

The impact of personal pseudoscientific beliefs in the pursuit for non-evidence-based health care

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ABSTRACT | INTRODUCTION: Pseudoscientific beliefs are widespread in society and are influenced by several factors. The endorsement of alternative medicine treatments, primarily not evidence-based, has relevant negative impacts on health care public policies. Understanding the impact of pseudoscientific beliefs on the endorsement of alternative treatments is a relevant issue in this matter. **OBJECTIVES:** We aim to describe scientific and pseudoscientific beliefs and how they impact people's choice of evidence-based healthcare treatments. **METHOD:** We surveyed a representative sample of 2,091 participants from all Brazil geopolitical regions and 130 different cities. We measured knowledge about health treatments, including alternative medicine treatments, and trust in each treatment, if treatment had been previously sought, if treatments should be funded by the public health system, among other issues. We also measured beliefs in scientific and pseudoscientific claims using a 5-point Likert agreement scale with nine items with two factors: Scientific beliefs and Pseudoscientific beliefs. **RESULTS:** Our results show that most of the sample recognizes conventional medicine as a treatment (64.5%), but also alternative medicine practices such as homeopathy (69.2%) and spiritual therapy (68.6%). We found that pseudoscientific beliefs significantly predict support of all alternative medicine treatments (betas regression coefficients ranging from .13 to .38 all $p < .01$). On the other hand, evidence-based medicine's support is rooted in scientific beliefs (beta = .12, $p < .01$). **CONCLUSION:** Our results have shown a high prevalence of pseudoscientific beliefs related to non-evidence-based health treatments. It also shreds favorable evidence that general pseudoscientific beliefs are relevant to assess the endorsement of non-evidence-based healthcare.

KEYWORDS: Alternative health care. Public Health Care Policy. Beliefs. Pseudoscience.

The belief in pseudoscientific knowledge is widespread in society. It is not restricted to any country, consisting of a worldwide issue. It is also not restricted to any field or specialty, ranging from business and science to medical solutions. In the present paper, we consider pseudoscience any claim with no evidence base, either because it lacks empirical research to produce such evidence or because there is actual evidence showing that such claims do not fit the empirical world's reality.¹⁻⁴ The use of pseudoscientific claims to deal with problems can produce wrong solutions to real problems or, in harsher situations, harm people and institutions.⁵ For instance, a survey conducted by Pew Research in the US in 2016 showed that 2% percent of Americans eschew science-based medicine altogether, using only "alternative" procedures.⁶

The appeal of non-evidence-based practices happens because of a plethora of factors. One set of such factors is related to consumers' belief systems, how people's cognitive processes gather information and build such beliefs, and the social environment in which people seek confirmation of such beliefs. The way beliefs and cognitive representations, based, overall, on personal and close one's experiences, biased by several distinct cognitive processes, are fundamental mechanisms to understand why people adhere to non-evidence-based practices.⁷⁻¹⁴ This study analyzes personal beliefs on science and pseudoscience as predictors of evaluations and intentions to seek non-evidence-based health practices. This kind of study can help to formulate public policies to inform the population better. In a post-COVID-19 pandemic era, it will be essential to understand such processes better to improve our capacity to deal with health emergencies.

We consider that the population knowledge about alternative medicine issues is a fruitful field to explore the impact of scientific and pseudoscientific beliefs. Alternative medicine can be defined as incorporating two key elements: (a) its efficacy is either unproven or disproved, and (b) the rationale for testing it in a trial cannot be expressed in acceptable scientific language.¹⁵ Language is an important, even if often overlooked, dimension of alternative medicine: in

some modalities of alternative medicine, even the distinction between "pseudo-profound bullshit" and "scientific bullshit," proposed in Bishop and Stenger¹⁶, seems to dissolve or to meet its borderline instances, as in the case of "quantum" health claims.¹⁶ There has been an effort to rebrand alternative medicine, and modern practitioners prefer to call it complementary or integrative. That is certainly the case in Brazil, where these practices are called Integrative and Complementary Practices (PICs, in the Portuguese Acronym). None of the 29 modalities of PICs offered in Brazil are evidence-based. A list of the modalities can be found on the Ministry of Health website (<https://antigo.saude.gov.br/saude-de-a-z/praticas-integrativas-e-complementares>). The lack of evidence to support these practices, all 29 of them, is described by Ernst.¹⁷ Ernst lists 150 modalities of alternative medicine and the level of evidence found for each one. Possible exceptions can be made only to a few practices involving sports, meditation, and some (but not all) herbal remedies.

Beliefs are a fundamental part of the social world because they are developed and reinforced through social contact within a culture.¹⁸⁻¹⁹ A kind of relevant issue is the beliefs developed about pseudoscientific knowledge. Particularly in health-related fields, the appeal of pseudoscientific practices is high, as evidenced by the significant number of products and treatments based on pseudoscientific assumptions.²⁰ It is the case of PICs that have been offered by the public health system since 1980 and were formally included in national health guidelines in 2006 through an administrative act privative to the health minister.²¹ More recently, in 2018, the Brazilian Ministry of Health increased the list of such PICs to 29.

Considering the context of non-evidence-based treatments produced by PICs in Brazil, we decided to analyze personal beliefs about science and pseudoscience as predictors of evaluations and intentions to seek PICs and non-PICs health treatments. The research was carried out in a representative sample of Brazilians, with standardized measures of beliefs, knowledge of PICs, seek for PICs to treatment, among other issues.

Method

Sampling and Data Collection Procedures

DataFolha Institute (<http://datafolha.folha.uol.com.br/>) was responsible for the data collection. DataFolha is a private polling service that performs routine surveys of public opinion using a standard methodology. It was a face-to-face procedure in which several researchers went to critical points of each city and town to recruit and interview each participant individually during March of 2019. The trained researchers had a protocol to follow concerning the approach, data collection, and questionnaire application. People were approached randomly at busy pedestrian traffic centers such as metro stations and bus stops. Interviews were made in person, by a trained pollster, with a ten-minute duration. Data was collected in the adult population in metropolitan and small-medium size cities, covering all Brazilian regions and 130 cities and towns. The data collection followed all ethical guidance described in international regulations of behavioral and survey research, such as obtaining participants oral consent after presenting information of the research purpose, the risk involved in taking part, the possibility to abandon the research at any moment without any consequences and about the confidentiality and anonymity of the participation.

Measures

The questionnaire applied had more than 40 items, surveying a broad list of features related to PICs, beliefs, and demographics. A set of 13 items evaluated knowledge about health treatments, including PICs, in a dichotomous answer scale yes-no (items examples: Do you know or even only heard of: conventional medicine, homeopathy, reiki). The same set of 13 items answered in an 11-points Likert trust scale (0=do not trust; 10=trust completely). Also, the same set of 13 practices were associated with a yes-no question of treatment previously sought. Five ranking questions, answered through the setlist of 13 practices to participants, inform the seeking priority in case of need. A list of six questions, associated with a yes-no answer, asked if some issues related to the 13 practices should be funded by the public health system (items examples: traditional knowledge, spiritual energy).

Belief measure. A set of nine items evaluating - in a 5-point Likert agreement scale - personal beliefs, exploring issues related to a diversified range of topics to explain nature events (items list: B1. Alternative medicine is a good option to treat diseases; B2. The Earth orbits the Sun; B3. Genetically modified food is bad for health; B4. Aliens visited ancient civilizations on Earth, B5. Governments hide information about aliens, B6. It is important to get vaccinated because it brings benefits to health; B7. Humans and chimpanzees come from a common ancestor, B8. Spiritual energy has healing power; B9 Global warming and climate changes from human activities are a real problem that will bring severe effects to society and the natural environment). As a strategy to analyze data with parsimonious structure, accessing the latent structure of beliefs organization, we did a principal component data reduction analysis. Using a Promax rotation method, the principal components analysis resulted in an interpretable two-factor latent structure. The first factor aggregated four pseudoscientific beliefs with factor loadings ranging from .42 to .80 in the following order (from higher to lower factor loading): B4, B5, B8, and B1. The second factor aggregates four scientific beliefs with factor loadings ranging from .66 to .40 in the following order (from higher to lower factor loading): B6, B2, B9, and B7. The belief related to genetically modified food (B3) did not reach the minimum level of factor loading (.30), then it is not possible to consider it as aggregated to the second factor. Such a result demonstrates that the correlation pattern indicates that the sample can discriminate between the two dimensions.

Statistical Analysis

The data analysis included descriptive statistics of all variables, knowledge of each health treatment, and beliefs. A factor analysis was done to identify the latent factorial structure of beliefs, as described in the measures section. It was done analysis of variance (ANOVAs) considering the two-belief factor measures as dependent variables and the seek and trust of each health treatment as independent variables. Finally, to reach the paper's main objectives, we did multiple regression analysis considering each health treatment as criterion variable and the two beliefs factors as antecedent variables.

Results

This study had a representative sample of 2,091 participants from all Brazil geopolitical regions and 130 different size cities. It was designed as representative of the Brazilian population, considering several demographic characteristics such as educational level, gender, monthly income, type of city of residence. The mean age was 40.8 years (SD = 16.2), with 52.1% of females. Most of the sample was married (44.2%), followed by singles (41%), divorced (9.6%), and widowed (5.2%). Concerning family monthly income, 44.9% received up to two minimum wages (approximately US\$ 400.00). As for educational level, 35.1% of the sample declared complete high school, and only 9.9% had a completed undergraduate degree. 95.8% of the sample believe in a supernatural being.

We present descriptive and correlational results. As shown in Table 1, an expressive amount of the sample (above 60%) recognizes conventional medicine and homeopathy, spiritual therapy, acupuncture, and benzedeira (Brazilian folk healers, mainly women). Concerning trust, the highest mean is related to conventional medicine, followed by acupuncture, homeopathy, and Herbal therapy.

Table 1. PICs recognition and trust

Do you know, even only heard about:	Yes	No	Trust
			Mean (SD) and [95% CI]
Conventional medicine	1,349 (64.5%)	742 (35.5%)	7.64 (2.33) [7.52; 7.77]
Homeopathy	1,446 (69.2%)	645 (30.8%)	6.73 (2.85) [6.58; 6.88]
Spiritual therapy	1,435 (68.6%)	656 (31.4%)	6.08 (3.53) [5.90; 6.27]
Acupuncture	1,491 (71.3%)	600 (28.7%)	7.06 (2.76) [6.92; 7.20]
Reiki	443 (21.2%)	1,648 (78.8%)	5.74 (3.18) [5.44; 6.03]
Anthroposophic medicine	231 (11%)	1,860 (89%)	6.18 (3.05) [5.78; 6.57]
Naturopathy	420 (20.1%)	1,671 (79.9%)	6.36 (2.86) [6.09; 6.64]
<i>Benzedeira</i> (folk healers)	1,671 (79.9%)	420 (20.1%)	5.22 (3.81) [5.04; 5.40]
Aromatherapy	848 (40.6%)	1,243 (59.4%)	5.47 (3.07) [5.26; 5.68]
Florals	879 (42%)	1212 (58%)	6.03 (3.07) [5.83; 6.24]
Herbal therapy	1,041 (49.8%)	1,050 (50.2%)	6.59 (2.98) [6.41; 6.77]
Ayurveda	141 (6.7%)	1,950 (93.3%)	5.79 (3.01) [5.29; 6.29]
Cromotherapy	548 (26.2%)	1,543 (73.8%)	6.07 (2.92) [5.83; 6.32]

Knowledge evaluation of each practice (percentage in brackets) and mean of trust assessment (standard deviation in parenthesis) to the health treatments setlist. All data are bases on 2,091 sample participants.

When asked which professional/practice the participant would choose as the first option in case of disease, 1,493 (71.4%) indicated the conventional medical doctor, followed by spiritual therapist 136 (6.5%), benzedeira 112 (5.4%), and homeopathic physician 103 (4.6%). When asked which professional the participant would choose as the second option in case of disease, 343 (16.4%) participants indicated the homeopathic doctor, followed by spiritual therapist 281 (13.4%), and conventional physician 168 (8%). Finally, when asked what criteria should be used to validate practices covered by the public health system, 1,284 (61.4%) participants agreed that traditional knowledge should be a valid criterium, followed by scientific tests 1,527 (73%), ancient wisdom 1,011 (48.4%), spiritual energies 750 (35.9%), the testimony of celebrities 541 (25.9%), and religious rituals 617 (29.5%).

Concerning the general beliefs of the sample, as can be seen in Table 2, there is a high degree of agreement (high means with a standard deviation above one) with fundamental knowledge produced by scientific discoveries, such as the importance of vaccines and the fact that Earth orbits the sun. Global warming also has a reasonable degree of agreement but with more disagreement within the sample. On the other hand, there is a low level of agreement concerning human evolution's scientific fact, also showing a higher level of disagreement within the sample. When we analyze the latent factor structure, the two last lines of Table 2, individual items' pattern is more precise. The sample endorses more scientific beliefs, with lower variation between sample than pseudoscientific beliefs that, for its turn, has more variation within the sample.

Table 2. Scientific and pseudoscientific beliefs agreement

Statements	Agreement
	Mean (SD) and [95% CI]
B1. Alternative medicine is a good option to treat diseases	4.15 (1.19) [4.10; 4.20]
B2. The Earth orbits the Sun	4.71 (.86) [4.68; 4.75]
B3. Genetically modified food is bad for health	3.95 (1.43) [3.89; 4.01]
B4. Aliens visited ancient civilizations on Earth	2.35 (1.63) [2.27; 2.42]
B5. Governments hide information about aliens	2.64 (1.73) [2.57; 2.72]
B6. It is important to take vaccines because it brings benefits to health	4.80 (.65) [4.77; 4.82]
B7. Humans and chimpanzees came from a common species	3.16 (1.71) [3.08; 3.23]
B8. Spiritual energy has healing power	3.57 (1.60) [3.50; 3.64]
B9. Global warming and climate changes from human activities are a real problem that will bring severe effects to the society and natural environment	4.50 (1.11) [4.45; 4.54]
Latent Component: Pseudoscientific beliefs	3.20 (1.04) [3.15; 3.24]
Latent Component: Scientific beliefs	4.30 (.65) [4.27; 4.33]

Mean agreement (standard deviation in brackets) with the belief statements in a 5-point agreement scale in which number near 5 indicates strong agreement. All data are bases on 2,091 sample participants.

To comprehend the impact of beliefs on the endorsement of treatment strategies, we explored correlations between the two sets of variables. Initially, we explored the relationship between trust in each strategy and the seek in case of diseases in the first choice. An ANOVA shows a significant difference between all levels of the first choice and trust assessment ($F_s > 1.7$; $p_s < .05$), probably because the categories have extremely high differences in their number of participants in each level. Analyzing each category's means shows that the trust level is coherent with the first choice to almost all categories. For instance, homeopathy's trust level is higher in participants who choose homeopathy as the first choice ($M=8.10$; $SD=2.42$). However, it is not the case when we analyze the category of a conventional physician as the first choice when the order of higher means are: reiki ($M=8.50$; $SD=1.73$), anthroposophic physician ($M=8.01$; $SD=2.57$), herbal therapist ($M=7.96$; $SD=2.88$), florals ($M=7.86$; $SD=1.77$), and conventional physician ($M=7.75$; $SD=2.20$). It could appear as a weird occurrence, but as cognitive research shows us, such kind of incoherence is perfectly explained by specific cognitive processes when it comes to beliefs.

When we cross-tabulate trust with the support given by the public system, some important results show up. There is no difference $F(1, 1347) = .44; p = .887$ in trust assessment of conventional medicine between individuals who endorse traditional knowledge to be funded by the public system, but there are differences when comparing trust assessment homeopathy, acupuncture, and herbal therapy. For homeopathy: $F(1, 1444) = 25.15; p < .001$, people who support public funding of traditional knowledge are more likely to trust homeopathy. For acupuncture $F(1, 1489) = 26.27; p < .001$ and herbal therapy $F(1, 1039) = 32.06; p < .001$ the same pattern is seen. When analyzing public funding support for scientific evidence, results have shown that there are significant differences in the four trust group assessments. For conventional medicine $F(1, 1347) = 9.93; p = .002$, people who support public funding of traditional knowledge also trust conventional medicine. The same pattern happens with homeopathy $F(1, 1444) = 40.08; p < .001$, acupuncture $F(1, 1489) = 42.67; p < .001$ and herbal therapy $F(1, 1039) = 7.26; p = .007$.

For the sake of brevity and parsimony, we explored the relation of beliefs and health practices, the primary purpose of this paper, only through the two-factor latent structure of beliefs. 13 multiple regression models were calculated to understand how general beliefs (pseudoscientific and scientific) predict trust evaluation of the health practices, one for each trust assessment. As can be seen in Table 3, there is a clear pattern between beliefs and trust. Scientific beliefs positively predict only trust in conventional medicine. All the other 12 health practices (PICs) are positively predicted by pseudoscientific beliefs, some of them with medium effect sizes. Only two PICs have scientific beliefs as predictors: acupuncture and benzedeira (folk healers). Probably the first is influenced by the fact that the Federal Medical Board recognizes it as a medical specialty, and the latter is a popular and nationally recognized religious practice. Given that the sample has a vast majority of theists, it is probable that believers' scientific beliefs account for such an effect.

Table 3. Prediction of beliefs about PICs

Practice:	Beta		Model
	Pseudoscience beliefs	Science beliefs [95%	
	[95% CI for B]	CI for B]	
Conventional medicine	.01 [-.01; .15]	.12* [.25; .65]	$R^2 = .02; F = 10.48^*$
Homeopathy	.16* [.30; .58]	.05 [-.004; .46]	$R^2 = .03; F = 23.20^*$
Spiritual therapy	.38* [1.12; 1.45]	.00 [-.27; .28]	$R^2 = .14; F = 117.21^*$
Acupuncture	.20* [.38; .65]	.08* [.12; .56]	$R^2 = .05; F = 38.10^*$
Reiki	.30* [.65; 1.20]	.04 [-.27; .64]	$R^2 = .10; F = 23.07^*$
Anthroposophic medicine	.29* [.51; 1.27]	.00 [-.61; .61]	$R^2 = .09; F = 10.63^*$
Naturopathy	.24* [.39; .91]	-.04 [-.63; .23]	$R^2 = .06; F = 12.13^*$
<i>Benzedeira</i>	.26* [.79; 1.13]	.11* [.38; .94]	$R^2 = .09; F = 80.89^*$
Aromatherapy	.25* [.55; .94]	.05 [-.07; .56]	$R^2 = .07; F = 30.27^*$
Florals	.23* [.51; .91]	-.01 [-.36; .29]	$R^2 = .05; F = 25.02^*$
Herbal therapy	.13* [.21; .57]	-.004 [-.31; .28]	$R^2 = .02; F = 9.23^*$
Ayurveda	.25* [.25; 1.24]	-.07 [-1.02; .43]	$R^2 = .07; F = 4.77^+$
Chromotherapy	.20* [.33; .79]	-.04 [-.58; .22]	$R^2 = .04; F = 11.25^*$
Bivariate Correlation (Pearson r)		.17*	-

* $p < .01$, + $p < .05$.

Multiple regression analysis of the 13 health practices with factors pseudoscientific and scientific beliefs as predictors. 95% confidence intervals is for unstandardized B coefficients and not of standardized Beta coefficients.

As a strategy to assess how beliefs can be explained by other measures used in this research, we performed a series of ANOVAs considering the two latent factor beliefs as dependent variables. When we analyzed the decision of what to seek in case of diseases as a first choice, we found a significant difference to pseudoscientific beliefs $F(12, 2070) = 4.73, p < .001$. The pairwise comparison has shown that this difference happens with participants who seek spiritual energy therapy; they endorse significantly more pseudoscientific beliefs than all other participants. Concerning scientific beliefs, there is also a significant difference with lower magnitude $F(12, 2078) = 2.04, p = .02$, but pairwise comparisons did not show any significant difference.

As of the ANOVA's evaluation of which strategy should base the inclusion of practices in the public health system, some differences stand out. There is a significant difference in pseudoscientific beliefs in participants who agree that traditional knowledge should base the system $F(1, 2081) = 60.76, p < .001$, with a participant who agrees with a more significant mean ($M=3.34, SD=.99$) than the ones who do not agree ($M=2.97, SD=1.08$). When evaluating if religious rituals should base the system, the same pattern appears. There are differences only in pseudoscientific beliefs $F(1, 2081) = 140.44, p < .001$ with a participant who agrees with a more significant mean ($M=3.60, SD=.95$) than the ones who do not agree ($M=3.02, SD=1.03$). On the other hand, when questioned if scientific tests should base the public health system, there are differences between both sets of beliefs. For pseudoscientific beliefs $F(1, 2080) = 76.05, p < .001$, participants who agree ($M=3.31, SD=1.01$) have a greater level of such beliefs than those who disagree ($M=2.87, SD=1.07$). For scientific beliefs $F(1, 2089) = 29.94, p < .001$, the same pattern repeats, in which participants who agree ($M=4.34, SD=.62$) have a greater level of such beliefs than those who disagree ($M=4.17, SD=.71$).

Further analysis in the data found out that 29% of the participants form a cluster of "science-aligned" citizens. Such citizens present the highest level of agreement with the statements: "The Earth revolves

around the Sun," "It is important to get vaccinated because vaccines are beneficial for your health," "Human beings and chimps come from a common-origin species," and "Human-made global warming and climate change are a real problem." They also present the highest levels of disagreement with the statements "Alternative medicine is a good option to treat diseases," "Spiritual energy can heal," "Transgenic food, that is, genetically modified food is bad for your health," "Aliens have visited ancient civilizations on Earth" and "Governments hide information about aliens."

However, even in this cluster, the acceptance of pseudoscientific claims is high: 74% of its members agree that "Alternative medicine is a good option to treat diseases," 63% agree that genetically modified organisms (GMOs) are harmful to human health (the proportions of those who disagree with both statements, of 24% and 35% respectively, are, nonetheless, the highest ones for these items in the whole sample). The trusting score on acupuncture is also high, of 7.1 points on a 0-to-10 scale (trust in conventional, science-based medicine has a score of 7.9 in the same cluster).

Discussion

This research aimed to evaluate the impact of scientific and pseudoscientific beliefs on the endorsement of PICs. Overall, our results show a systematic prediction of beliefs over trust and endorsement of PICs. Systematically the pseudoscientific beliefs positively predicted trust in PICs. On the other hand, scientific beliefs positively predicted trust in conventional medicine. Such a pattern of results is a shred of favorable evidence that general pseudoscientific beliefs are relevant to assess the endorsement of pseudoscientific claims in specific issues, as is the case of PICs in the field of health. This pattern shows that it is necessary to promote a broader understanding to the population of the features of pseudoscientific thinking and claims. However, there are wrinkles.

Besides our survey, other Brazilian and international surveys have assessed the public perception of science, although their focus has been mainly on how the population feels about science and scientists and public funding (<http://percepcaocti.cgee.org.br>, <https://wellcome.ac.uk/what-we-do/our-work/public-views-science-and-health>). The Brazilian survey, conducted by the Ministry of Science, Technology, and Innovation, shows that trust in science decreased from 2015 to 2019 and that 90% of the respondents could not name one single Brazilian Scientist or Research Institution. It also showed that 74% of the respondents are afraid of GMOs, and 78% believe that antibiotics work for virus infections. The Wellcome Trust survey, conducted in several countries worldwide, showed that mainly for the Brazilian population if scientific facts conflict with religious beliefs, Brazilians tend to choose religion over science. Together with our results, these results point to a very confused population when it comes to scientific thinking. It seems to us that the main reasons for this science illiteracy are the lack of understanding of how science works and the endorsement of pseudoscience by government and public universities.

Scientific literacy is not acquired solely by understanding the scientific method. Pseudoscience has to be described and adequately debunked. Dyer and Hall²² surveyed unwarranted beliefs among undergraduate students, comparing students who attended regular scientific method courses with those who attended a specific course on "Science and Nonsense." Siegrist and Bearth²³ evaluate decision-making processes regarding chemophobia and the appeal of the "natural" fallacy. Both studies suggest the need for better communication and exposure to pseudoscience. We suggest that the same principle applies to alternative medicine beliefs.

Many alternative medicine providers disseminate false information about the safety of vaccines, for instance.²⁴ The promotion of PICs can create risk for patients who decide not to seek mainstream medicine, harm people directly from the use of untested herbs or traditional procedures, and valuable waste resources, failing to provide real healthcare for those in need.⁶

Our study is certainly not without limitations. It is a preliminary study, and future ones should refine the questionnaire to assess science understanding, using more elaborate tests and problem-solving situations. A thorough survey on science understanding was conducted by the National Science Foundation in the US.²⁵ NSF assessed the respondent's ability to solve simple problems using scientific reasoning. The cases included using simple concepts of statistics and the use of control groups in clinical trials. Since our goal is to understand pseudoscientific beliefs in PICs, future surveys should assess these abilities and apply them to Brazilian PICs in the healthcare system. Replicating Dyer and Hall's work, introducing a Science and Nonsense course in Public Universities is also a goal to pursue.

In a new era after the COVID-19 pandemic, increasing literacy on scientific thinking and health strategies will be of utmost importance. Our work exposes the fragility of Brazilian's unwarranted beliefs. That might have contributed to the fact during the COVID-19 pandemic, our population and physicians adhered so easily to another set of unwarranted beliefs in unproven Covid drugs.

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Author contributions

Taschner NP and Orsi C designed and coordinated the study and data collection. Pilati R analyzed the data and drafted the first version. Taschner NP, Orsi C and Almeida P revised the manuscript. All authors reviewed and agreed to the publication of the final version of the paper.

Competing interests

No financial, legal, or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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