

The impact of conspiracy theories and vaccine knowledge on vaccination intention: a longitudinal study

O impacto de teorias da conspiração e do conhecimento sobre vacinas na intenção de vacinação: um estudo longitudinal

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Abstract *In this study, we analyzed associations between vaccination knowledge, vaccination intention, political ideology, and belief in conspiracy theories before and during the 2020 Sars-Cov-2 pandemic in the Brazilian population. It was conducted a longitudinal study into three data collections. Participants responded to the Flexible Inventory of Conspiracy Suspicions (FICS), questionnaires measuring their knowledge, and opinion about vaccines, and sociodemographic data. The results were: the greater the belief in conspiracy theories about vaccines, the lesser the intention to get vaccinated, the vaccine knowledge, and the attitudes towards vaccine investment. Religious, prone to right-wing politics, parents, and older people scored more for FICS than atheists/agnostics, and younger people. From 2019 to 2020 the vaccination intention and vaccination investment did not differ, showing that people did not change their opinion about vaccines regardless of personal experience or the pandemic scenario. The research strengthened the relevance of health education as a milestone for public health and protection from dangerous conspiracy theories.*

Key words *Conspiracy theories, Vaccine, COVID-19, Vaccination intention*

Resumo *Neste estudo, analisamos associações entre conhecimento sobre vacinação, intenção de vacinação, ideologia política e crença em teorias da conspiração antes e durante a pandemia da Sars-Cov-2 de 2020 na população brasileira. Foi realizado um estudo longitudinal em três coletas de dados. Os participantes responderam ao Inventário Flexível de Suspeitas de Conspiração (FICS), a questionários medindo seu conhecimento e opinião sobre vacinas e dados sociodemográficos. Os resultados obtidos foram: quanto maior a crença em teorias da conspiração sobre vacinas, menor a intenção de se vacinar, o conhecimento da vacina e as atitudes em relação ao investimento em vacinas. Religiosos, propensos à política de direita, pais e idosos pontuaram mais para FICS do que ateus/agnósticos e pessoas mais jovens. De 2019 a 2020, a intenção de vacinação e o investimento em vacinação não diferiram, mostrando que as pessoas não mudaram de opinião sobre as vacinas, independentemente da experiência pessoal ou de um cenário de pandemia. Nossa pesquisa sugere fortalecer a educação em saúde como um marco para a saúde pública e proteção de perigosas teorias da conspiração.*

Palavras-chave *Teorias da conspiração, Vacina, COVID-19, Intenção de vacinação*

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Introduction

Conspiracy theories are implausible alleged theories that key factors are the result of a secret plan led by a group of powerful people¹. The Sars-CoV-2 pandemic gave new impetus to anti-vaccine theories, boosted throughout social media²⁻⁴, especially on the conservative spectrum⁵. The greater the belief in conspiracy theories about the pandemic, the fewer individuals were willing to engage in safety behaviors and vaccination⁶.

A significant part of the population must be immunized to achieve the so-called “herd immunity” for the function of vaccines to be fulfilled, with its threshold subject to each disease⁷. However, in the context of Sars-CoV-2, the collective effectiveness of vaccines has been threatened by skeptical individuals who are part of anti-vaccine movements. This had been made explicit during the Sars-CoV-2 pandemic, in which only half of the European population appeared willing to be immunized against SARS-CoV-2⁸. The fact that the disease appeared in Communist China makes the situation complex in political terms too⁹. Studies have shown a strong association between anti-vaccine conspiracy beliefs and decreased vaccination intentions¹⁰⁻¹². Moreover, they also can reduce parents’ intention to vaccinate their children¹³.

Brazil and other countries are experiencing falling short of the targets for vaccination coverage rates since 2016¹⁴, with some factors influencing such numbers, such as politics, and socioeconomic. Still, there have been an increasing popularity of conspiracy theories in the last few years, which could contribute to this scenario. In 2018, 312 Brazilian cities had vaccination coverage rates against polio below 50%, and around 59% in 2021^{16,17}. Thus, the context of the COVID-19 pandemic was especially conducive to checking the acceptance of vaccination. During the pandemic, conspiracy theories arose about children or the pandemic’s intentional use to mitigate the capitalist economy. This requested studies, and statements from WHO and scientists to fight against misinformation and rumors that only contributed to the prejudice against Chinese people and jeopardized the global scientific collaboration against the virus¹⁸.

Conspiratorial thinking exists across the political spectrum, from Chavez to Trump and Bolsonaro, being more prevalent at the extremes of both the left and the right – despite being greater at the conservative extreme¹⁹⁻²¹. For example, in a recent study in Italy, during the first wave of

Sars-CoV-2, the greater the conservatism, the less favorable the attitude towards vaccination (in general and in the context of Sars-CoV-2)²². In France, the greater the belief in conspiracy theories, the greater the political conservatism, the more negative the attitude towards vaccines, and the greater the support for the use of hydroxychloroquine against COVID-19¹². On the other hand, these findings have also been challenged, with ideological extremity predicting conspiratory thinking only when these beliefs are partisan and the ideology is identity-based^{23,24}.

It is hypothesized that the origin of a conspiracy theory lies in a simpler way to explain complex phenomena¹⁹. Therefore, it is important to investigate if times of crisis and uncertainty, such as a pandemic situation or personal experience (history of vaccine/drug allergy), could be a crucial factor in vaccination intention.

The present study

We consider the present study to be relevant to the Brazilian context for three main reasons: 1) Since 2016, Brazil and other countries are falling short of the targets for vaccination coverage rates¹⁴. 2) Since the SARS-CoV-2 pandemic, Brazil and worldwide experienced an increase in anti-vax movements allied with several conspiracy theories^{12,25,26}. 3) Pandemic strengthened Brazil’s political polarization, which also divided people thinking about secure measures, drugs for treatment, and vaccination^{15,27,28}.

Considering this, it is proposed in 2019 a longitudinal study divided into two data collections that aim to verify if the beliefs in conspiracy theories about vaccines and/or knowledge about vaccines predict the intention of childhood vaccination and public investments in vaccines in the Brazilian context. Vaccination in Brazil is upheld by the National Immunization Program (PNI) and the Unified Health System (*Sistema Único de Saúde* – SUS). In 1988 the Brazilian Constitution said that healthcare is a “duty of the state” and “a right of all citizens”, which is assured by SUS throughout health-related tax expenditures. During our research, the Sars-Cov-2 stroke was given the unique opportunity to reassess people questioned in 2018 and 2019 to answer the psychometric tools used in this study to estimate the relationship between pandemic vaccine adhesion and political spectrum. Differences in a paired analysis before and during the Sars-Cov-2 pandemic can be useful for understanding the ecological impact on psychological decisions. There-

fore, data from three Brazilian samples ($N_{total} = 126 + 234 + 34$) at different periods were assessed to test the dynamic relationship between vaccination knowledge, vaccination intention, and conspiracy theories before and in the face of the 2020 Sars-Cov-2 pandemic. The pandemic scenario is a unique opportunity to compare vaccination intention and conspiracy theories' influence before and after political, economic, and health strategy changes.

In the first study, we made use of a factorial exploratory analysis to test the relationship among conspiracy thinking and associated factors in sample 1, which were reassessed in an also new and factorial confirmatory analysis in sample 2. To measure conspiracy thinking we used the Flexible Inventory of Conspiracy Suspicions (FICS), a questionnaire template from psychology, created by Wood²⁹, and adapted to measure suspicions of a conspiracy around vaccines. Individuals who score high on the FICS scale demonstrate a greater inclination towards conspiratorial thinking, specifically with the subject matter being examined, such as vaccines in this study. However, it is important to note that since the FICS scale has not been validated for use in Brazil, the factorial analysis conducted in Studies 1 and 2 was aimed at establishing the reliability and validity of the instrument for this research. In the second study, we investigated the impact of conspiracy theories on vaccination intention through five hypotheses which were pre-registered at <https://osf.io/3f28w>. For sample 1 and 2 we first hypothesized that 1) beliefs in conspiracy theories regarding vaccines significantly and negatively predict vaccination intention; 2) Knowledge about vaccines significantly and positively predicts vaccination intention; 3) Positive economic opinion about public investments in vaccines significantly and positively predicts vaccination intention; 4) Conspiracy theories about vaccines significantly and negatively predicts positive economic opinion about public investments in vaccines 5) Knowledge about vaccines significantly and positively predicts positive economic opinion about public investments in vaccines. Finally, in the third study making use of the reassessment of sample 2 at the beginning of the pandemic, we hypothesized that 6) we would expect a quadratic relationship between extreme political ideology and conspiracy beliefs and that 7) vaccination intention significantly and positively increased after the SARS-CoV-2 pandemic.

Method

Preregistration

The current study was preregistered at <https://osf.io/ipkea/> with the two surveys registered at: <https://osf.io/3f28w/> (March 2019) and the third and last survey at <https://osf.io/p728a> (August 4, 2020).

Participants

Data collection was conducted using an online questionnaire distributed by the authors through social media (Facebook), in Brazil, targeting all individuals (both men and women) aged 18 years or older. The questionnaire was administered using the Qualtrics platform on three separate occasions. Samples 1 and 2 were taken during the year 2018 and 2019, respectively, and sample 3 was a reassessment of individuals from sample 2 who provided their email for future contact. All participants provided online consent before beginning the questionnaire, according to the resolution of the national health council. The target recruitment for sample 1 (from November 2018 to December 2018) and sample 2 (from December 2018 to March 2019) were between 250 and 300 respondents per sampling site. For Sample 3 (August 2020 to November 2020), and considering testing hypotheses 6 and 7 with $Pr(Y = 1|X = 1) H_0 = 0.2$ for an expected odds of 0.31 and a power $(1 - \beta \text{ err prob}) = 0.80$, given $\alpha = 0.05$, we calculated a total sample size of 48, as indicated by Software G*Power 3.1.9.2 (critical $z = 1.644854$). Data collection ended after the sample size did not increase for two weeks. For a better understanding of the studies' design, see Supplementary Figure 1 (available at: <https://doi.org/10.48331/scielodata.5K4AZC>).

Study 1

Score conspiracy beliefs

For Sample 1, participants first responded to the Flexible Inventory of conspiracy suspicions (FICS)²⁹, which measures beliefs in conspiracy theories, adapted to the Brazilian context according to the International Test Commission. For instance, item 9 "Legitimate questions about ___ are being suppressed by the government, the media, and academia". The complete adapted questionnaire can be found in Portuguese in the supplementary material (available at: <https://doi.org/10.48331/scielodata.5K4AZC>).

Sociodemographic measures

Individuals reported their religion, religiosity (yes or no), economic class, education, school (private or public), region, city, gender, marital status, and age.

Study 2

Vaccination intention

The participants of Sample 2 also first responded to the FICS adapted to the Brazilian context, and then they were assigned to an experimental vignette¹⁰ in which they assumed the role of father/mother of an 8-month-old girl named Sofia, having to decide whether to vaccinate her against a fictional disease called Dysomeria. The responses ranged from 0 (I will certainly not vaccinate) to 6 (I will certainly vaccinate).

Vaccine knowledge

We applied a questionnaire with 10 items measuring general knowledge about vaccines - could mark "true", "false" or "I don't know" (e.g.: "Vaccines do not cause autism"; "Adverse vaccine reactions are exceptions"; "Vaccines prevent many deaths across the world")³⁰. The scale items were created based on the criteria used by Kata (2010) to search for anti-vaccine websites. The search was conducted to understand the most common motivations of these groups.

Knowledge about vaccine calendar

In Brazil, parents must follow the vaccination schemes of PNI to regularize their child's vaccination according to a nationwide mandatory vaccine calendar. Therefore, we also measured the knowledge about vaccines in Brazil by asking about their mandatory calendar to complement the general knowledge about vaccines: "In Brazil, vaccination is mandatory in childhood for which of the diseases below?" (Possibility of answers: "Mandatory," "not mandatory," "I do not know"). For the present study, the responses were dichotomized, and an ordinal logistic regression was conducted.

Sociodemographic measure

Participants were also questioned about their country-region, city, gender, age, religion, religiosity (yes or no), diet (vegan or vegetarian), drug and vaccine allergies, marital status if they have children, economic class, school (private or public), and education level. More questions were applied about their own and children's vaccination status and knowledge of vaccination allergy stories regarding their own and other people.

Public investment in vaccination

The economic opinion was measured by the following answers to the question: "If you could determine the Brazilian federal investments, how would you invest in the National Immunization Programme?". 1 - Certainly, reduce investment; 2 - Maybe reduce investment; 3 - Keep the same current investment; 4 - Maybe raise investment; 5 - Certainly raise investment. Vaccination knowledge was measured by how many correct answers participants provided. They answered if sentences are true, false, or if they do not know. Sentences are based on an earlier paper on vaccination knowledge³⁰.

Political orientation and pandemic impact

For the third survey, we added questions regarding the economic and political orientation on a scale ranging from 1 (far left) to 5 (far right) for four of five questions: 1) "In general, I think of myself as: 1 = left, 2 = center-left, 3 = center, 4 = center-right, 5 = right"; 2) "In general, economically speaking, I think of myself as: 1 = very liberal, 2 = somewhat liberal, 3 = moderate, 4 = somewhat conservative, 5 = very conservative". Importantly, for such issues, we explained that on one hand a conservative view was considered as ideas of a strong intervention of the state, nationalism, developmentalism, and protectionism. On the other hand, liberals were those who thought of a state that must intervene as little as possible in the economy, following ideas of globalization and a free market. Other questions about political views can be found in the supplementary material (available at: <https://doi.org/10.48331/scielodata.5K4AZC>). Here, we explained and considered conservatives as people with more affinity for traditional habits or values (e.g. against the legalization of drugs, abortion, and/or immigrant restriction), while liberals would be prone to progressive public policies, as being in favor of legalization of drugs, abortion, and/or flexible to immigrant policies. The questionnaire for pandemic impact regarding vaccination intention was: 6) "Do you believe that the pandemic scenario of 2020 influenced your opinion about vaccines?"; and 7) "Would you vaccinate your child against Sars-Cov-2?".

Inclusion and exclusion criteria

Respondents were allowed to access the survey to find eligibility if they had agreed with the terms for participation, were at least 18 years old, and answered at least 80% of the questionnaire.

The recruitment script can be found in the Appendix. The exclusion criteria were a) missing, erroneous, or overly consistent responses; b) missing in more than 20% of the answers; c) failing check-tests; and d) being less than 18 years old. Those criteria were the same for all three sampling sites.

The check-tests aimed to verify if the individuals read and understood the full text by the following questions: 1) Does the vaccine mentioned in the text protect against which infection? 2) What causes the disease mentioned in the text?

From 195 individuals recruited in Sample 1, a total of 194 agreed to take part, and 160 (male = 52; female = 108), being at least 18 years old, finished the questionnaire, and passed the check-tests. Sample 2 included 392 individuals recruited a total of 234 (men = 80; women = 154), being at least 18 years old, agreed to participate, completed the questionnaire, and passed the check-tests, which are usually the average sample size of studies about vaccination intention¹⁴. From sample 2, 125 individuals provided their emails for future contact and were invited to answer again the same questionnaire from sample 2 with additional questions regarding current political and pandemic scenarios. Unfortunately, we did not reach the planned sample size of 48 (with an odds ratio of 0.31 (alpha=0.05 two-tailed) and the usual power = 0.80 ($z = -1.9599640$) for the third survey, however, it is considered presenting the results that can be, in the future replicated.

Statistical analyses

The primary goal of this study was to show the relationship between vaccination intention and conspiracy theories and vaccination knowledge. Additionally, it was aimed to analyze the relationship between economic opinion on public investments in vaccination and vaccination intention. To answer hypotheses 1, 2, 3, and 4 we applied Ordinal Logistic Regression models for both vaccine intention and public investments in vaccination as response variables and FICS, vaccine knowledge, and obligatory vaccine calendar (more specific questions about vaccination in Brazil) as explanatory variables. It was analyzed if FICS were negatively associated with vaccination intention, with the vaccination knowledge and vaccination calendar knowledge as more independent variables were expected to be positively associated with vaccination. All statistical tests used an alpha level of 0.05 and models were calculated in the R platform us-

ing *glm* and *polr* functions through ordinal and MASS libraries, respectively for ordinal logistic regressions and *lm* function for linear regression analysis. Economic class, religion, political opinion, profession, and others had non-normal distributions and were compared through Kruskal-Wallis tests. Comparison between health and non-health professionals, religiosity (yes or no), and gender were compared by the Mann-Whitney test. Plots were generated using the packages *ggplot2* and *effects* in the R platform. All protocols for the study were approved and overseen by the institutional review board of the researchers' academic institution. To test hypothesis 6, a Kruskal-Wallis test to compare political opinion and their differences in FICS. Hypothesis 7 was tested by applying the Wilcoxon paired test between FICS from study 2 (pre-pandemic), and study 3 (post-pandemic).

Results

Study 1

For the exploratory factor analysis, it was measured the FICS for 160 Brazilians in Sample 1 throughout polychoric function in the *psych* package. The KMO (0.95) and Barlett's ($p < 0.01$) were significant for exploratory factor analysis, and parallel analysis suggested one as factor and number of components. Descriptive statistics for all Samples' FICS are displayed in Table 1.

Statistical analysis comparing FICS for several group categories found that natal, sex, marital status, school (public or private schools), living in the capital, and economic class were not significantly associated with different FICS. However, educational level, country region, religion, and religiosity had significant differences among them (Supplementary Table 1, available at: <https://doi.org/10.48331/scielodata.5K4AZC>). For instance, individuals with any religiosity presented sig-

Table 1. FICS distribution among studies.

Study	FICS			
	1 st Quartile	Median	Mean	3 rd Quartile
1 (n = 160)	1.176	1.765	2.069	2.426
2 (n = 234)	1.118	1.471	1.947	2.588
3 (n = 34)	1.059	1.324	1.606	1.779

Source: Authors.

nificantly higher scores for FICS than individuals without religiosity (Supplementary Table 1; Mann-Whitney, $p < 0.001$). Curiously, Agnostics and Atheists scored less for FICS, but Protestants scored less than both groups and other religions (Kruskal-test, $p < 0.001$) according to Bonferroni's *post-hoc* (Supplementary Table 2, available at: <https://doi.org/10.48331/scielodata.5K4AZC>). Northeastern of Brazil presented higher scores ($p < 0.001$) even when Center-West and Southeast regions are removed from the analysis ($p < 0.001$). On the other hand, Northeastern of Brazil differed from South in educational level ($p = 0.0156$, $Q^2 = 10.379$), which can explain why such differences were observed. In this sample individuals who completed High School had higher FICS than undergraduate and postgraduate students (Kruskal-Wallis, $p = 0.0047$). Age ($M = 30.38$, $\min = 18$, $\max = 64$), although significant ($p < 0.001$) to predict higher scores for conspiracy, has a low R^2_{adj} of 0.087.

Study 2

Sample 2 is composed of 234 Brazilians to replicate and strengthen the analysis handled in study 1, and test hypotheses 1 to 5. Differently from sample 1, the country region was not associated with alternative FICS. Still, the same results were found in Religion ($p < 0.001$), and religiosity ($p < 0.001$) as variables associated with different FICS (Table 2). Health professionals significantly scored lower for FICS compared with non-health professionals ($p = 0.031$), although no difference was seen when comparing all professional categories available ($p = 0.079$). As for sample 1, economic class, natal, sex, living in the capital, and school, as well as diet, vaccine allergy, and drug allergies did not differ for FICS in sample 2 (Table 2). Curiously, higher FICS were not associated with differences between those completely immunized according to the Brazilian Vaccination Calendar and those who were not, with the same results seen for their children. No association was also seen between FICS and different Marital Statuses. However, parents scored more for FICS than nonparents ($p < 0.001$). It should be highlighted that, although educational levels were not significant for different FICS regarding all categories available, it is possible to observe a decrease in mean FICS as the educational level is increasing (Supplementary Table 3, available at: <https://doi.org/10.48331/scielodata.5K4AZC>).

According to our results, one point for vaccine knowledge has 17.2 times higher odds of

vaccine intention, while FICS has 0.43 times lower odds (Table 3). Calendar Knowledge did not significantly contribute to the model. These results corroborated the hypothesis 1 and 2 that belief in conspiracy theories about vaccines significantly and negatively predicts vaccination intention, and that knowledge about vaccines significantly and positively predicts vaccination intention. The same pattern can be seen for vaccine investment. Here, we saw that vaccine knowledge and knowledge concerning the vaccine calendar is associated with higher odds and a positive economic opinion about public investments, while higher FICS is associated with lower investment (Table 3). When controlled for FICS and mandatory vaccine calendar, one point in vaccine knowledge and Calendar Knowledge indicates 9.16- and 2.14 times higher odds to invest resources in vaccines, respectively.

On the other hand, people scoring positive for FICS have 0.70 times lower odds to invest in vaccines. Therefore, as proposed by hypotheses 4 and 5, while conspiracy theories about vaccines significantly and negatively predict positive economic opinion about public investments in vaccines, the knowledge about vaccines significantly and positively predicts positive economic opinion about public investments in vaccines. Posteriorly, each category for Vaccination intention and FICS were individually tested and reproduced comparable results from the previously ordinal regression models (Supplementary Table 4, available at: <https://doi.org/10.48331/scielodata.5K4AZC>). Finally, as in Sample 1, aging (mean 29.07, $\min 18$, $\max 64$) could positively predict FICS ($R^2_{\text{adjusted}} = 0.02349$, $p = 0.023$) and vaccination intention ($p = 0.00375$), but was not considered for the main analysis as age is not a changeable category that could be used in the future as a strategy to improve vaccination intention.

Ordinal logistic regression between economic opinion about public investments in vaccines significantly and positively predicted vaccination intention ($p < 0.001$), corroborating hypothesis 3 (Table 3).

Study 3

Seventy-two percent of individuals reassessed in 2020 (24/34) considered that the pandemic influence their opinion about vaccination. Individuals who neither support nor disapprove of the current government (4/34; approve = 7, disapprove = 23) scored more for FICS ($\chi^2 = 8.1033$, $df = 2$, $p = .01$) (Table 4). No significant

Table 2. Group comparison for FICS 2019.

Group	Chi-squared	Df	p-value	Test
Religion	37.385	12	< 0.001	Kruskal-Wallis
Economic class	4.3013	5	0.5069	Kruskal-Wallis
Education	9.5715	5	0.0883	Kruskal-Wallis
Region	4.6474	3	0.1995	Kruskal-Wallis
Health professionals	16.796	10	0.0790	Kruskal-Wallis
Marital status	6.3209	4	0.1754	Kruskal-Wallis

	Mean (SD)			p-value	n (Yes/No)
	Wilcoxon	Yes	No		
Religiosity	8034	2.11 (1.030)	1.64 (0.827)	< 0.001	152/82
Natal sex	6990	2.02 (0.985)	1.81(0.982)	0.0903	154/80
Health professional	5662	1.81(0.898)	2.12(1.07)	0.0306	129/105
Vegan/vegetarian	2829	1.63(0.723)	2.00(1.02)	0.1169	34/200
Vaccine allergy	1856	2.07 (1.08)	1.94(0.982)	0.6687	16/218
Drug Allergies	6338	1.91 (0.914)	1.97 (1.030)	0.9114	87/147
Updated vaccine calendar (own)	4900.5	1.92 (0.972)	2.03 (1.030)	0.6488	176/58
Updated vaccine calendar (children)	92.5	2.47 (1.140)	2.87(1.310)	0.3485	50/5
Living in the capital	5515.5	1.91 (0.983)	2.03 (0.997)	0.2760	157/77
Having children	6829.5	2.51 (1.150)	1.77 (0.865)	< 0.001	55/179
Private school	6854	1.96 (0.996)	1.93 (0.980)	0.788	133/101

	Alfa	Beta	R ² _{Adj}	
Age	1.560402	0.013288	0.02192	0.0235 Linear Regression

Df = degrees of freedom.

Source: Authors.

Table 3. Ordinal logistic regression for vaccine investment.

	Exp (Beta)	95%CI ¹	p-value	
Vaccine investment	FICS	0.70	0.52, 0.96	0.024
	Vaccine knowledge	9.16	1.82, 45.8	0.007
	Calendar knowledge	2.14	1.08, 4.31	0.031
Vaccine intention	FICS	0.43	0.26, 0.67	< 0.001
	Vaccine knowledge	17.2	2.48, 143	0.006
	Calendar knowledge	2.42	0.79, 7.27	0.110

¹ CI = confidence interval.

Source: Authors.

Table 4. Statistical analysis comparing FICS among groups of study 3 (n = 34).

	Chi-squared	Df	P-value	Test
Economical opinion	6.2941	4	0.1782	Kruskal-Wallis
Political orientation ¹	6.1244	2	0.0469	Kruskal-Wallis
Progressive opinion (social issues)	5.2724	4	0.2605	Kruskal-Wallis
Current Brazilian government support	8.1033	2	0.0174	Kruskal-Wallis

¹ = individuals with no opinion were excluded, and considering center-left, center-right and center as one (n = 28). Df = degrees of freedom.

Source: Authors.

differences were seen among Economic, Political, and Progressive opinions for FICS (Supplementary Table 4, available at: <https://doi.org/10.48331/scielodata.5K4AZC>), although Far Conservatives in economical opinion scored higher for FICS. Importantly, paired Wilcoxon between Sample

2 and Sample 3 FICS, Vaccination intention, and Vaccination Investment were not significant, showing that people did not change their opinion about vaccines regardless the pandemic scenario

(Table 1 and Supplementary Table 4, available at: <https://doi.org/10.48331/scielodata.5K4AZC>).

Discussion

We live in a politically polarized post-pandemic scenario, in which many people may not be vaccinated against COVID-19 because they believe in conspiracy theories about the disease and the vaccine. The hypothesis (H1 and H2) is that the greater the belief in conspiracy theories, the less is the intention to be vaccinated and the less the knowledge about vaccines has been corroborated. Studies explain that relation is a psychological response associated with the attempt to understand complex processes toward threatening situations^{19,31}. Faced with chaotic and threatening situations, individuals become more predisposed to seek simpler explanations. Such explanations unequivocally show the problem, the solution, and the oppressive and oppressed groups (with which the conspirator tends to identify). Some conspiracy theories put vaccines as techniques used by oppressive groups to control the population, which can encourage believers not to get vaccinated. The effect of conspiracy theories can be even stronger in people with more intuitive thinking (i.e., less analytical) and less educated (they will predictably have less knowledge about how vaccines work)³².

Another predictable consequence of the belief in conspiracy theories is that the more one believes in such theories, the less positive the opinion on public investment in vaccines (H4), and that leads to a lesser intention to vaccinate (H3). Furthermore, the greater the knowledge about the vaccine, the more positive the opinion about public investment in it (H5). Such hypotheses have been corroborated. The literature shows that those prone to conspiracy theories are correlated with lower levels of education and lower levels of income. In general, conspiracy believers were more likely to be male, unmarried, less educated, have a lower income, be unemployed, be a member of an ethnic minority group, and have weaker social networks⁹. Curiously, in both of our studies, studies 1 and 2 it was seen no difference for conspiracy beliefs among these categories, but those related to education in Sample 1. Previous studies on the 2018 Brazilian general election revealed that individuals with higher levels of education played a significant role in electing Bolsonaro, particularly those who had completed high school³³. However, the observed positive

association between educational attainment and voting for the radical candidate may have been confounded by economic well-being, thus biasing the analysis for educational level. Importantly, recent studies demonstrated that conspiracy beliefs, including those supporting chloroquine's use during the pandemic, negatively predicted participants' intentions to be vaccinated against Sars-Cov-2 when such vaccines were already available¹².

It was also hypothesized that the more extreme political ideology, on the left and the right, the greater the belief in conspiracy theories (H6). In fact, in the context of the Sars-CoV-2 pandemic, the politicization of the situation has caused serious problems. In the United States of America, Democrats were more likely to say that they fear being hospitalized due to Sars-CoV-2 than Republicans. Still, Democrats and Republicans differ in their trust in the Center for Disease Control and Prevention²⁷.

Examples of conservative right-wing politicians in Brazil who downplay the pandemic threat and stimulate the use of chloroquine, and discourage social distancing are abundant. For instance, cities with a higher support base for politicians in denial of the Sars-CoV-2 crisis were associated with more cases and deaths³⁴.

Outgroup conspiracies can be fueled when one's social group has been treated unfairly according to their own experiences or to justify a disadvantaged position⁹. This can be found in some speeches from the right wing that their opinion has been disrespected during the previous government within the university, economy, and national press. Then, the positive association between right-wing and conspiracy theories regarding government may be due to previous negative experiences or feelings. Importantly, the situation of threats and crises, as Brazil passed in the last years, can also increase the likelihood of strong group attachment to foster conspiracy beliefs⁹.

In this study we replicated these results, observing higher FICS for the right wing than for the Left or Center ($p = 0.046$). Conspiracy beliefs were already observed in the United States, Netherlands, and studies in Sweden to be most prevalent at the political extreme, as at the far left and right^{9,35}. Different from the United States and the Netherlands, the far-left ideology is more likely to endorse conspiracy theories than those with far-right ideology in Sweden³⁵. Although it was not observed differences between economic and social issues and values considering political ori-

entation, there is evidence for conservatives being more prone to conspiracy theories than liberals, especially for right-wing authoritarianism, characterized by a preference for conventionalism, authoritarian aggression, and authoritarian submission to authorities^{9,36}.

Feelings of powerlessness, uncertainty, unpredictability, and low political trust, like political scandals, diminish trust in government, which in turn results in higher levels of conspiracy beliefs⁹. Here, compared populations before and after the pandemic when no vaccine was already available to test hypothesis 7. Our research showed that vaccination intentions and vaccination investment did not change after the pandemic, which could indicate that how people respond towards times of crisis with conspiracy beliefs could be a matter of previous education than the traumatic experience *per se* (we have samples of higher educated people). This suggests that experiences neither positive nor negative have a major influence on people's beliefs, as we also did not find any significance comparing vaccination intention and vaccine or drug allergies. Probably, the anti-vaccine group sentiments did not increase over time as the origin of such thinking is beyond the experience itself, but in arguments regarding logical or political thinking. Still, Bertin and colleagues (2020)¹² could predict vaccine intention to Sars-CoV even when people scored for other conspiracy beliefs than those associated with vaccines, which strengthens the importance of education to avoid general people misinformation.

Several variables might influence thoughts toward vaccines, as individuals or known someone who experienced side effects (e.g., allergy) of vaccines or even any drug. However, it was not observed any significant difference between those groups. Indeed, the mean for both allergic and non-allergic vaccines was virtually the same (Table 2). It is important to realize that conspiracy theories can change people's attitudes, although it depends on preexisting attitudes and other factors⁹. Here we observed significantly higher scores for FICS in parents than non-parents (2.53 and 1.78, respectively), which increases our concern about the need for educational investments in vaccine knowledge as children are dependent on their parents for vaccination. Notwithstanding, since 2016 PNI is not achieving its goals for vaccination coverage, regardless Brazil is one of the countries that offer the most vaccines free of cost to the population¹⁴.

Limitations of the study and conclusions

Our findings indicate that individuals who identify as religious, non-health professionals, parents, and those who lean towards the right-wing political spectrum tend to score higher values for this conspiracy thinking. The study aimed to analyze the relationship between vaccination intention, conspiracy theories, and vaccination knowledge. The results showed that belief in conspiracy theories negatively predicted positive economic opinion about public investments in vaccines. Knowledge about vaccines significantly and positively predicted positive economic opinion about public investments in vaccines. Vaccination intention did not change after the SARS-CoV-2 pandemic. Additionally, it successfully presented a validation of the use of the FICS tool in Brazil to measure conspiracy theories related to vaccines. Previous studies identified that conspiracy beliefs are most prevalent at the political extreme, which was not replicated by this study. However, we understand that the sample was limited ($n = 39$) and the lack of participants from both political extremes. Our comparison among professionals in health care and non-healthcare also has limitations as most of the sample was gathered within health sciences institutes and psychology. Importantly, from study 2 to its reassessment in study 3, an important part of our sample was lost, implying a high attrition rate. The analysis regarding religion and FICS also cannot reach the incredible plurality of religions that exist in Brazil and abroad, and some afro-religions (e.g., Umbanda) could be over or misrepresented as their structures widely differ from each region in Brazil. Still, educational level comparison among Brazilian regions lacks a similar sample size, with some regions not being represented, limiting our statistical model. Regarding age, although significant statistical results we observed low and different R^2 values in studies 1 and 2, suggesting only a small contribution of age to vaccination intention.

The results demonstrated that the spread of conspiracy theories reduces the intention of childhood vaccination. These theories have negative consequences, such as political extremism and rejection of science (i.e., denial of well-evidenced practices or theories)⁹. Beliefs in conspiracy theories negatively predict the intention of infantile vaccination, as the increase of one point in the FICS average reduces the chance of vaccination intention by 57%. They must be considered,

especially in the context of vaccine-preventable diseases among children and adolescents, which usually depend on their parents to be vaccinated. Therefore, conspiracy theories must be opposed

by health professionals based on scientific evidence and vaccination campaigns that must pay attention to the growing misinformation on the subject.

Collaborations

LH Viscardi: collected data, applied statistical analyses, and wrote the article. F Vilanova: collected data, wrote and reviewed introduction, method and discussion. FC Novaes: writing and reviewing introduction and discussion, abstract writing, adding references and formatting in APA standards. L Michelin: reviewed the article and contributed to the discussion about vaccination and public health. AB Costa: coordinated the research and reviewed the article.

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