

This is the peer-reviewed version of the article:

Teovanović, P.; Lukić, P.; Zupan, Z.; Lazić, A.; Ninković, M.; Žeželj, I. Irrational Beliefs Differentially Predict Adherence to Guidelines and Pseudoscientific Practices during the COVID-19 Pandemic. *Applied Cognitive Psychology* 2021, 35 , 486–496. <https://doi.org/10.1002/acp.3770>.



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Irrational Beliefs Differentially Predict Adherence to Guidelines and Pseudoscientific Practices During the COVID-19 Pandemic

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The study design and data collection were approved by the Institutional Review Board of the Department of Psychology, University of Belgrade (Protocol no. #2020-018).

The authors declare that they have no conflicts of interest concerning the authorship or the publication of this article. PT, PL, and ZZ designed the study. IŽ, AL, ZZ, MN, PL, and PT drafted the manuscript. MN, PT, and PL conducted the analyses. All authors revised and approved the manuscript.

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Abstract

In the coronavirus “infodemic”, people are exposed to both official recommendations and to potentially dangerous pseudoscientific advice claimed to protect against COVID-19. We examined whether irrational beliefs predict adherence to COVID-19 guidelines as well as susceptibility to such misinformation. Irrational beliefs were indexed by cognitive intuition, Type I error cognitive biases, COVID-19 knowledge overestimation, and belief in COVID-19 conspiracy theories. Participants ($N=407$) reported (a) how often they followed guidelines (e.g., handwashing), (b) how often they engaged in pseudoscientific practices (e.g., consuming garlic, colloidal silver), and (c) their intention to receive a COVID-19 vaccine. Conspiratorial beliefs consistently predicted all three outcomes. Cognitive intuition and knowledge overestimation predicted lesser, while cognitive biases predicted greater adherence to guidelines. Cognitive intuition and cognitive biases predicted greater use of pseudoscientific practices. Our results highlight the irrational beliefs predictive of COVID-19 related health behaviors, with conspiracy theories proving to be the most detrimental.

Keywords: COVID-19 Health Behavior, Pseudoscience, Conspiracy Theories, Cognitive Biases, Knowledge Overestimation

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With the developing coronavirus pandemic, societies are forced to introduce new measures to curb the infection rate. This means that, among other things, ordinary people are asked to adopt enhanced protective health behaviors, such as social distancing and frequent handwashing. However, along with these official recommendations, people are exposed to medical misinformation and unverified content pertaining to COVID-19, which have proliferated rapidly through social media (Depoux et al., 2020; Kouzy et al., 2020; Mian & Khan, 2020; Zarocostas, 2020). In fact, we are “not just fighting an epidemic; we’re fighting an infodemic. Fake news spreads faster and more easily than this virus, and is just as dangerous” (WHO, 2020). Pseudoscientific recommendations such as consuming garlic, drinking ginger tea or rinsing nose with saline, became so pervasive that the WHO (n.d.) had to officially debunk the claims about their effectiveness. Certain pseudoscientific practices (PSPs) are extremely dangerous – for example, more than 700 Iranians were reported dead of methanol poisoning falsely believing it was a miracle cure for COVID-19 (Associated Press, 2020). Another “victim” of the infodemic is the COVID-19 vaccine, which is still in development. Even amid the pandemic, the topic of vaccination has provoked an online backlash (e.g., Mooney, 2020). Given the grave consequences of vaccination refusal, such as failure to reach herd immunity, it is important to understand why some people might be reluctant to get immunized.

Both adherence to official public health recommendations and the use of PSPs might be embedded in a set of irrational beliefs. We refer to irrational beliefs as an umbrella term that covers beliefs which lack a solid evidence base or defy principles of normative rationality (Žeželj & Lazarević, 2019). In this study, we explored whether people who differ in their predisposition

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to form irrational beliefs also differ in their tendency to follow appropriate preventive measures for COVID-19. More precisely, whether irrational beliefs such as cognitive intuition, susceptibility to type I error cognitive biases, overestimation of one's own COVID-19 knowledge, and belief in COVID-19 conspiracy theories predict adherence to COVID-19 guidelines, use of PSPs, and intention to receive a COVID-19 vaccine if it were available. While cognitive intuition and cognitive biases can be seen as general, content-independent types of irrational beliefs, knowledge overestimation – a miscalibration error resting on a discrepancy between objectively measured and self-estimated knowledge – and belief in conspiracy theories – potential source of false knowledge about a particular subject – are content-laden irrational beliefs pertaining to a specific event or a class of events. The effect of each irrational belief on the chosen health behaviors was examined together with the three other types of irrational beliefs to discern its relative predictiveness.

Cognitive intuition is often assessed with the Cognitive Reflection Test (CRT; Frederick, 2005), which consists of three items that lead most people to answer quickly and incorrectly. Previous research has shown that misleading intuitions predict paranormal beliefs (Pennycook et al., 2012; Ståhl & van Prooijen, 2018) as well as religious beliefs (Pennycook, Fugelsang, & Koehler, 2015; Shenhav et al., 2012). In the health domain, cognitive intuition was related to beliefs about the effectiveness and self-reported use of complementary and alternative treatments both before (Browne et al., 2015; McPhetres & Pennycook, 2019; see also Lindeman, 2011) and during the COVID-19 pandemic (Čavojová et al., 2020; Erceg et al., 2020; Pennycook et al., 2020). However, recent findings on the relation between CRT performance and adherence to official COVID-19 guidelines are mixed – while some found a negative relation (Stanley et al., 2020), others failed to establish any link (Čavojová et al., 2020; Erceg et al., 2020; Pennycook et

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al., 2020; cf. Stanley et al., 2020). We expected that higher cognitive intuition would predict lesser adherence to COVID-19 guidelines (H1a), greater use of PSPs (H1b), and weaker intention to get vaccinated against COVID-19 (H1c).

Cognitive biases, as systematic departures from what is normatively defined rational behavior, can be viewed as yet another broad category of irrational beliefs. Although they have been proven to be predictive of some paranormal (Bressan, 2002; Pennycook et al., 2012; Šrol, 2020; van Prooijen et al., 2017) and pseudoscientific beliefs (Pennycook, Cheyne et al., 2015; Redelmeier & Tversky, 1996; Šrol, 2020), cognitive biases remain underexplored in the domain of both PSPs and adherence to public health guidelines. The list of cognitive biases is considerably heterogeneous and ever evolving (Kahneman & Frederick, 2005; Pohl, 2004; Stanovich, 2009; Teovanović et al., 2015). Therefore, in our study, we opted to include only a subset based on a general tendency to make a type I error, that is, to make false conclusions on relations between unrelated phenomena. These biases included illusory correlation detection, base-rate neglect, gambler's fallacy, and hot-hand fallacy. We expected that a higher susceptibility to such cognitive biases would predict lesser adherence to COVID-19 guidelines (H2a), greater use of PSPs (H2b), and weaker intention to get vaccinated (H2c).

Knowledge overestimation is typically calculated as a difference between self-estimated and objectively estimated knowledge on a certain subject (Ackerman et al., 2002; Harvey, 1997; Kleitman & Stankov, 2001; Kruger & Dunning, 1999; Stankov, 2000). Pennycook and colleagues (2017) showed that intuitive individuals tended to be more overconfident on the CRT, rating themselves as relatively reflective, despite their test scores showing otherwise. Thus, it is their non-reflexivity prevents them from recognizing their ignorance (see also Dunning, 2011; Kruger & Dunning, 1999). Disagreement between self-assessed and objectively assessed

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knowledge has been widely documented in the health domain (for a review, see Dunning et al., 2004), which carries obvious negative implications for people's safety. In this study, we expected that higher levels of COVID-19 related knowledge overestimation would predict lesser adherence to COVID-19 guidelines (H3a), greater use of PSPs (H3b), and weaker intention to get vaccinated (H3c).

The COVID-19 pandemic is a public health crisis and, as such, a fertile ground for *conspiracy theories* (Gonçalves-Sá, 2020; van Prooijen & Douglas, 2017). This aspect of the infodemic might be especially dangerous since medical conspiracy theories have been consistently associated with a range of risky health behaviors including less sunscreen use, not getting annual check-ups or vaccinations, less contraceptive use, and HIV medication non-adherence (e.g., Bogart et al., 2010; Jolley & Douglas, 2014; Oliver & Wood, 2014; Setbon & Raude, 2010; Thorburn & Bogart, 2005). However, recent studies examining the relation between belief in COVID-19 conspiracy theories and self-reported adherence to recommended behaviors have produced inconsistent results. While some found a relation with adherence to health guidelines (Imhoff & Lamberty, 2020; see also Swami & Barron, 2020), others did not (Čavojová et al., 2020; see also Plohl & Musil, 2020). Furthermore, conspiracy theories might be predictive of some, but not other types of recommended protective behaviors – for example, believing in COVID-19 conspiracy theories was related to less social-distancing but unrelated to personal-hygiene behaviors (Pummerer & Sassenberg, 2020). As for pseudoscientific practices, it was shown that people more prone to conspiratorial thinking were more likely to endorse claims related to the effectiveness of complementary and alternative medical treatments in general (Lamberty & Imhoff, 2018; Lobato et al., 2014; Pennycook, Cheyne et al., 2015) and that they reported greater use of PSPs to prevent contracting coronavirus (Čavojová et al., 2020;

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Pummerer & Sassenberg, 2020; see also Imhoff & Lamberty, 2020). Thus, although there is converging evidence suggesting that conspiracy theories are predictive of PSPs, more studies are needed to explore their influence on adherence to COVID-19 guidelines. We expected that stronger beliefs in COVID-19 conspiracy theories would predict lesser adherence to COVID-19 guidelines (H4a), greater use of PSPs (H4b), and a weaker intention to get vaccinated (H4c).

In sum, the present study builds upon emerging research on evidence and non-evidence based COVID-19 related recommendations by examining the predictiveness of different irrational beliefs for COVID-19 related health behaviors in a single design. We will examine if both content-independent (i.e., cognitive intuition and susceptibility to type I error cognitive biases) and content-laden irrational beliefs (i.e., overestimation of one's own COVID-19 knowledge and belief in COVID-19 conspiracy theories) are relevant for adherence to official COVID-19 guidelines, use of PSPs, and intention to receive a COVID-19 vaccine.

Methods

Sample and Procedure

We recruited a total of 754 participants via a snowball procedure and through social networks (Facebook and Viber groups), between April 10 and April 22. The final sample ($N = 407$) included participants who did all of the following: fully completed the questionnaires, accurately responded to all three attention check items, and confirmed that they did not search for information online while completing the questionnaires. The mean age of participants was 34.88 years ($SD = 12.81$). Females were overrepresented in the sample (76.9%), as were participants with higher education: about 0.5% of participants completed elementary school, 42.5% completed high-school, 30.2% completed undergraduate studies, and 26.3% completed graduate studies. The questionnaire was administered in Serbian language.

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This study is a part of a larger project (<https://osf.io/9njp3/>). The full list of measures is available at <https://osf.io/qk9nf/>.

Instruments and Variables

Cognitive Intuition was assessed via the CRT (Frederick, 2005), consisting of three items which cue a fast but incorrect response (we initially tried out three additional tasks, but decided to use the ones in the original version). One example of an item is the following question: “A racket and a ball cost 1100 RSD [Serbian currency] in total. The racket costs 1000 RSD more than the ball. How much does the ball cost?”. Although the correct answer is “50 RSD” approximately 40% of participants answered “100 RSD”. A total score was calculated as a sum of intuitive responses ($\alpha = .63$).

Type I Error Cognitive Biases were measured with six heuristics-and-biases tasks which tap into peoples’ tendency to erroneously recognize relations between unrelated phenomena. They were represented with two covariation detection problems as measures of illusory correlation (Smedslund, 1963), two base rate problems (Tversky & Kahneman, 1974), and two probability judgment tasks measuring hot-hand fallacy (Gilovich et al., 1985) and gambler’s fallacy (Tversky & Kahneman, 1974). We calculated the total score as the average of biased responses across tasks ($\alpha = .52$).

Belief in COVID-19 Conspiracy Theories Scale was developed for the purpose of this study. It consisted of 13 items representing most popular conspiracy theories circulating in digital media and conversations on social networks (e.g., “5G electromagnetic field exposure played a role in the coronavirus pandemic”). Response options ranged from 1 (*Completely Disagree*) to 5 (*Completely Agree*). The scale was highly reliable ($\alpha = .90$). We averaged responses for the 13 items to form a total score.

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COVID-19 Related Knowledge Overestimation represented the difference between standardized scores of subjectively estimated and objectively assessed knowledge. Subjective estimation of knowledge relating to COVID-19 was represented with a single item (“How would you rate your knowledge about the new coronavirus?”) on a scale ranging from 1 (*Insufficient*) to 5 (*Excellent*). Objective knowledge was assessed using a previously developed test (Lep et al., 2020), which consisted of nine true or false statements relating to COVID-19 (e.g., “The coronavirus is transmitted through respiratory droplets”); the total score was summed and ranged between zero and nine.

Adherence to COVID-19 Guidelines was measured with 12 items based on the official WHO and the Serbian Ministry of Health COVID-19 guidelines ($\alpha = .69$). Five items related to newly introduced (e.g., social distancing) or enhanced (e.g., thorough handwashing) health behaviors, in the previous two weeks, rated on a scale ranging from 1 (*Never*) to 5 (*Very Often*). Additional seven items referred to behaviors recommended to be avoided during the outbreak (e.g., visiting other households or attending social gatherings). Participants rated the frequency of these behaviors in the previous two weeks by entering a number. These seven items were multiplied by -1 so that higher scores would always correspond to greater adherence to recommended practices. To convert into a common metric, all item scores were standardized. To handle outliers, z-values above 3.29 were winsorized. A total score was calculated as an average of all 12 items.

Use of PSPs related to COVID-19 was assessed via a 12-item scale created for the purpose of this study ($\alpha = .73$). Five items were based on the list of common myths indicated on the WHO website (WHO, n.d.), while the remaining seven were based on PSPs against COVID-19 commonly reported in digital media outlets. Participants rated how often they used PSPs in

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the previous two weeks as a means to protect themselves against COVID-19 on a scale ranging from 1 (*Never*) to 5 (*Very Often*). We averaged the participants' responses for all 12 items to create a total score.

Vaccination intention was assessed by asking participants to rate their willingness to receive a COVID-19 vaccine if it were available at that time. The scale ranged from 1 (*Definitely would not*) to 5 (*Definitely would*).

Results

The dataset (<https://osf.io/cpe5t/>) and analysis code (<https://osf.io/5rabw/>) are available at the OSF.

Table 1 shows descriptives for health related behaviors during the pandemic. Frequencies regarding adherence to COVID-19 guidelines indicate that 76.7% ($n = 312$) of the participants reported adhering to *at least three out of five* newly introduced or enhanced health behaviors *often* or *very often*. As for behaviors that were recommended to be avoided (e.g., visiting other households), as much as 27.8% ($n = 113$) of participants reported *always* avoiding *all* of them. In terms of use of PSPs, responses were more diverse. While 67.6% ($n = 275$) of participants reported having used *at least one* PSP *often* or *very often*, 11.3% ($n = 46$) had *rarely* or *never* used *any* of the listed PSP. Finally, although 49.1% ($n = 200$) of participants reported they *would definitely or probably* receive a COVID-19 vaccine, a significant percent (26.8%; $n = 109$) of participants stated they *definitely or probably would not*.

Descriptive statistics and bivariate correlations between all measured variables are presented in Table 1. Regarding content-independent beliefs, even though participants did not produce many intuitive responses on the CRT, they showed moderate susceptibility to type I error cognitive biases. As for content-laden irrational beliefs, participants moderately endorsed

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COVID-19 conspiracy theories and only modestly overestimated their knowledge about COVID-19¹. Eight out of twelve zero order correlation coefficients between four types of irrational beliefs and the three health behaviors were statistically significant ($p < .05$), all in the expected direction.

[Table 1 about here]

To further test the hypotheses, that is, to discern the predictive power of a single variable in the set when the effects of others were controlled for, we ran three multiple regression models with adherence, PSPs, and vaccination intention as outcome variables. Cognitive intuition, susceptibility to type I error cognitive biases, Overestimation of COVID-19 knowledge, and belief in COVID-19 conspiracy theories served as predictors (see Table 2).

The model predicting adherence to COVID-19 guidelines had relatively low explanatory power ($F(4,402) = 7.78$, $R^2 = .07$, $p < .001$). As expected, cognitive intuition, overestimation of COVID-19 related knowledge, and belief in COVID-19 conspiracy theories, negatively predicted adherence to COVID-19 guidelines (H1a, H3a, and H4a respectively). Contrary to our hypothesis (H2a), susceptibility to type I error cognitive biases positively predicted Adherence to COVID-19 guidelines.

When it comes to use of PSPs, susceptibility to type I error cognitive biases, overestimation of COVID-19 related knowledge, belief in COVID-19 conspiracy theories significantly contributed to the model, explaining 14% of the variance ($F(4,402) = 16.89$, $R^2 = .14$, $p < .001$). This suggested that those with more biased thinking, knowledge overestimation and beliefs in COVID-19 conspiracy theories were more likely to follow pseudoscientific advice, which is in line with H3b, and H4b, but not with H2b.

¹ Since scores on all variables had a non-normal distribution, we re-ran all the analyses on normalized scores using Blom's transformation. Results of the analyses on normalized scores are detailed at <https://osf.io/8nfz2/>.

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Regarding vaccination intentions, the model explained a substantial amount of the variance, that is, 29% ($F(4,402) = 41.89, R^2 = .29, p < .001$). In line with H4c, belief in COVID-19 conspiracy theories negatively predicted COVID-19 vaccination intentions, suggesting that those endorsing COVID-19 conspiracy theories may be less likely to get vaccinated when a vaccine becomes available. Contrary to our expectations (H2c), we observed that susceptibility to type I error cognitive biases positively contributed to the model, suggesting that those that were more prone to cognitive biases may be more likely to get vaccinated against the virus. To make sure that the inclusion of a vaccine-related conspiracy in the total score (i.e., “One should be careful when a vaccine against coronavirus is developed because no one knows what they will inject in us”) did not artificially increase the predictivity of the model, we conducted a sensitivity analysis omitting this question. This model accounted for 26% of the variance ($F(4,402) = 35.2, p < .001$), corroborating the robustness of the relation between Beliefs in COVID-19 conspiracy theories and COVID-19 vaccination intentions.

Across all regression models, Belief in COVID-19 conspiracies and type I error cognitive biases were the most consistent predictors of health behaviors related to COVID-19.

[Table 2 about here]

To gain more insight about the relations between outcome variables, and to make sure that the significant regression models were not the result of p -value inflation, we conducted a canonical correlation analysis, a multivariate type of the general linear model (Thompson, 2005). The results are presented in Table 3, suggesting that two out of three canonical correlations were significant.

[Table 3 about here]

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The first canonical function reflects the relations between Beliefs in COVID-19 conspiracy theories and, to a much lesser extent, susceptibility to type I error cognitive biases and cognitive intuition, on the one hand, and weaker COVID-19 vaccination intentions and greater use of PSPs, on the other. These results indicate that vaccination hesitancy and use of PSPs have relations with intuitive and biased thinking and belief in conspiracy theories. This component explained more than 10% of the variance across the two sets of variables. Moreover, the proportions of explained variance support the examination of irrational beliefs as predictors of health behaviors.

The second canonical function reflects the relations between a greater susceptibility to type I error cognitive biases and lesser COVID-19 knowledge overestimation, on the one hand, and a higher rate of acceptance of all available preventive practices, on the other. This suggests that following all types of health practices is related to a greater susceptibility to type I error cognitive biases and lesser COVID-19 knowledge overestimation. However, since this component explained only 3% of the variance across the variable sets, this finding should be interpreted with caution.

Discussion

We found that health behaviors related to COVID-19 – adherence to COVID-19 guidelines, use of PSPs, and intentions to get vaccinated against COVID-19 – were all predicted by irrational beliefs to some degree.

Belief in COVID-19 conspiracy theories was the most consistent predictor of each type of health behavior. This is in line with previous findings showing positive relations between conspiratorial thinking and use of PSPs (Čavoјová et al., 2020; Oliver & Wood, 2014), non-adherence to medical or public health recommendations (Imhoff & Lamberty, 2020; Oliver &

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Wood, 2014), and unwillingness to get vaccinated (e.g., Setbon & Raude, 2010). It further strengthens the view of conspiratorial beliefs as a part of “contaminated mindware” (Rizeq et al., 2020; Stanovich et al., 2016) or unwarranted beliefs detrimental to one’s rational thought process, thus influencing decisions that may lead to detrimental health outcomes. In our study, the relation between conspiratorial beliefs and unwillingness to get vaccinated against COVID-19 was particularly strong. Importantly, this relation held even the total score in this model deliberately excluded vaccination conspiracy theory, leaving instead a number of theories about the origin of the virus and political abuse of the health crisis that do not necessarily lead to vaccine refusal. For example, it may be possible that a person believes that the virus was fabricated in a laboratory, but still considers it dangerous and is willing to protect themselves with a vaccine. Our data, however, show that even such beliefs are related to a weaker vaccination intention. This could be due to a more general assumption common to both phenomena: that key information, such as the truth about the harmfulness of vaccines or about the source of pandemic, is hidden from the general public and that one cannot trust official sources (Wood et al., 2012; Lukić et al., 2019).

Other irrational beliefs were also somewhat predictive of the health behaviors. While Type I error cognitive biases were directly related (zero order correlation) only to PSPs, after controlling for other irrational beliefs in the regression analyses, they positively predicted each health behavior. This seemingly surprising finding may be due to the cost asymmetry between false-positive and false-negative errors (Haselton & Buss, 2000) particularly in critical situations such as a global pandemic. More precisely, the cost of a type II error – refraining from preventive practices that may result in an avoidable COVID-19 infection – could be perceived as higher than the cost of a type I error – following ineffective practices. Thus, the susceptibility

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towards type I errors, despite the lower reliability of the measure, was consistently positively associated with opting to uncritically pursue *any* health recommendation.

We also found that, to a lesser degree, those that rely on cognitive intuition and follow their “gut feelings” may be more susceptible to pseudoscientific advice as well as being more relaxed when it comes to following evidence-based recommendations. Finally, those who overestimated their COVID-19 knowledge reported lesser engagement in recommended behavior, but were also somewhat less prone to using PSPs.

Both content-laden and content-independent irrational beliefs were to some degree predictive of COVID-19 health behaviors. Conspiratorial beliefs regarding COVID-19, as a content-laden irrational belief, was most strongly tied to all three types of behaviors; however, susceptibility to type I error cognitive biases also proved to be significant for all three outcomes, after controlling for other predictors. This is important, as the effects of content-independent irrational beliefs may have the potential to be generalized to various types of behaviors, beyond the pandemic. However, the relative power of content-independent beliefs to predict health outcomes, in comparison to content-laden ones, remains to be studied further.

Of note, adherence to COVID-19 guidelines was the most weakly predicted health behavior. A relatively modest predictive power of irrational beliefs on adherence to COVID-19 guidelines might be due to ceiling effects that have likely resulted from lockdown policies and campaigns (e.g., #StayAtHome), both world-wide and locally. This has left people with fewer behavioral choices, particularly with regards to social distancing. On the other hand, engaging in PSPs was optional and may have permitted greater influence of intrinsic dispositions, including irrational beliefs, on health behaviors. Similarly, at the time of data collection, there was no vaccine developed against COVID-19, meaning that no vaccination policies were in place. In

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addition, vaccination was assessed as an intention (as opposed to retrospective self-reporting). This may have led to a greater influence of intrinsic dispositions on the outcome.

Strengths, limitations, and suggestions for future work

Our study adds to the existing literature in several ways. First, we put together a comprehensive battery of irrational beliefs to predict health behaviors, which allowed us to compare their predictive power. Second, we examined different types of health behaviors pertaining to evidence-based and non-evidence-based recommendations related to the COVID-19 pandemic. In addition, the instruments we developed for their assessment proved to be discriminative and reliable. Third, the fact that the data were collected during the peak of the pandemic (Serbia Coronavirus, n.d.) adds to their validity.

Several limitations merit comment. The fact that only behaviors included in official guidelines were assessed, precluded other preventive behaviors, such as wearing masks or gloves. Importantly, the guidelines were supported by lockdown policies, which may have reduced the variability and influence of irrational beliefs on these behaviors. In addition, the health behaviors were self-reported. Future studies could examine observed behaviors (e.g., assessing social distancing using location tracking apps) to increase the confidence attached to the current findings. This study addressed the question of content overlap between predictors (irrational beliefs) and criteria (health behaviors). To further disentangle the differential effects of content-laden and content-independent beliefs, following studies need to include more diverse representatives of both types of beliefs and compare their relative contribution. This may be useful to inform future interventions targeting beliefs – for example, the relative importance of targeting cognitive belief systems versus health communication regarding a particular content.

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Finally, as we mentioned in the results, the scores on the COVID-19 knowledge test were negatively skewed indicating that the test was easy for the participants. This was likely due to heavy media coverage of COVID-19 and that people were continuously learning about the virus. Nonetheless, this and other assessments included in our study revealed meaningful relations between irrational beliefs, namely conspiratorial thinking, and relevant health behaviors during the COVID-19 pandemic.

The rapid proliferation of COVID-19 related misinformation through social media (Depoux et al., 2020; Kouzy et al., 2020; Mian & Khan, 2020; Zarocostas, 2020) may have the potential to substantially impact health outcomes. We propose that future interventions should focus on conspiracy theories, which, in our study, were detrimental for a range of preventive health behaviors. Some of the promising interventions to counter science misinformation and conspiracy theories include presenting people with factual corrections (e.g., Porter et al., 2018; Porter et al., 2019), combining factual corrections with personal/social narratives (Lazić & Žeželj, under review), “inoculating” them by presenting anti-conspiracy information *prior* to conspiracy theories (e.g., Jolley & Douglas, 2017), and exposing misleading argumentation techniques (e.g., Roozenbeek & van der Linden, 2019).

Conclusion

A starting point for social and behavioral sciences to mitigate the effects of global pandemics (Van Bavel et al., 2020) is to understand the psychological underpinnings of health behaviors during the course of the crisis. Our study highlights that people prone to a particular set of irrational beliefs are less likely to follow official COVID-19 guidelines and more likely to engage in PSPs. Once again, and strongly corroborating our hypotheses, conspiracy theories have shown to pose a serious threat to public health – one that demands future attention to

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prevent unfavorable health outcomes and spread of diseases. The pattern of results for cognitive intuition and COVID-19 knowledge overestimation was less robust, but mostly in line with initial expectations. Somewhat unexpectedly, susceptibility to type I error cognitive biases predisposed people to engage in any type of preventive behavior, whether it is evidence-based or not. Together, the findings show that irrational beliefs are an important factor to consider when tailoring behavioral health policies, especially in a global health crisis.

References

- Ackerman, P. L., Beier, M. E., & Bowen, K. R. (2002). What we really know about our abilities and our knowledge. *Personality and Individual Differences*, 33(4), 587–605.
[https://doi.org/10.1016/s0191-8869\(01\)00174-x](https://doi.org/10.1016/s0191-8869(01)00174-x)
- Associated Press. (2020, April 27). *Over 700 Iranians dead from methanol poisoning over false belief the chemical cures COVID-19*. TIME. <https://time.com/5828047/methanol-poisoning-iran/>
- Bogart, L. M., Wagner, G., Galvan, F. H., & Banks, D. (2010). Conspiracy beliefs about HIV are related to antiretroviral treatment nonadherence among African American men with HIV. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 53(5), 648–655.
<https://doi.org/10.1097/qai.0b013e3181c57dbc>
- Bressan, P. (2002). The connection between random sequences, everyday coincidences, and belief in the paranormal. *Applied Cognitive Psychology*, 16(1), 17–34.
<https://doi.org/10.1002/acp.754>
- Browne, M., Thomson, P., Rockloff, M., & Pennycook, G. (2015). Going against the herd: Understanding the psychosocial factors underlying the ‘vaccination confidence gap.’ *PLoS One*, 10(9), e0132562. <https://doi.org/10.1371/journal.pone.0132562>
- Čavojová, V., Šrol, J., & Mikušková, E. B. (2020). *Scientific reasoning as a predictor of health-related beliefs and behaviors in the time of COVID-19*. Retrieved from
<https://doi.org/10.31234/osf.io/tfy5q>
- Depoux, A., Martin, S., Karafillakis, E., Preet, R., Wilder-Smith, A., & Larson, H. (2020). The pandemic of social media panic travels faster than the COVID-19 outbreak. *Journal of Travel Medicine*. <https://doi.org/10.1093/jtm/taaa031>

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- Dunning, D. (2011). The Dunning-Kruger effect: On being ignorant of one's own ignorance. In J. M. Olson & M. P. Zanna (Eds.), *Advances in experimental social psychology. Advances in experimental social psychology* (Vol. 44, pp. 247–296). Academic Press.
<https://doi.org/10.1016/B978-0-12-385522-0.00005-6>
- Dunning, D., Heath, C., & Suls, J. M. (2004). Flawed self-assessment: Implications for health, education, and the workplace. *Psychological Science in the Public Interest*, 5(3), 69–106.
<https://doi.org/10.1111/j.1529-1006.2004.00018.x>
- Erceg, N., Ružojčić, M., & Galić, Z. (2020). *Misbehaving in the corona crisis: The role of anxiety and unfounded beliefs*. Retrieved from <https://doi.org/10.31234/osf.io/cgjw8>
- Frederick, S. (2005). Cognitive reflection and decision making. *The Journal of Economic Perspectives*, 19(4), 25–42. <https://doi.org/10.1257/089533005775196732>
- Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology*, 17(3), 295–314.
[https://doi.org/10.1016/0010-0285\(85\)90010-6](https://doi.org/10.1016/0010-0285(85)90010-6)
- Gonçalves-Sá, J. (2020). In the fight against the new coronavirus outbreak, we must also struggle with human bias. *Nature Medicine*, 26(3), 305–305. <https://doi.org/10.1038/s41591-020-0802-y>
- Harvey, N. (1997). Confidence in judgment. *Trends in Cognitive Sciences*, 1(2), 78–82.
[https://doi.org/10.1016/s1364-6613\(97\)01014-0](https://doi.org/10.1016/s1364-6613(97)01014-0)
- Haselton, M. G., & Buss, D. M. (2000). Error management theory: A new perspective on biases in cross-sex mind reading. *Journal of Personality and Social Psychology*, 78(1), 81–92.
<https://doi.org/10.1037/0022-3514.78.1.81>

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

- Imhoff, R., & Lamberty, P. (2020). *A bioweapon or a hoax? The link between distinct conspiracy beliefs about the Coronavirus disease (COVID-19) outbreak and pandemic behavior*. Retrieved from <https://doi.org/10.31234/osf.io/ye3ma>
- Jolley, D., & Douglas, K. M. (2014). The effects of anti-vaccine conspiracy theories on vaccination intentions. *PLoS ONE*, 9(2), e89177.
<https://doi.org/10.1371/journal.pone.0089177>
- Jolley, D., & Douglas, K. M. (2017). Prevention is better than cure: Addressing anti-vaccine conspiracy theories. *Journal of Applied Social Psychology*, 47(8), 459–469.
<https://doi.org/10.1111/jasp.12453>
- Kahneman, D., & Frederick, S. (2005). A model of heuristic judgment. In K.J. Holyoak, & R.G. Morrison (Eds.), *The Cambridge handbook of thinking and reasoning* (pp. 267–293). Cambridge University Press.
- Kleitman, S., & Stankov, L. (2001). Ecological and person-oriented aspects of metacognitive processes in test-taking. *Applied Cognitive Psychology*, 15(3), 321–341.
<https://doi.org/10.1002/acp.705>
- Kouzy, R., Abi Jaoude, J., Kraitem, A., El Alam, M. B., Karam, B., Adib, E., Zarka, J., Traboulsi, C., Akl, E., & Baddour, K. (2020). Coronavirus goes viral: Quantifying the COVID-19 misinformation epidemic on Twitter. *Cureus*, 12(3), e7255.
<https://doi.org/10.7759/cureus.7255>
- Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121–1134. <https://doi.org/10.1037/0022-3514.77.6.1121>

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

- Lamberty, P., & Imhoff, R. (2018). Powerful pharma and its marginalized alternatives? *Social Psychology*, 49(5), 255–270. <https://doi.org/10.1027/1864-9335/a000347>
- Lazić, A., & Žeželj, I. (under review). Telling stories to counter anti-vaccination conspiracy theories: A review of narrative interventions and implications for public communication. *Social Science and Medicine*.
- Lep, Ž., Ilić, S., Damnjanović, K., & Teovanović, P. (2020). *56 days and counting in the life of Homo pandemicus in Serbia*. Manuscript in preparation.
- Lindeman, M. (2011). Biases in intuitive reasoning and belief in complementary and alternative medicine. *Psychology & Health*, 26(3), 371–382.
<https://doi.org/10.1080/08870440903440707>
- Lobato, E., Mendoza, J., Sims, V., & Chin, M. (2014). Examining the relationship between conspiracy theories, paranormal beliefs, and pseudoscience acceptance among a university population. *Applied Cognitive Psychology*, 28(5), 617–625.
<https://doi.org/10.1002/acp.3042>
- Lukić, P., Žeželj, I., & Stanković, B. (2019). How (ir)rational is it to believe in contradictory conspiracy theories?. *Europe's Journal of Psychology*, 15(1), 94–107.
<https://doi.org/10.5964/ejop.v15i1.1690>
- McPhetres, J., & Pennycook, G. (2019). *Science beliefs, political ideology, and cognitive sophistication*. Retrieved from <https://doi.org/10.31219/osf.io/ad9v7>
- Mian, A., & Khan, S. (2020). Coronavirus: the spread of misinformation. *BMC Medicine*, 18(1).
<https://doi.org/10.1186/s12916-020-01556-3>
- Mooney, T. (2020, April 14). *Anti-vaxxers spread fear about future coronavirus vaccine*. CBS News. <https://www.cbsnews.com/news/anti-vaxxer-fear-coronavirus-vaccine/>

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

Oliver, J. E., & Wood, T. (2014). Medical conspiracy theories and health behaviors in the United States. *JAMA Internal Medicine*, *174*(5), 817.

<https://doi.org/10.1001/jamainternmed.2014.190>

Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., & Fugelsang, J. A. (2015). On the reception and detection of pseudo-profound bullshit. *Judgment and Decision Making*, *10*(6), 549–563. <http://journal.sjdm.org/15/15923a/jdm15923a.pdf>

Pennycook, G., Cheyne, J. A., Seli, P., Koehler, D. J., & Fugelsang, J. A. (2012). Analytic cognitive style predicts religious and paranormal belief. *Cognition*, *123*(3), 335–346. <https://doi.org/10.1016/j.cognition.2012.03.003>

Pennycook, G., Fugelsang, J. A., & Koehler, D. J. (2015). Everyday consequences of analytic thinking. *Current Directions in Psychological Science*, *24*(6), 425–432.

<https://doi.org/10.1177/0963721415604610>

Pennycook, G., McPhetres, J., Bago, B., & Rand, D. G. (2020). *Predictors of attitudes and misperceptions about COVID-19 in Canada, the U.K., and the U.S.A.* Retrieved from

<https://doi.org/10.31234/osf.io/zhjqp>

Pennycook, G., Ross, R. M., Koehler, D. J., & Fugelsang, J. A. (2017). Dunning–Kruger effects in reasoning: Theoretical implications of the failure to recognize incompetence.

Psychonomic Bulletin & Review, *24*(6), 1774–1784. <https://doi.org/10.3758/s13423-017-1242-7>

Plohl, N., & Musil, B. (2020). *Modeling compliance with COVID-19 prevention guidelines: The critical role of trust in science.* Retrieved from <https://doi.org/10.31234/osf.io/6a2cx>

Pohl, R.F. (Ed.). (2004). *Cognitive illusions: A handbook on fallacies and biases in thinking, judgement and memory.* Psychology Press.

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

- Porter, E., Wood, T. J., & Bahador, B. (2019). Can presidential misinformation on climate change be corrected? Evidence from Internet and phone experiments. *Research & Politics*, 6(3). <https://doi.org/10.1177/2053168019864784>
- Porter, E., Wood, T., & Kirby, D. (2018). Sex trafficking, Russian infiltration, birth certificates, and pedophilia: A survey experiment correcting fake news. *Journal of Experimental Political Science*, 5(2), 159–164. <https://doi.org/10.1017/XPS.2017.32>
- Pummerer, L., & Sassenberg, K. (2020). *Conspiracy theories in times of crisis and their societal effects: Case “corona”*. Retrieved from <https://doi.org/10.31234/osf.io/y5grn>
- Redelmeier, D. A., & Tversky, A. (1996). On the belief that arthritis pain is related to the weather. *Proceedings of the National Academy of Sciences*, 93(7), 2895–2896. <https://doi.org/10.1073/pnas.93.7.2895>
- Rizeq, J., Flora, D. B., & Toplak, M. E. (2020). An examination of the underlying dimensional structure of three domains of contaminated mindware: paranormal beliefs, conspiracy beliefs, and anti-science attitudes. *Thinking & Reasoning*, 1-25. <https://doi.org/10.1080/13546783.2020.1759688>
- Roozenbeek, J., & van der Linden, S. (2019). Fake news game confers psychological resistance against online misinformation. *Palgrave Communications*, 5(1), 65. <https://doi.org/10.1057/s41599-019-0279-9>
- Serbia Coronavirus: 10,496 Cases and 228 Deaths*. (n.d.). Worldometer. Retrieved May 17, 2020, from <https://www.worldometers.info/coronavirus/country/serbia/>
- Setbon, M., & Raude, J. (2010). Factors in vaccination intention against the pandemic influenza A/H1N1. *European Journal of Public Health*, 20(5), 490–494. <https://doi.org/10.1093/eurpub/ckq054>

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

- Shenhav, A., Rand, D. G., & Greene, J. D. (2012). Divine intuition: Cognitive style influences belief in God. *Journal of Experimental Psychology: General*, *141*(3), 423–428.
<https://doi.org/10.1037/a0025391>
- Smedslund, J. (1963). The concept of correlation in adults. *Scandinavian Journal of Psychology*, *4*(1), 165–173. <https://doi.org/10.1111/j.1467-9450.1963.tb01324.x>
- Šrol, J. (2020). *Individual differences in epistemically suspect beliefs: The role of susceptibility to cognitive biases*. Retrieved from <https://doi.org/10.31234/osf.io/4jcf7>
- Ståhl, T., & van Prooijen, J. W. (2018). Epistemic rationality: Skepticism toward unfounded beliefs requires sufficient cognitive ability and motivation to be rational. *Personality and Individual Differences*, *122*, 155–163. <https://doi.org/10.1016/j.paid.2017.10.026>
- Stankov, L. (2000). Complexity, metacognition, and fluid intelligence. *Intelligence*, *28*(2), 121–143. [https://doi.org/10.1016/s0160-2896\(99\)00033-1](https://doi.org/10.1016/s0160-2896(99)00033-1)
- Stanley, M., Barr, N., Peters, K., & Seli, P. (2020). *Analytic-thinking predicts hoax beliefs and helping behaviors in response to the COVID-19 pandemic*. Retrieved from <https://doi.org/10.31234/osf.io/m3vth>
- Stanovich, K.E. (2009). Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory. In K. Frankish, & J. St. B.T. Evans (Eds.), *In two minds: Dual processes and beyond* (pp. 55–88). Oxford University Press.
- Stanovich, K. E., West, R. F., & Toplak, M. E. (2016). *The rationality quotient: Toward a test of rational thinking*. MIT Press.
- Swami, V., & Barron, D. (2020). *Analytic thinking, rejection of coronavirus (COVID-19) conspiracy theories, and compliance with mandated social-distancing: Direct and*

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

indirect relationships in a nationally representative sample of adults in the United Kingdom. Retrieved from <https://doi.org/10.31219/osf.io/nmx9w>

Teovanović, P., Knežević, G., & Stankov, L. (2015). Individual differences in cognitive biases: Evidence against one-factor theory of rationality. *Intelligence, 50*, 75–86.

<https://doi.org/10.1016/j.intell.2015.02.008>

Thompson, B. (2005). Canonical correlation analysis. In B. Everitt & D. C. Howell (Eds.), *Encyclopedia of statistics in behavioral science* (pp. 192–196). John Wiley & Sons.

Thorburn, S., & Bogart, L. M. (2005). Conspiracy beliefs about birth control: Barriers to pregnancy prevention among African Americans of reproductive age. *Health Education & Behavior, 32*, 474–487. <https://doi.org/10.1177/1090198105276220>

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases.

Science, 185(4157), 1124–1131. <https://doi.org/10.1126/science.185.4157.1124>

Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., ... & Willer R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour, 1*–12. <https://doi.org/10.1038/s41562-020-0884-z>

van Prooijen, J. W., & Douglas, K. M. (2017). Conspiracy theories as part of history: The role of societal crisis situations. *Memory Studies, 10*(3), 323–333.

<https://doi.org/10.1177/1750698017701615>

van Prooijen, J.-W., Douglas, K. M., & De Inocencio, C. (2017). Connecting the dots: Illusory pattern perception predicts belief in conspiracies and the supernatural. *European Journal of Social Psychology, 48*(3), 320–335. <https://doi.org/10.1002/ejsp.2331>

IRRATIONAL BELIEFS PREDICT COVID-19 RELATED HEALTH BEHAVIORS

Wood, M. J., Douglas, K. M., & Sutton, R. M. (2012). Dead and alive: Beliefs in contradictory conspiracy theories. *Social Psychological and Personality Science*, 3(6), 767–773.

<https://doi.org/10.1177/1948550611434786>

World Health Organisation. (2020, February 15). *Munich Security Conference*. WHO.

<https://www.who.int/dg/speeches/detail/munich-security-conference>

World Health Organisation. (n.d.). *Coronavirus disease (COVID-19) advice for the public: Myth busters*. [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters)

[public/myth-busters](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters)

Zarocostas, J. (2020). How to fight an infodemic. *The Lancet*, 395(10225), 676.

[https://doi.org/10.1016/s0140-6736\(20\)30461-x](https://doi.org/10.1016/s0140-6736(20)30461-x)

Žeželj, I., & Lazarević, L. B. (2019). Irrational beliefs. *Europe's Journal of Psychology*, 15(1),

1–7. <https://doi.org/10.5964/ejop.v15i1.1903>

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Tables

Table 1

Descriptive Statistics and Correlations

	Min	Max	M	SD	Skewness	Kurtosis	1	2	3	4	5	6
1. Intuitive reasoning (0-1)	0.00	1.00	0.32	0.35	0.65	-0.92						
2. Type 1 cognitive bias (0-1)	0.00	0.83	0.24	0.22	0.70	-0.41	.39***					
3. COVID-19 conspiracy (1-5)	1.00	4.38	2.25	0.79	0.28	-0.87	.28***	.33***				
4. COVID-19 knowledge overestimation	-3.27	6.03	0.00	1.37	0.37	0.89	.04	.05	.08			
5. RHB COVID-19	-1.47	0.62	0.02	0.40	-1.11	1.52	-.14**	.05	-.17*	-.12*		
6. PSP COVID-19 (1-5)	1.00	3.42	1.83	0.52	0.53	-0.20	.20***	.28***	.31**	-.07	.14**	
7. Vaccine COVID-19 (1-5)	1.00	5.00	3.34	1.29	-0.32	-0.96	-.11*	-.09	-.53*	-.07	.33***	-.07

Note: RHB COVID-19 – adherence to recommended health behaviors to prevent COVID-19 infection; PSP COVID-19 – adherence to pseudoscientific preventive practices; Vaccine COVID-19 – willingness to get vaccinated for COVID-19.

Note: SE_{Skewness} = 0.12; SE_{Kurtosis} = 0.24

*** $p < .001$; ** $p < .01$; * $p < .05$

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Table 2

Multiple Regressions for RHB, PSP, and Intentions to Vaccinate

	RHB COVID-19	PSP COVID-19	Vaccine COVID-19
Cognitive intuition	-.16**	.07	.01
Type 1 error cognitive biases	.18**	.18**	.10*
COVID-19 knowledge overestimation	-.11*	-.10*	-.04
COVID-19 related conspiracy beliefs	-.17**	.24***	-.57***
<i>R</i> ² / <i>R</i> ² adjusted	.07 / .06	.14 / .14	.29 / .29

Note: RHB COVID-19 – adherence to recommended health behaviors to prevent COVID-19 infection; Vaccine COVID-19 – willingness to get vaccinated for COVID-19 PSP COVID-19 – adherence to pseudoscientific preventive practices.

****p* < .001; ***p* < .01; **p* < .05;

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Table 3

Results of Canonical Correlation Analysis

Canonical function	<i>R</i>	Wilk's Λ	<i>F</i>	<i>p</i>
1	.60	.58	20.38	< .001
2	.25	.91	6.85	< .001
3	.18	.97		

		Canonical function	
		1	2
Set 1	Cognitive intuition	-.33	.23
	Type 1 cognitive errors	-.34	.81
	COVID-19 knowledge overestimating	-.06	-.49
	COVID-19 conspiracy beliefs	-1.00	-.01
Set 2	RHB COVID-19	.28	.63
	PSP COVID-19	-.53	.80
	Vaccine COVID-19	.88	.40
Variance explained	Set 1 by self	.31	.24
	Set 1 by set 2	.11	.02
	Set 2 by self	.38	.40
	Set 2 by set 1	.14	.03

Note: RHB COVID-19 – adherence to recommended health behaviors to prevent COVID-19 infection; Vaccine COVID-19 – willingness to get vaccinated for COVID-19 PSP COVID-19 – adherence to pseudoscientific preventive practices.