Behaviors and attitudes in response to the COVID-19 pandemic: Insights from a cross-national Facebook survey

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Abstract

In the absence of medical treatment and vaccination, the mitigation and containment of the ongoing COVID-19 pandemic relies on behavioral changes. Timely data on attitudes and behaviors are thus necessary to develop optimal intervention strategies and to assess the consequences of the pandemic for different demographic groups. We developed a rapid response monitoring system via a continuously run online survey (the “COVID-19 Health Behavior Survey”) across eight countries (Belgium, France, Germany, Italy, the Netherlands, Spain, the United Kingdom, the United States). The survey was specifically designed to collect key information on people’s health status, behaviors, close social contacts, and attitudes in response to the COVID-19 pandemic. We developed an innovative approach to recruit participants via targeted Facebook advertisement campaigns in order to generate balanced samples for post-stratification. In this paper, we present results for the period from March 13-April 19, 2020. We estimate important differences by sex: women show a substantially higher perception of threat along with a lower level of confidence in the health system. This is paralleled by sex-specific behaviors, with women more likely to adopt a wide range of preventive behaviors. We thus expect behavior to serve as a protective factor for women. Our findings also show a higher level of awareness and concern among older respondents, in line with the evidence that the elderly are at highest risk of severe complications following infection from COVID-19. While across all the samples respondents were less concerned for themselves than for their country or for the world, we also observed substantial temporal and spatial heterogeneity in terms of confidence in institutions and responses to non-pharmaceutical interventions.

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
1 Introduction

The ongoing coronavirus disease 2019 (COVID-19) outbreak started in Wuhan City, China, in December 2019 and quickly spread globally, soon reaching pandemic proportions [1]. By mid-April 2020, the virus had already caused over 1.6 million cases and over 100,000 deaths worldwide [2], placing a substantial burden on national healthcare systems and posing unprecedented challenges for governments and societies. As yet, governmental responses to mitigate the coronavirus epidemic have varied considerably across countries. Non-pharmaceutical interventions, specifically intended to reduce sustained local transmission by reducing contact rates in the general population, have so far ranged from moderate containment measures, such as school closures and cancellations of public gatherings, to drastic measures, such as travel bans and nationwide lockdowns [3]. In Western democracies, individual behaviors, rather than governmental actions, are potentially crucial to control the spread of COVID-19 [4]. Human behavior is in fact a key factor in shaping the course of epidemics [5]. Individuals may spontaneously modify their behaviors and adopt preventive measures in response to an epidemic when mortality or the perception of risk is high, and this may in turn change the epidemic itself by reducing the likelihood of transmission and infection [6, 7, 8].

However, a key problem is a lack of data to assess people’s behavior and reactions to epidemics. Decision-making and the evaluation of non-pharmaceutical interventions require specific, reliable, and timely data not only about infections, but also about human behavior. Especially in the ongoing COVID-19 pandemic, where medical treatment and vaccination are still only remote options, mitigation and containment mainly rely on massive and rapid adoption of preventive measures [9]. Understanding how the members of different demographic groups perceive the risk, and consequently adopt specific behaviors in response to it, is therefore key to measure the effectiveness of non-pharmaceutical interventions, design more realistic epidemic models, and enable public health agencies to develop optimal control policies to contain the spread of COVID-19.

We seek to narrow this data gap by monitoring individual behaviors and attitudes in response to the COVID-19 pandemic in multiple countries. In March 2020, we launched a cross-national online survey, called the “COVID-19 Health Behavior Survey” (CHBS), to collect timely data on people’s health status, behaviors, close social contacts, and attitudes related to COVID-19. We recruit respondents through advertisement campaigns on Facebook, that we created via the Facebook Advertising Manager (FAM). This novel approach to recruiting respondents allows us to combine the flexibility of online surveys for rapid data collection, with the controlled environment of targeted advertisement. This makes it possible to recruit a balanced sample across demographic groups, that is approximately representative of the general population, after applying appropriate post-stratification weights [10, 11, 12]. Other similar online initiatives have emerged recently [13, 14, 15, 16]. However, to the best of our knowledge, this is the first cross-national study addressing multiple key factors, ranging from individual behaviors and attitudes to health-related indicators to social contact patterns. Moreover, our sampling approach and continued data collection allows us to compare people’s behaviors across countries that are at different stages of the COVID-19 pandemic, and to assess changes in behaviors after pivotal events, such as nationwide lockdowns.

In this paper, we present first results based on survey data collected over the period March 13 to April 19, 2020 in Belgium, France, Germany, Italy, the Netherlands, Spain, the United Kingdom, and the United States. Over this period, a total of 66,266 participants completed the questionnaire. Our goal in this paper is to provide insights into the relation between participants’ demographic characteristics and (i) the threat they perceive COVID-19 to pose to
various levels of society, (ii) the confidence they have in the preparedness of different national and international organizations to handle the current crisis, and (iii) the behavioral measures (preventive measures and social distancing measures) they have taken to protect themselves from the coronavirus. From a public health perspective, this information is key to understand the behaviors and attitudes of specific demographic groups in different countries and help guide the decision-making process to design adequate policies to contain the spread of COVID-19.

In the following sections, we outline our methodological approach and discuss the innovative aspects of participant recruitment through Facebook advertising campaigns, as well as the statistical adjustments needed to approximate a sample representative of the general population. Then we describe the main features of our sample and present results of the first analyses regarding behaviors and attitudes in response to COVID-19. We close with a discussion and an outlook for the next steps in our broader project.

2 Methods

2.1 Study design and data collection

The CHBS is designed to collect information on respondents’ health behaviors and attitudes related to COVID-19. Participation in the survey is anonymous and voluntary. Respondents can stop participating at any time and can skip questions they feel uncomfortable answering.

The questionnaire consists of four topical sections: (i) socio-demographic indicators (age, sex, country of birth, country of residence, level of education, household size and composition); (ii) health indicators (underlying medical conditions, flu vaccination status, pregnancy, symptoms experienced in the previous seven days); (iii) opinions and behaviors (perceived threat from COVID-19, level of trust in institutions, level of confidence in sources of information, preventive measures taken, disruptions to daily routine); (iv) social contact data, i.e. the number of interactions that respondents had the day before participating in the survey in different settings (at home, at school, at work, or in other locations). To facilitate validation and warrant comparability with existing surveys, we included standard questions from several sources, such as the European Social Survey (ESS) \[17\] regarding socio-demographic characteristics, Ipsos \[18\] regarding opinions on the coronavirus outbreak, and the Polymod project \[19\] regarding social contacts. Note that we ask respondents about their behavior and attitudes related to the coronavirus outbreak only if they indicated that they were aware of it. In more detail, we asked respondents how much, if at all, they had seen, read or heard about the coronavirus outbreak, with the answer options “A great deal”, “A fair amount”, “Not very much”, “Nothing at all”, and “Prefer not to answer”. Respondents who indicated that they knew nothing at all, or that they preferred not to answer, were not asked any further questions related to the outbreak.

We created the questionnaire first in English, and then translated it into the different official languages of the countries in our study, with support from professional translators. We considered country-level differences when adjusting the questionnaire for different countries, where applicable (e.g. differences in the educational system). In the online implementation, the questionnaire is available in both English and the national language(s) of the respective country in which respondents are located. The questionnaire was implemented in the online survey tool LimeSurvey (version 3.22.8+20030) and hosted by the Society for Scientific Data Processing (GWDG). The full English questionnaire (as used in the United States) is reported in Appendix A.

The link to the questionnaire is distributed through advertisement campaigns that we created via the FAM. Facebook is currently the largest social media platform, with 2.45 billion
monthly active users worldwide as of September 2019 [20]. In the United States, about 69% of adults used Facebook in 2019 [21], with similar penetration rates in Europe, ranging from 56% in Germany to 92% in Denmark [22]. The FAM enables advertisers to create advertising campaigns that can be targeted at specific user groups, as defined by their demographic characteristics (e.g. sex and age) and a set of characteristics that Facebook infers from their behavior on the network (e.g. interests). An increasing number of studies explore the use of Facebook in demographic and health research to recruit participants for online surveys [23, 24, 25]. Two main advantages of this approach are rooted in Facebook’s wide reach and the possibility to directly target members of different demographic groups. Two concerns that are often raised are that in online samples self-selection might lead to bias in results, and that online sub-populations may not be representative of the general population. However, there is increasing evidence that samples obtained from Facebook do not significantly differ from samples obtained from more traditional recruitment and sampling techniques in central demographic and psychometric characteristics, especially if post-stratification weights are applied adequately [10, 12, 26, 27].

We created one advertising campaign per country and stratified each campaign by sex (male and female), age group (18-24, 25-44, 45-64, and 65+ years), and region of residence (largely following the NUTS classification in Europe and the census regions in US; see Table S4 in the Supplementary Material), resulting in 24 to 56 strata per country, further stratified using six different ad images. Figure S1 in Section 1 of the Supplementary Material illustrates the structure of our Facebook advertising campaigns in the United States. Note that we aggregated the different regions of residence into larger macro-regions, to keep the number of strata in Facebook manageable (see Table S4 for the exact mapping). We launched the campaigns on March 13, 2020, in Italy, the United Kingdom, and the United States. We added Germany and France on March 17, Spain on March 19, the Netherlands on April 1, and Belgium on April 4, 2020. In the period 21-26 March, we were unable to recruit a significant number of participants due to technical issues with the FAM which prevented the delivery of our advertisements.

2.2 Data pre-processing

We select participants for our analysis in three steps. First, we include only participants who reported that they lived in the country that the respective advertising campaign and country-specific questionnaire targeted, and who reported their sex, age, and region of residence (the central variables in our post-stratification weighting approach, see details below). Second, when analysing responses to a given question, we exclude respondents who chose the options “Don’t know” or “Prefer not to answer”. In the analysis reported here, this particularly affects the question about awareness of the coronavirus outbreak (see Section 2.1); however, as Table S2 in the Supplementary Material shows, the share of respondents to whom this applies is less than 1% across countries. Third, given that in calendar week 12 we were only able to collect a small number of completed questionnaires in Spain (less than 100), we excluded these data from our analysis as the sample size would render our analysis unreliable for this period. Note that all period references consider local time zones across countries and regions.

After participant selection, we apply post-stratification weights to the final data set in order to correct for potential issues with non-representativeness in our sample. We use a standard procedure in survey research, in which appropriate weights are computed based on population information from more traditional data sources (e.g. census data). Here we use population data from Eurostat (2019) [28] and the US census (2018) [29]. Specifically, for each stratum $i$ (given by each combination of sex, age, and macro-region) in each country, we compute the fraction
\(p_i\) and \(\hat{p}_i\) of, respectively, the true population counts \(N_i\) and the sample counts \(\hat{N}_i\), compared to the total population \(\sum_i N_i\) and the total sample size \(\sum_i \hat{N}_i\). The weights \(w_i\) are then defined as \(w_i = \frac{p_i}{\hat{p}_i}\), thus giving less weight to groups which are over-represented (\(w_i < 1\)) and more weight to groups which are under-represented (\(w_i > 1\)) in the sample. We provide more details about our approach to post-stratification in Section 3 of the Supplementary Material.

2.3 Data Analysis

In our analysis, we focus on (i) perception of threat from COVID-19, (ii) confidence in the preparedness of different national and international organizations to respond to this threat, and (iii) behavioral measures taken to protect oneself from the virus. All our analyses are based on the weighted sample, whereas the reported sample sizes refer to the unweighted sample.

We asked respondents to rate the threat they perceived COVID-19 to pose for different levels of society (i.e. to themselves, their family, their local community, their country, and the world) on a 5-point Likert-type scale (1 = very low threat, 5 = very high threat), including the options “Don’t know” and “Prefer not to answer”, which are treated as missing values (Table S3 in the Supplementary Material reports the corresponding sample size for each item). For comparison, we asked respondents to answer the same questions also for the seasonal flu. We normalized respondents’ answers to each item to the range 0-1, meaning that values around 0.5 correspond to moderate perceived threat, whereas 0 and 1 correspond to low and high perceived threat, respectively.

In a similar way, we asked respondents to rate the confidence they had in the preparedness and ability of different organizations to effectively deal with the COVID-19 pandemic (i.e. doctors and healthcare professionals in their community, hospitals in their local area, health care services in their country, the World Health Organization, their local government, and their national government) on a 4-point Likert-type scale (1 = not confident at all, 4 = very confident), also including the options “Don’t know” and “Prefer not to answer”, which are treated as missing values (see Table S3 in the Supplementary Material). We normalized answers to the range 0-1, and aggregated responses related to the local health system (doctors and healthcare professionals in respondents’ community and hospitals in their local area) by averaging them across items within respondents.

Finally, we asked respondents which measures, if any, they had taken to protect themselves from the coronavirus. For this, we showed a list of actions, from which they can choose all that apply. This list includes preventive measures (e.g. washing hand more often), measures of social distancing (e.g. avoided social events), measures of reduced mobility (e.g. avoided public transportation), panic buying (e.g. stockpiling of food), and potential discriminatory actions (e.g. avoided eating in Asian restaurants). See the questionnaire in the Appendix A for the full list of actions. In the analysis, we consider the shares of participants who reported having adopted specific behaviors in response to COVID-19, including: (i) the stockpiling of food and/or medicine; (ii) the use of a face mask; (iii) the increased use of hand sanitizer; (iv) the increased washing of hands; (v) social distancing (if participants selected at least one of the following: avoided shaking hands, avoided social activities, and avoided crowded places); and (vi) the reduced use of transportation (if participants selected at least one of the following: avoided travelling by public transportation, and avoided travelling by taxi).

In our analyses, we used non-parametric tests for median comparisons (Wilcoxon test to compare two groups and Kruskall–Wallis test to compare three or more groups) and considered \(p\)-values of less than 0.05 to be significant. Data analysis was performed with the programming language Python (version 3.7).
3 Results

3.1 Participant characteristics

A total of 66,266 participants completed the survey in Belgium (N=5,520), France (N=6,216), Germany (N=11,030), Italy (N=9,310), the Netherlands (N=4,711), Spain (N=7,145), the United Kingdom (N=8,412), and the United States (N=13,922) in the period between March 13, 2020 (calendar week 11) and April 19, 2020 (calendar week 16). As Table 1 shows, participation by week was high in all countries, with a median number of 1,610 participants per week in Belgium, 1,490 in France, 1,646 in Germany, 1,810 in Italy, 1,743 in the Netherlands, 1,842 in Spain, 1,114 in the United Kingdom, and 2,498 in the United States.

Table 1 also shows the demographic characteristics of the participants in each country, based on the unweighted sample. The sex ratio is somewhat skewed towards females compared to the overall population, ranging from 63% female in Germany to 71% female in France. In terms of age, older respondents tend to be over-represented, with a median age of 48 years (IQR 31-62) in Belgium, 45 years (IQR 29-61) in France, 40 years (IQR 27-56) in Italy, 55 years (IQR 38-64) in the Netherlands, 49 years (IQR 36-60) in Spain, 56 years (IQR 41-65) in the United Kingdom, and 55 years (IQR 37-65) in the United States. When it comes to education, there is some variation across countries. More specifically, in Belgium (46%), France (71%), Spain (59%), the United Kingdom (46%), and the United States (60%) most respondents attained university-level education, whereas in Germany (62%), Italy (50%), and the Netherlands (58%) most respondents attained secondary-level education.

After applying post-stratification weights, the bias described above is reduced and the sample approximates the shares reported in nationally representative surveys in terms of sex, age, and educational attainment, as shown in Figure S3 in the Supplementary Material. For more details, see Section 3 of the Supplementary Material.

3.2 The perception of threat: higher for the elderly and for women, while everyone is less concerned for oneself than for the country as a whole

Figure 1 shows the threat that respondents perceive COVID-19 to pose to different levels of society (i.e. oneself, the family, the local community, the country, and the world), broken down by country (panel A), age group (panel B), sex (panel C), and calendar week (panel D). Overall, threat perception of COVID-19 is highest in Italy with a median value of 0.69 (IQR 0.64-0.76), followed by the United Kingdom with 0.68 (IQR 0.62-0.75), Spain with 0.65 (IQR 0.56-0.82), Belgium with 0.63 (IQR 0.56-0.75), France with 0.61 (IQR 0.56-0.77), the United States with 0.60 (IQR 0.52-0.69), the Netherlands with 0.59 (IQR 0.54-0.71), and lastly Germany with 0.53 (IQR 0.48-0.61). In all countries, there is significant variation in threat perceptions across levels of society ($p<0.001$). In particular, the perception of threat increases sharply from the personal sphere (oneself and the family) to more distal contexts, i.e. the local community, the country, and, ultimately, the world. Considering specifically the perceived threat to oneself and to the world, the latter is on average 32% greater, whereas this difference ranges from 24% in Italy to 37% in the United States.

Apart from these variations at the country level, the threat perception posed by COVID-19 is both age- and sex-specific. As shown in Figure 1B, the perceived threat to oneself and to the world is the author/funder, who has granted medRxiv a license to display the preprint in perpetuity. It is made available under a CC-BY-ND 4.0 International license. This is the accepted preprint version posted May 15, 2020. The copyright holder for this preprint (which was not certified by peer review)
|                | BE  | FR  | DE  | IT  | NL  | ES  | UK  | US  |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|
| No. participants| 5,520 | 6,216 | 11,030 | 9,310 | 4,711 | 7,145 | 8,412 | 13,922 |

**Participants per week**

| Week          | No. | Participants per week | %     | No. | Participants per week | %     | No. | Participants per week | %     |
|---------------|-----|-----------------------|-------|-----|-----------------------|-------|-----|-----------------------|-------|
| Week 11       | -   | 2,016                 | (22%) | -   | 1,188                 | (14%) | -   | 1,580                 | (11%) |
| (March 9-15)  | -   |                       |       | -   |                       |       | -   |                       |       |
| Week 12       | -   | 998                   | (9%)  | -   | 1,937                 | (21%) | -   | 800                   | (15%) |
| (March 16-22) | -   |                       |       | -   |                       |       | -   |                       |       |
| Week 13       | -   | 1,374                 | (22%) | -   | 1,590                 | (14%) | -   | 1,004                 | (20%) |
| (March 23-29) | -   |                       |       | -   |                       |       | -   |                       |       |
| Week 14       |     | 807                   | (15%) | 3,417 | 1,771                 | (31%) | 1,790 | 2,458                 | (34%) |
| (March 30-April 5) |     |                       |       |       |                       |       |       |                       |       |
| Week 15       |     | 3,103                 | (30%) | 3,379 | 1,085                 | (37%) | 1,743 | 2,404                 | (37%) |
| (April 6-12)  |     |                       |       |       |                       |       |       |                       |       |
| Week 16       |     | 1,610                 | (29%) | 881  | 1,646                 | (35%) | 652  | 1,178                 | (25%) |
| (April 13-19) |     |                       |       |       |                       |       |       |                       |       |

**Sex**

| Gender   | No.   | Participants per week | %     | No.   | Participants per week | %     | No.   | Participants per week | %     |
|----------|-------|-----------------------|-------|-------|-----------------------|-------|-------|-----------------------|-------|
| Female   | 3,716 | 6,936                 | (63%) | 6,033 | 4,899                 | (69%) | 5,487 | 9,194                 | (66%) |
| Male     | 1,804 | 4,094                 | (62%) | 3,277 | 2,246                 | (37%) | 2,925 | 4,728                 | (34%) |

**Age group**

| Age group | No.   | Participants per week | %     | No.   | Participants per week | %     | No.   | Participants per week | %     |
|-----------|-------|-----------------------|-------|-------|-----------------------|-------|-------|-----------------------|-------|
| 18-24     | 945   | 1,948                 | (21%) | 649   | 541                   | (8%)  | 677   | 1,549                 | (11%) |
| 25-44     | 1,667 | 4,246                 | (26%) | 3,763 | 2,628                 | (37%) | 2,062 | 3,782                 | (27%) |
| 45-64     | 1,870 | 2,916                 | (34%) | 2,507 | 2,926                 | (41%) | 3,469 | 4,744                 | (34%) |
| 65+       | 1,038 | 1,473                 | (20%) | 1,092 | 1,157                 | (35%) | 1,050 | 3,847                 | (28%) |

**Education**

| Education            | No. | Participants per week | %     | No. | Participants per week | %     |
|----------------------|-----|-----------------------|-------|-----|-----------------------|-------|
| Primary school or lower | 257 | 341                   | (4%)  | 288 | 95                    | (1%)  |
| Secondary school     | 2,423 | 4,627                 | (58%) | 1,818 | 3,126                 | (58%) |
| University level      | 2,559 | 4,329                 | (37%) | 4,239 | 3,897                 | (38%) |
| Other                | 281  | 499                   | (35%) | 800 | 1,294                 | (15%) |

Table 1. Characteristics of participants who completed the COVID-19 Health Behavior Survey during the period March 13–April 19, 2020 in Belgium (BE), France (FR), Germany (DE), Italy (IT), Netherlands (NL), Spain (ES), United Kingdom (UK), and United States (US). Unweighted sample.
Fig. 1. Perceived threat posed by COVID-19 to oneself, the family, the local community, the country, and the world, broken down by country (A), age group (B), sex (C), and week (D). Bar charts show median values as bars and 95%CI as errors. Weighted sample.

consistently lower for the younger age group (i.e. 18-24) with a median value of 0.37 (IQR 0.32-0.41), and higher for the elderly (i.e. 65+) with a median value of 0.58 (IQR 0.54-0.63). Overall, the perceived threat increases with age, with few notable exceptions, including the perceived threat to the family in Germany, the Netherlands, Spain, and the United States, the perceived threat to the local community in the Netherlands, Spain, and the United States, and the perceived threat to the country and to the world in the United States (all \( p > 0.06 \)). Importantly, as Figure 1C shows, the perceived threat is significantly higher among women than among men\(^2\).

The development of threat perceptions over time shows different temporal patterns across countries, as can be seen in Figure 1D. In particular, there is significant variation over time in Germany (\( p < 0.001 \)), and the United States (\( p < 0.001 \)). In Germany the perceived threat shows a negative trend, with the median value compared to that of week 12 decreasing by about 4% in week 13, 9% in week 14, 15% in week 15, and 18% in week 16. In the United States the trend changes over time, with the median value compared to that of week 11 increasing by about 20% in week 12, 28% in week 13, and 31% in week 14, but then dropping to being only 17% higher in week 15, and 15% higher in week 16. In France, Italy, and the United Kingdom, the temporal pattern is more mixed, with significant variation over time across levels of society (\( p < 0.02 \)), except for the perceived threat to oneself in France (\( p = 0.5 \)), Italy (\( p = 0.6 \)), and

\(^2\) All \( p < 0.01 \), except in Spain for the perceived threat to oneself (\( p = 0.06 \)), to the family (\( p = 0.2 \)), and to the local community (\( p = 0.05 \))
the United Kingdom ($p = 0.07$), to the family in the United Kingdom ($p = 0.06$), and to the country ($p = 0.09$) and to the world ($p = 0.2$) in France. By contrast, there is no significant variation across weeks for all levels of society in Belgium ($p = 0.3$), the Netherlands ($p = 0.07$), and Spain ($p = 0.1$).

Finally, Figure 2 compares the threat perception for seasonal influenza (panel A) with that for COVID-19 (panel B). The perceived threat posed by COVID-19 is significantly higher than the perceived threat posed by influenza (all $p < 0.001$). In more detail, the perceived threat to oneself is on average 51% higher (ranging from 41% in Germany to 61% in Belgium), the threat to the family is 46% higher (40% in the Netherlands to 51% in the United States), the threat to the local community is 44% higher (33% in France to 54% in the United Kingdom), the threat to the country is 64% higher (51% in Germany to 71% in Belgium), and the threat to the world is 55% higher (47% in Italy to 62% in Belgium). More details about the perceived threat posed by influenza can be found in Section 5 of the Supplementary Material.

### 3.3 The level of confidence in organizations: in a heterogeneous landscape, men have higher confidence in local and national health systems

Figure 3 shows the level of confidence that respondents have in various national and international organisations, broken down by country (panel A), age group (panel B), sex (panel C), and week (panel D). Overall, the level of confidence is highest in the Netherlands with a median value of 0.67 (IQR 0.63-0.72), followed by Italy with 0.66 (IQR 0.61-0.73), Germany with 0.64 (IQR 0.59-0.68), Spain with 0.63 (IQR 0.53-0.84), the United Kingdom with 0.57 (IQR 0.48-0.64), the United States with 0.57 (IQR 0.50-0.63), Belgium with 0.52 (IQR 0.45-0.64), and lastly France with 0.49 (IQR 0.39-0.60). In all countries, there is significant variation across organizations (all $p < 0.001$). First, respondents’ confidence in the national health system tends to be lower than their confidence in the local health system. Considering the median values, respondents’ confidence in the national health system is about 13% lower than their confidence in the local health system in Belgium, 19% lower in France, 6% lower in Germany, 6% lower in

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3 All $p < 0.007$, except Italy ($p = 0.2$) and the United Kingdom ($p = 0.9$)
the Netherlands, 2% lower in Spain, and 14% lower in the United States. Second, respondents’ confidence in local and national governments differs substantially in all countries \((p < 0.04)\). In particular, their confidence in the national government is about 3% lower than their confidence in the local government in Germany, it is 26% lower in France, 12% lower in Spain, and 31% lower in the United States. By contrast, it is about 1% higher in Belgium, 7% higher in Italy, 6% higher in the Netherlands, and 8% higher in the United Kingdom.

Apart from this variation, several other patterns stand out in the level of confidence by age group and sex. As shown in Figure 3B, overall the elderly tend to be more confident in the preparedness of the various organizations, with the exception of the WHO, in which young adults aged between 18 and 24 years show instead greater confidence. Additionally, the level of confidence is sex-specific across organizations, as can be seen in Figure 3C. Male respondents are more confident in the local or national health systems\(^4\), whereas female respondents are more confident in the WHO and in the local government\(^5\). As for the national government, instead, confidence is higher among female respondents in Germany \((p < 0.001)\), and Spain \((p = 0.01)\), but it is higher among male respondents in the United States \((p < 0.001)\).

Figure 3D shows the development of the level of confidence over time. Similarly to the perceived threat shown in Figure 1D, the temporal patterns vary across countries. In particular,

\(^4\) All \(p < 0.02\), except for the Netherlands, Spain, and the United Kingdom

\(^5\) As for the WHO, all \(p < 0.002\), except for Belgium, France, and Italy, while for the local government, all \(p < 0.02\), except Belgium, Italy, and the United States
there is significant variation across weeks in Germany ($p < 0.01$), Italy ($p < 0.03$), the United Kingdom ($p < 0.01$), and the United States ($p < 0.01$). While in Germany and in the United Kingdom, the trend is positive with the median value in week 16 being about 7% and 21% higher compared to the first week, on the contrary, in Italy this trend is negative with the median value in week 16 being about 12% lower than in week 11. In the United States, instead, the temporal pattern is more variable, with the level of confidence in the health systems increasing, whereas the level of confidence in the different levels of government diverges. It is higher for the local government (about 8% higher in week 16 than in week 11), while for the national government the trend changes over time, with the median value compared to that of week 11 decreasing by about 3% in week 12, 17% in week 13, and 12% in week 14, but then increasing to being only 7% lower in week 15, and 5% lower in week 16.

On the other hand, the temporal pattern in France shows significant variation, except for the local health system ($p = 0.09$), whereas there is no significant variation in the level of confidence over time in Belgium (all $p > 0.07$), the Netherlands (all $p > 0.08$), and Spain (all $p > 0.5$). Moreover, looking at the level of confidence in the WHO separately, this consistently shows a negative trend in France (about 14% lower in week 16 compared to week 13), Germany (about 13% lower in week 16 compared to week 12), Italy (about 12% lower in week 16 compared to week 11), the United Kingdom (about 7% lower in week 16 compared to week 11), and the United States (about 24% lower in week 16 compared to week 11).

3.4 Behaviors in response to COVID-19: Women changed their behavior more than men across all dimensions

Figure 4 shows the self-reported behaviors broken down by country (panel A), age group (panel B), sex (panel C), and week (panel D). As shown in Figure 4A, the least frequently reported behavior is the stockpiling of food and/or medicine, ranging from about 18% of respondents (IQR 16-21) in the Netherlands to about 31% (IQR 24-33) in Germany. Secondly, the share of participants who reported wearing a face mask ranges from about 6% (IQR 4-9) in the Netherlands to about 57% (IQR 54-61) in Italy. As for hand hygiene, the share of participants who increased the use of hand sanitizer ranges from about 49% (IQR 46-54) in Germany to about 70% (IQR 68-77) in the United States, while the share of participants who increased washing their hands ranges from about 89% (IQR 85-91) in Germany to about 94% (IQR 91-96) in Spain. Finally, the most frequently reported behaviors are, respectively, increased social distancing, which ranges from about 93% (IQR 90-95) in the United Kingdom to about 98% (IQR 97-99) in Italy, and the reduced use of transportation, which ranges from about 72% (IQR 68-75) in the United States to about 82% (IQR 78-85) in France.

Moreover, the share of participants adopting specific behaviors related to COVID-19 shows a variable pattern across age groups in all countries, as shown in Figure 4B. In particular, significant variations in the age distribution is observed in respondents who stockpiled food and/or medicine, increased the use of hand sanitizer, and reduced the use of transportation. However, there is no significant variation in the age distribution in terms of respondents who engaged in social distancing, increased hand washing, and worn a face mask.

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As for the stockpiling of food and/or medicine, all $p < 0.02$, except France ($p = 0.06$). As for the increased use of hand sanitizer, all $p < 0.05$, except France ($p = 0.2$), and the Netherlands ($p = 0.3$). As for the reduced use of transportation, all $p < 0.01$, except Belgium ($p = 0.9$), and Germany ($p = 0.2$).

As for the social distancing, all $p > 0.3$, except Spain ($p = 0.02$), and the United Kingdom ($p = 0.003$). As for the increased hand washing, all $p > 0.1$, except France ($p = 0.004$). As for the use of a face mask, all $p > 0.08$, apart from few notable exceptions, including France, Germany, and Italy, where older age groups reported more having used a face mask.
Fig. 4. Proportions of participants who reported having adopted specific behaviors in response to COVID-19 broken down by country (A), age group (B), sex (C), and week (D). Behaviors include the stockpiling of food and/or medicine, wearing a face mask, increased use of hand sanitizer, increased hand washing, increased social distancing, and reduced use of public transportation. Bar charts show median values and 95%CI as errors. Weighted sample.

As shown in Figure 4C, behaviors related to COVID-19 are sex-specific, with female respondents showing the highest adoption rates for specific behaviors.8

The development of behaviors over time shows different temporal patterns between countries, as can be seen in Figure 4D. In particular, the use of a face mask substantially increased over time (all \( p < 0.001 \), except Belgium, and the Netherlands), as well as hand hygiene in Germany, Italy, the United Kingdom, and the United States (\( p < 0.04 \)), and the reduced use of transportation in the United Kingdom (\( p < 0.001 \)), and the United States (\( p < 0.001 \)). Social distancing has increased sharply in the United Kingdom (\( p < 0.001 \)), and in the United States (\( p < 0.001 \)), whereas it has decreased in Germany (\( p = 0.001 \)), reflecting different stages of the epidemic and different policies.

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8 All \( p < 0.05 \), apart from few exceptions, including the stockpiling of food and/or medicine in Spain, and the United Kingdom, the use of a face mask in the United Kingdom, the increased use of hand sanitizer in Spain, and the United Kingdom, the increased hands washing in Spain, and the increased social distancing in Italy (\( p = 0.3 \)), and Spain (\( p = 0.4 \)).
4 Discussion

Understanding how different demographic groups perceive the risk of COVID-19, and thus adopt specific behaviors in response to it, is key to enable public health agencies to develop optimal intervention strategies to contain the spread of the disease. In this paper, we have presented insights from survey data collected through a cross-national online survey, the COVID-19 Health Behavior Survey (CHBS). The survey is ongoing, and here we presented results based on data collected during the period March 13–April 19, 2020 in Belgium, France, Germany, Italy, the Netherlands, Spain, the United Kingdom, and the United States. In this closing section, we summarize the main findings and provide our interpretation in light of the current evidence on the COVID-19 pandemic.

First, we found that the perception of the threat that COVID-19 poses was on average highest in Italy, followed by the United Kingdom, Spain, Belgium, France, the United States, the Netherlands, and Germany. Conversely, respondents’ confidence in the preparedness of local and national organizations to deal with COVID-19 was on average highest in the Netherlands, followed by Italy, Germany, Spain, the United Kingdom, the United States, Belgium, and France. In particular, Italy was the first most affected country in Europe in terms of numbers of cases and deaths, as well as the first country in Europe to implement a nationwide lockdown on March 11, 2020. This may explain the high threat perceived by the population in this country, and, together with the high confidence in the different health systems and different levels of government, the willingness to adopt preventive behaviors and adhere to social distancing measures.

After Italy, nationwide lockdowns were implemented also in Spain (March 14), France (March 17), Belgium (March 18), the Netherlands (March 24), and the United Kingdom (March 24) to slow the progression of the virus and to prevent overloading the healthcare system [30]. In the United States, instead, restrictive measures were implemented at the state level, starting in California on March 19, 2020. Notably, regarding the United Kingdom and the United States, our data collected before and after lockdown measures were implemented (considering the United States as a whole) allow to observe temporal variation in the self-reported behaviors and attitudes: the perceived threat has increased in the population, along with the adoption of social distancing measures. In the case of the United Kingdom, after the lockdown was implemented, the level of confidence in the health systems and different levels of government sharply increased, possibly reflecting discontent in the population about previously announced strategies. By contrast, the results for Germany are more difficult to interpret. In Germany, somewhat less restrictive measures were implemented on March 22, including school closures, cancellations of public gatherings, and the encouragement of social distancing. However, in contrast to the United Kingdom and the United States, for which we observe a change in the temporal trends only after the implementation of non-pharmaceutical interventions, we find for Germany that the share of respondents who had adopted social distancing measures was already high before such measures were implemented, and did not change much after this point. Furthermore, compared to other countries, the level of confidence in the health systems and different levels of government in Germany was high from the beginning of our observation period, and has further increased since then, whereas the perceived threat of COVID-19 has decreased over time. This might be interpreted as a case of spontaneous bottom-up behavioral changes emerging from the population, following high trust in decisions and preparedness of the government. Also, of the European countries considered in this study, Germany had the third highest number of cases (about 140,000), but placed only sixth in terms of deaths (about 4,000) as of April 19, 2020 [31], which might explain the lower perceived risk perception in the
population.

Second, we observe a clear pattern in threat perceptions regarding different levels of society, sharply increasing from moderate threat for the personal sphere (threat to oneself and the family) to very high threat for more distal contexts (i.e. the local community, the country, and the world). Yet, even though the perception of threat to oneself among our respondents was comparatively low, we found that a high share of them had increased their hand hygiene. This insight renders it uncertain as to what extent behavior can be straightforwardly linked to perceptions of personal threat. Furthermore, we found that the perceived threat posed by COVID-19 is significantly higher than the perceived threat posed by seasonal influenza. One likely explanation for this is that although seasonal influenza causes regular annual epidemics worldwide [32], the novelty and uncertainty that surround COVID-19 leads risk perception to be substantially higher.

Third, apart from variation at the country level, we also found sex- and age-specific differences. Looking at the age component, our findings suggest that younger people perceive the threat to themselves lower than older people. This is in line with the evidence that older adults are at highest risk of severe complications following infection from COVID-19 [33]. By contrast, the age structure in the perceived threat to the family is less pronounced, which suggests that respondents were concerned about their family members, regardless of their own age and the perceived threat to themselves.

Fourth, we also found sex-specific patterns in the data. Specifically, female respondents perceived the threat that COVID-19 poses substantially higher, reported a lower level of confidence in the health system, and were more willing to adopt protective behaviors. Since the case fatality rate for COVID-19 is substantially higher for men [34], we might expect that men are more concerned about it. Our results demonstrate that this is not necessarily true, and fact may have to be considered in the design of future communication campaigns.

We gained these insights by using a novel approach to collecting health behavior data in times of a pandemic. We employed Facebook advertising campaigns to continuously recruit a large number of participants for our survey over a long period of time. This approach allows us to target specific demographic groups in a comparative, cross-national approach, and to collect balanced samples to which post-stratification methods can be applied.

These advantages notwithstanding, our approach also has some limitations. First, online surveys potentially suffer from bias due to self-selection and non-representativeness of the sample. In the case of Facebook, there is increasing evidence that samples obtained from this social media network are not significantly different in central demographic and psychometric characteristics from samples obtained by more traditional recruitment and sampling techniques [12]. Furthermore, by applying post-stratification weighting, which is a standard procedure in survey research, we can correct for non-representativeness in observable characteristics (but not necessarily for self-selection based on unobservable characteristics), at least at the level of the entire sample. Ideally, in our cross-temporal comparisons, we would apply this approach at the level of the week, to warrant complete comparability of observations over time, but issues of data sparsity complicate this approach. We do not expect this to strongly affect our results, but it should be kept in mind that our weekly results might suffer from somewhat larger bias than our aggregate results.

Second, our data collection started at different time points across countries, and also pertains to different points in the trajectory of the pandemic across countries. This also encompasses differences in the implementation of non-pharmaceutical interventions ordered by local and national governments, and needs to be kept in mind when comparing and interpreting our results across countries.
Third, the data presented here have the form of repeated cross sections, which enables us to assess changes in the population samples over time, but does not allow us to assess changes within individuals.

We are planning to address some of the limitations in the future in the following way. First, we aim to expand our post-stratification weighting scheme, by applying multilevel post-stratification, which will enable us to achieve greater consistency among differently sized strata and greater precision in the estimates for population subsets, such as the weekly estimates presented here. Second, we aim to carry out a follow-up survey among participants who agreed to provide their email address for this. This panel perspective offers a unique possibility to understand how the COVID-19 pandemic affects the population in the long run and to assess the impact of loosening the lockdown measures on social contact patterns and health behaviors in a cross-national perspective.

To conclude, our work reduces the gap in human behavioral data, by providing timely and accurate data on individual behaviors and attitudes across countries. Our work also illustrates how social media networks, like Facebook, together with appropriate survey designs and statistical methods, offer an innovative and powerful tool for rapid and continuous data collection to monitor trends in behaviors relevant for mitigation strategies of COVID-19. Taken together, the insights gained from our survey data are particularly relevant for policy makers and help design appropriate public health strategies and communication campaigns, and to design realistic epidemic models, which can account not only for the spatio-temporal spread of the infection, but also for accurate data on individual human behaviors.

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Ethics statement

This study was conducted in agreement with the data protection regulations valid in Germany. Informed consent was obtained from all participants, enabling the collection, storage, and processing of their answers. Ethical approval for the study was obtained from the Ethics Council of the Max Planck Society.

Author Contributions

All authors designed the questionnaire and collected the data. DP conceived the project idea, devised the idea for the manuscript, analyzed the data, and wrote the manuscript. AG developed the strategy and technical implementation for data collection and the recruitment of survey participants, and wrote the manuscript. FR supported the strategy development and the technical implementation of the data collection, and wrote the manuscript. JC and EDF designed the post-stratification weighting scheme. DP, AG led the project and the implementation of the online survey. All authors provided input and edited and reviewed the manuscript.

Competing Interests

The authors declare that they have no competing interests.