ORIGINAL ARTICLE

Assessment of seismic risk perception in urban communities of the municipality of Moa, Holguín

Evaluación de la percepción del riesgo sísmico en comunidades urbanas del municipio de Moa, Holguín

Oclides Carmenate-Hechavarría[1*], Pedro David Labrada-Rosabal[2], Nelson Fernández- Hernández[3], Rafael Guardado-Lacaba[1], Daliana María Arjona-Mendoza[1], Adianes Ferrer-Batista[1]

[1]University of Moa, Holguín, Cuba.

[2]Hydraulic Project and Research Enterprise, Bayamo, Granma, Cuba.

[3]Ferronickel Mining Enterprise S.A, Moa, Holguín, Cuba.

[*]Corresponding author: ochechavarria@ismm.edu.cu

Abstract

The aim of this study was to assess the perception of seismic risk in urban communities of Moa, a municipality exposed to historical earthquakes of magnitude 6.5R–7.5R associated with the Bartlett-Caimán fault. The study comes from the lack of social diagnoses on the subject, despite evidence of structural vulnerability in neighborhoods such as *Miraflores* and *Armando Mestre*. A KAP (Knowledge, Attitudes, Practices) survey was applied to 120 residents (between March and June 2024), validated with α-Cronbach=0.82 and processed with SPSS v.28 (descriptive statistics/correlations) and ATLAS.ti v.9 (qualitative analysis). The results revealed: (I) underestimation of risk: 42-45% never perceived an earthquake, generating false security; (II) training deficit: only 20-33% received training in protocols; (III) high-risk practices: 33-45% would run away during an event, and 0% have community plans or participate in drills; (IV) prioritization of visible threats (floods/fires) over earthquakes. It is concluded that perception is "medium" in knowledge, but "low/none" in practices, demanding urgent psychoeducational interventions to strengthen urban resilience.

Keywords: seismic risk perception, urban communities, vulnerability, Moa municipality

Resumen

Esta investigación evalúa la percepción del riesgo sísmico en comunidades urbanas de Moa, municipio expuesto a sismos históricos de

magnitud 6.5R–7.5R asociados a la falla Bartlett-Caimán. El estudio surge ante la carencia de diagnósticos sociales sobre el tema, a pesar de evidencias de vulnerabilidad estructural en repartos como *Miraflores* y *Armando Mestre*. Se aplicó una encuesta CAP (Conocimientos, Actitudes, Prácticas) a 120 residentes (entre marzo y junio de 2024), validada con α-Cronbach=0.82 y procesada con SPSS v.28 (estadística descriptiva/correlaciones) y Atlas.ti v.9 (análisis cualitativo). Los resultados revelaron: (I) subestimación del riesgo: 42-45 % nunca percibió un sismo, generando falsa seguridad; (II) déficit formativo: solo 20-33 % recibió capacitación en protocolos; (III) prácticas de alto riesgo: 33-45 % huiría corriendo durante un evento, y 0 % cuenta con planes comunitarios o participación en simulacros; (IV) priorización de amenazas visibles (inundaciones/incendios) sobre sismos. Se concluye que la percepción es "media" en conocimiento, pero "baja/nula" en prácticas, exigiendo intervenciones psicoeducativas urgentes para fortalecer resiliencia urbana.

Palabras clave: percepción de riesgo sísmico, comunidades urbanas, vulnerabilidad, municipio de Moa

1. INTRODUCTION

Natural disasters are catastrophic events with measurable impacts on human lives, economies, and recovery capacity (Garcell-Rodríguez, 2014; Sánchez *et al*., 2016; Batista-Samé, 2019). Among these phenomena, earthquakes stand out, representing 56% of disaster-related deaths and the loss of US$661 billion between 1998 and 2017 (Frómeta-Alfaro and Guardado-Lacaba, 2017; Cred, 2018).

However, the magnitude of their consequences does not depend solely on the natural hazard, but on factors such as governmental efficiency in response (Argüelles *et al*., 2019), economic resilience (Zuñiga-Fuentes, 2019) and risk perception by communities (Tussen-Corrioso and Brull-González, 2018).

Perception is central to seismic risk management (Burton and Kates, 1964; Wilches-Chaux, 1993; Sjöberg, 2000), varying according to social, cultural contexts and prior experiences (Dalmau-Muguercia *et al*., 2013; Pérez-Figueredo, 2019), explaining the failure of technical measures in the face of limited understanding of risk (Frómeta-Alfaro *et al*., 2017).

Globally, literature has explored risk perception in seismic regions (Golden, 2010; Uprety and Poudel, 2012; Kundak *et al*., 2014; Santos-Reyes *et al*., 2014; Li *et al*., 2017; Ohtomo *et al*., 2017), the social construction of risk (García-Acosta, 2005) and vulnerability from gender and social organization perspectives (Aragón-Durand, 2009; Iturralde, 2014).

Therefore, vulnerability emerges from the interaction of natural hazards and socio-economic dynamics (Wilches-Chau, 1988; Hernández-Zaldívar, 2012; Hernández *et al*., 2015; Hernández-Columbié and Guardado-Lacaba, 2023), configuring risk as a social construction influenced by territorial development models (Lavell, 2010).

The Sendai Framework 2015-2030 (UN) emphasizes the need to integrate scientific knowledge, community participation, and land-use planning policies (Alonso-Leyva and Santana-González, 2023), especially in urban contexts where population density and insufficient planning aggravate risks (Silva-Reyes, 2017).

In Cuba, although studies exist on hazard, vulnerability and risk (Núñez *et al*., 2010; Mata, 2016; Parrado-Alvarez *et al*., 2019; Ernesto and Pupo, 2019; Palma, 2020), the assessment of social perception of seismic risk in urban communities remains a challenge (Linares-Acosta, 2022).

Seismic microzonation studies (Vinardell-Peña, 2018) identify critical areas in Moa, in ranges of VI and VII MSK and magnitude 6.5 R and 7.5 R (CENAIS, 2015; 2024). This is due to the interaction of the North American and Caribbean plates (Cuesta-Dublín, 2011) and the North Hispaniola fault (Riverón, 2008; Zuñiga-Fuentes, 2019).

This article aimed to evaluate the perception of seismic risk in the urban communities of the municipality of Moa, Holguín, specifically in the popular councils *Miraflores* and *Armando Mestre* (Figure 1) to identify gaps in community preparedness for perceptible magnitude seismic events.

Figure 1. Territorial context of the popular councils A) *Miraflores*, B) *Armando Mestre*, Moa. Source: Municipality Office of Physical Planning (2012).

Miraflores Popular Council is divided in three zones (Miraflores, Atlántico y Miramar). According to Municipality Office of Physical Planning in Moa,

Miraflores Popular Council has mainly Type I houses (2, 4, and 5 floor buildings), meanwhile Armando Mestre Popular Council has type III houses (solid walls, and light roofs) and type IV houses (wood walls and light roofs)

2. MATERIALS AND METHODS

The study employed a KAP (Knowledge, Attitudes and Practices) type questionnaire, adapted from Sánchez-Hernández and Vicuñan-Barrera (2022) and modified. Data were collected through in-person interviews between March and June 2024, ensuring confidentiality and informed consent.

The survey was randomly applied to 120 residents of the popular councils *Miraflores* and *Armando Mestre*. These areas were selected for their high vulnerability according to seismic microzonation studies (Vinardell-Peña, 2018). The sample included participants aged 15 to 65 years (52% women, 48% men), with inclusion criteria based on permanent residence and historical exposure to seismic events in the area.

The questionnaire, with 24 structured questions, explored four key dimensions: population, knowledge, attitudes and practices (Table 1) (Cuartas-Gómez *et al*., 2019).

Table 1. Questionnaire CAP type (Modified from Sánchez-Hernández y Vicuñan-Barrera, 2022)

Population

Age:	Genre: M F other:	Worker: Student: other:	
District	Popular Council:		
How long have you been living in this house?	Less than a year	From 1 to 5 years	From 5 to 10 years
	From 10 to 20 years	More than 20	
¿Are youd from any other city or province? Yes___ No___	If you come from other city, mention it		

Knowledge

	Yes	No	I D K
Have you ever percibed an eartquake in Moa?			
¿Do you believe a harmfull earthquake may occur in Moa?			
Any eartquake has affected the district where you live?			
Have you ever been affected in any way (physically, phsycologically or materially) by an earthquake?			

Have you been informed or trained in any way about protocols to face an eartquake?	
If you say ¨yes¨ to a previous question, what was the mean used for it?	Mass media (magazine, newspaper, televisión, radio)
	Educational institution and/or the university
	Through family or friends
	Through governmental entities of risk prevention
	Other, which one?
Which of these events could affect the most the district where you live?	Overflow
	Landslides
	Eartquake
	Fire
	others?
Do you consider Moa city is located in a dangerous seismical zone?	High
	Medium
	Low
	IDK
¿Por qué cree que tiembla en la ciudad de Moa? Why do you think in Moa eartquakes take place?	
Why do you think an eartquake causes damage?	

Attitude

	Sí	No	No sé
Do you think could you be affected in case any earthquake take place in Moa?			
Explain			
Do you consider it is important the preparation for facing an earthquake?			
Do you think it is important to include the preparation for facing earthquake in educactional cuban system?			

Do you think governmental institutions should inform and preparare people on this topic?				
If you say YES what media should be used?	Mass media (magazine, newspapers, televisión, radio, etc.)			
	Educational institution or university			
	Courses, meetings or simulations			
	Other, ¿which one?			
How would you do in case an earthquake occurs?	Run away			
	Scream			
	Keep calm and look for a save place			
	Do nothing and wait			
	Pray			

Practice

	Yes	No	IDK
Have you ever participated in any earthquake simulation?			
Have you ever got any insurance for covering earthquake damages?			
If you say YES, explain			
Is there any emergency plan or protocol to face an earthquake?			
If you say YES, explain			

For quantitative analysis, responses were coded on Likert scales (1-5) and processed with SPSS v.28, using descriptive statistics and Pearson correlations to identify patterns between variables. Qualitative responses were categorized using thematic content analysis (Atlas.ti v.9). The instrument's validity was ensured through a pilot test with 30 participants, adjusting semantic ambiguities, while reliability was verified with Cronbach's alpha ($\alpha = 0.82$).

The methodology aligns with the objectives of the Sendai Framework (UN) 2015-2030, prioritizing community participation in risk management (Cuartas-Gómez *et al*., 2019).

3. RESULTS AND DISCUSSION

Below are the findings derived from the KAP survey applied to the popular councils *Miraflores* and *Armando Mestre*.

3.1. Occupational profile of the surveyed population

The occupational distribution in both popular councils shows a similar profile (Figure 2), with a predominance of active workers (45% in Miraflores and 42% in Armando Mestre), followed by students (30% and 28%, respectively), and a more vulnerable group classified as "other" consisting of homemakers, retirees, and others (25% and 30%).

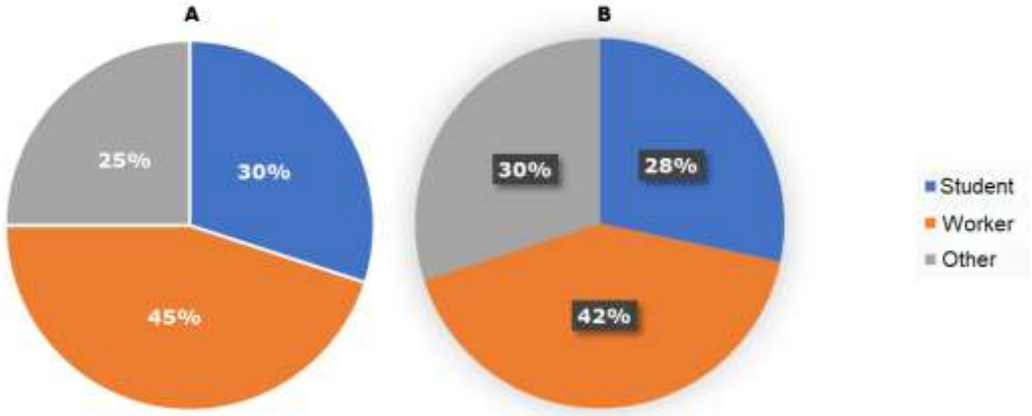

Figure 2. Occupational distribution. A) *Miraflores*, B) *A. Mestre*.

3.2. Length of residence in the location

Both popular councils present a similar population structure, as well as greater historical exposure (for more than 20 years) to seismic events, representing 47% in Miraflores and 45% in Armando Mestre (Figure 3). The group of recent residents (5 years or less), represented by 8% in Miraflores and 15% in Armando Mestre, lacks memory of perceived seismic phenomena.

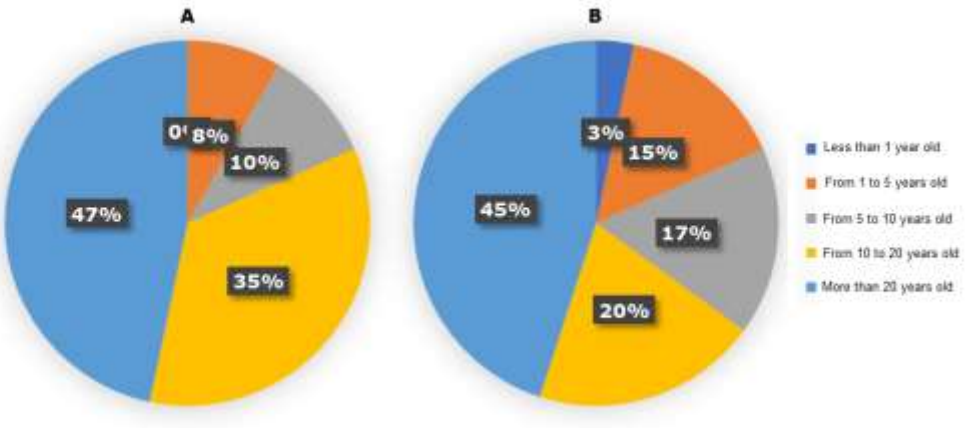

Figure 3. Length of residence. A) *Miraflores*, B) *A. Mestre*.

3.3. Historical experience with seismic events

The results indicate that in Miraflores, 42% of respondents (25/60) have never perceived an earthquake, while in Armando Mestre this value rises to 45% (27/60) (Figure 4). Although the majority, between 58% and 55% of both neighborhoods respectively, report having experienced at least one event, these data contrast with the high rootedness (more than 45% with over 20 years of residence). The above can be interpreted as a low frequency of intense earthquakes given that 50% of long-term residents do not remember these seismic events or that there is a normalization of risk due to the scarce reporting of impacts (37%-22%).

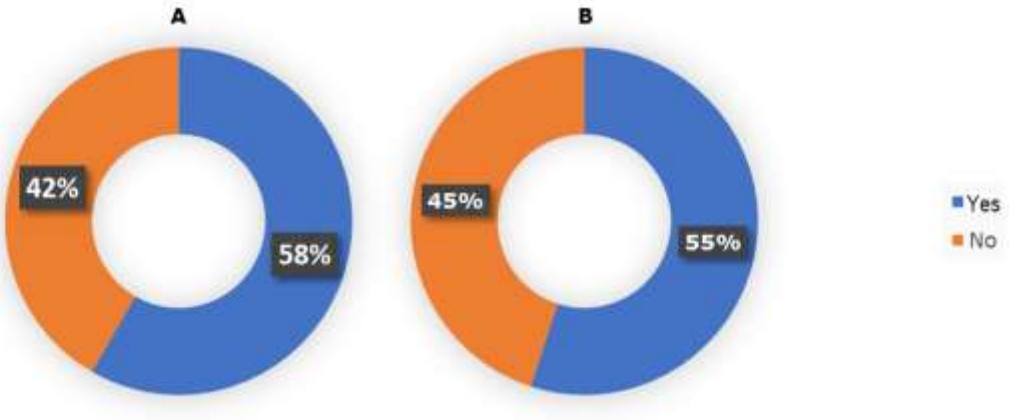

Figura 4. Historical experience with seismic events. A) *Miraflores*, B) *A. Mestre*.

3.4. Damages attributed to seismic events

In *Miraflores*, only 37% (22/60) report damages, while in *Armando Mestre* this indicator drops to 22% (13/60) (Figure 5). The majority in both territories deny material impacts (45% and 67%, respectively), and a relevant segment is unaware of any damages (18% and 11%). The predominance of "no damage" (>45%) suggests a normalization of seismic risk, where the absence of recent destructive events generates a false sense of security.

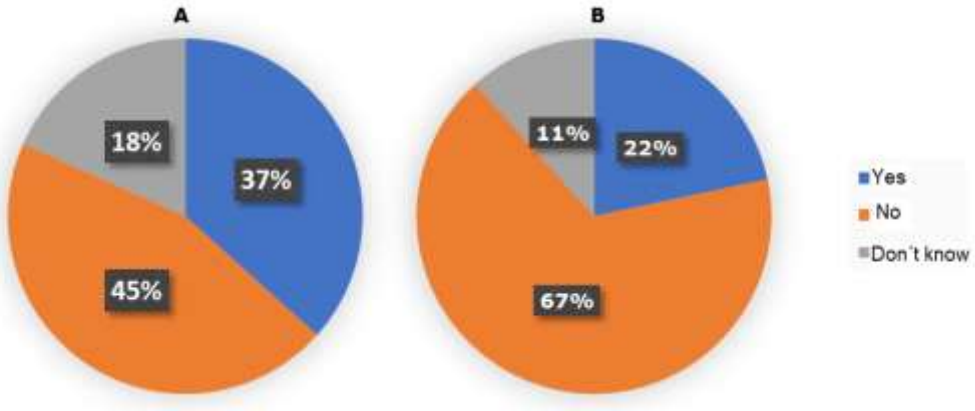

Figure 5. Damages attributed to seismic events. A) *Miraflores*, B) *Armando Mestre*.

3.5. Training on response protocols for an earthquake

In Miraflores, only 33% (20/60) received information on action protocols, while in Armando Mestre this indicator decreases to 20% (12/60) (Figure 6). The vast majority lack training (67% and 80%, respectively), a figure that constitutes an institutional alarm. The difference Miraflores-Armando Mestre (33% vs 20%) suggests disparities in the coverage of preventive campaigns, the latter being more vulnerable.

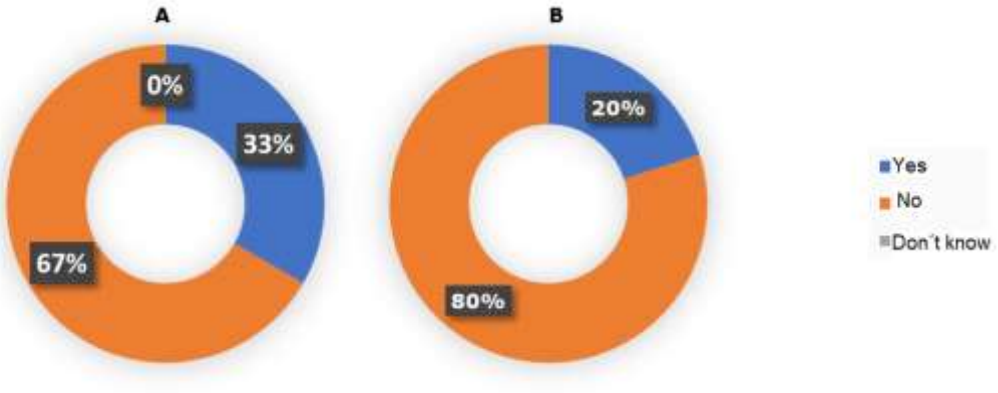

Figura 6. Training on response protocols for an earthquake A) *Miraflores*, B) *Armando Mestre*.

3.6. Perception of higher-impact threats

while in Armando Mestre, landslides are added as a dominant concern (they perceive less than 37% of impacts) (Figure 7). In this aspect, the absence of local education prevents internalizing this risk since only 20-33% received seismic training. 57% of the population has perceived low-intensity earthquakes without reporting serious damage.

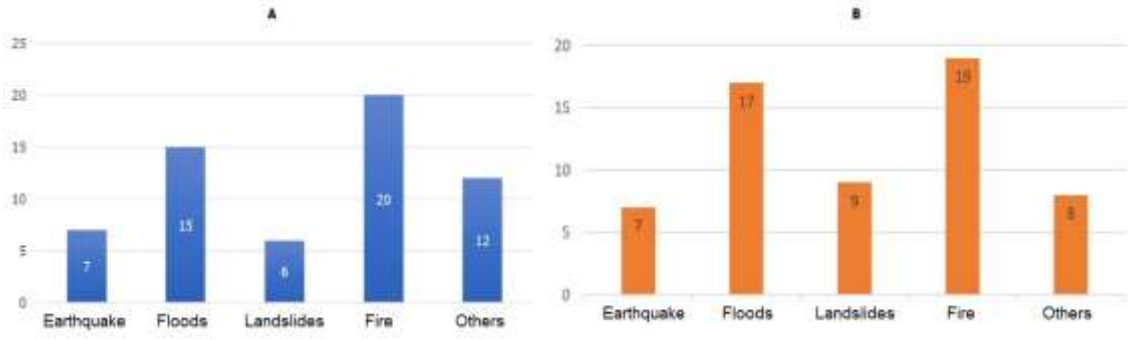

Figura 7. Perception of higher-impact threats. A) *Miraflores*, B) *A. Mestre*.

3.7. Expected reaction to an earthquake

In Miraflores, only 25% (15/60 respondents) would adopt the safe protocol, while in Armando Mestre this indicator drops to 9% (5/60) (Figure 8). Conversely, inadequate responses are predominant: 33% in Miraflores and 45% in Armando Mestre would run away. Likewise, 17-23% would assume a passive attitude, increasing their vulnerability to collateral damage, and 10-13% would manifest uncontrolled panic responses, while the cultural-religious component: 12-13% would entrust themselves to God.

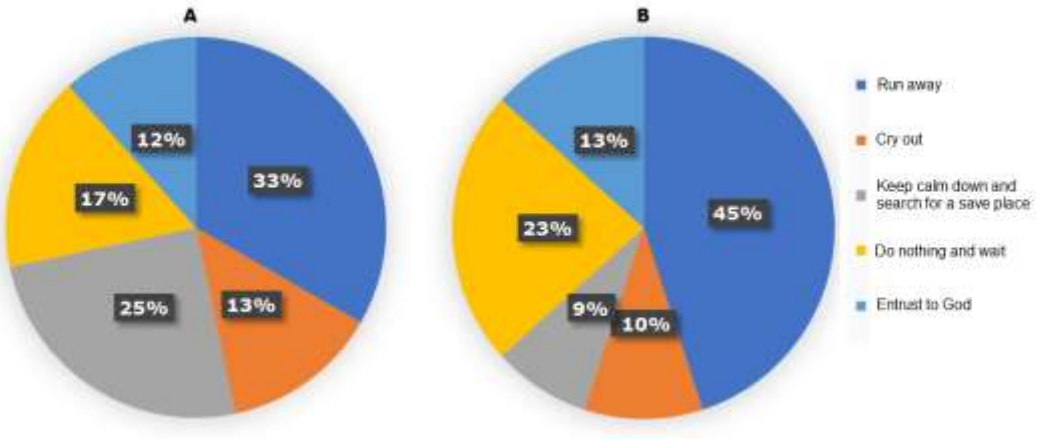

Figure 8. Expected reaction to an earthquake A) *Miraflores*, B) *Armando Mestre*.

4. DISCUSSION

Although moderate knowledge (medium level) about the seismic hazard is recorded, and a proactive attitude in training (100% willingness for training), an alarming operational gap persists: the practical dimension exhibits null values in emergency plans, drills, and economic mitigation measures (0% in all variables) (Figure 9). There is a disconnect between seismic reality and social perception: the lack of training (67% - 80%) and inadequate responses to earthquakes (only 9% - 25% seek safe shelter).

The absence of mass training (more than 67%) reflects the inefficacy of public policies for seismic prevention in the territory. Although more than 70% are workers/students, there was no effective transfer of knowledge. A direct correlation is reflected (33% in Miraflores vs. 20% in Armando Mestre) validating the absence of training in civil protection (67-80% without training) through the governmental entities of the territory.

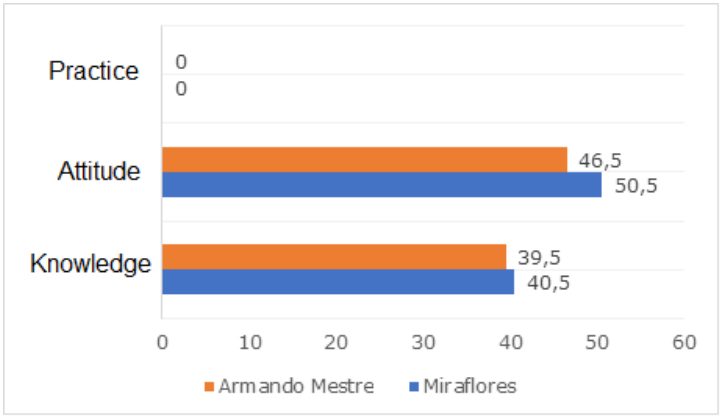

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Figure 9. Adapted seismic risk perception. Source: Sánchez-Hernández y Vicuñan-Barrera (2022) modified by authors.

5. CONCLUSIONS

- Fourty two percent (42 %) of residents in Miraflores and 45% in Armando Mestre have never perceived an earthquake. This evidences a normalization of risk due to the low intensity of recent events, generating a false sense of security that underestimates the latent threat.

- Only 20% of the population of Miraflores and 33% of Armando Mestre have received training on earthquake protocols, despite more than 70% being integrated into work/educational environments. This lack of information translates into high-risk behaviors.

- Earthquakes are perceived as an "abstract" risk versus more visible phenomena (floods, fires). Only 22% of the surveyed population in Miraflores and 37% in Armando Mestre report historical damages, which reinforces their perception as a secondary threat.

- The population of Armando Mestre shows a greater training gap since barely 9% would adopt safe behaviors vs. 25% in Miraflores, linked to lower training coverage (20% vs. 33%).

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Additional Information

Conflict of interest

The authors declare no conflicts of interest.

Author Contribution

OCH: literature review, article preparation, editing and compilation work. PDLR and NFH: literature review, fieldwork, editing and compilation work. RGL and DMAM: editing and reviewing work. AFB: editing and reviewing work. All approve the final version of the manuscript.

ORCID:

OCH, http://orcid.org/0009-0006-2509-2898
PDLR, http://orcid.org/0000-0001-5231-3429
NFH, http://orcid.org/0009-0000-0996-7507
RGL, http://orcid.org/0000-0003-1075-8176
DMAM, http://orcid.org/0009-0007-2393-7794
AFB, http://orcid.org/0009-0005-8515-5961

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