The Social Correlates of Mask Wearing as a COVID-19 Mitigation Strategy

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ABSTRACT

As medical science worked to understand how the coronavirus is transmitted and how it can be controlled, public health professionals have been faced with the challenge of translating medical science recommendations into actions that support community health. These actions must not only be effective, they must be adopted by individuals within the community. During the coronavirus pandemic, most people appeared to comply with recommended guidelines for wearing face masks when outside the home. On the other hand, a significant fraction of the population has consistently not worn masks over the course of the pandemic. The same can be said for whether or not an individual chooses to be vaccinated against COVID-19. This paper explores the factors involved in an individual's decision to wear a mask, looking also at the relationships among a wider range of actions recommended as part of the CDC's COVID-19 public health strategy. Using national panel data collected beginning in March 2020, we analyze the interaction among self-reported measures of adherence to public health recommendations, individual perceptions of the effectiveness of mask wearing as a mitigation strategy, and indicators of individual attitudes toward political aspects of coronavirus mitigation. Results from two distinct analytic methods suggest that compliance with protective measures is associated with the belief that the coronavirus presents a real threat to the individual, that the recommended actions are effective at limiting the spread of the virus, and that there is nothing in the social context that discourages the individual from following the guidelines.

INTRODUCTION

From the start of the coronavirus pandemic, medical science has been working to understand how the virus is transmitted and how it can be controlled. At the same time, the public health community faced the challenge of recommending actions to limit its spread that are both effective and will be accepted by individuals and communities (Brooks and Butler 2021; CDC 2020b). As scientific understanding evolved over the course of the pandemic, so did the recommended mitigation strategies, including complete isolation, avoiding those known to be sick, disinfecting surfaces, avoiding crowded public settings, wearing masks when public situations cannot be avoided, and frequent hand washing and sanitizing (Honein et al. 2020).

Strategies like hand washing and surface disinfection are intended to kill the virus before it can be transmitted, and are most often accomplished in private, out of the public eye. Other approaches create barriers between individuals in order to limit mostly airborne transmission. These may include creating physical barriers (e.g., face coverings, clear plastic dividers) or spatial barriers (e.g., physical distance beyond that typically needed for direct transmission). Some of these are publically visible but are at least semi-permanent and require little or no further action once they are put in place. Other barriers are more dynamic, requiring repeated visible actions by individuals, such as avoiding risky situations, maintaining physical distance while shopping, or wearing a mask around other people when outside the home.)

Each of these measures may decrease coronavirus transmission, yet they are also likely to disrupt individual and community social life (Van Bavel et al. 2020). For example, physical distancing and self-isolation create fundamental changes in the nature of work, shopping, and leisure activity, while altering individual patterns of time use and social interaction. Mask wearing itself has not been part of American life prior to the pandemic. All of this serves to disrupt daily routines and lifestyles in ways that could easily increase the risk of individual and aggregate non-compliance with public health guidance. The social aspects of mitigation (e.g., wearing masks or avoiding public settings) thus become critical for the success of any approach to COVID-19 mitigation. While these social aspects have received comparatively little attention in the literature, the social aspects of virus mitigation have been identified as an essential component of the CDC's COVID-19 research agenda (National Center for Immunization and Respiratory Diseases 2021: Priority Area VI).

This paper explores the factors involved in an individual's decision to wear a mask, looking also at the connection between a wider array of recommended actions central to the CDC's COVID-19 public health strategy since April 2020. There was initial confusion in March 2020 over whether masks should be widely worn by the public, due less to issues of effectiveness than of protecting the supply for medical workers and first responders (Balog-Way and McComas 2020; Peebles 2020). As a result, mask wearing was initially uncommon (AJMC Staff 2021; Brandt 2021; Jones 2020). As availability expanded and science established their effectiveness, public health recommendations shifted in favor of wearing face masks. This shift was important enough to be announced live on television by the U.S. Surgeon General on April 4, 2020 (USSG 2020). Since that time, estimates of the percentage of the adult U.S. population regularly wearing a mask in public grew from around 50% to over 90% (Peebles 2020).

Yet even as COVID-19 case counts and deaths increased, a visible fraction of the population continued to avoid the experts' guidance. Of particular interest are the factors that lead some people to wear face masks in public settings while others choose to not wear them, in spite of the apparent science supporting the centrality of masks for keeping individuals safe from the coronavirus and limiting its spread in the community. Some people undoubtedly found masks to be uncomfortable or inconvenient. Some did not trust the underlying science, believing that masks would be unnecessary so long as appropriate physical distance was maintained. Others may have focused on the symbolic nature of masks—viewing them as a signal the wearer is infected, will be perceived as weak, or signal of the political views held by the wearer (Ike et al. 2020). Even uncertainty over the amount of physical distance to maintain in public settings likely may have contributed to the slow initial adoption of mask wearing (Johansson 2021; Moghadas 2020).

Increasing evidence suggested that properly worn masks help protect others as well as the wearer from transmission of COVID-19. The protection provided by masks extended to asymptomatic carriers as well as those showing relevant symptoms (Johansson et al. 2021), and CDC reports estimate that those who are asymptomatic or pre-symptomatic may account for more than half of all direct person-to-person transmission of the virus (CDC 2020b). The best protection is to simply remain at home and avoid public situations where people may come into close contact with one another. Where avoidance is impossible or impractical, the best protection is afforded by maintaining physical distance *in conjunction with* barriers between individuals (e.g., wearing a mask, use of clear plastic dividers). Individuals concerned about their own health as well as the health of others should be well motivated to routinely follow all of these guidelines, including frequent hand washing (Peeples 2020; Marchiori 2020).

The research presented here examines the social factors that lead to public adoption of mitigation strategies that are likely to help slow the spread to the coronavirus. We emphasize strategies that require direct action by the individual and are visible to those around them. In what follows, we seek to locate coronavirus mitigation strategies (primarily mask wearing) within general theoretical approaches to health-related behaviors, and define several components that may be keys to understanding differential adherence to public health guidelines during the coronavirus pandemic. Utilizing existing panel data, we examine whether these behavioral and attitudinal keys have empirical relevance, using two distinct methodological approaches to analyzing complex interactions among categorical variables: Qualitative Comparative Analysis (QCA) and Multiple Correspondence Analysis (MCA).

MASK WEARING AS A HEALTH-RELATED BEHAVIOR

While medical science may be clear and settled on the appropriate measures that people should take in order to avoid transmission, the social context in which individual decisions are made can discourage or prevent proper mitigation. In order to understand, and influence, the effectiveness of such community-wide strategies, it is important to consider the social-psychological factors driving individual adherence to community recommendations. Of all of the commonly-available mitigation strategies, the most accessible and policy-relevant aspects will involve individual

action and typically have a social or publicly visibility component. This is particularly true for face masks.

Mask wearing as a U.S. public health strategy only arose as an issue in early 2020, thus we are only beginning to learn about the factors impacting their acceptance. A great deal of research has been done, however, to understand the acceptance of other health-related interventions. For example, multiple perspectives have been developed to help understand a variety of health-related behaviors such as individual seat belt use (Litt, Lewis, Lickenbach et al. 2014), driving while intoxicated (Duckworth and Lee 2019; Gastil 2000), and texting while driving (Tontodonato and Drinkard 2020), to mention but a few.

Among the perspectives developed, the approach taken here draws upon the Theory of Reasoned Action (Ajzen 2002) and the Health Belief Model (Champion and Skinner 2008). An amalgam of these two has been used to study COVID-19 behaviors with primary focus on mask wearing (Barile et al. 2021). All have roots in Soper's (1919) review of the public health approach to the Spanish Flu over a century ago. He suggests that people will often fail to follow public health recommendations in part because: they don't understand the real risks they and others are confronted with (owing in part to communication issues and misinformation); many of the recommended actions run counter to everyday culture (including mask wearing and "stay-at-home" orders); and people often act in ways that put themselves and others at risk (whether inadvertently or by choice).

Advanced to the present-day historical context of the coronavirus pandemic, we argue that people are most likely to accept wearing a protective face mask if they:

- believe that COVID-19 is real and personal threat;
- believe that masks are an effective and important strategy for preventing the spread of the coronavirus; and
- are willing and able to wear a mask given the sociocultural context in which they live.

Belief in the Existence and Seriousness of COVID-19. The Health Belief Model (Champion and Skinner 2008; Montaña and Kasprzyk 2015) considers a health issue to be a threat when it is perceived to be real and individuals believe they are personally susceptible to it. With respect to the coronavirus, it is more likely to be perceived as real when its consequences are visible. Early in the pandemic, when cases were (in hindsight) relatively sparse and geographically isolated into "hot spots," it was rather easy to overlook COVID-19 as a personal threat. Indeed, the consequences of becoming infected with the coronavirus are not immediately evident upon infection, taking up to several weeks to appear. Those infected may even remain asymptomatic. As the pandemic progressed, and as the counts of infections and deaths spiked multiple times, the reality of COVID-19 became unavoidable for most people.

Effectiveness of Mitigation. Even when individuals believe that there is a real and significant risk of becoming infected with the coronavirus, they may not believe that adherence to public health guidelines will be effective. They may not feel that wearing a mask or keeping physical distance will significantly reduce their chances of becoming infected or if already infected, of their transmitting the virus to others. This was fueled early in the pandemic by confusing and evolving guidance on wearing masks. As more studies were published, it became clear that

masks were effective when worn correctly. While masks may not completely block transmission of the virus, they will certainly reduce the risk of transmission (especially when everyone in a close, confined setting wears a mask). This is true for “outbound” transmission from the wearer to other individuals, as well as protecting the wearer from “inbound” transmission (Zhang, Zhang, Wang et al. 2020). Research related to other health-related behaviors (e.g., smoking, wearing seatbelts, driving while distracted or intoxicated) suggests that self-interest may have a major impact on promoting the avoidance of the unhealthy behavior (Oleckno and Blacconiere 1990; Ouimet et al. 2008). Thus, those believing that masks protect the wearer should be more likely to wear a mask than those who believe only that masks limit transmission from an infected wearer to other people.

Social Context. For those who perceive that COVID-19 is a real and personal threat, and have access to reasonable means of mitigating the virus’ impact, a number of factors can still make adherence to recommended guidelines impractical or undesirable. Those with essential jobs do not have the luxury of avoiding public settings, nor will those needing to buy groceries or obtain medical attention. Further, behavioral norms related to mask wearing or keeping physical distance in public may differ by community, social group or demographic category (Haischer, Beilfuss, Hart et al. 2020). These factors could create peer pressure to, for example, wear or not wear a mask in certain situations, or participate in events where physical distancing is not practiced, in much the same way that peers influence a variety of other behaviors (Grasmick and Bursik 1990; Kim and Kim 2012; Litt et al. 2014). Individuals may be responsive to typical patterns of behavior observable in an individual’s local community (e.g., the number of people not wearing masks in the grocery store) or the aggregate numbers of coronavirus-related cases and deaths reported within their communities. The decisions they make may also be impacted by the behavior of influential others, or within organizations and social networks.

Politics and Trust. A particularly relevant aspect of social context has been the declining trust in science, intellectualism, and traditional government. This shift laid the groundwork from which anti-mask (and anti-vaccine) influences grew among peer groups, organization, media outlets and public officials (Karić and Međedović 2021; Sturgis, Brunton-Smith, Jackson 2021). The socio-political environment in place during the pandemic became a significant challenge for the public health response to COVID-19, which has scientific evidence at its root. This is in part attributable to the anti-science view espoused by the Trump White House, and the general shift toward populism in the U.S. (Merkley 2020; Merkley and Loewen 2021). The net result is that the attitudes of many people shifted against the expertise of medical science, influencing their decisions to follow or not follow public health guidance during the pandemic (Sturgis et al. 2021). There is additional evidence that a segment of the U.S. population rejected face masks as an infringement on their individual rights (Ike et al. 2020). The current political environment has exacerbated this effect, and seems to have politicized face masks—an amalgamation of personal freedom and “Trumpian” political commitment (Igielnik 2020; Ike et al. 2020; Lang, Erickson and Jing-Schmidt 2021).

Rutledge (2020) identifies Trump’s overall war on experts as reducing the number of qualified medical scientists within the President’s sphere of influence, effectively putting at risk the country’s ability to respond to the pandemic. As scientific understanding of the coronavirus grew clearer, significant confusion arose out of the shifting guidance (Wright, Steptoe and

Fancourt, 2021). Balog-Way and McComas (2020) described this as the “fog of pandemic.” Evidence-based guidance was often rejected, and many in and out of government lost some of their faith in science. Trump’s war on administrative experts is consistent with (and a part of) the overall decline in trust, which is viewed as a driver of compliance with public health recommendations (Bargain and Aminjonov 2020; Blair, Morse and Tsai 2017). Ike et al. (2020) argue that the confusion created at the start of the pandemic in particular, and the anxiety that built as the number and geographic spread of cases grew, led to the increasing politicization of the pandemic and turned many against mitigation strategies like mask wearing.

Wearing a face mask can send a variety of messages about the wearer. “First, wearing a mask signifies a type of person who believes in medical sciences and desires to protect others (especially the most vulnerable), even at the cost of individual discomfort” (Ike et al. 2020). In addition, for a particular segment of the population, NOT wearing a mask represents a distinct political statement. Wearing a mask implies “submission to authoritarian rule and an emasculation of individual liberty” (Ike et al. 2021), in contrast to the sense of invincibility tied to the concept of masculinity (Cassino and Besen-Cassino 2020; Palmer and Peterson 2020). All of this was supported by anti-science, counter-CDC messaging from the White House that sought to downplay the pandemic (Ike et al. 2020).

Using national panel data collected beginning in March 2020, we analyze the interaction among self-reported measures of adherence to public health recommendations, individual perceptions of the effectiveness of mask wearing as a mitigation strategy, and indicators of individual attitudes toward political aspects of coronavirus mitigation. The next section briefly introduces the data set used and the variables analyzed in this paper.

DATA

The data used in this study come from the Coronavirus Tracking Survey, part of the Understanding America Survey (UAS) administered by the Center for Economic and Social Research at the University of Southern California (USC Center for Economic and Social Research, 2021). The sample of more than 6,000 respondents compose a panel that was contacted roughly every two weeks starting in March 2020 and remains active.¹ This creates a dataset with repeated observations across up to 28 waves through June 21, 2021. The sample itself is representative of the U.S. adult population, and contains a wealth of information on individual demographics, attitudes, and behaviors, along with aggregate level geographic metrics related to COVID-19 cases, deaths, and hospitalizations (USC Center for Economic and Social Research, 2021).

This project focusses on questions addressing behaviors and attitudes related to coronavirus mitigation strategies. Most of the variables for this analysis are drawn from three groups of questions on the survey. The first asks (CR016) “Which of the following have you done in the last seven days to keep yourself safe from coronavirus? Only consider actions that you took or decisions that you made personally.” Responses are coded 1 Yes, 2 No, and were recoded here as dummy variables (1 Yes, 0 No). Five behaviors are considered from this question. The first

two are included in the QCA analysis, while all five are used in the MCA analysis. The set includes:

- MASK:** Worn a mask or other face covering
- APUBLIC:** Avoided public spaces, gatherings, or crowds
- HANDS:** Washed your hands with soap or used hand sanitizer several times per day
- ARISK:** Avoided contact with people who could be high-risk
- AREST:** Avoided eating at restaurants

The second survey question set (CR070) is worded: “We would like to learn your general opinion about wearing a mask or face covering. Do you agree or disagree with each of the following statements?” The responses were coded: 1 Strongly disagree, 2 Disagree, 3 Neither agree nor disagree, 4 Agree, and 5 Strongly agree. For analysis, these variables were converted into dummy variables with “strongly agree” and “agree” recoded to a value of 1, and 0 for any of the remaining three response categories. Among the five variable used here, the first two address perceptions of mask efficacy, while the final three deal with anti-mask, counter-CDC beliefs. The last two variables (FREE, NOTNEED) are excluded from the QCA analysis. This set includes:

- MESAFE:** Wearing a mask helps keep me safe from coronavirus
- OTHERSAFE:** Wearing a mask helps keep others safe from coronavirus
- POL:** Wearing a mask is a political statement
- FREE:** We live in a free country and no one can force me to wear a mask
- NOTNEED:** Wearing a mask is unnecessary because coronavirus is not a serious threat to people like me

Finally, three variables were considered from another question set (CR015): “In the last seven days, have you done the following:” with responses coded: 1 Yes, 2 No, and 3 Unsure. The variables were recoded to 1 Yes and 0 No, treating those choosing unsure as missing. This set, not used for the QCA analysis, includes:

- B10PLUS:** Attended a gathering with more than 10 people, such as a reunion, wedding, funeral, birthday party, concert, or religious service
- BBAR:** Gone out to a bar, club, or other place where people gather
- BNONHHCONT:** Gone to a friend, neighbor, or relative’s residence (that is not your own)

The next section presents descriptive statistics for the variables used in this research. Simple proportions of respondents indicating a given behavior or attitude are discussed first, followed by an examination of the time trends in several of these variables. The results from two different analytic methods are then presented—QCA and MCA. Both allow the complexity observed in the data to be maintained and emphasized.

DESCRIPTIVE STATISTICS

Figure 1 displays the percentages coded “1” for each of the variables considered in this analysis, aggregating data across waves. Thus, individual panel participants will be included separately for each wave where they provided responses.²

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FIGURE 1 ABOUT HERE

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Overall, more than 90% of the sample reports wearing a mask and practicing hand hygiene, both individual actions. High percentages are also found for those avoiding risky people, restaurants, and public settings in general. Relatively few respondents reported participating in gatherings of 10 or more individuals or going out to a bar, but nearly two-thirds of the sample report visiting someone not from their household. The latter may seem inconsistent with public health guidelines, but it could just as easily represent visiting with a neighbor in their spacious backyard, as attending a crowded party at a friend’s house. Figure 1 also shows that more than two-thirds of those questioned believe that masks are effective (slightly more so for protecting others than self). Finally, a small percentage of respondents report potentially politicized beliefs that run counter to CDC guidelines, with around 5% believing the COVID-19 is not real, and 10% viewing masks as political statements.

Trends in Use of Mitigation Strategies. To provide a wider context, Figure 2 displays the number of new deaths reported within the respondent’s State of residence at the time of their wave-specific response, as compiled by the N.Y. Times (2021). It clearly shows the several highly-publicized coronavirus spikes since March 2020—peaking during Wave 2 (March/April 2020), Wave 11 (August 2021) and between Waves 23 and 25 (March/April 2021). Compare this to the proportion of individuals reporting they wear a face mask (Figure 3), wash their hands regularly (Figure 4) and avoid crowded public setting (Figure 5).

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FIGURES 2 THROUGH 5 ABOUT HERE

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Prior to wave 4 or 5, the likelihood of mask wearing was comparatively low but increasing rapidly. This may be due more to changes in expert guidance concerning masks than to public concern over masks themselves. Also increasing during this period of accelerating use is the sense that COVID-19 is a real threat. After that point, the overall stability is remarkable--80% to 90% during Waves 4-9 increasing to over 90% from Wave 10 onward. Mask wearing does not track closely with the overall number of deaths, but seems to endure once masks reach a peak level of acceptance.

The situation is rather different for hand washing and avoiding public settings (Figures 4 and 5, respectively). The level of reported hand washing and avoidance of public settings both declined

significantly through the spring from initially high levels, remaining rather stable through the summer and fall, and then dropping substantially from February 2021 onward. These trends are likely influenced heavily by the availability of COVID-19 vaccines, beginning in earnest by mid-January and peaked in April. There appears to be a correspondence between the drop in use of some mitigation strategies and the rise in percentage of the fully vaccinated population. Importantly, this does NOT include mask wearing, which persisted until local, state and federal guidelines for mask wearing began to relax in May 2021. Taken together, this suggests that adherence to all recommended mitigation strategies may not hang together as tightly as the pandemic wears on.³

Because the U.S. strategy toward fighting coronavirus became highly politicized from the start (Igielnik 2020; Ike et al. 2020), we incorporate individual views of the politics of mask wearing in order to understand this is a factor in explaining why some people follow recommendations for COVID-19 mitigation strategies more closely than others. Figure 6 displays the trend in mask wearing separately for four groups, defined by crossing dichotomous indicators of POL and FREE (see previous descriptions).

FIGURE 6 ABOUT HERE

If considered individually, mask wearing is much less common among those believing masks are political statements (POL) or that we live in a free country and thus should not be pressured into wearing a mask (FREE). As Figure 6 shows, the greatest reduction in mask wearing comes when individuals agree to BOTH of those statements about mask politicization. The probability of mask wearing drops when only one of POL or FREE is invoked by respondents drops by about 10 percentage points. But when BOTH are invoked, the probability of mask wearing drops to between 60% and 70%, and is slightly more likely to fluctuate over time. Indeed, the trend displayed in Figure 6 reveals a drop in mask use over the final few waves when at least one of POL or FREE is reported, mirroring a similar drop in mask use at the start of the school year (Waves 12-14) for those feeling that masks are political AND that individuals can't be forced to wear a mask since they live in a free country.

Figure 7 displays the trend for the proportion of respondents who feel that masks protect the wearer from infection, while Figure 8 displays the same for protecting others. From the latter part of July 2020 until late October 2020, around two-thirds of those questioned indicated that masks help keep the wearer safe from becoming infected with COVID-19. From early-November 2020 until the end of December 2020, the proportion increased a comparatively small yet statistically significant amount to around 70%. Beginning in late-January 2021, the proportion started a dramatic decline which continues through the most recent wave—perhaps a reflection of the increasing number of fully vaccinated individuals who no longer worry about becoming infected.

FIGURE 7 ABOUT HERE

FIGURE 8 ABOUT HERE

As noted above, on average people believe that masks protect others more than the wearer of the mask, regardless of the point within the pandemic. Nearly 78% of those questioned indicated a belief that masks keep others safe as of late July 2020. This proportion declined steadily until approximately the start of the school year, and hovered around 75% until mid-January 2021. From that point onward, the proportion again declined steadily. None of these shifts represents a large absolute change, yet the declines are statistically significant.

METHODS OF ANALYSIS

As noted earlier, results from two different analytic methods are presented. Both are appropriate for interpreting the relationships among a set of categorical variables, and both provide an insight into the complexity of multiple-variable relationships in a manner that is difficult using more “traditional” methods (such as logistic regression).

The first method (Qualitative Comparative Analysis or QCA) examines the set of all possible combinations of responses to variables are examined, and seeks to provide the simplest set of variable interactions to interpret the data. We use QCA to separately model those who wear masks and those who do not. Based on the earlier discussion, five variables are considered which fall into three categories: those that represent mitigation strategies; those that reference the perceived effectiveness of face masks; and the politicization of mask wearing. The first category includes: wearing a mask (MASK); and avoiding crowded public settings (APUBLIC). The second considers the belief that facemasks can help protect the wearer (MESAFE) and others (OTHERSAFE) from becoming infected with COVID-19. Finally, we incorporate an indicator of whether respondents view wearing a face mask a political statement (POL).

The second method is Multiple Correspondence Analysis (MCA). Rather than simplifying multiple-variable interactions as in QCA, this approach decomposes a matrix encompassing the association among the variables in a manner that permits a graphical interpretation. Oversimplifying, the graphs visually treat each category of each variable as a unique “observation,” which are plotted in two-dimensions. Points are interpreted based on their relative position with respect to the graph’s axes, the distance from the origin, their distance from other points, and the degree to which they form clusters on the graph. In general, points that are closer together are more closely associated, and we can examine (for example) whether the point representing those who do not wear masks is close to the point for those who believe that masks are political statements.

Crisp Qualitative Comparative Analysis (QCA)

While logistic regression might typically be used to predict mask wearing on these behavioral and attitudinal variables, such a method is impractical for uncovering the complexity that likely exists among the combinations of these behaviors. Instead, Ragin’s approach to Qualitative

Comparative Analysis (Ragin 2000; 2014) is used implementing the “fuzzy” module available in Stata (Longest and Vaisey 2008).

QCA is based on a Boolean reduction (Legewie 2013; Schneider and Grofman 2006). The exploration begins by considering all possible combinations of the set of dichotomous variables (essentially up to 5-way interactions in this case) observed for each level of the target variable (i.e., those wearing a mask are modeled separately from those not wearing a mask). Each combination is examined, starting with the most complex, eliminating combinations that can be merged and thus made redundant.

We fix ideas though a contrived example analyzing only POL and APUBLIC among those wearing a mask. For simplicity, refer to these as P and A respectively. Recall that upper-case letters refer to the presence of the variable and lower-case referring to its absence (e.g., P=views masks as political; p=does not view masks as political). Then PA (i.e., P*A) represents the condition of seeing masks as political *and* avoids public settings, whereas pA (i.e., p*A) denotes NOT seeing masks as political *and* avoiding public settings. Suppose that both arise (e.g., both pA or PA lead to mask wearing). It is clear that A occurs REGARDLESS of political views, and PA or pA can be simplified to A alone. The models implemented in Stata use an algorithm to merge combinations in this way and report the least-complex set of combinations that can describe those with a given outcome (those who wear masks and those who do not, separately).

Multiple Correspondence Analysis (MCA)

Another approach for analyzing how categorical variables fit together is Multiple Correspondence Analysis (MCA). Practically speaking, MCA decomposes the association among a set of variables into the smallest possible number of unique dimensions. This is logically similar to a principle component analysis (PCA), although the methods are not technically equivalent (Le Roux and Rouanet 2010; Schneider and Grofman 2006). MCA starts with a set of categorical variables, forms the set of all possible bivariate frequency tables, and constructs a Burt matrix (Le Roux and Rouanet 2010) by incorporating the information contained in each of the bivariate tables.

A number of independent dimensions are extracted from this matrix using the singular value decomposition (SVD). The method also allows each variable category to be positioned on a two-dimensional plot, defined by a pair of dimensions extracted, providing a visual representation of the how the variables are associated. Usually only the first few dimensions need to be interpreted in order to account for the bulk of the observed association, so that the “biplot” based on the first two dimensions is typically sufficient to account for the greatest proportion of the observed association. This plot provides a visual representation of the results that can be interpreted based on a point’s position relative to each axis, the distance between points, and the degree to which the points cluster.

HYPOTHESES

The methods used here are largely exploratory or descriptive in nature, but it is productive to derive hypotheses about what we expect to find and assess the results focusing on descriptive

rather than inferential statistics. The results produced by QCA and MCA differ, providing different looks at the underlying relationships. As a result, we define hypotheses that are similar but specific to the method used.

QCA Hypotheses

Those who follow recommended guidelines are not likely to be selective about the methods they use. Individuals who wear masks will most likely do so as part of the recommended “suite” of personal mitigation strategies, and thus we expect mask wearers to also avoid crowded public situations (APUBLIC). In contrast, individuals who choose not to wear masks in public settings are also unlikely to avoid public settings in general (apublic).

Those who wear masks are unlikely to believe that masks are unnecessary because COVID-19 is a real and serious threat to humans (notneed), while those who chose to not wear face masks may do so believe they believe the coronavirus is not a threat and thus will have no need to wear a face mask (NOTNEED).

The belief that masks are effective at keeping the wearer safe from coronavirus infection (MESAFE) should be commonly observed among those who wear facemasks, as would the belief that masks are effective at limiting transmission of the virus to others (OTHERSAFE). Among those who do not routinely wear facemasks, it is unlikely they will believe that masks protect either the wearer (mesafe) or others (othersafe) from coronavirus infection.

Individuals who regularly wear masks in public settings are unlikely to believe that wearing a mask is a political statement (pol). Those who believe that wearing a mask is a political statement will be much more common among those choosing to not wear masks (POL).

In sum, we expect the following variable outcomes to emerge from the QCA models:

- For those who wear a mask—APUBLIC, MESAFE, OTHERSAFE, notneed, pol.
- For those who do not wear a mask—apublic, hands, mesafe, othersafe, NOTNEED, POL.

MCA Hypotheses

We expect that individuals who are serious about limiting the spread of COVID-19 would exhibit all (or most) of the behaviors available to them. Thus there should be a great deal of overlap among the 8 methods (e.g., MASKS, HANDS, APUBLIC). We also anticipate that responses to POL, FREE and NOTNEED will be closely associated. However, as with the QCA results, we expect the behaviors of those believing masks are political to exhibit few if any of those 8 behaviors.

In short, we expect that MCA will divide the 11 dichotomous variables into two clusters—one that links use of appropriate COVID mitigation behaviors to the non-political responses on POL, FREE, and NOTNEED, and another cluster linking avoidance of mitigation strategies to the more politicized beliefs about mask wearing. The first cluster should be more tightly grouped, given the intensity with which the public health recommendations are communicated and enforced, while the second cluster should appear much “looser,” given the many reasons possible for not following guidelines and the more isolated nature of communicating this perspective.

ANALYSES

Qualitative Comparative Analysis.

Having already taken a descriptive look at trends in compliance with and attitudes toward common mitigation strategies, we turn next to examine the causal complexity in how these factors combine for those who wear masks and those who do not. These factors include one additional mitigation method (APUBLIC), the respondent's belief that masks are unnecessary because the coronavirus is not a serious threat (NOTNEED), two indicators of perceived mask efficacy (MESAFE, OTHERSAFE), and whether the respondent views masks as political (POL). Table 1 displays the simplest logical set of causal combinations observed among those wearing masks. Table 2 does the same for those not wearing masks.⁴

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TABLE 1 ABOUT HERE

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Wearing Masks. Causal combinations reported on a single line are seen as being sufficient to produce the outcome (mask or no mask), where “*” connects two variables such that they must occur together (i.e., “and”), while each combination (i.e., each row) is combined with the others by “or” to produce the outcome. Thus, the model shown in Table 1 implies that individuals will wear masks if:

- they believe COVID-19 is serious (notneed) OR
- the individual avoids public settings (APUBLIC), OR
- the believe that masks keep others safe AND they are not political statements (OTHERSAFE*pol)

Two measures of the “fit” are produced for this set of causal combinations—coverage and consistency. The overall coverage for this solution with five causal combinations is 0.984. Coverage indicates the degree to which the model's combinations (sometimes referred to as “recipes”) account for those who wear masks. This value shows that the simplest solution identified accounts for most all of the empirically observed respondents who indicate wearing a face mask. Among the individual variables, four of the five combinations have high coverage levels.

The overall consistency for this solution with five causal combinations is 0.939. As with coverage, consistency can reach a maximum value 1.0. It falls below 1.0 when there are respondents defined by a combination (or set of combinations) that do not have the expected outcome. Table 1 shows that only 6% of the cases accounted for by the set of causal combinations identified for model do not wear masks.

We next seek to interpret the set of causal combinations included in this solution. Combinations consisting of only one variable suggest that it is “sufficient” to identify the outcome without working in combination with other variables. In this case, rejecting the belief that the virus is not real (notneed) is itself sufficient for wearing a mask. It is not “necessary” or required in order to indicate mask wearing, but this confirms the expectation that a belief that COVID-19 is a real

threat is a general precursor to taking action to limit its spread. The same can be said for avoiding public situations (APUBLIC), which also emerges as a sufficient condition for mask wearing. Regardless of whether an individual believes masks are political statements, or whether masks are effective, avoiding public situations OR believing that COVID-19 is a real threat are sufficient to distinguish those who wear masks.

Beliefs about mask effectiveness are not as prominent as was expected. In fact, the belief that masks keep the wearer safe (MESAFE) is completely absent from this solution for mask wearers. Individuals will wear masks when they believe they protect others from infection (OTHERSAFE), but only when they fail to see masks as political statements. This is observed regardless of whether or not the respondent avoids public settings.

Not Wearing Masks. We turn next to combinations associated with not wearing a face mask, displayed in Table 2. Overall you can see that there is only one causal combination identified for outcome rejecting mask wearing, where the consistency and coverage measures (0.580, 0.238 respectively) are much lower than in Table 1. This implies that the causal combination identified as the minimally sufficient solution fails to account for a great many of the cases who do not wear masks.

TABLE 2 ABOUT HERE

The only causal combination associated with this solution suggests that face masks are rejected when the individual does not avoid public settings (apublic), AND does not believe that masks are effective for protecting either the wearer (mesafe) or others (othersafe), AND believes that masks are unnecessary because the coronavirus is not a serious threat (NOTNEED). This is more or less consistent with the expectation set out previously. The variables most closely related to the absence of active mitigation are included (apublic*mesafe*othersafe) along with the rejection of COVID-19 as a serious threat (NOTNEED) are indicative of those not wearing masks. While this is consistent with expectations, it does not appear as a particularly strong solution. Overall, the stronger solution for mask wearing may imply that the reasons for choosing to not wear a mask are more numerous and complex that a simplified solution can provide.

One other feature of this solution is worth noting. Neither POL nor pol appears in the final set of causal combinations, thus we can conclude that the politicization of mask wearing has little influence on the decision to NOT wear a mask independent of other factors. In fact, its only influence is observed in specifying the relationship between believing that masks keep others safe and mask wearing, such that OTHERSAFE is no longer relevant for those wearing a mask if the individual believes masks are political statements. Based on earlier discussion, we anticipated that anti-mask political views would be an important part of the solution for those not wearing a mask. It may be the case that the politicization of masks would be an important precursor for believing that the coronavirus is not a significant threat or for not following any of the mitigation strategies recommended by public health experts.⁵

Multiple Correspondence Analysis.

Figure 9 displays the biplot of the first two MCA dimensions.⁶ There are 22 points displayed, each representing one category of each dichotomous variable. They are arrayed in two dimensions, but we see that the relationship among these 11 variables is essentially captured by a single dimension. The first dimension (plotted along the horizontal axis) accounts for 91% of the association observed in the data, while the vertical axis accounts for around 2% of the association. Looking at the points themselves, outcomes to the left of the origin are seen to represent behaviors and attitudes consistent with recommended guidelines, while outcomes to the right indicate departures from those guidelines. The closer points appear to one another, the more closely they are associated.

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FIGURE 9 ABOUT HERE

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Perhaps the most obvious conclusion to be derived from Figure 9 is the tight clustering of points to the left of the origin. Consistent with expectations, this cluster includes points representing the guidelines-consistent behaviors on each of the 8 mitigation strategies (i.e., wears mask, avoids public settings, uses proper hand hygiene, avoids eating in restaurants, avoids contact with high-risk people, has not participated in group activities with 10 or more people, had extended contact with non-household members, and has not gone to a bar). The cluster to the left of the origin also includes outcomes that do NOT see masks as political, do NOT feel that living in a free country is a reason to avoid mask wearing, and do NOT believe that masks are unnecessary because COVID-19 is not a real threat. In short, all of the attitudes and behaviors consistent with guidelines recommended to slow the spread of the coronavirus are tightly packed, and thus closely associated. We might label this cluster as generally “conforming” to guidelines.

The opposite responses—for example, not wearing a mask (mask=0) or believing that masks ARE political (pol=1)—appear on the graph entirely to the right of the vertical axis. As expected, these outcomes form a much looser cluster than the one just discussed, and one that is much more evenly dispersed above and below the horizontal axis. We might label this cluster as “nonconforming.” The looseness of the nonconforming cluster suggests that there is greater observed variation in behaviors and attitudes which differ from recommended guidelines, and thus they appear only weakly associated. This stands in contrast to the conforming cluster. Those who do not consistently adhere to the recommended mitigation strategies are clearly not a homogeneous group, and deviations from recommended guidelines may arise for a variety of reasons. Some individuals may not follow a subset of recommended actions while adhering to other recommended behaviors. On the other hand, another group of respondents may have more fundamental objections to following public health guidelines and make no effort to comply with any of the recommendations.

Looking deeper into the nonconforming cluster, suppose we split the cluster into two categories—one above the horizontal axis and one below. This also divides the nonconforming cluster into two quadrants—the upper-right and the lower-right. On examination, outcomes below the axis generally capture those who acted in ways that brought them into contact with

greater numbers of people outside of their own household. Specifically, the outcomes in the bottom right quadrant include: not avoiding restaurants, not avoiding risky people, not avoiding groups of 10 or more people from outside their household, not avoiding bars, and not avoiding public settings in general.⁷

Outcomes in the upper-right quadrant include: not wearing a mask, not washing hands, and agreement with the three “political” anti-mask attitudes (i.e., masks are political statements, this is a free country so can’t be forced to wear a mask, masks are unnecessary because the coronavirus is not a threat). From this we might argue that the nonconforming cluster can be divided into at least two groups—one that has strong anti-mask political beliefs, and one that does not have as strong a view about masks being political but will venture into settings that are not recommended during an active pandemic (by choice or necessity).

The case of (NONHHCONT)—having contact with people who are not part of one’s immediate household—is interesting and a bit more ambiguous. Avoiding close contact with those not living in the respondent’s household is part of the tight cluster of mitigation actions consistent with guidelines, which includes mask wearing. Compared to other variables, however, the plotted separation between avoiding and not avoiding people from outside the immediate household is much smaller. Both the 0 and 1 responses to NONHHCONT are closer to the “conforming” cluster than to the “non-conforming” cluster (and thus farther from POL=1 or FREE=1.) This likely would not result from politics or a sense of personal freedom, but may suggest that people facing a growing sense of social isolation may be more relaxed about meeting with close friends whom they trust.⁸

SUMMARY AND DISCUSSION

This paper examined several behavior and attitudinal factors associated with mask wearing as a method to help limit the spread of COVID-19 in the U.S. during the pandemic of 2020-2021. Starting with a modification of the Health Behaviors Models, we proposed that mask wearing would be determined by: (a) an individual’s belief that the coronavirus is a real and serious threat, (b) the availability of masks that are perceived to be effective against the virus, and (c) the existence of a social environment supportive of those wearing masks. Hypotheses based on this framework were developed and tested descriptively using two distinct methods for analyzing association among categorical variables—Qualitative Comparative Analysis (QCA) and Multiple Correspondence Analysis (MCA).

- First, we expected the belief in the coronavirus as a serious threat to distinguish those who wear masks from those who do not wear them. This was largely supported by both the QCA and MCA analyses. In fact, perception of threat appears to be sufficient to lead individuals to wear masks regardless of the individual’s attitudes and behaviors patterns. Those who do not wear masks, on the other hand, tend not to see the virus as a serious risk, but also believe masks are ineffective and do not avoid public settings.
- We also anticipated that wearing a mask would be associated with the belief that masks are an effective means of protecting self and others from COVID-19 infection. While masks may be included among public health recommendations, people must still believe in their

effectiveness. This was supported among those not wearing masks who tended to see masks as ineffective, but the analyses also suggests that protecting others was more important than protecting oneself among those who wear masks.

- The results for the belief that masks are not political (used as an indicator of social context) were more complex. While we expected political perceptions to be an important discriminator for mask wearing, the results suggest that political may be nearly irrelevant all else being equal. Politics only factor into the QCA results for mask wearers, where the belief that masks keep others safe is linked to mask wearing only for those who do not see masks as political statements. The political aspects of face masks are seemingly irrelevant among those not wearing masks.
- Finally, we expected that those who wear masks are also likely to use other coronavirus prevention strategies. This was supported by QCA analysis which shows that mask wearing and avoiding public settings tend to occur (or not occur) together. The MCA analysis included a larger number of protective strategies, yet continued to support the idea that multiple strategies tend to be used together against transmission of COVID-19.⁹

The results presented support the Health Behaviors Model as employed in this paper, and may provide insights in how public health policy can be effectively implemented in similar public health situations. While the outcome variables considered here represent individual behaviors, the precursor variables are based on individual perceptions—of coronavirus, of recommended protective strategies, and of the sociopolitical context in which behavioral decisions are made. Communication strategies designed to provide accurate and timely information are needed to convince individuals that (for example) the coronavirus is a real and serious threat, and that face masks are an effective strategy for limiting the transmission of the virus. The natural tendency may be to emphasize the personal protection gained from masks, but our results imply a more effective communication strategy might be to focus more on how wearing a mask can protect others.

This may be especially important among those classified as part of the “nonconforming” group. This group is not homogeneous. Some people may believe they have freedom of choice and can’t be forced to adhere to recommended guidelines against their will. Such attitudes may be immovable. On the other hand, some people may be part of what has been referred to as the “moveable middle” (Barsade et al., 2021). They may believe that masks are uncomfortable, inconvenient, or even unhealthy. They may also be influenced by the behaviors of others in their immediate community or social network. Thus, deciding to not wear a mask may be associated with the views of influential authorities or political parties, related to mask wearing, science, experts and intellectuals. Or, as already noted, individuals may view masks as unnecessary because they don’t perceive the virus to be a serious threat or that masks are ineffective at protecting the wearer or others.

All of this leads to additional questions and analytical strategies. Most notably, this paper does not account for time or the panel nature of the data. Attitudes certainly change in the aggregate over the course of the pandemic, yet the analysis here ignores time altogether. Pooled cross-section and time-series models can more appropriately account for correlations between and within individuals by modeling the error term in (for example) traditional logistic regression.

Panel models could more appropriately incorporate shifts in the attitudes and perceptions held by panel participants over time, such as: whether their perceptions of the political aspects of face masks change over time; the ways in which political perceptions are related to perceptions of risk from COVID-19, how this relationships changes over time, and how those shifts might influence changes in anti-mask (or anti-vax) perceptions. Through models that exploit the panel aspects of the data set, we can ask whether political considerations are sufficiently important to overcome policies like mandatory mask requirements.

Finally, we can better specify social context by identifying characteristics in the respondent's local area (e.g., county or zipcode), and ask how the effect of the perceptions of threat from the virus and efficacy of protective strategies is influenced by characteristics of the local area and average perceptions considered here?

NOTES

1. The panel respondents were contact roughly once every two weeks until April 2021, when individual contact shifted to a frequency of once every four weeks.
2. In analyses not reported here, these results do not appear dependent on merging all years simultaneously or examining specific years individually.
3. While not studied here, this may be an indication that hand washing and especially avoiding public settings may be more susceptible to so called “COVID exhaustion” than is mask wearing (which is often supported by formal/legal policies related to wearing masks in at least some public settings).
4. Individual panel members are included in the data set multiple times depending on the number of waves in which they participate. Fifty percent of the respondents completed at least 25 or the 28 waves. Of those with lower participation, the vast majority were added to the panel in the middle of the pandemic and respondent consistently after joining. Repeat responses, then, will inflate the frequency with which patterns are observed but not significantly bias the results.
5. This might be captured in a panel model accounting for time as a factor in the development of individual attitudes.
6. While the QCA analysis included MESAFE and OTHERSAFE, they have been excluded from the MCA analysis to increase the readability of the biplots. In analyses not reported here, the interpretation is unchanged by including MESAFE and OTHERSAFE.
7. The latter is essentially on the axis, but we included it as below for reasons of logical consistency.
8. The outcome for FREE=1 included here as part of the “upper-right” cluster for its logical similarity to the view that masks are political statements. By positioning on the plot it might be seen as belonging to the “bottom-right” cluster, or that which is less political in its noncompliance.
9. Overall, the conclusions reached using QCA and MCA are remarkably similar. The core variables included in the two analyses are the same, although the MCA model is estimated with six additional mitigation behaviors, one additional measure of political views, and without the two mask efficacy indicators. In addition, the two methods differ markedly in their underlying logic, mathematical foundations, and computations strategies. The fact that the same overall conclusions are reached by each method is evidence that the findings appear quite robust.

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TABLES

TABLE 1: Combinations Associated with Mask Wearing

<u>Coverage Set</u>	<u>Raw Coverage</u>	<u>Unique Coverage</u>	<u>Solution Consistency</u>
OTHERSAFE*pol	0.766	0.003	0.979
APUBLIC	0.783	0.008	0.973
notneed	0.968	0.080	0.941
Total Coverage = 0.984			
Solution Consistency = 0.939			

TABLE 2: Combinations Associated with NOT Wearing a Mask

<u>Coverage Set</u>	<u>Raw Coverage</u>	<u>Unique Coverage</u>	<u>Solution Consistency</u>
apublic*mesafe*othersafe*NOTNEED	0.238	0.238	0.596
Total Coverage = 0.238			
Solution Consistency = 0.596			

FIGURES

Figure 1: Proportion of Sample Reporting Each Behavior or Attitude

Figure 2: Number of new deaths by wave (from NYT data)

Figure 3: Proportion wearing a mask, by wave

Figure 4: Proportion reporting frequent hand washing, by wave

Figure 5: Proportion reporting they avoid public settings, by wave

Figure 6: Proportion wearing a mask, by POL and FREE

Figure 7: Proportion reporting masks keep the wearer safe, by wave

Figure 8: Proportion reporting masks keep others safe, by wave

Figure 9: Biplot from MCA including variables MASK, HANDS, APUBLIC, AREST, ARISK, B10PLUS, BBAR, BNONHHCONT, POL, FREE, NOTNEED