



## Article

# Belief in Conspiracy Theories about COVID-19 Vaccines among Brazilians: A National Cross-Sectional Study

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**Abstract:** Background: Vaccine hesitancy is a complex challenge that demands a comprehensive approach, one that not only acknowledges legitimate concerns within communities but also actively confronts misinformation. In this context, this study aimed to investigate the prevalence of belief in conspiracy theories about COVID-19 vaccines among Brazilians, seeking to understand the factors associated with this behavior. Method: Utilizing a national online survey conducted between May and August 2020, with a sample of 4247 participants, we conducted multivariate analysis to identify the independent determinants of this adherence, calculating adjusted prevalence ratios (APRs) and their 95% confidence intervals. Results: It was revealed that 27.7% of participants believed in at least one conspiracy theory. Factors associated with a higher level of adherence included agreement with at least one piece of COVID-19 misinformation on social media (APR: 3.65; 95% CI: 3.07–4.34), lack of difficulty accessing leisure activities during the pandemic (APR: 3.11; 95% CI: 1.85–5.24), age 50 years or older (APR: 1.70; 95% CI: 1.49–1.94), absence of difficulty accessing protective measures (APR: 1.47; 95% CI: 1.26–1.72), use of face masks (APR: 1.62; 95% CI: 1.33–1.97), non-use of at least one traditional media source for information (APR: 1.47; 95% CI: 1.26–1.72), female gender (APR: 1.41; 95% CI: 1.25–1.60), and age between 30 and 49 years (APR: 1.35; 95% CI: 1.19–1.52). Conclusions: Our findings highlight that it is crucial to recognize that vaccine hesitancy is not merely an isolated phenomenon but often rooted in a complex interplay of social, cultural, psychological, and political factors. There is a need for multifaceted strategies to combat vaccine hesitancy, effectively address conspiracy theories, and consider the various factors associated with their prevalence.

**Keywords:** vaccines; vaccine hesitancy; COVID-19; health belief model; conspiracy theories; misinformation; global health

## 1. Introduction

The COVID-19 pandemic has become a phenomenon that influences how people access health-related materials and make decisions about protecting public health, including their choices regarding vaccination. In early 2024, the emergence of new transmissible variants, the inefficacy of control measures, relaxed restrictions, low vaccination rates, and reluctance to complete vaccination schedules led to a dramatic increase in COVID-19 incidence rates in countries like Brazil [1,2].

Public health officials are facing challenges in this scenario, as they must take additional precautions to halt the virus's transmission [1–3]. One of the most effective tactics for mitigating the virus's spread and reducing the severe health consequences of COVID-19 globally has been mass vaccination, which is considered one of the greatest achievements in public health. Vaccines interrupt the virus's spread within the population, reduce the number of people vulnerable to it, break the chain of transmission, and decrease the reproduction rate [4].

Conspiracy theories and misinformation about health pose threats to health literacy and belief systems, significantly impacting adherence to this preventive strategy [5–8].

## 2. Literature Review

Anti-vaccine groups have questioned the efficacy of COVID-19 vaccines, especially in online environments, despite concerted efforts to develop and distribute them swiftly. Consequently, vaccine hesitancy has become a significant obstacle to controlling COVID-19 and other vaccine-preventable diseases. This reluctance to vaccinate is fueled by several factors, including distrust of science and institutions, concerns over safety and side effects, the spread of conspiracy theories—which are amplified by an unprecedented phenomenon of mass misinformation—and cultural and religious considerations [9–12].

This issue is particularly acute in Brazil, a country with more than 200 million people facing numerous challenges, such as political division, unequal access to healthcare, and socioeconomic disparities that may shape attitudes toward immunization. For instance, a study exploring racial disparities revealed that Black men in Brazil were less likely to have received the COVID-19 vaccine [13–16].

Moreover, the 'infodemic' [17,18], characterized by an overload of information, misinformation, and conspiracy theories specifically about COVID-19 and the associated vaccines, has exacerbated the pandemic. Theories range from baseless speculations about vaccine ingredients to allegations of covert population control schemes. This phenomenon is not merely the result of distrust or ignorance; rather, it stems from our culture, influenced by complex interactions among psychological, social, and political factors that significantly affect vaccine acceptance [10,18,19].

More specifically, conspiracy theories are not merely explanations for specific events attributed to conspiracies; they also include unique characteristics that distinguish them from mainstream views because they are improbable or untrue [20]. Additionally, they can express extreme ideologies, explicit viewpoints, certain personality traits, cognitive biases, are widespread in social discourse and communication, and are all infused with psychological or political significance [21].

According to these beliefs, creating false material intended to deceive and confuse the general public is as crucial as the consumption and dissemination of incorrect information. Moreover, these processes are embedded within a broader framework of people's relationships with knowledge, truth, and facts, shaped by underlying epistemological concerns [22,23]. Conspiracy theories that amplify vaccine hesitancy have severe negative impacts on public health. These theories can significantly lower vaccination rates, which are essential for developing herd immunity, by fostering doubt and anxiety.

Additionally, conspiracy theories are not solely supported by members of marginalized groups; they are also prevalent among people from various social strata. These individuals are influenced by factors such as misinformation on social media, distrust in institutions, and past negative interactions of marginalized communities with the healthcare system [24–26].

Consequently, addressing vaccine hesitancy necessitates a multifaceted strategy that actively combats misinformation, recognizes and resolves legitimate community concerns, and promotes open and fact-based communication about the benefits of vaccination. To enhance vaccine acceptance and build trust, it is crucial to involve prominent public figures, healthcare professionals, and community leaders [27,28].

It is vital to note that this research provides an overview of the Brazilian context prior to the start of vaccination campaigns (2020). In Brazil, the first vaccination with the Coronavac vaccine, developed domestically by the Butantan Institute, was administered on 17 February 2021. Understanding the origins of these conspiracy theories and their potential effects on vaccination decisions is critical for individuals and communities.

Therefore, efforts should focus on eradicating misleading information and promoting health literacy, fostering trust in health organizations, and empathetically addressing community issues. Combating COVID-19 entails fighting the virus itself as well as the misinformation and distrust that hinder a successful pandemic response [28–31].

In this context, this study aimed to investigate the prevalence of belief in conspiracy theories about COVID-19 vaccines among Brazilians, seeking to understand the factors associated with such beliefs.

### 3. Materials and Methods

#### 3.1. Study Type and Location

This is an observational and analytical investigation carried out through online data gathering (web survey), exclusively conducted with Brazilians from May to August 2020.

#### 3.2. Sample, Sampling, and Eligibility Criteria

The minimum sample size was determined through simple sample calculation using the G Power software version 3.1.9.7, taking into account the size of the Brazilian adult population, a presumed prevalence rate of the studied phenomenon of 50% (we adopted this value due to the absence of previous studies with this population), a tolerable error of 3%, and a correction for the effect of sample design of 2, as well as a confidence level of 95%. According to the software, the minimum required sample size was calculated to be 4080 participants.

To recruit participants, we aimed to use a snowball sampling procedure adapted to the virtual environment. In this procedure, we recruited 15 adult Brazilian individuals from previous research (referred to here as “seeds”) who were randomly selected, ensuring diversity in terms of location (regions of Brazil), race/ethnicity (white and non-white), age (young, adult, and elderly), and level of education (elementary/high school, undergraduate, and postgraduate) [18,26]. Simultaneously, each participant was asked to recruit other individuals from the same category through their digital social networks, thereby including these subjects in the data collection system. Additionally, we promoted the research via Facebook to ensure that people outside major urban centers were adequately screened [18,26]. Ineligible participants included immigrants residing in the country, individuals under 18 years of age, and those who did not complete more than 50% of the mandatory survey questions.

#### 3.3. Outcome

The outcome of this study was evaluated through a dichotomous variable (yes/no), which consisted of believing in at least one of the conspiracy theories related to COVID-19 vaccines:

1. “Vaccines alter DNA”;
2. “The vaccine can cause other diseases such as autism or autoimmune diseases”;
3. “The COVID-19 vaccine contains implanted chips for people control”;
4. “I do not trust vaccines from ‘ideological countries’ such as China or Cuba (This reference pertains to nations perceived as having governmental systems or foreign policies strongly influenced by a specific ideology, such as communism or socialism).”;
5. “Vaccines cause infertility or affect virility”;

6. "The efficacy and studies disclosed are false".

### 3.4. Instrument and Data Collection

We employed a structured online questionnaire, developed by the authors themselves based on existing scientific literature and validated regarding its content theme [18,26]. The questionnaire covered various thematic sections, with specific and multiple-choice questions addressing each domain based on a comprehensive literature review. These thematic sections included the following: social and demographic information; knowledge and adherence to COVID-19 prevention measures; COVID-19 repercussions, isolation, and social distancing; consumption and source of information about COVID-19; and finally, participants' understanding and perceptions regarding COVID-19 vaccines, including their efficacy, safety, and perceived benefits [26].

Each thematic section comprised specific questions or scales adapted to comprehensively measure the relevant constructs. The questionnaire items were designed to be clear, concise, and culturally sensitive, ensuring relevance and comprehensibility for the Brazilian population. This questionnaire underwent a rigorous validation process by a panel of experts to ensure its reliability and validity. The content validity index (CVI) evaluation involved assessing the content validity index (CVI). The CVI was calculated for each question, and the overall value of the questionnaire was 0.97, indicating strong agreement among experts regarding the relevance and adequacy of the questionnaire items. The CVI reflects the extent to which the questionnaire adequately represents the content domain being measured, considering cultural and linguistic aspects, as well as construct validity [18,26].

### 3.5. Data Analysis

Statistical analyses were performed using IBM SPSS 27.0 software (SPSS Inc., Chicago, IL, USA). Initially, we conducted bivariate analysis, with results expressed in absolute frequencies, and the calculation of percentage frequencies was performed considering the rows of the contingency table. Pearson's chi-square test was used to select the variables to be included in the multivariate model. We adopted a statistical criterion of a  $p$ -value  $< 0.20$ . At this stage, we also calculated crude prevalence ratios (PRs) with their respective 95% confidence intervals (CI) as a measure of the strength of association between outcomes and their predictor variables, given that the prevalence of belief in conspiracy theories about COVID-19 vaccines was  $>10\%$ .

Next, we conducted multivariate modeling to identify factors independently associated with belief in conspiracy theories about COVID-19 vaccines. The regression model chosen was the generalized linear Poisson model with a log-linear link function. Adherence to the Poisson distribution was tested using the Kolmogorov–Smirnov test ( $p$ -value  $> 0.05$ ). Additionally, we checked for overdispersion assumption by observing the similarity between the variance and the mean of the outcome.

To calculate the adjusted prevalence ratios (PRs) and their respective 95% confidence intervals (CIs), we utilized a hybrid method of parameter estimation, robust variance estimator, and Type III analysis to assess model effects. The omnibus test was conducted to examine the hypothesis that the final multivariate model would provide a better explanation of the prevalence of belief in conspiracy theories about COVID-19 vaccines compared to a model including only the intercept, with a statistical significance level of 5% ( $p$ -value  $< 0.05$ ). The Akaike information criterion (AIC), deviance, and log-likelihood parameters served as benchmarks for selecting the most suitable model, with lower parameter values indicating better fit. The significance of the adjusted PRs for variables included in the final model was evaluated using the Wald chi-square test. Variables with a  $p$ -value  $< 0.05$  in the final model were deemed significant.

### 3.6. Ethical and Legal Considerations

This study was conducted following the ethical research rules of Brazil, being approved in the Brazilian context by the Research Ethics Committee (CONEP) under opinion

4,950,793 in 2020, and it followed the Declaration of Helsinki and relevant legislation in each country, including Resolution 466/12. We obtained a consent form online, which all participants signed.

#### 4. Results

Among the 4247 participants in the survey, 1177 (or 27.7%) reported believing in at least one conspiracy theory about COVID-19 vaccinations. The majority of the sample consisted of women (3193; 75.18%), adults over 30 (2688; 63.3%), individuals with a partner (2730; 64.3%), those with higher education (3426; 80.7%), those who practiced a form of religion (2928; 68.9%), those living in homes with six or more rooms (2381; 56.1%), and those living with one to three people (3007; 70.8%).

Regarding attitudes toward the COVID-19 pandemic, most respondents expressed fear about how the pandemic would impact their lives (3873; 91.2%), agreed that lockdowns and social distancing were necessary (4115; 96.9%), and believed at least one false report about the virus (2575; 60.6%).

Concerning the effects of the COVID-19 pandemic, participants reported that they had either not been tested for the virus (6858; 67.3%) or had been admitted to the hospital (4123; 97.1%). A significant number (2444; 57.5%) stated they knew someone with COVID-19. It is crucial to clarify, contrary to a previous statistic that may have caused confusion, that the number of participants who knew someone who passed away from COVID-19 was XXX (15.4%). This correction addresses an issue highlighted by the reviewer.

Most participants (3548; 83.5%) experienced difficulties contacting family members during the pandemic. However, there were no significant issues reported concerning access to employment (2680; 63.1%), leisure activities (4116; 96.9%), protective measures (3598; 84.7%), or necessities (3711; 87.4%).

Individual preventive measures against COVID-19 were adopted by the majority of survey respondents, including hand hygiene (4140; 97.5%), using disinfectants to clean surroundings (3107; 73.2%), and maintaining social distance (3578; 84.3%).

Regarding information sources, most participants reported using healthcare professionals (2225; 52.4%), at least one alternative media source (2952; 69.5%), and at least one conventional media source (3863; 91.0%). However, three-quarters of the sample (3217; 75.7%) indicated that they did not rely on information from friends and relatives (Table 1).

**Table 1.** Characterization and association between sociodemographic variables, belief in conspiracy theories about COVID-19 vaccines, and other related factors.

Variables	Believe in at Least 1 Conspiracy Theory				PR (95%CI)	p-Value	
	Yes (n = 1177)		No (n = 3070)				
	n	%	n	%			
<i>Sociodemographic</i>							
Age group	18–29 years [ref]	305	19.6	1254	80.4	-	<0.001
	30–49 years	584	30.3	1341	69.7	1.55 (1.37–1.75)	
	50+ years	288	37.7	475	62.3	1.93 (1.68–2.21)	
Civil status	Not single	814	29.8	1916	70.2	1.25 (1.12–1.39)	<0.001
	Single [ref]	363	23.9	1154	76.1		
Gender identity	Male [ref]	200	19.5	828	80.5	1.57 (1.37–1.80)	<0.001
	Female	975	30.5	2218	69.5		
Education level	Basic education	160	20.0	641	80.0	0.68 (0.58–0.78)	<0.001
	Higher education [ref]	1013	29.6	2413	70.4		
Religion	Yes	1177	40.2	1751	59.8	-	<0.001
	No [ref]	-	-	1319	100		
Number of rooms in the house	1–5	479	25.7	1387	74.3	0.88 (0.79–0.98)	0.008
	6+ [ref]	698	29.3	1683	70.7		
Number of people living in the house	1–3 [ref]	803	26.7	2204	73.3	1.13 (1.02–1.25)	0.022
	4+	374	30.2	866	69.8		

Table 1. Cont.

Variables		Believe in at Least 1 Conspiracy Theory				PR (95%CI)	p-Value
		Yes (n = 1177)		No (n = 3070)			
		n	%	n	%		
<b>Beliefs about COVID-19 pandemics</b>							
Agree with lockdown or social distancing	Yes [ref]	1155	28.1	2960	71.9	0.59 (0.40–0.87)	0.004
	No	22	16.7	110	83.3		
Agree with local government strategies	Yes [ref]	828	32.2	1747	67.8	0.65 (0.58–0.72)	<0.001
	No	349	20.9	1323	79.1		
Fear of pandemic repercussions in their lives	Yes [ref]	1116	28.8	2757	71.2	0.52 (0.40–0.68)	<0.001
	No	49	15.0	277	85.0		
Believe in at least 1 misinformation content about	Yes	1053	36.0	1872	64.0	3.84 (3.22–4.57)	<0.001
	No [ref]	124	9.4	1198	90.6		
<b>Repercussions of COVID-19 pandemics</b>							
Tested for COVID-19	Yes [ref]	471	33.9	918	66.1	0.73 (0.66–0.80)	<0.001
	No	706	24.7	2152	75.3		
Knowing someone who had COVID-19	Yes [ref]	688	28.2	1756	71.8	0.96 (0.87–1.06)	0.459
	No	489	27.1	1314	72.9		
Knowing someone who has died by COVID-19	Yes [ref]	163	24.7	498	75.3	1.15 (0.99–1.32)	0.056
	No	1014	28.3	2572	71.7		
Was hospitalized due to COVID-19	Yes [ref]	49	39.5	75	60.5	0.69 (0.55–0.87)	0.003
	No	1128	27.4	2995	72.6		
He had restricted access to his family due to the COVID-19 pandemic	Yes [ref]	970	27.3	2578	72.7	1.08 (0.95–1.23)	0.219
	No	207	29.6	492	70.4		
Had restricted access to Essentials supplies (food, water, and/or health services), due to the COVID-19 pandemic	Yes [ref]	194	36.2	342	63.8	0.73 (0.65–0.83)	<0.001
	No	983	26.5	2728	73.5		
Had restricted access to work due to the COVID-19 pandemic	Yes [ref]	518	33.1	1049	66.9	0.74 (0.67–0.82)	<0.001
	No	659	24.6	2021	75.4		
Had restricted access to leisure activities due to the COVID-19 pandemic	Yes [ref]	12	9.2	119	90.8	3.09 (1.80–5.31)	<0.001
	No	1165	28.3	2951	71.7		
Had restricted access to protection measures (alcohol,	Yes [ref]	121	18.6	528	81.4	1.57 (1.33–1.86)	<0.001
	No	1056	29.3	2542	70.7		
<b>Individual protection measures to prevent COVID-19</b>							
Use of face masks	Yes [ref]	1128	27.3	3010	72.7	1.65 (1.33–2.04)	<0.001
	No	49	45.0	60	55.0		
Hands hygiene	Yes [ref]	1144	27.6	2996	72.4	1.12 (0.84–1.49)	0.464
	No	33	30.8	74	69.2		
Use of sanitizers to clean the environment	Yes [ref]	861	27.7	2246	72.3	1.00 (0.90–1.12)	0.996
	No	316	27.7	824	72.3		
Social distancing/quarantine	Yes [ref]	975	27.2	2603	72.8	1.11 (0.98–1.26)	0.118
	No	202	30.2	467	69.8		
<b>Preferred or priority source of information</b>							
Traditional media (TV, radio, or newspaper)	Yes [ref]	997	25.8	2866	74.2	1.82 (1.61–2.05)	<0.001
	No	180	46.9	204	53.1		
Non-traditional media (Whatsapp, social media, or other websites)	Yes	819	27.7	2133	72.3	1.00 (0.90–1.11)	0.947
	No [ref]	358	27.6	937	72.4		
Family and friends	Yes	285	27.7	745	72.3	1.00 (0.89–1.12)	0.971
	No [ref]	892	27.7	2325	72.3		
Health personnel	Yes [ref]	603	27.1	1622	72.9	1.05 (0.95–1.15)	0.349
	No	574	28.4	1448	71.6		

Note: \*: The complete list of disinformation questions can be accessed in a published paper [18]. [Ref]: reference category.

In the bivariate analysis, out of the 28 predictor variables investigated, 21 met the statistical eligibility criterion established for inclusion in the multivariate modeling ( $p$ -value < 0.20). However, the final model included eight variables independently associated with a higher prevalence of the outcome and one adjustment variable (Table 2).

**Table 2.** Factors associated with belief in conspiracy theories related to COVID-19 vaccines.

Variables	$\beta$	aPR	CI95%		$p$ -Value
			Lower	Superior	
Agree with at least 1 fake misinformation content	1.295	3.65	3.07	4.34	<0.001
Not have access difficulties to leisure activities	1.134	3.11	1.85	5.24	<0.001
50+ Years	0.530	1.70	1.49	1.94	<0.001
Use of face masks	0.482	1.62	1.33	1.97	<0.001
Not have access difficulties to protection measures	0.386	1.47	1.26	1.72	<0.001
Not use traditional media (TV, radio, or newspaper)	0.462	1.59	1.41	1.78	<0.001
Female	0.346	1.41	1.25	1.60	<0.001
30-49 years	0.297	1.35	1.19	1.52	<0.001
High education	0.190	1.21	1.05	1.40	0.010

Adjusted by civil status; Deviance: 2531.10; AIC: 4895.16; log-likelihood: -2436.55; Omnibus test:  $[X^2(10) = 460.73; p$ -value < 0.001).

The variables that showed statistically significant association adjusted for marital status included the following: agreeing with at least one case of fake news about COVID-19 (adjusted prevalence ratio (aPR): 3.65; 95% CI: 3.07–4.34), not having difficulties accessing leisure activities during the pandemic (aPR: 3.11; 95% CI: 1.85–5.24), being aged  $\geq 50$  years (aPR: 1.70; 95% CI: 1.49–1.94), not having difficulty accessing protective measures (aPR: 1.47; 95% CI: 1.26–1.72), using face masks (aPR: 1.62; 95% CI: 1.33–1.97), not using at least one traditional media information source (aPR: 1.47; 95% CI: 1.26–1.72), being female (aPR: 1.41; 95% CI: 1.25–1.60), and being aged between 30 and 49 years (aPR: 1.35; 95% CI: 1.19–1.52).

**5. Discussion**

This study examined a sample of 4247 Brazilians to determine whether social, economic, and demographic factors, as well as those related to addressing COVID-19 prior to the start of vaccination, contributed to the belief in conspiracy theories about COVID-19 vaccinations. Surprisingly, about a quarter of the sample admitted to believing in at least one vaccine-related conspiracy theory, shedding light on a concerning situation that, although contextually linked to a period before the start of vaccination, still holds substantial relevance.

Given these results, it is pertinent to consider the intricate and varied environment that contributes to the emergence and spread of these theories. Our research documents persistent dissemination of anti-vaccine discourse, particularly notable on social media platforms. Although this discourse originated in 2004 associated with blogs, it has shown remarkable growth in recent years [32]. This association highlights a significant obstacle for public health communication initiatives, pointing to an inherent relationship between the increase of such material and the widespread distribution of information on the internet. Conspiracy theories may become even more prevalent in this era of broadly distributed digital social networks and shared emotions, posing unimaginable risks to public health. As a result, countries must begin to address these issues at an international level, focusing on how to handle manipulations that make it difficult for people to discern what is true from what is false.

The literature indicates that vaccine conspiracy theories have also influenced people’s intentions to vaccinate against COVID-19 in China [33], corroborating the findings of this study. This seems to be a recurring theme in the Brazilian context, as the study results showed a strong correlation (adjusted prevalence ratio, or aPR) between the acceptance of misinformation about COVID-19 and belief in conspiracy theories. This discovery high-

lights the interconnection between the spread of conspiratorial theories and misinformation, emphasizing how these phenomena are intertwined and can influence people's perceptions and behaviors concerning public health.

According to a study examining conspiracy theories in Brazil, these theories focus on events within the country's social and political reality and refer to power plays influenced by secretive groups controlling events of national importance [34]. Another study conducted in Brazil shows that this scenario is characterized by a strong relationship between individuals and society, intertwined with a clamor for vaccines and the paradoxes and contradictions that arise from hesitating to vaccinate due to political tensions, risk perceptions, a crisis of scientific trust, and polarization that is political, economic, and sociocultural, along with non-adherence to preventive and sanitary measures against COVID-19 [35]. Although this challenge is particularly acute in Brazil, it is a phenomenon also observed in other Latin American and African countries [36].

The discovery of a substantial association between the spread of fake news and adherence to conspiracy theories underscores the crucial need to combat misinformation comprehensively and effectively. This is essential for building trust in public health initiatives such as vaccination. Including topics related to conspiracy theories in the training curricula for health professionals and creating strategies to popularize science among the general public, particularly among groups more prone to consuming health misinformation, are vital tools [8].

During health crises, such as the COVID-19 pandemic, the dissemination of false information and the denial of health realities, including the necessity for vaccination, play a significant role in the successful implementation of preventive measures [37–39]. A hyper-connected population has turned social networks into fertile ground for spreading false information about vaccines, the COVID-19 pandemic, its treatment options, and other "instant miracle cures." This proliferation has severely compromised opinions about vaccine efficacy and trust in health authorities [40]. This dynamic is exacerbated by the speed and reach of digital platforms, where people can become confused and distrustful of each other as incorrect information spreads rapidly. Misinformation about the pandemic and its cures can influence people's actions, potentially harming their health and well-being and complicating efforts to stop the virus's spread and mitigate its effects.

In the context of the COVID-19 pandemic, the infodemic was characterized by an overabundance of information that compromised its quality [41,42]. The situation in Brazil was particularly challenging, with public figures, influencers, politicians, and administrators from both public and private sectors actively disseminating misleading information, fueling distrust and reluctance toward vaccination. This scenario is illustrated by anti-vaccine rhetoric and movements on social networks by public figures [43–46]. It is important to note that the environment in which our data were collected was highly politicized, with governmental initiatives aimed at containing the pandemic and reducing virus transmission being met with strong protests from parts of the population. In this context, there was a notable mistrust of scientific evidence and traditional information sources, accompanied by a growing spread of false information about COVID-19 and vaccines.

For a deeper understanding of the results, analyzing the social and demographic data of the sample is crucial. Considering that the majority of participants possess high levels of education, it is essential to recognize that the information and communication technologies (ICTs) used for data collection in this study may have influenced the composition of the sample, as indicated by previous research [47,48].

In this environment, it is imperative that public health policies be revised to account for rapid technological advancements, including the capabilities of artificial intelligence. Thus, intensifying efforts in digital health is considered beneficial to provide the public with reliable information and to develop strategies to engage the segment of the population that still shows low levels of digital health literacy [49–52].

The association between gender (specifically being female) and a higher likelihood of believing in conspiracy theories about COVID-19 vaccines is noteworthy (adjusted



prevalence ratio (aPR): 1.37). This finding offers a valuable opportunity to explore how gender influences the perception and acceptance of public health messages. The observed phenomenon can be explained by a combination of cultural, social, and communicative elements that impact women's interactions with health information differently from men. Analysis by Gonçalves et al. [36] provided evidence that women in African countries were more likely to delay COVID-19 vaccination, possibly due to misinformation, such as the myth that COVID-19 vaccination could cause infertility [36]. This is supported by a study in Spain, which found that women exhibited more unfavorable attitudes toward vaccination and were more likely than men to either not vaccinate or to remain undecided [53].

Surprisingly, the adjusted prevalence ratio (aPR) for believing in conspiracy theories was 3.03 among individuals who had no difficulty accessing leisure activities during the pandemic. This might suggest that those who maintained largely unchanged lifestyles during the pandemic, perhaps due to financial advantages, could have underestimated the severity of the disease, making them more susceptible to misinformation. A review study by Zhiyuan et al. [54] revealed that disbelief was higher in rural areas than in cities. In connection with our research, certain demographic groups dismissed the need for vaccination or social isolation during the pandemic, as well as the seriousness of the disease, which further promoted the spread of false information supporting conspiratorial ideas.

Another interesting aspect was that "ease of access to preventive measures" influenced belief in conspiracy theories, suggesting that even those who adopted recommended preventive measures could be swayed by conspiracy theories, possibly due to excessive trust in individual protection over vaccination. This again highlights contradictions in thinking, as people believe in vaccination fallacies despite understanding the mechanisms of transmission and the essential precautions for preventing infections.

Age was another key element. Individuals aged 50 and over, as well as those between 30 and 49 years, demonstrated a greater inclination to believe in conspiracy theories compared to younger people. This finding could be explained by varying levels of exposure and attitudes toward vaccination, or it might suggest that aging is linked to decreased receptivity to information [55,56].

The absence of at least one conventional source of media information was also associated with a greater inclination toward conspiracy theories, suggesting that news consumers' perceptions about vaccines can be influenced by how information is presented and interpreted. We do not rule out the possibility that individuals who rely on traditional media might still be influenced by false information originating from social networks, even in the absence of a statistically significant association between the outcome and the pursuit of unverified information via social media and related platforms. The association between the results of our investigation and belief in fake news lends credibility to this hypothesis.

The findings of the study by Jennings et al. [57] emphasize the link between information sources and belief in conspiracy theories, especially in environments where these sources are not well-regulated, such as YouTube. Researchers found that when individuals were exposed to content based on their search histories, they were more likely to support conspiracy theories, demonstrating how recommendation algorithms can enhance the dissemination of false information.

The reliability of information sources is partly attributed to the widespread availability of the internet and the extensive use of social networks, which often serve as the primary source of health-related information for users. This situation increases the likelihood of accepting conspiracy theories and other types of misinformation, further blurring the distinction between true and incorrect information.

Furthermore, the authors emphasize that individuals who believe in conspiracy theories generally do not trust the government because they associate vaccination laws with political beliefs and perceive them as threats to their personal freedom or health. This dynamic can hinder large-scale immunization campaigns and public health interventions, potentially compromising public health outcomes, especially during crises like the COVID-19 pandemic.

These findings underscore the importance of comprehensive and evidence-based strategies to combat misinformation, advance media literacy, and increase trust in scientific and health authorities. To mitigate the harmful effects of misinformation on public health, it is critical to implement effective communication tactics that openly and transparently address people's concerns and uncertainties.

### *5.1. Theoretical and Practical Implications of the Findings*

Our data contribute to a better understanding of how conspiracy theories fit within the framework of public health theories, specifically the Health Belief Model. This research demonstrates how beliefs not grounded in scientific evidence can significantly impact health behaviors, such as vaccine hesitancy, and highlights the need for more sophisticated approaches that consider social psychology and mass phenomena like the infodemic. Studies on informational behavior should address the psychological impacts of fear and uncertainty, the critical analysis of information, and the role that social networks and media sources play in promoting conspiracy theories.

There are clear implications for policymaking. Policymakers should actively combat misinformation through education and collaborations with community leaders and influencers, as well as by developing interventions that address the psychological and physical barriers to vaccination. This requires the use of scientific data and analysis.

### *5.2. Limitations*

This study presents significant limitations that should be considered when interpreting the results. The cross-sectional method used prevents the determination of causal relationships between the variables studied and the adherence to conspiracy theories, allowing only for the identification of associations. This means that while we can observe correlations, it is impossible to assert whether conspiratorial beliefs influenced health behaviors or vice versa. Additionally, the data collection through online surveys may have introduced significant selection bias, likely attracting respondents with greater internet access and digital skills, as well as higher education levels, which may not be representative of the Brazilian population as a whole. Lastly, the study was unable to examine the impact of all potential confounding variables, such as those related to the mental health of the participants, which could influence both vaccine hesitancy and the propensity to believe in conspiracy theories.

## **6. Conclusions**

In this study, we aimed to investigate the complex interaction of factors influencing beliefs in COVID-19 vaccine conspiracy theories before the onset of vaccination. We found that 27.7% of participants reported believing in at least one conspiracy theory about COVID-19 vaccines. Factors associated with a higher prevalence of belief in conspiracy theories on the topic included the following: agreeing with at least one false news item about COVID-19, not experiencing difficulties accessing leisure activities, being over 30 years old, wearing face masks, not facing difficulties accessing protective measures, not using at least one traditional media source (TV, radio, or newspaper), and being female.

Considering these factors, it is important to highlight that with the increase in the spread of false information, tools have been developed to aid in detecting fake news. Additionally, guidelines have been provided regarding where information is disseminated to avoid believing everything that is circulated and to report suspicious information. However, the results of this study indicate fragmented knowledge about COVID-19, prompting us to consider taking a more nuanced approach to understanding the doubts citizens have about the topic. Often, people believe in false information when they do not know or fully understand the subject.

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