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A systematic review of risk perception and natural disaster preparedness of validated questionnaires

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ABSTRACT

This study presents a systematic review of validated questionnaires for assessing risk perception and preparedness for natural disasters across diverse geographic and cultural contexts. The study focused on articles about people's perceptions of natural disasters, published between 2000 and 2023 in scientific databases. Of 100 articles, only 5 met the criteria. There is heterogeneity across the questionnaires, with variations in the assessed dimensions and the scales used. Most studies examined risk perception and preparedness for specific disasters, showing a limited relationship between awareness and the adoption of preventive measures. Gaps in methodological approaches were identified, including the lack of longitudinal studies and the underrepresentation of developing countries. Further studies with validated questionnaires are recommended, especially in developing countries.

Keywords: environmental disasters, preparedness, review, risk perception.

Revisão sistemática da percepção de risco e da preparação para desastres naturais com base em questionários validados

RESUMO

Este estudo apresenta uma revisão sistemática de questionários validados para avaliar a percepção de risco e o preparo para desastres naturais em diversos contextos geográficos e culturais. O estudo focou em artigos sobre a percepção das pessoas em relação a desastres naturais, publicados entre 2000 e 2023 em bases de dados científicas. De 100 artigos, apenas 5 atenderam aos critérios. Há heterogeneidade entre os questionários, com variações nas dimensões avaliadas e nas escalas utilizadas. A maioria dos estudos examinou a percepção de risco e o preparo para desastres específicos, mostrando uma relação limitada entre a conscientização e a adoção de medidas preventivas. Lacunas nas abordagens metodológicas foram identificadas, incluindo a falta de estudos longitudinais e a sub-representação de países em desenvolvimento. Recomenda-se a realização de mais estudos com questionários validados, especialmente em países em desenvolvimento.

Palavras-chave: desastres ambientais, percepção de risco, prevenção, revisão.

1. INTRODUCTION

Natural disasters such as flood, tsunami, landslides, volcanic eruptions, fire, and others, are a growing global threat. The threat is exacerbated by rapid climate change and the increased vulnerability of populations exposed to these events (UNDRR, 2015). In recent decades, the devastating impact of phenomena such as earthquakes, floods, landslides, volcanic eruptions, and tsunamis has intensified academic and government interest in understanding risk perception and strategies for preparing populations to be able mitigate the impacts of these events (Lindell and Perry, 2012; Wachinger *et al.*, 2013).

Risk perception, defined as the subjective judgment people make about the characteristics and severity of a hazard (Slovic, 1987), is a critical factor in determining people's preventive behaviors and responses to natural disasters. Studies suggest that populations with a greater understanding of the risks associated with certain disasters are more likely to adopt preventive measures, such as building safer infrastructure and participating in evacuation programs (Lindell, 2019; Paton and Johnston, 2001).

The relationship between risk perception and preventive action is neither linear nor simple. Cultural, economic, social, and psychological factors significantly influence how people perceive and react to these events (Bonati, 2021; Eiser *et al.*, 2012). Risk perception is an essential factor that influences how people respond to potential threats. Studies such as those by (Lindell and Perry, 2012; Paton and Johnston, 2001), show that a higher perception of risk generally leads to a greater likelihood of taking preventive measures, such as participating in evacuation programs or making structural improvements to homes. However, confirmation bias can lead to the search for information that reinforces risk minimization, even when there is clear evidence of the threat.

Disaster preparedness involves those actions taken before an event to improve response and recovery (Paton and Johnston, 2001), including measures such as drawing up emergency plans, stockpiling supplies, and participating in training. The scientific literature suggests that preparedness is associated with better outcomes during and after disasters, including lower mortality and faster recovery (Kohn *et al.*, 2012). However, studies indicate that even with risk awareness, many communities remain unprepared to deal with natural disasters. This disparity can be attributed to many factors, including a lack of clear information, lack of trust in local authorities, economic challenges that prevent the adoption of mitigation measures, and psychological barriers such as denialism or fatalism (Bonfanti *et al.*, 2023).

Questionnaires are instruments that allow for comparative assessment and provide reliable data that can guide public policy interventions and preventive actions. Survey questionnaires are widely used due to their practicality, broad reach of people, and the ability to capture perceptions and subtleties that observations by an external researcher cannot achieve. Questionnaires applied to people in areas of environmental risk are widely used (Solana and Kilburn, 2003; Brilly and Polic, 2005; Johnston *et al.*, 2005; Haynes *et al.*, 2008; Wachinger *et al.*, 2013; Lindell, 2019).

Validated questionnaires to assess risk perception and disaster preparedness have proven to be effective tools for understanding the attitudes and behaviors of populations in different geographical and cultural contexts (Shreve *et al.*, 2016). Validated questionnaires are more reliable because they have mechanisms of redundancy and checking, to verify that respondents' answers are strongly related to the object of study (Ranganathan and Caduff, 2023; Ranganathan *et al.*, 2024). In addition, well-developed questionnaires can capture important nuances, such as the influence of previous experience with disasters (3) and the role of trust in institutions (6) in shaping risk perception and motivation for preparedness. Therefore, validated

questionnaires are more reliable, have high comparability, and save resources (Ranganathan and Caduff, 2023; Ranganathan *et al.*, 2024). Thus, knowledge and application of validated questionnaires can be more reliable for defining disaster mitigation strategies by managers and other professionals involved.

Despite the validated questionnaires' advantages, there are no reviews of validated risk perception questionnaires, to the best of our knowledge from research of the scientific literature. It is therefore important to know which questionnaires on environmental risk perception are validated, so that they can be consulted in increasingly necessary research on environmental disaster risk perception. This systematic review critically examines validated questionnaires used to assess risk perception and preparedness for natural disasters in various contexts, identifying instruments, highlighting heterogeneity in approaches, and emphasizing the need for standardization to improve comparability between surveys.

2. MATERIAL AND METHODS

The research question was formulated using the PICo tool (McDonald *et al.*, 2002). This question was defined as follows: "Which validated questionnaires are available to assess risk perception and natural disaster preparedness, and what are the results of their application?" Population (P): Populations exposed to natural disasters (such as earthquakes, floods, landslides, volcanic eruptions, among others). Intervention (I): Use of validated questionnaires to assess risk perception and natural disaster preparedness. Comparison (C): Not applicable (descriptive study). Outcome (O): Identification of the questionnaires, dimensions assessed, and analysis of results of different studies.

The suitability of carrying out this systematic review in the PROSPERO (Prospective Register of Systematic Reviews) database (Chien *et al.* 2012) was assessed, and the results showed zero registered reviews that had the exact same focus as this study, which indicated that the investigation is original.

This review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (https://www.prisma-statement.org). The search for the articles that made up this review was carried out in August 2024 in the PubMed (https://pubmed.ncbi.nlm.nih.gov), Web of Science (https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform), and SciELO (https://www.scielo.br) academic databases. To identify the relevant articles, the Boolean operators "AND" and "OR" were used between the following descriptors: "Risk perception" AND "natural disasters", "Disaster preparedness" AND "validated questionnaires", "Questionnaires" AND "validated" AND "natural disasters". The combination of these terms was to be able to cover the areas of risk perception, preparedness, and the application of validated questionnaires to natural disasters, with a focus on recent and relevant studies.

Original studies (academic articles) using validated questionnaires to assess risk perception and preparedness for natural disasters were included. Articles published between 2000 and 2023, available in full in the selected databases, which directly addressed natural disasters (such as earthquakes, tsunamis, floods, landslides, volcanic eruptions, hurricanes, and tornadoes) and their relationship with the population's perception of risk and preparedness were considered. The publications selected were in English and Portuguese. Government and institutional reports, publicity materials, and non-academic documents were excluded. Also excluded were studies that did not present a clear methodological approach or that did not use validated questionnaires to assess risk perception, as well as those that did not deal directly with natural disasters or issues related to preparedness and risk perception. At this stage, the quality of the evidence was assessed using a grid system.

The study selection stage was carried out independently by two researchers, with a third researcher arbitrating any cases of disagreement. The results from the searches were entered into the Rayyan web application (https://www.rayyan.ai), developed by the Qatar Computing Research Institute (QCRI), to organize and select the articles. In the second phase, the selected articles were analyzed for eligibility, applying inclusion and exclusion criteria. Finally, the articles that met the criteria were read in full and included in the final review.

Data was extracted from the selected studies using a structured spreadsheet, in which information was collected, such as reference (author, title, year, journal), country of study, target population, type of disaster assessed, title, characteristics of the questionnaire (number of items, scales used), validation of the questionnaire (whether it was validated and the type of validation), as well as the main results, including the dimensions assessed and the results found regarding risk perception and preparedness.

The data analysis was descriptive, summarizing the characteristics of the questionnaires used and the main results reported in the included studies. The synthesis was organized in such a way as to identify recurring patterns and differences in the questionnaires applied in different disaster and environmental impact contexts. In addition, gaps and opportunities for future research in the area were highlighted.

In the next phase, a thematic analysis of the texts was carried out (Braun and Clark, 2023). A risk assessment was carried out to confirm the reliability and validity of the selected studies. The analysis included the creation of a forest plot, which made it possible to visualize the consistency of the results and identify possible heterogeneity between the studies. Finally, a sensitivity analysis was conducted to test the robustness of the conclusions, gradually removing studies with a high risk of bias and observing the impact of these exclusions on the results.

3. RESULTS

In the identification stage, 100 articles were found in the selected databases. After removing 27 duplicate articles, 73 articles remained. In the selection stage, 66 articles were excluded because they did not meet the eligibility criteria, 11 articles were excluded because they were outside the scope of publication type, such as editorials, letters to the editor and technical reports; 45 articles were excluded because they dealt with inappropriate samples (carried out outside the context of natural disasters or in regions outside the scope of the review); and ten articles were excluded because they did not meet the objective of this study.

In the eligibility stage, the remaining 18 articles were read in full, and 13 of these were excluded for the following reasons: five articles did not use validated questionnaires; three dealt with disasters outside the scope of the review; three did not have sufficient empirical data; and two only presented abstracts or insufficient data. At the inclusion stage, the remaining five articles were selected for this systematic review and tabulated for analysis and discussion (Figure 1).

This review contained five studies (Table 1), all involving the application of validated questionnaires to assess risk perception and natural disaster preparedness. The total sample comprises data from different regions and international contexts, including studies carried out in the United States of America (USA), Slovenia, Spain, New Zealand, and the Caribbean (Haiti and the Dominican Republic). The variables analyzed in the selected studies include risk perception, disaster preparedness, warning response, and adoption of preventive measures. All of the studies analyzed the effects of specific natural disasters such as earthquakes, floods, landslides, tsunamis, and volcanic eruptions on the behavior and attitudes of the affected populations.

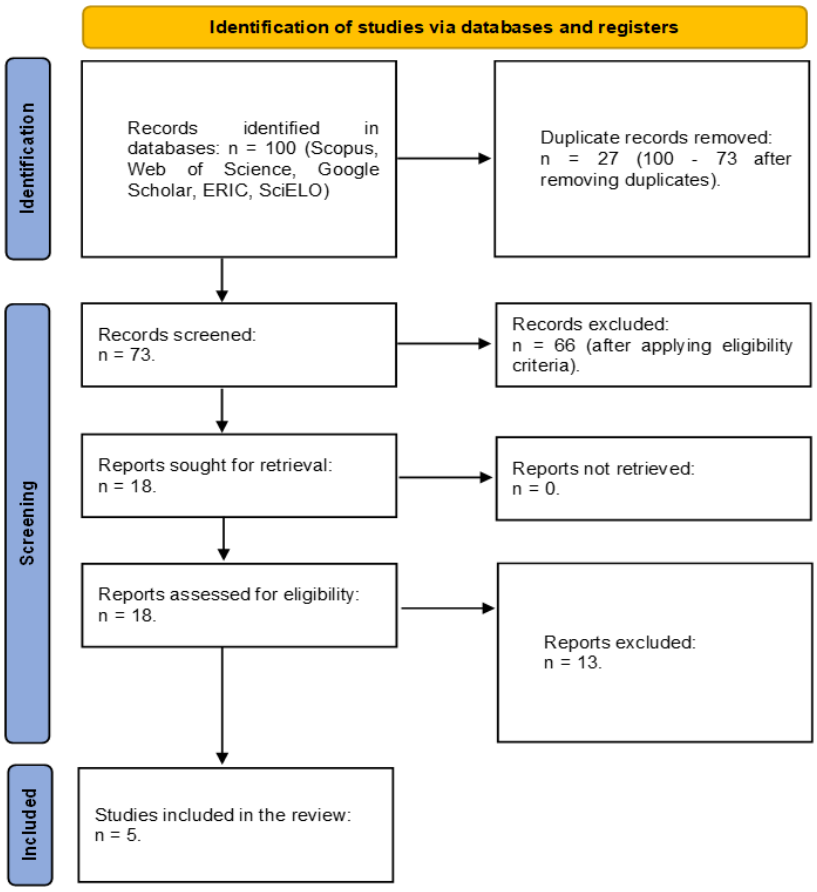

Figure 1. Steps and levels of article selection for the systematic review (adapted the Preferred Reporting Items for Systematic Reviews (PRISMA) statement.

Table 1. Questionnaires validated on environmental disasters found in scientific journals between years 2000 and 2023.

Reference	**Lindell; Whitney, 2000**	**Brilly; Polic, 2005**	**Solana; Kilburn, 2003**	**Johnston *et al.*, 2005**	**Haynes; Barclay; Pidgeon, 2008**
Country/region	USA	Slovenia	Spain	USA	Caribbean
Questionnaire title	Seismic Hazard Adjustment Adoption	Flood Risk Perception	Public Awareness of Landslides	Tsunami Preparedness	Volcanic Risk Perception
Questionnaire objective	Evaluate adoption of adjustment measures for seismic risks	Public perception of floods and preventive measures	Public perception of landslides and	Tsunami preparedness in coastal communities	Risk perception and volcanic crisis communication
Target population	Families	Community of Celje	Population of Gran Canaria Island	Washington coastal community	Community affected by the volcano in Montserrat
Number of questions	22	30	20	25	15
Continue...					

Continued...

Type of disaster	Earthquake	Flood	Landslide	Tsunami	Volcanic Eruption
Dimensions evaluated	Risk perception and adoption of measures	Frequency of floods and confidence in the warning system	Awareness of landslides and perception of threats	Knowledge of the warning and preparation system	Volcanic risk perception and crisis management
Scale	Likert	Likert	Likert	Likert	Likert
Type of validation	Psychometric	Psychometric	Psychometric	Psychometric	Psychometric
Principal Results and conclusions	Most families implement few preventive measures	Confidence in warning systems, but few preventive actions	Little awareness of landslides, but fear of the consequences	Limited knowledge of the tsunami warning system	The population trusts the authorities, but communication could be improved
Comments	Use of preventive adjustments is influenced by demographic variables	Importance of disaster management education	The population is aware of the risks, but lacks preventive actions	Recommendation to improve public education on tsunami warnings	Effective crisis management, but communication planning needs to be improved

In terms of geographical distribution, the studies cover diverse regions, with a particular focus on areas highly prone to natural disasters, such as the west coast of the USA (Lindell and Whitney, 2000; Solana and Kilburn, 2003; Johnston *et al.*, 2005; Shreve *et al.*, 2016), and volcanic areas in the Caribbean and New Zealand (Haynes *et al.*, 2008). Some articles also focused on European regions with a history of flooding, such as Slovenia (Brilly and Polic, 2005) and the Isla de Gran Canaria, Spain (Solana and Kilburn, 2003). The common interest among the studies was the application of validated questionnaires to measure the capacity of populations to perceive and prepare for disasters, as well as to evaluate the effectiveness of warning systems and any preventive measures applied.

4. DISCUSSION

This review aims to help scholars, students, and environmental managers assess which questionnaires on the perception of environmental stress are validated. Validated questionnaires are more reliable, especially when translated into other languages (Ranganathan and Caduff, 2023; Ranganathan *et al.*, 2024) (Ranganathan and Caduff, 2023; Ranganathan *et al.*, 2024). The five studies chosen for the systematic review provided a comprehensive overview of risk perception and natural disaster preparedness, using questionnaires validated in different geographical and cultural contexts. The first study, conducted by (Lindell and Whitney, 2000), focused on the perception of seismic risk and the adoption of preventive measures by families in earthquake-prone areas such as Los Angeles in the USA. The questionnaire, made up of 22 items, collected data on residents' preparedness actions. The authors concluded that there was awareness of the risk, but the adoption of protective measures was low and was influenced by demographic factors such as income and educational level. The psychometric validation of the instrument guaranteed the reliability of the data, allowing for a robust analysis of the behavior of families in relation to earthquake preparedness (Lindell and Whitney, 2000).

Another study examined the public perception of flood risks in the city of Celje, Slovenia (Brilly and Polic, 2005). The 30-item questionnaire assessed the population's trust in the flood warning system, as well as any preventive attitudes adopted by residents. The results revealed that, although the population trusted the warning systems, few took adequate preventive measures, highlighting the need for educational programs focused on disaster management. The psychometric validation of the questionnaire reinforced the consistency of the answers and the relevance of the conclusions (Brilly and Polic, 2005).

A third study (Solana and Kilburn, 2003) investigated public awareness of landslides in the Gran Canaria island, Spain. The study applied a 20-item questionnaire to measure the population's perception of risk and its preparedness to deal with a landslide event. The results indicated that the adoption of preventive actions was limited, although residents were aware of the risks. The questionnaire was psychometrically validated, providing reliable data for a more detailed analysis of the population's perception of risk and lack of preparedness (Solana and Kilburn, 2003).

A fourth study assessed tsunami preparedness in coastal communities in Washington State, USA (Johnston *et al.*, 2005). The 25-item questionnaire applied in this study assessed the population's knowledge of tsunami warning systems and readiness to deal with this type of disaster. The results showed that knowledge about warning systems was limited and that coastal communities were insufficiently prepared, suggesting the need for improvements in educational programs and specific training. The questionnaire was validated through psychometric analysis, also ensuring the validity and reliability of the data obtained (Johnston *et al.*, 2005).

Only one study was in Latin America (Haynes *et al.,* 2008). The authors investigated the perception of volcanic risk on the Caribbean island of Montserrat, where the population has been affected by volcanic eruptions in the past. The study used a 15-item questionnaire to assess public perception of risk and the effectiveness of communication during volcanic crises. The results indicated that risk communication could be improved, although the population trusted the authorities, especially with regard to advance planning and the clarity of information transmitted. The questionnaire was psychometrically validated, providing robust data for the analysis of public perception of volcanic disasters (Haynes *et al.,* 2008).

The findings of this systematic review indicate that, although the perception of risk is high among populations impacted by natural disasters, the implementation of preventive measures remains limited. For example, most families living in areas susceptible to earthquakes, such as Los Angeles, recognize the seriousness of the risks, but few implement adequate preventive measures (Lindell and Whitney, 2000). This finding is supported by some studies (e. g, Sutton *et al.*, 2024) which argued that risk perception does not invariably convert into preventive behavior, especially when factors such as income, educational level, and personal experience with disasters influence the decision-making process. Furthermore, the relationship of trust between public administrators and the population at risk is a critical variable, because the adoption of preventive measures is largely conditioned by the availability of resources and trust in the information provided by the authorities (Bodas *et al.*, 2022).

While trust in warning systems is a central element of risk perception, the practice of preventive actions does not seem to be frequent, as can be seen in the study on floods in Slovenia (Brilly and Polic, 2005). Studies such as that by Kellens *et al* (2011), which analyzed the perception of flood risk in Belgium, presented similar results, showing that, although trust in warning systems is high, this trust is not adequately translated into effective preventive actions, concluding that the difference between trust and the adoption of preventive measures is a critical issue that needs to be addressed through public education and awareness campaigns that not only disseminate information but also empower individuals to act.

In the Gran Canaria island, the population seems to be aware of the risks of landslides, but preparations to respond to a landslide were insufficient due to the lack of technical knowledge

to prevent and act in cases of disaster (Solana and Kilburn, 2003). This result is consistent with studies on landslide perception in Nepal, which found that economic limitations and limited technical understanding hinder the adoption of preventive measures (Tuladhar *et al.*, 2015). Thus, strengthening technical knowledge and the ability to interpret risk information is essential in regions that are susceptible to disasters.

The study on tsunami preparedness highlighted a substantial gap between the perception of risk and the actual preparedness of coastal communities in Washington (Johnston *et al.,* 2005). These findings are congruent with another study that examined tsunami preparedness in Australia, revealing that the preparedness of coastal communities for an emergency was inadequate, despite awareness of the risks (Forsyth *et al.*, 2023). The implementation of evacuation plans and knowledge of warning systems are often underestimated, indicating the need for local authorities to step up efforts to improve public education about disaster preparedness.

A critical aspect identified in this review was the disparity between risk perception and effective preparedness actions. There seems to be a point of convergence between the five selected studies that, even when there is a high perception of risk, it does not always translate into concrete preparedness measures. This corroborates the notion that mere awareness of risk does not ensure the adoption of preventive actions. Despite the fact that people understand the risks associated with natural disasters, elements such as trust in authorities, risk communication, and socio-economic barriers directly influence the implementation of preventive measures (Lahiri *et al.*, 2021). Thus, risk perception is a necessary but insufficient component to guarantee practical action. This gap between knowledge and action represents a significant challenge for disaster managers and policymakers, suggesting the need for instruments that not only assess perception but also explore the barriers to preventive action.

The decision to take a risk despite knowing the potential for negative outcomes is not a failure of logic, but rather a complex process of making decisions. The decision to remain in or even build communities within areas repeatedly ravaged by natural disasters presents a paradox that, on the surface, seems to defy rational self-preservation. The apparent lack of caution is rarely a simple ignorance of the danger. Most studies on risk perception show that the people are aware of the risks. Thus, the decision to stay in risky areas is the result of a powerful and often invisible web of emotional, economic, and psychological ties that bind people to a place (Raymond *et al.*, 2010). One of the most potent forces at play is the concept of "place attachment," the deep emotional bond that forms between individuals and their physical environment (Raymond *et al.*, 2010).

A home is more than a structure; it is the backdrop of a lifetime of memories, the site of family traditions, and the anchor of a community (Melo *et al.*, 2025). For someone whose family has lived in a place for many years or decades, the threat of an environmental disaster can be more abstract compared to the immediate, tangible reality of their daily life, their friends, and their cultural identity (Melo *et al.*, 2025). The decision to stay is heavily reinforced by powerful economic and practical realities. For many, a home in a disaster-prone area is not just a dwelling but their single largest asset and their only source of equity. This aspect is more pronounced among people of low socioeconomic status, whose decision-making abilities are limited by low family or individual income (Smith *et al.*, 2022).

Similarly, livelihoods are often inextricably linked to the land. Farmers tend to fertile volcanic soil (Haynes *et al.*, 2008), fishermen live near the ports they must reach to sell their fish (Seara *et al.*, 2016), and entire local economies are built around the tourism that a beautiful, albeit risky, coastline provides (Tsai *et al.*, 2016). The "bad consequence" of a potential future disaster is weighed against the immediate, certain consequence of losing one's job, community, and financial security by leaving. In this calculus, staying becomes not an act of carelessness, but a rational, if tragic, choice in the face of limited options and the human need for stability

and belonging.

There is evidence that a powerful psychological phenomenon known as "normalization bias," also contributes to people remaining exposed even when they are aware of the environmental risks. Normalization bias is a kind of cognitive desensitization to the warnings in hazardous areas (Heijungs *et al.*, 2007). Because the disaster is an infrequent event, the period of calm in between becomes the "normal" state, making it cognitively difficult to maintain a constant state of alertness or to justify the immense upheaval of leaving. However, there seem to be few studies on the connection between the place attachment and normalization bias.

Analysis of the validated questionnaires revealed a multidimensional approach to assessing risk perception. The understanding of natural disasters is complex in nature, which goes beyond mere awareness of danger to encompass emotional, cognitive, and behavioral aspects. This approach is in line with the theoretical models proposed by Wachinger *et al.* (2013), who emphasized the multifaceted nature of risk perception.

There is considerable heterogeneity among the instruments used to assess risk perception and disaster preparedness. This diversity reflects the complexity of the subject, presenting itself as a challenge for comparability between studies and contexts. The lack of standardization in assessment tools can make it difficult to synthesize evidence and formulate policies based on comparable data across different regions and cultures (Shreve *et al.,* 2016). A relevant finding was the significant influence of contextual factors on risk perception and disaster preparedness. Variables such as previous experiences with disasters, educational level, and trust in local authorities played important roles in shaping risk perceptions (Bonfanti *et al.,* 2023). Therefore, instruments for assessing community perceptions must be sensitive to cultural and contextual nuances and the complexity of the socio-ecological systems in which disasters occur.

These results demonstrate the diversity of contexts and types of natural disasters addressed by the selected studies, as well as the consistent application of validated questionnaires to measure the risk perception and preparedness of affected populations. In addition, these studies highlighted the need for improvements in public education and risk communication programs, especially in regions vulnerable to natural disasters. A growing trend towards the integration of mixed methods, which combine quantitative and qualitative approaches, was observed. This mixed approach allows for a richer and more nuanced understanding of risk perception and preparedness, capturing both measurable data and deep contextual insights (Lahiri *et al.*, 2021).

The review also highlighted the growing importance of community resilience as an integral component of disaster preparedness. Instruments that incorporate measures of social capital, community cohesion, and adaptive capacity are gaining prominence, aligning with the guidelines from the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNDRR, 2015). This more holistic approach recognizes that disaster preparedness is not just an individual matter, but a collective effort that requires community engagement. One aspect that deserves attention is the adaptability of the instruments to changing risk dynamics, particularly when more natural disasters are expected because of ongoing climate change. Therefore, assessment tools must be flexible enough to capture these changes in perception and preparedness over time (Lee *et al.,* 2024).

The review revealed some gaps in the literature as, notably, there is a dearth of cohort studies examining how risk perception and preparedness evolve over time, especially following disaster events. Most of the studies reviewed used a cross-sectional approach, capturing perceptions and behaviors at a specific point in time. However, risk perception and disaster preparedness are dynamic and can change over time, especially after traumatic events or with the implementation of public policies. The lack of longitudinal studies prevents a more in-depth assessment of how interventions and ongoing awareness can impact attitudes and behaviors over the long term.

Another common limitation of the studies reviewed was the size and representative-ness

of the samples. The samples used were relatively small or concentrated in specific communities. In the study about perception of landslide risk in the Gran Canaria island (Solana and Kilburn, 2003), the results may not be fully representative of other landslide-prone areas or areas with different socio-economic characteristics. The limited sample size makes it difficult to generalize the findings and can lead to bias in the interpretation of the results.

An important limitation is related to the external validation of the questionnaires used. Although all of the questionnaires were psychometrically validated, most were developed for very specific contexts, such as the study by Johnston *et al.* (2005) on tsunamis, which may not be applicable to disasters of different natures, such as earthquakes or floods. Validating questionnaires in different geographical and cultural contexts is essential to ensure the broad applicability of the results, which in many cases was insufficient or absent in the studies analyzed.

The geographical scope of some of the studies seems a limitation for generalization. For example, the study by Lindell and Whitney (2000) focused exclusively on urban areas in the United States, specifically Los Angeles. Although this is an earthquake-prone region, the generalizability of the results to other areas with different socioeconomic and demographic contexts may be limited. This geographical restriction also applies to the studies in the present review, which examined coastal communities in Washington (Johnston *et al.*, 2005) and a single city in Slovenia. The lack of geographical diversity may limit the global applicability of the findings on risk perception and disaster preparedness. This serves to highlight the clear need to expand risk perception studies with validated questionnaires in most regions of the world.

The review also points to the need for greater attention to vulnerable and marginalized populations when assessing risk perception and preparedness. Disaster risk is unevenly distributed in society, disproportionately affecting already vulnerable groups, and tools that specifically address the perceptions and needs of these groups are crucial to developing more equitable and inclusive risk reduction strategies (Blaikie *et al*, 2014). Most poor or developing countries are underrepresented in surveys that use environmental risk perception questionnaires. This is the case for large countries, such as Brazil, which is prone to many environmental disasters like floods, landslides, and forest fires (Oliveira *et al.*, 2022; Ribeiro *et al.*, 2022; Silva-Junior *et al.*, 2022). Simultaneously, environmental disasters exacerbate vulnerabilities to many diseases and epidemics, such as leptospirosis, respiratory diseases, and infectious diarrhea (Smith *et al.,* 2022). The psychological stress caused by disasters has long-term consequences, with cases of post-traumatic stress and depression (Smith *et al.,* 2022). The main outcomes of environmental disasters in countries whose populations are unprepared to cope with them, are increases in mortality, suffering on the part of those affected, and public health care costs (Smith *et al.,* 2022).

Some environmental disasters are cyclical events with no direct causes linked to human activities, while others are triggered by anthropogenic pressures. Some developed countries are preparing themselves by assessing behavioral aspects and the population's disposition towards resilience and resistance to environmental disasters, as in the cases reported in the articles in this review. However, most countries have not developed studies on risk perception and preparedness for environmental disasters. The consequences of environmental disasters are more severe for public health in countries with a population subjected to higher levels of poverty (Smith *et al.,* 2022).

In addition, studies often fail to explore cultural variables that may influence risk perception and the adoption of preventive measures. Cultures with different histories of disasters or different levels of trust in the authorities can respond very differently to questionnaires (Haynes *et al.*, 2008). The articles selected in this study are initial steps towards a model questionnaire that can be translated into the native language of each country and validated among their own population. The questionnaires should be adapted to the territorial

extent, rural or urban environments, existing biomes, and cultural diversity of each country. Finally, there is an urgent need to develop and apply risk perception questionnaires in developing and poor countries, given the enormous pressures of an economic system that overexploits natural resources and makes most of the population vulnerable to environmental disasters (Winsemius *et al.*, 2018).

5. CONCLUSIONS

The study identified and analyzed several validated questionnaires in order to measure risk perception and natural disaster preparedness, revealing the complexity and multidimensionality of these constructs. The most effective instruments were sensitive to socio-cultural context and incorporated elements of community resilience and psychosocial factors, but despite advances, significant gaps remain, especially in longitudinal studies and research in developing countries. The integration of new technologies in data collection and the development of instruments that address barriers to preventive action emerge as promising areas for future research.

The analysis reveals the importance of considering contextual, cultural, and socio-economic factors when designing and applying these questionnaires, with a trend towards multidimensional approaches, which encompass emotional, cognitive, and behavioral aspects of risk perception. The study points out significant gaps, such as the scarcity of longitudinal studies and the underrepresentation of developing countries, highlighting the need for instruments that not only assess perception but also explore barriers to preventive action and take community resilience into consideration.

The results of this study have crucial implications for disaster risk management, offering valuable insights for the development of more effective public policies and community preparedness programs. It is recommended that future studies prioritize the cultural adaptation of the instruments and the exploration of innovative approaches that can capture the complex dynamics of risk perception and preparedness in different global contexts.

6. AUTHOR CONTRIBUTIONS

Conceptualization, methodology, validation, formal analysis, investigation, writing—original draft preparation, and writing—review and editing, P. S. de S. V. S. R., V. S. P., M. P. V. S. R., P. da S. L., I. O. e S, and V. B.; visualization, P. S. de S. V. S. R.; supervision, V.|B.; project administration, V.B.; funding acquisition, P. S. de S. V. S. R. All authors have read and agreed to the published version of the manuscript.

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8. CONFLICTS OF INTEREST

The authors declare no conflicts of interest. During the preparation of this manuscript, the authors did not used GenAI.

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10. DATA AVAILABILITY STATEMENT

The survey data is only available upon request.

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