Master of Public Health - Master de Santé Publique

Public trust in scientists during the COVID-19 pandemic in Europe

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EPH 2020-22

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ACKNOWLEDGEMENTS

First and foremost, I would like to express deep gratitude to my professional supervisor Tamara Giles-Vernick, for the opportunity to join a fantastic team of Anthropology and Ecology of Disease Emergence Unit at Institut Pasteur, for guiding me through the challenges of the research work and supporting me throughout my time as an intern at the Unit. I would also like to thank Léonard Heyerdahl, for his constant help, support and advise during my first steps as a researcher. I am also incredibly grateful to Muriel Vray, for her expert counselling regarding statistical aspects of my research project. Lastly, I am deeply grateful to the whole team of the Unit for their warm welcome, continuous encouragement, and creating the environment that nurtures love and appreciation for research.

I would like to thank my academic supervisor Pascal Crepey, for his personal and professional support through this time and my course coordinator Aurore Gely-Penot for guiding the class through the year, as well as the whole EHESP team for providing a positive learning environment for us this year.

I am grateful to Europubhealth+ (EPH) program, Marion Leqoc and Marine Meyer in particular, for coordinating our educational journeys for the past two years, that led to this thesis, as a final step towards finishing the degree.

I would like to express deep appreciation to my Year 1 EPH institution – University of Sheffield, for preparing us to be the best public health professionals and researchers we could possibly be, and Richard Cooper and Amy Barnes for being amazing and supportive program leaders for our cohort.

Finally, I would like to mention my friends, family and loved ones, who have shown me an unprecedented level of support and understanding during these incredibly difficult times, given me strength and resilience to endure all the personal and professional difficulties that came my way during writing this thesis and were by my side when I needed it the most.

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LIST OF ACRONYMS

AIC Akaike information criterion

ICU Intensive care unit

NPIs Non-pharmaceutical interventions

ABSTRACT

Background: Trust is a crucial link between science and society, particular during public health emergencies. The COVID-19 pandemic drew attention to the importance of close interactions between scientists and the public. Research suggests that the level of public trust in science and scientists affects public behaviour, particularly in encouraging the adoption of non-pharmaceutical interventions. This research aims to shed light on factors associated with the level of trust in scientists during the COVID-19 pandemic in Europe.

Methods: The study is based on a survey administered to 7000 participants in 7 European countries in December 2020. Relationships between socio-demographic factors, use of information sources, personal experience with COVID-19, belief in specific rumours about COVID-19 and population trust in scientists was examined via a multiple regression model. Significant associations were investigated through thematic analysis of the open text responses to develop further insight into belief in specific rumours about COVID-19 and to understand its relationship with trust in scientists.

Results: Trust in scientists was associated with multiple socio-demographic characteristics (country, age, education, political views), use of certain information sources, as well as experience with COVID-19 and beliefs that SARS-CoV-2 virus was deliberately released from a laboratory and that 5G technology worsens its symptoms. Open text responses revealed that respondents believing in SARS-CoV-2's deliberate release contended that national or global actors orchestrated this release to reduce the human population size or to impose their economic and/or political dominance.

Conclusion: Results suggest that trust in scientists during COVID-19 pandemic is associated with multiple socio-demographic characteristics, information sources, COVID-19 related experiences and rumours beliefs. These findings offer greater nuance of the factors contributing to trust in scientists. They offer some key insights that can help scientists to communicate better about their methods, contributions to COVID-19 prevention and control, and independence from political and economic rivalries.

Keywords: COVID-19, Trust in scientists, Non-pharmaceutical interventions, Protective behaviours, Conspiracy, Information sources

ABSTRACT IN FRENCH

Contexte : La confiance est cruciale aulien entre la science et la société. La pandémie de COVID-19 a attiré l'attention sur l'importance d'une interaction étroite entre les scientifiques et le public. La littérature scientifique suggère que le niveau de confiance envers la science et les scientifiques peut affecter le changement des comportement, en particulier concernant l'adoption des interventions et pratiques qui protègent les individus contre l'infection. Cette étude vise à mettre en lumière les facteurs associés au niveau de confiance envers les scientifiques pendant la pandémie de COVID-19 en Europe.

Méthodes : L'étude se base sur un questionaire administré à 7000 participants dans 7 pays européens en décembre 2020. Les relations entre facteurs socio-démographiques, utilisation de sources d'information, expérience personnelle avec le COVID-19, croyance en des rumeurs spécifiques sur le COVID-19 et la confiance de la population envers les scientifiques ont été examinées via un modèle de régression multiple. Les associations significatives ont été étudiées par le biais d'une analyse thématique.

Résultats : Ls la confiance envers les scientifiques était associée à de multiples caractéristiques sociodémographiques, notamment le pays de résidence, l'âge, le niveau d'éducation, les opinions politiques ; l'utilisation de certaines sources d'information, ainsi que l'expérience avec le COVID-19 et la croyance en des rumeurs spécifiques sur la libération délibérée du COVID d'un laboratoire et sur le fait que la technologie 5G aggrave ses symptômes. L'analyse des réponses ouvertes a révélé que les répondants convaincus que le SRAS-CoV-2 a été libéré délibérément prétendaient que des acteurs nationaux ou mondiaux cherchaient par ce biais à réduire la taille démographiques d'une population ou pour à imposer leur domination économique et/ou politique.

Conclusion : Les résultats de l'étude suggèrent que la confiance dans les scientifiques pendant la pandémie de COVID-19 est associée à de multiples caractéristiques socio-démographiques, aux sources d'information, aux expériences liées au COVID-19 et aux croyances en matière de conspiration. Ces résultats offrent une plus grande nuance des facteurs contribuant à la confiance dans les scientifiques. Ils offrent des indications clés qui peuvent aider les scientifiques à mieux communiquer sur leurs méthodes, leurs contributions à la prévention et au contrôle du COVID-19, et leur indépendance vis-à-vis des rivalités politiques et économiques.

Mots-clés : COVID-19, Confiance dans les scientifiques, Interventions non pharmaceutiques, Comportements protecteurs, Conspiration, Sources d'information

INTRODUCTION

SARS-CoV-2 is a respiratory virus that is transmitted through coughing, sneezing, contaminated surfaces (e.g., hands) etc., therefore protective behaviours remain the priority for containing the virus spread (1). Current preventive measures (June 2022) include full vaccination, maintenance of social distance (at least 1 meter), use of a properly fitting mask, regular hand washing, and avoidance of large gatherings and crowded spaces (1). These recommendations are informed by evidence-based scientific findings and are revised regularly in accordance with local, national, regional, and global contexts, as well as changing epidemiological conditions. Social trust plays a pivotal role in relations between the scientific community and the public, shaping public responses to scientific recommendations. Available evidence suggests that adoption and adherence of non-pharmaceutical interventions (NPIs) are associated with the level of "public trust" in information sources, scientists and science, government, and beliefs in rumours (2–5).

"Trust", an important factor of adoption and adherence to NPIs, is a complex, multidimensional social construct that can be defined in several ways. In its broadest sense, trust can be seen as an acceptance of a certain degree of vulnerability of the truster (6), truster's acceptance of others (trustees) making decisions for them (7) and, with that, belief that trustees are acting in their best interests (8). A more straightforward and useful definition, however, is a "belief in the honesty, integrity and reliability of others – a "faith in people." (10, p1). During the COVID-19 pandemic, NPIs have included lockdowns, curfews, school closures, teleworking, travel bans, social distancing, mask wearing, limits on social gatherings, quarantine, and other measures (10,11).

Trust is a pivotal factor for interactions between science and the public (12). Trust in science and scientists has constituted a focus of research before and during the COVID-19 pandemic, notably because governments and the public rely on scientists to provide evidence and analysis to support public health decision-making. Studies have indicated that higher levels of trust in science are associated with the more widespread adoption of protective behaviours (4), including vaccine acceptance (13). Prior to the COVID-19 pandemic, a Wellcome Trust study found that 18% of people around the world had a high level of trust in science, 54% had moderate trust in science, whereas 14% had low trust, with the remaining 13% expressing no opinion (14). Educational levels, trust in government institutions, urban residence, and access to mobile phones and internet all appeared to predict levels of trust in science (14). During the current COVID-19 pandemic, major studies have found that public acceptance of and compliance with public health measures depends in part on trust in science and scientists (15–17). Nevertheless, because COVID-19 knowledge, as well as epidemiological and social conditions, have changed rapidly during the pandemic, producing public confusion and at times inappropriate public health communications, it seemed

reasonable to investigate on a European and national level the factors producing public trust in scientists at a key moment in the COVID-19 pandemic, just before vaccine rollout.

The present study draws from results of a mixed-method survey conducted in December 2020 among 7000 respondents in seven European countries. It identifies factors linked to the public trust in scientists involved in COVID-19 research and examines the relationship between this public trust and NPIs adoption.

AIMS AND OBJECTIVES

Aims of the research project

1. To investigate relationships between multiple factors (socio-demographic, usage of information sources, personal experience with COVID-19, belief in conspiracy theories) and population trust in scientists in the context of COVID-19 pandemic.
2. To highlight the relationship between trust in scientists and the reported adoption of protective behaviours against COVID-19.

Objectives of the research project

1. To evaluate selected European and national publics' trust in scientists.
2. To analyse the relationship between public trust in scientists and multiple factors (socio-demographic, information sources, personal experience with COVID-19, belief in conspiracy theories).
3. To develop further the analysis of public trust through qualitative analysis of public beliefs in conspiracy rumours using open-ended text questions.

METHODS

Data collection and sampling

The study is based on the results of a cross-sectional survey, conducted in 2020 in 7 European countries (Belgium, France, Germany, Italy, Spain, Sweden, and Ukraine) and administered by the market research firm Ipsos. A total of 7000 responses were collected between 4 and 16 December 2020, allowing quotas for age (18–65), gender, geographical region, and working status for each country. The data were fully anonymised prior to delivery to researchers at University of Antwerp and Institut Pasteur. Survey sample was derived from an existing Ipsos online panel database and disseminated through email to selected addresses. The following information was collected: socio-demographic characteristics, sources used to obtain information about COVID-19 and level of trust in each of the sources, level of knowledge and understanding of scientific studies, opinion on and acceptance of protective behaviours, future of COVID-19 impact, testing, treatment and prevention, beliefs

in conspiracy rumours, trust in scientists, pharmaceutical sector, local, national and international (non)governmental organizations, as well as personal experiences with the Coronavirus disease. When all quotas were filled, Ipsos automatically closed the survey. It therefore included 1000 respondents from each country.

Ethics and data protection

The ethical aspects of the research were comprehensively considered prior conducting the research, as well as for the purposes of the present internship project. The University of Antwerp Ethics Committee provided ethical approval for the research (20/13/150). The University of Sheffield Ethics Committee provided ethical approval for the dissertation project (ref. 045954).

Measures

Trust in scientists was defined based on participants' responses to three questions in the survey. Participants were asked to rank their level of agreement to the following 3 statements:

1. "Scientists working in my country are competent to do research on COVID-19."

2. "Scientists working in my country who are doing research on COVID-19 would be honest about what they discover."

3. "Scientists working in my country who are doing research on COVID-19 are doing their work in the best interests of the public".

Statements were answered on a 7-level Likert scale, from (1) "Strongly agree" to (5) "Strongly disagree", with (6) and (7) referring to "Don't know" and "Prefer not to say" respectively. The distribution of answers to each question is available in Figure 1 in the Results section.

These three variables were combined into a single binary variable, which served as a proxy to reflect trust in scientists. For each question, answers from *Strongly agree* and *Tend to agree* were transformed into *Yes*; *Neither agree nor disagree*, *Tend to disagree* and *Strongly disagree* were transformed into *No;* and *Don't know* and *Prefer not to say* were transformed into missing values (*NA*). These responses were consolidated to render more manageable analyses of this large, complex dataset. The distribution of modified answers is available in Figure 2 in the Results section. All three variables and frequencies of each answer were analysed and transformed into a single binary variable as *Yes* vs. *No + NA*.

Data analysis

Descriptive statistics: categorical variables are presented as N (number of participants) and % (percentage from the total study population) for each category of each variable. Results are available in Table 1. Political affiliation, initially presented as a scale-based question, was transformed into a categorical variable. Participants were asked to place themselves on a political spectrum, where 0 represented “Left” and 10 represented “Right” political affiliation. 11 and 12 provided respondents with options “Don’t know” and “Prefer not to say” respectively. Answers were coded from 1 to 13, therefore responses from 1 to 3 were transformed into a category “Left”, 4-5 into “Center”, 8-11 into “Right” and 12 and 13 as “NA”.

Analytical statistics: Relationships between trust in scientists and other factors (sociodemographic, information sources, personal COVID-19 experiences, and beliefs in specific rumours) were analysed using a multivariate regression model, in which socio-demographic factors, information sources, COVID-19 personal experiences, belief in conspiracy rumours served as independent variables, and trust in scientists was the dependent variable. The regression model is a statistical methodology widely used to investigate the relationship between a qualitative binary dependant variable and a set of independent variables (18). An AIC-based stepwise backwards procedure was used for the model selection. AIC, or Akaike information criterion (19), allows for the selection of the model that contains the most well-fitting set of variables and that has the smallest mean squared error of prediction/estimation (20). All quantitative analysis was performed using R software 4.1.1.

Qualitative coding: Ukraine and France were chosen for the qualitative analysis to facilitate better understanding of respondents’ perceptions and beliefs.

The survey collected open text responses to statements regarding participants’ beliefs in specific rumours. These text responses underwent qualitative coding and thematic analysis using Nvivo software 1.6.1. We analysed all individual responses available in several rounds, and, based on them, selected topics that were mentioned by most participants and combined them into main themes. The responses were analysed within each theme to provide both quantitative representation (number of responses within each domain) and qualitative insight (quotes, narratives etc.).

RESULTS

Descriptive statistics

Table 1 describes the main characteristics of the study population profile.

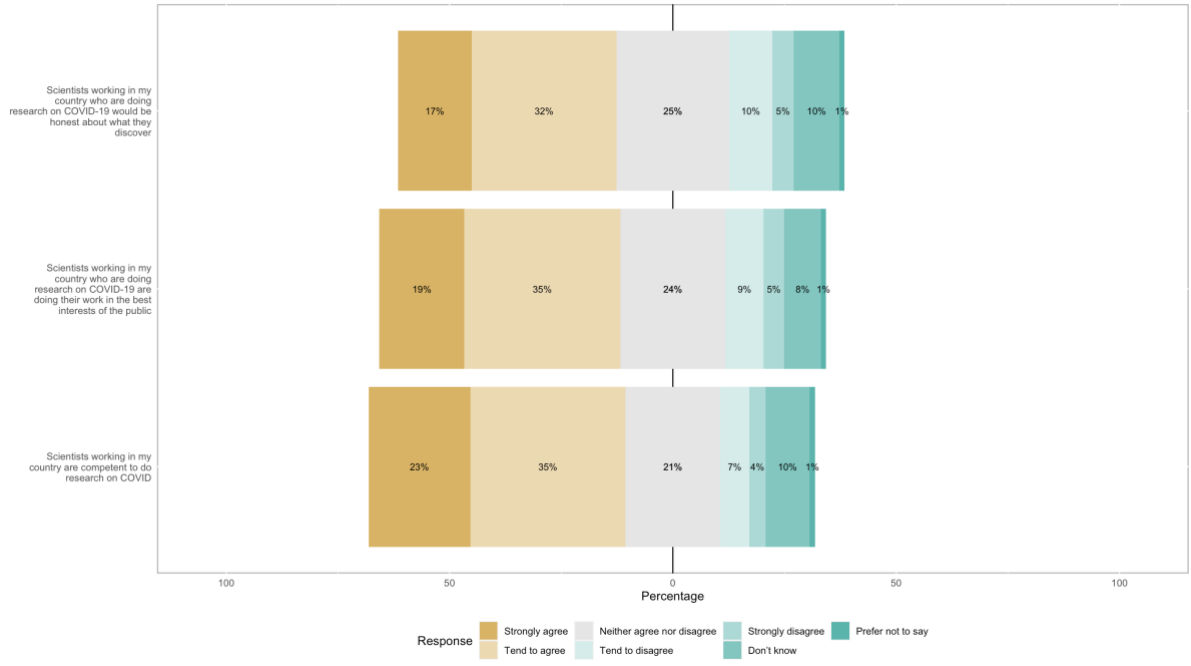
Table 1: Population characteristic, total and by country

Variable	TOTAL	Country						
		France	Belgium	Germany	Italy	Spain	Sweden	Ukraine
Age								
18-24	1000 (14%)	134 (34%)	132 (13%)	114 (11%)	110 (11%)	108 (11%)	157 (16%)	161 (16%)
25-34	1000 (14%)	200 (20%)	206 (21%)	192 (19%)	187 (19%)	212 (21%)	214 (21%)	244 (24%)
35-44	1000 (14%)	218 (22%)	215 (22%)	209 (21%)	258 (25%)	261 (26%)	180 (18%)	215 (22%)
45-54	1000 (14%)	224 (22%)	233 (23%)	259 (26%)	243 (24%)	229 (23%)	225 (22%)	277 (23%)
55-65	1000 (14%)	224 (22%)	214 (21%)	226 (23%)	212 (21%)	190 (19%)	224 (22%)	153 (15%)
Gender								
Female	3516 (50%)	511 (51%)	498 (50%)	497 (50%)	504 (50%)	498 (50%)	507 (51%)	501 (50%)
Male	3478 (50%)	487 (49%)	502 (50%)	499 (50%)	496 (50%)	502 (50%)	493 (49%)	499 (50%)
Other	4 (<0.1%)	1 (0.1%)	0 (0%)	3 (0.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Prefer not to say	2 (<0.1%)	1 (0.1%)	0 (0%)	1 (0.1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Work status								
Not working	2452 (35%)	339 (34%)	359 (36%)	254 (25%)	432 (43%)	435 (44%)	244 (24%)	389 (39%)
Working	4548 (65%)	661 (66%)	641 (64%)	746 (75%)	568 (57%)	565 (56%)	756 (76%)	611 (61%)
Education level								
Primary or lower	479 (6.8%)	5 (0.5%)	126 (13%)	37 (3.7%)	81 (8.1%)	106 (11%)	72 (7.2%)	52 (5.2%)
Secondary	3234 (46%)	412 (41%)	350 (35%)	612 (61%)	669 (67%)	238 (24%)	549 (55%)	404 (40%)
Tertiary	3287 (47%)	583 (58%)	524 (52%)	351 (35%)	250 (25%)	656 (66%)	379 (38%)	544 (54%)
Marital status								
Single	2866 (41%)	373 (37%)	448 (45%)	488 (49%)	426 (43%)	394 (39%)	399 (40%)	338 (34%)
Married/Domestic partner	4134 (59%)	627 (63%)	552 (55%)	512 (51%)	574 (57%)	606 (61%)	601 (60%)	622 (66%)
Political affiliation								
Right	1282 (18%)	250 (25%)	243 (24%)	140 (14%)	232 (23%)	189 (19%)	339 (34%)	194 (19%)
Center	3025 (43%)	421 (42%)	368 (37%)	606 (61%)	394 (39%)	458 (46%)	385 (38%)	393 (39%)
Left	969 (14%)	126 (13%)	111 (11%)	112 (11%)	170 (17%)	246 (25%)	141 (14%)	63 (6.3%)
NA	1724 (25%)	203 (20%)	278 (28%)	142 (14%)	204 (20%)	107 (11%)	135 (14%)	350 (35%)

Table 1: Percentages were rounded up to whole numbers.

The survey collected responses from the equal number of participants from each country (N=1000, total N=7000). Overall, a balanced distribution of age was achieved: 18-24 years old participants constituted 13%, 25-34 – 21%, 35-44 – 22%, 45-54 represented 23% and those aged 55-65 – 21%. Females and males represented equal 50% of the survey respondents, with 4 participants indicating their gender as “Other” and 2 participants preferring to leave the question unanswered. Most participants worked (65%), with only 35% indicating being unemployed. Almost half of the participants (47%) reported tertiary level of education as their highest, followed by 46% who indicated secondary education, and 6.8% reported having obtained only primary education. 41% of respondents were single, and 59% married. Based on the scale of political affiliation, 18% stated they vote towards the classic “Right”, 43% - classic “Left”, 14% - “Center” and 25% did not indicate their political views in the survey. The breakdown of descriptive statistics, total and by country, is available in Table 1.

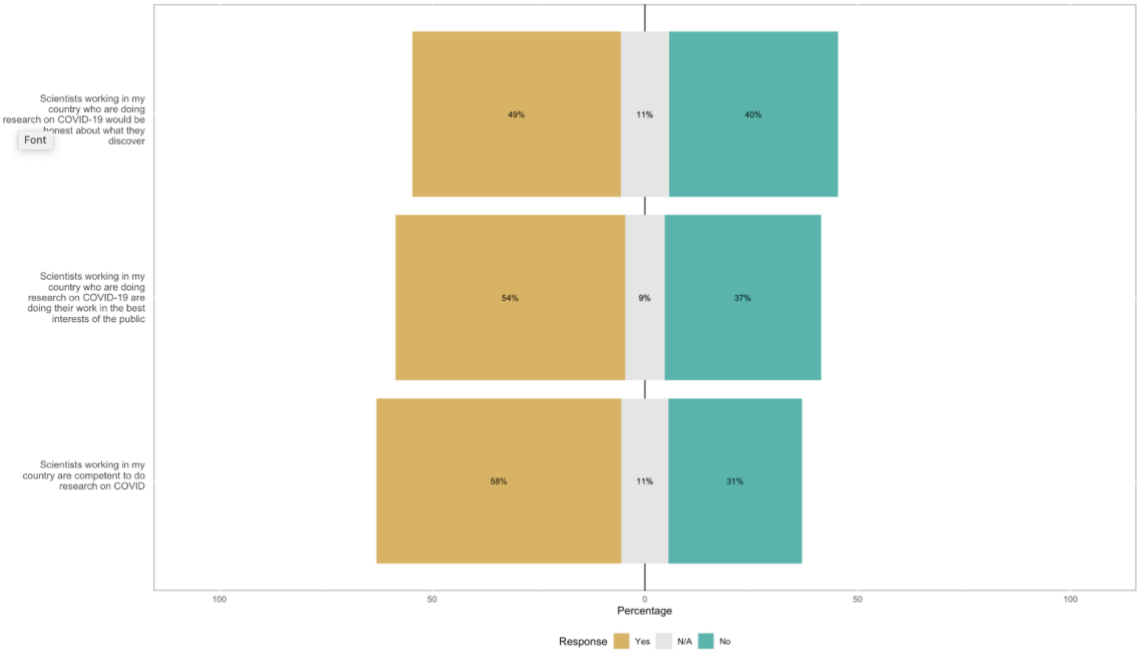
Figure 1: Distribution of initial responses to the questions regarding trust in scientists.



The initial results to the 3 questions about trust in the survey are available in Figure 1. In the first question, 17% (n=1159) of respondents stated they strongly agreed that scientists in their country working on COVID-19 research would be honest about their finding, 32% (n=2268) answered “tend to agree”, 25% (n=1767) neither agreed nor disagreed, 10% (n=674) tended to disagree, 5% (n=337) strongly disagreed and 10% (n=718) indicated they do not know the answer to the question. For the second question, 19% (n=1332) of participants reported they strongly agreed that scientists in their countries were acting in the best interest

of the public, 35% (n=2443) answered “tend to agree”, 24% (n=1649) neither agreed nor disagreed, 9% (n=598) tended to disagree, 5% (n=323) strongly disagreed and 8% (n=577) indicated “do not know”. For the third question, 23% (n=1595) of people participating in the survey reported they strongly agree that scientists were competent to do research about COVID-19, 35% (n=2433) - “tend to agree”, 21% (n=1484) neither agreed nor disagreed, 7% (n=456) tended to disagree, 4% (n=255) strongly disagreed and 10% (n=691) reported not knowing the answer. For all three questions, 1% (n=86) of respondents answered “prefer not to say”.

Figure 2: Distribution of responses to the questions regarding Trust in Scientists after transformation of the variables.



After the second step of the transformation of each variable, the results were as follows: 49% (n=3427) of people trusted that scientists were honest about their research, 40% (n=2778) did not, and 11% (n=795) had no opinion regarding the issue. 54% (n=3775) of respondents agreed that scientists would be acting in the best interest of the public, 37% (n=2570) disagreed with the statement, and 9% (n=655) did not express their opinion. 58% (n=4028) of the participants indicated they agree that scientists were competent in their work, 31% (n=2195) disagreed, and 11% (n=777) had no opinion.

The final step led to us obtaining a binary variable, a proxy for “Trust in Scientists”, where 36.11% (N=2582) of respondents trusted scientists, and 63.89% (N=4472) did not.

Multivariate analysis

Multivariate analysis was performed in several stages. First, bi-variate analysis was performed for each variable pair (independent variable vs. trust in scientists) (see Table 2 under the column “Crude”). Then, all variables with p-value < 0.2 were chosen for the multivariable model. A stepwise backwards AIC-based procedure was used for the model selection. Variables that were preserved are displayed in the Table 2 column “Adjusted”. Several insignificant variables (“Have lost a family member to COVID-19”, “Child has been critically ill in ICU”, “There are microchips in vaccines”) were preserved in the model since AIC (not the p-value) was used for model selection. Table 2 demonstrates the results of multivariate regression model.

There was a statistically significant association discovered between trust in scientists and socio-demographic characterises (country of origin, age, level of education, political affiliation). In comparison with France, respondents residing in certain countries had higher odds of trusting scientists, particularly those living in Belgium (OR 1.25, 95% CI 1.03-1.52, p <0.025), Italy (1.26, 1.04-1.54, p<0.020) and Sweden (1.41, 1.16-1.72, p<0.001). In contrast, respondents in Germany (0.79, 0.65-0.96, p=0.018) and Ukraine (0.39, 0.31-0.49, p<0.001) were less trustful.

Older participants expressed higher levels of trust towards scientists. Compared to the youngest generation of respondents (18-24 years old), the 44–54-year-old (1.36, 1.12-1.65, p=0.002) and 55–65-year-old (1.71, 1.41-2.08, p<0.001) age groups expressed significantly more trust in scientists. Participants with secondary (1.33, 1.05-1.70, p=0.018) and tertiary (1.57, 1.24-1.99, p<0.001) education levels also tended to trust scientists more than those with primary education only. Those declaring a preference to vote for “Centre” (1.15, 1.01-1.32, p=0.041) and “Left” (1.59, 1.33-1.89, p<0.001) political parties showed higher levels of trust than those affiliating themselves with politically “Right”-wing parties.

Use of certain information sources about Coronavirus was also significantly associated with the level of trust in scientists. Participants who obtained their information via legacy media (newspapers, TV, radio etc.) (1.48, 1.28-1.72, p<0.001), official organisational/institutional websites (1.39, 1.24-1.55, p<0.001), face-to-face discussions with friends and family (1.15, 1.02-1.30, p=0.016) and their healthcare environment (e.g., posters in hospital waiting rooms) (1.23, 1.07-1.43, p=0.005) trusted in scientists more than those who did not. Meanwhile, people who reported getting Covid-related information from blogs and non-official websites (0.81, 0.68-0.97, p=0.024), online conversations (0.84, 0.72-0.97, p=0.016) and those who

Table 2: Regression model

		Crude			Adjusted	
	N	OR	95% CI	P value	OR	95% CI	P value
Socio-demographic characteristics							
Country of residence *(vs. France)*	1000			<0.001			<0.001
Belgium	1000	1.16	0.97-1.38	0.11	1.25	1.03-1.52	**0.025**
Germany	1000	0.84	0.7-1.01	0.063	0.79	0.65-0.96	**0.018**
Italy	1000	1.24	1.04-1.48	**0.018**	1.26	1.04-1.54	**0.020**
Spain	1000	0.86	0.71-1.03	0.094	-	-	-
Sweden	1000	1.36	1.14-1.63	**<0.001**	1.41	1.16-1.72	**<0.001**
Ukraine	1000	0.32	0.25-0.39	**<0.001**	0.39	0.31-0.49	**<0.001**
Age *(vs. 18-24 years old)*	916			<0.001			<0.001
25-34 years old	1455	1.16	0.96-1.39	0.12	-	-	-
35-44 years old	1546	1.27	1.06-1.51	**0.009**	-	-	-
45-54 years old	1640	1.54	1.29-1.83	**<0.001**	1.36	1.12-1.65	**0.002**
55-65 years old	1443	2.06	1.73-2.46	**<0.001**	1.71	1.41-2.08	**<0.001**
Gender *(vs. Female)*	3516			0.045			
Male	3478	1.13	1.03-1.25	**0.014**	-	-	-
Other	4	0.63	0.03-4.90	0.7	-	-	-
Education *(vs. Primary or lower*)	479			<0.001			<0.001
Secondary	3234	1.49	1.21-1.86	**<0.001**	1.33	1.05-1.70	**0.018**
Tertiary	3287	1.82	1.47-2.27	**<0.001**	1.57	1.24-1.99	**<0.001**
Working status *(Working vs. Not working)*	4548 vs. 2452	1.13	1.02-1.26	**0.018**	-	-	-
Marital status *(Single vs. Married)*	2866 vs. 4134	1.05	0.95-1.16	0.3	-	-	-
Political affiliation *(vs. Right)*	1282			<0.001			<0.001
Centre	969	1.12	0.98-1.27	0.086	1.15	1.01-1.32	**0.041**
Left	3025	1.62	1.38-1.91	**<0.001**	1.59	1.33-1.89	**<0.001**
Use of information sources *(Yes vs. No)*							
The media	5332 vs. 1668	2.19	1.94-2.49	**<0.001**	1.48	1.28-1.72	**<0.001**
Internet websites (official org.)	2582 vs. 4418	1.51	1.37-1.67	**<0.001**	1.39	1.24-1.55	**<0.001**
Blogs and non-official websites	822 vs. 6167	0.71	0.61-0.83	**<0.001**	0.81	0.68-0.97	**0.024**
Influencers on social networks	934 vs. 6066	0.75	0.65-0.87	**<0.001**	-	-	-

Online written conversations with others	1516 vs. 5484	0.80	0.71-0.90	**<0.001**	0.84	0.72-0.97	**0.016**
Face-to-face discussions with others	2367 vs. 4633	1.24	1.12-1.37	**<0.001**	1.15	1.02-1.30	**0.021**
Articles shared on social media	2348 vs. 4652	0.89	0.81-0.99	**0.035**	-	-	**-**
Healthcare professionals	1549 vs. 5451	1.27	1.13-1.42	**<0.001**	-	-	**-**
Healthcare environment (e.g., posters)	1188 vs. 5812	1.27	1.12-1.45	**<0.001**	1.23	1.07-1.43	**0.005**
Other sources	596 vs. 6404	0.99	0.83-1.18	>0.9	-	-	-
Have not found/received info from any	179 vs. 6821	0.36	0.24-0.53	**<0.001**	0.62	0.40-0.94	**0.027**
Experience with COVID-19 *(Yes vs. No)*							
Admitted to the hospital due to COVID-19	89 vs. 6911	0.51	0.30-0.82	**0.008**	-	-	-
Had severe COVID-19	106 vs. 6894	0.87	0.57-1.30	0.5	-	-	-
Have tested positive for COVID-19	301 vs. 6699	0.81	0.63-1.03	0.093	-	-	-
Had symptoms resembling COVID-19	771 vs. 6229	0.92	0.79-1.08	0.3	-	-	-
Have lost a family member to COVID-19	475 vs. 6525	1.21	1.00-1.46	**0.055**	1.22	0.98-1.51	0.070
Close one admitted to hospital due to COVID-19	764 vs. 6236	1.05	0.90-1.23	0.5	-	-	-
Close one had severe COVID-19	769 vs. 6231	0.99	0.85-1.16	0.9	-	-	-
Close one has tested positive for COVID-19	1955 vs. 5045	1.31	1.17-1.45	<0.001	-	-	-
Close one had symptoms resembling COVID-19	1403 vs. 5597	1.31	1.16-1.48	**<0.001**	1.18	1.03-1.35	**0.017**
No experience with COVID-19	3092 vs. 3908	0.97	0.88-1.07	**0.5**	-	-	-
Experience with COVID-19 (ICU) *(Yes vs. No)*							
I have been critically ill with COVID-19 in ICU	296 vs.6704	1.00	0.78-1.27	>0.9	-	-	-
Close one has been critically ill in ICU	959 vs. 6041	1.00	0.87-1.16	>0.9	-	-	-
Child has been critically ill in ICU	155 vs. 6845	0.59	0.40-0.84	**0.005**	0.72	0.48-1.08	0.12
Other people have been critically ill in ICU	1116 vs. 5884	1.29	1.14-1.47	**<0.001**	1.21	1.01-1.44	**0.038**
No one has been clinically ill in ICU	4161 vs. 2839	1.16	1.05-1.28	**0.003**	1.24	1.08-1.42	**0.002**
Beliefs in conspiracy theories *(Yes vs. No)*							
Virus was deliberately released from the lab	1364 vs. 5636	0.34	0.29-0.39	**<0.001**	0.43	0.37-0.50	**<0.001**
COVID-19 symptoms are caused by 5G tech	182 vs. 6818	0.44	0.30-0.63	**<0.001**	-	-	-
COVID-19 symptoms worsen with 5G tech	253 vs. 6747	0.36	0.26-0.50	**<0.001**	0.53	0.37-0.75	**<0.001**
Don’t believe in any of above	641 vs. 6359	1.02	0.86-1.20	0.8	-	-	-
There are microchips in vaccines	981 vs. 5016	0.49	0.42-0.57	**<0.001**	0.86	0.73-1.03	0.1

stated they did not use any information sources of the listed in the survey (0.62, 0.40-0.94, p=0.027) were less trustful than those who did not.

Experience with COVID-19 also was associated with the level of trust in scientists. For instance, having a close family member or friend with symptoms similar to those of COVID-19 (1.18, 1.03-1.35, p=0.017), knowing someone who had been in an Intensive Care Unit (ICU) due to COVID-19 (1.21, 1.01-1.44, p=0.038) or not knowing anyone admitted to the ICU (1.24, 1.08-1.42, p=0.002) yielded higher odds of trusting scientists. The last two results could potentially be due to the significant difference in the numbers of positive and negative responses: 1116 vs 5884 for the first question, 4161 vs. 2839 for the second, as well as a large sample size that led to more variables being statistically significant. Both variables have a narrow margin of significance (95% confidence interval for 1.01 and 1.08 respectively).

Belief in specific rumours about the origins and purported roles of certain technologies in COVID-19 was significantly associated with decreased trust in scientists. Participants who believed that the COVID-19 was deliberately released from a laboratory (0.43, 0.37-0.50, p<0.001), and that COVID-19 symptoms worsened in the presence of 5G technology (0.53, 0,37-0.75, p<0.001) had much lower odds of trusting scientists than those indicating that they did not believe in these rumours.

Thematic analysis. Based on the quantitative analysis, agreement with two statements were discovered to be significantly associated with the trust in scientists:

1. “The coronavirus was released accidentally from a laboratory”
2. “The coronavirus symptoms are made worse by 5G technology”.

Overall, 224 open text responses were analysed, 81 from Ukraine, and 53 from France.

Two main themes emerged from the results of qualitative analysis: 1. Demographic control and 2. Economic and political power. Additionally, participants contended that they based their opinions on information from trusted external sources (e.g., media, or other people), as well as that the SARS-CoV-2 virus was a biological weapon, that the pandemic resulted from “a real-life clinical trial”. Table 3 reports a detailed breakdown by country, trust in scientists and theme.

Table 3: Conspiracy rumours beliefs, open responses categories

	France (N=27)		**Ukraine** (N=38)	
Trust in scientists:	YES	NO	YES	NO
Demographic control (n=27)	1 (4%)	9 (33%)	2 (5%)	15 (40%)
Economic and political power (n=38)	5 (19%)	12 (44%)	4 (10%)	17 (45%)

Table 3: Uncategorized answers were not included in the table. Percentages were rounded up to whole numbers.

Table 4: Population profile by theme

Characteristic	Total number (N=65)	Demographic Control (N=27)	Economic and political power (N=38)
Politics			
Left	6 (9%)	2 (7%)	4 (11%)
Centre	26 (40%)	10 (37%)	16 (42%)
Right	20 (31%)	7 (26%)	13 (34%)
Gender			
Female	32 (50%)	16 (59%)	16 (42%)
Male	33 (50%)	11 (41%)	22 (58%)
Age range			
18-24	4 (6%)	0 (0%)	4 (11%)
25-34	22 (34%)	9 (33%)	13 (34%)
35-44	22 (34%)	9 (33%)	13 (34%)
45-54	6 (9%)	5 (19%)	1 (3%)
55-65	11 (17%)	4 (15%)	7 (18%)
Education			
Primary	2 (3%)	1 (3%)	1 (3%)
Secondary	24 (37%)	15 (56%)	9 (23%)
Tertiary	39 (60%)	11 (41%)	28 (74%)

Table 4: Empty values (NA) for political affiliation were omitted from the table. Percentages were rounded up to whole numbers where possible.

Demographic control Most participants (n=27) in Ukraine and France explained the deliberate release of the virus in terms of a demographic concern that had both economic and biomedical implications. Many mentioned that "the Earth is overpopulated" (n=10), and that virus was released to "reduce the population" (n=15) and to "eliminate the old and the sick/vulnerable" (n=5). One person added a "lack of food and resources" to the problem of overpopulation. Several respondents mentioned that population reduction from the pandemic could yield economic benefits, including lower pension payments or improvements to "the health of the economy". One participant also indicated a benefit for the environment, resulting in "less pollution". Interestingly, further analysis revealed that most respondents believing that coronavirus was created to address demographic burdens were women, those who were young to middle aged (25-44 years old), had secondary education as their highest level achieved, and who placed themselves in the centre of the political spectrum (Table 3).

Economic and political power. In their open text responses, survey participants appeared preoccupied with the exercise of economic and political power. Major subthemes focused on the important role of China in the pandemic, global political power dynamics, and benefits accruing to economic actors, including powerful governments, politicians and wealthy and powerful classes. Many participants (n=16) thought that China created the virus as a biological weapon and intentionally released it from laboratories, so that the country could "become a leader of global economy". Others claimed the pandemic either "benefits the rich", "is in someone's interest" or "it's a coup of the world elite". One response contained vaccine-

related explanations, such as “the profit of 47 billion on vaccines”. Population analysis revealed that most participants discussing economic and political power were males of young and middle age, primarily with tertiary education and leaning towards the centre of political spectrum (Table 3).

Additionally, many participants (n=15) said they believed in the deliberate release of the virus or the influence of 5G technology in aggravating COVID-19 symptoms because they heard or read about it from media, social media, or the Internet or because someone told them so. In particular, respondents stated that they received such information “from news”, “from media”, or from a “trusted source.” They noted that “There is a lot of information confirming this in social networks from different people and scientists, including doctors”, and that “Given all the contradictory information that has been dumped in the media and social networks, we have the right to believe in a conspiracy” and “THESE ARE TESTS THAT HAVE BEEN ON TV”. Most such respondents were women between 25 and 44 with tertiary education who placed themselves towards the right-wing political space (Table 3).

DISCUSSION

The present study investigated the factors associated with public trust in scientists during the COVID-19 and then further explored respondent’s beliefs in specific rumours.

Trust in scientists was generally higher in high-income countries (Belgium, Italy, Sweden) and lower in those with lower income (Ukraine). Older and more educated respondents were more trustful towards scientists in their countries, as well as those who affiliated themselves with the political Left and Centre. Additionally, people who received their news from the legacy media (newspapers, TV etc.), official governmental/institutional websites, in-person discussions with friends and family and healthcare structures (e.g., posters in the doctors’ office) had higher levels of trust in scientists. Meanwhile, participants who reported obtaining their information from blogs and non-official websites or through online conversations with friends and family or who used none of the listed information sources appeared to be less trustful towards scientists. Respondents whose family member or friend had experienced COVID-19-like symptoms, as well as respondents who knew and who did not know someone admitted to an ICU because of COVID-19 had higher levels of trust towards scientists. Participants who believed rumours that COVID-19 was deliberately released from a laboratory and that 5G technology could worsen Coronavirus disease symptoms had lower levels of trust in scientists.

In investigating factors associated with trust in scientists, the present research did not address trust in science more generally. First, the survey contained specific questions about scientists’ honestly, integrity and intention to act in the interest of the public. In addition, “science” is a very broad term, encompassing multiple other actors in addition to scientists.

Nevertheless, the following discussion compares our results with studies that address both trust in “scientists” and “science”, although we recognize that these terms do not have the same meaning for respondents.

Previously, an average higher level of income and education, residence in high-income countries, and trust in governmental institutions have all been positively associated with a higher level of trust in science (14). In line with previous research, the present study found that people living in high income countries and with higher level of education trust scientists more. However, in contrast with previous research conducted by the Wellcome Trust, which concluded that older people tended to have no opinion about trusting science (14), we found that respondents over 45 years old trusted scientists more than those of younger age. Although limited literature is available regarding age and trust in science or scientists, but overall age-related trust in science appears to increase with age (21).

How respondents situated themselves on a political spectrum appears to be related to trust in scientists too. The present study suggests that left- and centre-affiliated participants are more trustful of scientists than those who situate themselves on the right wing of a political spectrum. Somewhat similar results were reported in previous studies both in the United States and Europe. For instance, in the US, Democrats’ voters trust in science is higher and has only increased in recent years, as compared to Republicans’ (22). Similar trends have also been observed in European countries, with suggestions that multiple attacks on science from politicians, right-winged in their majority, have influenced public perceptions of science (23). In contrast, one German study examining changing levels of trust in science over the course of the pandemic, reported that this trust increased at the outset of the pandemic, but declined over time, more so among right-wing voters. (24).

Where people obtain their health information also is linked to their trust of scientists. We found that people using print and online newspapers, magazines, television, radio, news websites or apps, websites of official organisations, as well as obtained information through personal conversations with friends and family or from healthcare environment (e.g., posters) trust the scientists in their countries more than those who don’t. We also found that people obtaining Covid-related information via personal discussions were more trustful of scientists.

Our findings differ from a broader literature on information sources during the Covid-19 pandemic, which have not addressed correlations with trust in scientists. This literature has focused primarily on the sources used, notably traditional media, health media, and social media, but that source use varied by age profiles, with older populations using more traditional media and personal sources (2,4,25). These analyses have not, however, addressed associations between pandemic information sources and trust in scientists.

This study also found that beliefs in rumours – the deliberate release of the SARS-CoV-2 virus from a laboratory and the role of 5G technology in exacerbating COVID-19

symptoms – were associated with lower levels of trust in scientists. Similarly, previous studies reported that beliefs in conspiracy theories were negatively associated with public trust in science (26), government, institutions and professionals (27). Multiple publications have observed that the COVID-19 pandemic provoked considerable and more rapidly circulating mis- and disinformation that characterize an “infodemic” (28–30). The development and circulation of rumours or conspiracy theories (beliefs that “major public events are secretly orchestrated by powerful and malevolent entities acting in concert”) (17, p.1) have been a crucial dimension of this pandemic. (32,33). This problem has preoccupied public health authorities because it could undermine trust in scientists and adherence and compliance with pandemic control measures. Previous studies discovered a negative relationship between beliefs in conspiracy theories and adoption of protective behaviours (3,31,34). For example, research found that people with conspiracy beliefs and distrust in science are more hesitant to accept COVID-19 vaccines (34) and that those who distrust information sources are less likely to adhere to NPIs (31).

Finally, our study integrated an unusual dimension, the use of open text boxes for respondents to amplify their responses to specific questions. Our analysis found that text explanations provide a unique insight into people’s perceptions and motivations. Curiously, these text responses made little mention of scientists, instead addressing the broader demographic, economic and political interests behind a purportedly deliberate release of the virus. These findings suggest that selected publics in Ukraine and France seem to perceive scientists as serving more powerful political and economic actors and are not guided by their own questions and methods. Communications to improve “science literacy” among these publics, providing insight into the questions and methods of biomedical research may be useful to improve the public level of trust in scientists. During the COVID-19 pandemic with its time pressures and urgent public health needs for convincing evidence, significant debates about the most effective ways of communicating research findings have erupted (29,35). Effective communication of scientific findings to lay publics requires specific skills, knowledge, time, and funding (36), which can pose barriers for researchers. Diverse strategies and methods have been proposed to translate COVID-19 related scientific findings (35,37) and COVID-19 risks (38) to broad publics. There is no single way to do so, however, particularly when epidemiological and social contexts are changing. More strategic, operational efforts for assisting scientists and public health agencies to deliver scientific messages to the public is needed.

Although our quantitative analysis showed that conspiracy beliefs are associated with lower level of trust in scientists, our qualitative analysis revealed that several respondents believing selected conspiracy theories about deliberate viral release and 5G technology claimed that they trusted scientists. One possible explanation for these divergent results is

that survey questions are open to interpretation. Survey respondents who follow non-mainstream scientists or clinicians or who do not adhere to evidence-based practices, may nevertheless consider themselves to "trust scientists".

There are many factors influencing a public's trust in scientists. Public trust may not always reflect the quality of scientific research, but public perceptions of this research, or of the scientists. For instance, a lay public may be less trusting of research results that it deems not valuable or readily understandable. (12). Additionally, scientists might not be the major actors, and public trust of them may be shaped, for example, by their employers or by powerful actors whose interests they potentially serve (12). Lay public may also trust specific scientific discoveries or particular individuals, but not others (23).

Public trust in science and scientists has previously been shown to be associated with the level of acceptance and adoption of NPIs (4,15,16) with vaccine acceptance (13). This research has found that trust in scientists is a "driving force" for compliance with NPIs (15, p,1). NPIs, in turn, can reduce viral transmission and thus decrease disease burden significantly (39,40). However, levels of trust seems to have fluctuated over the course of the pandemic (15). Solutions need to be found in order to maintain the desirable level of public's adherence to protective behaviours. Consequently, a better understanding of public and personal motivations behind accepting or refusing NPIs might offer some solutions to the problem. Our study offers unique insight into both quantitative and qualitative data on trust in scientists on selected European populations and individual levels. More mixed methods research into trust in science and scientists should be conducted.

Behavioural and social sciences could be used to help influence human behaviour in line with epidemiological recommendations (41). In particular, improvements and adjustments in health science communication have potential to alter population behaviour, for instance, through improving health literacy and trust. Research suggests that people who have low levels of health literacy and are less trustful towards professional information recourses (e.g., doctors, heath websites) (42), are more prone to trust conspiracy rumours and less likely to identify and adhere to recommended protective behaviours (43). Improved health communication and education have a potential to narrow the health literacy gap and improve populations' trust of scientists.

Limitations of the study

There are several limitations to this study. Firstly, as the survey was administered online, it is expected that people with better access to computers and the Internet, as well as higher levels of education, would be more likely to be recruited and to participate.

Secondly, we acknowledge that the survey was conducted in seven European countries. We cannot therefore claim that our results are representative of all European

countries, of high-income countries outside of Europe, or of middle- and low-income countries (where populations may be less trustful of scientists). Therefore, we limit our findings to the seven European countries where the study was conducted.

Finally, the study had a large (N=7000) sample size in countries with diverse health, political, social, economic, and cultural indicators, and conditions, leading to more variables being statistically significant, but often with the narrow margin. A study of individual countries could shed additional light on more significant associations.

Conclusion

The present study offers insight into factors associated with levels of trust in scientists at a crucial moment in the COVID-19 pandemic in Europe, just before COVID-19 vaccine rollout. Trust in science and scientists has been strongly associated with better adoption of protective behaviours, including vaccination. However, it is not fully clear what factors could be associated with the level of such trust in the first place. Our mixed methods questionnaire offered insight into factors associated with trust in scientists, but also revealed that qualitative explanations for beliefs in certain conspiracy rumours focused less on scientists and more on powerful economic and political actors and interests. This finding suggests that there is an opportunity to improve communications around scientific research, to improve scientific literacy with better explanations of how scientists develop and investigate questions, of scientific uncertainty, and of the significance of scientific findings related to the pandemic. Such efforts might help to improve public adherence to NPIs, during pandemic times and beyond.

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APPENDICES

Appendix 1

Exact definitions of questions used as independent variables for Regression model (See Table 2 for Regression model).

Use of information resources	**Over the past 14 days, from which, if any, sources did you find or receive information about COVID-19?**
The media	The media (print and online newspapers, print and online magazines, television, radio, news websites or apps)
Internet websites (official org.)	Internet websites of official organisations/institutions (National public health site, etc.)
Blogs and non-official websites	Blogs or non-institutional internet websites specialising in health
Influencers on social media	Influencers I follow on social networks (Facebook, Twitter, Instagram, YouTube, etc.)
Online written conversations with others	Online written discussions with friends, family or acquaintances via instant messaging (WhatsApp, etc.)
Face-to-face discussions with others	Discussions face-to-face, via telephone or video calling with friends, family or acquaintances
Articles shared on social media	Articles shared on social media
Healthcare professionals	Directly from healthcare professionals (doctors, nurses, pharmacists, etc.)
Healthcare environment	Information in healthcare environments (e.g. posters at a doctor's surgery/hospital, etc.)
Other sources	Other sources
Have not found/received info from any	Have not found/received information from any source
Experiences with COVID-19	
Admitted to the hospital due to COVID-19	I have been admitted to hospital due to confirmed or suspected COVID-19 illness
Had severe COVID-19	I have experienced severe illness due to COVID-19
Have tested positive for COVID-19	I have tested positive that I have/have had COVID-19
Had symptoms resembling COVID-19	I have had symptoms resembling COVID-19 (e.g. fever, dry cough, loss of smell or taste) since January 2020, but not confirmed by a test
Have lost a family member to COVID-19	I have lost a close family member or friend to COVID-19
Close one admitted to hospital due to COVID-19	I have a close family member or friend who has been admitted to hospital due to confirmed or suspected COVID-19 illness
Close one had severe COVID-19	I have a close family member or friend who has experienced severe illness due to COVID-19

Close one has tested positive for COVID-19	I have a close family member or friend who has tested positive that they have/have had COVID-19
Close one had symptoms resembling COVID-19	I have a close family member or friend who has had symptoms resembling COVID-19 (e.g. fever, dry cough, loss of smell or taste) since January 2020
No experience with COVID-19	None of these
Experience with COVID-19 (ICU)	
I have been critically ill with COVID-19 in ICU	I have been critically ill in an ICU
Close one has been critically ill in ICU	A close family member has been critically ill in an ICU (husband, wife, boyfriend, or girlfriend, parent or parent in-law, sibling, close relative)
Child has been critically ill in ICU	My child has been critically ill in an ICU
Other people have been critically ill in ICU	Other people I know have been critically ill in an ICU
No one has been clinically ill in ICU	No-one I know has been critically ill in an ICU
Beliefs in specific rumours	
Virus was deliberately released from the lab	The coronavirus was released deliberately from a laboratory
COVID-19 symptoms are caused by 5G tech	The coronavirus symptoms are caused by 5G technology
COVID-19 symptoms worsen with 5G tech	The coronavirus symptoms are made worse by 5G technology
There are microchips in vaccines	Authorities want to insert microchips in the COVID-19 vaccine to impose control over people