

ORIGINAL ARTICLE

The scientific worldview and its relationships with fear of COVID, conspiracy beliefs, preventive behaviors, and attitudes towards vaccines during the COVID-19 pandemic in a Polish sample

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BACKGROUND

The scientific worldview is characterized by the tendency to justify beliefs and behavior with scientific findings and to function on the basis of theorems and opinions formulated by scientists. The aim of this study was to test whether the attitudes typical for the scientific worldview could be related to beliefs and behaviors that may reduce the risk of contracting and spreading COVID-19.

PARTICIPANTS AND PROCEDURE

The study was conducted on a Polish sample of 1286 participants, using an online survey platform. Participants were asked to complete questionnaires to measure attitudes towards vaccines on COVID-19, the scientific worldview, fear of COVID, conspiracy beliefs about the COVID-19 pandemic, and preventive behaviors undertaken. Participants were also asked about their personal experiences with the pandemic.

RESULTS

The study showed that the scientific worldview was associated with a higher fear of COVID, a higher level of contain-

ment-related behavior, a lower level of conspiracy beliefs about the COVID-19 pandemic, and more positive attitudes towards vaccination against COVID-19. A structural model of relations between the studied variables turned out to be very effective and explained 51% of the variance of containment-related behavior and 63% of the variance of attitudes towards the COVID-19 vaccines.

CONCLUSIONS

The study found that preventive behaviors and attitudes towards vaccination against COVID-19 were weakly related to personal experiences during the pandemic but significantly correlated with psychological variables. The results suggest that very positive, scientific attitudes towards science may be related to higher adherence to science-based public health recommendations.

KEY WORDS

attitudes towards science; scientific worldview; compliance with preventive recommendations during the COVID-19 pandemic; conspiracy beliefs about COVID-19 pandemic; fear of COVID

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BACKGROUND

The COVID-19 pandemic is a global crisis that has been widely addressed by implementing preventive recommendations based on scientific knowledge (Carley et al., 2020; Pramesh et al., 2021). However, the effectiveness of such measures depends on the public perception of science (Bennett, 2020; Dohle et al., 2020). Studies conducted during the COVID-19 pandemic have shown that positive attitudes towards science and trust in science are associated with a lower level of conspiracy beliefs about the COVID-19 pandemic (Freeman et al., 2020; Pivetti et al., 2021; van Mulukom et al., 2020), higher compliance with COVID-19 prevention guidelines (Dohle et al., 2020; Pivetti et al., 2021; Plohl & Musil, 2021), and higher acceptance of COVID-19 vaccines (Murphy et al., 2021; Pivetti et al., 2021).

Attitudes towards science may be considered a part of a broader context in which people perceive and evaluate the importance of science in the modern world. Hartman et al. (2017) postulate that perceived credibility of science (PCoS) is an important variable that lends insight across a range of science-related beliefs and behaviors. PCoS refers to the general evaluation of science and scientists, including perceptions regarding the motives, objectivity, and competence of scientists, as well as the accuracy, objectivity, importance, and societal utility of the scientific community's theories, conclusions, and recommendations (Hartman et al., 2017). PCoS is positively related to confidence in scientific institutions and many beliefs consistent with scientific knowledge (e.g., related to evolution, vaccines, and climate change) and negatively related to conspiracist ideation and paranormal beliefs (Hartman et al., 2017).

Another psychological construct relating to the attitudes towards science embedded in a broader context is the scientific worldview (Jach, 2019, 2021). A scientific worldview is characterized by the tendency to justify beliefs and behavior with scientific findings and functioning based on theorems and opinions formulated by scientists (Jach, 2019, 2021). Characteristic aspects of the scientific worldview include recognizing the scientific language as the most suitable for describing even everyday phenomena, considering theories and results of scientific research in axiological terms, and hoping that science will bring ultimate prosperity to humanity (Jach, 2015, 2019, 2020).

The scientific worldview construct is a psychological conceptualization of the beliefs and attitudes characteristic of the philosophical approach called *scientism*. There are many definitions of scientism (Gasparatou, 2017; Hietanen et al., 2020) and ways of addressing this perspective, both affirmative (e.g., Ross et al., 2007) and critical (e.g., Pigliucci, 2013). The scientific worldview has a lot in common with

the perspective indicating that the basic tenets of scientism are the following: (1) only certifiably scientific knowledge counts as true knowledge, (2) the methods and assumptions underlying the natural sciences are appropriate for all sciences, (3) only science can produce knowledge and solve the problems facing humanity and (4) the world must be exactly like the methods of contemporary natural science assume it to be (Williams, 2015). Studies by Farias et al. (2013) have shown that such beliefs correlate negatively with religiosity and are strengthened in crises, suggesting that some people may use science as a form of "faith" that helps them to deal with anxiety-provoking situations.

Research conducted in Poland has shown that the scientific worldview is positively associated with, among others, the perceived credibility of advertisements relating to the scientific context (Jach & Chmiel, 2018), the aesthetic evaluation of graphics depicting objects associated with science (e.g., fractals, neurons or chemical molecules; Jach, 2020) and the assessment of the credibility of popular science reports (Jach, 2020). A higher level of the scientific worldview was also associated with more positive attitudes towards vaccination (Jach, 2020) and greater acceptance of violation of ethical norms for scientific reasons (Jach & Buczek, 2021).

AIMS OF THE STUDY AND RESEARCH HYPOTHESES

During the COVID-19 pandemic, the most effective preventive recommendations were expected from experts referring to the results of scientific research (e.g., European Commission, 2020; Moradian et al., 2020). From a different perspective, studies conducted so far have shown associations of positive attitudes towards science and trust in science with fewer conspiratorial beliefs about the COVID-19 pandemic (Constantinou et al., 2021; Eberl et al., 2021; Hartman et al., 2021; Pivetti et al., 2021; Plohl & Musil, 2021), greater compliance with preventive recommendations (Constantinou et al., 2021; Dohle et al., 2020; Pivetti et al., 2021; Plohl & Musil, 2021), and more positive attitudes towards vaccination against COVID-19 (Pivetti et al., 2021). The aim of the present study was to test whether the attitudes characteristic of the scientific worldview could also be related to beliefs and behaviors that may reduce the risk of contracting the disease and spreading COVID-19. Among the mentioned beliefs and behaviors, conspiratorial beliefs about the pandemic, protective behaviors during the pandemic, and attitudes towards vaccination against COVID-19 were considered. Another aim of the present study was to test a structural path model in which (1) the scientific worldview (as the general context of everyday functioning) is considered an exogenous variable, (2) emotional and cognitive

aspects of attitudes towards the COVID-19 pandemic (such as the fear of COVID and conspiratorial beliefs) are considered as mediators, and (3) vaccine attitudes and pandemic preventative behavior are considered as the final explained variables.

During the ongoing COVID-19 pandemic, numerous conspiratorial beliefs emerged. They concerned the causes of the pandemic (e.g., that the pandemic was caused intentionally and that the coronavirus was human-made), its course (e.g., that the virus is much less dangerous than reported in the media), and its consequences (e.g., that COVID-19 vaccination serves to increase the level of global control over humans) and even whether the coronavirus truly exists or was a hoax (see Constantinou et al., 2021; Freeman et al., 2020; Imhoff & Lamberty, 2020; van Mulukom et al., 2020). Since studies conducted so far have shown that conspiratorial beliefs are associated with distrust of science (Landrum & Olshansky, 2019; Lewandowsky et al., 2013; Plohl & Musil, 2021), and trust in the scientific method is one of the core sub-dimensions of the scientific worldview (Jach, 2019, 2021), Hypothesis 1 was put forward that the scientific worldview would negatively correlate with conspiratorial beliefs about the pandemic.

In the current study, fear of COVID (Ahorsu et al., 2020) was included as a general variable related to the perceived pandemic threat. Threats such as infectious diseases are described in scientific (mainly biological and medical) terms; therefore, information about them may be considered more reliable by people who particularly value the use of this type of terminology in everyday discourse. Based on the above assumption, Hypothesis 2 was put forward that fear of COVID would correlate positively with the scientific worldview. Additionally, fear of COVID may be positively associated with protective measures and attitudes towards vaccination against COVID-19 (see e.g., Detoc et al., 2020; Pilch et al., 2021).

During the COVID-19 pandemic, preventive recommendations were made to change daily habits, such as, e.g., social distancing, leaving home only when necessary, and wearing protective masks (Faasse & Newby, 2020; Imhoff & Lamberty, 2020; Makhanova & Shepherd, 2020). The necessity of these behaviors was justified by referring to scientific knowledge (World Health Organization, 2020), but some people considered them irrational, redundant, and negatively influencing their sense of freedom (Shelus et al., 2020). As the need to change everyday habits during the COVID-19 pandemic was justified scientifically (see e.g., Pramesh et al., 2021), Hypothesis 3 was put forward that the scientific worldview would positively correlate with preventive behaviors during the pandemic.

The recently developed vaccines against COVID-19 may stop the pandemic, but their effectiveness depends on people's willingness to vaccinate (Fadda

et al., 2020). Studies have shown that willingness to get vaccinated is related to positive attitudes towards medical authorities and science (Jolley & Douglas, 2014; Murphy et al., 2021; Pivetti et al., 2021) and to a higher level of perceived credibility of science (Hartman et al., 2017). As the scientific worldview manifests itself through a high level of trust and admiration for the scientific system, Hypothesis 4 was put forward that the scientific worldview would positively correlate with attitudes towards vaccination against COVID-19.

PARTICIPANTS AND PROCEDURE

DATA COLLECTION AND SAMPLE CHARACTERISTICS

The study was conducted from 3 February to 11 February 2021 on a Polish quota sample, selected according to the criteria of gender and age. At the time of data collection, none of the participants were vaccinated against COVID-19. Until then, less than 1.9 million people in Poland (less than 10% of adult citizens) had been vaccinated against the coronavirus. Data were collected using the Polish online survey platform Ariadna, and the participants were recruited from a representative sample of Polish Internet users. Inclusion criteria for the study were (a) a minimum age of 18, (b) understanding the Polish language, (c) being an Internet user, and (d) not being vaccinated for COVID-19 at the time of the study. Participation in the study was anonymous and voluntary. Before filling in the questionnaire, the participants read the instructions describing the procedure and gave their informed written consent. Participants received points that they could exchange for gifts offered by the survey platform. The design was approved by the Ethics Committee of the University of Silesia (decision number: KEUS.97/02.2021).

Six hundred and sixty-five female participants, 618 male participants, and three people who indicated a different gender aged 18 to 86 ($M = 49.24$, $SD = 16.33$) participated in the study. One hundred and twenty-seven participants (9.88%) reported education below the secondary level, 589 (45.80%) reported secondary level education, and 570 (44.32%) reported having completed education at the university level. The groups of male and female participants did not differ in terms of age ($t(1281) = -1.56$, $p = .118$). Female participants prevailed in the group with secondary education and male participants in the groups with less than secondary and university education ($\chi^2(2) = 16.94$, $p < .001$, Cramer's $V = .11$).

Participants were also asked about their personal experiences with the COVID-19 pandemic. Among the respondents, 141 (10.96%) had previously had COVID-19, 534 (41.52%) had relatives who had had

COVID-19, 66 (5.13%) had relatives who had died of COVID-19, 211 (16.41%) had previously been in quarantine for COVID-19, and 610 (47.43%) had relatives who had previously been in quarantine for COVID-19.

A sensitivity analysis conducted in G*Power (Faul et al., 2007) showed that this study was powered to detect small effects in two-tailed tests ($|\rho| = .08$, $1-\beta = .80$, $\alpha = .05$).

MEASURES

The scientific worldview. The Views of Science Questionnaire (Jach, 2019, 2021) was used to measure the scientific worldview. The tool consists of 16 items to which the participants respond by selecting options arranged on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The statements of the questionnaire refer to such aspects related to the scientific worldview as trust in the scientific method, perceiving scientists as the most competent experts, recognizing science as a tool of practical influence, and hoping that scientific progress will lead humanity to a better future (sample items were presented in Supplementary Information A; the complete questionnaire is available in Jach, 2021). The higher the score obtained, the more positive are the attitudes towards science. In the current study, the standardized Cronbach's α coefficient for this tool was .93.

Conspiracy beliefs related to the COVID-19 pandemic were measured using the six statements proposed by Imhoff and Lamberty (2020). Three of them are related to the opinion that the COVID-19 pandemic is a hoax, and the other three are related to the opinion that the SARS-CoV-2 virus was human-made. The standardized Cronbach's α coefficients were subsequently .94 and .75.

Preventive behaviors during the COVID-19 pandemic. Imhoff and Lamberty (2020) developed statements concerning containment-related behavior and self-centered prepping behavior to measure the pandemic-related protective behaviors. A shortened list including 11 items was used in the current study. Seven of them concerned containment-related behavior, and the remaining four concerned self-centered prepping behavior (see Supplementary Information A). The standardized Cronbach's α values of these tools were respectively .89 and .82.

Attitudes towards the COVID-19 vaccines were measured by asking five questions the participants could respond to by selecting responses from 1 (*definitely not*) to 7 (*definitely yes*) (see Supplementary Information A). The more points the participants scored, the more positive their attitudes towards the COVID-19 vaccines were. The standardized Cronbach's α of the scale was .93.

The level of COVID-19-related anxiety was measured using the Fear of COVID Scale (Ahorsu et al.,

2020) in the Polish adaptation by Pilch et al. (2021). It consists of seven statements, to which the participants responded by selecting one of the five answers arranged on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores on this scale indicate a higher level of anxiety related to COVID-19. In the current study, the standardized Cronbach's α coefficient of the scale was .93.

DATA ANALYSIS METHODOLOGY

Statistica 13 and JASP 0.14.1.0 software was used for statistical analysis. Descriptive statistics related to the studied variables are presented in Supplementary Information B. Pearson's r correlation coefficient was used to measure relationships between the variables studied. Intergroup comparisons were conducted using the Student t -test and ANOVA F test. A p -value below .05 was considered statistically significant, but the Bonferroni correction was applied for multiple comparisons. Effect sizes were measured with Cohen's d coefficient and the partial eta-squared (η_p^2) coefficient.

Structural equation modeling analysis was also performed using the maximum likelihood method (ML) to estimate the model parameters. For evaluation of the goodness of fit of the model, standard criteria were utilized: χ^2/df below 5.00, comparative fit index (CFI), Tucker-Lewis index (TLI), goodness-of-fit index (GFI) and parsimonious goodness-of-fit index above .90; standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) below .08 indicate acceptable fit (Hu & Bentler, 1999). For total, direct and indirect effects, 95% confidence intervals were established by the bootstrapping method with 10,000 samples.

RESULTS

DEMOGRAPHIC ASPECTS OF THE STUDIED VARIABLES

Table 1 provides information on the relationships between the studied psychological variables and gender, age, and personal experiences related to the COVID-19 pandemic. Since each variable was compared seven times, p -values of less than $.050 / 7 = .007$ were considered statistically significant.

Male participants were characterized by more self-centered prepping behavior and more positive attitudes towards the COVID-19 vaccines than female participants. Compared to male participants, female participants had higher levels of fear of COVID and containment-related behavior. There were no gender differences concerning the conspiracy beliefs about the pandemic.

Table 1

Comparisons of psychological variables in terms of gender and level of education

Psychological variable	Gender	Education level	Have you had COVID-19?	Have any of your relatives had COVID-19?	Have any of your relatives died of COVID-19?	Have you been quarantined during the COVID-19 pandemic?	Have any of your relatives been quarantined during the COVID-19 pandemic?
Scientific worldview	$t(1281) = -2.47$ Cohen's $d = -.14$ Mean (SD): F = 52.54 (11.23) M = 54.46 (11.98)	$F(2, 1283) = 0.87$ $\eta_p^2 = .00$ Mean (SD): BSL = 53.12 (8.72) SL = 52.85 (11.96) UL = 53.75 (11.87)	$t(1284) = 0.09$ Cohen's $d = .01$ Mean (SD): Yes: 53.19 (10.74) No: 53.29 (11.75)	$t(1284) = 1.33$ Cohen's $d = .08$ Mean (SD): Yes: 52.76 (11.92) No: 53.64 (11.43)	$t(1284) = -0.86$ Cohen's $d = .11$ Mean (SD): Yes: 54.47 (12.69) No: 53.21 (11.58)	$t(1284) = 2.20$ Cohen's $d = .17$ Mean (SD): Yes: 51.66 (10.82) No: 53.59 (51.66)	$t(1284) = 0.97$ Cohen's $d = .05$ Mean (SD): Yes: 52.94 (11.39) No: 53.57 (11.86)
	COVID-19 hoax	$F(2, 1283) = 5.07^{***}$ $\eta_p^2 = .01$ Mean (SD): BSL = 11.31 (5.54) SL = 10.43 (5.71) UL = 9.72 (5.54)	$t(1284) = -0.16$ Cohen's $d = .01$ Mean (SD): Yes: 10.27 (5.54) No: 10.19 (5.65)	$t(1284) = 3.74^{***}$ Cohen's $d = .21$ Mean (SD): Yes: 9.51 (5.44) No: 10.69 (5.73)	$t(1284) = 3.27^{***}$ Cohen's $d = .41$ Mean (SD): Yes: 8.00 (5.35) No: 10.32 (5.63)	$t(1284) = -1.17$ Cohen's $d = .09$ Mean (SD): Yes: 10.62 (5.52) No: 10.19 (5.66)	$t(1284) = 1.55$ Cohen's $d = .09$ Mean (SD): Yes: 9.94 (5.41) No: 10.43 (5.83)
SARS-CoV-2 human-made	$t(1281) = 2.02$ Cohen's $d = .11$ Mean (SD): F = 11.30 (4.66) M = 10.78 (4.61)	$F(2, 1283) = 9.57^{***}$ $\eta_p^2 = .02$ Mean (SD): BSL = 12.09 (4.64)a SL = 11.41 (4.54)b UL = 10.49 (4.70)ab	$t(1284) = -0.26$ Cohen's $d = .02$ Mean (SD): Yes: 11.16 (4.44) No: 11.05 (4.68)	$t(1284) = 2.21$ Cohen's $d = .13$ Mean (SD): Yes: 10.72 (4.54) No: 11.30 (4.72)	$t(1284) = 1.47$ Cohen's $d = .19$ Mean (SD): Yes: 10.24 (4.36) No: 11.11 (4.66)	$t(1284) = -2.27$ Cohen's $d = .17$ Mean (SD): Yes: 11.73 (4.44) No: 10.93 (4.68)	$t(1284) = 0.46$ Cohen's $d = .03$ Mean (SD): Yes: 11.00 (4.57) No: 11.12 (4.73)
	Containment-related behavior	$t(1281) = 3.80^{***}$ Cohen's $d = .21$ Mean (SD): F = 38.37 (8.75) M = 36.39 (9.92)	$F(2, 1283) = 0.60$ $\eta_p^2 = .00$ Mean (SD): BSL = 36.51 (9.85) SL = 37.48 (9.48) UL = 37.48 (9.25)	$t(1284) = -0.84$ Cohen's $d = .08$ Mean (SD): Yes: 38.04 (8.87) No: 37.31 (9.47)	$t(1284) = -2.15$ Cohen's $d = .12$ Mean (SD): Yes: 38.05 (8.93) No: 36.91 (9.71)	$t(1284) = -2.08$ Cohen's $d = .26$ Mean (SD): Yes: 39.73 (8.51) No: 37.26 (9.44)	$t(1284) = -0.11$ Cohen's $d = .01$ Mean (SD): Yes: 37.45 (8.58) No: 37.37 (9.57)

(Table 1 continues)

Table 1

Table 1 continued

Psychological variable	Gender	Education level	Have you had COVID-19?	Have any of your relatives had COVID-19?	Have any of your relatives died of COVID-19?	Have you been quarantined during the COVID-19 pandemic?	Have any of your relatives been quarantined during the COVID-19 pandemic?
Self-centered prepping behavior	$t(1281) = -4.14^{***}$ Cohen's $d = .23$ Mean (SD): F = 6.23 (3.27) M = 7.11 (4.28)	$F(2, 1283) = 0.40$ $\eta_p^2 = .00$ Mean (SD): BSL = 6.89 (3.64) SL = 6.58 (3.66) UL = 6.71 (4.10)	$t(1284) = 0.15$ Cohen's $d = .01$ Mean (SD): Yes: 6.62 (4.12) No: 6.67 (3.82)	$t(1284) = -2.15$ Cohen's $d = .12$ Mean (SD): Yes: 38.05 (8.93) No: 36.91 (9.71)	$t(1284) = -1.18$ Cohen's $d = .15$ Mean (SD): Yes: 7.21 (4.30) No: 6.64 (3.83)	$t(1284) = -0.29$ Cohen's $d = .02$ Mean (SD): Yes: 6.74 (4.25) No: 6.66 (3.77)	$t(1284) = -1.33$ Cohen's $d = .08$ Mean (SD): Yes: 6.82 (3.80) No: 6.53 (3.90)
Attitudes towards the COVID-19 vaccines	$t(1281) = -3.91^{***}$ Cohen's $d = -.22$ Mean (SD): F = 20.75 (9.96) M = 22.92 (9.94)	$F(2, 1283) = 4.47$ $\eta_p^2 = .01$ M (SD): BSL = 19.99 (9.54) SL = 21.37 (10.04) UL = 22.60 (10.03)	$t(1284) = 0.49$ Cohen's $d = .04$ Mean (SD): Yes: 21.39 (9.46) No: 21.83 (10.08)	$t(1284) = -1.71$ Cohen's $d = .10$ Mean (SD): Yes: 22.35 (9.69) No: 21.38 (10.23)	$t(1284) = -2.47$ Cohen's $d = .31$ Mean (SD): Yes: 24.74 (9.72) No: 21.62 (10.01)	$t(1284) = 1.43$ Cohen's $d = .11$ Mean (SD): Yes: 20.88 (9.41) No: 21.96 (10.12)	$t(1284) = -1.32$ Cohen's $d = .07$ Mean (SD): Yes: 22.17 (9.68) No: 21.43 (10.30)
Fear of COVID	$t(1281) = 3.09^{**}$ Cohen's $d = .17$ Mean (SD): F = 17.88 (6.62) M = 16.76 (6.34)	$F(2, 1283) = 1.78$ $\eta_p^2 = .00$ Mean (SD): BSL = 18.02 (6.48) SL = 17.52 (6.76) UL = 16.98 (6.25)	$t(1284) = -0.12$ Cohen's $d = .01$ Mean (SD): Yes: 17.39 (6.31) No: 17.32 (6.54)	$t(1284) = 0.01$ Cohen's $d = .00$ Mean (SD): Yes: 17.33 (6.46) No: 17.33 (6.55)	$t(1284) = -2.63$ Cohen's $d = .33$ Mean (SD): Yes: 19.38 (6.24) No: 17.22 (6.51)	$t(1284) = 0.31$ Cohen's $d = .02$ Mean (SD): Yes: 17.20 (6.59) No: 17.36 (6.50)	$t(1284) = -1.09$ Cohen's $d = .06$ Mean (SD): Yes: 17.54 (6.41) No: 17.14 (6.60)

Note. $^{**}p < .007$, $^{***}p < .001$; F – female; M – male; BSL – below secondary education level; SL – secondary education level; UL – university education level; the same letters next to mean and standard deviation values indicate significant differences at $p < .05$ (post-hoc Tukey test for unequal samples); due to the small sample ($n = 3$) of participants who indicated a gender other than male or female, their data were excluded from the gender comparisons.

Relating to the level of education, only in the case of conspiracy beliefs, participants with university education demonstrated a lower level of belief that the SARS-CoV-2 virus was human-made than participants with secondary and below-secondary education.

Personal experiences related to the pandemic were almost unrelated to the measured psychological variables. Participants whose relatives had suffered from COVID-19 were less likely to believe that COVID-19 was a hoax than participants whose relatives had not suffered from COVID-19. Also, participants whose relatives had died of COVID-19 had a lower tendency to believe that COVID-19 was a hoax than participants whose relatives had not died of COVID-19. Other relationships between the studied variables were non-significant.

The older the participants, the higher their fear of COVID ($r = .40, p < .001$), containment-related behavior ($r = .40, p < .001$) and scientific worldview ($r = .25, p < .001$). The age of the participants correlated negatively with the beliefs that COVID-19 was a hoax ($r = -.35, p < .001$) and that SARS-CoV-2 was human made ($r = -.16, p < .001$). There was no significant association between age and self-centered prepping behavior ($r = -.015, p = .590$).

CORRELATIONS BETWEEN THE STUDIED VARIABLES

Correlation analyses were conducted to evaluate the relationships between the studied variables. The

results of these analyses are presented in Table 2. Since each variable was correlated with six other variables, a Bonferroni correction was applied. *P*-values were considered significant if they were below $.050 / 6 = .008$.

Following Hypothesis 1, the scientific worldview correlated negatively with conspiratorial beliefs that COVID-19 was a hoax and that SARS-CoV-2 was human-made. The collected data confirmed also Hypotheses 2 and 4 that the scientific worldview correlated positively with fear of COVID as well as the attitudes towards COVID-19 vaccines. Hypothesis 3 was confirmed partially; the scientific worldview was positively correlated with containment-related behavior but was not associated with self-centered prepping behavior.

STRUCTURAL MODEL OF RELATIONSHIPS BETWEEN STUDIED VARIABLES

One of the aims of the study was to test the structural model of the relationship between the studied variables. This model was constructed as described in the *Aims of the study and research hypotheses* section, but the results presented so far relating to demographic variables and correlations between psychological variables were also taken into account. The age of the participants was related to most of the variables studied; therefore, it was included as an additional exogenous variable. The fear of COVID and conspiratorial beliefs about the pandemic were correlated,

Table 2

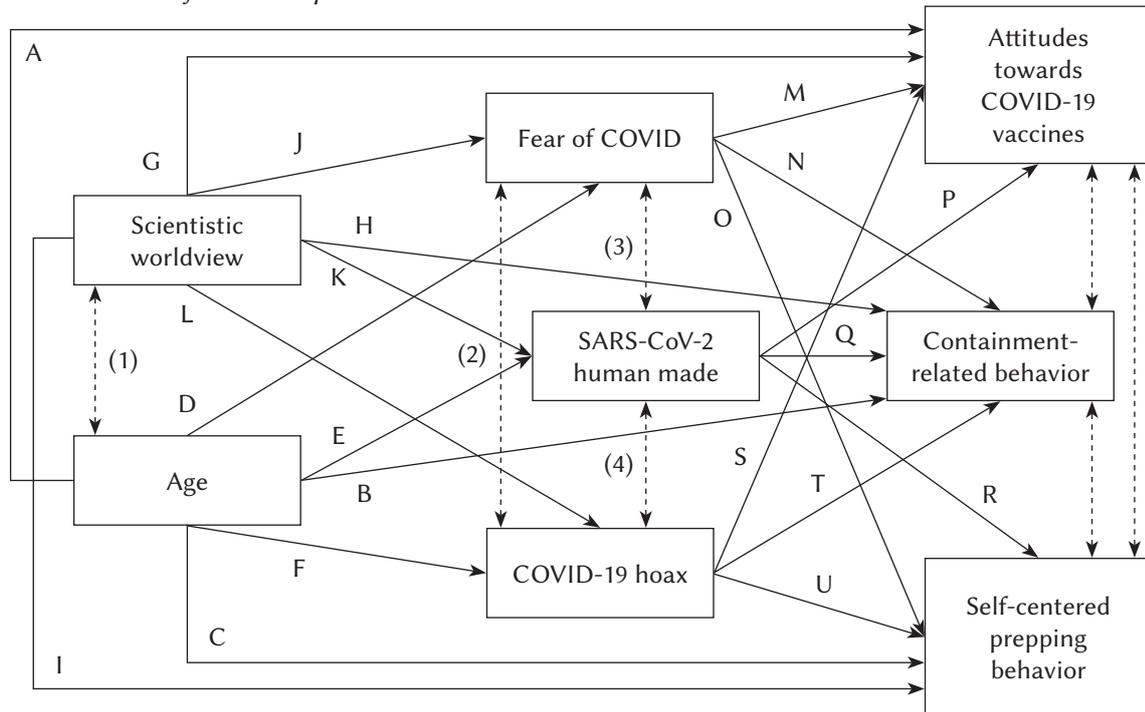
Pearson's r correlation coefficients of the studied variables

	COVID-19 hoax	SARS-CoV-2 human- made	Contain- ment-related behavior	Self-centered prepping behavior	Attitudes towards the COVID-19 vaccines	Fear of COVID
Scientific worldview	-.40***	-.32***	.37***	.02	.45***	.35***
COVID-19 hoax		.59***	-.61***	.10***	-.74***	-.49***
SARS-CoV-2 human-made			-.30***	.13***	-.48***	-.16***
Containment- related behavior				.02	.58***	.60***
Self-centered prepping behavior					-.04	.16***
Attitudes towards the COVID-19 vaccines						.55***

Note. *** $p < .001$.

Figure 1

Structural model of relationship between variables studied



Note. The letters next to the arrows refer to the direct effects shown in Table 3.

which was also included in the model. As male and female participants differed in some of the variables, a measurement invariance analysis across gender was performed. As the groups distinguished by the level of education and personal experiences with the COVID-19 pandemic did not differ in terms of most studied variables, the level of education and personal experiences with COVID-19 were not included in the path analyses.

The analyzed structural model is presented in Figure 1. Due to its complexity, each path is marked with a different letter for greater clarity. Different numbers in parentheses indicate covariances.

In the full sample of respondents, the model had satisfactory fit indices: $\chi^2/df = 4.37$; GFI = .997; PGFI = .961; CFI = .997; TLI = .976; RMSEA = .051 (90% CI [.025, .081]); SRMR = .009. To test configural invariance, model fit analyses were performed separately in groups of female and male participants. In both cases the model fit indices were satisfactory – for the sample of female participants: $\chi^2/df = 2.57$; GFI = .996; PGFI = .957; CFI = .998; TLI = .978; RMSEA = .049 (90% CI [.000, .092]); SRMR = .008, and for the sample of male participants: $\chi^2/df = 4.16$; GFI = .994; PGFI = .924; CFI = .995; TLI = .954; RMSEA = .071 (90% CI [.034, .115]); SRMR = .012. The obtained results support the assumption about the configural invariance across the groups distinguished by gender.

To test metric invariance, the factor loadings were constrained to be equal across the groups dis-

tinguished by gender. The criteria for supporting the assumption of metric invariance were $\Delta CFI \leq -.010$, $\Delta RMSEA < .015$ and $\Delta MFI < -.020$ compared to the unconstrained model (Chen, 2007; Cheung & Rensvold, 2002). The fit indices of the unconstrained model were as follows: CFI = .996, RMSEA = .061, and MFI = .994. The fit of the model with constrained factor loadings were: CFI = .994, RMSEA = .037, and MFI = .991. The obtained results partially support the assumption of metric invariance: ΔCFI was less than $-.010$ and ΔMFI was less than $-.020$, but $\Delta RMSEA$ was greater than .015.

For scalar invariance, the factor loadings and means of the items were constrained to be equal. The criteria for supporting the assumption of scalar invariance were $\Delta CFI \leq -.010$, $\Delta RMSEA < .015$ and $\Delta MFI < -.020$ compared to the model with constrained factor loadings. The fit indices of the model with constrained factor loadings and means were the same as in the case of the model with constrained factor loadings: CFI = .994, RMSEA = .037, and MFI = .991. These results support the assumption about the scalar invariance across the groups distinguished by gender.

Detailed information on the direct and indirect effects as well as the proportion of the explained variances in the full sample is presented in Table 3. Confidence intervals were established by the bootstrapping method with 10,000 samples.

Almost all of the effects included in the model were significant, excluding a few effects related to

Table 3

Direct and indirect effects in the structural equation model

Effect mark	Direct effects	<i>b</i>	<i>SE</i>	<i>b</i> : 95% CI	β	<i>p</i>
G	Scientistic worldview → Attitudes towards COVID-19 vaccines	.10	.02	[.06, .14]	.12	< .001
H	Scientistic worldview → Containment-related behavior	.05	.02	[.02, .09]	.07	.003
I	Scientistic worldview → Self-centered prepping behavior	.01	.01	[-.01, .03]	.03	.225
J	Scientistic worldview → Fear of COVID	.15	.01	[.12, .18]	.27	< .001
L	Scientistic worldview → COVID-19 hoax	-.16	.01	[-.19, -.14]	-.34	< .001
K	Scientistic worldview → SARS-CoV-2 human-made	-.12	.01	[-.14, -.10]	-.30	< .001
A	Age → Attitudes towards COVID-19 vaccines	.08	.01	[.06, .11]	.14	< .001
E	Age → Containment-related behavior	.06	.01	[.03, .09]	.10	< .001
C	Age → Self-centered prepping behavior	-.01	.01	[-.03, .00]	-.06	.065
D	Age → Fear of COVID	.13	.01	[.11, .15]	.33	< .001
F	Age → COVID-19 hoax	-.09	.01	[-.11, -.08]	-.27	< .001
E	Age → SARS-CoV-2 human-made	-.03	.01	[-.04, -.01]	-.09	< .001
M	Fear of COVID → Attitudes towards COVID-19 vaccines	.30	.04	[.23, .38]	.20	< .001
N	Fear of COVID → Containment-related behavior	.50	.04	[.43, .57]	.35	< .001
O	Fear of COVID → Self-centered prepping behavior	.16	.02	[.12, .21]	.27	< .001
S	COVID-19 hoax → Attitudes towards COVID-19 vaccines	-.87	.05	[-.97, -.76]	-.49	< .001
T	COVID-19 hoax → Containment-related behavior	-.66	.05	[-.76, -.57]	-.40	< .001
U	COVID-19 hoax → Self-centered prepping behavior	.13	.03	[.08, .18]	.18	< .001
P	SARS-CoV-2 human-made → Attitudes towards COVID-19 vaccines	-.22	.05	[-.33, -.12]	-.10	< .001
Q	SARS-CoV-2 human-made → Containment-related behavior	.06	.05	[-.05, .17]	.03	.281
R	SARS-CoV-2 human-made → Self-centered prepping behavior	.06	.03	[.01, .11]	.07	.017
Indirect effects		<i>b</i>	<i>SE</i>	<i>b</i> : 95% CI	β	<i>p</i>
Scientistic worldview → Fear of COVID → Attitudes towards COVID-19 vaccines		.05	.01	[.03, .06]	.05	< .001
Scientistic worldview → COVID-19 hoax → Attitudes towards COVID-19 vaccines		.14	.02	[.11, .17]	.16	< .001
Scientistic worldview → SARS-CoV-2 human-made → Attitudes towards COVID-19 vaccines		.03	.01	[.01, .04]	.03	< .001
Scientistic worldview → Fear of COVID → Containment-related behavior		.08	.01	[.06, .09]	.09	< .001

(Table 3 continues)

Table 3

Table 3 continued

Indirect effects	<i>b</i>	<i>SE</i>	<i>b</i> : 95% CI	β	<i>p</i>
Scientific worldview → COVID-19 hoax → Containment-related behavior	.11	.01	[.09, .13]	.13	< .001
Scientific worldview → SARS-CoV-2 human-made → Containment-related behavior	-.01	.01	[-.02, .01]	-.01	.289
Scientific worldview → Fear of COVID → Self-centered prepping behavior	.02	.00	[.02, .03]	.07	< .001
Scientific worldview → COVID-19 hoax → Self-centered prepping behavior	-.02	.00	[-.03, -.01]	-.06	< .001
Scientific worldview → SARS-CoV-2 human-made → Self-centered prepping behavior	-.01	.00	[-.01, .00]	-.02	.033
Age → Fear of COVID → Attitudes towards COVID-19 vaccines	.04	.01	[.03, .05]	.07	< .001
Age → COVID-19 hoax → Attitudes towards COVID-19 vaccines	.08	.01	[.06, .10]	.13	< .001
Age → SARS-CoV-2 human-made → Attitudes towards COVID-19 vaccines	.01	.00	[.00, .01]	.01	.008
Age → Fear of COVID → Containment-related behavior	.07	.01	[.05, .08]	.12	< .001
Age → COVID-19 hoax → Containment-related behavior	.06	.01	[.05, .08]	.11	< .001
Age → SARS-CoV-2 human-made → Containment-related behavior	.00	.00	[-.01, .00]	.00	.329
Age → Fear of COVID → Self-centered prepping behavior	.02	.00	[.02, .03]	.09	< .001
Age → COVID-19 hoax → Self-centered prepping behavior	-.01	.00	[-.02, -.01]	-.05	< .001
Age → SARS-CoV-2 human-made → Self-centered prepping behavior	.00	.00	[.00, .00]	-.01	.062
Total indirect effects	<i>b</i>	<i>SE</i>	<i>b</i>: 95% CI	β	<i>p</i>
Scientific worldview → Attitudes towards COVID-19 vaccines	.21	.02	[.18, .25]	.25	< .001
Scientific worldview → Containment-related behavior	.18	.02	[.15, .21]	.22	< .001
Scientific worldview → Self-centered prepping behavior	.00	.01	[-.01, .01]	-.01	.508
Age → Attitudes towards COVID-19 vaccines	.13	.01	[.11, .15]	.21	< .001
Age → Containment-related behavior	.13	.01	[.11, .15]	.22	< .001
Age → Self-centered prepping behavior	.00	.01	[-.01, .01]	-.01	.508
Total effects	<i>b</i>	<i>SE</i>	<i>b</i>: 95% CI	β	<i>p</i>
Scientific worldview → Attitudes towards COVID-19 vaccines	.31	.02	[.27, .35]	.36	< .001
Scientific worldview → Containment-related behavior	.23	.02	[.19, .28]	.29	< .001
Scientific worldview → Self-centered prepping behavior	.01	.01	[-.01, .03]	.02	.388
Age → Attitudes towards COVID-19 vaccines	.21	.02	[.18, .24]	.34	< .001
Age → Containment-related behavior	.19	.02	[.16, .22]	.32	< .001
Age → Self-centered prepping behavior	-.01	.01	[-.02, .01]	-.02	.458

(Table 3 continues)

Table 3*Table 3 continued*

<i>R</i> ² values for endogenous variables	All participants	Male participants	Female participants
Attitudes towards COVID-19 vaccines	.63	.64	.62
Containment-related behavior	.51	.51	.53
Self-centered prepping behavior	.07	.10	.09
Fear of COVID	.23	.27	.22
COVID-19 hoax	.23	.25	.21
SARS-CoV-2 human-made	.11	.13	.10

self-centered prepping behavior. Both scientific behavior and age had significant total, direct and indirect effects on containment-related behavior and attitudes towards COVID-19 vaccines. However, the total effects of the scientific worldview and age on self-centered prepping behavior were insignificant.

The model turned out to be very effective in explaining the variances of attitudes towards vaccines and containment-related behavior, regardless of the gender of participants. It also explained the considerable proportion of the variances of fear of COVID and the belief that COVID-19 was a hoax. However, regarding self-centered prepping behavior and the belief that SARS-CoV-2 was human-made, the effectiveness of the model was lower.

DISCUSSION

Studies conducted so far have shown that a higher level of trust in science is associated with a lower tendency towards conspiracy beliefs, a higher level of compliance with preventive recommendations, and a higher level of acceptance of vaccination against COVID-19 (Freeman et al., 2020; Murphy et al., 2021; Pivetti et al., 2021; Plohl & Musil, 2021). However, attitudes towards science and trust in science may be grounded in more general views of the world (Dagnall et al., 2019; Farias et al., 2013). The construct referring to the worldview aspects of positive attitudes towards science was described as the scientific worldview (Jach, 2019, 2021). This kind of worldview is related to high trust in the scientific method, perceiving scientists as the only experts, recognizing science as a path to a better future for humanity, and considering science a reliable tool of practical influence (Jach, 2019, 2021).

The aim of the study was to test the links between the scientific worldview and conspiratorial beliefs about the COVID-19 pandemic, the fear of COVID, pandemic-related preventive behavior, and attitudes

towards COVID-19 vaccines. The results supported most of the hypotheses put forward. However, the analyses related to the structural model enabled a more advanced interpretation of the relationships between the studied variables, clearly broadening the conclusions drawn from the correlation analysis. It should also be noted that most of the studied variables did not show any relationship with gender, level of education, or personal experiences related to the COVID-19 pandemic. Among demographic variables, only age turned out to be significantly correlated with most psychological variables; therefore, it was included in the structural model as an exogenous variable. However, due to the relatively large number of gender differences in the levels of the studied variables, in the case of the structural model, a multigroup invariance analysis was performed according to the gender criterion. The obtained results generally supported assumptions about configural, metric and scalar invariance, which allows the relations between the constructs included in the model to be considered as identical between male and female gender.

In line with Hypothesis 1, the scientific worldview negatively correlated with conspiratorial beliefs that COVID-19 was a hoax and that SARS-CoV-2 was human-made. These results suggest that highly positive (or even quasi-religious; see Lessl, 1996) perceptions of the scientific system may have been a protective factor against the adoption of conspiracy concepts about the COVID-19 pandemic.

Consistently with Hypothesis 2, a positive link between the scientific worldview and the fear of COVID was observed. Similar results were obtained by Plohl and Musil (2021), where trust in science was associated with higher ratings of risk related to COVID-19. This result can be related to the fact that the coronavirus threat, the current situation, and future predictions were often presented in mainstream media in a scientific context (Anwar et al., 2020). From a different perspective, according to Farias et al. (2013), in situations perceived as dangerous, people

may lean towards faith in science and its capability of reducing anxiety.

The obtained results confirmed Hypothesis 3 only partially: the scientific worldview correlated positively with containment-related behavior but did not significantly correlate with self-centered prepping behavior. Research conducted so far has shown that trust in science is positively associated with adherence to the recommended containment-related behaviors, such as wearing protective masks or maintaining social distance (Constantinou et al., 2021; Dohle et al., 2020; Pivetti et al., 2021; Plohl & Musil, 2021). Since these recommendations were presented as scientifically validated (Pramesh et al., 2021), they could have been more convincing to those with a higher scientific worldview, who tend to perceive messages embedded in a scientific context as more credible (Jach & Chmiel, 2018). Analyses related to the structural model showed significance of the direct effect of the scientific worldview on containment-related behavior and indirect effects mediated by fear of COVID and conspiracy beliefs about the pandemic. These results suggest that adherence to such preventive behavior may be considered scientifically valid and catalyzed by scientifically motivated concerns about the disease and a lower level of susceptibility to conspiracy theories that negate the need to protect oneself.

Contrary to Hypothesis 3, self-centered prepping behavior did not correlate with the scientific worldview. The total effect of the scientific worldview on self-centered prepping behavior in the structural model was also insignificant. Regarding other relationships, self-centered prepping behavior correlated positively with fear of COVID and conspiracy beliefs about the pandemic but did not correlate with containment-related behavior or attitudes towards vaccination against COVID-19. These results are in line with other studies which showed associations of self-centered prepping behavior with more conspiracy beliefs (Fetterman et al., 2019; Imhoff & Lamberty, 2020), higher COVID-19 threat perception (Imhoff & Lamberty, 2020), and a higher frequency of negative emotions (Smith & Thomas, 2021). The obtained results suggest that self-centered prepping behavior may have different dynamics than other preventive behaviors during the COVID-19 pandemic (see Fetterman et al., 2019). It seems that people choosing self-centered prepping behavior do not negate the risks associated with the pandemic but have a higher level of overall distrust, e.g., towards official descriptions of the causes of the pandemic and recommended preventive measures.

Hypothesis 4, concerning the positive relationship between the scientific worldview and attitudes towards COVID-19 vaccines, was confirmed by the obtained results. Research conducted so far has shown that positive attitudes towards science and a higher

level of perceived credibility in science are linked to supporting vaccination (Hamilton et al., 2015; Hartman et al., 2017) also for COVID-19 (Soveri et al., 2021). In the current study, the scientific worldview was considered as a potential source of this kind of trust and positive attitudes. For people who perceive science as a credible way to explore the world, influence reality, and positively shape the future, taking vaccines supported by the scientific community may be a natural consequence of their worldview. Moreover, the structural model revealed both the direct effect of the scientific worldview on attitudes towards science and indirect effects mediated by fear of COVID and conspiracy beliefs about the COVID-19 pandemic. Other studies have shown that more positive attitudes towards vaccination against COVID-19 are associated with a higher level of fear of COVID (Detoc et al., 2020) and a lower level of conspiracy beliefs (Bertin et al., 2020; Pivetti et al., 2021). Similar results were obtained in the current study, but this time, it was also shown that the effects mentioned above could be embedded in more general worldview aspects related to the perception of the scientific system.

Among the demographic variables, only age significantly correlated with most of the other psychological variables studied. In line with other research findings, age was positively associated with fear of COVID (Pilch et al., 2021) and protective behaviors (Dohle et al., 2020), and negatively with pandemic conspiracy beliefs (Uscinski et al., 2020). Higher age was a risk factor for death in adult COVID-19 patients (e.g., Tehrani et al., 2021). That could motivate older people to protect themselves and get vaccinated. This interpretation is supported by the current study results, where fear of COVID mediated the effects of age on attitudes towards COVID-19 vaccines and containment-related behavior.

In the current study, personal experiences with the COVID-19 pandemic were also taken into account. However, such experiences were almost unrelated to the psychological variables studied. Only participants whose relatives had had COVID-19 or had died from COVID-19 had a lower tendency to believe COVID-19 was a hoax. So far, research results on personal experiences during the COVID-19 pandemic are ambiguous. Ciardi et al. (2021) found that respondents who had had personal experience with someone with COVID-19 were more likely to be vaccinated than respondents without such experience. From a different perspective, Attema et al. (2021) did not observe an impact of personal experience with COVID-19 on beliefs. Similarly, in a study by Sallam et al. (2021) on a large sample of Arab citizens, participants with personal or family member experience of COVID-19 did not differ in the level of willingness to vaccinate against COVID-19 from participants without such experience. Relatively small relationships between personal experiences and attitudes towards

the pandemic would lead to recognizing psychological aspects as more crucial in this regard.

PRACTICAL IMPLICATIONS, STRENGTHS, AND LIMITATIONS

The study was conducted on a large sample of Poles, taking into account participants of different gender, age, and levels of education. The study found that preventive behaviors and attitudes towards vaccination against COVID-19 are weakly related to personal experiences during the pandemic. The measured variables explained a significant part of the variance of such behaviors and attitudes, indicating the importance of psychological factors concerning the aspects related to the pandemic. The obtained results indicate that people may be more inclined towards preventive behaviors and vaccinations when they feel a certain level of fear of this disease. It is also vital to prevent conspiracy beliefs in society because of the negative associations of such beliefs with behaviors and attitudes contributing to global health.

The study also showed that the scientific worldview was associated with a higher level of fear of COVID, containment-related behavior, and attitudes towards the COVID-19 vaccine. These results suggest that in the specific conditions of a pandemic, very affirmative perceptions of science and scientists may be related to greater compliance with prevention recommendations. However, other studies indicate similar effects connected with trust in science (Freeman et al., 2020; Murphy et al., 2021; Pivetti et al., 2021; Plohl & Musil, 2021). All these studies indicate that the development of confidence in science may be crucial for global health. From a different perspective, the need to consider a worldview background of such confidence was mentioned in the studies by Farias et al. (2013) and Hartman et al. (2017). In the current study, attitudes towards science have been analyzed in the context of the scientific worldview construct (Jach, 2019, 2021), understood as a set of beliefs convergent with philosophical scientism (Gasparatou, 2017; Hietanen et al., 2020).

The study also has some limitations. One of them is related to the dynamic nature of the pandemic and the preventive measures taken. The study was conducted among unvaccinated people, at a time when few Poles had had a chance to get vaccinated against COVID-19. Since the study was conducted, many citizens in Poland have been vaccinated, a new vaccine model has become available, and the media have presented new reports on vaccine efficacy and cases of adverse vaccine reactions. The data relating to patients with COVID-19 and deaths from COVID-19 have also changed. Such situational issues that were not considered in this study may influence the pandemic and vaccination attitudes.

Another limitation involved measuring only the scientific worldview without measuring similar variables: the general trust in science (Hendriks et al., 2016), perceived credibility of science (Hartman et al., 2017), scientific literacy, and reasoning (Čavojová et al., 2020; Laugksch, 2000; Motoki et al., 2021) and the tendency towards analytical thinking (Pennycook et al., 2015). Having positive attitudes towards science is not directly related to knowing what science is and how it works (Bauer, 2009; Daniela-Luminița, 2016; Evans & Durant, 1995; Lee & Kim, 2018). Therefore, in future research on the relationship between attitudes towards science and aspects of everyday life, it would be worth considering the broader context of such attitudes. It would be interesting to test whether the role of the scientific worldview is smaller concerning attitudes towards preventive behaviors and vaccination when also taking into account the general level of knowledge about the COVID-19 pandemic (Faase & Newby, 2020).

Similar limitations apply to the study of pandemic conspiracy beliefs. The current study used the categorization proposed by Imhoff and Lamberty (2020), distinguishing beliefs that COVID-19 was a hoax and that SARS-CoV-2 was human-made. However, more systematic research into COVID-19-related conspiracy theories has shown many more such theories (see Constantinou et al., 2021; van Mulukom et al., 2020). Future research on conspiracy beliefs regarding the COVID-19 pandemic should take into account a broader spectrum of such beliefs.

CONCLUSIONS

The study, conducted on a large Polish sample, showed that the scientific worldview was associated with a higher fear of COVID, a higher level of compliance with containment-related recommendations, a lower level of conspiracy beliefs about the COVID-19 pandemic, and more positive attitudes towards vaccination against COVID-19. The results suggest that scientific, very positive attitudes towards science may result in increased adherence to science-based public health recommendations. The study also showed the importance of age, fear of COVID, and conspiracy beliefs related to the COVID-19 pandemic as variables relevant to containment-related behavior, attitudes towards the COVID-19 vaccine, and (to a lesser extent) self-centered prepping behavior.

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SUPPLEMENTARY INFORMATION A

Items from the scale used to measure attitudes towards the COVID-19 vaccine

1. Would you agree to get vaccinated with one of the recently developed vaccines against COVID-19?
2. Would you convince your family members to get vaccinated with one of the recently developed vaccines against COVID-19?
3. Would you dissuade your family members from getting vaccinated with one of the recently developed vaccines against COVID-19?
4. Do you think that a coronavirus vaccine should be mandatory for all citizens of Poland?
5. Do you think that a coronavirus vaccine should be mandatory for certain especially vulnerable citizens of Poland, such as all medical workers or people older than 65?

Items from Imhoff and Lamberty (2020) that were used to measure preventive behavior

Containment-related behavior: items 1, 2, 3, 4, 5, 6, and 13

Self-centered prepping behavior: items 9, 10, 11 and 12

Sample item from the Views of Science Questionnaire (Jach, 2019, 2021)

Item 1: Doubting in the objectivity of science is like doubting the world's existence.

Item 2: Scientists may replace philosophers and priests in their attempts to answer questions that have been puzzling humanity for thousands of years.

Item 10: The discoveries of scientists make us feel less and less anxious about our future.

Item 12: Due to the progress of science, we will soon be able to modify the world according to our needs.

SUPPLEMENTARY INFORMATION B

Descriptive statistics of the studied psychological variables

Quantitative variable	<i>M</i>	<i>SD</i>	Skewness	Kurtosis	Median	Lower quartile	Upper quartile
Attitudes towards COVID-19 vaccines	21.78	10.01	-0.21	-1.28	23	13	31
Fear of COVID	17.33	6.51	0.20	-0.59	17	12	22
Containment-related behavior	37.38	9.41	-1.07	0.64	40	32	44
Self-centered prepping behavior	6.67	3.85	1.82	3.46	5	4	8
COVID-19 hoax	10.20	5.64	0.34	-0.95	10	5	14
SARS-CoV-2 human-made	11.06	4.65	0.19	-0.60	11	8	14
Scientific worldview	53.28	11.64	-0.26	0.36	53	47	61