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Research article

Risk perception of healthcare workers in the first wave of the COVID-19 pandemic in Brazil

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ABSTRACT

Objectives: To validate the items of the Emotional Impact Questionnaire coronavirus disease-2019 (COVID-19) related to risk perception, estimating its degree, among healthcare workers in the first wave of COVID-19 pandemic, identifying possible associated factors.
Methods: cross-sectional study in 1872 healthcare workers of Brazil. The population was characterized by sociodemographic and occupational information, knowledge about COVID-19, quality of information received, risk perception and preventive measures about the disease, and sense of coherence.
Results: Being divorced, having a chronic disease, spending more than 1 h per day getting informed about COVID-19, and always or almost always wearing a mask regardless of symptoms, as well as self-perception of health were associated with high-risk perception. An inverse association was found between risk perception, sense of coherence and not knowing if one has had occasional contact with confirmed COVID-19 cases.
Conclusion: Risk perception is influenced by emotions, experiences, and knowledge. Sense of coherence and resilience have a role in reducing risk perception. Understanding risk perception is crucial for developing effective strategies to mitigate the impact of the COVID-19 pandemic and other similar scenarios.

Key messages

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- This study highlights the relevance of the association between risk perception and attitudes towards COVID-19 among healthcare workers.
- The findings emphasize the subjective nature of risk perception, influenced by emotions, experiences, and knowledge.
- Risk perception emphasizes the role of the sense of coherence and resilience.
- Understanding risk perception is crucial for developing effective strategies to mitigate the impact of the COVID-19.

1. Introduction

Little over three years after the first cases of COVID-19 emerged and the World Health Organization (WHO) declared it a pandemic [1,2], the disease has infected nearly 690 million people (88,455 cases per million) and caused approximately 6.9 million deaths (883 deaths per million) [3]. Healthcare workers experienced a substantial burden during this period, characterized by high morbidity and mortality rates, alongside various physical and mental health issues [4]. The demands placed on these professionals, who were at the forefront of the pandemic response, combined with the inadequate availability of personal protective equipment exposed them to an increased risk of infection, resulting in a higher infection rate when compared to the general population [4,5], increased odds of COVID-19 death [6] and a high excess mortality rate [7,8], at least until vaccines became available [9].

In view of the above circumstances, it should come as no surprise that healthcare workers presented a higher risk perception for COVID-19 than the general public [10,11]. Risk perception (RP) addresses the intuitive risk assessment that people do when evaluating hazards that they are or might be exposed to Ref. [12]. Even though risk is considered an objective state of the world by various disciplines, including health sciences [12,13], individuals may perceive risk differently [13,14]. How someone will perceive a risk is influenced by three key factors: (I) hazard characteristics (both qualitative and quantitative); (II) individual characteristics (including sociodemographic characteristics, psychological traits, worldviews, value orientations, specific knowledge, and scientific reasoning abilities); and (III) the utilization of simplifying "shortcuts" known as heuristics to interpret risk information [15–17].

Previous research indicates that RP plays a significant role in health-related events by influencing individuals' adherence to preventive measures [18,19], attitudes and behaviors [20–22], including testing [23] and social distancing [24], vaccination intentions [25,26] and support for vector control strategies [27]. These factors, in turn, may impact the spread and control of epidemics by affecting their timing, dynamics, and overall case numbers [28]. Moreover, risk perception is intricately linked to mental health outcomes [29]. High levels of perceived risk can lead to increased fear, anxiety, depression, and psychological distress [29–31]. Therefore, understanding RP during a pandemic is crucial, as it significantly influences both public health outcomes and individual well-being. This importance is especially pronounced among healthcare workers, who play an essential role in pandemic response. However, while in some fields, such as environmental risks, risk perception has been studied intensively, there is still much to understand about RP of emerging infectious diseases [32].

Consequently, numerous studies have investigated several aspects of COVID-19 RP [10,11,29–31,33–35]. However, despite the fact that the COVID-19 pandemic created a disastrous scenario in Brazil, placing the country at the top of the ranking of infections and deaths alongside the United States [36], there is a limited body of research specifically addressing COVID-19 RP in the country. This knowledge gap is particularly distinct among healthcare workers, as existing studies on their RP were limited to individuals from Rio de Janeiro [37,38] or to members of two specific professional societies, namely the Society of Intensive Care and the Brazilian Association of Emergency Medicine [39]. Thus, this study aims to assess COVID-19 RP and its associated factors among Brazilian healthcare workers across the entire country and various professions during the first pandemic wave.

2. Methods

2.1. Design

This cross-sectional study followed the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) guidelines and is part of a broader international research project, that aimed to evaluate the psychological impact of the COVID-19 pandemic, both within the general population and among healthcare professionals [40]. The coordination of the study was centralized in Spain, and it was implemented in 16 countries across Latin America, Europe, Africa, and Asia. A consistent methodology was employed, albeit with variations due to the adaptation of the questionnaire to each participating country and differences in data collection timelines. In Brazil, data collection was carried out from April 23 to May 30, 2020 (thus, encompassing the initial two months following WHO's pandemic declaration), and obtained over 5500 responses, of which 1872 were from healthcare workers.

2.2. Participants

Participation was limited to healthcare workers aged 18 years or older who resided in Brazilian territory. Considering the crucial need for social distancing measures during this period, all the recruitment process was needed to be conducted exclusively through online means. Therefore, participants were recruited using a non-probabilistic snowball sampling method through e-mails, professional networks, and digital social channels such as WhatsApp, Facebook, Instagram, Twitter, and LinkedIn. Snowball sampling techniques are frequently employed in cases where the study population is unknown, presenting challenges in the selection of participants who satisfy the specified eligibility criteria [41]. Thus, since there is not a national registry of Brazilian healthcare workers

and its demography is unknown, snowball sampling was deemed a suitable method for the recruitment of study participants.

2.3. Data collection instrument

The research questionnaire (see Supplementary File 1), denominated Emotional Impact Questionnaire COVID-19 Brazil (EIQ-BR), was translated and culturally adapted to the Brazilian population from a questionnaire that had already been developed and validated for use in the Spanish population. Further information regarding the Spanish questionnaire development and validation is available elsewhere [42]. The Brazilian version of the questionnaire was initially analyzed by a panel of ten experts consisting of psychologists, physical therapists, physicians, nurses, and public health professionals, and items that presented difficulty in terms of understanding were subsequently modified. After that, it was made available online (at https://cutt.ly/IMPACT_COVID-19_BRASIL) and open to anyone interested in responding. In addition to the translation and cultural adaptation for the Brazilian population, EIQ's Spanish version was also translated, validated, and used in several countries [43–47].

The EIQ-BR collected a variety of information, including sociodemographic, occupational, health-related and COVID-19 contact history, as well as data regarding the sense of coherence. Sense of coherence is a theoretical construct that describes an individual's ability to comprehend, cope with, and find meaning in stressful life situations. A high sense of coherence is associated with the perception that stressors are comprehensible, predictable, and manageable, and that the person possesses resources to deal with them [48]. Sense of coherence was assessed through the 13 item version of Antonovsky's sense of coherence scale (SOC-13) [49]. In addition to the aforementioned information, the EIQ-BR also included 9 questions about RP concerning COVID-19. Participants were asked to rate the following questions on a scale of 1–10, reflecting a spectrum of increasing RP: 1) How would you rate your level of concern about COVID-19? (scale: not at all to very concerned); 2) What probability do you believe you have of surviving COVID-19 if you become infected or have already been infected? (scale: very likely to not likely at all); 3) How confident are you in the ability of healthcare workers to diagnose or recognize COVID-19? (scale: very confident to not confident at all); 4) How confident are you in the ability of the healthcare system to diagnose or recognize COVID-19? (scale: very confident to not confident at all); 5) How likely do you think it is that you will become infected with COVID-19? (scale: not likely at all to very likely); 6) Do you believe that getting infected with COVID-19 would have serious consequences for your health? (scale: not at all to certainly); 7) Do you believe that COVID-19 infection is difficult to treat? (scale: not at all to very difficult); 8) To what extent are you concerned about contracting COVID-19? (scale: not at all to very concerned); 9) To what extent are you concerned about being a carrier and transmitting the virus to family members, close contacts, or patients? (scale: not at all to very concerned).

Likewise, the EIQ-BR encompassed 8 questions regarding adherence to preventive measures. These questions employed a five-point response scale (never, rarely, sometimes, almost always and always) to assess the level of compliance to the following preventive measures: 1) covering the mouth with the elbow when coughing or sneezing; 2) avoiding sharing utensils during meals; 3) washing hands with soap and water; 4) cleaning hands with alcohol-based solution; 5) washing hands immediately after coughing, touching the nose, or sneezing; 6) washing hands after touching potentially contaminated objects; 7) wearing masks regardless of the presence of symptoms; and 8) maintaining at least 1.5 m of distance from other people.

2.4. Variables

In the current study, the following sociodemographic variables were elected for analyses: gender (female and male); age (complete years); marital status (single, married or living with partner, separated or divorced and widowed); having children (yes and no); having pets (yes and no); education level (high school, college, specialization, master's degree, doctorate); region of residence (North, Northeast, Midwest, Southeast, South); type of housing (apartment with balcony, apartment without balcony, house with garden or backyard, house without garden or backyard and other) and time spent per day getting informed about COVID-19 (up to 1 h, 1–4 h, 4–8 h and more than 8 h).

While the occupational variables were: employment status (partial work from home, partial work outside home, full-time work from home, full-time work outside home, mixed and Other); type of employment (self-employed, public sector employee and private sector employee); healthcare profession (nurse, physician and other); professional experience (up to 5 years, 6–10 years and more than 10 years); and being involved in healthcare provision (yes and no).

The health-related and COVID-19 contact history variables were: having any type of disability; having a chronic illness; currently taking medication; medical care at a healthcare facility in the past 14 days; hospitalization in the past 14 days; currently in isolation; underwent diagnostic testing for COVID-19; experienced symptoms of COVID-19 (responses for this and the previous seven variables were yes and no); number of symptoms experienced (none, 1, 2–4, 5–7, 8–10); perception of health in the last 14 days (very poor, poor, fair, good and very good); close contact - i.e. up to 15 min or less than 2 m - with a confirmed infected person (yes, not sure and no); occasional casual contact with a confirmed infected person (yes, not sure and no); contact with a suspected infected person or material (yes, not sure and no); family member infected with COVID-19 (yes, not sure and no); belief of having contracted the virus (yes, probably yes and no).

To assess participant's sense of coherence, a score was obtained by the sum of the responses from the SOC-13 items (discrete variable ranging from 13 to 91 points). The higher the score, the stronger the sense of coherence.

With respect to preventive measures, an adherence score (discrete variable ranging from 0 to 8 points) was created by summing the individual scores for each of the 8 question that assessed the adherence to preventive measures. To do so, the responses "always" and "almost always" were both assigned one point, while the other response options were assigned zero points. The higher the score, the greater the adherence.

Finally, an overall RP score (discrete variable ranging from 9 to 90) was created by summing the individual score for each question of the nine RP questions. Subsequently, the RP variable was dichotomized. The cutoff point for dichotomization was determined by the median score. Consequently, individuals whose RP score fell at or below the RP score median were categorized as presenting a low RP, while those with RP scores above the median were categorized as presenting a high RP.

It is worth noting that, to assess the validity of the overall RP score employed in this study as a valid measure of RP, a cross-validation was conducted. This cross-validation involved examining the association between the overall RP score and the score of adherence to preventive measures by fitting an ad hoc simple linear regression model. The rationale behind this was based on the findings from previous studies that have found a strong association between RP and compliance with preventive measures [18,19]. The results from the simple linear regression model revealed a statistically significant association between the overall RP score and the score of adherence to preventive measures ($p < 0.01$). Additionally, it indicated a high degree of collinearity ($p < 0.01$), which corroborates findings in the existing literature.

Furthermore, the internal consistency of the nine RP questions was evaluated using Cronbach's Alpha. The result of the Cronbach's Alpha test was 0.692. This indicates that these questions are coherent and adequately capture the dimension of RP assessed in the study. It is important to note that Cronbach's Alpha values range from 0 to 1, with reliability categorized as low (0–0.2), fair (0.21–0.4), moderate (0.41–0.6), substantial (0.61–0.8), and almost perfect (0.81–1) [50]. Values above 0.6 or 0.7 are typically considered reliable [50]. Based on this criterion, our overall RP score was deemed to be reliable.

2.5. Data analysis

Initially, a descriptive analysis of the study variables was conducted. Categorical variables were analyzed using frequency measures, whereas numerical variables were examined using measures of central tendency and dispersion. Additionally, the Kolmogorov-Smirnov test was employed to assess the assumption of normality for the numerical variables.

Finally, we investigated the relationship between the independent variables and the dependent variable, RP (categorized as low and high), through logistic regression models. To do so, simple logistic regression models for each independent variable were performed. Variables with p-values less than 0.05 were subsequently incorporated into the multiple logistic regression model employing a stepwise forward procedure. In the final model, variables with p-values less than 0.05 (using a two-tailed test) were deemed associated with RP.

Variable coding and statistical analyses were performed using the IBM/SPSS statistical package, version 27.0 (IBM, Armonk, NY, USA).

2.6. Ethics approval

This study was authorized by the National Research Ethics Committee in Brazil (CAAE 30437120.4.0000.5411, April 23, 2020). Participants only had access to the questionnaire upon confirming their eligibility and expressing their willingness to participate by providing explicit consent through a digital Informed Consent Form (ICF), which was fully presented on the website's homepage.

3. Results

The study included 1872 healthcare workers from Brazil (see flow diagram in Fig. 1). Most of them (61.9 %) were engaged in direct patient care. Among the participants, 82.1 % were female, and their average age was 39.99 years (±12.41 years). In terms of their professions, 18.6 % were nursing workers, 14.3 % were physicians, while the remaining represented other healthcare professions.

Most participants followed preventive measures recommendations, perceived their own health as regular to very good, reported no

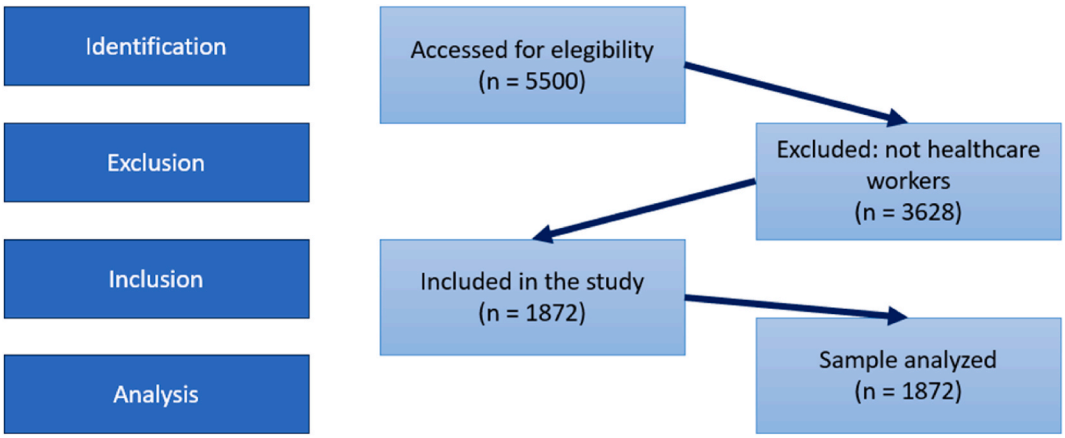

Fig. 1. Study flow chart according to STROBE guidelines.

Table 1
Sociodemographic variables, information related to COVID-19, preventive practices, and risk perception of healthcare workers (EIQ-BR, Brazil).

Variable	Categories	n	%
Gender	Male	335	17.9
	Female	1537	82.1
Marital status	Single	640	34.2
	Married or living with partner	1041	55.6
	Separated/Divorced/Widowed	191	10.2
Education level	High school	102	5.4
	College	377	20.1
	Specialization	609	32.5
	Master's degree	429	22.9
	Doctorate	355	19.0
Region of residence	North	26	1.4
	Northeast	145	7.7
	Midwest	175	9.3
	Southeast	1275	68.1
	South	251	13.4
Type of housing	Apartment with balcony	445	23.8
	Apartment without balcony	314	16.8
	House with garden or backyard	916	48.9
	House without garden or backyard	128	6.8
	Other	69	3.7
Have children	Yes	908	48.5
	No	964	51.5
Have pets	Yes	1102	58.9
	No	770	41.1
Employment status	Partial work from home	169	9.0
	Partial work outside	281	15.0
	Full-time work from home	332	17.7
	Full-time work outside	561	30.0
	Mixed	110	5.9
	Other	419	22.4
Type of employment	Self-employed	325	17.4
	Public sector employee	821	43.9
	Private sector employee	298	15.9
Healthcare profession	Nurse	345	18.4
	Physician	266	14.2
	Other	1248	66.7
Involved in healthcare provision	Yes	1158	61.9
	No	714	38.1
Professional experience	Up to 5 years	545	29.1
	6–10 years	448	23.9
	More than 10 years	879	47.0
Time spent per day getting informed about COVID-19	Up to 1 h	323	17.3
	1–4 h	776	41.5
	4–8 h	327	17.5
	More than 8 h	265	14.2
Always or almost always covering mouth with elbow when coughing or sneezing	No	160	8.5
	Yes	1496	79.9
Always or almost always avoiding sharing utensils during meals	No	295	15.8
	Yes	1361	72.7
Always or almost always washing hands with soap and water	No	22	1.2
	Yes	1634	87.3
Always or almost always cleaning hands with alcohol-based solution	No	127	6.8
	Yes	1529	81.7
Always or almost always washing hands immediately after coughing, touching the nose, or sneezing	No	350	18.7
	Yes	1306	69.8
Always or almost always washing hands after touching potentially contaminated objects	No	105	5.6
	Yes	1551	82.9
Always or almost always using a mask regardless of symptoms	No	406	21.7
	Yes	1250	66.8
Always or almost always maintaining at least a 1.5-m distance from other people	No	248	13.2
	Yes	1408	75.2
Currently in isolation	No	1385	74.0
	Yes	271	14.5
Perception of health in the last 14 days	Very poor	6	.3
	Poor	31	1.7
	Fair	256	13.7
	Good	775	41.4
	Very good	510	27.2

(*continued on next page*)

Table 1 (*continued*)

Variable	Categories	n	%
Having any type of disability	Yes	81	4.3
	No	1497	80.0
Symptoms[a] experienced in the last 14 days	No	313	16.7
	Yes	1265	67.6
Number of symptoms[a] experienced in the last 14 days	1	337	18.0
	2–4	752	40.2
	5–7	158	8.4
	8–10	18	1.0
Have a chronic illness	No	1016	54.3
	Yes	562	30.0
Currently taking medication	Yes	752	40.2
	No	826	44.1
Hospitalization in the last 14 days	Yes	10	0.5
	No	1568	83.8
Medical care at a healthcare center, hospital, or clinic in the last 14 days?	Yes	126	6.7
	No	1452	77.6
Close contact with a confirmed infected person (up to 15 min or less than 2 m)	Yes	162	8.7
	Not sure	699	37.3
	No	709	37.9
Occasional casual contact with a confirmed infected person	Yes	141	7.5
	Not sure	1256	67.1
	No	173	9.2
Contact with a suspected infected person or material	Yes	222	11.9
	Not sure	1150	61.4
	No	198	10.6
Family member infected with COVID-19	Yes	87	4.6
	Not sure	1417	75.7
	No	66	3.5
Underwent diagnostic testing for COVID-19	Yes	119	6.4
	No	1446	77.2
Belief of SARS-CoV-2 infection	Yes	61	3.3
	No	627	33.5
	Probably yes	768	41.0

Variable	**mean**	**SD**	**median**
Age	39.99	12.42	38
Final score of the risk perception scale	58.61	9.82	59
Final score of the preventive measures scale	6.96	1.21	7
SOC-13 score	60.52	14.36	61

[a] Fever, cough, headache, muscle pain, nausea, diarrhea, sore throat, runny nose, chills, and difficulty breathing. EIQ-BR: Emotional Impact Questionnaire COVID-19 Brazil. SOC-13: Sense of coherence scale.

disabilities, chronic diseases, hospitalizations, or medical care at a healthcare facility in the two weeks prior to data collection.

Regarding COVID-19, a minority of the participants reported exposure to potentially risky situations involving contact with infected individuals or contaminated objects, and having family members who were infected with the coronavirus. In contrast, the majority either denied any such contact or were unsure about it. Furthermore, most of them either denied or expressed uncertainty about having contracted COVID-19. However, approximately 67 % of the participants experienced at least one flu-like symptom within the two weeks preceding data collection, while only 6.4 % of all participants underwent diagnostic testing for COVID-19. Table 1 describes the characteristics of the overall participants.

In terms of the overall RP, the average score was 58.61 points (±9.82), with a median of 59 (out of a maximum of 90). Table 2

Table 2
Item response statistics, mean and standard deviation values of answers to risk perception questions for COVID-19 among healthcare workers (EIQ-BR, Brazil).

	Mean	SD
How would you rate your level of concern about COVID-19?	8.78	1.574
What probability do you believe you have of surviving COVID-19 if you become infected or have already been infected?	3.23	2.004
How confident are you in the ability of healthcare workers to diagnose or recognize COVID-19?	3.56	1.902
How confident are you in the ability of the healthcare system to diagnose or recognize COVID-19?	4.29	2.134
How likely do you think it is that you will become infected with COVID-19?	6.81	2.486
Do you believe that getting infected with COVID-19 would have serious consequences for your health?	6.72	2.481
Do you believe that COVID-19 infection is difficult to treat?	7.64	2.071
To what extent are you concerned about contracting COVID-19?	8.13	2.200
To what extent are you concerned about being a carrier and transmitting the virus to family members, close contacts, or patients?	9.44	1.392

EIQ-BR: Emotional Impact Questionnaire COVID-19 Brazil.

details the descriptive statistics to the nine COVID-19 RP questions. Among the participants, the most significant RP was related with the fear of being a carrier and potentially transmitting the virus to family members, close contacts, or patients. Conversely, the least prominent concern among them was related to their perceived likelihood of surviving a COVID-19 infection.

Table 3 presents the independent variables that met the criteria for inclusion in the multiple regression model. According to the result of the multiple logistic regression model (Table 4), the odds of experiencing a high RP was 183 % higher when participants perceived their health status as being poor. Divorced individuals also had a 77 % increased likelihood of presenting high RP, a magnitude like that of having a chronic disease or consistently wearing a mask regardless of symptoms. Finally, devoting 1–4 h per day to acquiring information about COVID-19 was associated with a 56 % higher likelihood of experiencing high RP. This likelihood rose to 85 % and 62 % for individuals that reported spending 4–8 h and more than 8 h daily acquiring information about COVID-19, respectively. Additionally, an inverse association was found between the sense of coherence and RP, where each one-point increase in the SOC-13 score was associated with a 3 % reduction in the likelihood of having high RP. Furthermore, not knowing if one has had casual and occasional contact with confirmed COVID-19 cases reduced the odds of having high RP by approximately 52 %.

4. Discussion

Our findings indicated that Brazilian healthcare workers presented a mean score of 58.61 points out of 90 on EIQ-BR's overall RP score. When examining individual RP questions, their highest level of concern was related to the transmission of COVID-19 to family members, friends, and patients. Previous studies have also shown that healthcare workers were more concerned about infecting others, especially family members and loved ones, than about being infected themselves [33,51–53]. Therefore, the government and/or employing organization should provide healthcare workers with essential resources (e.g., masks and hand sanitizers) to protect their families or alternative housing arrangements to prevent transmission. Government authorities and employing organizations should also provide reassurance regarding the medical care of healthcare workers' family members in case they develop the disease.

Our findings also suggest that RP was associated with various factors, including sociodemographic characteristics (being divorced), personal traits (having chronic diseases, perceived health status, and sense of coherence), information seeking behavior (daily hours spent acquiring information about COVID-19), pandemic experiences (uncertainty regarding casual or occasional contact with confirmed COVID-19 cases), and adherence to preventive measures (mask wearing regardless of symptoms). This aligns with RP theory, which states that RP is influenced by different factors [15–17]. And that RP represents an assessment of the likelihood of an adverse event (such as infection, illness, or death) occurrence, which can be more rational and systematic when based on scientific information but is not free from the influence of subjectiveness, such as emotions and personal life experiences [20,54].

The association between marital status and a high COVID-19 RP, is corroborated by two previous studies, one conducted in China [55] and another also in Brazil [37]. One possible explanation for this finding is that individuals living with a partner may possess a more robust social support network, with whom they can share daily caregiving responsibilities and concerns, including those related to COVID-19. Conversely, single or separated individuals may experience a greater burden of individual decision-making and

Table 3
Odds Ratio, confidence intervals, and p-values estimated in the adjustments of the simple logistic regression models for high-risk perception for COVID-19 among healthcare workers (EIQ-BR, Brazil).

	OR	95 % CI		p-value
		LL	UL	
Divorced (ref. single)	1.638	1.133	2.369	0.009
Master's degree (ref. high school)	0.579	0.347	0.359	0.968
Nurse (ref. other)	1.326	1.024	1.718	0.032
Time spent per day getting informed about COVID-19 (ref. Up to 1 h)				
1–4 h	1.629	1.237	2.145	0.001
4–8 h	2.199	1.594	3.035	<0.001
More than 8 h	2.205	1.562	3.113	<0.001
Always or almost always using a mask regardless of symptoms (ref. no)	1.722	1.362	2.178	<0.001
Perception of health in the last 14 days (ref. very good)				
Poor	5.051	2.215	11.519	<0.001
Fair	3.185	2.329	4.357	<0.001
Good	1.664	1.324	2.092	<0.001
Having any type of disability (ref. no)	1.812	1.145	2.869	0.011
5-7 symptoms experienced in the last 14 days (ref. none)	2.437	1.640	3.623	<0.001
Have a chronic illness (ref. no)	2.047	1.660	2.524	<0.001
Currently taking medication (ref. no)	1.539	1.262	1.878	<0.001
Medical care at a healthcare center, hospital, or clinic in the last 14 days? (ref. no)	1.730	1.193	2.509	0.004
Close contact with a confirmed infected person (ref. no)				
Yes	1.820	1.289	2.568	0.001
Not sure	1.569	1.271	1.938	<0.001
Not knowing if there was occasional and casual contact with a confirmed case (ref. no)	0.452	0.325	0.629	<0.001
Not knowing if there was contact with a person or material suspected of contamination. (ref. no)	0.577	0.425	0.783	<0.001
Not knowing if one may have contracted COVID-19 (ref. did not contract)	0.644	0.521	0.797	<0.001
SOC-13 score	0.974	0.966	0.981	<0.001

EIQ-BR: Emotional Impact Questionnaire COVID-19 Brazil. SOC-13: Sense of coherence scale.

Table 4
Odds Ratio, confidence intervals, and p-values estimated in the adjustments of the multiple logistic regression models for high-risk perception for COVID-19 among healthcare workers (EIQ-BR, Brazil).

	OR	95 % CI		p-value
		LL	UL	
Divorced (ref. single)	1.775	1.143	2.755	0.011
Perception of health in the last 14 days (ref. very good)				
Good	1.330	1.023	1.731	0.034
Fair	2.465	1.697	3.580	<0.001
Poor	2.832	1.020	7.864	0.046
Always or almost always using a mask regardless of symptoms (ref. no)	1.688	1.283	2.220	<0.001
Not knowing if there was occasional and casual contact with a confirmed case (ref. no)	0.482	0.328	0.707	<0.001
Time spent per day getting informed about COVID-19 (ref. Up to 1 h)				
1–4 h	1.561	1.139	2.140	0.006
4–8 h	1.858	1.278	2.702	0.001
More than 8 h	1.624	1.075	2.453	0.021
Have a chronic illness (ref. no)	1.648	1.294	2.099	<0.001
SOC-13 score	0.977	0.969	0.986	<0.001

EIQ-BR: Emotional Impact Questionnaire COVID-19 Brazil. SOC-13: Sense of coherence scale.

caregiving, which could potentially contribute to an increase in their RP. However, it is important to note that the literature on this association is still inconclusive, since two other studies, conducted in Iran [56] and Ethiopia [57], did not find this association. This difference may be attributed to the fact that these studies were carried out in distinct countries, each with its unique cultural context. And RP may not be uniformly interpreted across diverse cultures [32]. Another possible interpretation is that these distinctions may be a result of cultural variations in the way survey questions are answered rather than actual differences in risk perception [32]. However, the limited availability of comparative studies on emerging infectious diseases RP makes it challenging to comprehensively interpret differences between countries [32].

Regarding the association between having a chronic disease and a higher likelihood of perceiving a high risk for COVID-19, it is supported by previous studies conducted in China [19], the United States [58] and Portugal [59]. This finding aligns with the well-established understanding of a higher risk of severe forms of COVID-19 and/or the need for additional care in the presence of comorbidities or chronic conditions.

This reasoning may also explain the association between self-perception of health and a high RP, which corroborates findings from Japanese [60] and American [61] studies. Notably, a Portuguese study [59] did not observe this association when controlling for underlying chronic diseases. The authors of this study suggest that RP may be more influenced by the knowledge of having a chronic illness than by how an individual feel about their health. However, both the Japanese study [60] and ours found a significant association between self-perception of health and RP even when controlling for the presence of chronic diseases. The same interpretations used before to explain variations in the relationship between marital status and a high RP, as observed in different studies, may be applied to this variable.

The current study also identified a negative association between sense of coherence and RP. A high sense of coherence is characterized by the belief that stressors, such as COVID-19, are comprehensible, predictable, and manageable [48,62,63]. Individuals with a strong SOC tend to perceive their environment as organized and comprehensible, while also being more likely to perceive that they possess adequate resources to cope with these stressors [48,62,63]. These attributes enable them to approach chaotic situations as challenges rather than obstacles, facilitating better adaptation and reduced fear and suffering [48,62,63]. Consequently, it is reasonable to expect that an increase in the sense of coherence is associated with a decrease in RP. It is also worth noting that the observed association seems not only theoretically plausible but has also been empirically validated in Polish [63] and Japanese [64] studies.

In relation to the positive association found between time spent acquiring information about COVID-19 and RP, it is important to note that in the early stages of the COVID-19 pandemic, there was a substantial level of uncertainty surrounding various aspects of the disease. Given this context, it is reasonable to hypothesize that healthcare workers who presented greater COVID-19 RP spent more time seeking information about it. Previous studies lend credit to this hypothesis, since it has already been observed that high levels of information seeking were associated with higher levels of RP [65,66].One intriguing finding in this study was the observed negative association between uncertainty regarding casual or occasional contact with confirmed COVID-19 cases and risk perception (RP), despite the absence of an association between casual or occasional contact with confirmed COVID-19 cases and RP. This is contrary to expectations based on existing RP literature. Direct contact with the virus is typically assumed to make the risk more salient and personal, potentially increasing individuals' RP [67]. Notably, widespread testing for COVID-19 was not conducted in the Brazilian population during the research period [36]. At that time the Brazilian Ministry of Health recommended testing primarily in severe cases [68], contributing to an underreporting of confirmed cases. It is estimated that the actual number of SARS-CoV-2 infections was approximately 15 times higher than official statistics, resulting in fewer confirmed cases in Brazil at the time of the survey [36]. The low number of confirmed cases has already been suggested by a previous study as a potential explanation for unexpected results regarding direct contact with COVID-19 and RP in Australia and Sweden [67].

The final association observed in this study was between consistent mask usage, regardless of symptoms, and RP. Mask usage was widely recommended as an effective preventive measure in the early stages of the COVID-19 pandemic. When there were few known

resources to control the virus, masks were identified as one of the main forms of prevention, even in the absence of visible symptoms. Previous research has demonstrated a positive association between mask usage and increased RP, indicating that individuals recognize its importance in reducing contagion and protecting both themselves and others [69,70]. Additionally, it is also well-known that not only mask usage, but also general preventive behaviors are positively associated with RP. Accordingly, several studies on COVID-19 RP conducted in different countries - such as Bolivia [18], China [24], Poland [35], United States [61] and Canada [19] - as a study that surveyed participants in the United Kingdom, United States, Australia, Germany, Spain, Italy, Sweden, Mexico, Japan, and South Korea [67], and a systematic review [10] have supported this relationship.

As a final point of interest, no association was observed between involvement in healthcare provision and COVID-19 RP. While this may appear surprising, this result is consistent with those of previous studies conducted in Egypt [71] and the Philippines [72] However, it is worth noting that that other studies have identified such an association [73].

The limitations of this study include its sampling and data collection strategy, which makes it difficult to establish a precise overview of the general casuistic and the specific profile of healthcare workers. Since snowball sampling is not a non-probability samples it may have limited representativeness. This means that participants might have recruited others who were more likely to have similar COVID-19 risk perception, propagating participation among a homogenous group of respondents [74]. This can introduce an unknown and immeasurable selection bias in the data, although it is identifiable. In this case, even a large sample size may not fully mitigate this potential limitation. Therefore, even though our results insights might be valuable, it is possible that they overestimate the actual extent of risk perception among Brazilian healthcare workers. It should be noted that, despite its potential for biased estimates, snowball sampling methods were employed by most of the published studies that assessed risk perception and mental health problems of different populations during the COVID-19 pandemic initial stages.

Regarding the strategy of online data collection, it is important to note that despite common concerns, the literature suggests that there are few differences between data collected online and those obtained through traditional self-report methods. Additionally, there is evidence that participants recruited online are more demographically diverse and equally motivated to provide viable data [75,76]. Therefore, while there are specific limitations associated with online data collection, it is possible to obtain valid and representative information through this method.

It is also important to cite that the cross-sectional study design does not allow the examination of temporal sequences in variables that change over time. Consequently, it is impossible to clarify the direction of the associations for such variables, and the associations found cannot be assumed to be causal.

Therefore, it is crucial to acknowledge the limitations of the study and interpret the results with caution, considering the possible biases and inherent restrictions of the methodology used. These considerations highlight the importance of replicating the findings in different contexts and with more diverse samples to obtain a comprehensive and robust understanding of the phenomena under investigation.

These limitations are partly balanced with some of the study's strengths, such as the large national sample size, as well as the diversity of the participants that were not limited to healthcare workers from only a handful of organizations, a city, or a state. It is also important to stress that, although RP about emerging infectious diseases vary significantly among countries [10,32,67], existing evidence suggests that RP may be similar across clusters of countries that share some common features [77]. One such cluster is that of "developing countries", characterized by a "strong desire for economic growth, and few concerns for human health and safety" [77]. Therefore, our results may have relevance not only for Brazil but also for other developing countries.

5. Conclusions

The COVID-19 pandemic highlighted the indispensability of analytical research, particularly in the first six months of the pandemic when many investigations were based on analogies, and numerous epidemiological parameters specific to the disease were established. Beyond reinforcing established methodologies and introducing new ones, the advancement of knowledge about COVID-19 constituted enormous academic contributions. These contributions had almost instantaneous repercussions for health protocols and the industry of supplies, medications, and vaccines. They contributed to understanding vulnerable populations, the dynamics of work during the pandemic, especially for healthcare professionals, virus evolution and mutations, modes of transmission, severity, and therapeutic alternatives on a global scale.

Real-time assessment tools using artificial intelligence and data learning methodologies were prominently featured during this period. Additionally, the dissemination of knowledge through preprint mechanisms, albeit outside the existing knowledge production structures, aided not only the continued accurate development but also facilitated the dissemination of evidence in a more agile and flexible manner. This allowed for more effective course corrections and a reduction in potential sources of harm to people.

In this nearly unprecedented and rapidly evolving health context this study has contributed to the understanding of COVID-19 RP among healthcare workers. From an academic perspective, this study identified key items of Brazilian healthcare workers COVID-19 RP, along with various factors associated with their RP. These factors encompass sociodemographic characteristics, personal traits, information seeking behaviors, experiences during the pandemic, and adherence to preventive measures.

From a practical standpoint, our findings suggest three key strategic actions for people, organizations, and countries during a pandemic. The first is ensuring the well-being of healthcare workers, their families and loved ones by providing effective protection means and ensuring access to timely medical care in case of illness. Indeed, for healthcare professionals, safety priorities are immediate and often concern their families, patients, as well as themselves. Therefore, understanding, recognizing, accepting, and following health and safety recommendations, including social distancing, will keep the entire family safe and reduce stress for the healthcare professional, which could be an important factor for resilience. Also, virtual contact has become indispensable and, facilitated by

technologies, reduces physical distance, enabling shared and well-communicated family decisions when situations seem disoriented or out-of-control.

The second strategic action is to balance healthcare workers' risk perception to improve adherence to preventive measures while avoiding unnecessary psychological distress. This is achieved through a comprehensive approach that combines clear communication, training and education, recognition and support, empowerment, improvement of the workplace environment, encouraging peer support and collaboration, regular feedback and assessment, crisis preparedness, and cultural sensitivity.

And, finally, the third action involves implementing interventions to enhance healthcare workers' sense of coherence, reflecting a worker's ability to perceive life situations as comprehensible, manageable, and meaningful. Here are some strategies for implementing interventions, including some that overlap with the first two strategic actions: training and education, supportive work environment, mental health resources, recognition and appreciation, flexibility and control, clear communication, promoting social support, regular feedback, health and wellness programs, crisis preparedness, promoting meaningful work, or leadership support could be cited. However, it is important to remember that interventions should be adapted to the specific needs and challenges faced by healthcare professionals in a particular environment. Regular assessments and adjustments of intervention strategies will contribute to their effectiveness.

Even though our research and proposed interventions may have contributed to a better understanding of the COVID-19 pandemic, there are still several implications for the management of hypothetical future pandemics that need to be investigated. The dynamic nature of the pandemic, marked by its evolution, the emergence of new variants and the urgency, and rapid pace of decision-making, in its early months emphasizes the need for ongoing research to address these changing circumstances. Therefore, the use of real-time assessment tools in the workplace is a field that still needs improvements and more robust research. Furthermore, the long-term effects of the pandemic on healthcare workers' well-being and mental health needs sustained research efforts to fully understand these impacts. To do so, longitudinal studies should be designed to investigate not only the lasting impact of the pandemic on healthcare workers, but also the effectiveness of implemented interventions. Cross-cultural research, through comparative studies across different cultural and healthcare contexts, to enhance understanding and identify culturally specific factors would be another interesting venue of future research.

It is key to recognize that, while the urgency of the pandemic necessitated quick responses, future research should prioritize maintaining methodological rigor and incorporating robust study designs. The complex nature of the pandemic calls for multidisciplinary research approaches that consider medical, psychological, sociological, and cultural dimensions. In this aspect, inclusivity is crucial; research should aim to include diverse participants, ensuring that the experiences and needs of different healthcare worker populations are adequately represented. Ethical considerations, especially when dealing with vulnerable populations, should be prioritized in ongoing research to ensure that interventions do not inadvertently cause harm.

In conclusion, although the research conducted thus far has been instrumental, continued, and adaptive research efforts are essential to address the evolving challenges posed by the COVID-19 pandemic. Such efforts are crucial to inform evidence-based strategies for the well-being of healthcare workers and broader public health.

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Ethics approval

This study was authorized by the National Research Ethics Committee in Brazil (CAAE 30437120.4.0000.5411, April 23, 2020).

Data availability statement

The study data will be made available on request and has not been deposited into a publicly available repository.

CRediT authorship contribution statement

Joana Muraguti Griesi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **João Marcos Bernardes:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Melissa Spröesser Alonso:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Juan Gómez-Salgado:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Carlos Ruiz-Frutos:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Javier Fagundo-Rivera:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Daniel López-López:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Juan Carlos Camacho-Vega:** Writing – review & editing, Writing – original draft,

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

The author Prof. Juan Gómez-Salgado, PhD, is an Associate Editor of Heliyon's Public Health section. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix ASupplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25297.

Abbreviations

Coronavirus disease-2019 (COVID-19)
Emotional Impact Questionnaire COVID-19 Brazil (EIQ-BR)
Informed Consent Form (ICF)
Risk perception (RP)
Sense of coherence scale (SOC-13)
STROBE (STrengthening the Reporting of OBservational studies in Epidemiology)
World Health Organization (WHO)

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