Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Personal Protective Measures during the COVID-19 Pandemic in Germany

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ABSTRACT

Objectives: The coronavirus SARS-CoV-2 is highly contagious and can only be contained if the majority of the population takes measures to protect themselves against infection. The present study aimed to investigate personal protective measures, their development over the course of the pandemic in Germany, and potential differences in behavior in terms of sex, age, and education.

Methods: Data from 20 waves of the serial cross-sectional study "BfR-Corona-Monitor" were analyzed. The total sample consisted of $N = 20{,}317$ respondents (about 1000 per wave). Data were collected through telephone surveys between June 2020 and March 2021.

Results: To protect themselves from infection, participants primarily relied on wearing covers for mouth and nose, keeping their distance from other individuals, and washing their hands thoroughly. Analyses over time showed a strong positive correlation between the number of measures taken and the national incidence rate. Sociodemographic differences also emerged, with women and those who are higher educated as well as younger respondents taking a higher number of protective measures.

Conclusions: Our results indicated that in times of greater infection risks, individuals adapted accordingly and took more protective measures. However, on the basis of sociodemographic differences, campaigns should especially focus on older individuals, the male sex, and those with lower education to enhance their protective behavior.

INTRODUCTION

The first case of COVID-19 in Germany was reported on January 27, 2020 (Bavarian State Ministry of Health and Care, 2020). The virus SARS-CoV-2 spreads fast, and within the first two months, more than 42,000 cases had been notified (Robert Koch Institute, 2021). Containment of the virus was not only complicated by the fact that it was found to be contagious even before the onset of symptoms but also because some individuals can live through an infection without showing any symptoms and still infect others (Almadhi et al., 2021; Buitrago-Garcia et al., 2020). In a study by Johannson et al. (2021), it was estimated that about half of the transmissions happened this way. Protective measures were soon applied in all areas of life and the entire population was urged to implement them (Federal Ministry of Health, 2021). Such measures and recommendations included keeping a distance of 1.5 meters between individuals, staying at home, limiting the number of individuals one is allowed to meet, and washing one's hands thoroughly.

However, previous studies suggested that individual health behavior can vary according to different sociodemographic aspects. The review by Hiller et al. (2017) shows that sex plays an important role in this because women are usually more health-conscious. Men, on the other hand, are often found to engage less in preventive health behavior. This difference is also evident in preventive behavior during a pandemic (Bish and Michie, 2010). Another factor that is associated with the conduction of health behavior is age. Most studies showed that in a pandemic, older individuals are generally more likely to carry out preventive behavior (Bish and Michie, 2010; for an exception, see Pasion et al., 2020). Behavioral effects of age and sex are particularly important with regard to COVID-19 because they are risk factors for a severe course of the disease. In fact, older individuals and men have been shown to be

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at a higher risk for a severe progression of the disease (Gallo Marin et al., 2020).

In addition, the level of education may also influence the protective behavior. The review by Bish and Michie (2010) concluded that in most studies, more educated individuals are generally more likely to adopt preventive behavior during a pandemic. A lower level of education is also often associated with an increased risk of numerous diseases and an unhealthier lifestyle (Mielck, 2012). These findings were further supported by Lampert et al. (2005), indicating that individuals with low education have a higher risk for diseases than those with a higher level of education. However, they also found that preventive behavior was either not linked to the participants' education level or was even more likely to be taken up by individuals with a lower level of education. The latter result pattern was also found in a study on protective behavior during the COVID-19 pandemic (Betsch et al., 2021). In summary, previous studies yielded ambiguous results regarding preventive behavior during a pandemic.

COVID-19 is an example of a highly contagious disease that developed into a global health crisis. The containment of this and future pandemics depends on a population-wide adaptation of adequate protective measures. Therefore, the aim of the present study was to investigate personal protective behavior of citizens in Germany during the COVID-19 pandemic between June 2020 and March 2021. Owing to the dynamic course of the pandemic, we also tested for development over time and a potential correlation between protective measures and infection rates. Because previous research suggests that sociodemographic factors might influence the implementation of preventive behavior, we further explicitly tested for differences regarding sex, age, and education. The knowledge about the impact of these factors on behavior can help in managing a health crisis, for example, by developing information campaigns for specific target groups.

METHODS

Participants and procedure

We used data from 20 waves of the serial cross-sectional study "BfR-Corona-Monitor" (German Federal Institute for Risk Assessment, 2021). The sample consisted of 997–1,037 respondents per wave, resulting in a total sample size across all waves of N = 20,317 respondents. Data were collected on two consecutive days every other week between June 23, 2020 and March 17, 2021 via telephone surveys in the Federal Republic of Germany (see Table 1; three consecutive days for wave 4). Data collection was carried out by the market research institute Kantar GmbH as part of their daily omnibus telephone interviews (computer-assisted telephone interviewing, CATI; Choi, 2004).

Respondents had to be aged at least 14 years to participate in the study. Samples were drawn using a random digit dialing procedure that included mobile as well as landline telephone numbers. When a mobile phone number was called, the individual who answered the call was selected for the interview. This was different for landline telephone numbers, where the respondent within the household was randomly selected using the Kish selection method (Kish, 1949). Data were statistically weighted to ensure representativeness (Gabler et al., 2016): First, data were weighted according to the number of mobile phones and landline numbers a person could be reached by. This ensured that each individual had the same chance to be selected for an interview. Second, data were weighted according to various sociodemographic variables (sex, education, age, employment, size of city, and German federal state). This process was carried out for each survey wave individually. As a result, the weighted sample is representative for the population in Germany with a balanced sex ratio (51% female) and a mean age of M = 49.1 years (SD = 19.9).

Table 1
Overview of survey waves.

Wave	Date	Sample size (n)
W1	June 23–24, 2020	1,037
W2	July 7–8, 2020	1,011
W3	July 21–22, 2020	1,037
W4	August 4–6, 2020	1,024
W5	August 18–19, 2020	1,033
W6	September 1–2, 2020	1,013
W7	September 15–16, 2020	1,026
W8	September 29–30, 2020	1,012
W9	October 13–14, 2020	1,015
W10	October 27–28, 2020	1,006
W11	November 10–11, 2020	1,009
W12	November 24–25, 2020	1,018
W13	December 8–9, 2020	1,004
W14	December 21–22, 2020	1,010
W15	January 5–6, 2021	1,017
W16	January 19–20, 2021	1,018
W17	February 2–3, 2021	1,004
W18	February 16–17, 2021	997
W19	March 2–3, 2021	1,014
W20	March 16–17, 2021	1,012

Note. W = wave.

Protective measures

Protective behavior of the respondents was assessed using the question "Which of the following measures have you taken to protect yourself or your family from the novel coronavirus?". The question consisted of several items that referred to protective measures from different areas of everyday life, including the respondent's individual hygiene behavior (e.g., washing hands more thoroughly), changes in their social behavior (e.g., meeting friends and family less frequently), or their consumer behavior (e.g., having food delivered more frequently). The list of measures was predominantly developed on the basis of previous waves of the BfR-Corona-Monitor, in which protective behavior was explored using an open-ended question (Kirsch et al., 2021). In the current study, participants indicated for each measure on a binary scale if they applied it or not. Within the scope of this study, we analyzed the nine protective measures that were consistently asked across the 20 waves (see Table 3). Respondents could choose not to answer to the question of protective measures. These respondents (n = 60 across all waves; 0.03% of the total sample) were not considered in the statistical analyses presented below.

A sum score across these nine protective measures was computed, resulting in a score ranging from 0 (if none of the nine protective measures were taken) to nine (if all of the nine protective measures were taken). As the question used a binary response format, we followed the recommendations by Gadermann et al. (2012) to compute an ordinal alpha as a parameter for reliability that is on the basis of the polychoric correlation matrix. Reliability for the sum score was good, with α = 0.77.

Further variables

Sociodemographic variables. Among the sociodemographic variables, sex, age, and education were used for further analyses. Sex was assessed as binary (male vs female). Age was assessed as a continuous variable and split into three groups for analyses: up to 39 years, between 40 and 59 years, 60 years and older. These age limits are based on common definitions of age groups (Klimczuk, 2016; Lachman, 2001). Further, from an epidemiological point of view, 60 years is also a critical threshold because

Table 2
Interpretation of used effect sizes.

	small effect	medium effect	large effect
Cohen *d*	|0.20|	|0.50|	|0.80|
partial η^2	0.01	0.06	0.14
Cramer *V* [*df* = 1]	0.10	0.30	0.50
Cramer *V* [*df* = 2]	0.07	0.21	0.35

Note. Rules of thumb for interpretation of effect sizes based on Cohen (1988).

the mortality of COVID-19 increases considerably from this age onwards (Bonanad, 2020). This has led the Standing Committee on Vaccination in Germany to prioritize this age group for vaccination (Vygen-Bonnet et al., 2021). Education was assessed by five education levels. The levels of "pupil," "secondary general school (Volks-/Hauptschule)", and "secondary school without Abitur" were combined to represent lower education, whereas the levels of "Abitur, university/polytechnic entrance qualification" and "academic degree (university, academy, polytechnic)" were combined to represent higher education.

7-day incidence rate. During the COVID-19 pandemic, every day, the Robert Koch Institute (2021) reported an incidence value for Germany on the basis of the notified infection rates of the past seven days ("7-day incidence rate"). For each wave, we computed the mean of reported incidence values across the corresponding survey days. These incidence values were used for comparison with the development of the protective behavior.

Data analysis plan

Data were processed and analyzed using SPSS (Version 26). All analyses are based on the weighted sample (see "Participants and procedure"); thus, Rao-Scott adjustment (Rao and Scott, 1984) for complex survey data was applied to all tests of significance. For measures of effect sizes, we computed the following coefficients: Cramer *V* for differences in the uptake of single protective measures based on sex, education, and age groups; Cohen *d* for differences in the mean sum score of protective measures for sex and education; and partial η^2 for the difference in the mean sum score for the age groups. For the interpretation of effect sizes, common thresholds were used (Cohen, 1988), as shown in Table 2.

RESULTS

General uptake of protective measures

Table 3 shows descriptive statistics for the total sample of the nine protective measures and their corresponding sum score across all 20 survey waves. On average, respondents reported taking $M = 5.64$ protective measures ($SD = 1.59$). The most frequently reported measures were using covers for mouth and nose, keeping more distance to other individuals, and washing one's hands more thoroughly (each >90%). In contrast, having food delivered more frequently was the least practiced protective measure (<10%).

Sociodemographic factors of protective measures

Table 3 further shows the results of sociodemographic analyses across all waves. For most comparisons, sociodemographic differences were significant with small effect sizes.

Regarding sex comparisons, female respondents, on average, took a higher number of protective measures than male respondents. Considering single protective measures, female respondents implemented almost all measures more frequently than male respondents, with the greatest effect sizes for changes in their social behavior (e.g., keeping distance to other individuals). However, no sex difference was found in terms of the use of the Corona-Warn-App, and male respondents were slightly more inclined to have food delivered more frequently.

Higher educated respondents also reported taking a higher number of protective measures than lower educated respondents. On the level of single measures, the uptake rate was higher among higher educated respondents than lower educated respondents for changes in their social behavior (e.g., meeting friends and family less frequently). In addition, the greatest effect size was found for the use of the Corona-Warn-App. No educational difference was found for items referring to hygiene behavior (e.g., washing hands more thoroughly) as well as building up larger stocks and food delivery.

For age, we found the youngest age group (up to 39 years) taking a significantly higher number of protective measures than older respondents. On the level of single measures, however, we found a more diverse result pattern. For some measures (e.g., meeting friends and family less frequently), we found younger age groups reporting a higher uptake rate than older age groups, with the greatest effect size for using the Corona-Warn-App. For other measures (e.g., food delivery), we found the youngest and the oldest age group reporting a higher uptake rate than the middle-aged group. And for washing hands more thoroughly, the oldest age group reporting a higher uptake rate than both younger groups. There was no age difference for the usage of covers for mouth and nose as well as keeping distance from other individuals.

Development of number of protective measures over time

Fig 1 shows the development of the mean sum score of protective measures as well as the 7-day incidence rate over the period of the 20 waves. Both values were strongly correlated ($r = 0.86$, $p < 0.001$); that is, with increasing incidence rate, respondents showed a higher number of protective measures. The development over time shows that in early waves (June–September 2020), both values were relatively low. At the beginning of October 2020, the incidence started to show a substantial increase, as did the sum score of protective measures, with a peak for both values in December 2020. In January and February 2021, incidence dropped and so did the sum score.

DISCUSSION

This study aimed to investigate personal protective behavior of the population in Germany during the COVID-19 pandemic between June 2020 and March 2021 by analyzing 20 waves of the serial cross-sectional study "BfR-Corona-Monitor" (German Federal Institute for Risk Assessment, 2021). Overall, the most frequently reported measures were using covers for mouth and nose, keeping more distance to other individuals, and washing one's hands more thoroughly. These most common measures are in line with official orders, recommendations, and campaigns by the federal government at that time (the "AHA-Formel" recommended to keep distance, pay attention to hygiene, and cover mouth and nose; Press and Information Office of the Federal Government of Germany, 2020).

Analyses over time showed a strong correlation between the number of protective measures taken by the respondents and the seven-day incidence rate in Germany that was reported every day by the Robert Koch Institute (2021). When the incidence rate in Germany was low (e.g., in the summer of 2020), the population showed a relatively low number of protective measures. However, with rising incidence values (e.g., in October 2020), the population reacted by taking more protective measures. These results indicate that in times of greater infection risks (i.e., high incidence rate), individuals adapt their protection behavior accord-

Table 3
Uptake of protective measures across all waves.

	Total sample	Sex			Education			Age			
		male	female	difference	low	high	difference	up to 39 years	40 to 59 years	60 years or over	difference
n	20,257	9,967	10,290		13,901	6,356		6,921	6,997	6,339	
Use covers for mouth and nose	96%	95%	97%	$F^{a} = 17.0^{***}$, $V = 0.05$	96%	97%	$F^{a} = 3.3$, $V = 0.02$	97%	95%	96%	$F^{b} = 1.8$, $V = 0.02$
Keep more distance to other individuals	91%	89%	94%	$F^{a} = 47.0^{***}$, $V = 0.08$	90%	94%	$F^{a} = 38.2^{***}$, $V = 0.06$	91%	91%	92%	$F^{b} = 0.6$, $V = 0.01$
Wash hands more thoroughly	91%	89%	93%	$F^{a} = 31.1^{***}$, $V = 0.06$	91%	90%	$F^{a} = 1.1$, $V = 0.01$	90%	90%	93%	$F^{b} = 14.1^{***}$, $V = 0.06$
Meet friends or family less frequently	76%	74%	79%	$F^{a} = 26.0^{***}$, $V = 0.06$	74%	83%	$F^{a} = 92.5^{***}$, $V = 0.10$	79%	78%	73%	$F^{b} = 15.9^{***}$, $V = 0.06$
Use disinfectant more frequently	73%	71%	74%	$F^{a} = 12.4^{***}$, $V = 0.04$	73%	71%	$F^{a} = 3.3$, $V = 0.02$	74%	69%	74%	$F^{b} = 11.0^{***}$, $V = 0.05$
Leave home less frequently	70%	66%	73%	$F^{a} = 42.7^{***}$, $V = 0.07$	68%	74%	$F^{a} = 30.9^{***}$, $V = 0.06$	74%	68%	68%	$F^{b} = 14.0^{***}$, $V = 0.06$
Use the Federal Government's Corona-Warn-App	37%	37%	37%	$F^{a} = 0.1$, $V = 0.00$	32%	50%	$F^{a} = 267.3^{***}$, $V = 0.17$	43%	36%	32%	$F^{b} = 36.1^{***}$, $V = 0.09$
Build up larger stocks	20%	18%	21%	$F^{a} = 13.3^{***}$, $V = 0.04$	20%	19%	$F^{a} = 2.2$, $V = 0.02$	20%	18%	21%	$F^{b} = 3.3^{*}$, $V = 0.03$
Have food delivered more frequently	9%	10%	9%	$F^{a} = 4.2^{*}$, $V = 0.02$	9%	10%	$F^{a} = 2.5$, $V = 0.02$	12%	7%	10%	$F^{b} = 20.8^{***}$, $V = 0.07$
Sum score (0–9)				$t(20{,}263) =$			$t(20{,}263) =$				$F(2,$
M	5.64 (1.59)	5.50 (1.67)	5.77 (1.50)	7.5^{***},	5.53 (1.60)	5.87 (1.55)	9.6^{***},	5.79 (1.57)	5.53 (1.63)	5.59 (1.55)	$20162) = 16.5^{***}$,
(SD)				$d = 0.17$			$d = 0.22$				$\eta^{2} = 0.01$

Notes:
[a] $df_{\text{numerator}} = 1$, $df_{\text{dominator}} = 20{,}316$.
[b] $df_{\text{numerator}} = 2$, $df_{\text{dominator}}$ ranging between 39,207 and 39,718, *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

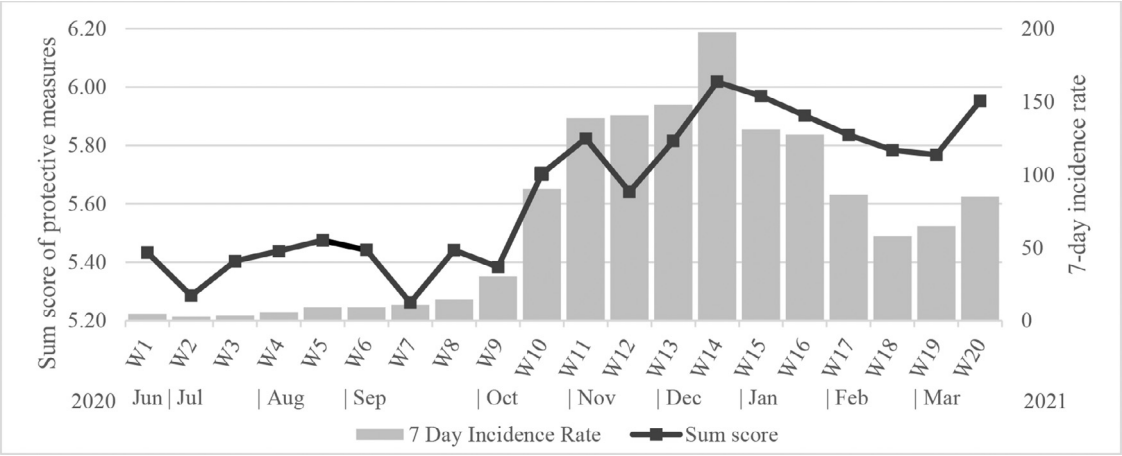

Figure 1. Development of the sum score of protective measures and seven-day incidence rate over time.
Notes. W = wave.

ingly. At first glance, this result seems to contrast with a study by Rosman et al. (2021), showing that the acceptance of protective measures decreased over the course of the pandemic, leading to the assumption that the uptake of such measures would also decrease over time. However, Rosman et al. (2021) examined the period between March and July 2020, which is an early period where incidence values were decreasing or at a comparable low level; whereas in the current study, a time period with a more dynamic development of incidence values is covered (June 2020–March 2021), including a sharp increase in reported infection numbers in autumn and winter 2020. In addition, various psychological theories outline that attitudes are not the only predictor for actual behavior (e.g., the theory of planned behavior; Ajzen, 1991). In the context of COVID-19, for example, a study by Schillings et al. (2021) showed that, besides the attitude, perceived expectations from the social environment (i.e., subjective norms) also play an important role for the intention to comply with social restrictions, such as reducing social contacts or staying at home.

Regarding sociodemographic differences, we found that women as well as younger and higher educated respondents, on average, take a higher number of protective measures. Effect sizes for these differences were small, but the results for sex are in line with previous research and could, in part, be explained by different attitudes influencing individual behavior. For example, women often feel more susceptible to diseases than men, which may then lead to a greater focus on preventive measures (for a review, see Bish and Michie, 2010).

For education, our results are in line with previous research on other pandemics (e.g., Bish and Michie, 2010), but there is a marked difference with research in context of the COVID-19 pandemic. For example, although our study seems to indicate an increasing uptake rate of protective measures with age, the study by Betsch et al. (2021) found a reverse effect. To better understand this discrepancy, it helps to look at the methodological differences, especially regarding the protective measures included in the questionnaire. For example, the study by Betsch et al. (2021) included more hygiene measures (e.g., covering the mouth when coughing, not touching one's face), whereas our study also considered changes in the social behavior (e.g., meeting friends or family less frequently, leaving one's home less frequently) and the use of the Corona-Warn-App. As shown in Table 3, these particular items accounted for the largest differences in uptake regarding the education level of the respondents. Furthermore, the study by Betsch et al. (2021) analyzed data exclusively from March 2020 (although the COSMO study itself covers a larger timeframe, see Betsch et al., 2020; University of Erfurt, 2022). In addition, it is important to remember that not all individuals have the same resources or opportunities to take protective measures against an infection because of their current job, their housing conditions, or other limiting factors. Against this background, it is not surprising that studies have found that individuals with a lower educational status are more likely to be infected with SARS-CoV-2 (Hoebel et al., 2022) and perceive COVID-19 as more dangerous (Wachtler et al., 2021).

An even more diverse pattern emerged with respect to the relationship between protective measures and age. Although the number of taken protective measures was higher for the youngest age group (up to 39 years), the oldest age group (60 years and over) also showed a high uptake rate for some single measures, for example, washing hands more thoroughly or having food delivered more frequently. These mixed results are in line with the varied findings in previous studies. Although a number of studies indicate that older individuals are more likely to engage in protective behavior (Atchinson et al., 2021), others show no correlation with age (Helsingen et al., 2020) or even an inverse correlation (Pasion et al., 2020). The fact that there is no clear pattern indicates that other factors might also influence the link between age and protective behavior. For instance, the study by Pasion et al. (2020) showed that middle-aged adults had a higher risk perception regarding COVID-19 than older and younger adults. Further research on how age affects protective behavior should therefore focus more on the attitudes and risk perceptions of individuals in different age groups, as well as how their living conditions or other environmental aspects might influence their behavior (e.g., available resources, household size).

Consequently, the sociodemographic differences identified in this study indicate that some parts of the population may be of greater risk of becoming infected during a pandemic due to their less pronounced protective behavior, in this particular instance: men, individuals with a lower level of education, and individuals who are 40 years and older. This is especially concerning because men and older individuals face a greater risk for a severe course of COVID-19 (Peckham et al., 2020; Katzenschlager et al., 2021) and individuals with a lower education level show higher infection rates (Hoebel et al., 2022). This highlights the importance of communication formats or campaigns that address and provide information precisely to these target groups. However, the comparison with other studies also shows the complexity of protective behavior during a pandemic. The possibility to implement many measures is often also dependent on factors that one cannot directly

influence oneself, such as the place of work or housing conditions. To better understand the protective behavior of the population and to derive better forecasts, future studies should also pay attention to the influence of individual circumstances on personal protective measures.

There are some limitations to this study. First, as the length of questionnaires is limited within omnibus telephone surveys, we assessed the protective behavior using a binary response scale (yes/no). A more granular response scale could have provided more information (e.g., frequency of behavior). Second, our list of protective measures is not exhaustive. That is, in addition to the nine measures, we considered in our study, we cannot exclude that respondents may have shown other behaviors that could be classified as protective measures. As a final limitation, the serial cross-sectional study design cannot consider the development of a single individual over time (intraindividual development), which only can be investigated using a longitudinal study design.

In conclusion, our results show that the population in Germany has shown a variety of behaviors to protect themselves or their family from an infection during the COVID-19 pandemic. In times of greater infection risks, individuals adapted accordingly, with a higher number of protective measures. However, on the basis of sociodemographic differences, campaigns could be essential to educate older individuals, the male sex, and those with lower education on the necessity of protective behavior.

CONFLICT OF INTEREST

The authors have no competing interests to declare.

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ETHICAL CONSIDERATIONS

Ethical approval was not required for this study on the basis of the following considerations: the study did not include medical aspects, person-identifiable data, or sensitive or confidential data. No experimental manipulation or psychological tests were used. It was always possible for respondents to drop out of the survey before completion or to not answer one or more questions in the survey. In addition, data collection was carried out in line with the standards established by the Association of German Market Research Institutes (ADM; see https://www.adm-ev.de/en/standards-guidelines/). Respondents expressed their consent to participate in the surveys. All data were recorded and processed anonymously.

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AUTHOR CONTRIBUTIONS

Fabian Kirsch, Ann-Kathrin Lindemann, Mark Lohmann, and Gaby-Fleur Böl conceptualized the study. Fabian Kirsch and Dan Borzekowski managed and analyzed the data. Ann-Kathrin Lindemann and Johanna Geppert provided input for data analyses and reviewed scientific literature. Fabian Kirsch, Johanna Geppert, and Ann-Kathrin Lindemann prepared the original draft of the manuscript. All authors read and approved the final manuscript.

REFERENCES

Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process 1991;50:179–211. doi:10.1016/0749-5978(91)90020-T.
Almadhi MA, Abdulrahman A, Sharaf SA, AlSaad D, Stevenson NJ, Atkin SLet al. The high prevalence of asymptomatic SARS-CoV-2 infection reveals the silent spread of COVID-19. Int J Infect Dis 2021;105:656–61. doi:10.1016/j.ijid.2021.02.100.
Atchison C, Bowman LR, Vrinten C, Redd R, Pristerà P, Eaton Jet al. Early perceptions and behavioural responses during the COVID-19 pandemic: A cross-sectional survey of UK adults. BMJ Open 2021;11. doi:10.1136/bmjopen-2020-043577.
Betsch C, Korn L, Burgard T, Gaissmaier W, Felgendreff L, Eitze Set al. The four weeks before lockdown during the COVID-19 pandemic in Germany: A weekly serial cross-sectional survey on risk perceptions, knowledge, public trust and behavior, 3 to 25 March 2020. Euro Surveill 2021;26. doi:10.2807/1560-7917.ES.2021.26.42.2001900.
Betsch C, Wieler LH, Habersaat K, group COSMO. Monitoring behavioural insights related to COVID-19. Lancet 2020;395:1255–6. doi:10.1016/S0140-6736(20)30729-7.
Bish A, Michie S. Demographic and attitudinal determinants of protective behaviours during a pandemic: a review. Br J Health Psychol 2010;15:797–824. doi:10.1348/135910710X485826.
Bonanad C, García-Blas S, Tarazona-Santabalbina F, Sanchis J, Bertomeu-González V, Fácila Let al. The effect of age on mortality in patients with COVID-19: A meta-analysis with 611,583 subjects. J Am Med Dir Assoc 2020;21:915–18. doi:10.1016/j.jamda.2020.05.045.
Buitrago-Garcia D, Egli-Gany D, Counotte MJ, Hossmann S, Imeri H, Ipekci AMet al. Occurrence and transmission potential of asymptomatic and presymptomatic SARS-CoV-2 infections: A living systematic review and meta-analysis. PLOS Med 2020;17. doi:10.1371/journal.pmed.1003346.
Bavarian State Ministry of Health and Care, Bestätigter Coronavirus-Fall in Bayern – Infektionsschutzmaßnahmen laufen [Confirmed coronavirus case in Bavaria – infection protection measures underway]. https://www.stmgp.bayern.de/presse/bestaetigter-coronavirus-fall-in-bayern-infektionsschutzmassnahmen-laufen/, 2020 (accessed 27 Sep 2021).
Choi BCK. Computer assisted telephone interviewing (CATI) for health surveys in public health surveillance: methodological issues and challenges ahead. Chronic Dis Can 2004;25:21–7.
Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd. New York: Routledge Academic; 1988.
Federal Ministry of Health, Coronavirus-Pandemie (SARS-CoV-2): Chronik bisheriger Maßnahmen und Ereignisse [Coronavirus pandemic (SARS-CoV-2): chronicle of measures and events to date]. https://www.bundesgesundheitsministerium.de/coronavirus/chronik-coronavirus.html, 2021 (accessed 4 October 2021).
Gabler S, Kolb JP, Sand M, Zins S. Weighting, GESIS survey guidelines. Mannheim: GESIS. Leibniz Institute for the Social Sciences, 2016. doi:10.15465/gesis-sg_en_007.
Gadermann A, Guhn M, Zumbo B. Estimating ordinal reliability for likert-type and ordinal item response data: A conceptual, empirical, and practical guide. Pract Assess Res Eval 2012;17:1–13.
Gallo Marin B, Aghagoli G, Lavine K, Yang L, Siff EJ, Chiang SSet al. Predictors of COVID-19 severity: A literature review. Rev Med Virol 2020;31:e2146. doi:10.1002/rmv.2146.
German Federal Institute for Risk Assessment, BfR-Corona-Monitor. https://www.bfr.bund.de/en/bfr_corona_monitor-244792.html, 2021 (accessed 18 June 2021).
Helsingen LM, Refsum E, Gjøstein DK, Løberg M, Bretthauer M, Kalager Met al. The COVID-19 pandemic in Norway and Sweden – threats, trust, and impact on daily life: A comparative survey. BMC Public Health 2020;20:1597. doi:10.1186/s12889-020-09615-3.
Hiller J, Schatz K, Drexler H. Gender influence on health and risk behavior in primary prevention: A systematic review. Z Gesundh Wiss 2017;25:339–49. doi:10.1007/s10389-017-0798-z.
Hoebel J, Grabka MM, Schröder C, Haller S, Neuhauser H, Wachtler Bet al. Socioeconomic position and SARS-CoV-2 infections: seroepidemiological findings from a German nationwide dynamic cohort. J Epidemiol Community Health 2022;76:350–3. doi:10.1136/jech-2021-217653.
Johansson MA, Quandelacy TM, Kada S, Prasad PV, Steele M, Brooks JTet al. SARS-CoV-2 transmission from people without COVID-19 symptoms. JAMA Netw Open 2021;4. doi:10.1001/jamanetworkopen.2020.35057.
Katzenschlager S, Zimmer AJ, Gottschalk C, Grafeneder J, Schmitz S, Kraker Set al. Can we predict the severe course of COVID-19 – A systematic review and meta-analysis of indicators of clinical outcome? PLOS ONE 2021;16. doi:10.1371/journal.pone.0255154.
Kirsch F, Lindemann AK, Lohmann M, Böl GF. Serial cross-sectional data on the public's perception on the coronavirus during the first months of the pandemic in Germany. Data Brief 2021;38. doi:10.1016/j.dib.2021.107430.
Kish L. A procedure for objective respondent selection within the household. J Am Stat Assoc 1949;44:380–7. doi:10.1080/01621459.1949.10483314.
Klimczuk A. Adulthood. In: Miller HL, editor. The SAGE encyclopedia of theory in psychology. Thousand Oaks: SAGE Publications, 2016. p. 15–8.
Lachman ME. Adult development, psychology of. In: Smelser NJ, Baltes PB, editors. International encyclopedia of the social & Behavioral Sciences. Oxford: Elsevier; 2001. p. 135–9.
Lampert T, Saß AC, Häfelinger M, Ziese T.]. Beiträge zur Gesundheitsberichterstat-

tung des Bundes: Armut, Soziale Ungleichheit und Gesundheit [Contributions to federal health reporting: poverty, social inequality and health. Berlin: Robert Koch-Institut; 2005.

Mielck A. Soziale Ungleichheit und Gesundheit: Empirische Belege für die zentrale Rolle der schulischen und beruflichen Bildung [Social inequality and health: empirical evidence for the central role of schooling and vocational education]. In: Brähler E, Kiess J, Schubert C, Kiess W, editors. Gesund und gebildet: Voraussetzungen für eine moderne Gesellschaft [Healthy and educated: prerequisites for a modern society]. Göttingen: Vandenhoeck & Ruprecht; 2012. p. 129–45.

Pasion R, Paiva TO, Fernandes C, Barbosa F. The AGE effect on protective behaviors during the COVID-19 outbreak: sociodemographic, perceptions and psychological accounts. Front Psychol 2020;11. doi:10.3389/fpsyg.2020.561785.

Peckham H, de Gruijter NM, Raine C, Radziszewska A, Ciurtin C, Wedderburn LRet al. Male sex identified by global COVID-19 meta-analysis as a risk factor for death and ITU admission. Nat Commun 2020;11:6317. doi:10.1038/s41467-020-19741-6.

Press and Information Office of the Federal Government of Germany. Die "AHA-Regeln" im neuen Alltag [The „AHA rules“ in the new everyday life]; 2020 https://www.bundesregierung.de/breg-de/themen/coronavirus/die-aha-regeln-im-neuen-alltag-1758514 accessed 9 September 2021.

Rao JNK, Scott AJ. On chi-squared tests for multiway contingency tables with cell proportions estimated from survey data. Ann Statist 1984;12:46–60. doi:10.1214/aos/1176346391.

Robert Koch Institute. 7-Tage-Inzidenzen nach Bundesländern und Kreisen (fixierte Werte) sowie Gesamtübersicht der pro Tag ans RKI übermittelten Fälle und Todesfälle [7-day incidences by federal states and counties (fixed values) as well as total overview of cases and deaths transmitted per day to the RKI]; 2021 https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Daten/Fallzahlen_Kum_Tab.html accessed 18 June 2021.

Rosman T, Kerwer M, Steinmetz H, Chasiotis A, Wedderhoff O, Betsch Cet al. Will COVID-19-related economic worries superimpose health worries, reducing nonpharmaceutical intervention acceptance in Germany? A prospective preregistered study. Int J Psychol 2021;56:607–22. doi:10.1002/ijop.12753.

Schillings J, Mohr M, Mohren J. No way out? Intention zur Einhaltung von Corona-Ausgangsbeschränkungen im Kontext einer „extended theory of reasoned action" [No way out? Intention to comply with corona restrictions in the context of an extended theory of reasoned action]. Präv Gesundheitsf 2021;16:89–94. doi:10.1007/s11553-020-00790-0.

University of Erfurt. COSMO — COVID-19 snapshot monitoring; 2022 https://projekte.uni-erfurt.de/cosmo2020/web/ accessed 10 May 2022.

Vygen-Bonnet S, Koch J, Bogdan C, Harder T, Heininger U, Kling Ket al. Beschluss und Wissenschaftliche Begründung der Ständigen Impfkommission (STIKO) für die COVID-19-Impfempfehlung. Epid Bull 2021;2:3–63. doi:10.25646/7755.2.

Wachtler B, Müters S, Michalski N, Koschollek C, Albrecht S, Haller Set al. Socioeconomic inequalities in the prevalence and percieved dangerousness of SARS-CoV-2 infections in two early German hotspots: findings from a seroepidemiological study. BMC Res Notes 2021;14:375. doi:10.1186/s13104-021-05784-5.