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Assessing self-selection biases in online surveys: Evidence from the COVID-19 Health Behavior Survey

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Assessing self-selection biases in online surveys: Evidence from the COVID-19 Health Behavior Survey

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Abstract

During the COVID-19 pandemic, many primary data collection efforts relied on online surveys via social media recruitment. According to the leverage-salience theory, respondents' differential levels of interest in the survey topic can lead to differential survey responses, potentially introducing biases. In this study, we investigate the potential impact of survey recruitment materials on survey responses. We use data from the "COVID-19 Health Behavior Survey", a cross-national online survey that we ran between March and August 2020 in eight countries in Europe and North America (N=120,184). Respondents were recruited via targeted Facebook advertisements with varying degrees of reference to the survey topic of COVID-19. The aim of our study is to understand whether survey responses from images more strongly (or weakly) related to COVID-19 are associated with higher (or lower) threat perceptions of COVID-19 and the adoption of preventive behaviors, including face mask usage and increased hand-washing. Descriptive results indicate variations in our sample composition by ad image in terms of sex, age, and educational status of respondents. Our findings from the regression analyses show that, in 18 of the 32 models, ad images had no significant effect on the survey outcomes. Factors like the month of survey participation or respondents' age were more influential. In the remaining models where unexplained image effects persisted, the impact was minimal. The mask-wearing images were generally associated with lower threat perceptions of COVID-19 to oneself and the family. On the contrary, we found no consistent association between higher topic salience and the adoption of protective behaviors. Our findings provide empirical evidence of minimal self-selection biases based on recruitment images used early on during the COVID-19 pandemic, thus alleviating concerns regarding potential sources of bias in unobservable characteristics.

1 Introduction

Online surveys are popular in social science because they offer a flexible and timely approach to data collection (Wenz 2019). At present, a sizable fraction of these studies utilize Facebook and other social media platforms as a source for recruiting respondents due to their broad coverage and the advantage to implement sampling quotas to target users with certain characteristics (Thornton et al. 2016). This approach was extensively used during the COVID-19 pandemic, given the impracticality of employing more traditional forms of data collection (e.g., in-person interviews). Online surveys therefore offered researchers the opportunity to collect real-time data essential to inform health policies and to increase situational awareness (Hlatshwako et al. 2021). Survey studies were designed for various purposes, some examples include measuring public concerns and compliance with health regulations (Nelson et al. 2020), investigating the sources people relied on for COVID-19 information (Wang et al. 2020), and assessing the psychological impact of lockdown measures to inform policy recommendations (Qiu et al. 2020).

While many scholars have highlighted the advantages of using social media for survey recruitment, concerns have also been raised about data quality, often due to non-representativeness and self-selection biases (De Man et al. 2021). Since internet users differ from non-internet users, non-representativeness may bias results, and this risk might be even higher when respondents are recruited solely via a single social media site (Bethlehem 2010). Additionally, the multi-step decision-making process that individuals typically undergo before participating in a survey may introduce self-selection bias into the sample (Bethlehem 2010). For example, the salience of and the level of interest in the survey topic may affect participation, which in turn may affect survey responses (Robert M. Groves, Singer, and Corning 2000, R. M. Groves, Presser, and Dipko 2004, Zillmann et al. 2014). Previous studies have in fact indicated that when a survey topic is highly salient in the recruitment process, it tends to attract participants with specific interest in the topic, potentially leading to response behaviors that differ from those of the general population (Batterham 2014, Choi et al. 2017). In the case of survey recruitment via Facebook, participation invitations are promoted through ad-hoc advertisements that include a caption and image or video. These elements play a crucial role in conveying the survey topic during recruitment, potentially affecting self-selection issues (Kühne and Zindel 2020).

In the context of the COVID-19 pandemic, while online surveys provided timely and valuable insights, the extent to which survey data may have overestimated certain outcomes due to the self-selection of respondents with greater interest (or concern) in the pandemic remains unclear. As an example, a survey advertisement explicitly mentioning the disease in the recruitment process may have recruited participants with a particular interest in the topic, potentially leading to biased

survey outcomes (e.g., inaccurate estimates of threat perceptions or the uptake of protective measures).

In this paper, we seek to address this research question by investigating whether making the survey topic salient during the recruitment process may affect self-selection bias and, consequently, survey results. The aim of this study is therefore to improve our understanding on whether, and to what extent, self-selection based on topic interest can influence the quality of responses to online surveys. For this, we use data from the "COVID-19 Health Behavior Survey" (CHBS), a cross-national online survey that we conducted between March 13 and August 12, 2020, in eight countries in Europe and North America (Perrotta, Grow, et al. 2021). It focused on respondents' behaviors and attitudes related to the COVID-19 pandemic. Recruitment took place via targeted advertisements on Facebook that were stratified by various demographic characteristics. The ads varied in the level of salience of the survey topic depending on the image used in the ad: some images made COVID-19 highly salient, while others made no reference to the disease. The CHBS therefore offers quasi-experimental data that allow us to assess the impact of self-selection bias induced by topic salience on survey outcomes. If topic salience indeed affected respondents' selection, we would expect to observe significant differences in survey responses based on the level of salience of the ad images used in the recruitment process. This is based on the leverage-salience theory developed by Groves and colleagues, which posits a positive association between people's interest in the survey topic and their willingness to participate (Groves 1992). On the contrary, our results show that the ad images had no effect on the survey outcomes in 18 out of 32 models we calculated. Furthermore, in those cases where the responses differed depending on the advertising images, the observed effect size was small, and there was no clear evidence that increased topic salience resulted in higher levels of threat perceptions and compliance with preventive measures.

2 Theory and background

Non-probability samples suffer from self-selection bias, as respondents recruit themselves into the sample. This leads to biased samples, and thus to biased estimates, given that not all potential participants have an equal probability of participating (Bethlehem 2010). While differences in known characteristics, such as age and gender, can be addressed through post-stratification methods, adjusting for unknown factors, such as interest in the survey topic, is more challenging as they cannot be observed (Perrotta, Grow, et al. 2021, Zhang et al. 2020).

In the following, we will first introduce the leverage-salience theory, which aims to explain the mechanisms influencing survey participation. Next, we will present prior research on the impact of various advertisement designs on survey participation and

responses, with a particular emphasis on Facebook surveys. Lastly, we will provide an overview of the demographic characteristics associated with varying degrees of interest in the survey topic and different responses to the pandemic.

2.1 Leverage-salience theory

The leverage-salience theory explains that people's participation in surveys is influenced by their perception of the benefits, and how these benefits are emphasized in the survey request. This approach was developed based on experiences with in-person recruitment, which suggested that interviewers can increase participation by emphasizing survey aspects of interest to potential respondents (Groves 1992). These factors can be, for example, the survey topic, the monetary incentive, the length of the survey, or the institution that conducts the research. People's likelihood of participating in surveys is therefore influenced by their perceptions of these factors, which can also vary depending on their individual characteristics (Robert M. Groves, Singer, and Corning 2000). For example, for people with a specific interest in the study subject, a monetary incentive has less influence on their likelihood of participation compared to those not interested in the subject (R. M. Groves, Presser, and Dipko 2004). Applying these theoretical considerations to our COVID-19 survey study, we hypothesize that the level of salience of our survey invitation may have influenced differently potential respondents' perceptions of the benefits of participation and, consequently, their motivation to participate.

2.2 Topical self-selection in Facebook surveys

Leveraging Facebook as a recruitment tool for online surveys has gained popularity in survey research (Iannelli et al. 2020, Grow, Perrotta, Del Fava, Cimentada, Rampazzo, Gil-Clavel, Zagheni, et al. 2022, Pötzschke and Braun 2017). One key advantage is its nearly global coverage, and its status as one of the most used social networks (Kassa, R. Cuevas, and A. Cuevas 2018). Additionally, Facebook offers researchers the opportunity to recruit hard-to-reach populations, such as sexual minorities, who are typically difficult to recruit via traditional forms of recruitment (Kühne and Zindel 2020).

The recruitment of respondents through Facebook usually takes place via targeted advertisements that allow researchers to specify which Facebook users will be shown the advertisement based on their characteristics, such as age, gender, region, or specific interest. Facebook ads can include various elements, such as an image or a video, a caption incorporating the topic and name of the survey, or some other phrase intended to motivate potential respondents to participate, and a link to the questionnaire. The ads are hosted by a Facebook page, which is ideally specific to the survey. The aim of this page is to provide additional background information about

the research, and thus to build trust with potential respondents. By clicking on the link included in the advertisement, respondents are directed to an external webpage hosting the questionnaire (Kühne and Zindel 2020). The elements included in the advertisements can impact participation, and therefore also the survey measures (Neundorf and Öztürk 2023). This is referred to as topical self-selection, whereby participants with a specific interest in the topic are recruited (Lehdonvirta et al. 2021). The challenge for this kind of selection process is that the characteristics that determine the respondents' interest in the study are often unknown, and thus cannot be accounted for (Eysenbach and Wyatt 2002).

Only a few studies that used Facebook as a recruitment tool have reported differences in the performance of their advertisement design. Overall, it appears that simpler images and designs result in lower cost per completed questionnaire and higher participation. Ramo et al. 2014 recruited young adult smokers for an intervention study, and found that more simplistic advertisement images (e.g., showing only a cigarette) resulted in higher participation rates. Similarly, Bennetts et al. 2019 used a Facebook ad campaign to recruit working parents in Australia, and reported that using simpler images (e.g., a picture of a father and a son on a bike ride) recruited more participants, and was thus less expensive than using more crowded images (e.g., a picture of parents with several children). Batterham 2014 used Facebook to recruit participants for a survey on mental health in Australia, and found that advertisements using problem-focused phrasing resulted in higher completion rates than those using positive phrasing. Specifically, the formulation "mental health problems" was more effective in recruiting participants than "emotional well-being" (Batterham 2014). Machado et al. 2019 reported similar results for a smoking intervention study in Brazil, which indicated that advertisements showing the risk of smoking received a higher number of clicks than advertisements showing the benefits of not smoking. Additionally, August et al. 2018 found that framing ads on respondents' self-discovery (e.g., "How is your brain wired?") increased participation rates. However, the study found that participants recruited through this framing were more motivated by boredom compared to those recruited through a compare (e.g., "Do you think like others?") or "fun and bored" framing (e.g., "Can you predict the weather?").

The images and captions in the advertisements can have an effect not only on participation rates, but also on survey responses. While studying mental health among men in Australia, Choi et al. 2017 found that the choice of images and of phrasing of the Facebook advertisements had an effect on the measured mental health outcomes, engagement levels, and time spent on the survey. While the formulation "How tough is your mind?" received the highest number of clicks on Facebook, these participants completed fewer questions about mental health. On the other hand, the participants recruited through the phrasing "Worried about your mental health?"

reported poorer mental health status (Choi et al. 2017).

Stern et al. 2020 used Facebook to recruit young men in the United States from sexual minorities. While they found that using a video vs. using an image in the advertisement made no difference in the response rates, they also observed that respondents who entered the survey through the ad with the image had fewer non-substantive answers than those who entered the survey through the ad with the video. Neundorf and Öztürk 2022 compared advertisements with and without political references and advertisements offering an incentive in Turkey and in Spain. They found that the advertisements with political references had lower recruitment costs, but also recruited a larger share of participants with a heightened interest in politics, which resulted in an unbalanced sample. The most representative sample was achieved through advertisements mentioning an incentive. However, the different design choices had no impact on the response quality (e.g., passing an attention check question in the survey) (Neundorf and Öztürk 2022).

Finally, previous research using the survey data from the "COVID-19 Health Behavior Survey" indicated that the perceived threat of COVID-19 differed between respondents depending on whether they were or were not recruited through an advertisement image with reference to the pandemic (Grow, Perrotta, Del Fava, Cimentada, Rampazzo, Gil-Clavel, and Zagheni 2020).

Our study expands on this previous research in several ways. First, while most of the existing studies focused on participation rates, here we focus on the effect of the advertisement content on the survey responses. Moreover, while prior studies targeted a specific subpopulation (e.g., parents, smokers, or men), in our study we targeted the general population and controlled for additional demographic characteristics that may have affected the response behavior. Moreover, whereas previous studies focused on one country only, our study offers a cross-national comparison, and thus provides important insights for the design of future campaigns aimed at international recruitment.

2.3 Online surveys during the COVID-19 pandemic

Surveys conducted during the early months of the COVID-19 pandemic showed a general heightened interest in the topic of COVID-19 (De Man et al. 2021). However, empirical evidence suggests that this effect differed across demographic subgroups, with sex, age, and education being among the most important determinants. Since our aim is to estimate the effect of the display of the survey topic on different outcomes, we need to consider aspects that may impact the interest in the survey topic in our analysis. Early empirical evidence has suggested that women were generally more concerned than men about COVID-19 (Galasso et al. 2020, McElroy et al. 2020, Oreffice and Quintana-Domeque 2021). Similarly, older individuals reported being more concerned about the disease than younger individuals (Maxfield

and Pituch 2021). As for educational attainment, Lüdecke and von dem Knesebeck 2020 indicated that lower-educated people were less likely to comply with COVID-19 containment measures, such as avoiding large gatherings or increasing hand hygiene, than their higher-educated counterparts.

Previous research using the survey data from the "COVID-19 Health Behavior Survey" support the findings by age and gender, indicating that the perceived threat of COVID-19 was indeed higher among women than among men, and that younger respondents perceived COVID-19 as a lower threat to themselves, but as a higher threat to their family members. Consequently, the adoption rates of protective behaviors, such as wearing a face mask, were higher for women and for people over age 45 (Perrotta, Grow, et al. 2021). Additionally, different levels of vulnerability to COVID-19, such as age over 65 years or the presence of comorbidities, were found to be associated with higher threat perception and higher probability of wearing a face mask. Threat perception itself, independent of vulnerabilities, was also found to be associated with a higher likelihood of wearing a face mask (Perrotta, Fava, and Zagheni 2021).

Alessandro, De Gaetano et al. 2023 employed a cross-national Facebook survey to look at changes in the adoption of protective behaviors (e.g., social distancing and hygiene measures) after respondents received the vaccination against COVID-19. Their findings show that after the respondents were vaccinated, they reduced their compliance with protective behaviors related to the social sphere, but their likelihood of wearing a mask or following hand hygiene recommendations remained high (Alessandro, De Gaetano et al. 2023).

To conclude, previous research showed that the design of the advertisements can impact the participation and response behavior to survey requests, and the leverage-salience theory highlights several elements within the survey request that can impact the likelihood of survey participation. In this study, we focus on the display of our survey topic. Based on those insights, we expect that a survey request emphasizing COVID-19 may yield systematically different responses compared to a survey request that does not make any reference to the disease. Drawing on previous research that showed varying interest in COVID-19 and threat perceptions across demographic groups, we expect that these differences in responses may be attributed to the demographic characteristics of the sample.

3 Materials and methods

3.1 Study design

In this work, we use data from the "COVID-19 Health Behavior Survey" (CHBS), an online survey that we conducted via Facebook between March 13 and August

12, 2020, in seven European countries and the United States (Grow, Perrotta, Del Fava, Cimentada, Rampazzo, Gil-Clavel, and Zagheni 2020, Perrotta, Grow, et al. 2021). The survey data collection started on different dates across the various countries: March 13, 2020, in Italy, the United Kingdom, and the United States; March 17, 2020, in Germany and France; March 19, 2020, in Spain; April 1, 2020, in the Netherlands; and April 2, 2020, in Belgium. The data collection ended in all countries on August 12, 2020. The questionnaire was designed to explore people's behaviors and attitudes related to the COVID-19 pandemic (e.g., threat perceptions, uptake of preventive measures), along with socio-demographic characteristics (e.g., age, sex, and education) and health indicators (e.g., underlying medical conditions). The questionnaire was available in both English and the national language(s) of the respective countries. The full questionnaire in English can be found in Perrotta, Grow, et al. 2021.

Respondent recruitment took place via targeted advertisements on Facebook. Specifically, we implemented targeting criteria with the aim of disseminating our survey homogeneously across different demographic groups and thus limiting the bias that Facebook's advertising algorithms may generate in the recruiting process when optimizing the ad campaigns. For this, we stratified our advertisements by sex (i.e., male and female), age group (i.e., 18–24, 25–44, 45–64, and 65+ years), and region of residence[1] (as inferred by Facebook). Additionally, we used six different advertisement images, each with distinct reference to the survey topic (Figure 1). Each advertisement displayed one single image, selected by Facebook's algorithms to optimize ad delivery and enhance the likelihood of user engagement. Hence, we had no control over the image shown to Facebook users in the recruiting phase. Nevertheless, for each survey participant, we collected the information about the specific advertisement that targeted them on Facebook and led them to our survey, thus enabling us to associate the ad image and targeting criteria with the survey responses. More details on the design of the Facebook advertising campaigns can be found in Grow, Perrotta, Del Fava, Cimentada, Rampazzo, Gil-Clavel, and Zagheni 2020; Perrotta, Grow, et al. 2021. It is important to note that participation in our survey was contingent upon several factors, including user activity on Facebook during the sampling period, the implemented targeting criteria, and the algorithmic optimization to target respondents more likely to click on the link provided in the advertisement.

Figure 1 shows the six images used in our survey study. All images were health-related, but differed in how prominently they referred to the survey topic of the

[1]In the European countries, the region classification largely followed the NUTS-1 classification, which we aggregated into larger macro-regions. In the United States, the region classification was based on census regions. More details on region stratification used in the Facebook advertising campaigns can be found in Perrotta, Grow, et al. 2021.

COVID-19 pandemic. Images 1 and 2, showing individuals exercising outdoors, made no direct reference to the pandemic. Images 3 and 4 generated moderate levels of salience by featuring people blowing their noses, thus referring to respiratory illnesses but not to COVID-19 specifically. Lastly, images 5 and 6 generated the highest salience, portraying individuals wearing protective face masks. Image 5, in particular, explicitly referred to COVID-19 by displaying an early name of the virus. It is important to note that the only reference to COVID-19 was through the ad images, whereas the ad caption and Facebook page name referred to "health behavior" but not specifically to COVID-19. Based on the leverage-salience theory, we expect that, depending on the respondents' interest in the survey topic of COVID-19, the various images would have different potential to generate topical self-selection bias, ranging from low potential (images 1 and 2) to medium (images 3 and 4) to high (images 5 and 6).

(1) Male athlete
©Adobe Stock/grki

(2) Group of athletes
©Adobe Stock/nd3000

(3) Woman blowing nose
©iStockphoto/Goodboy Picture Company

(4) Couple blowing nose
©iStockphoto/Goodboy Picture Company

(5) Woman wearing mask
©Adobe Stock/shintartanya

(6) Man wearing mask
©iStockphoto/Mihail Rudenko

Figure 1: Images used in the Facebook ads to recruit respondents for the "COVID-19 Health Behavior Survey" conducted between March and August 2020 in eight countries in Europe and North America.

3.2 Data preparation

Out of a total of 289,973 questionnaires, we included only the completed ones in our analyses (N=144,034). From this, we further removed i) questionnaires with missing information on the ad (and thus on the image) through which respondents entered the survey[2], and ii) questionnaires with non-informative responses (i.e., "Don't

[2]This is because this information can only be collected for Facebook users who were directly targeted by the advertisements. Note that respondents could still access the survey through other

know" and "Prefer not to answer") in both dependent and independent variables. Applying these filtering criteria the final data set consists of 120,184 completed questionnaires.

After respondent selection, we apply a standard post-stratification weighting technique in order to correct for potential issues with non-representativeness in the sample. For this, we used population-representative data from Eurostat (Eurostat 2019) and the US census (U.S. Census Bureau, Population Division 2019). In each country, we stratified weights by age group (18-24, 25-44, 45-64, 65+), sex (female, male), and region of residence. We calculated the weights as the proportion of the true population per stratum divided by the proportion of survey respondents. More details on the post-stratification approach can be found in Perrotta, Grow, et al. 2021. Data analysis was conducted using R version 4.0.2.

3.3 Statistical modeling

We assessed the impact of the various ad images, used to recruit survey respondents, on four distinct survey outcomes related to the threat perception and the adoption of preventive measures in response to the COVID-19 pandemic.

The first two survey outcomes refer respectively to respondents' threat perception of COVID-19 to themselves and their family members. Specifically, the perceived threat of COVID-19 was measured in the survey using a five-point Likert-scale, ranging from "very low threat" to "very high threat". From this scale, we created a variable having three possible values (low, medium, and high) by combining the categories "very low threat" and "low threat", and "very high threat" and "high threat". The other two outcomes refer to respondents' adoption of preventive measures to protect themselves from COVID-19, namely, wearing a face mask and increasing the frequency of hand-washing (compared to the pre-pandemic period). While mask-wearing was influenced by public health interventions, hand hygiene was more dependent on changes in individuals' behaviors. Both survey outcomes were measured as a dichotomous variable with the categories "yes" and "no". It is worth mentioning that both survey questions were slightly reworded starting from May 7, 2020, to include a more comprehensive description of each behavior, but with no substantive change in meaning (see Appendix Table A1).

For the survey outcomes related to threat perception, we employed a multinomial logistic regression analysis. By using the "high" category as a base category, the model takes the following forms:

$$\ln \frac{P_{\text{Low}}}{P_{\text{High}}} = \beta_0 + \beta_{\text{image}} + \beta_{\text{sex}} + \beta_{\text{age}} + \beta_{\text{education}} + \beta_{\text{month}} + e_{\text{i}} \qquad (1)$$

means, such as if the advertisement was shared and appeared in their feed, or if someone shared the link to the survey.

$$\ln \frac{P_{\text{Medium}}}{P_{\text{High}}} = \beta_0 + \beta_{\text{image}} + \beta_{\text{sex}} + \beta_{\text{age}} + \beta_{\text{education}} + \beta_{\text{month}} + e_{\text{i}} \quad (2)$$

To predict the adoption of the two preventive behaviors, instead, we used a binomial logistic regression model of the form:

$$\log \frac{P}{1-P} = \beta_0 + \beta_{\text{image}} + \beta_{\text{sex}} + \beta_{\text{age}} + \beta_{\text{education}} + \beta_{\text{month}} + e_{\text{i}} \quad (3)$$

where P refers to the probability of having adopted the given behavior, i.e., wearing a protective face mask or increasing the frequency of hand hygiene.
The regression analysis calculates separate step-wise models for each country and survey outcome. We included respondents' age, sex, and educational attainment as control variables to account for the effects that the image may have on the sample composition. Moreover, since public health recommendations varied over time in each country, we also controlled for the month of survey participation. Specifically, the independent variables in the models above correspond to the following categories:

- *Image* refers to the ad image through which a Facebook user reached our survey. We used image 3 ("Women blowing nose") as the reference.
- *Sex* refers to the respondents' self-reported sex (i.e., male, female). We used female as the reference.
- *Age* represents the respondents' age, grouped into four age brackets (i.e., 18-24, 25-44, 45-64, and 65+). We used the 18-24 age group as the reference.
- *Education* refers to the respondents' educational attainment, grouped into three categories: "secondary school or lower", "university level", and "post-graduate degree". We used "secondary school or lower" as the reference. The detailed breakdown and the re-coding of the education categories can be found in the Appendix Table A2.
- *Month* refers to when the respondent participated in our survey, ranging from March to August 2020. We used March as the reference in all countries, except for Belgium and the Netherlands, where we used April as the reference due to a later start of the data collection.

4 Results

4.1 Descriptive results

In the following sections, we will provide descriptive results on the respondents' recruitment based on the advertising image through which they accessed the survey, as well as by their socio-demographic characteristics and survey outcomes.

4.1.1 Sample characteristics

Our dataset consists of 120,184 questionnaires completed in Belgium (N = 11,337), France (N = 11,791), Germany (N = 22,518), Italy (N = 14,397), the Netherlands (N = 8,364), Spain (N = 11,280), the United Kingdom (N = 11,500), and the United States (N = 28,997). In all countries, the highest share of participants reached our survey through the "woman wearing mask" image (image 5), ranging from 56% in the Netherlands to 81% in the US. This was followed by the "man wearing a mask" image (image 6), which recruited from 10% of participants in Italy to 27% of participants in Belgium. For the "woman blowing nose" image (image 3) participation ranges between 18% in the Netherlands to 3% in the United States. The "couple blowing nose" image (image 4) recruited fewer participants, between 3% of the participants in Spain and 1% in Germany. Finally, the images displaying athletes (images 1 and 2) recruit only a very small share of participants, ranging from 0.1% in France to 2% in Spain (see Table 1). It is worth to note that these participation rates by ad image are a direct result of the ad reach and link clicks, which respectively refer to the number of unique Facebook users who saw the ad and clicked on it. These metrics are provided by Facebook as part of the metadata on the performance of the various ads. Additional details on survey participation rates and metrics are reported in Section 1 in the Appendix.

Looking at the sex ratio of respondents in Table 1, the participation rate was higher for women than for men in all countries, ranging from 60% in Germany to 70% in France. The participation rate was also higher for women across all images, except for the athlete images (images 1 and 2). Specifically, the "group of athletes" image (image 2) recruited more men in all countries, whereas the "male athlete" image (image 1) recruited more men than women in Belgium, France, the Netherlands, and the UK.

Respondents' median age varied, with the lowest in Germany and Italy at 42 years and highest in the United States and the United Kingdom at 58 years (Table 1). Certain images tended to attract younger participants. In all countries, the "woman wearing mask" images (image 5) recruited participants below the median age of the respective country. The "male athlete" (image 1) attracted younger participants in all countries, expect for Germany and Spain. Similarly, the "group of athletes" (image 2) attracted younger participants in Belgium and the Netherlands, and the "couple blowing nose" image (image 4) in France and the United States.

	IMG 1 Male athlete	**IMG 2** Group of athletes	**IMG 3** Woman blowing nose	**IMG 4** Couple blowing noses	**IMG 5** Woman wearing mask	**IMG 6** Man wearing mask	Country total
	Participation rates (%)						
BE	38 (0.3%)	155 (1%)	877 (8%)	181 (2%)	6,981 (62%)	3,105 (27%)	11,337 (100.0%)
FR	6 (0.1%)	115 (1%)	427 (4%)	189 (2%)	9,569 (81%)	1,485 (13%)	11,791 (100.0%)
DE	45 (0.2%)	110 (0.5%)	776 (3%)	136 (1%)	17,964 (80%)	3,360 (15%)	22,518 (100.0%)
IT	47 (0.3%)	148 (1%)	1,154 (8%)	309 (2%)	11,238 (78%)	1,501 (10%)	14,397 (100.0%)
NL	20 (0.2%)	121 (1%)	1,519 (18%)	220 (3%)	4,663 (56%)	1,821 (22%)	8,364 (100.0%)
ES	137 (1%)	179 (2%)	1,133 (10%)	299 (3%)	7,052 (63%)	2,480 (22%)	11,280 (100.0%)
UK	24 (0.2%)	75 (1%)	876 (8%)	259 (2%)	8,630 (75%)	1,639 (14%)	11,500 (100.0%)
US	199 (1%)	398 (1%)	840 (3%)	395 (1%)	23,594 (81%)	3,571 (12%)	28,997 (100.0%)
	Female-to-male ratio in participation rates						
BE	45%	39%	66%	66%	63%	72%	66%
FR	17%	24%	69%	86%	69%	74%	70%
DE	58%	25%	73%	62%	60%	59%	60%
IT	66%	42%	73%	71%	65%	71%	67%
NL	40%	32%	71%	67%	58%	68%	62%
ES	69%	45%	72%	66%	68%	68%	68%
UK	46%	23%	72%	67%	65%	61%	65%
US	72%	15%	70%	67%	64%	63%	64%
	Respondents' median age (IQR)						
BE	43 (24-66)	44 (22-66)	60 (50-66)	53 (23-67)	43 (29-59)	60 (46-66)	51 (34-63)
FR	36 (24-51)	58 (34-66)	58 (44-64)	29 (22-54)	44 (29-69)	61 (47-69)	48 (30-62)
DE	56 (37-65)	52 (24-69)	58 (49-65)	55 (34-66)	40 (28-55)	56 (42-65)	42 (30-58)
IT	35 (24-48)	41 (24-64)	55 (40-63)	42 (28-61)	40 (28-55)	59 (43-67)	42 (29-58)
NL	56 (22-66)	52 (23-68)	62 (54-67)	58 (36-67)	51 (35-62)	62 (55-69)	57 (41-65)
ES	54 (38-60)	53 (36-64)	56 (45-63)	53 (38-62)	45 (36-58)	59 (48-65)	52 (39-61)
UK	40 (23-62)	61 (45-70)	62 (54-68)	60 (42-69)	56 (41-64)	64 (57-70)	58 (43-66)
US	41 (30-59)	63 (52-70)	63 (51-70)	54 (34-67)	57 (39-66)	64 (55-71)	58 (40-67)

Table 1: Descriptive statistics by country and advertising image, including participation rates, gender ratios, and age distribution (median age and IQR in brackets).

Figure 2 shows the variation in the educational attainment across countries and ad images. Respondents with the largest share of university-level education came from France (70%), Spain (56%), and the United States (56%). In Germany (64%), Italy (55%), and the Netherlands (74%) the largest percentage of respondents had a secondary school or lower level education. In Belgium and the United Kingdom, both secondary school or lower education and university education account for approximately 46% to 48% in both countries. We observe that some images recruited higher shares of respondents with a university level education in comparison to the country average. The "male athlete" image (image 1) recruited a higher percentage of university-educated participants, ranging between six and 12 percentage points higher than the country total, in Germany, the Netherlands, the United States, and France. The "group of athletes" image (image 2) showed a similar pattern in Belgium, Germany and the Netherlands. The "woman wearing mask" image (image 5) correlated with higher university education in Belgium, France, Spain, the United Kingdom, and the Netherlands although with smaller differences with maximum eight percentages point above the total country (Figure 2).

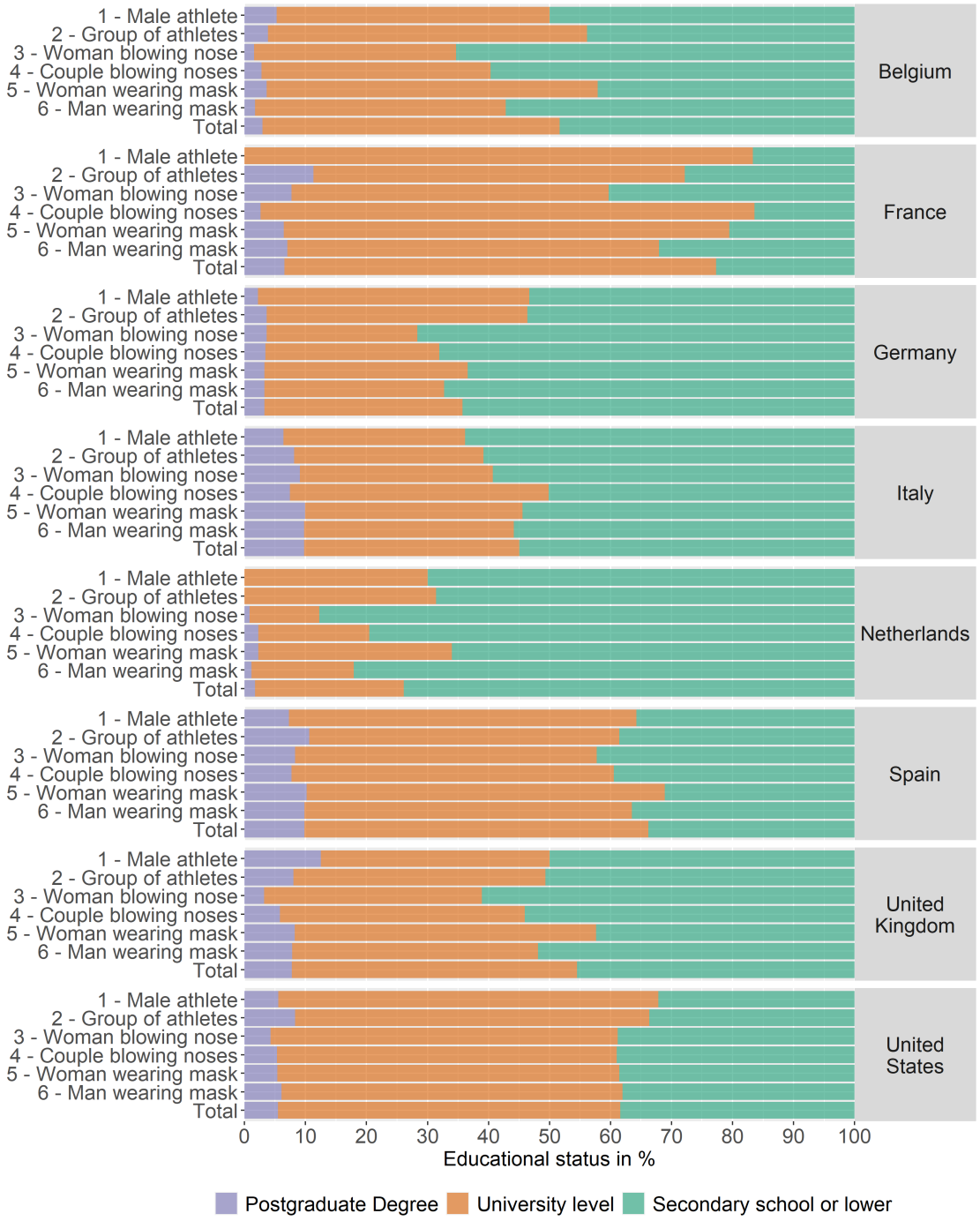

Figure 2: Respondents' educational status by advertisement image and country. Unweighted sample.

4.1.2 Survey outcomes

Figure 3 shows the variation in the perceived threat that COVID-19 posed to the family and to oneself across the various countries and advertisement images. Respondents generally perceived COVID-19 as a higher threat to their family than to themselves (e.g., in Italy 50% perceived COVID-19 as a high threat to their family

vs. 35% to themselves or Germany where 26% perceived COVID-19 as a high threat to their family vs. 19% that perceived it as a high threat to themselves). On the other hands, compared to the values at the country level, we observe differences in the threat perceptions in the athlete images (images 1 and 2) and the "couple blowing nose" image (image 4), which tended to recruit respondents with a lower threat perceptions [3]. Notably, we do not observe striking difference in threat perceptions in the respondents recruited through the mask-wearing images (image 5 and 6).

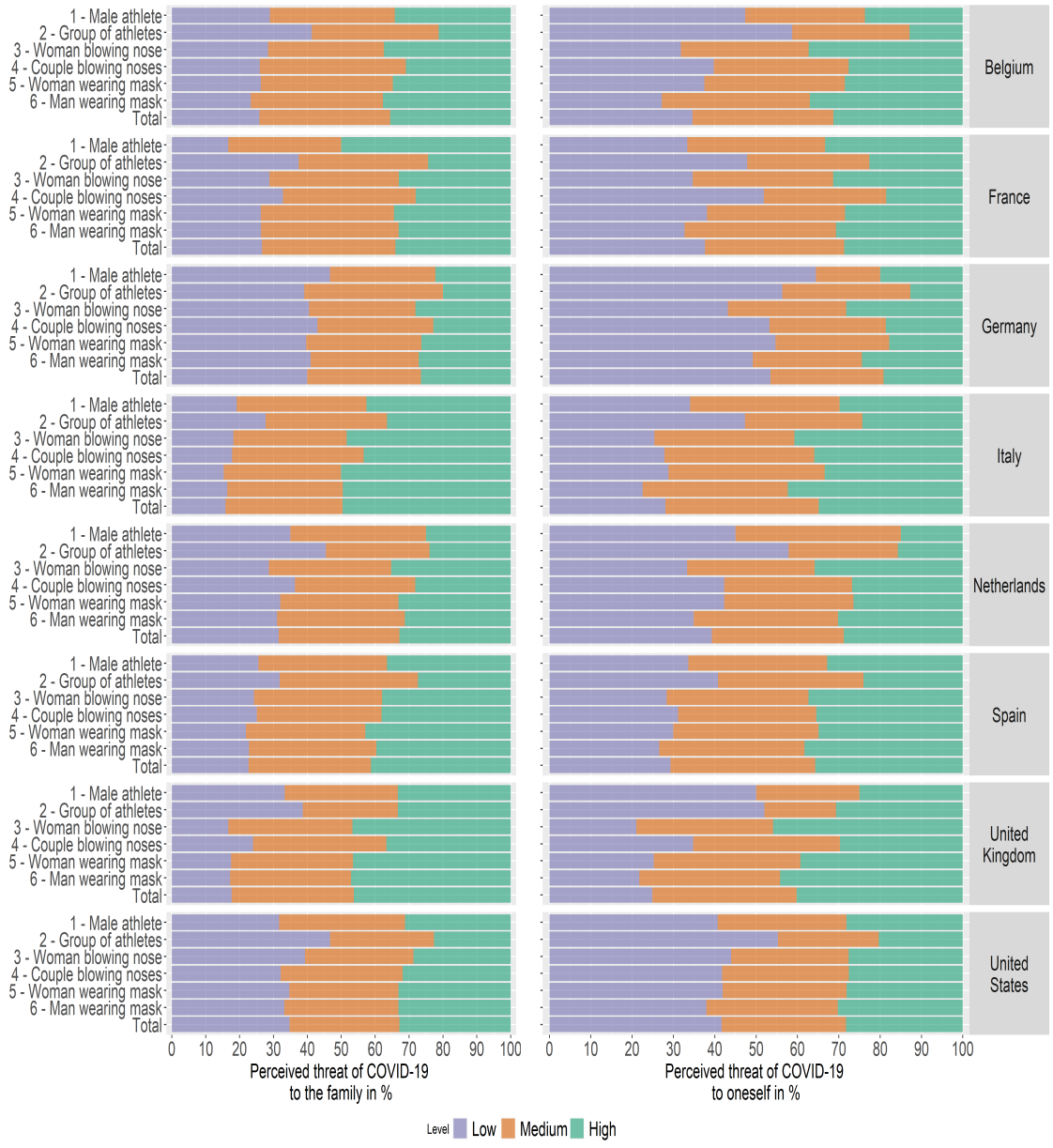

Figure 3: Respondents' threat perception of COVID-19 to the family and to themselves, by advertisement image and country. Unweighted sample.

[3]Except in France, where the "male athlete" image (image 1) resulted in the highest threat perceptions. Although it needs to be noted that this only refers to a sample size of 6 respondents.

Figure 4 shows the adoption rates of preventive measures, i.e. wearing a face mask and increased hand-washing, across the various countries and advertisement images. The use of face masks was lowest in the Netherlands (14%) and the United Kingdom (27%), while being the highest in Spain (70%) and Italy (73%). In all countries, more than 87% of participants increased the frequency of hand washing as a reaction to the pandemic. Notably, we do not observe major differences in the adoption rates for respondents recruited through the mask-wearing images (image 5 and 6). In the majority of the countries, the respondents recruited through the athlete images (images 1 and 2) and the nose-blowing images (images 3 and 4) reported higher adoption of face masks, except in France for the "male athlete" image (image 1) and in the Netherlands for the "woman blowing nose" image (image 3). In Belgium, the Netherlands and Spain the "group of athletes" image (image 2) is associated with a higher adoption of wearing a face mask, but lower adoption of hand washing. In the Netherlands, respondents recruited through the "group of athletes" image (image 2) and the "couple blowing nose" image (image 4) had a higher rate of mask-wearing that is, about 24% of the respondents recruited through those images stated that they had worn a face mask, compared to 14% for the whole country. By contrast, the respondents recruited through the "group of athletes" image (image 2) in the Netherlands were less likely to increase the frequency of hand washing. Overall, we observe that the level of compliance with hand hygiene recommendations did not differ across images, with the exception of the "group of athletes" image (image 2) .

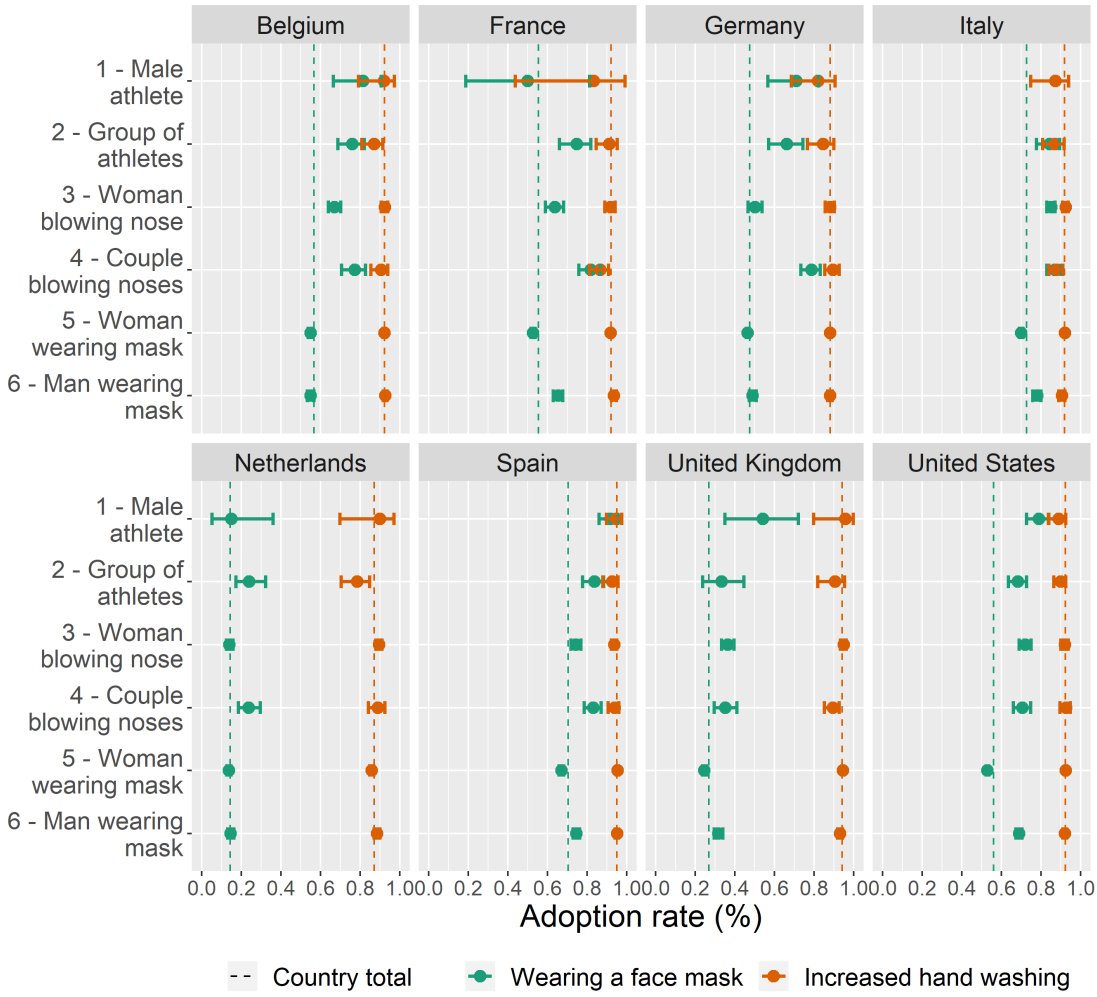

Figure 4: Adoption rates of preventive measures by advertisement image and country. The plots show the proportion of respondents who adopted the behavior and 95% Wald confidence interval. The vertical lines indicate the adoption rate at the country level.

4.2 Model results

In the following, we will present the model results on the probability of threat perceptions and the adoption of preventive measures based on the advertising image through which respondents entered the survey. Note that for this part of the analysis, we excluded images 1 and 2 (i.e., "male athlete" and "group of athletes") because of the low numbers of respondents who reached our questionnaire through the corresponding ads on Facebook (see Section 4.1.1 for more details).

4.2.1 Impact of images on respondents' threat perceptions of COVID-19

To predict respondents' threat perception of COVID-19 to themselves and their family, we applied a multinomial logistic regression model to our survey data by using

image 3 ("women blowing nose") as the reference. The variable threat perception takes three possible values (i.e., low, medium, and high) and we used the "high" category as the model base category.

Figure 5 shows the resulting model estimates of the probability of threat perception of COVID-19 to the family and to oneself, broken down by advertisement image and country. Overall the model estimates confirm the pattern that we observed looking solely at descriptive statistics on how the threat perception is generally higher to family members than to oneself. From the figure it stands out that the model estimates for the threat perception to oneself are consistently higher for the low threat perception in comparison to the estimates for the threat perception to the family. We observe the opposite for the high threat perception, here the probability is higher for the perceived threat to the family, than for the perceived threat to oneself. Looking at the threat perception of COVID-19 to the family, we observe that the perceived threat of COVID-19 differed across advertisement images only in the United States. Here, the respondents recruited through the "woman wearing mask" image (image 5) had a slightly higher probability of perceiving a low threat (34%, CI: 0.33-0.35) compared to the respondents recruited through both the "couple blowing nose" (0.28%, CI: 0.24-0.33) image (image 4) and the "man wearing mask" image (image 6) (30%, CI: 0.28-0.31). The respondents recruited through the "couple blowing nose" image (image 4) had a higher chance (39%, CI: 0.34-0.44) of perceiving a medium threat compared to those recruited through the "woman wearing mask" image (image 5) (33%, CI: 0.32-0.34). The respondents recruited through the "man wearing mask" image (image 6) had a slightly higher chance of perceiving a high threat (36%, CI: 0.34-0.38), than those recruited through the "woman wearing mask" image (image 5)(33%, CI: 0.32-0.34).

The perceived threat of COVID-19 to the family did not differ across advertisement images in the remaining countries. Specifically, the images had no effect on the perceived threat of COVID-19 to the family in any of the models in France, Germany, Italy, and the United Kingdom. Initial differences in Spain were explained by adding the age to the model. For Belgium and the Netherlands, the month of participation explained previous differences by image. The corresponding figures of the step-wise models of the threat perception of COVID-19 to the family can be found in Figures A2A to A2G in the Appendix.

As for the perceived threat of COVID-19 to oneself, instead, we found some effects of the advertising image on the respondents' threat perceptions to themselves in the final model in Belgium, Germany, Italy, and the United States. First, in Germany and the United States the image "woman wearing mask" (image 5) was associated with a lower threat perception compared to the image "men wearing mask" (image 6). In Germany, the participants recruited through the "woman wearing mask"

Figure 5: Predicted probability of perceived threat of COVID-19 to the family (in green) and to oneself (in orange) by advertisement image (on the y-axis) and country. Controlled for sex, age, education, and month of survey participation. Weighted by age, sex, and region of residence.

image (image 5) had a lower probability (18%, CI: 0.17-0.18) of perceiving COVID-19 as a high threat, compared to those recruited through the "man wearing mask" image (image 6) (20%, CI: 0.19-0.22). In the United States, the respondents recruited via the "woman wearing mask" image (image 5) had a higher chance (42%, CI: 0.41-0.43) of perceiving COVID-19 as a low threat to oneself, compared to those recruited through the "man wearing mask" image (image 6) (36%, CI: 0.35-0.38).

Secondly, in Italy we found differences in comparison to the "woman blowing nose" image (image 3): the participants recruited through the "woman wearing mask" image (image 5) had in fact a higher chance (28%, CI: 0.27-0.28) of perceiving COVID-19 as a low threat than those recruited through the "woman blowing nose" image (image 3) (24%, CI: 0.22-0.26).

Finally, we observe both effects in Belgium. The respondents recruited through the "woman wearing mask" image (image 5) had a higher probability (34%, CI: 0.33-

0.36) of perceiving COVID-19 as a low threat compared to those recruited through the "man wearing mask" image (image 6) (30%, CI: 0.28-0.32). Additionally, respondents recruited through the "woman blowing nose" image (image 3) had a higher chance (35%, CI: 0.32-0.38) of perceiving COVID-19 as a high threat than those recruited through the "woman wearing mask" image (image 5) (30%, CI: 0.29-0.31).

On the contrary, we found no effect of the advertising image on the respondents' perceived threat of COVID-19 to themselves in the final model in France, Spain, the Netherlands, and the United Kingdom. The initial differences were explained by adding age to the model in Spain, France, and the United Kingdom (see Appendix Figures A3F, A3B and A3G) and by adding the month of survey participation in the model in the Netherlands (see Appendix Figure A3E).

4.2.2 Impact of images on respondents' adoption of preventive behaviors

To predict the adoption of preventive behaviors in each country, we applied a binomial logistic regression model to our survey data by using image 3 ("Women blowing nose") as the reference. Figure 6 shows the resulting model estimates of the probability of wearing a face mask and of increased hand washing by advertisement image and country.

As for the probability of wearing a face mask, we found that some effects of the images remained unexplained in the final model in all countries, except for Spain and the Netherlands. In Belgium and Italy, the mask-wearing images (images 5 and 6) were generally associated with lower masking in comparison to the nose-blowing images (images 3 and 4). In Belgium, we found a small effect size with nearly overlapping confidence intervals. Specifically, the respondents recruited through the "man wearing mask" image (image 6) had a lower chance (55% , CI: 0.53-0.57) of wearing a face mask compared to those recruited through the "couple blowing nose" image (image 4) (65% , CI: 0.58-0.73). We observe a similar but smaller difference in Italy, where the participants recruited through the "man wearing mask" image (image 6) had a slightly lower chance (76%, CI: 0.74-0.78) of wearing a face mask than those recruited through the "woman blowing nose" image (image 3) (80%, CI: 0.78-0.82).

Results for Germany and the United States differ slightly. In Germany, all images have a lower chance of respondents wearing a face mask compared to the "couple blowing nose" image (image 4), with about 50% compared to about 60% (CI: 0.52-0.67) for those recruited through the 'couple blowing nose" image (image 4). In the United States, the respondents recruited through the "woman wearing mask" image (image 5) have a lower chance (53%, CI: 0.53-0.54) of wearing a face mask compared to the "men wearing mask" image (image 6) (61%, CI: 0.60-0.63) and "woman blowing nose" image (image 3) (62%, CI: 0.58-0.66).

In France, we observe slight differences in mask-wearing between image 5 and

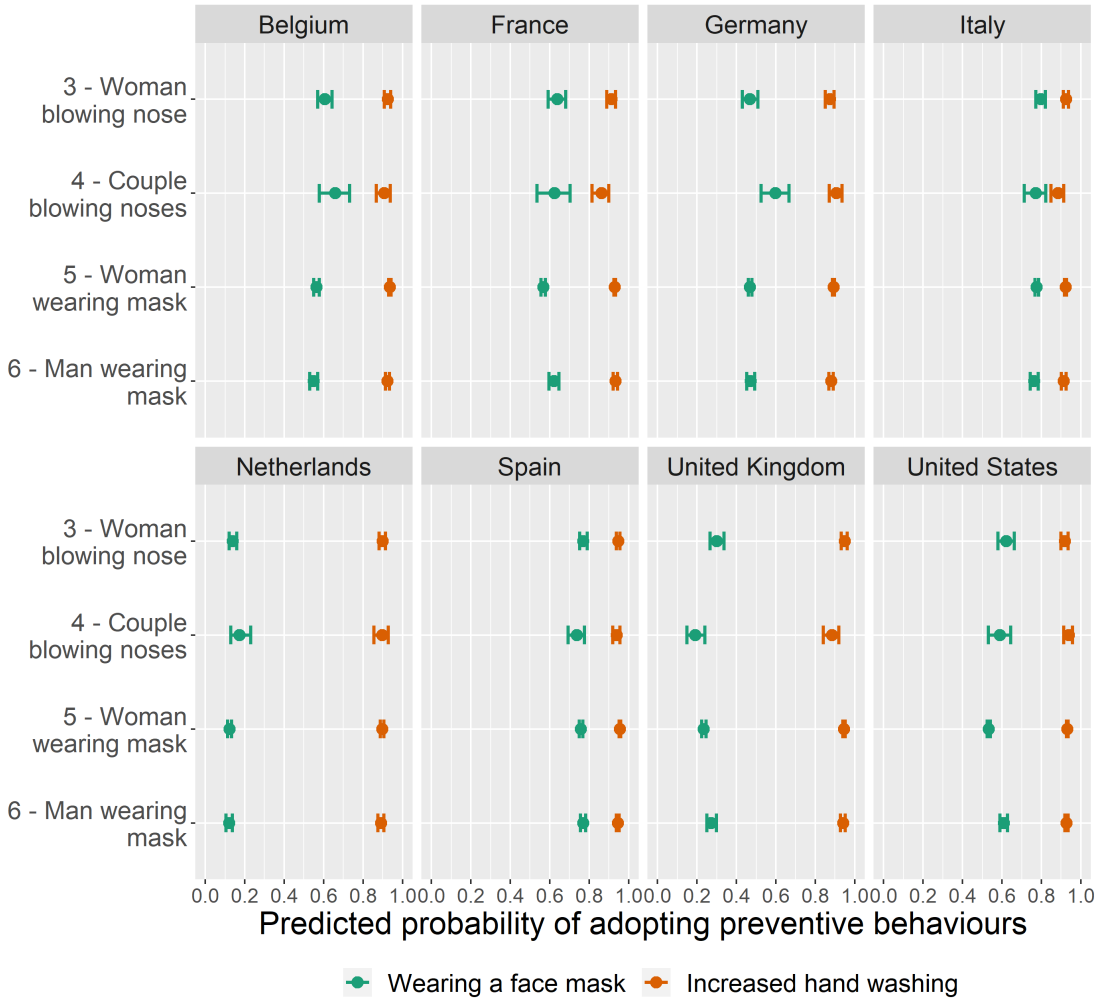

Figure 6: Predicted probability of wearing a face mask (in green) and increased hand washing (in orange) by advertisement image (on the y-axis) and country. Controlled for sex, age, education, and month of survey participation. Weighted by age, sex, and region of residence.

6. Respondents from the "woman wearing mask" image (image 5) had a slightly lower chance (57%, CI:0.56-0.58) of wearing a face mask compared to respondents from the "men wearing mask" image (image 6)(62%, CI: 0.60-0.65). In contrast to the other countries, only in the United Kingdom, respondents recruited through the " couple blowing nose" image (image 4) were less likely to wear a face mask. The respondents from the "couples blowing nose" (19%, CI: 0.15-0.24) and "woman wearing mask" (24%, CI: 0.22-0.25) images had a lower probability of wearing a face mask than those recruited through the "woman blowing nose" image (30%, CI: 0.27-0.34).

Lastly, the differences across images n Spain and the Netherlands were explained by adding the month of survey participation to the model (see Appendix Tables A9 and A10).

Looking at the probability of increased hand hygiene in Figure 6, we found significant differences across images in fewer countries, namely France, Italy, and the UK, with smaller effect sizes compared to the use of face masks. Notably, contrary to the previous outcome of wearing a face mask, the "couple blowing nose" image (image 4) was associated with a lower probability of increased hand hygiene compared to the mask-wearing images (images 5 and 6). However, the effect size was very small. In France, the respondents recruited through the "couple blowing nose" image (image 4) had lower chance (87%, CI: 0.81-0.9) of increased hand hygiene, compared to about 93% for those recruited through the mask-wearing images (images 5 and 6). We observed similar results in the United Kingdom, where respondents recruited through the "couple blowing nose" image (image 4) had an 89% chance (CI: 0.84-0.92) of increased hand hygiene, compared to about 95% for the mask-wearing images (images 5 and 6). In Italy, the participants recruited through the "couple blowing nose" image (image 4) had a slightly lower chance (89%, CI: 0.85-0.91) of increasing the frequency of hand washing only in comparison to those recruited through the "woman wearing mask" image (image 5) (92%, CI: 0.92-0.93).

Finally, we found no meaningful effect of the images on the survey measure of increased hand hygiene in Belgium, Germany, Spain, the Netherlands, and the United States. Initial differences were explained by adding the month of survey participation to the model (see Appendix Tables A13, A14, A18, A17 and A20).

Overall, the most significant predictor of the adoption of preventive behaviors was time in all countries. In Spain and the Netherlands, the effect of the various images on the survey outcome of wearing a face mask was fully explained by adding the month of survey participation to the model. When unexplained differences between images remained, the effect sizes were small and no systematic direction could be detected. The confidence intervals for these estimates are closely grouped, with differences of no more than 10 percentage points.

5 Discussion

According to the leverage-salience theory, differential levels of interest in the survey topic are associated with differential answering behavior in the survey. The goal of this work was to investigate the effect of survey recruitment material on the survey responses provided in the survey. Specifically, we explored whether the survey responses differed depending on the image used in the advertisement to recruit respondents via Facebook. To do so, we leveraged unique survey data from the "COVID-19 Health Behavior Survey", a cross-national online survey that we ran via Facebook between March and August 2020 in eight countries in Europe and North America. We analyzed a total of 120,184 completed questionnaires. Survey respondents were recruited via Facebook advertisements that differed only in the

ad image, chosen by Facebook algorithms among six different images with different reference to the survey topic. In our analysis, we first provided descriptive results on four different survey outcomes by advertising image, namely: i) the respondents' perception of the threat of COVID-19 to their family members, ii) the respondents' perception of the threat of COVID-19 to themselves, iii) the use of protective face masks, and iv) the increased frequency of hand washing (compared to the pre-pandemic period). Then, we used regression analyses to examine the effects of four ad images on the probability of the threat perceptions of COVID-19 and the adoption of preventive measures. We hypothesized that images with stronger reference to the COVID-19 pandemic would lead to a selection of respondents with greater interest in the survey topic, and thus with higher threat perceptions of COVID-19 and higher levels of compliance with recommended health behaviors compared to respondents recruited through images that made little to no reference to the survey topic.

Our findings can be summarized in three main points. First, the descriptive analysis showed that the sample composition varied by ad image in terms of the sex, age, and educational status of the respondents. While the participation rate was generally higher for women, the athlete images (images 1 and 2) recruited more men. Regarding the age composition, respondents tended to be younger than the median age in the respective countries for the athlete images (images 1 and 2) and the "woman wearing mask" image (image 5). The respondents who were recruited through the athlete images (images 1 and 2) and the "couple blowing nose" image (image 4) tended to perceive the threat of COVID-19 as lower. For the adoption of preventive measures, we observed some variations across the various images, with respondents from the mask-wearing images (images 5 and 6) being less likely to use a face mask. We found no differences in the likelihood of increased hand hygiene depending on the ad image.

Second, the results from the regression models revealed that the impact of the ad image on the various survey outcomes was explained by adding either the month of survey participation or the respondents' age to the model. Specifically, the month was a significant explanatory factor for face mask usage in Spain and the Netherlands, as well as for increased hand hygiene in Belgium, Germany, the Netherlands, and the United States. Similarly, it accounted for image effects on the threat perception of COVID-19 to the family in Belgium and the Netherlands, and on the threat perception of COVID-19 to oneself in France and Spain. Age also played a crucial role, explaining the image effect on the threat perception of COVID-19 to oneself in France, Spain, and the United Kingdom, as well as on the threat perception of COVID-19 to the family in Spain.

Third, in cases where unexplained image effects on the survey outcomes persisted, the direction of these effects differed depending on the specific outcome and country. Contrary to our initial hypothesis, we generally found that higher salience

of the survey topic in the ad image was associated with lower compliance with the recommendation to wear face masks. However, this association also displayed variations across countries. For instance, respondents recruited through the "couple blowing nose" image (image 4) were more likely to wear face masks in Germany (60%, CI: 0.52-0.67), but less likely in the United Kingdom (19%, CI: 0.15-0.24). Conversely, respondents recruited through mask-wearing images were about three to six percentage points more likely to report increased hand washing. Regarding the threat perception of COVID-19 to oneself, respondents recruited through the "woman wearing mask" image (image 5) tended to have a lower threat perception, although the effect sizes were small. This pattern was similarly observed for the threat perception of COVID-19 to the family, but only in the United States.

This study comes with several limitations that need to be considered for a comprehensive interpretation of our results. First of all, it is important to recognize the unique circumstances during the first months of the COVID-19 pandemic. The public health interventions and the progression of the COVID-19 pandemic varied across countries and over time (Yuri Bruinen de Bruin et al. 2020, Woskie et al. 2021). For example, Italy experienced a large COVID-19 outbreak early on in March, leading to the implementation of public health interventions in early March. Similar measures were implemented in mid-March in Spain and France. By the end of March, movement restrictions were also enforced in Belgium, Germany, the Netherlands, and the United Kingdom. In contrast, the situation was very different in the United States, where COVID-19 became a highly polarizing and political issue soon after the pandemic's onset (Hart, Chinn, and Soroka 2020, Hubner 2021). This polarization may have led to stronger self-selection, particularly for advertising images that explicitly referred to the disease.

In addition, it is important to note that our survey data collection began at different times, with variations of up to three weeks across the countries, ranging from March 13 to April 2, 2020. Analyzing the images' performance over time, we observed that during the first weeks of the Facebook advertising campaigns, the images with the highest topic salience (i.e., the mask-wearing images) recruited the majority of respondents. However, the self-selection bias arising from interest in the survey topic might have been less pronounced than expected. This could be attributed to the various non-pharmaceutical interventions and lockdown measures in effect during that period, which likely leading people to spend more time at home and, thus, more time online and on social media.

Moreover, although some of our advertisements did not explicitly mention the pandemic, they still referred to health-related topics in the ad text and in the name of our Facebook project page (i.e., "Health Behavior Survey"). This reference to health-related topics in the advertisements might have offset some of the effects attributed to the visual image, potentially attracting with higher concerns or interest

in health topics. However, it is important to note that previous research contradicts this assumption, indicating that the visual image in an advertisement has a more substantial impact than the accompanying text (Neundorf and Öztürk 2022).

Regarding the representativeness of the sample, we employed demographic targeting as a measure to mitigate the effects of bias introduced by Facebook algorithms (Neundorf and Öztürk 2023). However, it is important to acknowledge another aspect of the algorithmic bias, which is the platform's tendency to promote advertisements to users more likely to click on links, thus increasing potential self-selection biases.

Lastly, since we lacked independent measures of respondent's pre-survey interest in the survey topic, we relied on the survey topic' salience in the advertising materials as an approximation. This implies that we could only assume that the ad images that made the survey topic more salient attracted respondents with a higher level of interest in the topic.

Despite these limitations, our study provides a significant contribution to the existing literature. Here we shifted the conventional attention on participation rates to delve into the analysis of survey responses influenced by advertisement content. Furthermore, our research offers insights drawn from a cross-national analysis encompassing eight different countries in Europe and North America. Lastly, our emphasis lies in capturing trends within the general population, rather than on specific subpopulations, such as parents, smokers, or men, as done in previous research.

6 Conclusions

Following the leverage-salience theory, in this work we investigated the potential impact of the survey recruitment materials on respondents' survey responses. For this, we leveraged survey data from the "COVID-19 Health Behavior Survey", a cross-national online survey that we ran via Facebook between March and August 2020 in eight countries in Europe and North America.

Notably, our findings did not support our initial hypothesis that higher topic salience in the survey recruitment materials would lead to systematically different survey responses, potentially introducing biases in the survey responses related to the threat perceptions of COVID-19 and the level of compliance with COVID-19 measures. Instead, our study showed that, within the context of the COVID-19 pandemic, the survey responses were not significantly affected by the advertising materials used for respondent recruitment.

In conclusion, the limited influence of topical self-selection observed in our research alleviates concerns about potential biases arising from unobserved characteristics in online surveys that utilized social media for respondent recruitment during the early stages of the COVID-19 pandemic.

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Data availability

The survey data collected and analyzed in this study are not publicly available due to data protection policy.

Ethics approval and consent to participate

This study received ethics approval from the Ethics Council of the Max Planck Society (Application No: 2020_07) on April 2, 2020. National ethics approval from local institutional review committees was deemed unnecessary. This study was conducted by the Max Planck Institute for Demographic Research in agreement with the data protection regulations valid in Germany. Electronic informed consent was obtained from all participants who actively opted in to participate in the online survey, enabling the collection, storage, and processing of their answers. All participants' data was treated anonymously.

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Appendix

Question wordings from March 12, 2020 to May 7, 2020	Question wordings from May 7, 2020 to August 12, 2020
Which of the following actions, if any, have you already taken to protect yourself from the coronavirus?	The list below shows again the same measures. This time, we would like to know which of these measures you have already taken to keep you and others from getting infected with the new coronavirus.
Worn a face mask	Wearing a protective face mask in public (especially when visiting busy, closed spaces, such as grocery stores, shopping centers, or when using public transport, etc.)
Washed hands more often	Washing your hands often with soap and water for at least 20 seconds

Table A1: Question wordings concerning preventive behaviors, specifically wearing a face mask and increasing hand washing, in the "COVID-19 Health Behavior Survey", before and after implementing some changes to the questionnaire on May 7, 2020.

Survey option	Education category
1 or more years of college credit, no degree	Secondary school or lower
12th grade - NO DIPLOMA	Secondary school or lower
Grade one through 11	Secondary school or lower
GED or alternative credential	Secondary school or lower
Kindergarten	Secondary school or lower
No formal education	Secondary school or lower
No schooling completed	Secondary school or lower
Primary school	Secondary school or lower
Regular high school diploma	Secondary school or lower
Secondary school	Secondary school or lower
Some college credit, but less than 1 year of college credit	Secondary school or lower
Associates degree (e.g., AA, AS)	University level
Bachelors degree (e.g., BA, BS)	University level
Masters degree (e.g., MA, MS, MEng, MEd, MSW, MBA)	University level
University-level education (e.g., bachelor's degree, master's degree)	University level
Doctorate degree (e.g., PhD, EdD)	Postgraduate Degree
Postgraduate degree (e.g., PhD, medical doctorate)	Postgraduate Degree
Professional degree beyond a bachelors degree (e.g., MD, DDS, DVM, LLB, JD)	Postgraduate Degree

Table A2: Grouping of the education survey options in questionnaire in the United States to match the education categories in the other countries.

Country	1 - Male athlete	2 - Group of athletes	3 - Woman blowing nose	4 - Couple blowing noses	5 - Woman wearing mask	6 - Man wearing mask	Total
Reach							
BE	63345 (4.6%)	198689 (14.6%)	224747 (16.5%)	100394 (7.4%)	520814 (38.2%)	256952 (18.8%)	1364941 (100.0%)
FR	43968 (2.3%)	331656 (17.1%)	295546 (15.2%)	115462 (5.9%)	919925 (47.4%)	234058 (12.1%)	1940615 (100.0%)
DE	62662 (2.4%)	196876 (7.6%)	531648 (20.6%)	101132 (3.9%)	1283363 (49.8%)	400641 (15.6%)	2576322 (100.0%)
IT	264990 (4.7%)	923367 (16.4%)	878650 (15.6%)	336139 (6.0%)	2620848 (46.5%)	610514 (10.8%)	5634508 (100.0%)
NL	77492 (4.5%)	226966 (13.1%)	418282 (24.2%)	148299 (8.6%)	601557 (34.8%)	255274 (14.8%)	1727870 (100.0%)
ES	834902 (8.1%)	2210993 (21.5%)	1870019 (18.2%)	972593 (9.4%)	2736582 (26.6%)	1673384 (16.2%)	10298473 (100.0%)
UK	110195 (4.4%)	263026 (10.5%)	368143 (14.6%)	186986 (7.4%)	1282140 (51.0%)	304748 (12.1%)	2515238 (100.0%)
US	250864 (6.1%)	974485 (23.9%)	305529 (7.5%)	277172 (6.8%)	1855355 (45.4%)	419466 (10.3%)	4082871 (100.0%)
Total	1708418 (5.7%)	5326058 (17.7%)	4892564 (16.2%)	2238177 (7.4%)	11820584 (39.2%)	4155037 (13.8%)	30140838 (100.0%)
Clicks							
BE	1258 (1.3%)	5314 (5.4%)	19132 (19.3%)	3524 (3.5%)	41657 (42.0%)	28384 (28.6%)	99269 (100.0%)
FR	472 (0.4%)	10478 (8.7%)	17954 (14.9%)	2314 (1.9%)	72464 (60.2%)	16703 (13.9%)	120385 (100.0%)
DE	1358 (0.5%)	7346 (3.0%)	55478 (22.4%)	4743 (1.9%)	135521 (54.8%)	42859 (17.3%)	247305 (100.0%)
IT	5798 (2.0%)	39366 (13.7%)	51519 (18.0%)	8084 (2.8%)	152023 (53.1%)	29653 (10.4%)	286443 (100.0%)
NL	1785 (1.1%)	7022 (4.3%)	59985 (36.4%)	7024 (4.3%)	60014 (36.4%)	29076 (17.6%)	164906 (100.0%)
ES	39249 (7.6%)	113005 (21.9%)	102595 (19.9%)	25504 (4.9%)	145235 (28.1%)	91236 (17.7%)	516824 (100.0%)
UK	2203 (1.5%)	6594 (4.4%)	21493 (14.5%)	5283 (3.6%)	93467 (63.0%)	19241 (13.0%)	148281 (100.0%)
US	3863 (1.8%)	32434 (15.0%)	11094 (5.1%)	5533 (2.6%)	138274 (63.9%)	25080 (11.6%)	216278 (100.0%)
Total	55986 (3.1%)	221559 (12.3%)	339250 (18.9%)	62009 (3.4%)	838655 (46.6%)	282232 (15.7%)	1799691 (100.0%)

Table A3: Facebook reach and link clicks by advertisement image and country. The Facebook reach is the number of unique Facebook users who saw the advertisement.The link clicks by advertisement are numbers of unique Facebook users who clicked on the advertisement).

1 Survey participation rates

Looking at the participation rates over time (Figure A1), the mask-wearing images (images 5 and 6) and the "woman blowing nose" image (image 3) recruited the majority of participants during the first months of the campaign in March and April 2020. The remaining images recruited a stable number of participants over time. Notably, the number of participants recruited through the athlete images (images 1 and 2) never surpassed 100 participants per month. Because of these low numbers, we excluded the two athlete images from the multivariate analysis.

We also calculated the survey completion rate as the number of completed questionnaires divided by the number of link clicks that each advertisement received. On average, the images most closely related to the survey topic of COVID-19 had higher survey completion rates. The completion rate was the lowest for the athlete images (images 1 and 2). It ranged from 0.2% in Spain to 5% in the United States. For the nose-blowing images (images 3 and 4), the completion rate ranged from 1.1% in Spain for the "woman blowing nose" image (image 3) to 8.2% in France for the "couple blowing nose" image (image 4). Finally, the completion rate was the highest for the mask-wearing images (images 5 and 6), ranging from 2.7% for the "man wearing mask" image (image 6) in Spain to 17% in the United States for the "woman wearing mask" image (image 5) (see Table A4).

Country	**1 - Male athlete**	**2 - Group of athletes**	**3 - Woman blowing nose**	**4 - Couple blowing noses**	**5 - Woman wearing mask**	**6 - Man wearing mask**
Belgium	3.0%	2.9%	4.6%	5.1%	16.8%	10.9%
France	1.3%	1.1%	2.4%	8.2%	13.2%	8.9%
Germany	3.3%	1.5%	1.4%	5.5%	13.3%	7.8%
Italy	0.8%	0.4%	2.2%	3.8%	7.4%	5.1%
Netherlands	1.1%	1.7%	2.5%	3.1%	7.8%	6.3%
Spain	0.3%	0.2%	1.1%	1.2%	4.9%	2.7%
United Kingdom	1.1%	1.1%	4.1%	4.9%	9.2%	8.5%
United States	5.2%	1.2%	7.6%	7.1%	17.1%	14.2%

Table A4: Survey completion rate by advertisement images and country. The survey completion is calculated as the number of completed questionnaires divided by the number of unique Facebook users who clicked on the advertisement and reached our survey homepage.

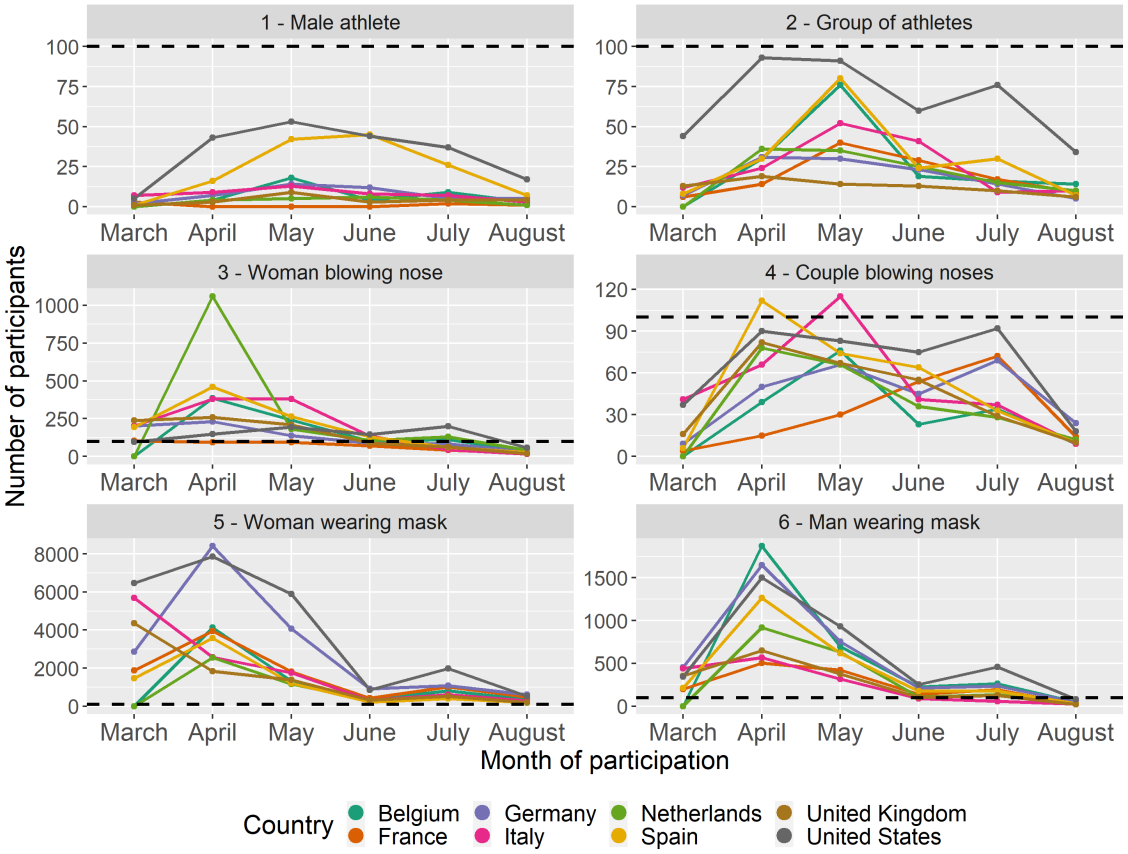


Figure A1: Number of participants by advertisement image and country over the survey period. Please note the different scales on the y-axis due to the large differences in participation by image. The horizontal line marks 100 participants.

	Odds Ratio estimates for binary logistic regression, Belgium				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.507**	1.533**	1.763***	1.727***	1.253
	(0.259)	(0.265)	(0.308)	(0.302)	(0.238)
Image: Woman wearing mask	0.623***	0.640***	0.736***	0.694***	0.839**
	(0.045)	(0.047)	(0.055)	(0.052)	(0.071)
Image: Man wearing mask	0.616***	0.600***	0.601***	0.589***	0.796***
	(0.048)	(0.047)	(0.047)	(0.046)	(0.069)
Sex: Male		0.707***	0.704***	0.714***	0.615***
		(0.027)	(0.027)	(0.028)	(0.027)
Age: 25-44			1.483***	1.404***	1.274***
			(0.093)	(0.089)	(0.089)
Age: 45-64			1.765***	1.720***	1.437***
			(0.112)	(0.110)	(0.102)
Age: 65+			2.090***	2.017***	1.656***
			(0.145)	(0.140)	(0.128)
Education: University level				1.278***	1.156***
				(0.051)	(0.052)
Education: Postgraduate Degree				1.477***	1.498***
				(0.184)	(0.207)
Month: May					4.204***
					(0.222)
Month: June					7.427***
					(0.739)
Month: July					13.074***
					(1.166)
Month: August					17.519***
					(2.688)
Constant	1.738***	2.035***	1.164*	1.107	0.541***
	(0.119)	(0.145)	(0.104)	(0.100)	(0.055)
Observations	11,144	11,144	11,144	11,144	11,144
Log Likelihood	-7,996.856	-7,940.828	-7,888.105	-7,862.352	-6,722.598
Akaike Inf. Crit.	16,001.710	15,891.660	15,792.210	15,744.700	13,473.200

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A5: Step wise regression results for Belgium, Outcome: Wearing a face mask

	Odds Ratio estimates for binary logistic regression, Germany				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	3.116***	3.212***	3.347***	3.328***	1.690***
	(0.467)	(0.482)	(0.505)	(0.502)	(0.292)
Image: Woman wearing mask	0.931	0.974	1.114	1.099	1.000
	(0.062)	(0.065)	(0.076)	(0.075)	(0.082)
Image: Man wearing mask	1.025	1.061	1.083	1.077	1.016
	(0.074)	(0.077)	(0.079)	(0.078)	(0.089)
Sex: Male		0.810***	0.819***	0.813***	0.668***
		(0.022)	(0.022)	(0.022)	(0.022)
Age: 25- 44			1.335***	1.281***	1.005
			(0.061)	(0.060)	(0.054)
Age: 45- 64			1.586***	1.543***	1.027
			(0.072)	(0.071)	(0.055)
Age: 65+			1.900***	1.835***	1.551***
			(0.092)	(0.089)	(0.088)
Education: University level				1.171***	1.138***
				(0.035)	(0.039)
Education: Postgraduate Degree				1.235***	1.301***
				(0.092)	(0.113)
Month: April					4.074***
					(0.233)
Month: May					32.104***
					(2.054)
Month: June					30.160***
					(2.595)
Month: July					28.773***
					(2.332)
Month: August					29.987***
					(3.126)
Constant	0.993	1.055	0.633***	0.624***	0.130***
	(0.064)	(0.069)	(0.049)	(0.048)	(0.013)
Observations	22,363	22,363	22,363	22,363	22,363
Log Likelihood	-14,544.330	-14,509.130	-14,436.920	-14,419.380	-11,379.350
Akaike Inf. Crit.	29,096.650	29,028.260	28,889.830	28,858.760	22,788.690

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A6: Step wise regression results for Germany, Outcome: Wearing a face mask

	Odds Ratio estimates for binary logistic regression, France				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	2.271***	2.158***	2.872***	2.828***	0.938
	(0.431)	(0.410)	(0.552)	(0.544)	(0.197)
Image: Woman wearing mask	0.608***	0.612***	0.695***	0.679***	0.743***
	(0.053)	(0.053)	(0.061)	(0.060)	(0.076)
Image: Man wearing mask	1.059	1.036	1.018	1.005	0.932
	(0.103)	(0.101)	(0.100)	(0.099)	(0.105)
Sex: Male		0.771***	0.783***	0.781***	0.652***
		(0.025)	(0.026)	(0.026)	(0.025)
Age: 25-44			1.533***	1.527***	1.318***
			(0.078)	(0.078)	(0.076)
Age: 45-64			1.968***	2.013***	1.772***
			(0.100)	(0.105)	(0.105)
Age: 65+			2.365***	2.428***	2.172***
			(0.130)	(0.137)	(0.140)
Education: University level				1.175***	1.120**
				(0.048)	(0.052)
Education: Postgraduate Degree				1.427***	1.248***
				(0.100)	(0.100)
Month: April					2.534***
					(0.133)
Month: May					12.239***
					(0.766)
Month: June					21.450***
					(2.322)
Month: July					22.023***
					(1.771)
Month: August					16.174***
					(1.629)
Constant	1.814***	2.046***	1.071	0.942	0.257***
	(0.154)	(0.177)	(0.104)	(0.097)	(0.032)
Observations	11,670	11,670	11,670	11,670	11,670
Log Likelihood	-10,114.190	-10,080.390	-9,941.482	-9,927.081	-8,172.188
Akaike Inf. Crit.	20,236.390	20,170.780	19,898.960	19,874.160	16,374.380

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A7: Step wise regression results for France, Outcome: Wearing a face mask

	Odds Ratio estimates for binary logistic regression, Italy				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.153	1.175	1.268	1.276	0.856
	(0.185)	(0.189)	(0.205)	(0.206)	(0.150)
Image: Woman wearing mask	0.446***	0.470***	0.511***	0.514***	0.880
	(0.032)	(0.034)	(0.037)	(0.037)	(0.070)
Image: Man wearing mask	0.596***	0.605***	0.602***	0.604***	0.816**
	(0.050)	(0.051)	(0.051)	(0.051)	(0.075)
Sex: Male		0.669***	0.675***	0.672***	0.732***
		(0.022)	(0.023)	(0.023)	(0.027)
Age: 25-44			1.709***	1.774***	1.369***
			(0.091)	(0.096)	(0.081)
Age: 45-64			2.125***	2.181***	1.534***
			(0.113)	(0.117)	(0.090)
Age: 65+			1.935***	1.993***	1.387***
			(0.109)	(0.114)	(0.087)
Education: University level				0.905***	0.888***
				(0.033)	(0.036)
Education: Postgraduate Degree				0.865**	0.812***
				(0.050)	(0.052)
Month: April					4.533***
					(0.213)
Month: May					11.700***
					(0.844)
Month: June					13.474***
					(2.016)
Month: July					14.571***
					(1.930)
Month: August					20.708***
					(4.883)
Constant	5.067***	5.952***	3.157***	3.220***	1.098
	(0.348)	(0.419)	(0.263)	(0.269)	(0.103)
Observations	14,202	14,202	14,202	14,202	14,202
Log Likelihood	-11,357.570	-11,287.890	-11,165.620	-11,159.460	-9,458.571
Akaike Inf. Crit.	22,723.130	22,585.790	22,347.230	22,338.920	18,947.140

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A8: Step wise regression results for Italy, Outcome: Wearing a face mask

	Odds Ratio estimates for binary logistic regression, Netherlands				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.759***	1.784***	1.899***	1.855***	1.273
	(0.323)	(0.327)	(0.352)	(0.345)	(0.249)
Image: Woman wearing mask	0.897	0.925	1.022	0.965	0.857
	(0.079)	(0.082)	(0.094)	(0.090)	(0.083)
Image: Man wearing mask	0.955	0.961	0.952	0.928	0.847
	(0.101)	(0.101)	(0.101)	(0.099)	(0.094)
Sex: Male		0.849**	0.848**	0.838***	0.753***
		(0.054)	(0.055)	(0.054)	(0.050)
Age: 25-44			1.200*	1.143	0.920
			(0.131)	(0.125)	(0.105)
Age: 45-64			1.214*	1.243**	0.956
			(0.130)	(0.134)	(0.107)
Age: 65+			1.643***	1.691***	1.319**
			(0.185)	(0.191)	(0.154)
Education: University level				1.360***	1.192**
				(0.098)	(0.090)
Education: Postgraduate Degree				1.690**	1.481*
				(0.345)	(0.316)
Month: May					1.986***
					(0.168)
Month: June					3.777***
					(0.426)
Month: July					5.582***
					(0.536)
Month: August					7.503***
					(1.019)
Constant	0.175***	0.186***	0.137***	0.130***	0.102***
	(0.014)	(0.015)	(0.017)	(0.016)	(0.013)
Observations	8,223	8,223	8,223	8,223	8,223
Log Likelihood	-3,727.371	-3,721.794	-3,709.128	-3,697.357	-3,450.879
Akaike Inf. Crit.	7,462.742	7,453.588	7,434.257	7,414.714	6,929.757

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A9: Step wise regression results for the Netherlands, Outcome: Wearing a face mask

	Odds Ratio estimates for binary logistic regression, Spain				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.239*	1.276**	1.350***	1.358***	0.821
	(0.141)	(0.146)	(0.155)	(0.156)	(0.104)
Image: Woman wearing mask	0.748***	0.770***	0.831***	0.841***	0.933
	(0.041)	(0.042)	(0.046)	(0.047)	(0.056)
Image: Man wearing mask	1.048	1.065	1.066	1.073	0.983
	(0.064)	(0.066)	(0.066)	(0.066)	(0.066)
Sex: Male		0.722***	0.721***	0.713***	0.753***
		(0.023)	(0.023)	(0.023)	(0.026)
Age: 25-44			1.394***	1.395***	1.174***
			(0.076)	(0.077)	(0.069)
Age: 45-64			1.702***	1.690***	1.328***
			(0.094)	(0.093)	(0.079)
Age: 65+			1.669***	1.684***	1.330***
			(0.101)	(0.102)	(0.087)
Education: University level				0.864***	0.890***
				(0.030)	(0.033)
Education: Postgraduate Degree				0.892**	0.901*
				(0.050)	(0.054)
Month: April					1.749***
					(0.072)
Month: May					12.400***
					(0.877)
Month: June					28.199***
					(5.173)
Month: July					11.531***
					(1.306)
Month: August					8.487***
					(1.355)
Constant	2.717***	3.118***	1.979***	2.161***	1.000
	(0.139)	(0.166)	(0.142)	(0.162)	(0.084)
Observations	10,964	10,964	10,964	10,964	10,964
Log Likelihood	-10,851.790	-10,796.560	-10,746.510	-10,738.080	-9,525.281
Akaike Inf. Crit.	21,711.570	21,603.120	21,509.030	21,496.170	19,080.560

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A10: Step wise regression results for Spain, Outcome: Wearing a face mask

	Odds Ratio estimate for binary logistic regression, UK				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	0.872	0.873	0.897	0.898	0.549***
	(0.134)	(0.134)	(0.138)	(0.139)	(0.094)
Image: Woman wearing mask	0.509***	0.511***	0.523***	0.524***	0.712***
	(0.041)	(0.041)	(0.042)	(0.043)	(0.064)
Image: Man wearing mask	0.778***	0.781***	0.778***	0.781***	0.881
	(0.074)	(0.074)	(0.074)	(0.074)	(0.092)
Sex: Male		0.966	0.969	0.969	0.962
		(0.041)	(0.041)	(0.041)	(0.045)
Age: 25-44			1.176**	1.182**	1.062
			(0.083)	(0.084)	(0.081)
Age: 45-64			1.146*	1.147*	0.819***
			(0.081)	(0.081)	(0.063)
Age: 65+			1.233***	1.232***	0.818**
			(0.093)	(0.093)	(0.068)
Education: University level				0.982	0.916*
				(0.044)	(0.045)
Education: Postgraduate Degree				0.960	0.857*
				(0.080)	(0.079)
Month: April					2.076***
					(0.130)
Month: May					3.860***
					(0.242)
Month: June					8.418***
					(0.841)
Month: July					17.683***
					(1.699)
Month: August					30.576***
					(5.435)
Constant	0.645***	0.653***	0.555***	0.559***	0.239***
	(0.049)	(0.051)	(0.055)	(0.057)	(0.028)
Observations	11,401	11,401	11,401	11,401	11,401
Log Likelihood	-6,358.574	-6,357.979	-6,353.486	-6,353.223	-5,563.732
Akaike Inf. Crit.	12,725.150	12,725.960	12,722.970	12,726.450	11,157.460

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A11: Step wise regression results for UK, Outcome: Wearing a face mask

	Odds Ratio estimate for binary logistic regression, US				
	Outcome: Wearing a face mask (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.328	1.404	1.372	1.347	1.353
	(0.308)	(0.327)	(0.320)	(0.315)	(0.317)
Image: Woman wearing mask	1.157	1.253*	1.252*	1.250*	1.202
	(0.150)	(0.163)	(0.164)	(0.164)	(0.159)
Image: Man wearing mask	1.089	1.154	1.139	1.130	1.125
	(0.155)	(0.165)	(0.163)	(0.162)	(0.163)
Sex: Male		0.430***	0.431***	0.443***	0.440***
		(0.020)	(0.020)	(0.021)	(0.021)
Age: 25- 44			0.831**	0.754***	0.771***
			(0.060)	(0.056)	(0.057)
Age: 45- 64			0.770***	0.719***	0.742***
			(0.055)	(0.052)	(0.054)
Age: 65+			0.933	0.853**	0.880
			(0.074)	(0.068)	(0.071)
Education: University level				1.435***	1.438***
				(0.066)	(0.066)
Education: Postgraduate Degree				1.595***	1.589***
				(0.181)	(0.181)
Month: April					0.817***
					(0.049)
Month: May					0.921
					(0.059)
Month: June					0.817*
					(0.098)
Month: July					0.829**
					(0.069)
Month: August					0.696***
					(0.093)
Constant	9.695***	14.582***	17.129***	14.842***	16.994***
	(1.232)	(1.906)	(2.478)	(2.165)	(2.578)
Observations	28,400	28,400	28,400	28,400	28,400
Log Likelihood	-21,679.650	-21,412.360	-21,297.720	-21,214.150	-17,673.610
Akaike Inf. Crit.	43,367.310	42,834.730	42,611.450	42,448.310	35,377.230
Note:					*p<0.1; **p<0.05; ***p<0.01

Table A12: Step wise regression results for US, Outcome: Wearing a face mask

	Odds Ratio estimates for binary logistic regression, Belgium				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.507*	1.533*	1.763	1.727	1.253
	(0.151)	(0.156)	(0.179)	(0.174)	(0.193)
Image: Woman wearing mask	0.623	0.640	0.736**	0.694*	0.839
	(0.128)	(0.138)	(0.168)	(0.159)	(0.149)
Image: Man wearing mask	0.616	0.600	0.601	0.589	0.796
	(0.153)	(0.146)	(0.149)	(0.146)	(0.133)
Sex: Male		0.707***	0.704***	0.714***	0.615***
		(0.031)	(0.031)	(0.031)	(0.032)
Age: 25-44			1.483	1.404	1.274
			(0.105)	(0.100)	(0.104)
Age: 45-64			1.765***	1.720***	1.437***
			(0.168)	(0.163)	(0.176)
Age: 65+			2.090***	2.017***	1.656***
			(0.223)	(0.214)	(0.231)
Education: University level				1.278***	1.156***
				(0.092)	(0.098)
Education: Postgraduate Degree				1.477**	1.498**
				(0.446)	(0.468)
Month: May					4.204***
					(0.057)
Month: June					7.427***
					(0.068)
Month: July					13.074***
					(0.063)
Month: August					17.519***
					(0.051)
Constant	1.738***	2.035***	1.164***	1.107***	0.541***
	(1.077)	(1.798)	(1.487)	(1.430)	(1.907)
Observations	11,144	11,144	11,144	11,144	11,144
Log Likelihood	-3,403.414	-3,326.243	-3,301.822	-3,295.536	-3,258.655
Akaike Inf. Crit.	6,814.828	6,662.486	6,619.645	6,611.072	6,545.311

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A13: Step wise regression results for Belgium, Outcome: Increased hand hygiene

	Odds Ratio estimates for binary logistic regression, Germany				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.087	1.202	1.191	1.185	1.430
	(0.233)	(0.260)	(0.258)	(0.257)	(0.312)
Image: Woman wearing mask	0.935	1.100	1.207*	1.197*	1.189
	(0.098)	(0.116)	(0.129)	(0.128)	(0.128)
Image: Man wearing mask	0.948	1.073	1.073	1.068	1.058
	(0.107)	(0.123)	(0.123)	(0.122)	(0.122)
Sex: Male		0.484***	0.490***	0.488***	0.496***
		(0.021)	(0.021)	(0.021)	(0.021)
Age: 25-44			1.016	0.990	1.056
			(0.068)	(0.067)	(0.072)
Age: 45-64			1.046	1.029	1.144**
			(0.069)	(0.069)	(0.077)
Age: 65+			1.534***	1.504***	1.635***
			(0.115)	(0.114)	(0.125)
Education: University level				1.128***	1.150***
				(0.052)	(0.053)
Education: Postgraduate Degree				1.008	1.025
				(0.113)	(0.115)
Month: April					0.729***
					(0.051)
Month: May					0.587***
					(0.044)
Month: June					0.453***
					(0.044)
Month: July					0.434***
					(0.040)
Month: August					0.490***
					(0.058)
Constant	7.787***	10.026***	8.283***	8.186***	11.430***
	(0.792)	(1.042)	(0.993)	(0.982)	(1.492)
Observations	22,363	22,363	22,363	22,363	22,363
Log Likelihood	-7,798.988	-7,645.497	-7,622.366	-7,621.046	-7,552.950
Akaike Inf. Crit.	15,605.980	15,301.000	15,260.730	15,262.090	15,135.900

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A14: Step wise regression results for Germany, Outcome: Increased hand hygiene

	Odds Ratio estimates for binary logistic regression, France				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	2.271***	2.158***	2.872***	2.828***	0.938**
	(0.111)	(0.096)	(0.120)	(0.117)	(0.136)
Image: Woman wearing mask	0.608	0.612	0.695*	0.679	0.743
	(0.159)	(0.163)	(0.184)	(0.178)	(0.180)
Image: Man wearing mask	1.059*	1.036	1.018	1.005	0.932
	(0.222)	(0.211)	(0.215)	(0.211)	(0.215)
Sex: Male		0.771***	0.783***	0.781***	0.652***
		(0.030)	(0.031)	(0.031)	(0.032)
Age: 25-44			1.533***	1.527***	1.318***
			(0.114)	(0.115)	(0.121)
Age: 45-64			1.968***	2.013***	1.772***
			(0.145)	(0.156)	(0.167)
Age: 65+			2.365***	2.428***	2.172***
			(0.174)	(0.190)	(0.203)
Education: University level				1.175***	1.120***
				(0.091)	(0.092)
Education: Postgraduate Degree				1.427***	1.248***
				(0.231)	(0.242)
Month: April					2.534***
					(0.069)
Month: May					12.239***
					(0.058)
Month: June					21.450**
					(0.109)
Month: July					22.023***
					(0.065)
Month: August					16.174***
					(0.057)
Constant	1.814***	2.046***	1.071***	0.942***	0.257***
	(1.334)	(1.949)	(1.300)	(1.129)	(1.635)
Observations	11,670	11,670	11,670	11,670	11,670
Log Likelihood	-4,294.382	-4,230.469	-4,202.258	-4,192.361	-4,164.182
Akaike Inf. Crit.	8,596.763	8,470.939	8,420.516	8,404.723	8,358.363

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A15: Step wise regression results for France, Outcome: Increased hand hygiene

	Odds Ratio estimates for binary logistic regression, Italy				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.153***	1.175***	1.268***	1.276***	0.856***
	(0.112)	(0.114)	(0.114)	(0.113)	(0.114)
Image: Woman wearing mask	0.446	0.470	0.511	0.514	0.880
	(0.091)	(0.098)	(0.100)	(0.099)	(0.098)
Image: Man wearing mask	0.596	0.605	0.602	0.604	0.816
	(0.100)	(0.102)	(0.101)	(0.101)	(0.101)
Sex: Male		0.669***	0.675***	0.672***	0.732***
		(0.033)	(0.033)	(0.034)	(0.034)
Age: 25-44			1.709***	1.774**	1.369**
			(0.109)	(0.106)	(0.109)
Age: 45-64			2.125*	2.181	1.534*
			(0.099)	(0.097)	(0.100)
Age: 65+			1.935***	1.993**	1.387**
			(0.115)	(0.113)	(0.116)
Education: University level				0.905***	0.888***
				(0.071)	(0.071)
Education: Postgraduate Degree				0.865	0.812
				(0.101)	(0.100)
Month: April					4.533***
					(0.052)
Month: May					11.700
					(0.071)
Month: June					13.474
					(0.179)
Month: July					14.571***
					(0.076)
Month: August					20.708
					(0.293)
Constant	5.067***	5.952***	3.157***	3.220***	1.098***
	(1.110)	(1.406)	(1.449)	(1.408)	(1.632)
Observations	14,202	14,202	14,202	14,202	14,202
Log Likelihood	-5,653.832	-5,610.819	-5,605.117	-5,601.095	-5,586.480
Akaike Inf. Crit.	11,315.660	11,231.640	11,226.240	11,222.190	11,202.960

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A16: Step wise regression results for Italy, Outcome: Increased hand hygiene

	Odds Ratio estimates for binary logistic regression, Netherlands				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.759**	1.784*	1.899*	1.855*	1.273
	(0.133)	(0.145)	(0.145)	(0.144)	(0.215)
Image: Woman wearing mask	0.897***	0.925*	1.022	0.965	0.857
	(0.067)	(0.081)	(0.087)	(0.086)	(0.101)
Image: Man wearing mask	0.955**	0.961*	0.952**	0.928**	0.847
	(0.087)	(0.092)	(0.090)	(0.089)	(0.111)
Sex: Male		0.849***	0.848***	0.838***	0.753***
		(0.025)	(0.025)	(0.025)	(0.027)
Age: 25-44			1.200***	1.143***	0.920
			(0.075)	(0.075)	(0.091)
Age: 45-64			1.214	1.243	0.956
			(0.091)	(0.092)	(0.117)
Age: 65+			1.643	1.691	1.319**
			(0.119)	(0.120)	(0.152)
Education: University level				1.360	1.192***
				(0.078)	(0.091)
Education: Postgraduate Degree				1.690	1.481
				(0.214)	(0.250)
Month: May					1.986***
					(0.032)
Month: June					3.777***
					(0.027)
Month: July					5.582***
					(0.025)
Month: August					7.503***
					(0.036)
Constant	0.175***	0.186***	0.137***	0.130***	0.102***
	(0.692)	(1.222)	(1.891)	(1.875)	(2.547)
Observations	8,223	8,223	8,223	8,223	8,223
Log Likelihood	-3,788.422	-3,662.762	-3,653.245	-3,652.846	-3,470.245
Akaike Inf. Crit.	7,584.843	7,335.524	7,322.490	7,325.692	6,968.490

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A17: Step wise regression results for the Netherlands, Outcome: Increased hand hygiene

	Odds Ratio estimates for binary logistic regression, Spain				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	0.776	0.820	0.863	0.860	0.915
	(0.149)	(0.158)	(0.167)	(0.167)	(0.179)
Image: Woman wearing mask	1.039	1.108	1.213*	1.208*	1.217*
	(0.110)	(0.118)	(0.131)	(0.131)	(0.132)
Image: Man wearing mask	0.906	0.935	0.925	0.921	0.952
	(0.105)	(0.109)	(0.108)	(0.107)	(0.111)
Sex: Male		0.521***	0.526***	0.528***	0.524***
		(0.034)	(0.034)	(0.034)	(0.034)
Age: 25-44			1.429***	1.435***	1.536***
			(0.144)	(0.145)	(0.157)
Age: 45-64			1.586***	1.597***	1.728***
			(0.161)	(0.162)	(0.178)
Age: 65+			1.981***	1.985***	2.137***
			(0.230)	(0.231)	(0.252)
Education: University level				1.075	1.064
				(0.073)	(0.072)
Education: Postgraduate Degree				0.999	1.000
				(0.109)	(0.109)
Month: April					0.674***
					(0.064)
Month: May					0.775**
					(0.087)
Month: June					0.708**
					(0.121)
Month: July					0.592***
					(0.088)
Month: August					0.365***
					(0.067)
Constant	16.641***	22.692***	14.083***	13.503***	17.481***
	(1.633)	(2.372)	(1.912)	(1.910)	(2.752)
Observations	10,964	10,964	10,964	10,964	10,964
Log Likelihood	-3,955.092	-3,908.448	-3,894.046	-3,893.407	-3,875.554
Akaike Inf. Crit.	7,918.184	7,826.897	7,804.092	7,806.814	7,781.108

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A18: Step wise regression results for Spain, Outcome: Increased hand hygiene

	Odds Ratio estimate for binary logistic regression, UK				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	0.872***	0.873***	0.897***	0.898***	0.549***
	(0.095)	(0.096)	(0.100)	(0.098)	(0.105)
Image: Woman wearing mask	0.509	0.511	0.523	0.524	0.712
	(0.153)	(0.163)	(0.173)	(0.169)	(0.161)
Image: Man wearing mask	0.778	0.781	0.778	0.781	0.881
	(0.162)	(0.173)	(0.171)	(0.167)	(0.167)
Sex: Male		0.966***	0.969***	0.969***	0.962***
		(0.046)	(0.047)	(0.047)	(0.046)
Age: 25-44			1.176	1.182	1.062
			(0.137)	(0.132)	(0.135)
Age: 45-64			1.146	1.147	0.819
			(0.137)	(0.135)	(0.142)
Age: 65+			1.233***	1.232***	0.818***
			(0.190)	(0.189)	(0.200)
Education: University level				0.982	0.916
				(0.090)	(0.090)
Education: Postgraduate Degree				0.960***	0.857***
				(0.291)	(0.289)
Month: April					2.076**
					(0.078)
Month: May					3.860***
					(0.080)
Month: June					8.418
					(0.170)
Month: July					17.683
					(0.153)
Month: August					30.576***
					(0.095)
Constant	0.645***	0.653***	0.555***	0.559***	0.239***
	(2.621)	(3.396)	(3.163)	(3.094)	(3.852)
Observations	11,401	11,401	11,401	11,401	11,401
Log Likelihood	-2,637.671	-2,613.654	-2,610.082	-2,605.342	-2,595.301
Akaike Inf. Crit.	5,283.341	5,237.308	5,236.164	5,230.684	5,220.601

Comment

*p<0.1; **p<0.05; ***p<0.01

Weighted by age, gender, sub-national region.

Table A19: Step wise regression results for UK, Outcome: Increased hand hygiene

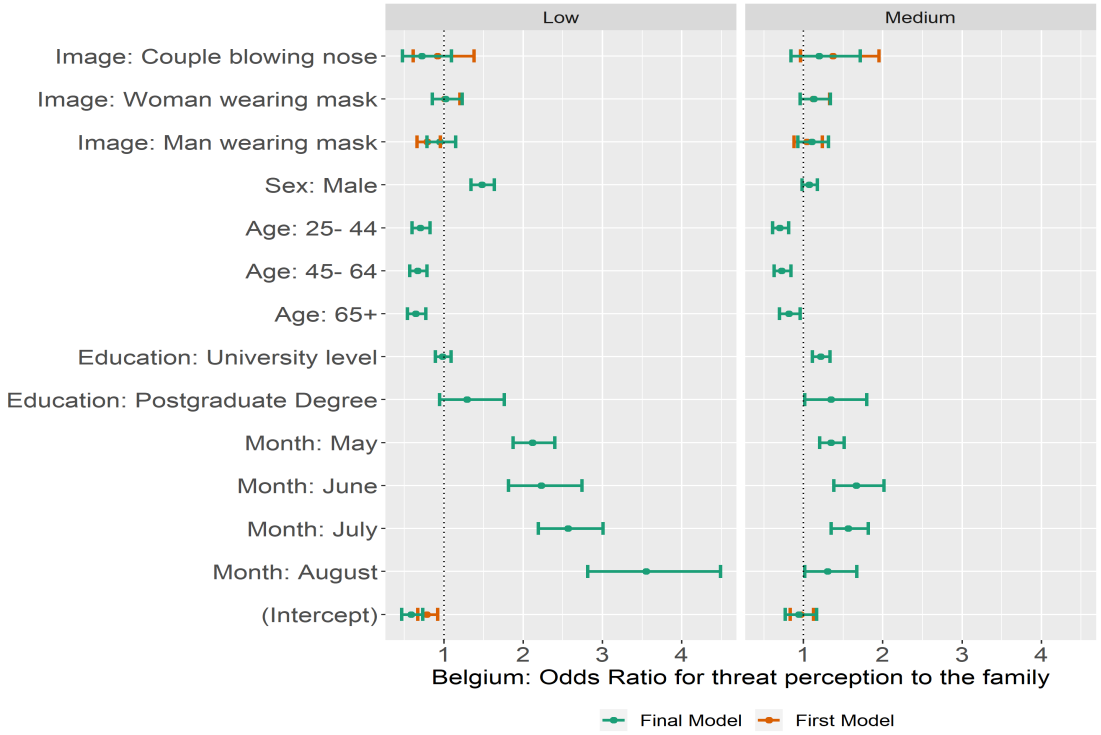
	Odds Ratio estimate for binary logistic regression, US				
	Outcome: Increased hand hygiene (Ref. Yes)				
	(1)	(2)	(3)	(4)	(5)
Image: Couple blowing nose	1.328	1.404	1.372	1.347	1.353
	(0.308)	(0.327)	(0.320)	(0.315)	(0.317)
Image: Woman wearing mask	1.157	1.253*	1.252*	1.250*	1.202
	(0.150)	(0.163)	(0.164)	(0.164)	(0.159)
Image: Man wearing mask	1.089	1.154	1.139	1.130	1.125
	(0.155)	(0.165)	(0.163)	(0.162)	(0.163)
Sex: Male		0.430***	0.431***	0.443***	0.440***
		(0.020)	(0.020)	(0.021)	(0.021)
Age: 25-44			0.831**	0.754***	0.771***
			(0.060)	(0.056)	(0.057)
Age: 45-64			0.770***	0.719***	0.742***
			(0.055)	(0.052)	(0.054)
Age: 65+			0.933	0.853**	0.880
			(0.074)	(0.068)	(0.071)
Education: University level				1.435***	1.438***
				(0.066)	(0.066)
Education: Postgraduate Degree				1.595***	1.589***
				(0.181)	(0.181)
Month: April					0.817***
					(0.049)
Month: May					0.921
					(0.059)
Month: June					0.817*
					(0.098)
Month: July					0.829**
					(0.069)
Month: August					0.696***
					(0.093)
Constant	9.695***	14.582***	17.129***	14.842***	16.994***
	(1.232)	(1.906)	(2.478)	(2.165)	(2.578)
Observations	28,400	28,400	28,400	28,400	28,400
Log Likelihood	-8,932.931	-8,729.050	-8,722.518	-8,685.077	-8,676.657
Akaike Inf. Crit.	17,873.860	17,468.100	17,461.040	17,390.150	17,383.310

Comment

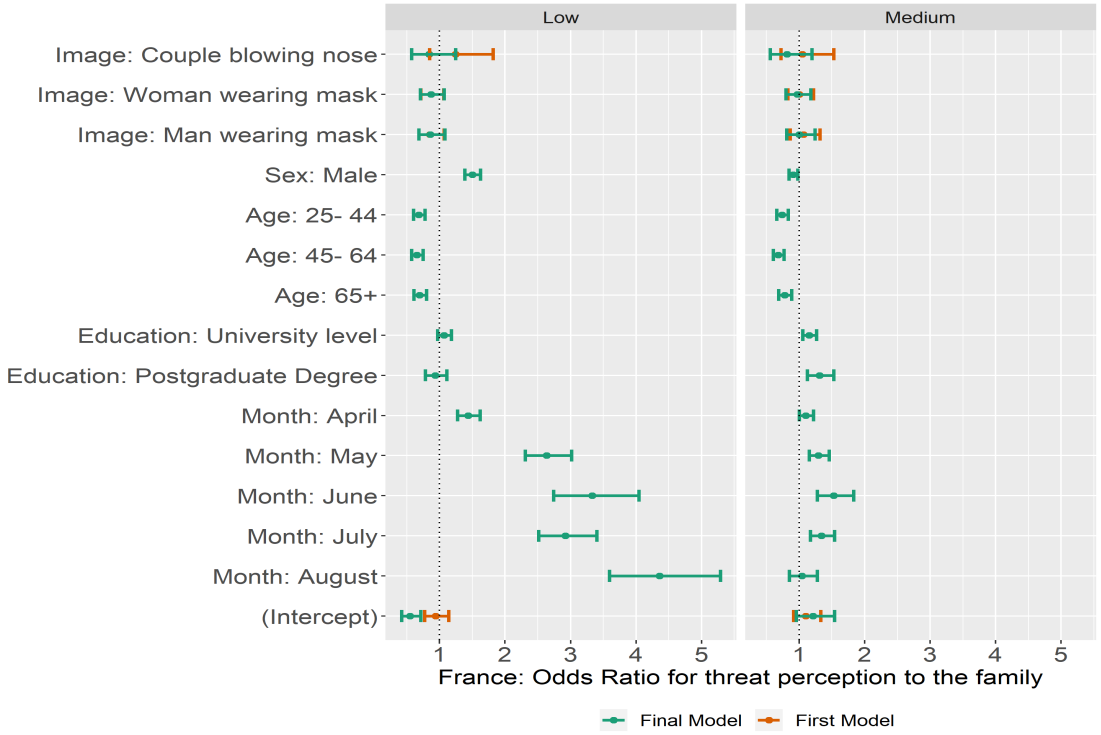
*p<0.1; **p<0.05; ***p<0.01

Weight by: Sex, Age, Subnational region

Table A20: Step wise regression results for US, Outcome: Increased hand hygiene

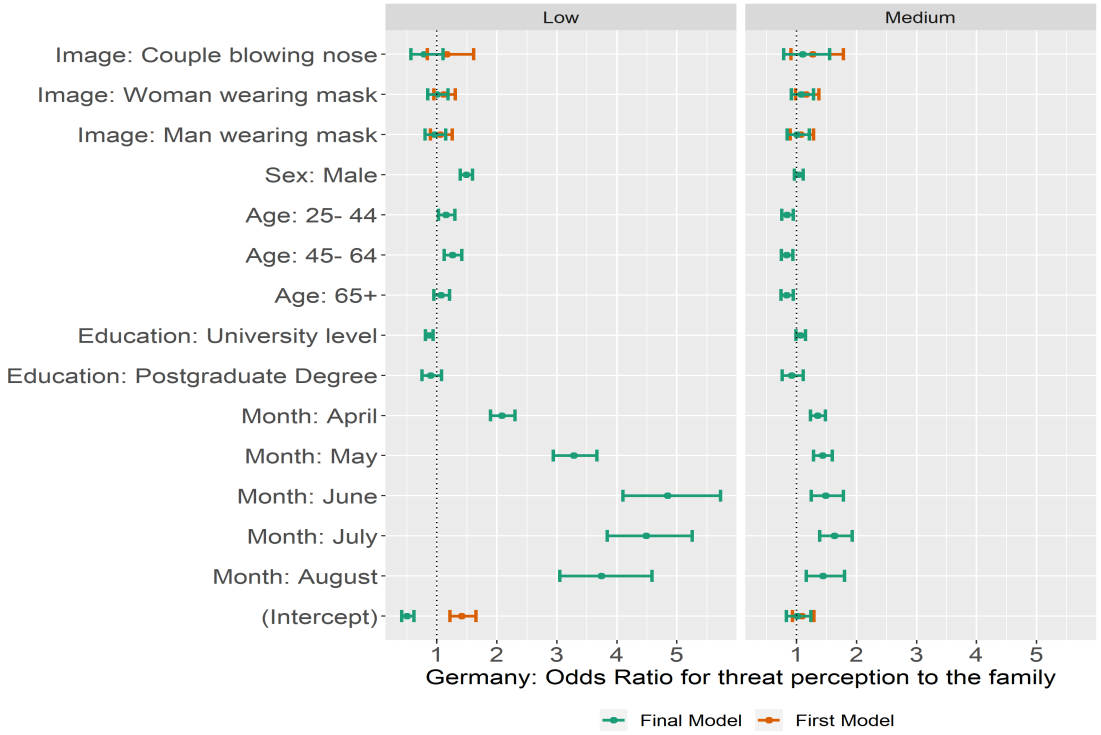


(A) Belgium

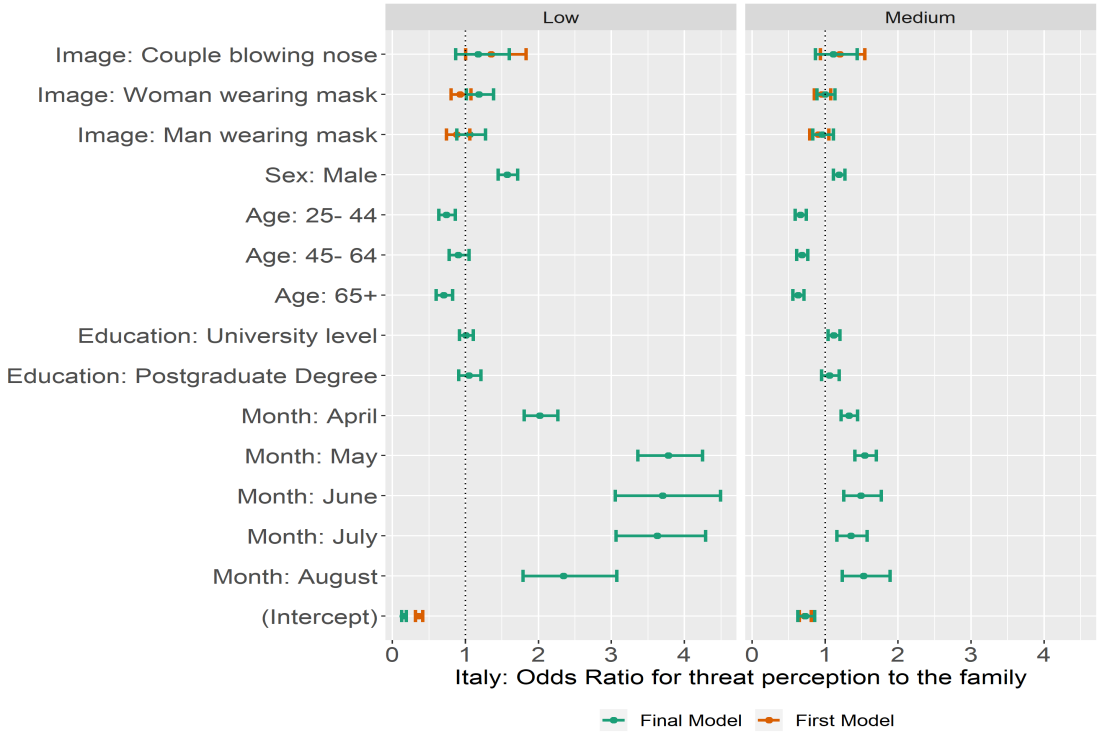


(B) France

Figure A2: Coefficient plot for the models estimating the perception of threat to the family (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.

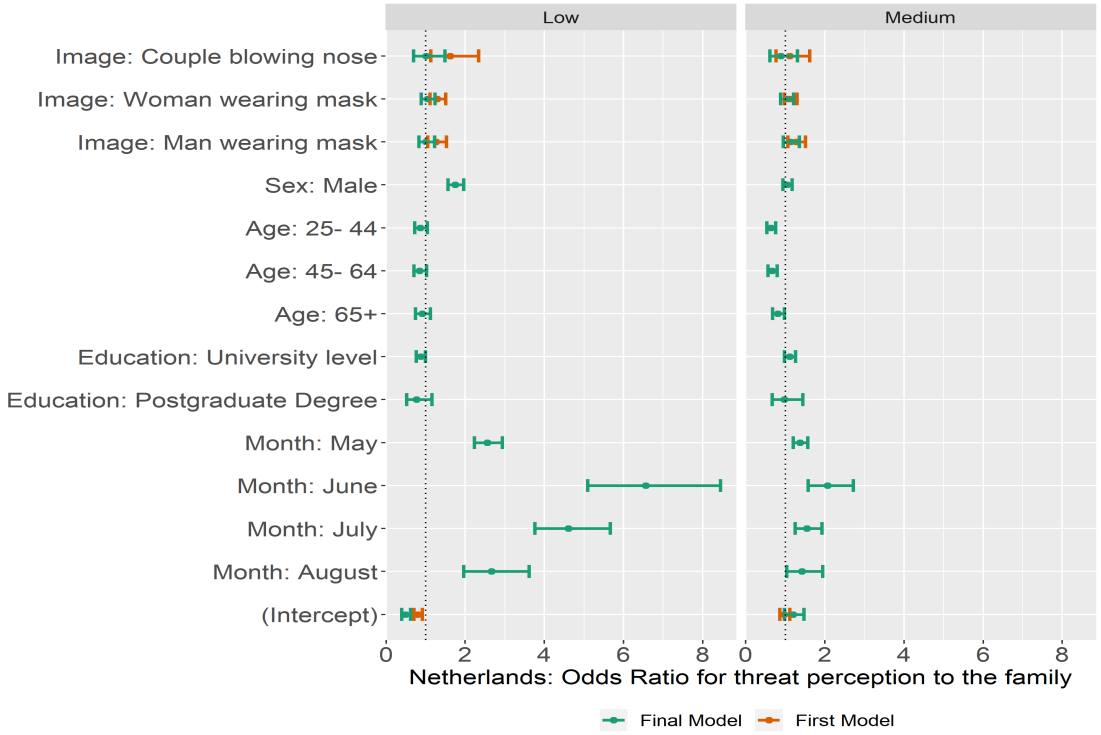


(C) Germany

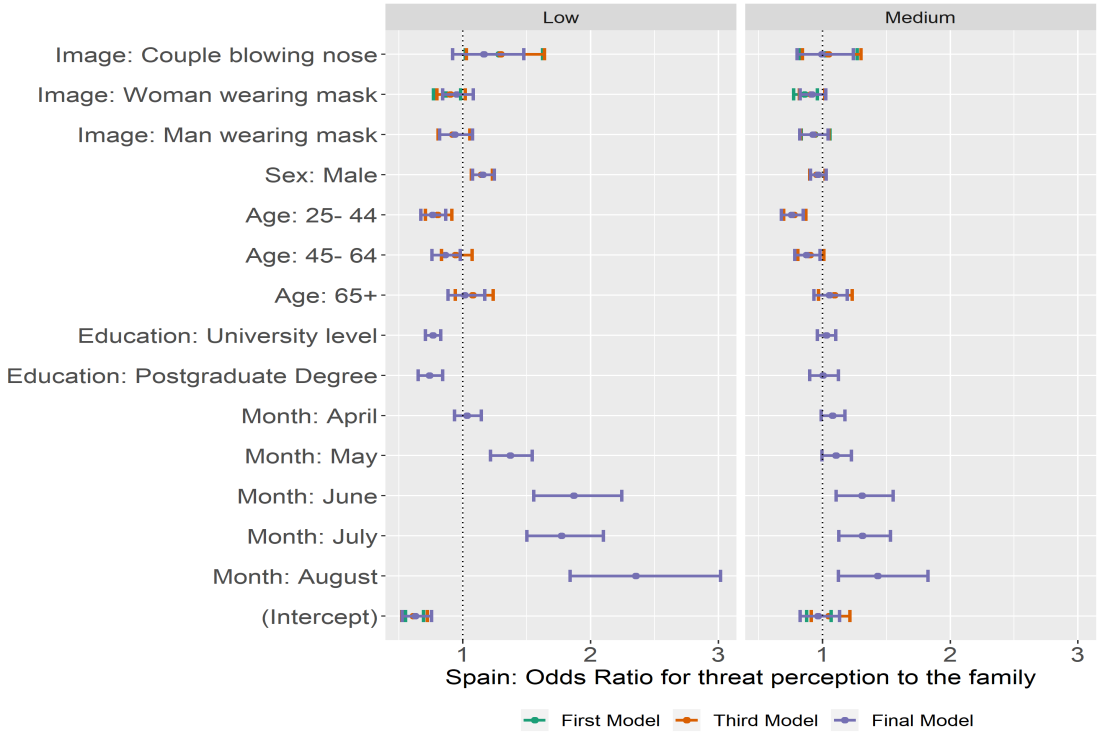


(D) Italy

Figure A2: Coefficient plot for the models estimating the perception of threat to the family (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.

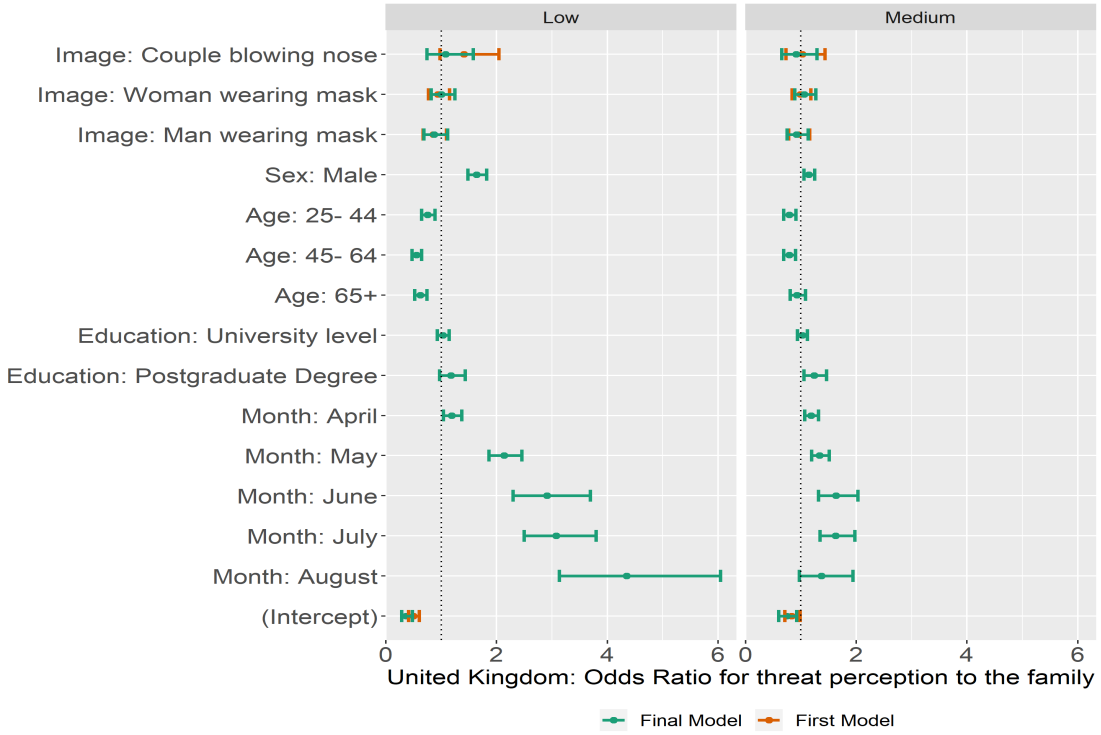


(E) Netherlands

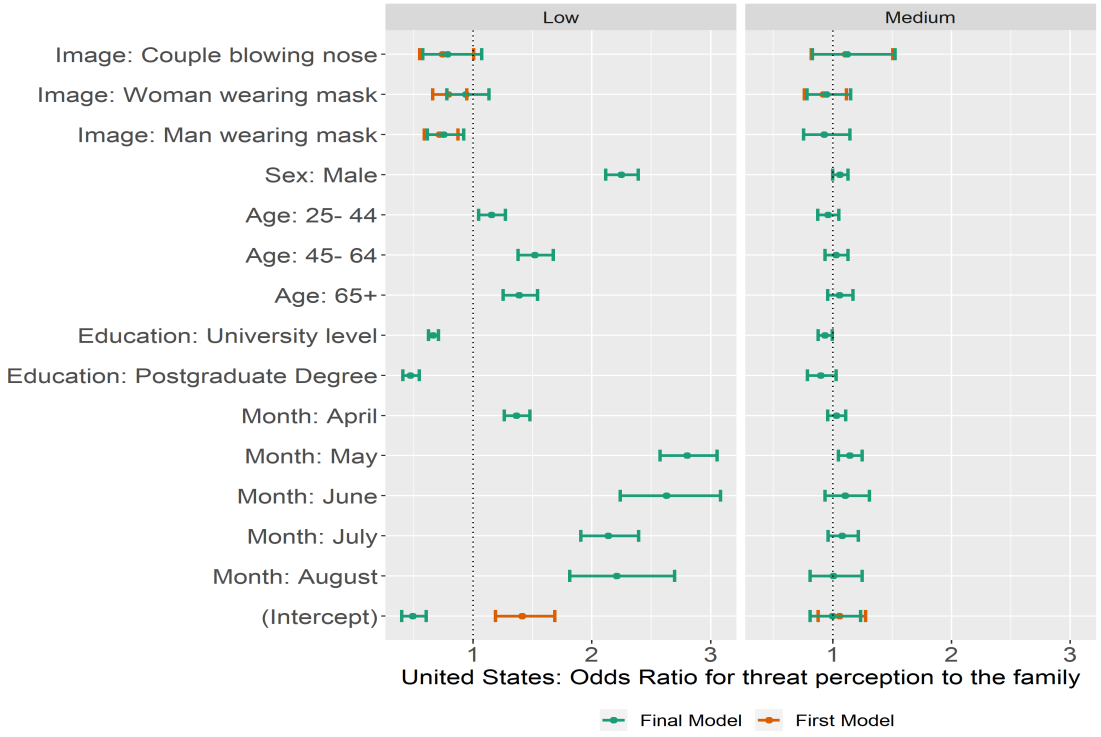


(F) Spain

Figure A2: Coefficient plot for the models estimating the perception of threat to the family (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.

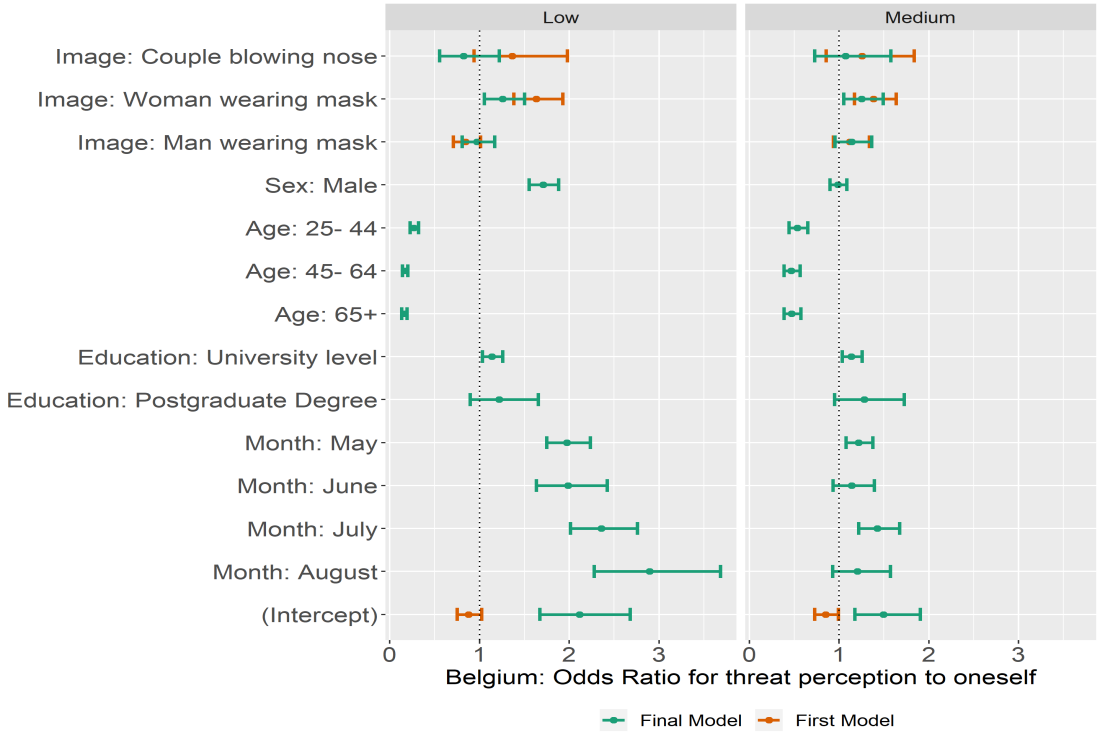


(G) United Kingdom

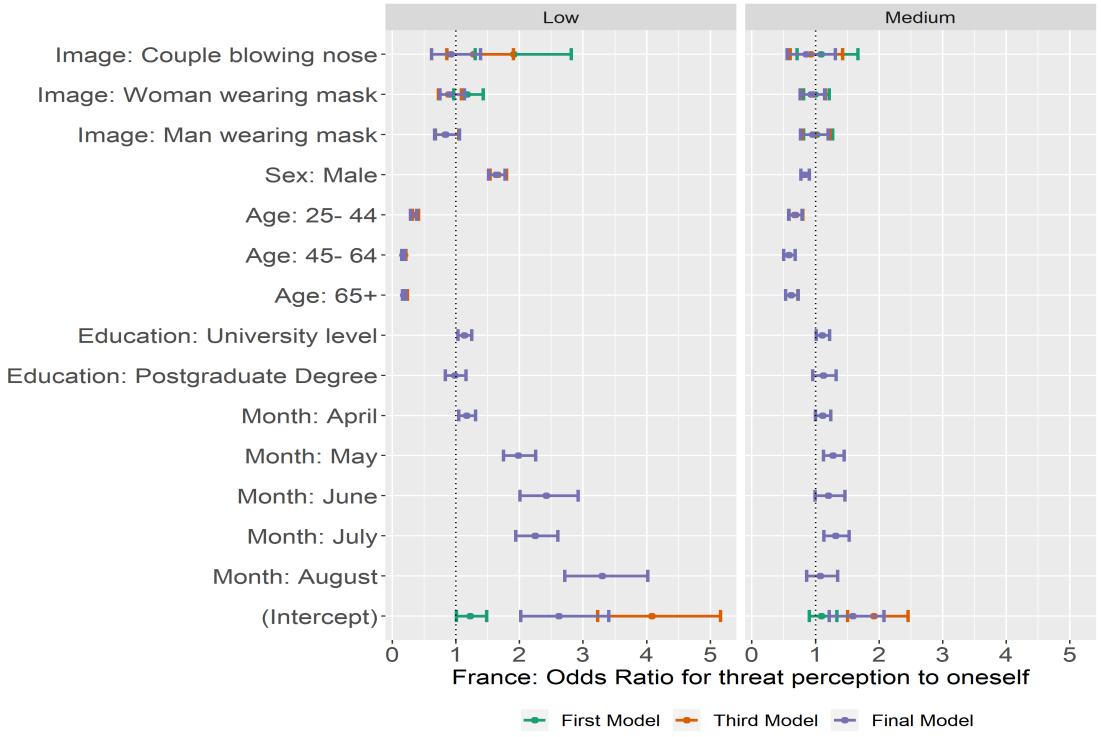


(H) United States

Figure A2: Coefficient plot for the models estimating the perception of threat to the family (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.

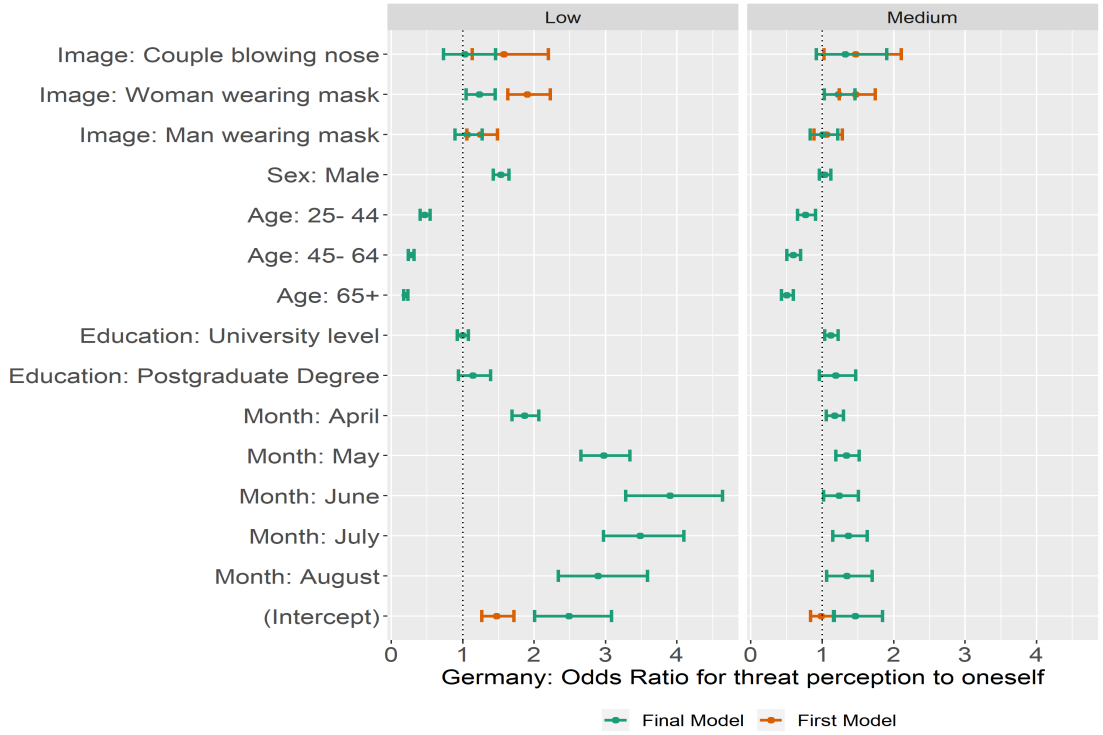


(A) Belgium

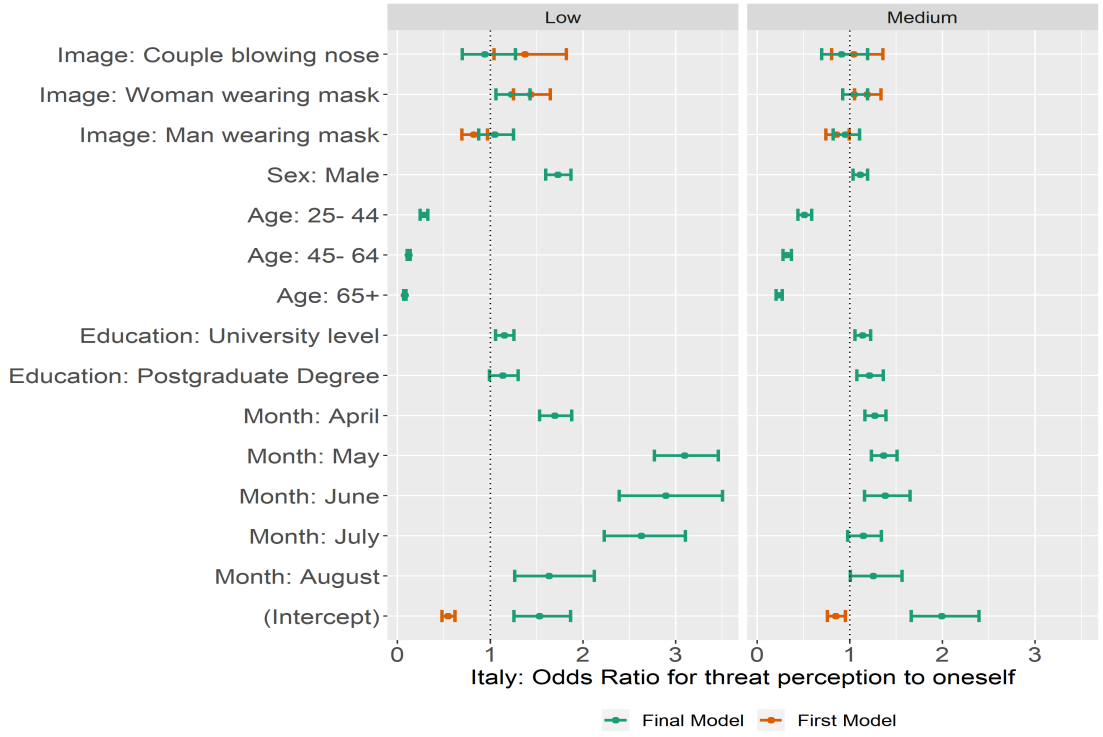


(B) France

Figure A3: Coefficient plot for the first and final model estimating the perception of threat to oneself (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.

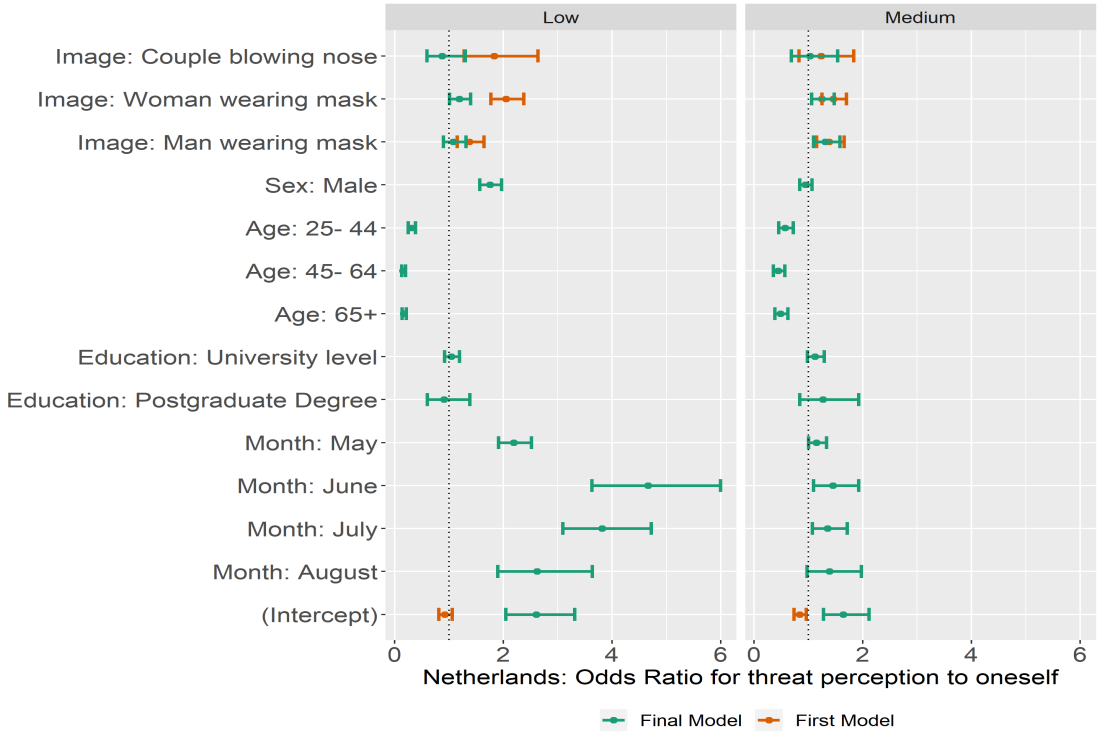


(C) Germany

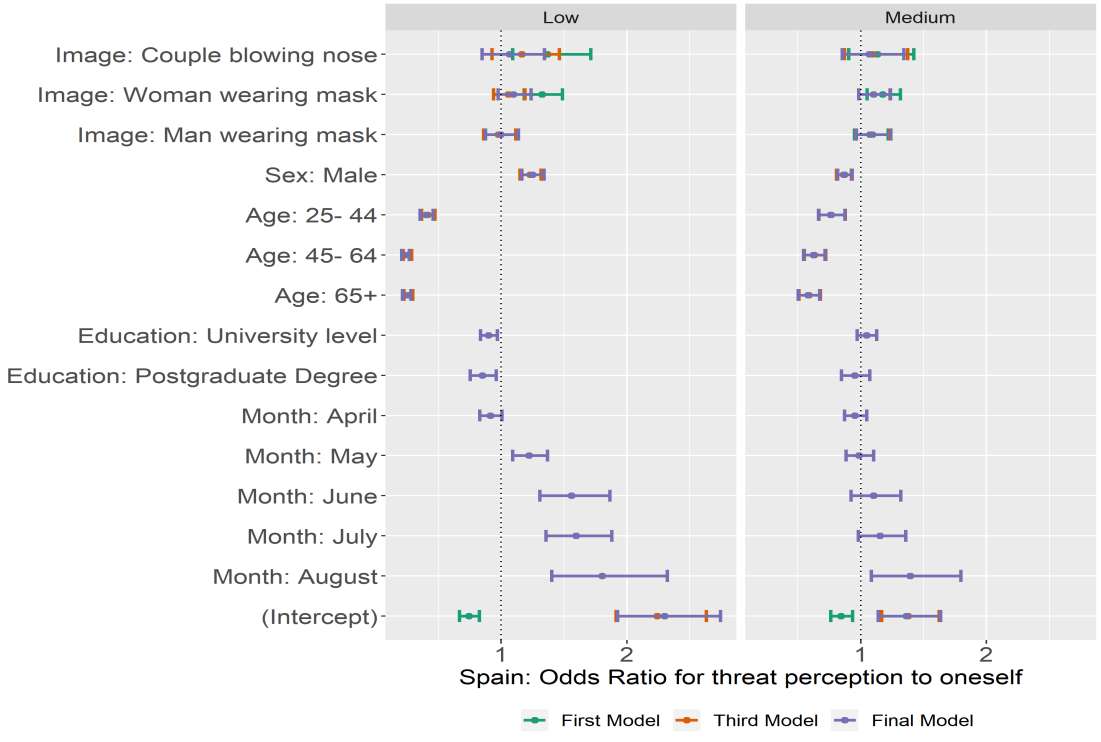


(D) Italy

Figure A3: Coefficient plot for the first and final model estimating the perception of threat to oneself (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.

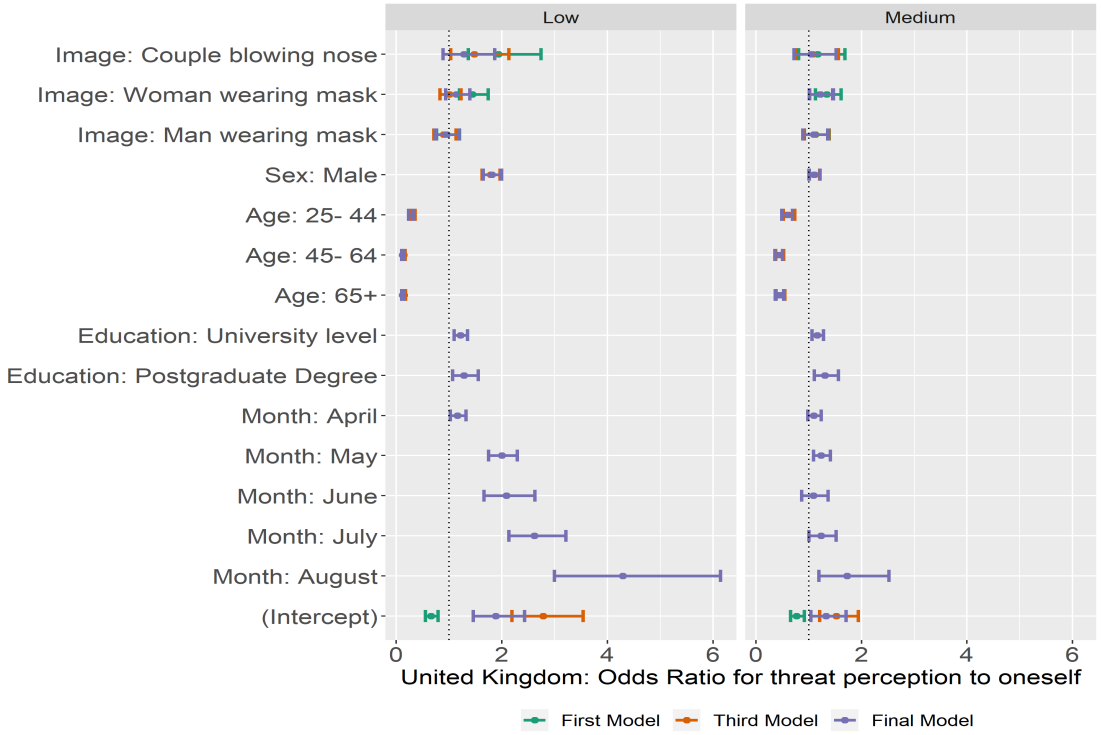


(E) Netherlands

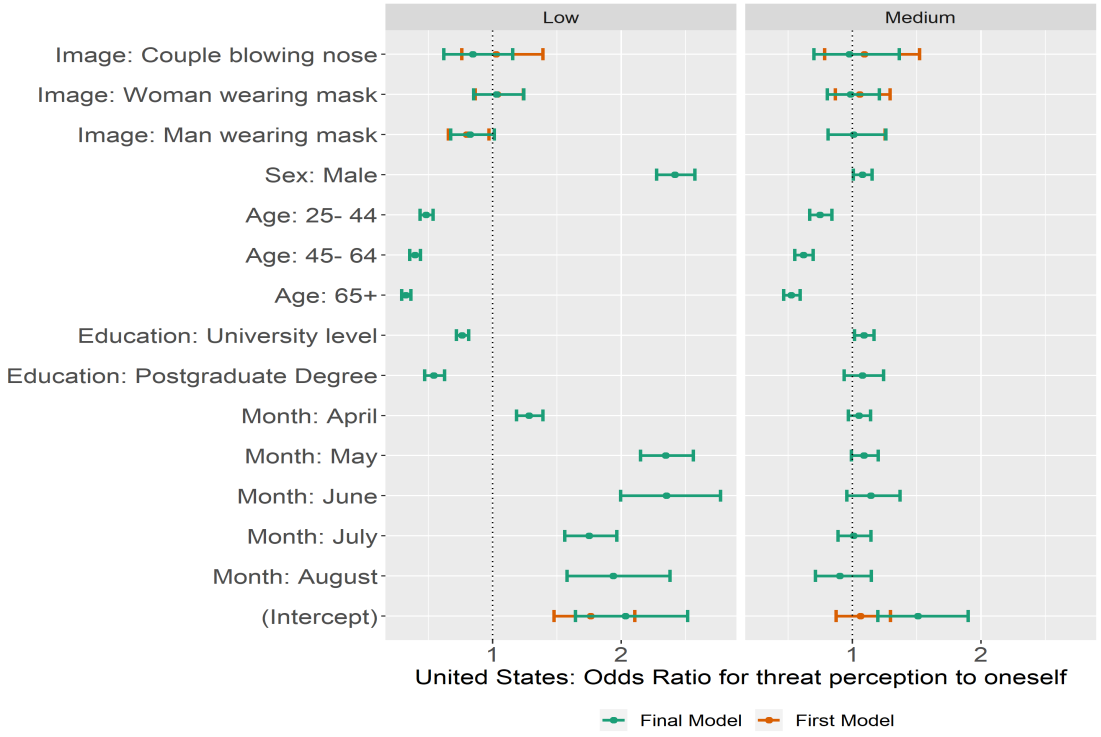


(F) Spain

Figure A3: Coefficient plot for the first and final model estimating the perception of threat to oneself (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.



(G) United Kingdom



(H) United States

Figure A3: Coefficient plot for the first and final model estimating the perception of threat to oneself (Ref. High). Models are step-wise controlled for image, sex, age, education, and month. Weighted by age, gender, sub-national region.