vaccine, as well as attitude towards vaccine safety.

H2.—The percentage of Republicans in personal network will negatively predict vaccine confidence & likelihood of getting COVID-19 shot

In addition to political affiliation, we also predict that having a higher amount of people in your network that are vaccinated will predict greater likelihood of getting the vaccine and having more positive attitudes towards vaccines as well.

H3.—The percentage of Covid-19 vaccinated in personal network will positively predict vaccine confidence & likelihood of getting COVID-19 shot

Finally, we were interested in how relationship type could act as a potential moderator for political identity and getting the COVID-19 vaccine. As mentioned above, network studies frequently lump the attitudes of friends and family together when analyzing their impact on vaccine attitudes. This is an exploratory analysis to assess how relationship type intersects with vaccine attitudes and behaviors. We aim to investigate whether partners, kin, friends, or non-kin others differ in their influence towards attitudes towards vaccination. For example, respondents may already have similar politics and vaccination attitudes as their close friends and family, but nonkin others offer a bridge to different political opinions that could influence them suggesting strength in weaker ties.

2. Methods

2.1. Respondents

Participants were recruited from Prolific, which is an online platform designed to recruit research participants in exchange for monetary payment (Palan and Schitter, 2018). We recruited 600 total participants who were separated equally into 200 Republicans, 200 Democrats, and 200 Independents. However, despite recruiting 200 participants who listed themselves as independents on Prolific, we found that 24 independents identified as Republicans and 60 identified as Democrats in our survey so we used their survey results as their political categorization. It is possible their politics shifted between when they signed up for Prolific and when they took our survey. Thus, our final political sample had a total of 260 Democrats, 224 Republicans, and 116 Independents. Our study focused on Republicans and Democrats as these groups are polarized against each other, but we included independents in some analyses for comparison. As noted above, independents generally have COVID-19 attitudes between Republicans and Democrats, making them an appropriate comparison group. The average participant age was 39.9 years old (SD = 14.9), 54% had a college degree or higher, 49% were male, and 75% were White. Data were collected in March of 2022. As of March 2022, the COVID-19 vaccine had been widely available in the United States for about one year. The Senate voted on vaccine mandates for healthcare workers in March of 2022 (Cochrane, 2022) and the United States just had its worst surge of COVID-19 cases during the winter, which overwhelmed hospitals and forced some schools to go back to remote learning (Astor et al., 2022). Thus, COVID-19 and vaccinations were still quite topical during data collection.

After agreeing to participate in our study, participants were paid $2.37 to complete our survey (about $12 per hour). To collect ego network data, participants listed up to six people they discussed “important matters” with. The average number of names listed was 4.6 (SD = 1.6) people. After listing these names, the participant was asked about the political affiliation of each associate (Democrat, Republican, Independent, Other). This allowed for a calculation of political homogeneity in one’s network. Participants were also asked if each name given received at least one shot of a COVID-19 vaccine. We then calculated vaccine homogeneity in a respondent’s network by dividing the total number of vaccinated individuals in one’s network by the total number of individuals listed in it. Even if participants have some inaccuracy regarding their network’s attitudes, Lerman et al. (2016) found that perceived network homogeneity can still influence judgments and

behaviors. Participants were also asked to list the type of relationship they had with each name given (parent, sibling, spouse/romantic partner, child, other family members, boss/supervisor, employee, coworker, friend, neighbor, ex-spouse, other). These relationship types were then categorized into partner, kin, friend, or non-kin other.

Next participants answered questions about the COVID-19 vaccine. First, we asked if they received a COVID-19 vaccine (at least 1 shot and no booster, 2 shots and booster, no shots at all). Then we asked seven questions about their beliefs regarding the safety of the COVID-19 vaccine (Cronbach's $\alpha = 0.922$) as well as six questions asking about their support for COVID-19 vaccine mandates (Cronbach's $\alpha = 0.971$). These questions were adopted from a 2020 Pew Research Survey (see Appendix A) Then participants shared their responses to the 12-item Vaccination Attitudes Examination (VAX) scale (Cronbach's $\alpha = 0.947$) that measures attitudes towards general vaccine safety and effectiveness (Martin and Petrie, 2017). The VAX scale consisted of four subscales (trust/mistrust of vaccine benefit, worries over unforeseen future effects, concerns about commercial profiteering, & preference for natural immunity). Overall, the VAX scale measures general trust and confidence in vaccines and we included the entire scale in our analyses. Additionally, participants answered questions measuring their political ideology (how socially & fiscally liberal or conservative they were on a 1–7 scale). We also included measures of demographics (age, race, sex, education, political affiliation) as well as an attention check asking participants to calculate 10% of 100 (see Appendix B for correlations, means, and SDs of main variables). Twelve participants answered the attention check incorrectly and were excluded from our analyses. Finally, participants were debriefed and thanked for their time.

2.1.1. Analytic procedure

We conducted a series of logistic and OLS regressions predicting scores on the VAX scale, attitudes towards COVID-19 safety, attitudes towards COVID-19 mandates, and whether or not the participant received at least one shot of the COVID-19 vaccine. We controlled for political identity, age, sex, education, and race in all models. Models and figures presented below were generated by Stata 17.0 MP. The datasets and code to reproduce the main and exploratory results of the study are available on the Open Science Framework:https://osf.io/tujxz/?view_only=acb61505ff3e4a449a0595c56d50667e.https://osf.io/tujxz/

To test Hypothesis 1, we regressed the proportion of Democrats in one's network on each outcome. If the proportion of Democrats in one's network positively predicts scores for a dependent variable, this would provide evidence in support of H1: The percentage of Democrats in personal network will positively predict vaccine confidence & likelihood of getting COVID-19 shot. To test Hypothesis 2, we regressed the proportion of Republicans in one's network on each outcome. If the proportion of Republicans in one's network negatively predicts scores for a dependent variable, this would provide evidence in support of H2: The percentage of Republicans in personal network will negatively predict vaccine confidence & likelihood of getting COVID-19 shot. These two hypotheses are related but measure separate concepts since individuals can have proportions of Democrats and Republicans in their networks that do not total 1 due to the possibility of Independent

and “don’t know” responses for a given alter. If the proportion of COVID-19-vaccinated individuals in one’s network positively predicts scores for a dependent variable, this would provide evidence in support of H3: The percentage of individuals who have been vaccinated for Covid-19 in one’s personal network will positively predict confidence & likelihood of respondent receiving COVID-19 shot.

Finally, we conducted an exploratory analysis examining whether alter relationship (partner [reference], kin, friend, non-kin other) moderates the effects of alter party identity and alter vaccination status on ego-level outcomes. We used a multi-level model with alters nested in respondents predicting ego vaccine attitudes and uptake as a function of ego characteristics, network characteristics (ego-level), and alter characteristics (relationship to ego, party, and vaccination status) to test this hypothesis. This analysis allows us to determine if any relationship type is especially likely to predict vaccination attitudes in combination with political identity and vaccine status. Our analyses test whether alter relationship type interacts with alter political identity and alter vaccination status. We conduct tests of joint significance for all interaction terms.

2.2. Post hoc statistical power analysis

We used GPower software (Faul et al., 2009) to calculate the post hoc power for the regressions used in our three directional hypotheses (we excluded H4 since it was exploratory). We used a sample size of 588 (removing the participants who failed the attention check), 8 predictor variables, and an alpha level of $p < .05$ in our analysis. We used Cohen’s guidelines to describe the magnitude of the effect sizes (Cohen, 1988), which can be interpreted as small ($f^2 = 0.02$), medium ($f^2 = 0.15$) or large ($f^2 = 0.35$), with statistical power greater than or equal to 0.80 being preferrable. Our post hoc analyses confirmed that the statistical power for our study was over 0.99 for detecting a medium and large effect and 0.67 for detecting small effects.

3. Results

First, we evaluated descriptive statistics of our respondent’s vaccination status and network composition. Consistent with national polling at the time of data collection (March 2022), Democrats were far more likely to be vaccinated with 95% of Democrats receiving at least one COVID-19 shot compared to just 72% of Independents and 63% of Republicans in our sample. Next, we measured political homogeneity and vaccine homogeneity for each political group (see Table 1). As expected, Democrats and Republicans were much more likely to have politically similar individuals in their networks. Additionally, Democrats were more likely to have alters in their networks who had at least one shot of the COVID-19 vaccine compared to Republicans. Democrat participants were unsure about the vaccination status of about 5% of their alters with Republicans reporting a similar with just 7% of their alters having an unknown vaccination status. These descriptive results confirm that there are significant differences between the vaccination behaviors of Democrats and Republicans and that both groups have quite homogeneous networks as expected. Next, we will analyze if these homogeneous networks have an independent effect on predicting vaccination attitudes.

3.1. Network homogeneity and attitudes towards vaccination

We estimated a series of models to evaluate if having more Democrats in one's network increases the likelihood of having positive attitudes towards COVID-19 and vaccination more broadly. Table 2 shows that identifying as a Democrat predicts greater belief in the safety of the COVID-19 vaccine ($p < .001$), the likelihood of getting the COVID-19 vaccine ($p < .001$), support of COVID-19 vaccine mandates ($p < .001$), and less skepticism towards vaccines in general ($p < .001$). Identifying as a Republican predicted reduced belief in the safety of the COVID-19 vaccine ($p < .001$), lower likelihood of getting the COVID-19 vaccine ($p < .05$), lower support of COVID-19 vaccine mandates ($p < .001$), and more skepticism towards vaccines in general ($p < .001$).

Regardless of one's own party identification, a greater proportion of Democrats in one's network was positively associated with greater belief in the safety of a COVID-19 vaccine ($p < .01$), the likelihood of the respondent receiving the COVID-19 vaccine ($p < .01$), support of COVID-19 vaccine mandates ($p < .01$) and more positive general vaccine attitudes on the VAX scale ($p < .05$). Fig. 1 illustrates how the likelihood of receiving a COVID-19 vaccine increases as an individual has more Democrats in their network. The proportion of Democrats in one's network positively influenced attitudes towards the COVID-19 vaccine and general vaccines, which supports H1: The percentage of Democrats in one's personal network will positively predict vaccine confidence & likelihood of getting COVID-19 shot.

Next, we estimate a parallel set of regression analyses to determine if having more Republicans in one's network would predict more negative attitudes towards COVID-19 and general vaccination (see Table 3). This model reveals similar partisan effects for our vaccination-dependent variables. Identifying as a Democrat predicts greater belief in the safety of the COVID-19 vaccine ($p < .001$), the likelihood of getting the COVID-19 vaccine ($p < .001$), support of COVID-19 vaccine mandates ($p < .001$), and less skepticism towards vaccines in general ($p < .001$). Identifying as a Republican predicted reduced belief in the safety of the COVID-19 vaccine ($p < .01$), lower support of COVID-19 vaccine mandates ($p < .01$), and more skepticism towards vaccines in general ($p < .01$). The coefficient for Republican party identification remains negative but no longer significantly predicts a lower likelihood of vaccination.

After controlling for other demographic factors, a greater proportion of Republicans in one's network was negatively associated with greater belief in the safety of the COVID-19 vaccine ($p < .001$), support of COVID-19 vaccine mandates ($p < .001$), and less skepticism towards vaccines in general ($p < .01$). A greater proportion of Republicans in one's network did not predict a lower likelihood of getting the vaccine, but did trend in the predicted direction (see Fig. 2). This null finding suggests that Republican identity-based network effects may matter more for reported beliefs than behavior. Additionally, a greater proportion of the Democrat network composition did not predict general vaccine attitudes while a greater proportion of the Republican network composition did predict general vaccine attitudes. These findings reveal some nuance between the partisan influence towards vaccines. In summary, because a greater proportion of Republicans in one's network only positively influenced attitudes towards the COVID-19 vaccine and general vaccines and not vaccine uptake, this provides

partial support for H2: The percentage of Republicans in one's personal network will negatively predict vaccine confidence & likelihood of getting COVID-19 shot.

We also evaluated if perceiving more alters as vaccinated for COVID-19 in one's network would predict more positive attitudes towards COVID-19 and general vaccination (see Table 4). A greater proportion of COVID-19 vaccinated alters in one's network was positively associated with greater belief in the safety of the COVID-19 vaccine ($p < .001$), the likelihood of having received the vaccine ($p < .001$), support of COVID- 19 vaccine mandates ($p < .001$), and less skepticism towards vaccines in general ($p < .001$). The proportion of COVID-19 vaccinated alters predicted results for each of our vaccination outcomes and provides full support for H3: The percentage of Covid-19 vaccinated in one's personal network will positively predict vaccine confidence & likelihood of getting COVID-19 shot.

3.2. Exploratory analysis on relationship type

Finally, we examine whether alter relationship type moderates the effect of political identity and vaccine status when looking at ego vaccine attitudes using a multilevel regression model predicting ego COVID-19 vaccine safety beliefs as a function of ego characteristics, network characteristics, and alter characteristics. We find evidence of a significant 3-way interaction of alter political identity X vaccination status X relationship type (see Appendix C for full models). Alter party identity has an effect on vaccine safety belief when the alter is also unvaccinated. We observe significantly lower COVID-19 vaccine safety attitudes when non-democrat alters are also unvaccinated across all relationship types (see Fig. 3). However, non-kin others who are both unvaccinated and non-democrat are especially likely to predict lower COVID-19 vaccine safety attitudes ($p < .01$). Among respondents with Democratic alters, alter vaccination status did not have strong effects on respondent COVID-19 vaccine safety beliefs.

We observe similar results for COVID-19 mandate beliefs (see Fig. 4). Alter party identity has an effect on ego vaccine mandate beliefs when the alter is also unvaccinated. Having nonkin others who are both non-democrat and unvaccinated in one's network predicts lower COVID-19 vaccine mandate attitudes among respondents ($p < .05$).

Effects of alter party identity and vaccination status matter less for vaccine uptake. We do not find that having more nonkin others who are both non-democrat and unvaccinated significantly predicts a lower likelihood of getting the COVID-19 vaccine (see Fig. 5).

When analyzing general vaccine attitudes, we only observe clear effects for partners (see Fig. 6). If participants have a partner who is a Republican and who is not vaccinated, this increases the respondent's general anti-vaccine attitudes compared to those with a partner who is Republican and vaccinated ($p <.01$). The partner who is Republican and not vaccinated also contributes more to a respondent's general anti- vaccine beliefs compared to those with a partner who is a Democrat and not vaccinated ($p < .01$). Overall, we observe significant differences across relationship types in the effect of alter party identification and alter vaccination status on COVID-19 vaccine and general vaccine beliefs.

4. Discussion

The present study investigated the relationship between political and vaccine homogeneity in personal networks and vaccine confidence. Using a sample of Democrats, Republicans, and Independents, we predicted that a greater proportion of Democrats and vaccinated individuals in one's network would increase vaccine confidence. We also predicted that a greater proportion of Republicans in one's network would decrease vaccine confidence. We also evaluated whether the relationship of alters would moderate these effects.

We found that a higher proportion of Democrats in one's network did predict a higher likelihood of getting the COVID-19 shot, more positive attitudes towards the COVID-19 shot, more positive attitudes towards COVID-19 vaccine mandates and higher general vaccine confidence. Because Democrats in one's network predicted higher confidence in both COVID-19 and general vaccines, we only find full support for our first hypothesis.

Moving on to Republicans, we found that a higher proportion of Republicans in one's network did predict more negative attitudes towards the COVID-19 shot, more negative attitudes towards COVID-19 vaccine mandates, and more negative attitudes towards vaccines in general. A higher proportion of Republicans in one's network did not predict a lower likelihood of getting the COVID-19 vaccine. Because the proportion of Republicans in one's network did not predict vaccine behaviors, we only find partial support for our second hypothesis.

Because Republican homogeneity only influenced attitudes, it is possible that network effects may matter more for reported beliefs than behavior. Importantly, over 60% of our Republican sample had already received the COVID-19 vaccine. The disconnect between beliefs and action has been well-documented in sociology (Jerlomack & Khan 2014; Swindler, 1986). It is possible that many Republicans still got the vaccine to be able to live and work without restriction despite their negative feelings about it. Indeed, the link between exposure to misinformation, attitudes, and health behaviors is quite complex with many moderating factors involved (Wu et al., 2022). Psychological interventions aimed at increasing vaccine confidence had historically yielded small effects for changing vaccine attitudes and even smaller effects for increasing vaccine uptake (Brewer et al., 2017). Thus, policies aimed at improving access to vaccines may be the most effective strategy for increasing overall vaccination rates.

Despite potential mismatches between beliefs and behavior, the partisan divide towards vaccines remains clear and may grow in the future. We found both Democrat and Republican network composition predict attitudes towards general vaccines, not just COVID-19 vaccines. These results are consistent with other research (Estep et al., 2022) that shows anti-vaccination attitudes are a growing part of the Republican party platform. This creates a significant challenge for public health because the COVID-19 pandemic resulted in greater deaths among Republicans (Wallace, Goldsmith-Pinkham, Schwartz, 2022) due to their greater vaccine hesitancy. A future pandemic or public health crisis may result in similar unnecessary deaths due to partisanship if vaccination continues to be politicized. Reducing political polarization may help increase vaccine confidence.

Social scientists have found successful interventions for reducing animus of political opponents through moderated group discussions, where Democrats and Republicans are guided towards civil dialogue (Levendusky and Stecula, 2021). These types of interventions are difficult to scale so other successful and scalable strategies, such as showing videos of Democrats and Republicans working together, may have more widespread promise (Sidik, 2023). Political leaders working together and calming their polarizing rhetoric will set a strong example for depolarization as the cues from political elites do influence their constituent's attitudes (Druckman et al., 2021). Reducing political polarization will require various interventions at both the micro and macro levels.

While political homogeneity was a significant predictor of vaccine confidence, COVID-19-vaccinated individuals in one's network may be an even stronger predictor. We found that a higher proportion of COVID-19-vaccinated individuals did predict more positive attitudes towards the COVID-19 shot, more positive attitudes towards COVID-19 vaccine mandates, more positive attitudes towards vaccines in general, and a higher likelihood of getting the COVID-19 vaccine. This provides full support for our third hypothesis and highlights the importance of having connections with vaccinated alters.

Education was not part of our hypotheses, but higher education regularly predicted higher vaccine confidence and vaccine uptake as a covariate in our models. This is consistent with other research showing a positive relationship between vaccine confidence and education (Hudson and Montelpare, 2021). Education may also serve as a proxy for socioeconomic status as higher socioeconomic status also predicted a greater likelihood of getting the COVID-19 vaccine, which may be explained by having greater access to healthcare (Fiscella and Williams, 2004). Overall, education is an important variable to consider when evaluating vaccine attitudes and largely remained a significant predictor in our analyses that also included robust effects for partisanship.

Finally, we wanted to explore how the relationship type of the alter could influence the political and vaccine status of their networks. We observe significantly lower COVID-19 vaccine safety attitudes when non-Democrat alters are also non-vaccinated. When looking at relationship type, we see that having more non-kin others who are unvaccinated and non-Democrat are especially likely to predict lower COVID-19 vaccine safety and COVID-19 mandate attitudes. When looking at Democratic alters, whether or not they were vaccinated or unvaccinated did not appear to have a strong effect on COVID-19 vaccine safety beliefs of the ego. For self-reported vaccination behaviors, we see that relationship type has less of an impact than COVID-19 vaccine attitudes. When looking at general vaccine attitudes, we see that only the partner matters as a moderator of relationship type. Specifically, if participants have a partner who is a Republican and who is not vaccinated, then that person increases the general anti-vaccine attitudes compared to others with a partner who is also Republican but is vaccinated. The partner who is Republican and not vaccinated also contributes more to general anti- vaccine beliefs compared to others with a partner who is not vaccinated but is a Democrat. Thus, because non-kin others yielded a significant result in this interaction, our exploratory analysis was successful and warrants further study. In addition to our findings of homophily and vaccine attitudes, we find that weaker ties (such as unvaccinated co- workers or online associates) may be a significant social group for forming

vaccine hesitancy. Our findings fit within the nuanced social network influence approach of The Social Convoy model (Antonucci et al., 2014) where non-kin others may have different personal or situational relevance to the question of whether a person thinks they should get vaccinated or not. An individual may have already accepted that they have opposing views with certain family members and avoid political discussion, which reduces the impact that family member has on their beliefs. However, a more distant connection, such as an online acquaintance that also has legitimacy and trust regarding their political viewpoints, may have more of an impact on that same individual's political beliefs. Research has shown that having online connections can provide a rich sense of community (Haythornthwaite, 2007) and is even linked to more positive well-being (Gilmour et al., 2020).

5. Limitations

This study collected its data from the online platform Prolific, which does cause issues with generalizability as the sample was gathered only from people who use this specific digital platform. While data collected from an online platform can have greater diversity in age and geographic region than datasets using college undergraduates, it is still not representative of the average US adult. Therefore, using a larger, more representative dataset would greatly assist comparisons among studies. Furthermore, because of the present study's small sample size, it was not possible to conduct a meaningful statistical analysis of demographic differences (e.g. race, gender, age, or education) or relationship role differences (e.g., neighbor versus coworker). Additionally, the interaction results in our exploratory analyses lack robustness and would benefit from replication in a subsequent study. Our power analyses revealed we were also slightly underpowered for detecting small effects; however, the average effect size we observed was consistently in the medium to large range.

Another major limitation of this study is that it cannot establish causality. While these results show a clear association between network homogeneity and political polarization, it is unclear if feelings toward political groups impact who we associate with or if our associations impact our feelings toward these groups. Future research could employ an experimental and/or longitudinal design to determine causality (see Blanchar and Norris, 2021; Minozzi et al., 2020). Finally, alter political affiliation is based on the participant's account. Individuals who like their alter may assume their political affiliation is similar to their own, but there may be more disagreement than they realize (Goel et al., 2010). However, perceived network homogeneity can still influence judgments and behaviors (Lerman et al., 2016). Collecting data from each alter would be more time intensive but would also provide a more robust opportunity for network analysis. Finally, our participants who identified as independent were only included as a comparison within several of our analyses. A future study could investigate how network composition influences independent and/or politically unaffiliated individuals.

5.1. Future directions

Beyond collecting a larger sample and conducting experimental and longitudinal designs, this study offers several promising avenues for future research. Future research can

determine more exact pathways between relationship type, political identity, and vaccine status, but we showcase that increasing the granularity to the type of relationship is a worthwhile endeavor. Additionally, we did not collect data on alter demographics so a future study could determine how race, gender, education, and age may also moderate network effects on vaccination attitudes. One possible study could collect ego network data using the “important matters” item, political discussion item, as well as other items among one larger sample to directly test how each ego network measure produces different results. The present study suggests that the “important matters” question collects ego network data of associates who the respondent is close enough with to discuss politics with. These discussions appear to either embolden polarization if their network is homogeneous or they weaken polarization if their network is heterogeneous. While mutual identity verification may explain this result (Stets et al., 2021), further work could analyze the identity verification process more directly. The present study demonstrated that nonkin others may be particularly relevant for vaccination attitudes, but further work will need to confirm this exploratory result. Additionally, a future study could measure unique characteristics of those labeled non-kin others and compare their level of emotional closeness to other network ties. Finally, future work can also investigate how other variables such as social media influence, news influence, and other personality and cognitive measures interact with the relationship between network homogeneity and polarization.

6. Conclusion

The present study demonstrated that ego network composition predicts vaccine attitudes and vaccination behaviors among a sample of Republicans and Democrats. Having a higher proportion of Democrats and COVID-19-vaccinated individuals in one’s network is positively associated with higher levels of vaccine confidence. Conversely, having a higher proportion of Republicans in one’s network is positively associated with lower levels of vaccine confidence. Relationship type also had a significant moderating effect on these results as unvaccinated nonkin others in one’s network – perhaps as coworkers – may especially be likely to influence vaccine attitudes. Political polarization continues to grow in the United States, and it is both influencing our susceptibility to misinformation (Van Bavel et al., 2021) and even disagreement among partisans on what constitutes truth (Rauch, 2021). Given these serious consequences, it will be crucial for social scientists to better understand how social factors such as network composition influence polarization and their relationship with public health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability

Data has been uploaded on this website and will be uploaded on OSF and we included a link in our methods section.

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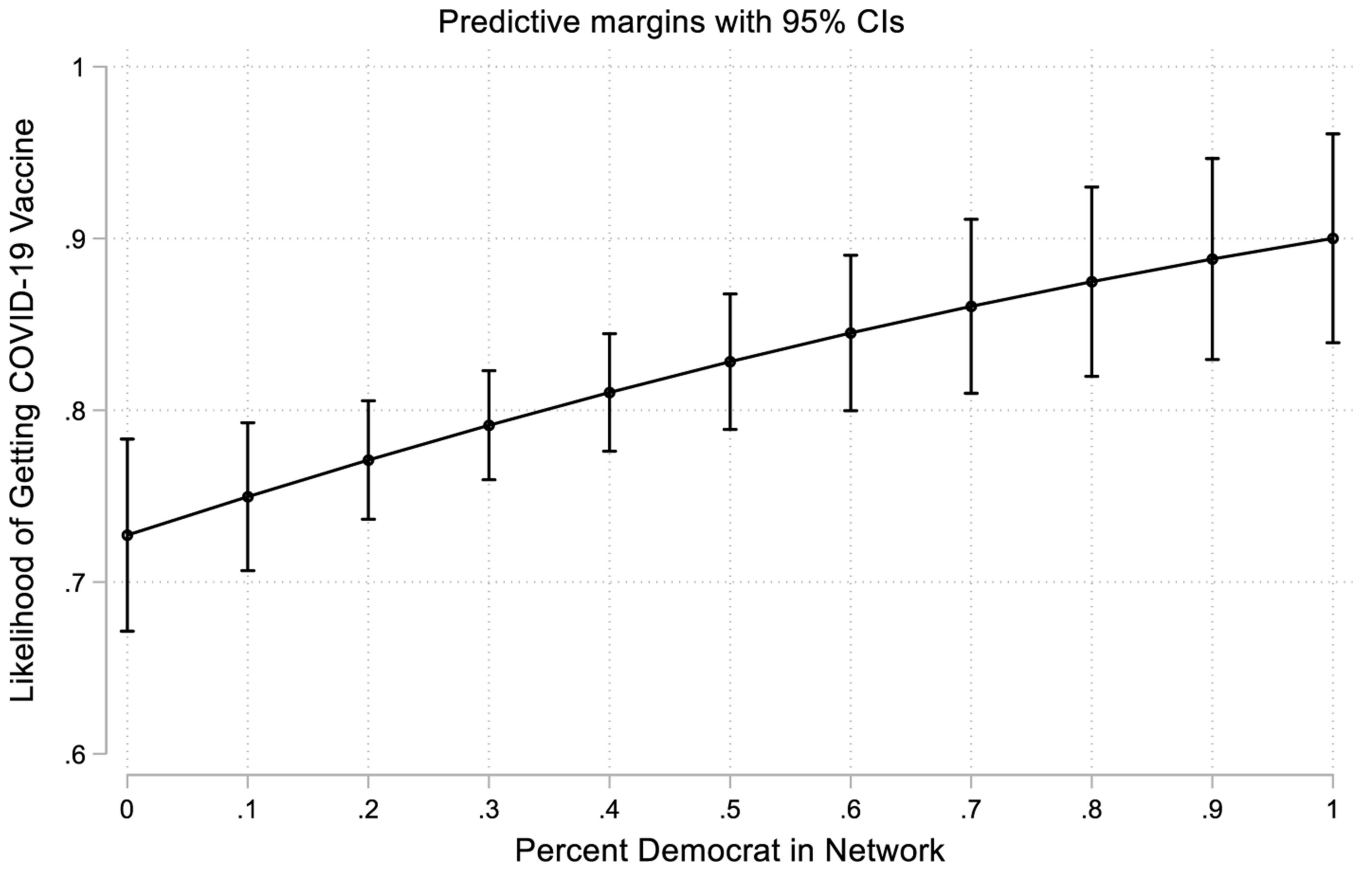

Fig. 1.
Likelihood of getting COVID-19 vaccine rises with proportion of Democrat alters.

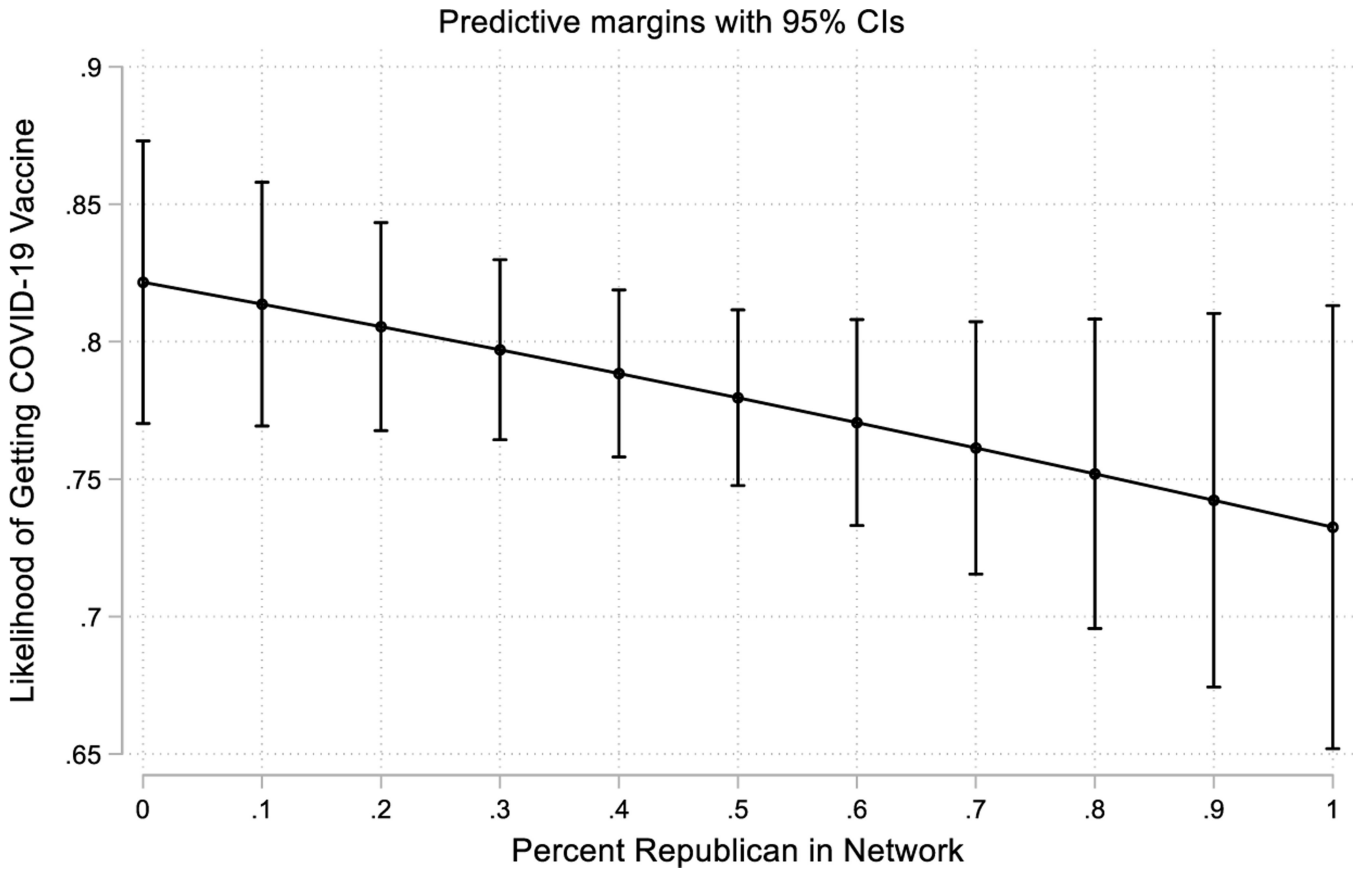

Fig. 2.

Likelihood of getting COVID-19 vaccine decreases with proportion of Republican alters

Note: The relationship between getting COVID-19 vaccine and proportion of Republican alters was not statistically significant.

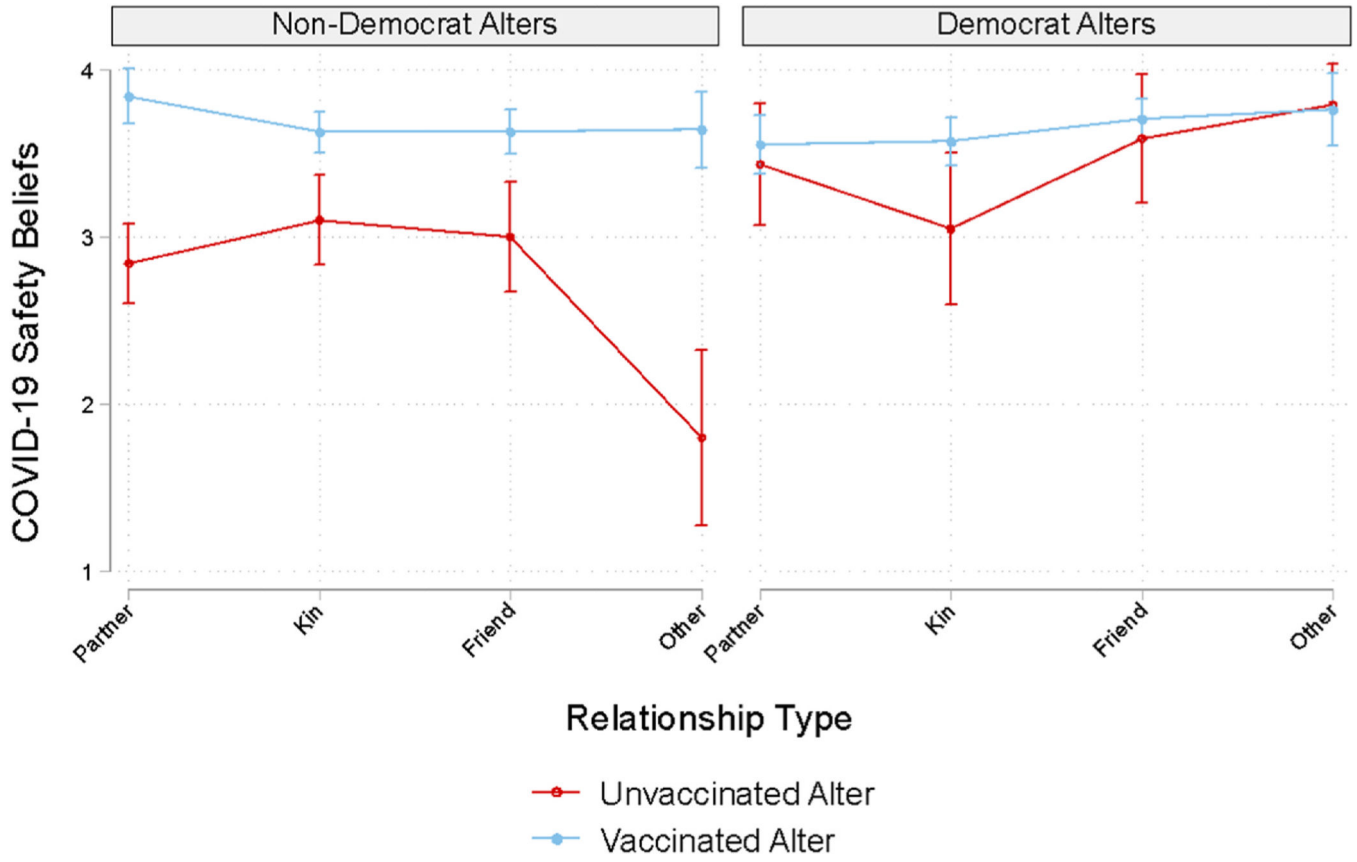

Fig. 3.

Three-way Interaction (relationship, political identity, vaccine status) from COVID-19 Vaccine Safety Beliefs (Predictive Margins 95% CIs).

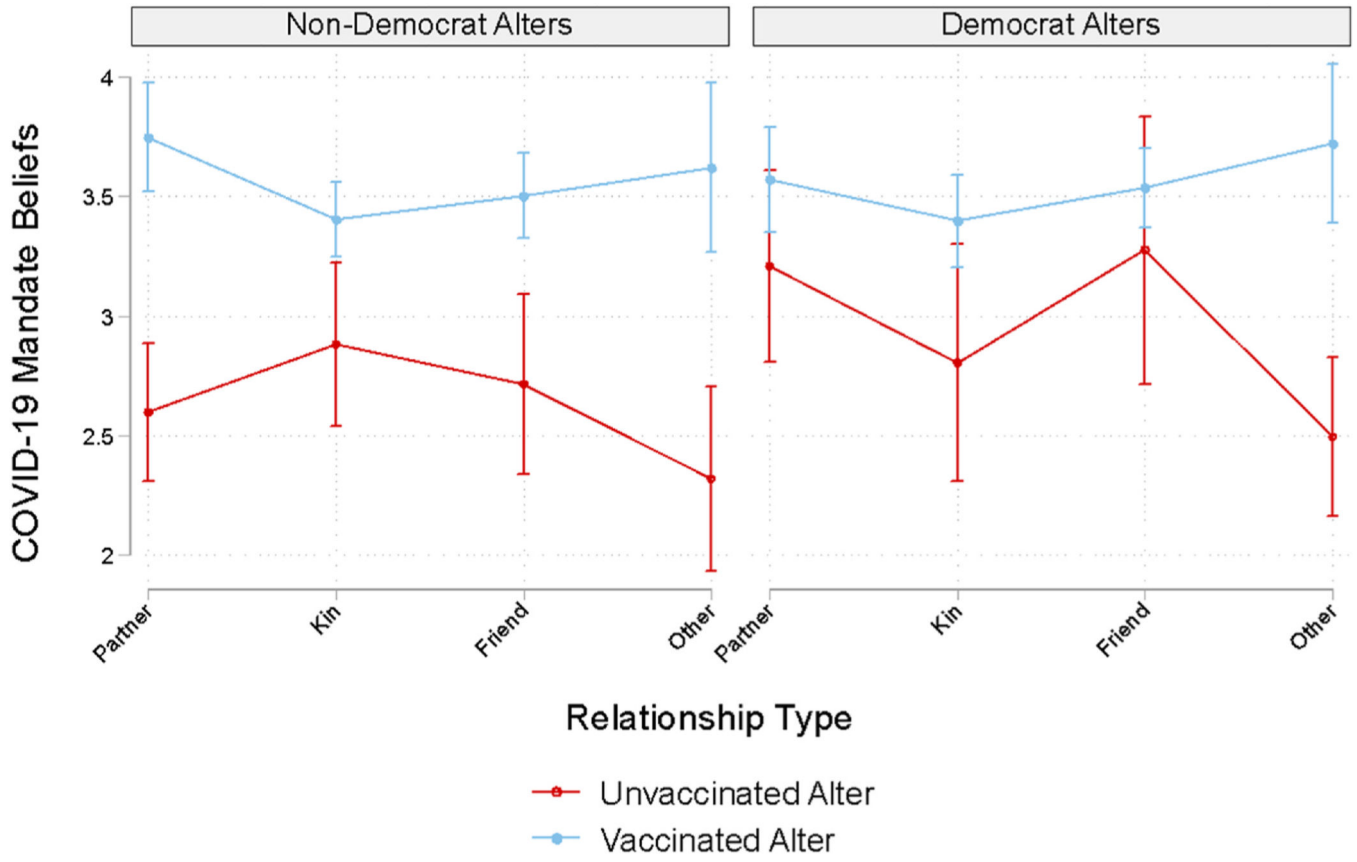

Fig. 4.

Three-way Interaction (relationship, political identity, vaccine status) from COVID-19 Mandate Beliefs (Predictive Margins 95% CIs).

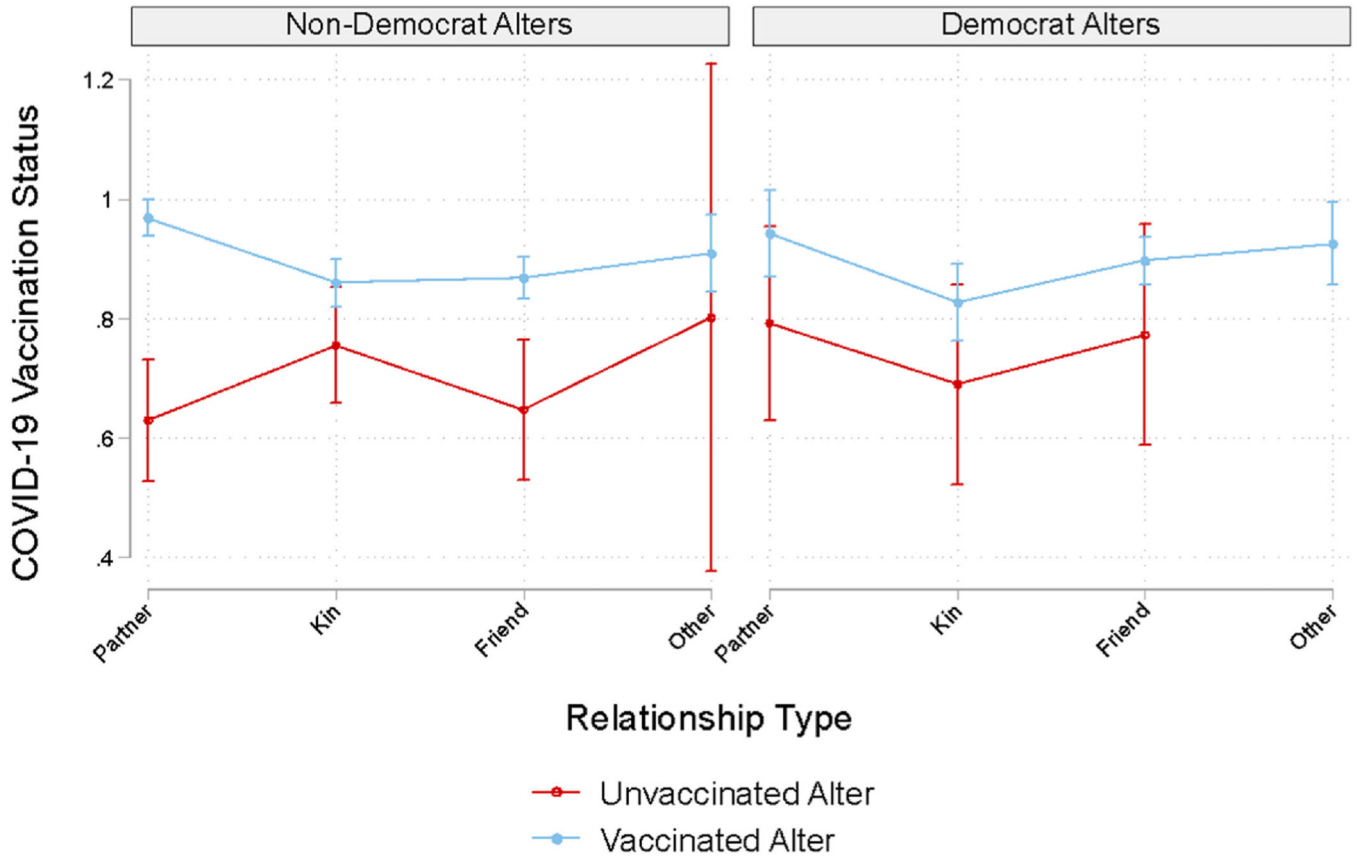

Fig. 5.

Three-way Interaction (relationship, political identity, vaccine status) from COVID-19 Vaccine Status (Predictive Margins 95% CIs).

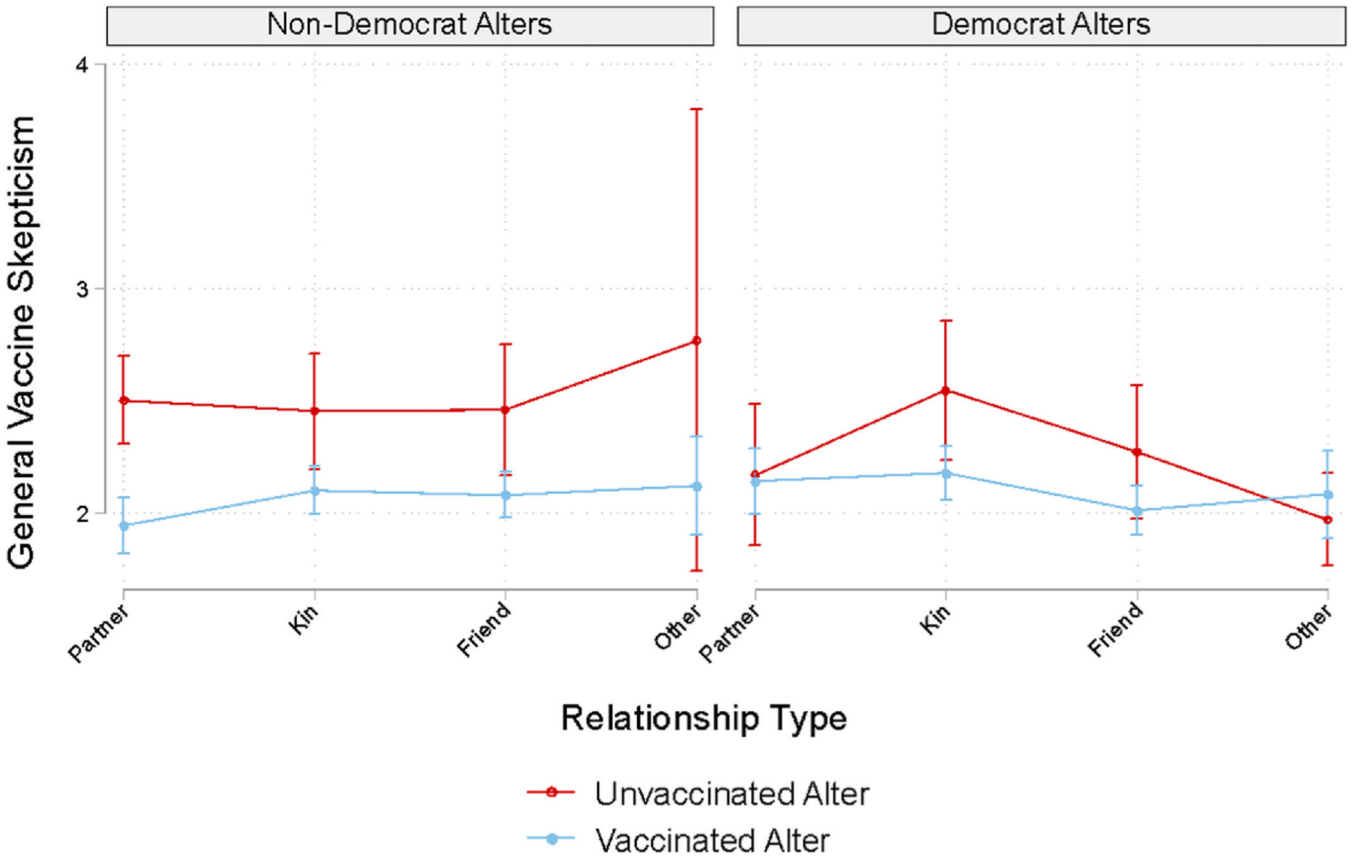

Fig. 6.

Three-way Interaction (relationship, political identity, vaccine status) from General Vaccine Skepticism (Predictive Margins 95% CIs).

Table 1

Network composition by political identity and Covid-19 vaccination status.

	Democrat Respondent (N = 256)	Republican Respondent (N = 220)
Democrat Alters	67%	19%
Republican Alters	13%	62%
Independent/Other Alters	20%	19%
COVID-19 Vaccinated Alters	87%	66%
COVID-19 Nonvaccincated Alters	7%	27%
Unsure about alter's COVID-19 vaccination status	5%	7%

Table 2

Higher percent of Democrat alters predicts more positive COVID-19 attitudes & vaccination likelihood.

	C-19 Safety	C-19 Vaccine	C-19 Mandate	General Anti-Vaccine
Number of Democrat Alters	0.428***	1.509***	0.566***	−0.270**
	(0.151)	(0.486)	(0.189)	(0.134)
Network Size	−0.0310	−0.144*	−0.0481	0.0260
	(0.0260)	(0.0768)	(0.0325)	(0.0231)
Age	0.00499*	0.0196**	0.00955***	0.00113
	(0.00287)	(0.00825)	(0.00359)	(0.00255)
Male	0.121	0.00960	0.0165	−0.0716
	(0.0821)	(0.233)	(0.103)	(0.0729)
College	0.273***	0.910***	0.136	−0.260***
	(0.0840)	(0.239)	(0.105)	(0.0746)
Nonwhite	0.0355	0.310	0.347***	0.0571
	(0.0977)	(0.296)	(0.122)	(0.0867)
Democrat	0.774***	1.558***	0.864***	−0.533***
	(0.124)	(0.409)	(0.155)	(0.110)
Republican	−0.604***	−0.560**	−0.782***	0.459***
	(0.117)	(0.279)	(0.146)	(0.104)
Constant	2.848***	0.106	2.583***	2.587***
	(0.206)	(0.565)	(0.258)	(0.183)
Observations	588	588	588	588
R-squared	0.372		0.358	0.282

Standard errors in parentheses

*** p < .01

** p < .05

* p < .1.

Table 3

Higher percent of Republican alters predicts more negative COVID-19 attitudes & vaccination likelihood.

	C-19 Safety	C-19 Vaccine	C-19 Mandate	General Anti-Vaccine
Number of Republican Alters	−0.528***	−0.642	−0.836***	0.372***
	(0.162)	(0.418)	(0.202)	(0.144)
Network Size	−0.0300	−0.135*	−0.0456	0.0251
	(0.0260)	(0.0757)	(0.0323)	(0.0231)
Age	0.00545*	0.0196**	0.0103***	0.000804
	(0.00287)	(0.00821)	(0.00357)	(0.00255)
Male	0.102	0.00688	−0.0128	−0.0584
	(0.0821)	(0.232)	(0.102)	(0.0728)
College	0.316***	0.999***	0.195*	−0.287***
	(0.0831)	(0.239)	(0.103)	(0.0738)
Nonwhite	0.0437	0.368	0.351***	0.0538
	(0.0970)	(0.291)	(0.121)	(0.0861)
Democrat	0.900***	2.027***	1.025***	−0.610***
	(0.112)	(0.382)	(0.139)	(0.0995)
Republican	−0.421***	−0.402	−0.479***	0.326***
	(0.136)	(0.327)	(0.169)	(0.120)
Constant	3.034***	0.524	2.846***	2.465***
	(0.202)	(0.553)	(0.251)	(0.179)
Observations	588	588	588	588
R-squared	0.375		0.367	0.285

Standard errors in parentheses

*** p < .01

** p < .05

* p < .1.

Table 4

Higher percent of COVID-19 vaccinated alters predicts more positive COVID-19 attitudes & vaccination likelihood.

	C-19 Safety	C-19 Vaccine	C-19 Mandate	General Anti-Vaccine
Number of COVID-19 Alters	1.660***	4.934***	1.776***	−1.197***
	(0.129)	(0.496)	(0.168)	(0.120)
Network Size	−0.000574	−0.0810	−0.0164	0.00377
	(0.0233)	(0.0952)	(0.0302)	(0.0215)
Age	0.00256	0.0151	0.00693**	0.00288
	(0.00256)	(0.0100)	(0.00332)	(0.00237)
Male	0.124*	0.0575	0.0190	−0.0741
	(0.0729)	(0.283)	(0.0947)	(0.0675)
College	0.190**	0.861***	0.0548	−0.197***
	(0.0745)	(0.290)	(0.0968)	(0.0690)
Nonwhite	−0.0432	0.0431	0.271**	0.117
	(0.0866)	(0.349)	(0.112)	(0.0802)
Democrat	0.663***	1.628***	0.783***	−0.439***
	(0.102)	(0.442)	(0.132)	(0.0941)
Republican	−0.556***	−0.556*	−0.743***	0.419***
	(0.103)	(0.335)	(0.134)	(0.0953)
Constant	1.812***	−2.723***	1.507***	3.345***
	(0.200)	(0.769)	(0.260)	(0.186)
Observations	588	588	588	588
R-squared	0.504		0.454	0.383

Standard errors in parentheses

*** p < .01

** p < .05

* p < .1.