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ORIGINAL PAPER

Disaster risk perception in urban contexts and for people with disabilities: case study on the city of Iquique (Chile)

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Abstract About 15% of the world's population suffers from some kind of disability. In addition to experiencing high rates of poverty, exclusion and lack of access to education, employment, health care, legal support and other services, individuals with disabilities are disproportionately affected by disasters, recording a mortality rate two to four times higher than that of people without disabilities. These facts are not reflected in information surveys used in planning for disaster risk management in urban contexts. This study proposes an approach to characterize the population with disabilities within a risk perception framework using the city of Iquique, in northern Chile, as a case study. This research encompasses the following stages: first, a review of the social risk perception approach; second, a determination of exposure to natural hazards; third, the sample selection, survey design and implementation; fourth, the generation of four indices: (1) the overall or generic risk perception index; (2) the specific index for each of the identified hazards; (3) the anticipated behavior index; and (4) the local risk management index; and finally, the statistical analysis of the indices and the selected independent variables, emphasizing the disability

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factor. The study allowed us to estimate Iquique's population with disabilities, the types of disabilities present and the characteristics of families with disabled members. Risk perception and disabled people represent new issues with high social value and deserve more attention from research, planning and response agencies.

Keywords Risk perception · Disaster · Urban · Disability · Earthquake · Tsunami

1 Introduction

About 15% of the world's population has some kind of disability (WB-WHO 2011). People with disabilities may also experience higher rates of poverty, exclusion and lack of access to education, employment, health care, legal support and other services, circumstances that significantly increase their vulnerability to external events such as natural hazards, environmental problems such as climate change, and man-made actions.

This increased level of risk is supported by figures obtained after different emergencies and disasters showing that people with disabilities are disproportionately affected in comparison with other population groups without disabilities. Data on individuals with disabilities have recorded a mortality rate two to four times higher than that of people without disabilities (Stough and Kang 2015). Paradoxically, the issue of disability has not been integrated into planning processes for risk management and emergency management at both urban and rural levels.

This study proposes an approach to measure and characterize the population with disabilities within a framework to evaluate risk perception in urban contexts of socio-natural and climate change-based events on a case study in the city of Iquique, located in the Tarapaca region in a macro-zone in northern Chile. The authors selected the city of Iquique due to four major reasons: (1) the city has previous hazard and risk studies supported by the National Fund for Scientific and Technological Development (FONDECYT) that show high exposure to tsunamis, earthquakes and landslides; (2) Iquique has recently experienced emergency evacuations following tsunami alerts; (3) there have been anecdotal references to issues evacuating population with disabilities; and (4) there are no estimates about Iquique's population with disabilities—types or figures. These circumstances create a unique opportunity to deepen themes not sufficiently studied such as risk perception and people with disabilities.

1.1 Disabilities

There is no universal agreement on the concept of disability. This may vary according to interests, study areas or action by those seeking to address it. Traditionally, people with disabilities are referred to people with sensory problems (e.g., a reduced ability or inability to see, speak, hear, learn, understand, remember); motor skills (e.g., walking, managing); physical (e.g., neurological, musculoskeletal, cardiovascular); and psychiatric (e.g., long-term mental health condition such as dementia, schizophrenia, and self-harm) (Kailes and Enders 2007). One could then say that a "disability is a functional limitation or restriction of an individual's ability to perform an activity" (NEADS 2016).

It is important to understand that individuals with disabilities and physical limitations are part of society. Kailes and Enders (2007) state that the factor of aging alone makes elderly people enter the disabled group. In this aspect, these authors point out that four out of ten adults over 65 years old experience some form of disability.

1.2 Disasters and disability

Disasters are the materialization of risk conditions. Risk conditions are generated by the relationship between subjects, objects or systems, and external factors that could significantly affect them, factors called hazards. These hazards may be caused by natural phenomena (geological, hydro-meteorological, climatic or biological), anthropogenic (technological, armed conflict, social unrest or terrorism) or a mix of them when there is interaction between natural phenomena and man-made action (landslides, deforestation and forest fires).

Subjects, objects or systems are found at different exposure levels to hazards, they have particular characteristics that determine higher or lower fragility or susceptibility (Cutter and Emrich 2006), and they may develop a kind of resilience; such combined conditions define vulnerability (Cardona 2005a; Birkmann et al. 2011).

Hazards, vulnerability and exposure factors define risk conditions for a community. Therefore, disasters are no longer seen as “natural” events as they become socially constructed events where natural phenomena such as earthquakes, tropical storms, tsunamis and others form part of cumulative processes of social risk construction.

Cardona points out that “risk itself is the fundamental problem and (that) a disaster is a derivative issue” (2008: 9). This statement allows us to understand the transition that occurred in the 1980s with a shift from disaster management to risk management. Risk management covers four specific processes: risk identification and assessment; risk reduction, risk transfer and financing; disaster management; and disaster recovery (Cardona 2008).

According to Aldrich and Benson (2008, cited by Stough and Kang 2015), people with disabilities have an increased risk of death, a circumstance clearly visible in the Tōhoku earthquake and tsunami in 2011, where the mortality rate of people with disabilities was double than that of the general population and in the Indian Ocean tsunami where more than half of the children with disabilities attending special schools died in the disaster.

More than the functional problem and existing limitations to appropriately prepare and act when facing an eventual warning or disaster situation, there are other factors that complicate the scenario. The same condition of disability interacts with other variables such as age, gender, ethnicity, status, beliefs and customs, resulting in a complex multifaceted problem that is extremely difficult to address (IDA and IDDC 2016).

Donner and Rodriguez (2008) compared different scenarios with the blind, people in wheelchairs, the elderly and individuals with arthritis to see how they reacted to a simulated emergency situation, finding that the evacuation times for people with disabilities were significantly higher than that for younger people and those without disabilities (from 27% in older people to up to 247% for the blind).

The coexistence of poverty, unemployment, segmentation and marginalization, structural deficiencies in housing and environmental sanitation problems accentuate risk conditions for people with disabilities (Stough and Kang 2015).

Moreover, the impact of disasters experienced by a population with disabilities may increase due to factors other than those described, such as separation from those who provide them with support and care, a greater predisposition to anxiety, depression or anxiety (Rooney and White 2007), and the lack of assistance programs to promptly detect and intervene.

1.3 Disability and disaster risk management

In the last ten years, United Nations has been promoting the development of a regulatory framework at a worldwide level that intends to recognize the rights of individuals with disabilities with an inclusive approach looking at specific aspects aimed at the protection and safety in cases of adverse events of a socio-natural character (UN 2016).

At a regional level, policies are being carried out with specific advances in the area of protection for people with disabilities. Worth noting are the Charter of Verona of the European Union—for the rescue of people with disabilities in disasters—and the Incheon Strategy that sets out an inclusive approach for those with disabilities within the disaster risk management framework in Asia and the Pacific (European Emergency Number Association 2007 and UNESCAP 2012 cited by Stough and Kang 2015).

In addition, the Sphere Project included the topic of disability as a crossover for different sectors involved in emergency management as a regulation standard. This effort adds great value to the extent that the Sphere Project is considered essential for national and international non-governmental organizations as well as governmental bodies in recipient and donor countries (Stough and Kang 2015).

At the national initiative level, we need to mention the robust policy of the USA which defines "special needs" in a broader way, including people with disabilities, severe mental illness, minorities, individuals who do not speak English, minors (<15 years) and the elderly (>65 years). For this approach, the functional aspects are of the greatest importance, rather than the deficiencies, diagnostics or labels that are placed on individuals (Kailes and Enders 2007).

More recently, the Sendai Framework for Disaster Risk Reduction 2015–2030 includes specific recommendations on the issue of people with disabilities. The support of people with disabilities and groups that work with this group has significantly contributed to writing this document showing them as active participants in designing and developing risk reduction policies.

One of the main stumbling blocks for inclusive policies targeting the disabled population to move forward is the lack of information of authorities and aid agencies. This has resulted in an underestimation of the reality of this group and a lack of understanding of the complexity of problem. These failures lead to a segmentation of the population that may even end in exclusion, exacerbating their vulnerability and compromising their resilience to disasters (IDA-IDDC 2016). A lack of knowledge also leads to the exclusion of people with disabilities in disaster management and relief.

2 Materials and methods

The technical design of this study contemplates the following stages (Fig. 1): first, a review of the social risk perception approach; second, determination of exposure to natural hazards; third, the sample selection, survey design and implementation; fourth, the generation of four indices: (1) the overall or generic risk perception index; (2) the specific index for each of the identified hazards; (3) the anticipated behavior index; and (4) the local risk management index; and finally, the statistical analysis of the indices and the selected independent variables, emphasizing the disability factor.

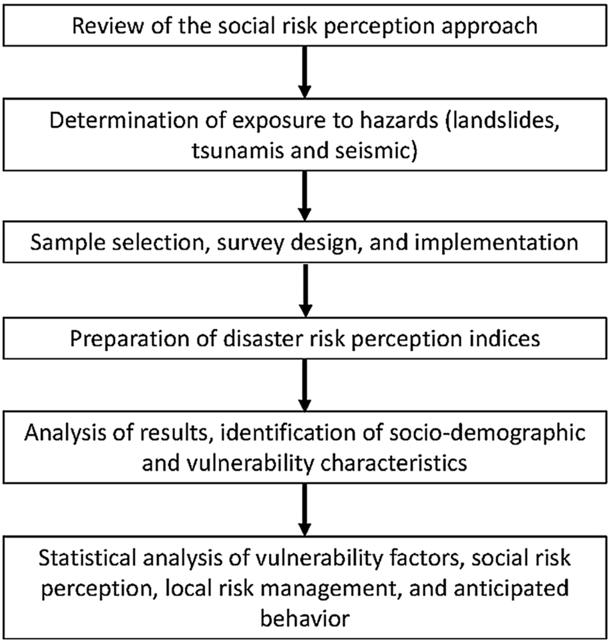

Fig. 1 Methodology flowchart

2.1 The social risk perception approach

According to Slovic (2000), risk perception not only refers to psychological aspects experienced by the individual, but also influenced by cultural factors, prior knowledge and wisdom (Burton et al. 1968) creating a social representation. The social perception of risk corresponds to a mental and cultural construction that forms the basis of experiences, also in relation to the environment which is often associated with a population's prolonged exposure to hazards (Sjöberg 2000, 2003; Thompson et al. 1990; Douglas 1985), generating a familiarity with this danger (Ittelson 1978; Okada 2004). Such representations are not permanent since there is a continuous construction and reconstruction process that forms the living experiences day by day. Rather than presenting a clear definition, perception is an amalgam of beliefs and cultural symbols (Sorensen 1991) that must be recognized to improve preventive processes of risk management. Some factors that influence risk perception are economic, social (Dibben and Chester 1999) beliefs, education (Chardon 2002), gender (Ulleberg and Rundmo 2002) and the age range (Dominey-Howes and Minos-Minopoulos 2004; Gregg et al. 2004; Tobin and Whiteford 2002). According to Wilches-Chaux (1998: 16): "… It is known that risk scenarios are not only dynamic and changing and that static readings become invalid very quickly, however there are different views and possible and valid interpretations of the same situation and are so right those who interpret a scenario through scientific and technological eyes, as well as those who may interpret the same in the light of local, popular and traditional knowledge. The acceptance of validity of different views, from different imaginary and different subjectivities, not only has theoretical and conceptual significance but results in attitudes and emotions or disaffected, in practical behavior and, ultimately, in decisions that on one hand or the other are taken to address a particular situation."

Risk perception is conceived as a judgment, a belief associated with individuals' attitudes and knowledge about their environment, and also the product of their experience in previous events, rather than of objective information on risk. "In this regard, the individual's framework including assumptions and subjectivities strongly influences a particular way of reacting and acting" (Cid Ortiz et al. 2012: 116). In brief, the perceptual process relates objective knowledge with the image or risk perception that the individual has and this is influenced by a value system, objective knowledge and the experience of the person or social group in risk events. This determines the measure of their self-protection abilities and attitudes of self-management, as expressed in their behavior toward emergency events and also their involvement and responsibility in the prevention stage.

In this study, we sought a further analysis of the social perception of risk as a fundamental aspect of social vulnerability (McFarlane 2010 in Castro et al. 2015). The perception of risk is seen as an important aspect in a "social behavior" analysis when facing a catastrophic event.

The conceptual foundation of this study builds on the original pressure and release model (Blakie et al. 1994) considering two dimensions: social cognitive and technical scientific, where both permanently interact (Fig. 2).

Building upon this conceptual foundation, we indicate the social perception of disaster risk measuring process in Sect. 2.4, which includes the indicators, definitions and key factors considered.

The initial process involved gathering background information on social and institutional vulnerability in the areas to be analyzed and then incorporating them into the analysis of social perception as a contextual framework. The background of social vulnerability was collected by a review of secondary information. Also a series of in-depth interviews were conducted with key actors, such as presidents of neighborhood associations, risk prevention and safety directors at the community level, and regional managers in areas of land use and emergency management.

2.2 Determination of exposure to hazards

The determination of hazard exposure was conducted through the spatial overlapping of the natural hazard information and the population in this area. The hazard maps for the city of Iquique were prepared previously by Castro et al. (2015), including the three main natural hazards: landslides, flooding due to tsunami and seismic amplification. The assessment of landslide areas was conducted mainly through geomorphological mapping techniques such as the interpretation of air photographs, and the multi-temporal analysis of Google Earth satellite images (Fookes et al. 2007; Knight et al. 2011 in Castro et al. 2015). The tsunami hazard areas were identified by the official information provided by the

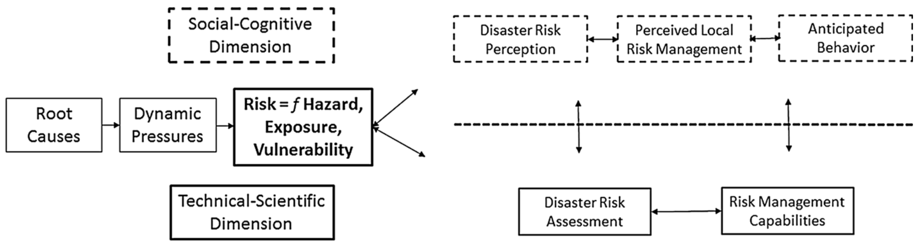

Fig. 2 Social risk perception evaluation model

Chilean Navy's Hydrographic and Oceanographic Service (SHOA 2012 in Castro et al. 2015). At the same time, the study incorporated the assessment of the seismic amplification conducted by Ramírez (2008 in Castro et al. 2015). Finally, the results were systematized by geographic information system (GIS) using ArcGIS software 10.3.

Next, we overlapped the hazard maps obtained from the 2011 Census projection (185,994 inhabitants) at a square level (*manzanas censales*) for the city of Iquique. Then, we calculated the population exposed to the three identified hazards (Fig. 3):

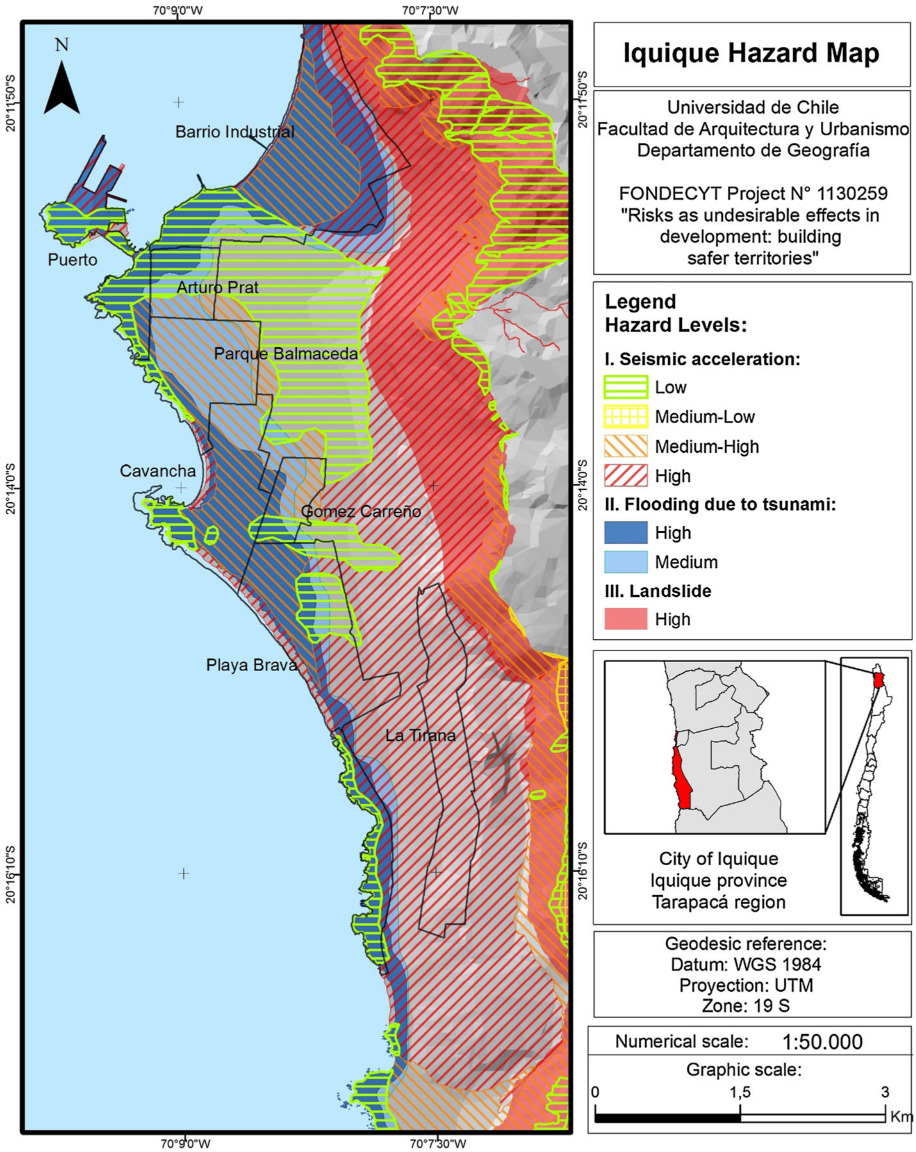

Fig. 3 Iquique hazard map and neighborhoods studied

- Seismic hazard exposure (SE): very high (HSE), medium (MSE), low (LSE)
- Tsunami hazard exposure (TE): very high (HTE), high (MTE), rest (LTE)
- Landslide hazard exposure (LE): very high (HLE), rest (LLE)

2.3 Sample selection, survey design and implementation

The sampling method corresponds to a combination of spatial agglomeration sampling and random sampling (Stephenson 1994: 16). The sample selection was performed using the following steps:

Selection of census areas exposed to natural hazards: The main variable for sample selection in this study was hazard exposure. Even though Iquique is entirely exposed to the seismic hazard, we limited the study to the city area with urban development and multi-hazard environment. The study area includes the tsunami flooding (HTE and MTE), landslides (HLE) and seismic (HSE and MSE) hazards.

The determination of population exposed was conducted through the spatial overlapping of the multi-hazard study area and the projected population. The outcome of this calculation shows that 31% of Iquique's population (57,838 inhabitants) lives in the exposed area. According to the census, the neighborhoods identified within the study area are Port, Barrio Industrial, Playa Brava, Cavancha, Parque Balmaceda, Arturo Prat, Gómez Carreño and La Tirana.

Sample size The estimated size of the sample was carried out using the sample calculator Raosoft Inc. (Bird and Dominey-Howes 2008), considering a margin of error of 8.7% and a 95% confidence level, resulting in $n = 127$. Subsequently, this total was distributed in proportion with the estimated population in the selected neighborhoods.

The survey consisted of a total of sixty-five questions equally divided into seven subtopics: background, vulnerability, social risk perception, risk awareness, preparation, risk management and behavior facing events. It is important to note that the vulnerability section collected information on demographic and socioeconomic aspects of household respondents in order to supplement and update information obtained through the last nationwide 2002 Population and Housing Census.

The questions used in this survey were mixed close-ended, open-ended, multiple choice and single answer. For single answer questions, we used the five-level Likert scale (from "strongly agree" to "strongly disagree").

The surveys were conducted during the fourth week of August 2015. The fieldwork was carried out from 9 a.m. to 6 p.m. estimating an average of 45 min per survey. The surveys were carried out by sector and neighborhood. During the application of the survey, the location of the respondents' houses was identified on a map. Later, the locations were georeferenced using ArcGIS software 10.3. Respondents were randomly selected following the sample design in order to maintain a homogeneous spatial distribution.

2.4 Generation of indices or scores

Building on the social risk perception evaluation model illustrated in Fig. 2, we generated four indices or scores by manipulating key factors or individual variables to produce an aggregate measure of disaster risk perception. As indicated by Cutter et al. (2010), the indices "…reveal the relative position of the phenomena being measured and when evaluated over time, can illustrate the magnitude of change (a little or a lot) as well as direction of change (up or down; increasing or decreasing)" (Cutter et al. 2010: 2). The data required were standardized and placed within categories of analysis to reduce the initial set of key factors considered, and then, each variable was coded and added to obtain the selected four indices. These are: (1) the overall or generic risk perception index; (2) the specific index for each of the identified hazards; (3) the anticipated behavior index; and (4) the local risk management index. The statistical analysis was conducted using SPSS Statistic 22.

Tables 1 and 2 illustrate the model used to measure the social perception of disaster risk. Table 1 shows the independent variables and their justification based on the relevant literature.

Table 2 identifies and defines the indices proposed, categories of analyses, key factors/variables and their justification based on the relevant literature, and the variable's effect on the index.

To generate these indices, it was necessary to recode perception variables, from a five-level Likert scale (strongly agree, agree, indifferent, disagree and strongly disagree) toward a numeric 1–5 scale.

We proceeded to generate a generic perception (GP) index, comprising of general perception variables not associated with a particular hazard (Table 3b). Adjustments were made to the components' cardinality [positive (+) or negative (−)] to insure that higher numbers mean high risk perception and lower numbers mean low risk perception.

Table 1 Measuring social perception of disaster risk—independent variables

	Category	Key factor/variable	References
Independent variables	Social demographic information	Age	Cutter et al. (2003)
		Gender	Ajibade et al. (2013) and Azad et al. (2013)
		Education level	Norris et al. (2008) and Morrow (2008)
		Participation in community organizations	Esteban et al. (2013)
		Number of household members	Rumbach and Shirgaokar (2016) and Sam et al. (2016)
		Household income	Cutter et al. (2003)
	Vulnerability	Disabilities	UN (2016)
		Retirees	Greenberg (2013)
		Unemployment	Mileti (1999)
		House tenancy	Cutter et al. (2003)
		Access to sewage	Rumbach and Shirgaokar (2016) and Sam et al. (2016)
		Access to potable water	Rumbach and Shirgaokar (2016) and Sam et al. (2016)
	Risk knowledge	Zoning and disaster risk information	Castro et al. (2016)
		Information on adverse events occurred	Mendoza (2005) and Cárdenas (2008)
		Particular disaster experience	Cutter et al. (2008) and Wachinger et al. (2013)

Table 2 Measuring social perception of disaster risk-indices

Index	Definition	Category	Key factor/variable	References	Effect
Generic perception index (GPI)	The generic risk index corresponds to the value that an individual, family or community makes about the probability of occurrence of an adverse event and to experience its consequences	Social risk perception	Attachment to the territory	Mendoza (2005), Anton and Lawrence (2014) and Bonaiuto et al. (2016)	Positive
			Perceived hazard exposure	Ittelson (1978) and Mendoza (2005)	Positive
			Awareness of human interventions as contributors to risk creation	Holcombe et al. (2013)	Positive
			Influence of previous disaster experience	Cid Ortiz et al. (2012)	Positive
			Perceived community problems and prioritization	Anton and Lawrence (2014)	Positive
		Preparation	Perceived individual preparedness capabilities	Burby et al. (2000), Tierney et al. (2001) and Esteban et al. (2013)	Positive
			Perceived neighborhood preparedness organization	Anton and Lawrence (2014)	Positive
			Familiarity with Local Emergency Plans	Burby et al. (2000), Godschalk (2007) and Gellert De Pinto (2012)	Positive
			Familiarity with emergency signage in the city	Wachinger et al. (2013)	Positive
			Preparedness based on experience and instinct, not planned	Aneas de Castro (2000)	Negative
			Existence of emergency measures which involve children	Esteban et al. (2013)	Positive

Table 2 continued

Index	Definition	Category	Key factor/variable	References	Effect
Specific hazard perception indices • Seismic risk (SRP) • Tsunami (TRP) • Landslide (LRP)	The specific hazard represents the level of risk awareness, and the perceived capabilities to face it.	Social risk perception	Level of awareness about the specific hazard	Cid Ortiz et al. (2012) and Esteban et al. (2013)	Positive
			Perceived exposure and susceptibility to the specific hazard	Cid Ortiz et al. (2012) and Esteban et al. (2013)	Positive
		Preparation	Perceived capabilities to face the specific hazard risk	Ittelson (1978) and Mayunga (2007)	Positive
Local risk management (LRM) index	The local risk management index corresponds to the value that an individual, family or community makes about the information, skills and resources of local organizations and the community to deal with existing risks and the resulting/future adverse events	Local risk management	Information on disaster risks, local emergency plans, and signposts for emergency evacuation and safety areas	Cid Ortiz et al. (2012) and Wachinger et al. (2013)	Positive
			Participation in training on emergency management and evacuation drills	Wilches-Chaux (1998) and Esteban et al. (2013)	Positive
			Emergency and disasters as priority issues in the community	Mayunga (2007), Cárdenas (2008) and Esteban et al. (2013)	Positive
			Perceived performance of emergency organizations	Cid Ortiz et al. (2012) and Castro et al. (2016)	Positive
			Perceived community role in emergency management	Mayunga (2007) and Esteban et al. (2013)	Positive

Table 2 continued

Index	Definition	Category	Key factor/variable	References	Effect
Anticipated behavior (AB) index	The anticipated behavior index corresponds to attitude toward disaster risks and the willingness or inclination of an individual, family or community to deal with an adverse event	Behavior	Reacting when an adverse event occurs	Cid Ortiz et al. (2012)	Positive
			Discussing these topics within the family	Esteban et al. (2013)	Positive
			Having limitations to improve home's conditions	Esteban et al. (2013)	Positive
			Helping family and neighbors in case of emergency	Esteban et al. (2013)	Positive
			Following emergency managers' instructions	Esteban et al. (2013)	Positive

Table 3 Hazards exposure

	Frequency	Percentage	Valid percentage	Accumulated percentage
(a) Exposure to earthquakes (very high = HSE; medium = MSE; low = LSE)				
Valid				
HSE	31	24.4	24.4	24.4
MSE	49	38.6	38.6	100.0
LSE	47	37.0	37.0	61.4
Total	127	100.0	100.0	
(b) Exposure to tsunami (very high = HSE; medium = MSE; low = LSE)				
Valid				
HTE	45	35.4	35.4	35.4
MTE	43	33.9	33.9	100.0
LTE	39	30.7	30.7	66.1
Total	127	100.0	100.0	
(c) Exposure to landslides (very high = HLE; remainder = LLE)				
Valid				
LLE	127	100.0	100.0	100.0

A particular risk perception index was generated for each of the three hazards analyzed: (1) seismic risk (SRP); (2) tsunami risk (TRP); and (3) landslide risk (LRP). Adjustments were made to the components' cardinality [positive (+) or negative (−)] where higher numbers mean high risk perception and lower numbers mean low risk perception.

Then, we proceeded to generate the anticipated behavior (AB) index, representing the variables associated with the ability and willingness to appropriately respond—as individuals and households—to an adverse event. Adjustments were made to the components' cardinality [positive (+) or negative (−)] where higher numbers mean inclination to action and lower numbers mean inaction.

The fourth index, local risk management (LRM) index, was generated, using the variables associated with specific actions and the expected results from effective local risk management. Adjustments were made to the components' cardinality [positive (+) or negative (−)] where higher numbers mean positive risk management and lower numbers mean poor management.

Finally, using the hazard maps mentioned previously for the city of Iquique, we proceeded to geo-reference the surveys, classifying them by level of exposure to each of the three identified hazards.

3 Results

A total of 127 valid surveys addressing household heads with an average age of 54.06 years (SD 16.03 years) were obtained. The ratio was 1.6 men for every woman surveyed, 34.6% had completed full secondary education, 9.4% full-time higher education and 18.9% university education. The average number of people in the households was 4.1%, which statistically fits the national trend. Worth noting is that four households were home to more than 11 people.

Regarding the number of families per household, 81% of respondents reported one family per household, followed by 11% declaring at least two families per household with an average of 1.20 families per household (SD 0.682). This condition of sharing a home with extended family or another family is called "*external allegamiento*" (external lodging) in Chile. The data obtained in this study are similar to what has been recorded in the *allegamientos*/household lodgings index by the Survey of National Socioeconomic Characterization (CASEN) of the Ministry of Development for the period 2003–2009, where this reflects higher external *allegamiento* figures (14%) in Iquique than regional (12%) and for the country (5%) (CASEN 2016).

As for housing tenure, this was primarily owned and mortgaged in 6 out of 10 households surveyed. Rented accommodation represented 2 out of 10 households, while conditions of free accommodation, by assignment and paying short term, represent 7%, respectively.

Access to basic services like sewage and drinking water is 100% in the households surveyed. The percentage of retired people in households in the study area was 0.46% (SD 0.676) per household. The percentage of unemployed in households in the study area was 0.22% (SD 0.518).

Seventy-two percent of households have an average income that fluctuates below minimum wage and does not reach 1 million pesos (US$ 1500 approximately). Only 7% reported earnings above 1.5 million pesos (US$ 2250 approximately).

3.1 Exposure to a hazard

Through geo-referencing surveys with hazard maps on seismic, tsunami and landslides in the area, the levels of exposure to various threats were determined (Table 3).

This revealed that households in the study area show a medium to low exposure in all three categories.

3.2 Risk perception

3.2.1 Relationship between the Generic Perception (GP) Score and each specific hazard

Table 4 shows an interesting relationship between the generic risk perception and the risk perception to specific hazards. Indeed, an association with greater force corresponds to the seismic risk perception [$r = 0.517$; Sig. (2-Tailed) = 0.000], followed by landslide risk perception [$r = 0.305$; Sig. (2-Tailed) = 0.000] and tsunami risk perception [$r = 0.224$; Sig. (2-Tailed) = 0.011]. This finding could be directly related to recurrence aspects of identified hazards. Interestingly, associations by type of risk show that respondents tend to relate seismic risk to landslides and then tsunamis.

3.2.2 Relationship between Generic Perception Score and level of exposure for each type of risk

In spite of what was stated by respondents with regard to feeling exposed, no association was found between generic perception and exposure to specific types of risk in the study area. Therefore, in this case, the level of exposure does not alter the generic risk perception.

Table 4 Generic perception of risk and perception of type of hazard

	Generic perception score (GP)	Perception score earthquake risk (SRP)	Perception score tsunami risk (TRP)	Perception score landslide risk (LRP)
Generic perception score (GP)				
Pearson's correlation	1	.517**	.224*	.305**
Sig. (2-Tailed)		.000	.011	.000
N	127	127	127	127
Perception score earthquake risk (SRP)				
Pearson's correlation	.517**	1	.236**	.349**
Sig. (2-Tailed)	.000		.008	.000
N	127	127	127	127
Perception score tsunami risk (TRP)				
Pearson's correlation	.224*	.236**	1	.209*
Sig. (2-Tailed)	.011	.008		.018
N	127	127	127	127
Perception score landslide risk (LRP)				
Pearson's correlation	.305**	.349**	.209*	1
Sig. (2-Tailed)	.000	.000	.018	
N	127	127	127	127

** 0.01 (2-Tailed), correlation is significant

* 0.05 (2-Tailed), correlation is significant

3.2.3 Relationship between specific scores of perception by risk type and level of exposure for each type of risk

The association between specific scores by risk perception and exposure to each of them is weak.

3.2.4 Generic relationship between risk perception and socioeconomic variables of householders

The relationship between generic risk perception and socioeconomic variables of household heads is weak. However, projecting the characteristics of age and educational level may show some differences in perception, but the relationship remains weak and does not exceed 15% of association between the variables.

3.3 Disability and perception

This section reports the findings related to emphasis given in this study to the relationship between disability and social risk perception. In the study, it is noted that cases claiming to have persons with disabilities in households account for 10% of the total, with less than one person per household on average. Regarding the most frequently reported types of disabilities are physical mobility conditions with 4.7% of the total, while hearing and mental disabilities together represent 3.2% of the total. This figure is less than 15% compared with the international literature (WB–WHO 2011).

3.3.1 *Relationship between disability and socioeconomic variables of the head of household*

The relationship between households that report having persons with disabilities and the socioeconomic variables of household heads is weak. In fact, the strength of an association between the variables fluctuates between 14 and 20%.

However, when considering the average household income variable, it tends to show a slightly higher relation with the number of people with disabilities in the household [$r = 0.208$; Sig. (2-Tailed) = 0.019] (Table 5).

The finding of higher incomes in families with people with disabilities could be attributable to the need to cover expenses associated with treatment or care required by people with disabilities.

3.3.2 *Risk perception and disability*

It was examined whether there was any difference in the generic risk perception (GP) and the fact of having (or not) people with disabilities in the family. A weak level of association was observed with a correlation index that does not exceed 30%.

Despite a weak association between variables, the risk perception to a specific hazard associated with people with disabilities at a household level is mainly linked to the perceived risk of landslides and tsunamis. As respondents do not recognize a high exposure to landslide risk, it may be assumed that the reason for the higher risk perception in this group is attributed—in this context—to events associated with tsunamis. Interestingly, the perception of seismic risk is the lowest of the three types evaluated (Table 6).

3.3.3 *Participation in community organizations and presence of persons with disabilities in the family*

No relationship between participation in community organizations and the existence of people with disabilities at a household level was observed. It is necessary to study the existence of support networks and the level of consolidation of social capital in the study area, since the results obtained are associated with weak community organizations or intermittent actions.

Table 5 Disability and income level

	Number of disabled people per household (2.1)	Average income per household (7)
Number of disabled people per household (2.1)		
Pearson's correlation	1	.208*
Sig. (2-Tailed)		.019
N	127	127
Average Income per household (7)		
Pearson's correlation	.208*	1
Sig. (2-Tailed)	.019	
N	127	127

* 0.05 (2-Tailed), correlation is significant

Table 6 Risk perception to a specific hazard and disability

	Number of disabled people per household (2.1)	Perception score earthquake risk (SRP)	Perception score tsunami risk (TRP)	Perception score landslide risk (LRP)
Number of disabled people per household (2.1)				
Pearson's correlation	1	.033	.187*	.201*
Sig. (2-Tailed)		.709	.036	.024
N	127	127	127	127
Perception score earthquake (SRP)				
Pearson's correlation	.033	1	.236**	.349**
Sig. (2-Tailed)	.709		.008	.000
N	127	127	127	127
Perception score tsunami risk (TRP)				
Pearson's correlation	.187*	.236**	1	.209*
Sig. (2-Tailed)	.036	.008		.018
N	127	127	127	127
Perception score landslide risk (LRP)				
Pearson's correlation	.201*	.349**	.209*	1
Sig. (2-Tailed)	.024	.000	.018	
N	127	127	127	127

* 0.05 (2-Tailed), correlation is significant

** 0.01 (2-Tailed), correlation is significant

3.4 Risk perception and anticipated behavior

No relationship was seen between anticipated behavior and generic risk perception. As previously mentioned, a greater association—although weak—was observed between risk perception and the existence of people with disabilities in households.

The anticipated behavior may be partially influenced by age variables of household heads and the average income of surveyed households. However, levels of association are weak given that the correlation values are 14.6 and 17.8%, respectively. The other variables show no association with anticipated behavior actions that are noteworthy.

3.5 Perceived problems

Regarding the more serious problems perceived in the community, respondents indicated crime (88.2%) and drug abuse (55.9%) as the most concerning, while problems associated with earthquakes, mudslides and landslides are also considered serious with 36, 8.7 and 10%, respectively. No differences were found in relation to the existence of persons with disabilities in the family.

3.6 Local risk management

As for local risk management, 22% of the community has participated in training emergency management; however, in 67% of the cases a family member has participated in evacuation drills.

While nearly 60% of households stated that emergency organizations have performed well in handling emergency drills, 40% of the cases had a negative opinion or did not know how to evaluate this question.

Facing a possible emergency, the families surveyed indicated that the most reliable sources of information are the radio with 80.3%, followed by television with 11% (Table 7).

The Internet reaches 2.4%, with neighbors and the press at 0.8% (respectively). No differences were found in relation to the existence of persons with disabilities in the family.

These results on preferences and confidence on risk and emergency information are vital to interpret some risk communication issues experienced during recent tsunami events in Iquique, and to revisit existing procedures.

4 Discussion

Beyond a weak association between risk perception associated with people with disabilities in households and risk exposure—particularly to tsunami—the statistical results obtained do not significantly contribute to the understanding of the dynamics of perception and the association with the different variables studied. This circumstance shouldn't underestimate the importance of this research, which allowed us to estimate the population with disabilities in the city of Iquique, types of disabilities present, the characteristics of families with disabled members, and their perception about disaster risks, the local emergency management and their planned behavior.

Acknowledging the presence of this population segment with special needs and exposure to natural hazards demand special attention, and imply immediate action, not only from those who work in urban planning, disaster risk and emergency management, but for the whole society.

With that in mind, the research team decided to further the study and conduct a georeferencing analysis. ArcMap 10.3 software was used to display the results of risk perception to earthquake and tsunami hazards, and results are shown in Figs. 4 and 5.

Table 7 Confidence in information sources

	Frequency	Percentage
Validity		
Internet	3	2.4
Neighbors	1	0.8
Newspaper	1	0.8
Radio	102	80.3
Television	14	11.0
Variety	2	1.6
Others	3	2.4
Don't know	1	0.8
Total	127	100.0

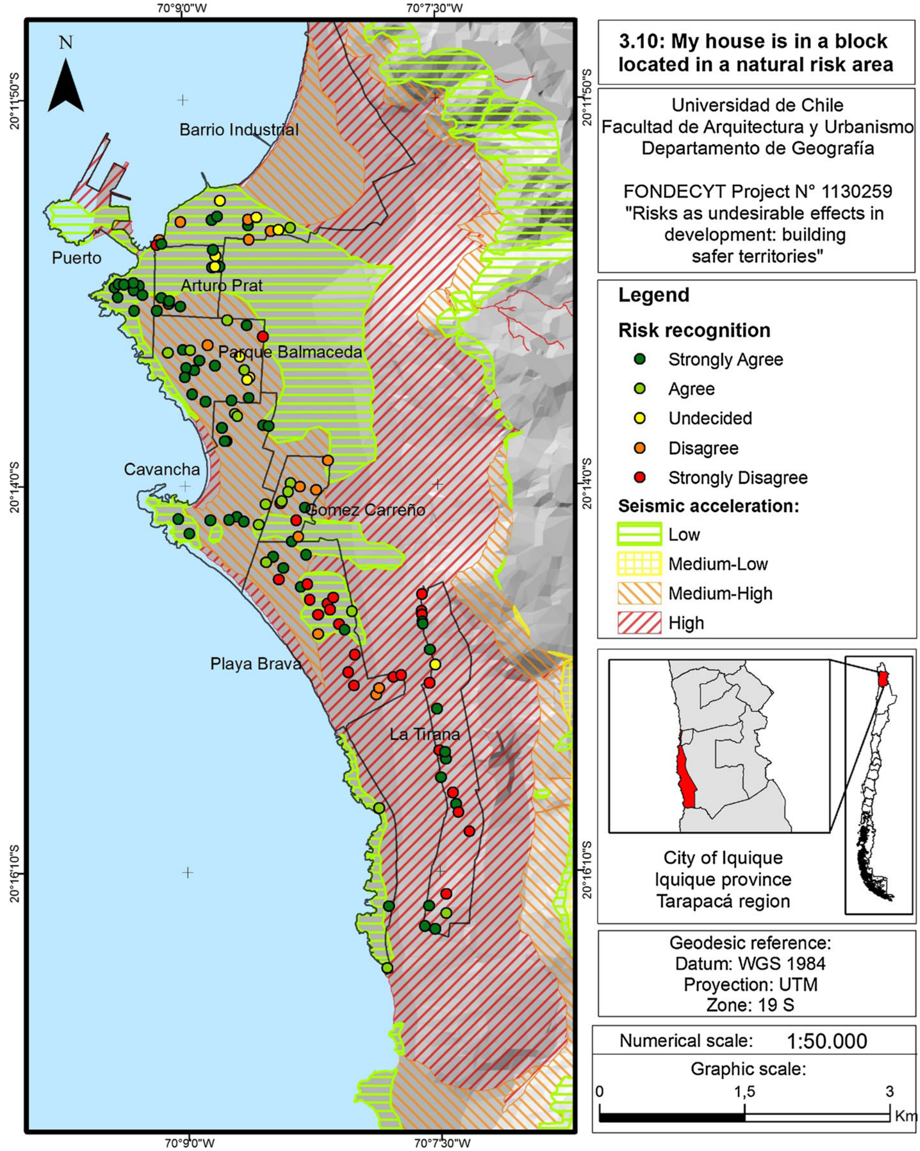

Fig. 4 Geo-referencing: earthquake risk perception and hazard exposure

As for the tsunami hazard there are clear spatial patterns, an overlap between high hazard perception (strongly agree and agree with the statement) and medium and high exposure was observed in the coastal line. However, to the south a small cluster was identified, which despite being within the flood zone, disagreed or strongly disagreed to being in an exposed area to natural hazards.

Regarding seismic hazard, the perception of the population does not reflect any clear patterns. Respondents to the south, where residences are located in areas of high–medium

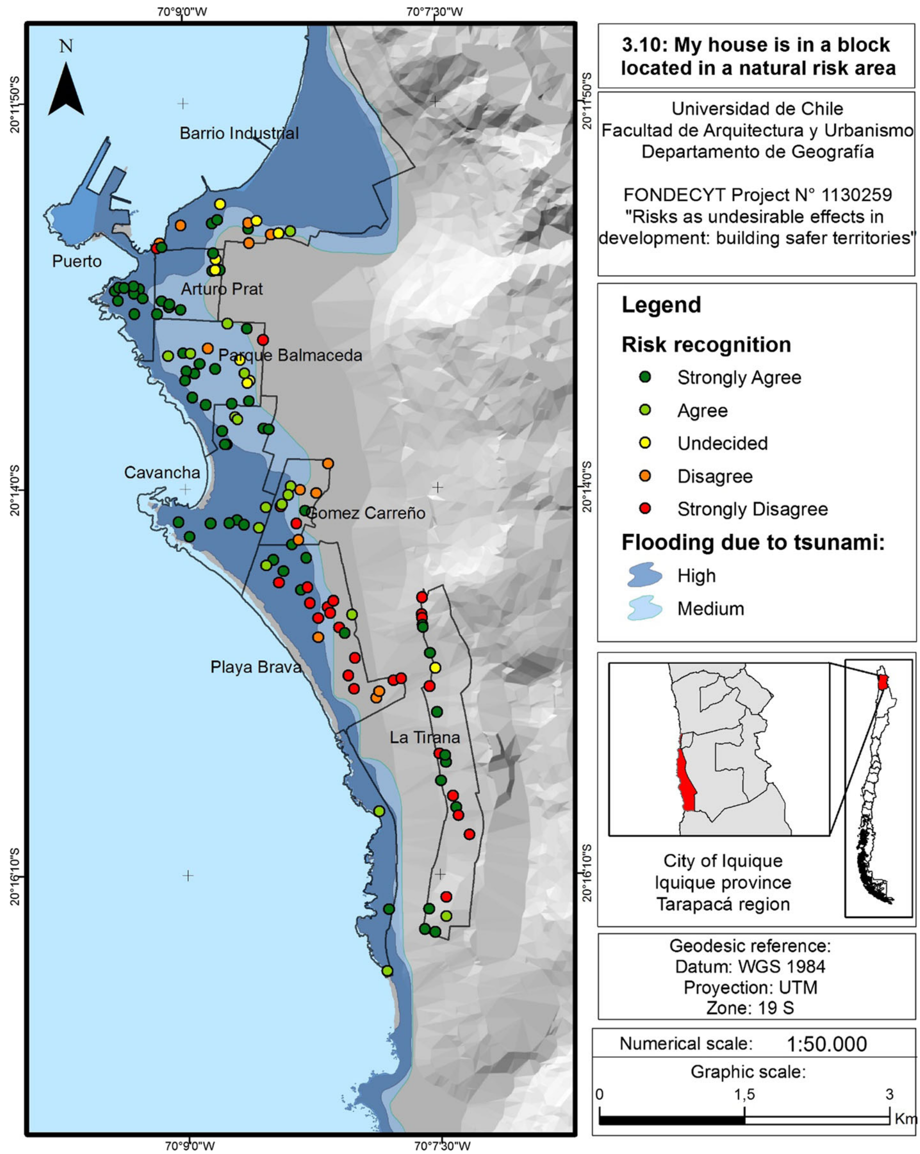

Fig. 5 Geo-referencing: tsunami risk perception and hazard exposure

seismic acceleration, disagreed or strongly disagreed with being located in hazardous areas. The higher concordance is given in the districts of Parque Balmaceda and Cavancha, where people acknowledged that they are at risk, in contrast to in the south, in the dune area, where the answers are heterogeneous, despite being in a zone of high seismic acceleration. There is also a low risk perception in Playa Brava. With these findings, it was decided to revisit the associated statistical data, which is reflected in Table 8.

For Chile and in particular Iquique, an area particularly exposed to these two hazards, the results indicate that 69% say that their home is at risk of tsunami and 68% report being

Table 8 Tsunami and earthquake risk perception and exposure to hazards

Tsunami		Earthquake	
Sixty-one out of eighty-eight recognize living at high or medium risk ($n = 88$)	69%	Fifty-four out of eighty recognize living at high or medium risk ($n = 80$)	68%
Eighteen believe they are at risk but they are not ($n = 127$)	14%	Twenty-five believe they are at risk but they are not ($n = 127$)	20%
Nineteen said there was no risk ($n = 88$)	22%	Twenty-two said there was no risk ($n = 80$)	28%

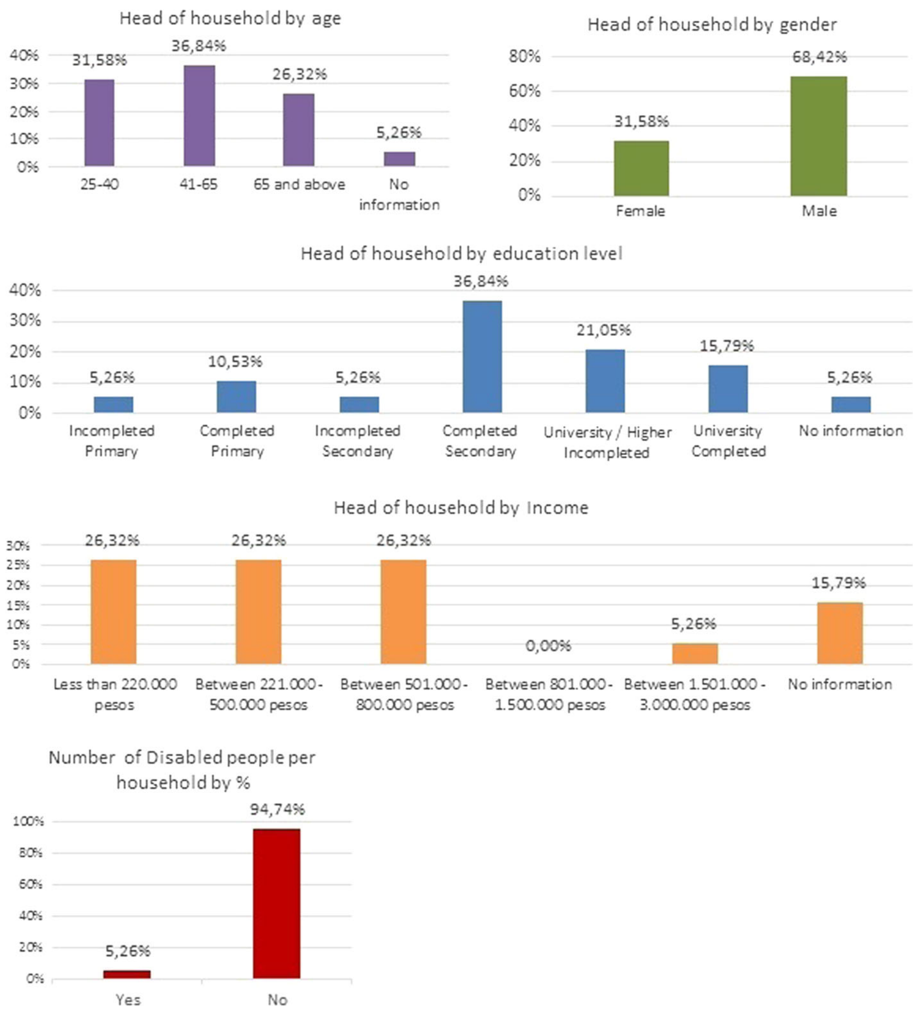

Fig. 6 Analysis of population exposed to tsunami risk that declared not being at risk

exposed to earthquakes, and the exposure map corroborates this. The concern is the lower line where 22% and 28% of the population said that they are not at risk, but the tsunami and earthquake exposure map, respectively, indicates that they are indeed at risk. With this information arises the next question for both types of risk, tsunami and earthquakes: Do these respondents (disagree and strongly disagree) + (tsunami high and medium risk) share characteristics of age, education, income or disability?

Figure 6 shows the results of the analysis where people exposed to tsunamis that do not recognize this hazard are distributed into three age groups, predominating the group between 41 and 65 years old with 36%, followed closely by the 25–40-year-old group with 31%. As for the gender, this is male-dominated with 68% as opposed to 31% women. At the educational level, most cases are people who completed secondary education, followed by householders who did not complete higher education. With regard to the income level of the head of household, 78% earn a monthly salary of less than CH$800,000 pesos (US$1200 approximately). Only 5% of households were living people with disabilities.

By repeating the analysis for those exposed to areas prone to earthquakes (Fig. 7) and that do not acknowledge the hazard, the results show a wide prevalence in household heads

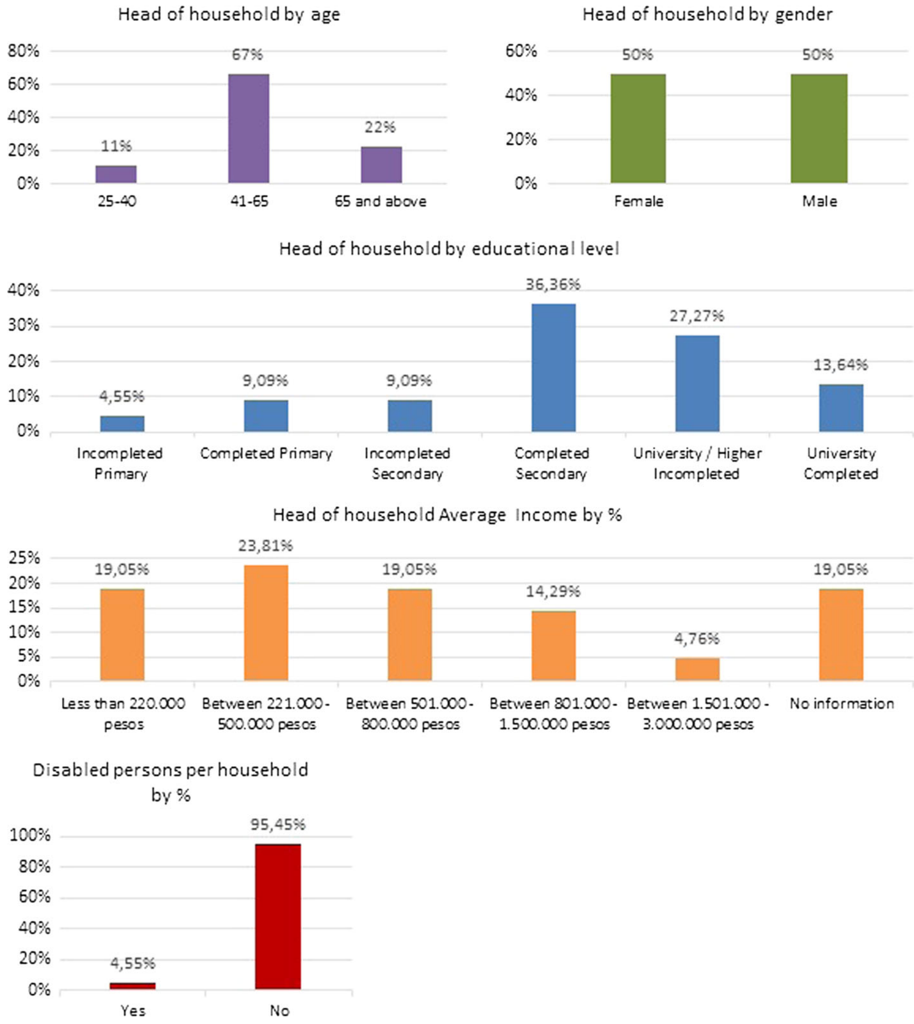

Fig. 7 Analysis of population exposed to earthquake risk that declared not being at risk

in the group between 41 and 65 years in a third of cases. There is parity in gender distribution. As for the educational level, the trend is repeated, predominated by those who have completed secondary education, followed by those who have not completed higher education. The average income shows a heterogeneous distribution but with a predominance of persons receiving a salary of less than CH$500,000 per month (US$ 750 approximately). Only 4.5% of households were registered as disabled.

5 Conclusions

This study demonstrates the need to advance the technical and scientific approaches to the topic of disaster risk management and, at the same time, deepen the aspects that dominate the understanding and behavior of society toward the subject, that is, the social perception of risk.

In the process of developing hazard mapping, applying surveys, geo-referencing and statistical analysis, it was possible to obtain critical primary information for the study. The results allowed us to characterize the city of Iquique placing it within national socioeconomic trends and explore its exposure patterns to natural hazards. The study allowed us to estimate Iquique's population with disabilities, the types of disability present and the characteristics of families with disabled members.

The coding of qualitative variables and preparation of perception, anticipation and risk management indices provided a statistical analysis that showed weak correlation between households with disabilities and risk perception. It is worth mentioning that though weak, increased risk perception is seen when there are people with disabilities in the household.

The decision to advance the analysis using geo-referencing identified patterns in the spatial distribution of results with a differentiation in the levels of hazard exposure clusters that allowed a deeper analysis of the studied variables.

Given that today GIS is a tool used in multiple environments and disciplines, detailed studies should be carried out where GIS can be jointly used with programs such as SPSS, in order to potentiate study results.

The information obtained in this disaster risk perception study in urban contexts and for populations with disabilities is of great importance for response and planning agencies. For the emergency and response audience geographic areas with more in-depth analysis of the causes, contexts and associated risk factors should be identified. It is important to understand and explain low participation in community organizations, problems of access to information on risks, and particularly the non-recognition of risk by a significant percentage of the population exposed to hazards. As for the latter, possible answers might include issues such as lack of information, involuntary denial or convenience.

For planning institutions, there are still large areas of the city at high risk which increases the need to analyze a reduction in hazard exposure, partial relocations, protection works, changes in land use, policies to discourage the development of these zones and promote the development of safer areas, and lastly, a specific approach to work with population with disabilities, incorporating them in all disaster risk and emergency management processes.

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Compliance with ethical standards

Conflict of interest This manuscript is an original work, which has not been previously published, whole or in part, and is not under consideration for publication elsewhere. The authors declare that they do not have actual or potential competing financial interest regarding the submitted manuscript. The authors agree that the work is ready for submission to the journal and accept responsibility for the manuscript's contents.

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