

The Role of Vulnerability in Mediating the Relationship between Threat Perception and the Use of Face Masks in the Context of COVID-19

Daniela Perrotta,¹ Emanuele Del Fava,¹ Emilio Zagheni¹

¹ Max Planck Institute for Demographic Research, Rostock, Germany

{perrotta, delfava, zagheni}@demogr.mpg.de

Abstract

Vulnerable populations may have had a different behavioral response to the COVID-19 pandemic. We investigate the association between the threat perception of COVID-19 and the use of face masks, and its stratification along the lines of vulnerability. We leverage data from a large cross-national online survey, the “COVID-19 Health Behavior Survey” (CHBS), that we conducted on Facebook via targeted advertisements. Specifically, we analysed a sample of 91,376 completed questionnaires collected from March 13 to May 7, 2020 in seven European countries and in the United States. We found evidence that both the adoption of face masks and the threat perception to oneself were higher among the vulnerable segments of the populations, especially for those with a comorbidity, those who had been vaccinated for influenza, and older adults. Overall, we estimated that individuals who perceived a high threat of COVID-19 to themselves were 2.25 times (95% CI: 1.94–2.60) more likely to wear a face mask than those with lower threat perception. Our results also show how vulnerabilities can accumulate, leading to higher levels of threat perception and protective behavior against the virus.

Introduction

The COVID-19 pandemic has affected people’s daily lives in unprecedented ways, both directly and indirectly. Globally, millions of people have died and an order of magnitude more have been infected and suffered from mild to severe symptoms. Although non-pharmaceutical interventions have been implemented to curb the spread of COVID-19, individual behavior may have also played a key role in the rapid adoption of public health recommendations (Betsch 2020). In this context, vulnerable populations may have had a stronger behavioral response due to belonging to risk groups for COVID-19, for example due to pre-existing health conditions or old age, or co-residence with such individuals. Assessing the strength of the association between this protective mechanism and the degree to which the vulnerable segments of the population adopt more preventive behaviors is therefore crucial to understand how the same events may trigger different perceptions of threats and behavioral responses in different groups (Hakes and Viscusi 2004). This would also help us evaluate the potential impact of the pandemic on stress-related mental health effects (Xiong et al.

2020), and how those may be differentially stratified in the population.

In this study, we focus on the first wave of the pandemic and leverage a unique source of data, the “COVID-19 Health Behavior Survey” (CHBS), a large cross-national survey that we conducted at the early stage of the pandemic, when initial physical distancing guidelines were introduced across many countries in Europe and North America (Perrotta et al. 2021; Del Fava et al. 2020). The survey participants were recruited via targeted advertisement campaigns run on Facebook (Grow et al. 2020). The survey collected key information on people’s health status, health-related behaviors, social contacts, and attitudes in response to the COVID-19 pandemic. The data collection took place in eight countries, namely Belgium, France, Germany, Italy, the Netherlands, Spain, the United Kingdom, and the United States. Our analysis is based on 91,376 completed questionnaires collected from March 13 to May 7, 2020. The aim of this study is to quantify the association between the threat perception of COVID-19 and preventive behaviors, in particular the use of face masks, and how this relationship varies between different levels of vulnerability. While people might have adapted to the ‘new normal’ for the second and third waves of the epidemic, our ability to assess changes in perceptions and behaviors at a crucial time of sudden changes and heightened uncertainty enables us to fully assess how events like a pandemic might differentially affect vulnerable groups.

Methods

Data

In this study, we employ data collected through the “COVID-19 Health Behavior Survey” (CHBS) (Perrotta et al. 2021) and we focus, in particular, on two questions in the questionnaire related to threat perceptions of COVID-19 and the adoption of preventive measures with respect to the pre-pandemic period. More specifically, we consider the following variables: i) perception of threat to oneself, which respondents were asked to rate on a 5-point Likert-type scale (1 = very low threat, 5 = very high threat), and ii) the adoption rate of a protective face mask. The sample was limited to respondents who resided in the surveyed country and reported their sex and age (respondents had to be at least 18 years old to participate). More details about the survey de-

	BE	FR	DE	IT	NL	ES	UK	US
No. respondents	7,919	8,233	17,400	11,639	7,209	9,040	10,254	19,682
Women	67%	71%	61%	66%	66%	68%	65%	65%
Older adult	19%	18%	14%	12%	26%	14%	27%	29%
Co-morbidity	28%	28%	31%	18%	37%	29%	33%	39%
Flu vaccinated	23%	21%	19%	17%	28%	20%	43%	55%
Household w/ 65+	10%	9%	9%	16%	11%	16%	15%	16%
Household w/o 65+	15%	14%	10%	14%	9%	10%	12%	14%

Table 1: Characteristics of respondents who completed the CHBS questionnaire from March 13 to May 7, 2020 in Belgium (BE), France (FR), Germany (DE), Italy (IT), Netherlands (NL), Spain (ES), United Kingdom (UK), and United States (US).

sign, the questionnaire, and the recruitment strategy on Facebook can be found in Perrotta et al. (2021) and Grow et al. (2020).

Data analysis

In this study, we explore the perception of threat to oneself and the early adoption of face masks across various groups of potentially vulnerable people, in terms of higher risk of severe complications following an infection from SARS-CoV-2. Specifically, we consider the groups of people who reported i) being an older adult (65 years of age or older), ii) having a co-morbidity, iii) being vaccinated for influenza, iv) living in a household with at least one member aged 65 or over, and v) living in a household without members aged 65 or over. The latter serves as a baseline for evaluating outcomes among non-vulnerable groups.

We use statistical analyses to assess the impact of the aforementioned types of vulnerabilities on the adoption of face masks and the threat perception to oneself – codified as a dummy variable that takes value 1 when respondents reported high or very high threat level, and 0 otherwise. Our modelling strategy is designed to account for the dependence between the outcomes (as they are measured on the same subjects). For this purpose, we use a *bivariate Dale model* (BDM) (Molenberghs and Verbeke 2005), which we use to jointly model the marginal probability of the two outcomes (using logistic regression) and the odds ratio (OR) between the two outcomes (using a log-linear model). For each of the three models, we assess the effect of the vulnerabilities and their interactions on the outcomes, also correcting for sex and country. Finally, to adjust for the simultaneous test of all model coefficients and avoid overconfidence in our results, we construct Bonferroni-corrected confidence intervals (CI), having a 95% confidence in our set of analyses as a whole.

Results

Sample description

Table 1 reports the participation rates and the characteristics of the sample for each country. A total of 91,376 respondents completed the CHBS questionnaire from March 13 to May 7, 2020. The gender ratio is skewed towards women compared to the overall population, ranging from 61% in Germany to 71% in France. Older adults aged 65 or over tend to be over-represented, ranging from 13% in Italy to

29% in the United States. The sample of respondents with co-morbidity ranges between 18% in Italy to 39% in the United States. Vaccinations against influenza is lowest in Italy (17%) and highest in the United States (55%). As for the living arrangements, vulnerable households range from 9% in France and Germany to 16% in Italy, Spain, and the United States, whereas non-vulnerable households range between 9% in the Netherlands to 15% in Belgium.

Descriptive analysis

Overall, the adoption rate of face masks ranges from 8% in the Netherlands to 64% in Italy. These values vary significantly when considering the various categories of perceived threat posed by COVID-19 to oneself. Figure 1 shows that the adoption rates of face masks increases substantially as the perception of threat increases. Taking Italy as an illustrative example, the adoption of face masks increases from 48% for respondents who perceive very low threat to themselves, to 74% for respondents who perceive very high threat to themselves. Considering specifically the adoption of face masks for respondents who perceive a very high threat to themselves, this is on average 53% greater than the adoption of face masks for respondents who perceive a very low threat to themselves (ranging from 30% greater in Spain to 69% greater in the Netherlands).

Figure 2 shows the relationship between the perception of threat to oneself by vulnerable group (indicated by symbols) and country (indicated by colors). We notice that the vulnerable groups cluster by country, sorted from lowest threat perception (Germany) to highest threat perception (the United Kingdom). Moreover, Figure 2 shows that the perception of threat to oneself is highest for respondents with co-morbidity (ranging from 0.51 in Germany to 0.70 in the United Kingdom), followed by those vaccinated for influenza, and those aged 65 or over. The pattern by living arrangements is also revealing: while respondents living in vulnerable households with members aged 65 or over perceive higher threat to themselves, respondents living in non-vulnerable households perceive lower threat to themselves, with the exception of the United States.

Statistical modelling

The descriptive findings are further supported by the BDM estimates (Figure 3), which we used to assess which types of vulnerability were associated with both protective behavior

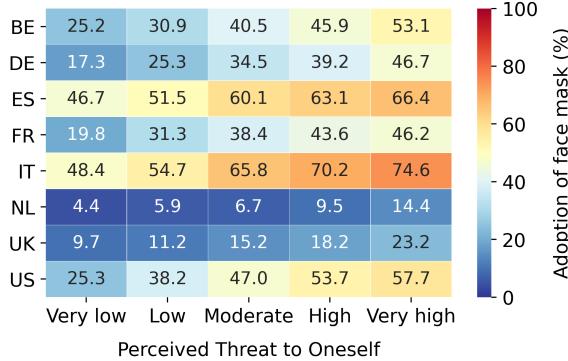


Figure 1: Adoption rates of face masks (indicated by the color code) for each category of perceived threat posed by COVID-19 to oneself, from very low to very high threat, by country (on the y-axis).

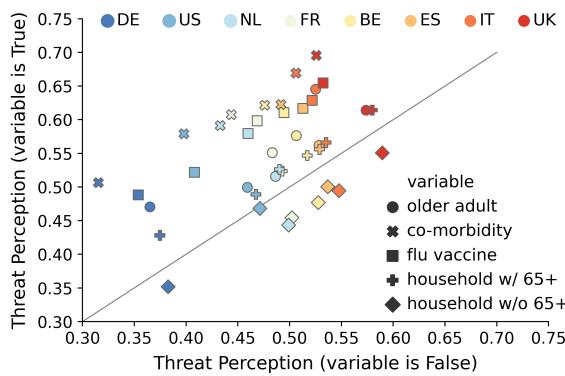


Figure 2: Relationship between the threat perceived to oneself by respondents with (y-axis) or without (x-axis) vulnerability (indicated by symbols). The color code indicates countries, sorted by perceived threat, from lowest (Germany) to highest (United Kingdom). Perceived threat data points are means of Likert-scale values normalized in the range 0–1.

(wearing a face mask) and threat perception (high threat to oneself), and also with their OR.

We found that, across all countries, individuals with a certain type of vulnerability (being an older adult, having a co-morbidity, living in a household with at least one older adult, and being vaccinated for influenza) were more likely to wear a face mask than those not having these characteristics. Such vulnerabilities tended to accumulate and lead to an increased likelihood of adopting the protective behavior. For instance, a person vaccinated for influenza was, on average, 40% (95% CI: 32%–49%) more likely to wear a face mask than someone not vaccinated. However, such probability was 50% (95% CI: 15%–95%) higher if this person was an older adult and 83% (95% CI: 45%–130%) higher if this person had a co-morbidity. Taking the United States as a reference country, we also found that the adoption of face masks was two times larger in Spain and almost three times larger in Italy (OR=2.77, 95% CI: 2.60–2.95). Con-

versely, the adoption of face masks was particularly low in the Netherlands, where its use was 89% (95% CI: 88%–90%) lower than in the United States.

Similarly, individuals with the four aforementioned vulnerabilities were also, on average, more likely to perceive a high threat of COVID-19 to themselves. The odds were especially large for those individuals with a co-morbidity, as they were almost three times more likely to feel highly threatened by COVID-19. For this outcome too, vulnerabilities accumulated, leading to an increased threat perception. For example, on average an older adult was 41% (95% CI: 26%–56%) more likely than a younger adult of feeling highly threatened. However, this threat perception was more than three times larger (OR=3.17, 95% CI: 2.38–4.22) when such older adult was also affected by a co-morbidity. As for differences between countries, the threat perception was more than two times higher in Italy and in the United Kingdom than in the United States, while it was almost 25% lower in Germany, possibly reflecting cross-country differences in the COVID-19 incidence rate at the time of data collection.

Finally, we evaluated the association between face mask adoption and high perceived threat to oneself. After adjusting for the effects of several types of vulnerability, we found that, across countries, individuals who personally felt highly (or very highly) threatened by COVID-19 were 2.25 times (95% CI: 1.94–2.60) more likely to wear a face mask than those who felt very little to moderately threatened. Compared to the United States, this association was weaker in Spain (OR=1.71, 95% CI: 1.27–2.30) and in Italy (OR=1.84, 95% CI: 1.38–2.46). After controlling for the vulnerabilities in both threat perception and behavioral outcomes, we did not find a further impact of such vulnerabilities on the odds ratio, but only a difference between sexes, as for women it was 15% (95% CI: 4%–25%) lower than for men.

Our results were robust to the introduction in the model of the week in which the questionnaire was completed, to reflect the change of the government interventions over time and the effect of social influence.

Discussion and conclusions

The aim of this study was to quantify the association between the threat perception of COVID-19 and the adoption of preventive behaviors, and how it varied between different levels of vulnerability. For this, we leveraged online survey data collected via Facebook using targeted advertising campaigns during the first wave of the COVID-19 pandemic in Europe and the United States.

We focused on specific vulnerable groups we could identify in the survey data, including older adults aged 65 or over, respondents with a co-morbidity, and vulnerable households with at least one member aged 65 or over.

Our findings show that both the adoption of face masks and the threat perception to oneself were higher among the vulnerable segments of the population, especially for those with a co-morbidity, those who had been vaccinated for influenza, and older adults. Overall, we estimated that individuals who perceived a high threat of COVID-19 to themselves were 2.25 times (95% CI: 1.94–2.60) more likely to wear a

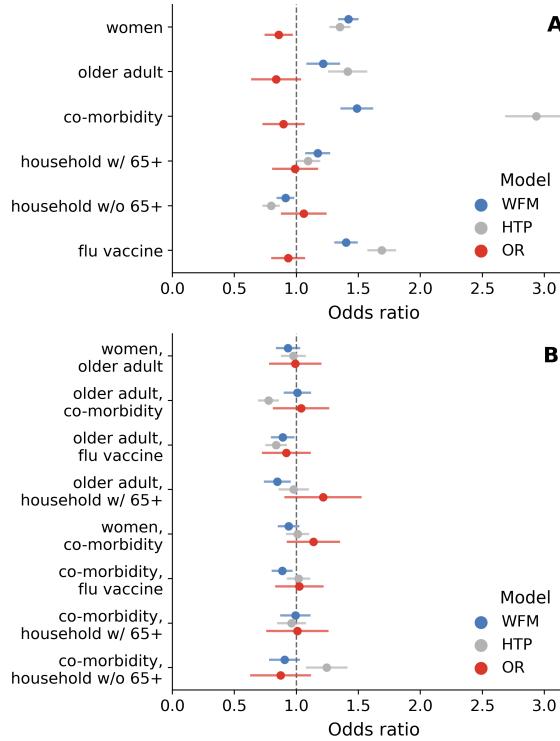


Figure 3: Exponentiated regression coefficients and 95% CI estimated by the BDM for the univariate (A) and interaction terms (B). WFM is a logistic regression for the likelihood of Wearing a Face Mask, HTP is a logistic regression for High Threat Perception to oneself, and OR is a log-linear model for the Odds Ratio between WFM and HTP. The confidence level of each is equal to $1 - \alpha/m$, where m is the number of tested parameters in the model, so that the overall confidence level is 95%.

face mask than those with lower threat perception. Our results also show how vulnerabilities can accumulate, leading to higher levels of threat perception and protective behavior.

It is important to note that, in the observation period of this study, the recommendation of using a protective face mask in public or in closed spaces was still in its early phase, with substantial heterogeneity across countries, ranging between the beginning of April (Germany and Italy) and June (the Netherlands and the United Kingdom) (Hale et al. 2021). However we were able to capture a very unique moment in history of bottom-up behavioral change in the population, especially in contemporary Western societies where the use of face mask is not common.

Our study comes with limitations, including the biases related to self-selection that may emerge in online surveys. Although digital data have enhanced our understanding of the COVID-19 pandemic, attention to what types of data are used and who is represented in the data are critical to avoid limiting the validity of conclusions drawn (Chunara and Cook 2020). In this context, post-stratification techniques allow one to correct for major biases and approximate a representative sample of the population in each country, at

least in central demographic variables. More methodological work to assess biases is beyond the scope of this article, but we consider it an important aspect that we will explore in future works to guarantee appropriate coverage of under-represented groups (Schonlau et al. 2009).

In conclusion, our study contributes to reduce the gap in human behavioral data and shed light on how vulnerable populations rapidly adopted the use of face masks early on in the COVID-19 pandemic, as driven by their perception of threat. As the pandemic progresses with new waves of infections, such insights are crucial to increase situational awareness of the most vulnerable and guide the decision-making process.

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