Beliefs in misinformation about COVID-19 and dengue in a sample of the Rio de Janeiro State

Creencias en la desinformación sobre COVID-19 y dengue en una muestra del estado de Río de Janeiro

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Recibido: Mayo 16 de 2024
Aceptado: Noviembre 16 de 2024

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Abstract

Given the ongoing dengue epidemic in Rio de Janeiro (RJ) and the prevalence of misinformation related to COVID-19 and dengue, this study aims to: 1) compare belief levels in COVID-19 and dengue misinformation; 2) examine associations between sociodemographic factors, health-related outcomes, and misinformation beliefs; and 3) explore the reasons underlying these beliefs among residents of Rio de Janeiro. A cross-sectional opinion online survey was conducted using quantitative and qualitative data retrieved from 180 adults who live in RJ. Participants answered a self-report questionnaire about sociodemographic and health-related outcomes. Next, they rated as true or false and inform why they believe or not in six misinformation. Our findings reveal higher levels of belief in COVID-19 compared to dengue misinformation among the Rio de Janeiro population. Furthermore, for each unity increase in number of received COVID-19 vaccine doses, there is an increase of 277% in the odds of the individuals not believing in misinformation about COVID-19. Individuals with right-wing political affiliations and those opposed to child vaccination exhibited a moderate to strong propensity to believe in misinformation. Trust in vaccines and health professionals emerged as primary determinants of belief in misinformation.

Keywords: Misinformation; Vaccine Hesitancy; Political Ideology; Ivermectin; Genetically Modified Organisms.

Resumen

Este estudio tiene como objetivo: 1) Comparar los niveles de creencias en la desinformación sobre COVID-19 y dengue; 2) Examinar las asociaciones entre factores sociodemográficos, resultados relacionados con la salud y creencias en la desinformación; 3) Explorar las razones subyacentes a estas creencias entre los residentes de Río de Janeiro. Se realizó una encuesta transversal de opinión en línea utilizando datos cuantitativos y cualitativos obtenidos de 180 adultos. Los participantes respondieron a un cuestionario de autoinforme sobre dados sociodemográficos y relacionados a salud. Después, calificaron de verdadero o falso e informaron por qué creían o no en seis desinformaciones. Descubrimos que los individuos creen más en la desinformación sobre el COVID-19 que el dengue. Además, por cada unidad de aumento en el número de dosis recibidas de la vacuna COVID-19, hay un aumento del 277% en las probabilidades de que los individuos no crean en la desinformación sobre COVID-19. Los individuos de derechas y los que no tienen intención de recibir o administrar vacunas a sus hijos son entre moderada y fuertemente más propensos a creer en desinformaciones. La confianza en las vacunas y los profesionales de la salud surgió como los principales determinantes de la creencia en la desinformación.

Palabras clave: Desinformación; Vacilación a la Vacunación; Ideologías políticas; Ivermectina; Organismos modificados genéticamente.

Introduction

Previous studies have demonstrated the negative impacts of misinformation related to COVID-19 and dengue on general population beliefs (e.g., vaccine trust: Allington et al., 2023; Del Riccio et al., 2021; Gagnon-Dufresne et al., 2023) and behaviors (e.g., vaccine hesitancy: Allington et al., 2023; Gagnon-Dufresne et al., 2023; Roozenbeek et al., 2020). Consequently, the spread of health-related misinformation has been recognized as a critical global health challenge, often referred to as an "infodemic" (World Health Organization, 2024; Ricaurte, 2021). This phenomenon is prevalent in Brazil, with several studies indicating high prevalence of health-related misinformation spread by both the general public and health authorities/professionals during the COVID-19 pandemic (Martins-Filho et al., 2022; Paumgartten et al., 2020; Salvador et al., 2023; Silva et al., 2023).

Moreover, it is well-established that some sociodemographic (e.g., political views, age, income, education) and health-related outcomes (e.g., number of vaccine doses received, intentions to receive or administer vaccines to their own children) are associated with susceptibility to COVID-19 misinformation (Del Riccio et al., 2021; Ramos et al., 2022; Roozenbeek et al., 2020; Salvador et al., 2023). However, while the impact of multiple factors on belief in COVID-19 misinformation has been extensively studied, research addressing misinformation about arboviruses, particularly dengue, remains scarce (Carey et al., 2020; Nan et al., 2022). A recent systematic review identified only one Brazilian study addressing misinformation about Zika and yellow fever (Nan et al., 2022). This gap is concerning given Brazil's history of dengue outbreaks and epidemics (Xavier et al., 2017), including the current record-breaking outbreak in Rio de Janeiro (Secretaria Estadual de Saúde do Rio de Janeiro [SES-RJ], 2024), which may be exacerbated by beliefs

in misinformation about false prevention and treatment measures (e.g., use of vinegar and ivermectin – Estadão, 2024; Ministério da Saúde [MS], 2024; Uol, 2024).

Previous research has suggested potential connections between COVID-19 and dengue outbreaks, with lockdowns and social distancing possibly contributing to increased dengue cases in several Asian countries due to reduced prevention efforts and misdiagnosis because of the similarity of symptoms (Wiyono et al., 2021). Nevertheless, to our knowledge, no studies have directly investigated the possible similarities or differences between reasons to believe, sociodemographic and health-related outcomes of individuals who believe in misinformation about dengue and COVID-19 in Brazil. Given the ongoing dengue epidemic in Rio de Janeiro and the dissemination of health-related misinformation, this study aims to: 1) compare levels of belief in misinformation about COVID-19 and dengue; 2) investigate associations between sociodemographic factors, health-related outcomes, and beliefs in misinformation; 3) explore the reasons underlying these beliefs among residents of Rio de Janeiro State (RJ).

Method

Desing and Sample

A cross-sectional online opinion study was conducted in February 2024 using Qualtrics platform to retrieve quantitative and qualitative with a 20-minutes questionnaire. This study was conducted by researchers from the Federal Fluminense University , with funds from the Rio de Janeiro State government. Participants were recruited only in the Rio de Janeiro State through snowball sampling technique (i.e., via dissemination in WhatsApp groups of the researchers' network) and boosting publications with information about our research on Facebook. The only target used during boosts was the location (i.e., Rio de Janeiro state). The initial sample was composed by 196 adults, 16 cases were

removed because participants answered only the sociodemographic or health-related questions (i.e., independent variables). The final analytic sample comprised 180 adults that answered at least one of the misinformation questions (i.e., dependent variables). This study followed the Brazilian National Health Council guideline 510/2016, which dispenses the submission and registration of public opinion surveys to ethics committees.

Variables and research questionnaire descriptions

All variables assessed were collected with an ad hoc questionnaire divided into two parts: 1) sociodemographic and health-related outcomes; 2) misinformation outcomes. The survey questionnaire used skip logic to improve the participant experience. For example, if the participant answered that he/she does not search for health information on social media, the question about which social media was most used to consult such information was not displayed. Consequently, variations in response rates across questions should be interpreted with caution, as they reflect sub-sample differences rather than missing data.

Sociodemographic and health-related variables (independent variables)

The first part of the questionnaire employed a structured format to collect data on sociodemographic and health-related variables. These included age, family income, religious belief level, number of COVID-19 vaccine doses received by the participant, and number of doses given to their children (continuous variables); gender (1 = Male; 2 = Female), education level (1 = Elementary school; 5 = Postgraduate), political view (left wing, center, right wing, no political preference), search for health information in social media, most used social media for health information (Youtube, Facebook, Instagram, Twitter/X, Whatsapp, Telegram, TikTok, Kwai), have children under 18 years old, intends to receive new COVID-19 and dengue vaccines, intends to vaccinate child with new COVID-19 and dengue vaccines (0 = No; 1 = Yes). To account for potential biases,

two additional dichotomous questions were included at the end of the online survey. Participants were asked whether they consulted external sources (e.g., Google) to answer the questions related to misinformation. Participants were also asked to indicate if they were health professionals.

Misinformation outcomes (dependent variables)

Following the assessment of sociodemographic and health-related outcomes, participants assess the veracity (0 = False; 1 = True) of six statements about COVID-19 and dengue (Table 1). These statements were derived from mainstream media and Brazilian government anti-misinformation campaigns (#Brasilcontrafake). Subsequently, participants were asked to justify their belief or disbelief in each statement. A predefined list of potential reasons was provided (e.g., trust in vaccines, and healthcare professionals - HCPs), allowing participants to select more than one option. An 'other' category was also available for specifying alternative justifications.

Table 1. Misinformation rated as false or true by the participants

Theme	COVID-19 misinformation[1]
COVID-19 supervirus	It has recently been discovered that the application of the second and third doses of vaccines with Spike protein allows for "prolonged viral persistence", which can generate a supervirus that is resistant to immunizers. Therefore, multiple doses of the COVID-19 vaccine should be avoided
COVID-19 vaccine side-effects in children	Brazil is the only country that vaccinates children against Covid-19. Several countries do not recommend vaccinating children due to possible serious side effects (such as an increased risk of developing heart disease)
Ivermectin for COVID-19 prevention and treatment	Ivermectin helps prevent and treat COVID-19
Theme	**Dengue Misinformation[1]**
Dengue GMO (Mosquito)	The Zika virus outbreaks occurred due to the release of genetically modified mosquitoes that were used to combat dengue
Dengue Vinegar	Vinegar can keep the dengue mosquito away from domestic environments, having a larvicidal and ovicidal effect (it kills the mosquito's larvae and eggs)
Ivermectin for dengue prevention and treatment	Ivermectin helps prevent and treat dengue

Note. [1]All the statements were false; GMO = Genetically modified organisms.

Data analysis

Binary logistic regression was used for ordinal independent variables, given the dichotomous nature of the dependent variables. Chi-squared or Fisher's exact test (when expected count < 5 in one of the response categories) were employed for categorical independent variables (Tabachnick et al., 2013). To assess multicollinearity between independent variables, variance inflation factor (VIF) values were calculated, with results indicating low collinearity (VIF < 4; Kim et al., 2019). Pairwise deletion was applied to handle missing data in Chi-square and Fisher's exact tests, while listwise deletion was used for logistic regression. All quantitative analyses were performed using SPSS version 26 and the software JASP version 0.17.2.1.

Qualitative data on reasons for belief or disbelief in misinformation were analyzed using Bardin's content analysis (1977/2016). Data were organized and synthesized based on thematic similarities and wording, adhering to Bardin's criteria of mutual exclusivity, homogeneity, and pertinence. Analyses were performed using MS excel and SPSS version 26.

Results

Sample characteristics

The mean age of the sample was 56.65 (SD = 12.99), most are Female (66.45%). The mean family monthly income was R$ 9.963,64 (SD = 7.680,71), which is equivalent to $ 1.992.73 (SD = 1.536.14)[1]. Most participants did not have children (64.43%), were attending or had already completed an undergraduate degree (35.6%), followed by individuals with postgraduate degree (32.2%) and high school diploma (28.1%). The sample leaned left politically (45.2%), with a quarter (26.03%) reporting no political preference and 21.92% identifying as right-wing. Approximately half (48.9%) of

participants sought health information related to COVID-19 and dengue on social media, primarily YouTube (41.4%), followed by Facebook (33.33%) and Instagram (12.64%).

Participants reported receiving a mean of 3.55 COVID-19 vaccine doses (SD = 1.5). Vaccine acceptance for future COVID-19 and dengue vaccinations was high, with 65.7% and 80% of participants expressing interest, respectively. A mean of 2.33 COVID-19 vaccine doses (SD = .96) was reported for participants' children, and 71% and 86.5% of participants intended to vaccinate their children against COVID-19 and dengue, respectively. These findings suggest a potentially higher confidence in the safety and efficacy of the dengue vaccine compared to the COVID-19 vaccine. They may also indicate more concern about dengue than COVID-19.

To mitigate potential biases, we assessed participant reliance on external information sources and healthcare professional status. Results indicated that 92.62% of participants did not consult any external information (e.g., google) while answering our questionnaire, and 85.81% were not health professionals. Detailed descriptive statistics for sociodemographic, health-related and misinformation outcomes are presented in Table 2.

Table 2. Descriptive statistics for sociodemographic, health-related, and misinformation outcomes

Variable type	Variables	Groups	N (%)	Mean (SD)	Min-Max
IV	Age		180	56.65 (12.99)	18-80
	Family income (R$)		139	9963,64 (7680,71)	0-30.000
	Religious belief level		146	1.38 (.87)	0-3
	Vaccine doses N°		149	3.55 (1.5)	0-6
	Child vaccine doses N°		52	2.33 (.96)	0-3
	Gender	Male	51 (33.55)		
		Female	101 (66.45)		
	Education	Elementary school	6 (4.02)		
		High school	42 (28.18)		
		Undergraduate	53 (35.57)		
		Postgraduate	48 (32.21)		
	Political view	Left wing	66 (45.20)		
		Center	10 (6.85)		
		Right wing	32 (21.92)		
		No political preference	38 (26.03)		
	Have child (< 18 years)	Yes	53 (35.57)		
		No	96 (64.43)		
	Health Info. in social media	Yes	88 (48.89)		
		No	92 (51.11)		
	Most used social media for health info.	YouTube	36 (41.38)		
		Facebook	29 (33.33)		
		Instagram	11 (12.64)		
		Twitter (X)	7 (8.04)		
		WhatsApp	4 (4.6)		
	Intends to receive new COVID-19 vaccines	Yes	98 (65.77)		
		No	51 (34.23)		
	Intends to receive dengue vaccine	Yes	119 (79.87)		
		No	30 (16.67)		
	Intends to vaccinate child with new COVID-19 vaccine dose	Yes	37 (71.15)		
		No	15 (28.85)		
	Intends to vaccinate child for dengue*	Yes	45 (86.54)		
		No	7 (13.46)		
	Information search during survey	Yes	11 (7.38)		
		No	138 (92.62)		
	Health professional	Yes	21 (14.19)		
		No	127 (85.81)		
DV	COVID-19 super virus	False	142 (80.23)		
		True	35 (19.77)		
	COVID-19 vaccine side-effects in children	False	113 (67.26)		
		True	55 (32.74)		

	Ivermectin for COVID-19 prevention and treatment	False	118 (71.95)
		True	46 (28.05)
	Dengue GMO (mosquito)	False	135 (85.99)
		True	22 (14.01)
	Dengue Vinegar	False	113 (75.33)
		True	37 (24.67)
	Ivermectin for dengue prevention and treatment	False	139 (93.29)
		True	10 (6.71)

Note. *During this study, Rio de Janeiro had not started dengue vaccination; DV = Dependent variable; GMO = Genetically modified organisms IV = Independent variable; R$ = Brazilian real; SD = Standard deviation.

Difference in levels of belief in misinformation about COVID-19 and dengue

Participants exhibited higher levels of belief in COVID-19 misinformation (M = 26.85%) compared to dengue misinformation (M = 15.1%). This difference is more noticeable between the misinformation about ivermectin as prevention/treatment, with 28.05% endorsing the misinformation about COVID-19 versus 6.7% for dengue. Furthermore, a significant proportion of the participants believed in the COVID-19 children vaccine side-effects (32.74%), and in the COVID-19 supervirus (19.77%) misinformation. Regarding dengue, 24.67% believed the misinformation about genetically modified mosquitoes (GMO) contributing to Zika virus outbreaks during an attempt to combat dengue, while 14.01% believed in vinegar as dengue prevention strategy.

Associations between sociodemographic, health-related outcomes and beliefs in misinformation

Logistic regressions were performed to assess whether ordinal variables (i.e. age, income, education, religious beliefs, number of COVID-19 vaccine doses received and administered to children) were predictors of belief in misinformation about COVID-19 and dengue. However, model fit information and omnibus test demonstrate that our regression models for the COVID-19 supervirus, vinegar and ivermectin for dengue prevention misinformation are no better than a null model ($p > .05$). Therefore, these dependent variables were not further explored in regression results. The findings of the logistic regressions for the remaining dependent variables are presented in Table 3.

Table 3. Logistic regression models for predicting belief in misinformation about COVID-19 and dengue between Rio de Janeiro citizens

Predictors	COVID-19 vaccine side-effects in children[1]	Ivermectin for COVID-19 prevention/treatment[2]	Dengue GMO (mosquito)[2]
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Vaccine doses N°	3.77 (1.31, 10.81)*	.27 (.09, .78)*	.21 (.05, .86)*
Child vaccine doses N°	2.42 (.72, 8.10)	.73 (.21, 2.44)	2.11 (.37, 11.95)
Age	.95 (.87, 1.04)	1.06 (.96, 1.16)	1.10 (.97, 1.25)
Religious belief level	.83 (.28, 2.48)	.82 (.26, 2.59)	1.44 (.41, 5.02)
Family income (R$)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
Education	1.84 (.57, 5.93)	.40 (.11, 1.47)	.19 (.02, 1.47)

Note. OR odds ratio; *CI* confidence interval;* $p < .02$; [1] The category "False" is the reference; [2] The category "True" is the reference.

Logistic regression analyses revealed that for each unit increase in the number of received COVID-19 vaccine doses, there is greater 277% times the odds of the individual not believing the misinformation about COVID-19 vaccine side-effects in children (OR 3.77, 95% CI 1.31, 10.81). Similarly, the odds of endorsing misinformation about ivermectin for COVID-19 prevention/treatment decreased by 73% (OR .27, 95% CI .09, .78), and dengue misinformation related to GMO by 79% (OR = .21, 95% CI: .05, .86) for each additional vaccine dose. No significant differences were found between other sociodemographic or health-related variables and misinformation beliefs.

To examine associations between categorical variables and misinformation beliefs, chi-square or Fisher's exact tests were employed. Significant associations were found between political view and belief in the misinformation regarding COVID-19 supervirus, vaccine side-effects in children, ivermectin as COVID-19 prevention/treatment, dengue GMO ($p < .001$), and ivermectin as dengue prevention/treatment ($p = .003$). Right-wing individuals exhibited a moderate to strong propensity to endorse misinformation claims about COVID-19 supervirus ($\varphi = .47$), dengue GMO ($\varphi = .34$), ivermectin as dengue

prevention/treatment (φ = .30), COVID-19 children vaccine side-effects (φ = .73), and ivermectin as COVID-19 prevention/treatment misinformation (φ = .67). There was no significant association between political view and beliefs in the vinegar for dengue prevention (Table S1).

Significant associations were also found between search health information in social media and belief in the misinformation regarding COVID-19 supervirus (p = .002), vaccine side effects in children (p < .001), and ivermectin as COVID-19 prevention/treatment (p = .003). Individuals who search health information in social media were slightly (φ = .23 to .29) more inclined to believe in all COVID-19 misinformation. On the other hand, there was no significant association between search health information in social media and beliefs in any dengue misinformation (Table S2).

Furthermore, there were significant associations between intend to receive new COVID-19 vaccines and belief in the misinformation regarding COVID-19 supervirus, vaccine side effects in children, dengue GMO, ivermectin for COVID-19 and dengue prevention/treatment (p < .001). Individuals who do not intend to receive new COVID-19 vaccines were strongly more inclined to believe in all COVID-19 misinformation (φ = .52 to .77), and moderately more inclined to believe in dengue GMO (φ = .33), and ivermectin as dengue prevention/treatment (φ = .31). No significant association was found between intention to receive new COVID-19 vaccines and belief in vinegar as dengue prevention strategy (Table S3).

Similarly, there were significant associations between intend to receive dengue vaccine and belief in the misinformation regarding COVID-19 supervirus, vaccine side effects in children, dengue GMO, ivermectin as COVID-19 prevention/treatment strategy (p < .001), and dengue prevention/treatment (p = .01). Individuals expressing hesitancy

towards dengue vaccination exhibited a stronger propensity to believe in all COVID-19 misinformation (φ = .55 to .59), and slightly more inclined to believe in dengue GMO (φ = .29), and ivermectin as dengue prevention/treatment misinformation (φ = .24). No significant association was found between dengue vaccination intent and belief in the vinegar as dengue prevention strategy (Table S4).

Significant associations also emerged between have child and belief in the misinformation regarding COVID-19 supervirus (p = .022), with individuals who had no children under 18 years old exhibiting a slightly higher likelihood of endorsement (φ = .19). There were no significant associations between have child and beliefs in any other misinformation (Table S5). On the other hand, significant associations were observed between intention to vaccinate child with new COVID-19 vaccines and belief in the misinformation regarding COVID-19 vaccine side effects in children (p < .001), dengue GMO (p = .04), ivermectin for COVID-19 (p < .001) and dengue prevention/treatment (p = .02). Individuals who do not intend to vaccinate their child with new COVID-19 vaccines were strongly more inclined to believe in COVID-19 vaccine side effects in children (φ = .86), ivermectin as COVID-19 prevention/treatment misinformation (φ = .56), and moderately more inclined to believe in dengue GMO (φ = .31) and ivermectin as dengue prevention/treatment (φ = .37). Conversely, no significant associations were found between intention to vaccinate child with new COVID-19 vaccines, and beliefs in COVID-19 supervirus, or vinegar as dengue prevention strategy (Table S6).

Similarly, there were significant associations between intention to vaccinate child for dengue and belief in the misinformation regarding COVID-19 supervirus (p = .006), vaccine side effects in children and ivermectin for COVID-19 prevention/treatment (p < .001). Individuals who do not intend to vaccinate their child were strongly more inclined

to believe in all COVID-19 misinformation (φ = .52 to .59). However, in contrast with the findings related to the intention to vaccinate the child with new doses of COVID-19, no associations were identified between intention to vaccinate child for dengue and belief in any dengue misinformation (Table S7).

Regarding possible differences between healthcare professionals and overall Rio de Janeiro population, we found that healthcare professionals exhibited a slightly lower likelihood of believe in ivermectin as COVID-19 prevention/treatment (p = .047, φ = .16). No significant associations were found between being a healthcare professional and beliefs in any other misinformation (Table S8), or between misinformation beliefs and social media usage (Table S9), gender (Table S10), information search behavior during the survey (Table S11).

Reasons to believe or disbelieve misinformation

Overall, our quantitative findings indicated higher levels of belief in COVID-19 misinformation compared to dengue misinformation. These disparities were also corroborated by our qualitative data, with participants providing more reasons to justify beliefs in COVID-19 misinformation (e.g., "I don't trust COVID vaccines, I have full confidence in other vaccines").

A minimum of 150 participants provided responses to questions regarding reasons for believing or disbelieving misinformation. To enhance data manageability and analysis, only reasons endorsed by at least 5% ($n \geq 7$) of participants were included in subsequent analyses. The main reasons are listed in Table 4. Most reasons were displayed as an answer option to the questions “why you believe that this information is true/false?” during the survey. Only the reasons beginning with "other:" were formulated based on a synthesis of

the comments (Bardin content analysis) provided by participants in the "other, which?" answer option.

Table 4. Descriptive statistics for reasons to believe or disbelieve misinformation

Misinformation	Reasons why believe[1]	N°	Reasons why don't believe[1]	N°
COVID-19 supervirus	Belief that vaccines are not reliable	13*	Belief that vaccines are reliable	94*
	Health professionals said it was true	10	See the information in mainstream media	15
	-	-	Health professionals said it was false	22
	-	-	Other 1: previous knowledge/beliefs	17
COVID-19 vaccine side-effects in children	See the information in social media	9	Belief that vaccines are reliable	68*
	Belief that vaccines are not reliable	11	See the information in mainstream media	11
	See the information in mainstream media	10	Health professionals said it was false	34
	Health professionals said it was true	25*	Other 1: previous knowledge/beliefs	18
Ivermectin for COVID-19 prevention and treatment	Used as prevention and had no COVID-19	20*	See the information in social media	16
	Health professionals said it was true	15	See the information in mainstream media	40
	Used as a treatment and got better	12	Health professionals said it was false	69*
	See the information in social media	7	Other 1: previous knowledge/beliefs	10
	Family or peers believe in the information	7	Family or peers believe in the information	7
Dengue GMO (MOSQUITO)	See the information in mainstream media	8*	See the information in social media	10
	-		See the information in mainstream media	34
	-		Health professionals said it was false	50*
	-	-	Other 1: previous knowledge/beliefs	23
	-	-	Other 2: never saw the information	12
Dengue Vinegar	See the information in social media	9	See the information in social media	10
	See the information in mainstream media	10*	Health professionals said it was false	39*
	Family or peers believe in the information	7	See the information in mainstream media	28
	-		Family or peers believe in the information	7
	-		Other 1: previous knowledge/beliefs	17
	-		Other 2: never saw the information	11
Ivermectin for dengue prevention and treatment	-		See the information in social media	11
	-		See the information in mainstream media	40
	-		Health professionals said it was false	63*
	-		Other 1: previous knowledge/beliefs	14

-	Other 2: never saw the information	10

Note. [1]Participants could provide more than one reason why they believed (or not) in the misinformation but the same participant could not provide both reasons to believe and disbelieve; *Most reported.

Main reasons for believing misinformation about COVID-19 were: 1) listen to health professionals who reinforce misinformation; 2) used ivermectin as prevention and not having contracted COVID-19; and 3) belief that vaccines are unreliable. Similarly, the main reasons for not believing in the COVID-19 misinformation were: 1) trust in vaccines; and 2) listen to health professionals who refute misinformation. Other reasons for not believing the misinformation related to COVID-19 supervirus, vaccine side effects, and ivermectin for prevention/treatment were related to: 1) previous knowledge/beliefs (e.g., "ivermectin is a dewormer, not an antiviral"; "Covid-19 is a virus, basic biology"; "vaccines don't create super viruses"; "many countries already vaccinate children").

Regarding dengue, the main reason for believing the misinformation was: 1) seeing the information being disseminated in mainstream media. No reasons were listed for the misinformation related to the use of ivermectin, as only 10 participants believed this information and provided different reasons for their belief. On the other hand, the main reason for not believing in the dengue misinformation was listen to health professionals who refute misinformation. Other reasons for not believing the misinformation related to dengue GMO, vinegar and ivermectin as dengue prevention/intervention strategy were related to: 1) previous knowledge/beliefs (e.g., "these mosquitoes were bred and monitored by Fiocruz"; vinegar does not kill larvae"; "ivermectin does not kill virus"); and 2) never saw the information (e.g., "I haven't seen this news"; "I've never heard of this happening").

Discussion

The main aim of this paper was to compare belief levels in COVID-19 and dengue misinformation in a sample from the RJ. Our primary finding indicates that participants

exhibited greater belief in COVID-19 misinformation compared to dengue misinformation. Specifically, misinformation concerning COVID-19 vaccine side effects in children and dengue GMO was perceived as accurate by a substantial proportion of the sample. Conversely, few individuals endorsed misinformation about vinegar and ivermectin as dengue prevention or intervention strategies. This discrepancy is noteworthy, particularly given the higher prevalence of beliefs in ivermectin's efficacy against COVID-19 (28.05%) relative to dengue (6.7%). The observed disparity in misinformation beliefs between COVID-19 and dengue might be attributed to several factors.

For instance, the Brazilian government's denialist stance during the pandemic (Carvalho et al., 2022; Martins-Filho & Barberia, 2022; Silva et al., 2023; Souto et al., 2024), alongside with recommendations regarding the use of ivermectin as part of a so-called "early treatment for COVID-19" (Hentschke-Lopes et al., 2022; Silva et al., 2023), likely contributed to the proliferation of ivermectin-related beliefs. Additionally, the promotion of the ivermectin use and anti-vaccination campaigns by healthcare professionals during COVID-19 pandemic (Hentschke-Lopes et al., 2022; Silva et al., 2023; Paumgartten & Oliveira, 2020), as well as the widespread circulation of COVID-19-related fake news on mainstream and social media platforms (Carvalho et al., 2022; Souto et al., 2024), likely exacerbated the spread of misinformation. However, given the concurrent circulation of dengue-related misinformation about ivermectin and vinegar on Brazilian media platforms (MS, 2024; Estadão, 2024; Uol, 2024), the observed discrepancy does not appear consistent with a recency effect. (i.e., cognitive bias that favors recent events over historical ones; a memory bias – Wyler & Oswald, 2016). If this were the case, a higher prevalence of dengue misinformation would be expected, especially considering the severity of the dengue epidemic in RJ during this study period (SES-RJ, 2024).

The proposed explanations are supported by the findings related to the reasons for believing and disbelieving misinformation, as well as the associations between sociodemographic factors, health outcomes, and misinformation beliefs. Trust in vaccines and information from healthcare professionals emerged as primary determinants of both belief and disbelief in COVID-19 misinformation. These findings align with previous national and international research linking trust in science, vaccines, and healthcare institutions to vaccination uptake (Carvalho et al., 2022; Del Riccio et al., 2021; Roozenbeek et al., 2020; Salvador et al., 2023; Souto et al., 2024; Oliveira et al., 2024). Conversely, reliance on mainstream media as a source of information was associated with belief in dengue misinformation, while trust in healthcare professionals remained a key factor in disbelief. These results corroborate prior research on COVID-19 and dengue, highlighting the critical role of both traditional and social media in both the dissemination and correction of misinformation during public health crises (Lwin et al., 2021; Oliveira et al., 2024; Gagnon-Dufresne et al., 2023).

Furthermore, our findings reveal that for each unit increase in the score for COVID-19 vaccine doses number there is greater 277% times the odds of the individual not believing the misinformation about COVID-19 vaccine side-effects in children, less 73% and 79% odds of the individual believe in the misinformation about ivermectin for COVID-19 prevention/treatment, and in the misinformation about dengue GMO respectively. Moreover, individuals with no intention to receive or administer the COVID-19 vaccine to their children exhibited significantly higher belief in all COVID-19 misinformation and slightly to moderate belief in dengue GMO and ivermectin misinformation. Similar patterns were observed for dengue vaccination intentions with strong associations between unwillingness to vaccinate children for dengue and belief in COVID-19 misinformation.

These findings aligned with previous national and international research demonstrating that belief in misinformation related to COVID-19 reduces the intention to get vaccinated and to vaccinate own children (Carvalho et al., 2022; Del Riccio et al., 2021; Roozenbeek et al., 2020; Salvador et al., 2023; Souto et al., 2024; Oliveira et al., 2024), as well as increase the willing to use ivermectin (Van Scoy et al., 2023; Silva et al., 2023). This is especially true in Brazil, with some authors suggesting that the "COVID kit" (including ivermectin and chloroquine as prevention/treatment) promoted by the government may have contributed to reduced adherence to vaccination (Silva et al., 2023).

While prior research has not explicitly examined the connection between COVID-19 vaccination intentions and dengue-related misinformation, our findings align with previous authors who suggest that misinformation and conspiracy theories can negatively impact overall vaccination uptake (Allington et al., 2021). The observed lack of association between dengue vaccination intentions and dengue misinformation may be attributed to the small sample size (n = 7) of individuals who did not intend to vaccinate their children against dengue.

Our findings also reveal that right-wing individuals were moderately more inclined to believe in COVID-19 supervirus, dengue GMO and ivermectin misinformation, being strong more inclined to believe in both COVID-19 misinformation about vaccine side-effects and ivermectin as prevention/treatment. These findings align with previous national and international research linking right-wing ideology and political conservatism to increased susceptibility to COVID-19 misinformation in Ireland, Mexico, Spain (Roozenbeek et al., 2020), USA (Calvillo et al., 2020), and Brazil (Ramos et al., 2022). In addition, in April 2024 we searched Pubmed, Scopus, Web of Science and the Virtual Health Library using broad keywords (i.e., misinformation and dengue) aiming to discuss

our findings regarding dengue misinformation and political view. Unfortunately, we were unable to find papers to discuss our findings, our searches retrieved only between eight and 46 papers in each database. The scarcity of studies in this area highlights a significant knowledge gap and underscores the need for further national and international research to investigate potential links between political views and dengue misinformation beliefs.

We also found that individuals who search health information in social media demonstrated a slightly increased likelihood of endorsing COVID-19 misinformation but not dengue misinformation. This finding aligns with a systematic review indicating that reliance on social media is associated with greater susceptibility to health misinformation compared to individuals who trust healthcare professionals or scientists (Nan et al., 2022). However, as only one study within this review originated from Brazil (Carey et al., 2020), further Brazilian studies are warranted to investigate the predictive role of social media use in the belief in health-related misinformation.

Our analysis of control and sociodemographic variables revealed a limited impact on misinformation beliefs. Health professionals exhibited a slight tendency to disbelieve in ivermectin as a COVID-19 prevention or treatment. No significant associations were found between misinformation beliefs and other variables, including profession (i.e., healthcare professional vs. non-healthcare professional), social media use, gender, information search behavior during the survey. These findings align with previous Brazilian studies documenting off-label treatment recommendations and anti-vaccination stances among healthcare professionals (Hentschke-Lopes et al., 2022; Silva et al., 2023; Paumgartten & Oliveira, 2020), as well as by Brazilian Health Minister during the COVID-19 pandemic period (Martins-Filho & Barberia, 2022).

It is noteworthy that in addition to misinformation about dengue vinegar being the second least believed, this misinformation has no significant association with any sociodemographic or health-related outcomes. On the other hand, although misinformation about ivermectin for the prevention/treatment of dengue was the least believed, we found associations with sociodemographic and health-related outcomes. This discrepancy may be attributed to the widespread dissemination of ivermectin-related misinformation during the COVID-19 pandemic, which likely primed individuals to accept similar claims in the context of dengue (Hentschke-Lopes et al., 2022; Silva et al., 2023; Paumgartten & Oliveira, 2020). Given the recent emergence of dengue vaccine misinformation (MS, 2024), it is reasonable to infer that when large-scale vaccination begins, there may also be an increase in the dissemination of misinformation challenging the efficacy of dengue vaccines in Brazil. Therefore, proactive measures targeting both the general public and healthcare professionals are warranted to prevent the proliferation of these harmful narratives and their potential impact on vaccine uptake and public health outcomes.

Lastly, it is essential to interpret our findings within the context of the study's limitations. The sample, primarily composed of middle-aged to older adults from upper-middle and high-income backgrounds with higher education, may not accurately represent the broader Rio de Janeiro population. Furthermore, we had a limited number of healthcare professionals (n = 21) in the sample. Therefore, findings related to differences between healthcare professionals and the general RJ population should be interpreted with caution. To address these limitations, future research should involve larger, more representative samples of both the general population and healthcare professionals across diverse socioeconomic and demographic strata within Brazil.

Conclusion

In sum, the current paper is valuable because it has some strengths. The main one is that, as far as we know, this is the first study investigating possible differences in levels of belief in misinformation about COVID-19 and dengue, as well as associations between sociodemographic, health-related outcomes and beliefs in misinformation regarding dengue. We found preliminary evidence indicating that RJ population may hold stronger beliefs in COVID-19 misinformation compared to dengue misinformation, with right-wing individuals exhibiting heightened susceptibility to both. These results hint at a potential consolidation of certain misinformation as factual knowledge, possibly influenced by the pervasive misinformation landscape during the pandemic. Alternatively, the sustained prevalence of COVID-19 misinformation compared to other health issues may contribute to this disparity. Further studies should address these hypotheses.

Additionally, our findings indicate a positive correlation between the number of COVID-19 vaccine doses received and lower susceptibility to any presented misinformation. Conversely, higher levels of misinformation belief were associated with decreased intention to receive both COVID-19 and dengue vaccines, as well as reduced intent to vaccinate children against COVID-19, but not for dengue. Individuals who searched for health information in social media were slightly more inclined to believe in all COVID-19 misinformation, but not in any of dengue misinformation. Although healthcare professionals demonstrated slightly lower belief in ivermectin as a COVID-19 treatment, trust in vaccines, information from healthcare professionals, and mainstream media emerged as key factors influencing both belief and disbelief in misinformation related to both COVID-19 and dengue.

Given the observed disparities in misinformation beliefs between dengue and COVID-19, and the pivotal role of trust in healthcare professionals and information sources, further research is imperative to elucidate the impact of misinformation disseminated by both health authorities and professionals on public perceptions and behaviors related to COVID-19 and arboviruses. A deeper understanding of the mechanisms through which misinformation influences health-related beliefs and behaviors is crucial. Moreover, developing effective strategies to counter misinformation propagated by these trusted sources, as well as addressing the underlying denialism that may fuel its spread, represents a critical public health challenge.

Note

1. In 2024 the Brazilian minimum wage was R$ 1.412 ($ 282.4). A mean of R$ 9963,64 indicates that our samples represent mainly the upper-middle population.

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Table S1. Fisher's exact test comparisons between political view and belief in misinformation

		Political view				
COVID-19 Super virus		**Left wing**	**Center**	**Right wing**	**No political preference**	**Total**
False	Count	63	9	16	31	119
	Expected count	54.54	8.26	26.44	29.75	119
	Standardized residuals	1.1	.3	-2.0	.2	
True	Count	3	1	16	5	25
	Expected count	11.46	1.74	5.56	6.25	25
	Standardized residuals	-2.5	-.6	4.4	-.5	
Fisher's exact test, *p* value, Phi-coefficient	27.62, $p < .001$, $\varphi = .47$					
COVID-19 vaccine side-effects in children		**Left wing**	**Center**	**Right wing**	**No political preference**	**Total**
False	Count	63	8	3	24	98
	Expected count	44.24	6.81	21.78	25.18	98
	Standardized residuals	2.8	.5	-4.0	-.2	
True	Count	2	2	29	13	46
	Expected count	20.76	3.19	10.22	11.82	46
	Standardized residuals	-4.1	-.7	.59	.3	
Fisher's exact test, *p* value, Phi-coefficient	81.71, $p < .001$, $\varphi = .73$					
Ivermectin for COVID-19 prevention and treatment		**Left wing**	**Center**	**Right wing**	**No political preference**	**Total**
False	Count	65	7	6	28	106
	Expected count	48.58	7.36	22.08	27.97	106
	Standardized residuals	2.5	-.1	-3.4	.0	
True	Count	1	3	24	10	38
	Expected count	17.42	2.64	7.92	10.03	38
	Standardized residuals	-3.9	.2	.57	.0	
Fisher's exact test, *p* value, Phi-coefficient	67.38, $p < .001$, $\varphi = .67$					
Dengue GMO (mosquito)		**Left wing**	**Center**	**Right wing**	**No political preference**	**Total**
False	Count	63	9	20	29	121
	Expected count	55.39	8.52	25.56	31.53	121
	Standardized residuals	1.0	.2	-1.1	-.5	
True	Count	2	1	10	8	21
	Expected count	9.61	1.48	4.43	5.47	21
	Standardized residuals	-2.5	-.4	2.6	1.1	
Fisher's exact test, *p* value, Phi-coefficient	17.18, $p < .001$, $\varphi = .34$					

Note. GMO = Genetically modified organisms.

Table S1. Fisher's exact test comparisons between political view and belief in misinformation (continuation)

Vinegar		**Political view**				
		Left wing	**Center**	**Right wing**	**No political preference**	**Total**
False	Count	52	7	20	27	106
	Expected count	50.66	7.79	21.04	26.5	106
	Standardized residuals	.2	-.3	-.2	.1	
True	Count	13	3	7	7	30
	Expected count	14.34	2.21	5.96	7.5	30
	Standardized residuals	-.4	.5	.4	-.2	
Fisher's exact test, p value, Phi-coefficient	1.08, p = .80, φ = .07					
Ivermectin for dengue prevention and treatment		**Left wing**	**Center**	**Right wing**	**No political preference**	**Total**
False	Count	66	10	24	33	133
	Expected count	61.82	9.37	27.16	34.65	133
	Standardized residuals	.5	.2	-.6	-.3	
True	Count	0	0	5	4	9
	Expected count	4.18	.63	1.84	2.34	9
	Standardized residuals	-.20	-.8	2.3	1.1	
Fisher's exact test, p value, Phi-coefficient	11.96, p = .003, φ = 0.29					

Table S2. Chi square and Fisher's exact tests comparisons between search health information in social media and belief in misinformation

COVID-19 Super virus		Health information in social media			Dengue GMO (Mosquito)		Health information in social media		
		No	**Yes**	**Total**			**No**	**Yes**	**Total**
False	Count	82	60	142	False	Count	74	61	135
	Expected count	73.81	68.19	142		Expected count	72.34	62.77	135
	Standardized residuals	3.09	-3.09			Standardized residuals	.82	-.82	
True	Count	10	25	35	True	Count	10	12	22
	Expected count	18.19	16.81	35		Expected count	11.77	10.23	22
	Standardized residuals	-3.09	3.09			Standardized residuals	-.82	.82	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 177) = 9.57, p = .002, φ = .23				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 157) = .67, p = .41, φ = .06			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	72	41	113	False	Count	65	48	113
	Expected count	60.54	52.46	113		Expected count	60.23	52.73	113
	Standardized residuals	3.78	-3.78			Standardized residuals	1.8	-1.8	
True	Count	18	37	55	True	Count	15	22	37
	Expected count	29.46	25.54	55		Expected count	19.73	17.27	37
	Standardized residuals	-3.78	3.78			Standardized residuals	-1.8	1.8	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 168) = 14.28, p < .001, φ = .29				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 150) = 3.23, p = .07, φ = .15			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	71	47	118	False	Count	78	61	139
	Expected count	62.6	55.4	118		Expected count	75.56	64.44	139
	Standardized residuals	2.93	-2.93			Standardized residuals	1.6	-1.6	
True	Count	16	30	46	True	Count	3	7	10
	Expected count	24.4	21.6	46		Expected count	5.44	4.56	
	Standardized residuals	-2.93	2.93			Standardized residuals	-1.6	1.6	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 164) = 8.56, p = .003, φ = .23				Fisher's exact test, *p* value, Phi-coefficient	1.08, p = .18, φ = .13			

Note. GMO = Genetically modified organisms.

Table S3. Chi square and Fisher's exact tests comparisons between intend to receive new covid-19 vaccines and belief in misinformation

COVID-19 Super virus		Intend to receive new covid-19 vaccines			Dengue GMO (Mosquito)		Intend to receive new covid-19 vaccines		
		No	**Yes**	**Total**			**No**	**Yes**	**Total**
False	Count	27	95	122	False	Count	34	90	124
	Expected count	40.67	81.33	122		Expected count	41.9	82.1	124
	Standardized residuals	-6.36	6.36			Standardized residuals	-3.94	3.94	
True	Count	22	3	25	True	Count	15	6	21
	Expected count	8.33	16.67	25		Expected count	7.1	13.9	21
	Standardized residuals	6.36	-6.36			Standardized residuals	3.94	-3.94	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 147) = 40.51, $p < .001$, φ = .52				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 145) = 15.55, $p < .001$, φ = .33			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	9	91	100	False	Count	31	76	107
	Expected count	34.01	65.99	100		Expected count	35.41	71.59	107
	Standardized residuals	9.34	-9.34			Standardized residuals	-1.89	1.89	
True	Count	41	6	47	True	Count	15	17	32
	Expected count	15.99	31.01	47		Expected count	10.59	21.41	32
	Standardized residuals	-9.34	9.34			Standardized residuals	1.89	-1.89	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 147) = 87.19, $p < .001$, φ = .77				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 139) = 3.57, $p = .059$, φ = .16			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	14	93	107	False	Count	38	97	135
	Expected count	36.39	70.6	107		Expected count	43.12	91.87	135
	Standardized residuals	-8.76	8.76			Standardized residuals	3.78	-3.78	
True	Count	36	4	40	True	Count	8	1	9
	Expected count	13.60	26.4	40		Expected count	2.87	6.1	9
	Standardized residuals	8.76	-8.76			Standardized residuals	-3.78	3.78	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 147) = 76.74, $p < .001$, φ = .72				Fisher's exact test, *p* value, Phi-coefficient	2.99, $p < .001$, φ = .31			

Note. GMO = Genetically modified organisms.

Table S4. Chi square and Fisher's exact tests comparisons between intend to receive dengue vaccine and belief in misinformation

COVID-19 Super virus		Intend to receive dengue vaccine			Dengue GMO (Mosquito)		Intend to receive dengue vaccine		
		No	Yes	Total			No	Yes	Total
False	Count	12	110	122	False	Count	18	106	124
	Expected count	24.07	97.93	122		Expected count	23.94	100.05	124
	Standardized residuals	-6.66	6.66			Standardized residuals	-3.55	3.55	
True	Count	17	8	25	True	Count	10	11	21
	Expected count	4.93	20.07	25		Expected count	4.05	16.94	21
	Standardized residuals	6.66	-6.66			Standardized residuals	3.55	-3.55	
X^2 (DF, N°), p value, Phi-coefficient	X^2 (1, N = 147) = 44.32, p < .001, φ = .55				Fisher's exact test, p value, Phi-coefficient	1.66, p < .001, φ = .29			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	4	96	100	False	Count	18	89	107
	Expected count	20.41	79.59	100		Expected count	21.55	85.45	107
	Standardized residuals	7.2	-7.2			Standardized residuals	-1.78	1.78	
True	Count	26	21	47	True	Count	10	22	32
	Expected count	9.6	37.41	47		Expected count	6.45	25.55	32
	Standardized residuals	-7.2	7.2			Standardized residuals	1.78	-1.78	
X^2 (DF, N°), p value, Phi-coefficient	X^2 (1, N = 147) = 51.84, p < .001, φ = .59				X^2 (DF, N°), p value, Phi-coefficient	X^2 (1, N = 139) = 3.19, p = .07, φ = .15			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	6	101	107	False	Count	22	113	135
	Expected count	21.11	85.89	107		Expected count	25.31	109.7	135
	Standardized residuals	-7.04	7.04			Standardized residuals	-2.92	2.92	
True	Count	23	17	40	True	Count	5	4	9
	Expected count	7.87	32.11	40		Expected count	1.69	7.31	9
	Standardized residuals	7.04	-7.04			Standardized residuals	2.92	2.92	
X^2 (DF, N°), p value, Phi-coefficient	X^2 (1, N = 147) = 49.51, p < .001, φ = .58				Fisher's exact test, p value, Phi-coefficient	1.84, p = .01, φ = .24			

Note. GMO = Genetically modified organisms.

Table S5. Chi square and Fisher's exact tests comparisons between have child and belief in misinformation

COVID-19 Super virus		Have child (< 18 years)			Dengue GMO (Mosquito)		Have child (< 18 years)		
		No	**Yes**	**Total**			**No**	**Yes**	**Total**
False	Count	73	49	122	False	Count	80	44	124
	Expected count	78.01	43.99	122		Expected count	79.53	44.47	124
	Standardized residuals	-2.29	2.29			Standardized residuals	.23	-.23	
True	Count	21	4	25	True	Count	13	8	21
	Expected count	15.99	9.01	25		Expected count	13.47	7.5	21
	Standardized residuals	2.29	-2.29			Standardized residuals	-.23	.23	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 147) = 5.25, p = .022, φ = .19				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 145) = 0.05, p = .82, φ = .02			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	62	38	100	False	Count	68	39	107
	Expected count	64.63	35.37	100		Expected count	67.74	39.26	107
	Standardized residuals	-.97	.97			Standardized residuals	.11	-.11	
True	Count	33	14	47	True	Count	20	12	32
	Expected count	30.38	16.63	47		Expected count	20.26	11.74	32
	Standardized residuals	.97	-.97			Standardized residuals	-.11	.11	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 147) = .94, p = .33, φ = .08				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 139) = 0.01, p = .91, φ = .01			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	66	41	107	False	Count	87	48	135
	Expected count	68.42	38.58	107		Expected count	85.31	49.69	
	Standardized residuals	-.93	.93			Standardized residuals	1.2	-1.2	
True	Count	28	12	40	True	Count	4	5	9
	Expected count	25.58	14.42	40		Expected count	5.69	3.31	9
	Standardized residuals	.93	-.93			Standardized residuals	-1.2	1.2	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 147) = .87, p = .35, φ = .08				Fisher's exact test, *p* value, Phi-coefficient	1.25, p = .23, φ = .1			

Note. GMO = Genetically modified organisms.

Table S6. Fisher's exact tests comparisons between intention to vaccinate child with new COVID-19 vaccines and belief in misinformation

COVID-19 Super virus		Vaccinate child with new COVID vaccine			Dengue GMO (Mosquito)		Vaccinate child with new COVID vaccine		
		No	**Yes**	**Total**			**No**	**Yes**	**Total**
False	Count	12	36	48	False	Count	10	33	43
	Expected count	13.85	34.15	48		Expected count	12.65	30.35	43
	Standardized residuals	-2.12	2.12			Standardized residuals	-2.23	2.23	
True	Count	3	1	4	True	Count	5	3	8
	Expected count	1.15	2.85	4		Expected count	2.35	5.65	8
	Standardized residuals	2.12	-2.12			Standardized residuals	2.23	-2.23	
Fisher's exact test, *p* value, Phi-coefficient	2.15, $p = .07$, $\varphi = .29$				Fisher's exact test, *p* value, Phi-coefficient	1.66, $p = .04$, $\varphi = .31$			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	2	35	37	False	Count	11	27	38
	Expected count	10.88	26.12	37		Expected count	11.4	26.6	38
	Standardized residuals	-6.12	6.12			Standardized residuals	-.29	.29	
True	Count	13	1	14	True	Count	4	8	12
	Expected count	4.12	9.88	14		Expected count	3.6	8.4	12
	Standardized residuals	6.12	-6.12			Standardized residuals	.29	-.29	
Fisher's exact test, *p* value, Phi-coefficient	5.13, $p < .001$, $\varphi = .86$				Fisher's exact test, *p* value, Phi-coefficient	.20, $p = 1.00$, $\varphi = .04$			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	6	34	40	False	Count	11	36	47
	Expected count	11.54	28.46	40		Expected count	13.56	33.44	47
	Standardized residuals	-4.02	4.02			Standardized residuals	-2.66	2.66	
True	Count	9	3	12	True	Count	4	1	5
	Expected count	3.46	8.54	12		Expected count	1.44	3.56	5
	Standardized residuals	4.02	-4.02			Standardized residuals	2.66	-2.66	
Fisher's exact test, p value, Phi-coefficient	2.75, $p < .001$, $\varphi = .56$				Fisher's exact test, *p* value, Phi-coefficient	2.51, $p = .02$, $\varphi = .37$			

Note. GMO = Genetically modified organisms.

Table S7. Fisher's exact tests comparisons between intention to vaccinate child for dengue and belief in misinformation

COVID-19 Super virus		Intends to vaccinate child for dengue			Dengue GMO (Mosquito)		Intends to vaccinate child for dengue		
		No	Yes	Total			No	Yes	Total
False	Count	4	44	48	False	Count	5	38	43
	Expected count	6.46	41.54	48		Expected count	5.9	37.1	43
	Standardized residuals	-3.75	3.75			Standardized residuals	-1.1	1.1	
True	Count	3	1	4	True	Count	2	6	8
	Expected count	.54	3.46	4		Expected count	1.1	6.9	8
	Standardized residuals	3.75	-3.75			Standardized residuals	1.1	-1.1	
Fisher's exact test, *p* value, Phi-coefficient	3.35, $p = .006$, $\varphi = .52$				Fisher's exact test, *p* value, Phi-coefficient	.91, $p = .30$, $\varphi = .14$			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	1	36	37	False	Count	4	34	38
	Expected count	5.08	31.92	37		Expected count	5.32	32.68	38
	Standardized residuals	-3.72	3.72			Standardized residuals	-1.26	1.26	
True	Count	6	8	14	True	Count	3	9	12
	Expected count	1.92	12.08	14		Expected count	1.68	10.32	12
	Standardized residuals	3.72	-3.72			Standardized residuals	1.26	-1.26	
Fisher's exact test, *p* value, Phi-coefficient	3.21, $p < .001$, $\varphi = .52$				Fisher's exact test, *p* value, Phi-coefficient	1.02, $p = .34$, $\varphi = .18$			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	1	39	40	False	Count	5	42	47
	Expected count	5.38	34.61	40		Expected count	6.33	40.67	47
	Standardized residuals	-4.23	4.23			Standardized residuals	-1.83	1.83	
True	Count	6	6	12	True	Count	2	3	5
	Expected count	1.61	10.38	12		Expected count	.67	-.67	5
	Standardized residuals	4.23	-4.23			Standardized residuals	1.83	-1.83	
Fisher's exact test, p value, Phi-coefficient	3.48, $p < .001$, $\varphi = .59$				Fisher's exact test, *p* value, Phi-coefficient	1.67, $p = .13$, $\varphi = .25$			

Note. GMO = Genetically modified organisms.

Table S8. Chi square and Fisher's exact tests comparisons between being a health professional and belief in misinformation

COVID-19 Super virus		Health professional			Dengue GMO (Mosquito)		Health professional		
		No	Yes	Total			No	Yes	Total
False	Count	101	20	121	False	Count	104	19	123
	Expected count	103.6	17.4	121		Expected count	105.06	17.94	123
	Standardized residuals	-1.62	1.62			Standardized residuals	-.71	.71	
True	Count	24	1	25	True	Count	19	2	21
	Expected count	21.4	3.6	25		Expected count	17.94	3.05	21
	Standardized residuals	1.62	-1.62			Standardized residuals	.71	-.71	
Fisher's exact test, *p* value, Phi-coefficient	1.55, $p = .13$, $\varphi = .13$				Fisher's exact test, *p* value, Phi-coefficient	.55, $p = .74$, $\varphi = .06$			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	83	16	99	False	Count	91	15	106
	Expected count	84.76	14.24	99		Expected count	27.59	4.41	106
	Standardized residuals	-.89	.89			Standardized residuals	-.24	.24	
True	Count	42	5	47	True	Count	28	4	32
	Expected count	40.24	6.76	47		Expected count	37.59	4.41	32
	Standardized residuals	.89	-.89			Standardized residuals	.24	-.24	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, $N = 146$) = .79, $p = .37$, $\varphi = .07$				Fisher's exact test, *p* value, Phi-coefficient	.14, $p = 1.00$, $\varphi = .02$			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	87	19	106	False	Count	113	21	134
	Expected count	90.75	15.24	106		Expected count	114.32	19.68	134
	Standardized residuals	-2.00	2.00			Standardized residuals	-1.29	1.29	
True	Count	38	2	40	True	Count	9	0	9
	Expected count	34.25	5.75	40		Expected count	7.68	1.32	9
	Standardized residuals	2.00	-2.00			Standardized residuals	1.29	-1.29	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, $N = 146$) = 3.94, $p = .047$, $\varphi = .16$				Fisher's exact test, *p* value, Phi-coefficient	1.67, $p = .13$, $\varphi = .25$			

Note. GMO = Genetically modified organisms.

Table S9. Chi square and Fisher's exact tests comparisons between most used social media for health information seeking and belief in misinformation

		Most used social media for health information					
COVID-19 Super virus		**Inst**	**FB**	**X**	**YT**	**WA**	**Total**
False	Count	9	21	5	23	2	60
	Expected count	7.9	20	5	25	2.1	50
	Standardized residuals	.4	.2	.0	-.4	-.1	
True	Count	2	7	2	12	1	24
	Expected count	3.1	8	2	10	.9	24
	Standardized residuals	-.6	-.4	.0	.6	.2	
Fisher's exact test, *p* value, Phi-coefficient	1.57, p =.89, φ = .13						
COVID-19 vaccine side-effects in children		**Inst**	**FB**	**X**	**YT**	**WA**	**Total**
False	Count	6	17	3	14	1	41
	Expected count	5.3	13.8	3.7	16.5	1.6	41
	Standardized residuals	.3	.8	-.4	-.6	-.5	
True	Count	4	9	4	17	2	36
	Expected count	4.7	12.2	3.3	14.5	1.4	36
	Standardized residuals	-.3	-.9	.4	.7	.5	
Fisher's exact test, *p* value, Phi-coefficient	3.43, p =.52, φ = .21						
Ivermectin for COVID-19 prevention and treatment		**Inst**	**FB**	**X**	**YT**	**WA**	**Total**
False	Count	9	17	4	16	1	47
	Expected count	6.2	15.5	4.3	19.2	1.9	47
	Standardized residuals	1.1	.4	-.2	-.7	-.6	
True	Count	1	8	3	15	2	29
	Expected count	3.8	9.5	2.7	11.8	1.1	29
	Standardized residuals	-1.4	-.5	.2	.9	.8	
Fisher's exact test, *p* value, Phi-coefficient	6.33, p =.16, φ = .28						
Dengue GMO (mosquito)		**Inst**	**FB**	**X**	**YT**	**WA**	**Total**
False	Count	8	23	6	23	1	61
	Expected count	7.6	21.2	5.9	24.6	1.7	61
	Standardized residuals	.1	.4	0	-.3	-.5	
True	Count	1	2	1	6	1	11
	Expected count	1.4	3.8	1.1	4.4	.3	11
	Standardized residuals	-.3	-.9	-.1	.7	1.3	
Fisher's exact test, *p* value, Phi-coefficient	3.93, p = .37, φ = .22						
Vinegar		**Inst**	**FB**	**X**	**YT**	**WA**	**Total**
False	Count	7	17	5	17	1	47
	Expected count	6.1	16.3	4.8	18.4	1.4	47
	Standardized residuals	.4	.2	.1	-.3	-.3	
True	Count	2	7	2	10	1	22
	Expected count	2.9	7.7	2.2	8.6	.6	22
	Standardized residuals	-.5	-.2	-.2	.5	.5	
Fisher's exact test, *p* value, Phi-coefficient	1.46, p = .90, φ = .13						

Note. GMO = Genetically modified organisms; FB = Facebook; Inst = Instagram; YT = Youtube; WA = Whatsapp.

Table S9. Chi square and Fisher's exact tests comparisons between most used social media for health information seeking and belief in misinformation (continuation)

Ivermectin for dengue prevention and treatment		Most used social media for health information					
		Inst	**FB**	**X**	**YT**	**WA**	**Total**
False	Count	8	22	6	23	2	61
	Expected count	7.3	21.9	6.4	23.7	1.8	61
	Standardized residuals	.3	.0	-.1	-.1	.1	
True	Count	0	2		3	0	6
	Expected count	.7	2.1	.6	2.3	.2	6
	Standardized residuals	-.8	-.1	.5	.4	-.4	
Fisher's exact test, *p* value, Phi-coefficient	1.70, $p = .84$, $\varphi = .15$						

Note. FB = Facebook; Inst = Instagram; YT = Youtube; WA = Whatsapp.

Table S10. Chi square and Fisher's exact tests comparisons between gender and belief in misinformation

COVID-19 Super virus		Gender			Dengue GMO (Mosquito)		Gender		
		Male	Female	Total			Male	Female	Total
False	Count	41	82	123	False	Count	42	85	127
	Expected count	41	82	123		Expected count	42.05	84.95	127
	Standardized residuals	0	0			Standardized residuals	-.02	.02	
True	Count	9	18	27	True	Count	7	14	21
	Expected count	9	18	27		Expected count	6.95	14.05	21
	Standardized residuals	0	0			Standardized residuals	.02	-.02	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 150) = .0, p = 1.00, φ = .0				X^2 (DF, N°) *p* value, Phi-coefficient	X^2 (1, N = 148) = .0, p = .98, φ = .0			
COVID-19 vaccine side-effects in children		**Male**	**Female**	**Total**	**Vinegar**		**Male**	**Female**	**Total**
False	Count	35	65	100	False	Count	36	74	110
	Expected count	33.33	66.68	100		Expected count	37.18	72.82	110
	Standardized residuals	.61	-.61			Standardized residuals	-.5	.5	
True	Count	15	35	50	True	Count	12	20	32
	Expected count	16.68	33.33	50		Expected count	10.82	21.18	32
	Standardized residuals	- .61	.61			Standardized residuals	.5	-.5	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 150) = .37, p = .54, φ = .05				X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 142) = .25, p = .61, φ = .04			
Ivermectin for COVID-19 prevention and treatment		**Male**	**Female**	**Total**	**Ivermectin for Dengue prevention and treatment**		**Male**	**Female**	**Total**
False	Count	34	74	108	False	Count	44	92	136
	Expected count	35.28	72.72	108		Expected count	44.71	91.29	136
	Standardized residuals	-.5	.5			Standardized residuals	-.5	.5	
True	Count	15	27	42	True	Count	4	6	10
	Expected count	13.72	28.28	42		Expected count	3.29	6.71	10
	Standardized residuals	.5	-.5			Standardized residuals	.5	-.5	
X^2 (DF, N°), *p* value, Phi-coefficient	X^2 (1, N = 150) = .25, p = .62, φ = .04				Fisher's exact test, *p* value, Phi-coefficient	.33, p < .73, φ = .04			

Note. GMO = Genetically modified organisms.

Table S11. Chi square and Fisher's exact tests comparisons between information search during survey and belief in misinformation

COVID-19 Super virus		Information search during survey			Dengue GMO (Mosquito)		Information search during survey		
		No	**Yes**	**Total**			**No**	**Yes**	**Total**
False	Count	112	10	112	False	Count	114	10	124
	Expected count	112.9	9.13	112		Expected count	114.59	9.41	124
	Standardized residuals	-.73	.73			Standardized residuals	-.53	.53	
True	Count	24	1	25	True	Count	20	1	21
	Expected count	23.13	1.87	25		Expected count	19.41	1.59	21
	Standardized residuals	.73	-.73			Standardized residuals	.53	-.53	
Fisher's exact test, *p* value, Phi-coefficient	.75, $p = .69$, $\varphi = .06$				Fisher's exact test, *p* value, Phi-coefficient	.56, $p = 1.00$, $\varphi = .04$			
COVID-19 vaccine side-effects in children		**No**	**Yes**	**Total**	**Vinegar**		**No**	**Yes**	**Total**
False	Count	90	10	100	False	Count	97	10	107
	Expected count	92.52	7.48	100		Expected count	98.53	8.47	107
	Standardized residuals	-1.69	.169			Standardized residuals	-1.14	1.14	
True	Count	46	1	47	True	Count	31	1	32
	Expected count	43.48	3.52	47		Expected count	29.47	2.53	32
	Standardized residuals	1.69	-.169			Standardized residuals	1.14	-1.14	
Fisher's exact test, *p* value, Phi-coefficient	1.62, $p = .17$, $\varphi = .14$				Fisher's exact test, *p* value, Phi-coefficient	1.15, $p = .46$, $\varphi = .10$			
Ivermectin for COVID-19 prevention and treatment		**No**	**Yes**	**Total**	**Ivermectin for Dengue prevention and treatment**		**No**	**Yes**	**Total**
False	Count	97	10	107	False	Count	124	11	135
	Expected count	98.99	8	107		Expected count	124.69	10.31	135
	Standardized residuals	-1.4	1.4			Standardized residuals	-.89	.89	
True	Count	39	1	40	True	Count	9	0	9
	Expected count	37	2.99	40		Expected count	8.31	.69	9
	Standardized residuals	1.4	-1.4			Standardized residuals	.89	-.89	
Fisher's exact test, p value, Phi-coefficient	1.38, $p = .29$, $\varphi = .11$				Fisher's exact test, *p* value, Phi-coefficient	0, $p = 1.0$, $\varphi = .07$			

Note. GMO = Genetically modified organism.