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ARTICLE

How students perceive natural and human-made risks on the island of Madeira (Portugal)

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Abstract

In this study the spatial perceptions of students about the likelihood of natural and environmental risks were examined, considering both mainland Portugal and island of Madeira. It intends to understand how students perceived the risks, taking into account the causal attributions, future tendency, and the support from public entities, as well as the willingness of attitudinal changes with respect to mitigating and reducing risks. The results suggest that students have a relatively low perception of analysed risks, considering the risk of forest fires, heatwaves, air and water pollution, and floods the most likely to occur, mainly as a consequence of climate change intensification. Gender proved to be the variable with the greatest influence on perception, particularly in terms of risk occurrence and personal perception of risk. These results could be important for the improvement of strategies and resources to be applied in the educational context in order to reduce disaster risk and strengthen the resilience of the community at large.

KEYWORDS

Island of Madeira (Portugal), natural and human-made risks, risk perception

1 | INTRODUCTION

Risk perception is characterised as an evaluation of the likelihood of hazard and the likelihood of the impacts (most often the negative outcomes) perceived by society (Becker et al., 2013). This subjective risk assessment sees risk perception as a critical factor in a scenario of risk management and vital to any strategy for disaster reduction (Babcicky & Seebauer, 2016; Birkholz et al., 2009; Bradford et al., 2012; Bubeck et al., 2013; Diakakis et al., 2018; Fuchs et al., 2017; Kellens et al., 2011; Slovic, 2010; Wachinger et al., 2013). Comprehending how people perceive natural and human-made risks is crucial for defining a suitable scheme to disseminate information about risk occurrence, to improve society's confidence in its government, and to enhance the ability to react to crises and increase social resilience (Malatesta & Di Friedberg, 2017). Bradford et al. (2012) consider that public perceptions of risk need be the focal point since the authorities' poor understanding of society is one of the most important causes for lack of success in the politics of risk management. Some works have ably demonstrated the importance of understanding how local people interpret risks and choose actions based on their interpretations as a way of mitigating risk (Kusumi et al., 2017; Rudiak-Gould, 2013;

Stancioff et al., 2018). Several authors consider that research on human emotions, awareness, and behaviours with regard to hazards also must be integrated in the study of risk perception (Kellens et al., 2011).

In fact, risk perception depends on several local/geographical and personal factors, including the individual's physical location (Bera & Danek, 2018; Bustillos Ardaya et al., 2007; Kellens et al., 2011), residence characteristics (Koks et al., 2015; Thistlethwaite et al., 2018), size consequences (Siegrist & Gutscher, 2008; Stojanov et al., 2015), range of impacts (Bera & Danek, 2018; Miceli et al., 2008; Thistlethwaite et al., 2018), socio-economic and demographic profiles (such as age, education, gender, number of children, income) (Balog-Way et al., 2020; Bera & Danek, 2018; Thistlethwaite et al., 2018; Yang et al., 2017), direct experience (Bera & Danek, 2018), race (Macias, 2016), historical-cultural context (Armas et al., 2015; Działek et al., 2013), level of literacy (Kusumi et al., 2017), and political and religious context (Bichard & Kazmierczak, 2012; Weber, 2010). Other authors also consider that risk perception and risk behaviour often result from people's gut feelings (Wagar & Dixon, 2006), prior experiences (Traczyk & Zaleskiewicz, 2015), or expected emotions (Mellers et al., 1999). In this case, people feel or instinctively experience the magnitude of a likely danger.

Several authors (Armas & Avram, 2009; Botzen et al., 2009) make the point that personal, social, and demographic characteristics play a major role in determining natural and human-made risk disasters perception, especially when age, gender, and education are analysed. Among the multiple variables that can influence risk perception, gender difference has been described as a factor in various studies, with women reporting superior levels of risk as a concern more often than men (Bustillos Ardaya et al., 2007; Martins et al., 2019; Poortinga et al., 2011; Sjöberg, 1998). Other studies (Bradford et al., 2012), however, have not reported a robust correlation between the perception of uneasiness and gender.

Besides gender, several authors confirm the relationship between individuals with more education and more effective, organised, and coordinated ways of responding to risk, both individually and collectively (Bardsley et al., 2018; Martins et al., 2019). In fact, education, and school in particular, seem to play a very important role in reducing risk. In general, individuals with a higher level of education tend to develop more accurate levels of risk perception, and they generally adopt preventive and more effective risk-taking behaviours (Donovan et al., 2018; Frankenberg et al., 2013; Wamsler et al., 2012). Donovan et al. (2018) consider that higher risk perception may be associated with raised alert level, and that alert level systems act as boundary objects in the translation of scientific information. However, research by Bradford et al. (2012) and Sjöberg (1998) shows that those with poorer education worry more about flooding risk. Given that there is a relationship between the level of income and education, it can be assumed that those with lower income are more concerned about the effects of disasters, since they are less likely to be protected by insurance and it is harder for them to substitute lost property and reduce disaster impacts (Bradford et al., 2012).

The effect of education on reducing risk is recognised in the world campaign. Disaster risk reduction begins at school, implemented in 2006 and 2007 by the International Strategy for Disaster Reduction (ISDR, 2007). This was the outcome of the World Conference on Disaster Risk Reduction held in Japan in 2005, which sought to raise awareness and mobilise governments to make disaster risk reduction a part of school curricula in primary and secondary schools. In fact, there is an international consensus that disaster education programmes for children and youth will improve preparedness and resilience among children and community members outside schools against disasters (Lopes, 1999; Takeuchi et al., 2011; Torani et al., 2019; Williams et al., 2017).

In Portugal, it was only in 2011 that the National Board of Education, through Recommendation No. 5/2011, considered that schools should integrate education for risk by including appropriate subjects in their curricula. These should look at the various concepts of risk and address these issues both by transmitting information and knowledge and by promoting actions that deal with specific cases of risk, in practice. In 2015, meanwhile, the 'Risk Education Referential (RERisco)' was presented, a joint work by the Directorate General for Education (DGE), Directorate General for School Establishments (DGEstE), and the National Authority for Civil Protection (ANPC), aimed at Pre-School Education, Primary Education, and Secondary Education. Its aim is to support the implementation of education for risk, within the framework of Education for Citizenship, both in its cross-cutting dimension and in the development of projects and initiatives that contribute to the personal and social training of students. RERisco was also involved in providing complementary curricular components in the 1st, 2nd, and 3rd cycles of the school year, and in the offer of complementary curricular components in the 1st, 2nd, and 3rd cycles of basic education. Analysing the curricula in force in Portugal, geography and the natural and physical–chemical sciences are the subjects that tackle the different risks affecting the Portuguese territory. The emphasis is on the factors that trigger and aggravate risks, as well as the measures to be adopted to mitigate their consequences.

The current study aims first to analyse students' perceptions of spatial likelihood of the natural and human-made risks that affect both mainland Portugal and the area where they live, in this case, the island of Madeira. It also aims to understand how students perceive the risks, considering the causal attributions, perceptions of support from public

entities, and future trends. Finally, a third purpose is to relate students' perceptions to the behaviour, actions, and willingness of attitudinal changes with respect to mitigating and reducing risks in accordance with the variables of gender, grades obtained in the subjects where natural and human-made risks are taught, and the academic level of the parents.

2 | MATERIALS AND METHODS

2.1 | Study area location

The Madeira archipelago is located between 30° 01′ and 33° 07′ North latitude, and between 15° 01′ and 17° 16′ West longitude. From a geodynamic point of view, the islands of Madeira, Desertas, and Porto Santo correspond to the south-western end of a structural complex, composed of enormous volcanic constructions called the Madeira Volcanic Mountain Range. This was created by the displacement of the African tectonic plate over a hotspot (Madeira hotspot), which is supposedly currently located to the south-west of the island of Madeira, given that the ages of the volcanic constructions progressively increase from south-west to north-east (Geldmacher et al., 2006).

The origin of the Madeira archipelago is, in geological terms, intrinsically linked to the opening and expansion of the Atlantic, which led to the archipelago's remoteness relative to the mid-Atlantic rift. The seismic activity in the archipelago is low in most cases, reflecting the earthquakes generated on the Azores–Gibraltar transform fault or on the active faults that split the West Iberian and African continental shelves (Carvalho & Brandão, 1991). The eruptive inactivity gives the archipelago a low volcanic risk, allied to an incipient secondary volcanic activity (Prada, 2000).

The island of Madeira is 57 km long and has an elongated shape, in an E–W direction. It is 23 km across at its widest part, in a N–S direction, with a total area of 785.6 km^2 (Figure 1). The very steep hillsides and the few flat areas that do exist are almost always occupied by settlements. The highest points on the island occupy the Central Mountain Massif, with Pico Ruivo reaching 1862 m and Pico Cidrão 1818 m. Together with the rugged morphology, episodes of strong and concentrated precipitation are responsible for mass movements and detrital flows over almost the entire island. With a Mediterranean climate (Csb), the morphology, orientation of the relief, and exposure of the slopes cause remarkable spatial variability in the distribution of precipitation and temperatures.

The archipelago consists of eleven municipalities, ten of which are on Madeira Island and one on Porto Santos. The resident population in 2021 is 250,769, 2.1% less than in 2011. Regarding the age structure, 12.7% of the population are under 14, a figure very close to that of the population aged between 15 and 24 years old. The proportion of the population between 25 and 65 years old is 56%, and about 20% are over 65 years old. Population density is lower in the parishes to the north of Madeira and in Porto Santo, while higher population density is found in the parishes in the south. More than 40% of the total population of the archipelago live in Funchal. In 2021, about half of the population of the Madeira island

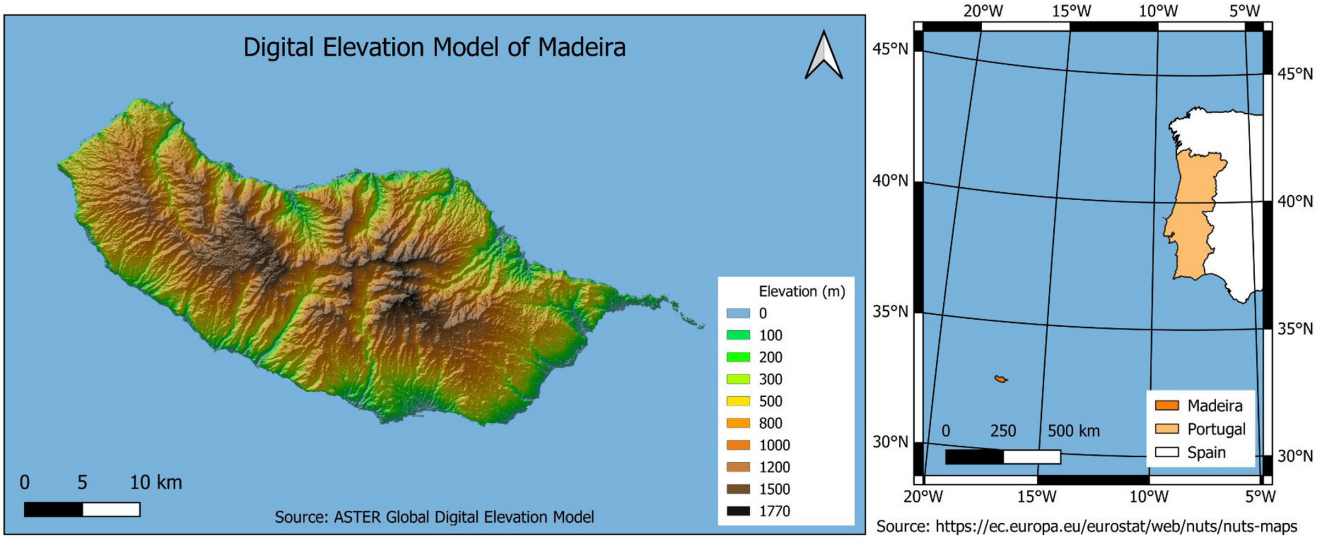

FIGURE 1 Madeira's island location.

have primary education, 20% have secondary education, and 15% have higher education, and about 15% of the population cannot read or write.

The natural conditions of Madeira imply coexistence with a set of risks, of which rapid floods, with torrential characteristics, are the main risks. These processes are characterised by the very significant transport of solid material associated with mountain areas, with special incidence in small basins, embedded valleys, and accentuated slopes. This process is known in English as debris flow. On Madeira it is known as 'alluvium'.

The island of Madeira has a long history of events of this nature (Matos et al., 2018; Quintal, 1999). Of these, we draw attention to the 1803 flood that killed almost 1000 people, or the more recent flood in 2010 that, in addition to the huge damage it caused, killed about 47 people and made 600 individuals homeless. Besides the occurrence of intense rainfall in areas at higher altitude, other factors contribute to the development of these processes, such as the rugged orography, the small size of the hydrographic basins of the island, nearly always associated with embedded and sloping valleys, combined with a prolific availability of large amounts of solid material that will easily shift. Debris flows share some features with floods that usually occur in other areas of the national territory, but they differ significantly in their solid component, making them potentially more dangerous and increasing their complexity so that the challenges of monitoring, modelling, and forecasting them have not yet been completely overcome.

In fact, Madeira is notable for a history of natural and human-made disasters, with 582 events with personal, environmental, and socio-economic consequences having been identified since the beginning of the last century. There have been 386 deaths from natural and human-made disasters, mainly caused by heavy rainfall that contributed to the occurrence of landslides and flash floods.

Thus, in addition to debris flows, landslides, collapses, and falling blocks are also common on the island. Forest fires also occur regularly on Madeira, with the years 2010, 2012, and 2016 being particularly bad because there was a higher incidence in the municipalities of Funchal, Calheta, Santa Cruz, Ribeira Brava, and the Central Mountain Massif (Neri, 2019). The 2016 fire caused the deaths of three people and forced the evacuation of hundreds of inhabitants. Forest fires not only destroy vegetation cover but also exacerbate soil erosion, disturb the hydrological balance, and increase the risk of flooding. In response to the 2010 episode, the Regional Government of Madeira launched the Madeira Flood Risk Assessment Study (EARAM), which proposed an integrated approach to risk control by adopting a set of measures, including the construction of solid material retention infrastructure, works to improve the flow of streams, and installation of a meteorological radar in Porto Santo (Oliveira, 2020).

Although they occurred less often, earthquakes, tsunamis, coastal instability, and erosion events were responsible for serious damage, as was the case with the 1975 earthquake and the 1930 Câmara de Lobos tsunami.

2.2 | Questionnaire design and statistical analysis

The applied survey questionnaire (Armas & Avram, 2009; Kellens et al., 2011; Raaijmakers et al., 2008) consists of six parts (Figure 2). The first part, entitled 'Characterisation of respondents', was only concerned with gender, parents' academic qualifications, and grades obtained in subjects that include topics linked to natural and human-made risks in their curricula, i.e., geography, natural sciences, and physical and chemical sciences.

The second part of the questionnaire, 'Ranking risks according to the probability of their occurrence', aimed to evaluate the students' capacity to identify and rank the likelihood of occurrence of natural and human-made risks on a national scale and in their municipality of residence. To accomplish this purpose, 15 natural and human-made risks were listed and a qualitative Likert scale was used to rank them, varying between a null/minimum and a maximum value, which was matched by a quantitative scale, respectively ordered from 1 to 5, as follows: 1 null/minimum; 2 low; 3 moderate; 4 high; 5 maximum. The lowest value (null or minimum) is therefore linked to a very low risk perception in relation to the probability of risk occurrence, as opposed to the highest value (maximum), correlated with a very high probability of manifestation.

The third part of the questionnaire consisted of five questions intended to analyse the respondents' perceptions of risks. The fourth part aimed to analyse perceptions of causal attributions. The fifth part, 'Channels of information on risk', aimed to examine the means of communication perceived as most effective in risk communication and information, considering the role of education, the media, and the Internet. Finally, the sixth part of the questionnaire looked at the students' perceptions of State support in the event of crisis (Figure 2).

Differences statistically significant across sociodemographic variables and risk perception were determined by performing the Mann–Whitney *U* test (Mann & Whitney, 1947) and Kruskal–Wallis *H* test (Kruskal & Wallis, 1952). Both

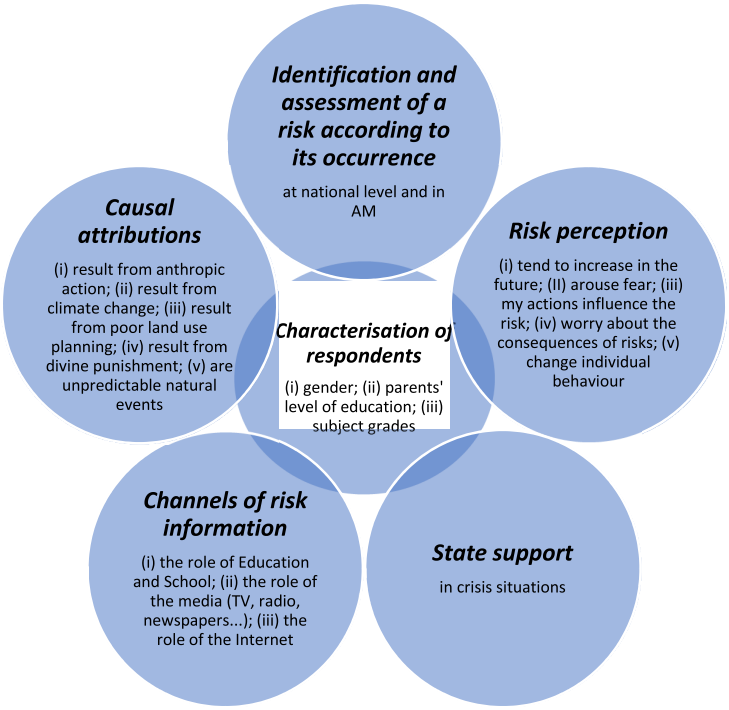

FIGURE 2 The six components featured in the student questionnaire.

tests are rank-based non-parametric tests that can be applied to a continuous or ordinal dependent variable for two or three independent groups, respectively. With the aim to find the primary factors associated with risk perception, categorical principal component analysis (CATPCA) was applied. CATPCA is a principal component analysis (PCA) variant which does not assume linear relationships between numerical data nor does it require the assumption of multivariate normal data, indicated especially when mainly categorical (ordinal) variables are considered. This means it can deal with both ordinal and nominal variables, as well as identifying underlying nonlinear relationships among variables (Linting et al., 2007). IBM SPSS (Version 24.0 for Windows) was used to perform all statistical analyses.

A survey questionnaire was applied to 162 students living on Madeira Island to assess the perceptions that students have regarding a set of risks at the end of 3rd cycle of basic education. They were attending the first year of secondary education in Portugal (10th grade), the average age was 15 years, and 37% were female and 63% male. All the schools participate in the EDURISK project. At end of the 9th grade, the end of the 3rd cycle of basic education, the marks obtained in geography, natural sciences, and physical and chemical sciences were, on a scale from 1 to 5, 3.21, 3.19, and 3.10, respectively.

Twenty-seven of their parents/guardians have a degree, around 30% have secondary education qualifications, 28% have basic education, and around 11% have completed the first cycle. One per cent of parents are illiterate. Ethical approval was obtained prior to commencing the research.

3 | RESULTS

3.1 | The perception of the likelihood of a risk occurring

In general, the perception of the risks considered on a national scale is low to moderate. The risks with the highest perception values are forest fire (mean 3.78; $n = 162$) and heatwaves (mean 3.10; $n = 162$). This is followed by air pollution risks (mean 2.94; $n = 162$), floods (mean 2.94; $n = 162$), and water pollution (mean 2.91; $n = 162$). The lowest values of risk perception related to geophysical risks, in particular the risk of volcanism (mean 1.54; $n = 162$) and tsunami (mean 1.72; $n = 162$) (Figure 3).

The results suggest significant differences in the perception of risks, taking gender into account. This is more observable at the archipelago scale, and for the risks of heatwaves, floods, water and air pollution, soil degradation, desertification, forest fires, coastal erosion, and geophysical risks (Table 1).

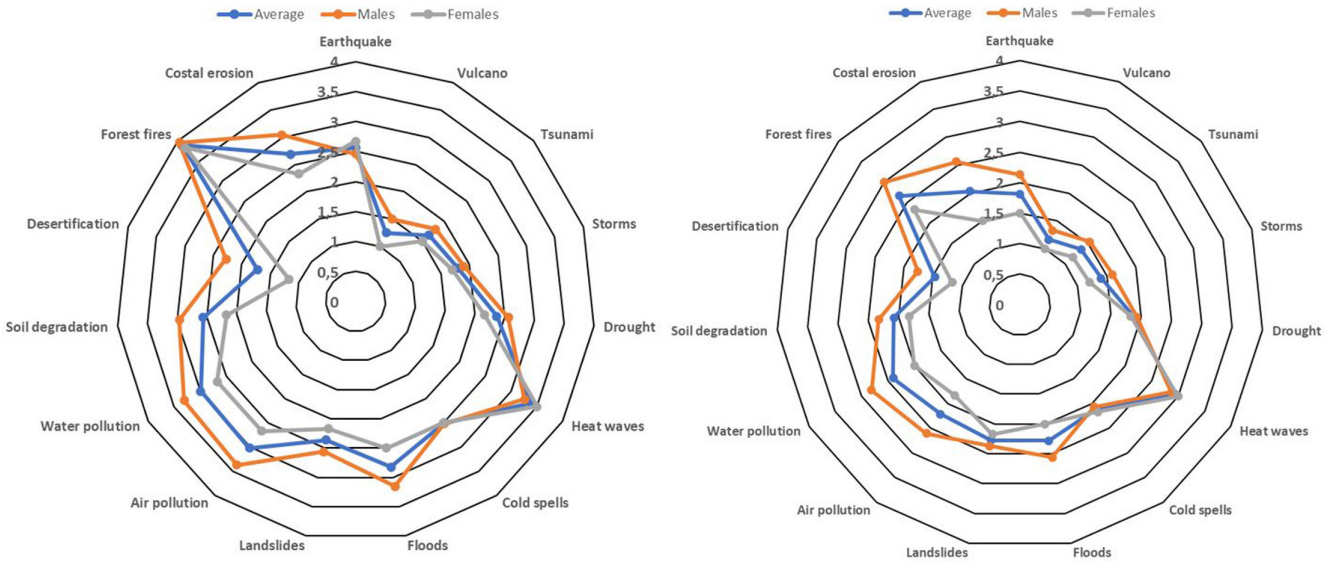

FIGURE 3 Overall risk rating (mean) for females and males (left: national level; right: Madeira) (Likert scale: 1 null/minimum; 2 low; 3 moderate; 4 high; 5 maximum).

Male students have a higher perception of risks than female students, particularly when considering the risk of soil degradation, water and air pollution, coastal erosion, landslides, and floods. This perception is confirmed at both national and archipelago level.

Most students agree that the occurrence of the risks considered may cause material and human losses, highlighting forest fires, tsunamis, storms, and earthquakes as potentially more dangerous risks. Likewise, they consider that the occurrence of the risks will tend to increase in the future, especially those associated with air and water pollution, forest fires, and heatwaves (Figure 4a). On the other hand, for most of the risks considered, there is a statistically significant correlation between the increase in risk occurrences in the future and their consequences in terms of material and human losses. They therefore consider that tsunamis, forest fires, storms, earthquakes, and floods cause the greatest human and material losses (Figure 4b).

When asked about anthropic action as a risk-amplifying factor, respondents consider this factor most relevant for increasing the risk of pollution of water (mean 4.23; $n = 162$) and air (mean 4.20; $n = 162$), and the risk of forest fire (mean 4.06; $n = 162$; Figure 4c). Climate change is perceived as a cause for increasing the risk of heatwaves (mean 4.10; $n = 162$), droughts (mean 4.02; $n = 162$), cold spells (mean 3.93; $n = 162$), and forest fires (mean 3.86; $n = 162$), reinforcing the idea of the climate change factor as a risk amplifier. This perception is especially noticeable for heatwaves, droughts, cold spells, desertification, forest fires, and floods (Figure 4d).

Climate change is considered to be relevant to increasing the occurrence of some risks, mainly associated with climatic and hydrological extremes, while humans are more involved in risks associated with water and air pollution, forest fires, and soil degradation. These are the same risks that will tend to increase more in the future.

No statistically significant relationships are found between the tendency of different risks to increase in the future with gender, socio-economic background, and students' ranking in the different subjects where the topic of risks and disasters are considered.

Nevertheless, gender establishes statistically significant correlations with the fear that risks generate, with individual actions as an influencing factor for risk, with the concern that risks rise, and with behavioural change in favour of risk mitigation (Table 2).

Thus, female students are more concerned about the consequences of risks; they are afraid of them and believe that their actions can contribute to reduce risk. They also tend to attribute the causes of an increase in risk occurrences to inadequate land-use planning policies and consider changing their behaviour in order to mitigate the risk (Figure 5).

Considering the mean values for perceptions, the student respondents also agree that risks are mainly the result of incorrect land-use planning policies and not nature's revenge or, even less, a divine punishment. These last variables do not show statistically significant correlations between gender, the academic level of the household, or the marks obtained in the different subjects that address the issue of risks and disasters.

TABLE 1 Levene's and *t*-test considering the perception of the analysed risks and the gender variable.

	Levene's test for equality of variances	*t*-Test for equality of means
	Sig.	**Sig. (2 extremities)**
National		
Earthquakes	.220	.574
Volcanoes	.975	.499
Tsunamis	.695	.438
Storms	.207	.830
Drought	.405	.555
Heatwaves	.962	.070
Cold spells	.394	.860
Floods*	**.018**	**.038**
Landslides	.846	.972
Air pollution*	.780	**.000**
Water pollution*	.440	**.000**
Soil degradation	.732	**.001**
Desertification*	**.003**	.065
Coastal erosion*	.674	**.017**
Forest fires*	**.006**	**.025**
Madeira Island		
Earthquakes*	.691	**.012**
Volcanoes	.806	1.000
Tsunamis*	**.001**	**.043**
Storms	.299	.152
Drought*	.775	**.009**
Heatwaves*	.101	**.005**
Cold spells	.166	.870
Floods*	.748	**.035**
Landslides	.298	.531
Air pollution*	**.003**	**.001**
Water pollution*	.133	**.000**
Soil degradation	.150	.052
Desertification	.740	.474
Coastal erosion*	**.045**	**.011**
Forest fires*	.911	**.029**

*Relationships between groups statistically significant (bold values = *p*-value < .05); $n = 162$.

More than half of the students perceive risks as being poorly or moderately predicted and known by science, in particular the forest fire, landslide, and soil degradation risks. But seismic risks, storm, heatwave, cold spell, and volcanic risks are perceived as more likely to be predicted and known by science. No statistically significant correlations were found with gender, the academic level of the household, or the marks obtained in the different subjects that address the topic of risks and disasters.

Regarding the channels of communication and information on risks, respondents believe that the media, the Internet, and schools are the best channels of communication. Most students ascribed a very important role to education and the media as vectors for risk communication and information (mean 4.09; $n = 162$ and 4.09; $n = 162$, respectively). However, the Internet is the medium indicated as the most effective in the risk communication and information process (mean 4.11; $n = 162$). These results corroborate the lack of correlations between risk perception and the marks obtained in the different subjects where the topic is addressed.

In crisis situations, students today feel supported by government bodies.

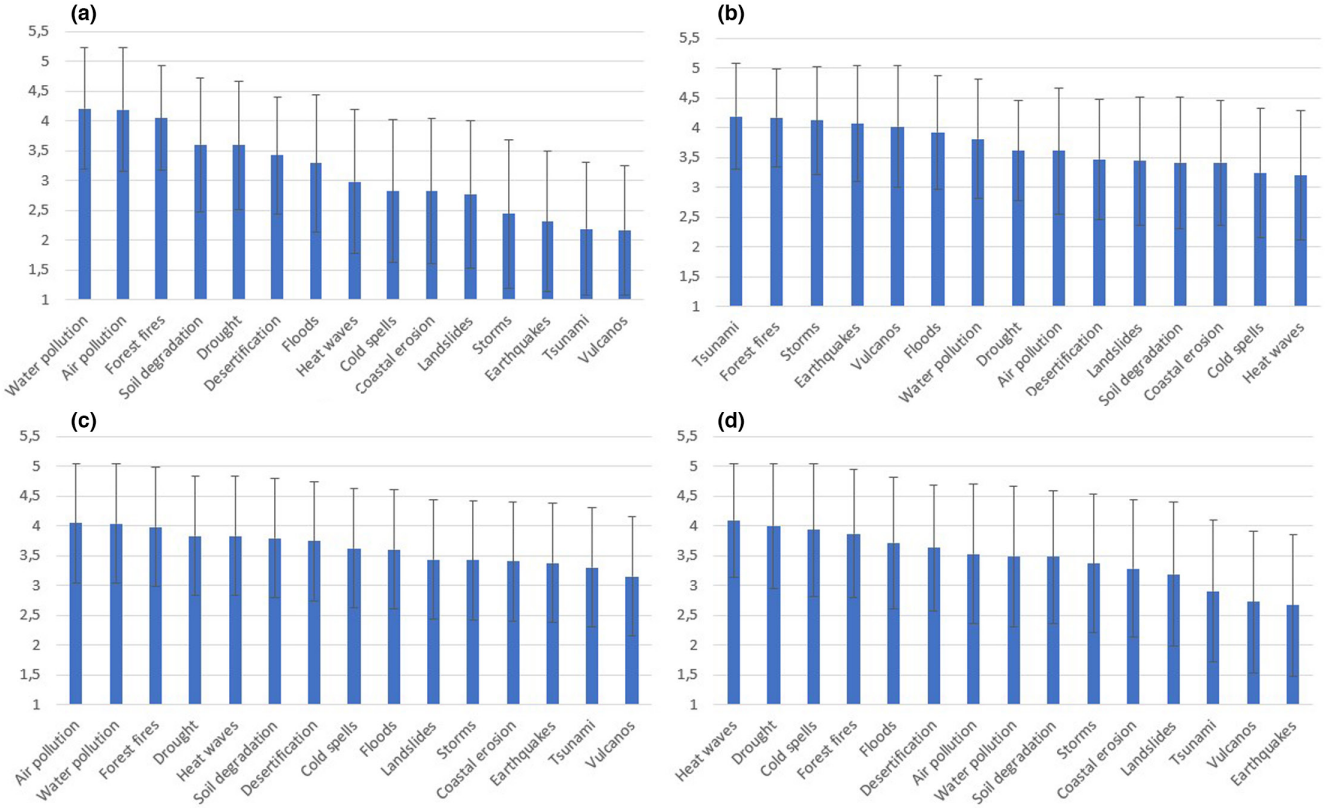

FIGURE 4 Risk perception: (a) tendency to increase in the future; (b) the contribution of climate change in risk intensification; (c) material and human losses; (d) the action of the human being in risk intensification (mean value and standard deviation; Likert scale: 1 null/minimum; 2 low; 3 moderate; 4 high; 5 maximum).

3.2 | Categorical principal components analysis – CATPCA

The CATPCA application delivered a solution with three main dimensions (components) and an excellent Cronbach's α value. The three resulting dimensions explain 61% of the variance, and are determined by the first two with 49% of the total variability (Table 3).

The first dimension considers a set of variables associated with risk behaviour, information, and communication. In the first group, concern with the consequences of disasters is emphasised and the importance of individual behaviour as a determining factor in risk reduction is highlighted. The individual willingness to change habits and adopt actions capable of contributing to risk reduction is also evident. At the same time, education, the media, and the Internet are considered as favoured channels of communication and information on risks. The second dimension lists a set of variables related to causal attributions, suggesting that crisis situations are the result of nature's revenge, divine punishment, and inadequate land-use planning policies. In this dimension, fear is also seen as the emotion most associated with the occurrence of risk (Table 4).

The analysis of the chart of components, considering two components, enables a set of outliers to be identified. These are the marks obtained by students in the subjects whose curriculum addresses the issue of risks, as well as their parents' level of education. On the other hand, the risks perceived as divine punishment and nature's revenge have a negative factor loading with component 1, suggesting an opposition to the other variables (Figure 6).

4 | DISCUSSION

Knowledge of students' perceptions can help a great deal to improve the effectiveness of education as a risk reduction factor. School in particular plays a very important role as a risk reduction factor by serving to increase knowledge of the different potentially dangerous physical processes, and also in raising awareness of practices designed to improve safety.

TABLE 2 Results of Mann–Whitney *U* tests applied to gender.

	Mann–Whitney *U*	*Z*	Sig. (two tailed)
Unforeseeable natural events	2372.5	−1.549	.121
Divine punishment	2288.5	−1.82	.069
Nature's revenge	2734	−0.077	.939
Planning policies*	2266	−1.917	.055
My actions can lessen the risk*	2033.5	−2.899	**.004**
I am worried about the consequences of the risks*	1463	−5.141	**.000**
These risks cause me fear*	2011	−2.933	**.003**
I am willing to change behaviour*	1605	−4.583	**.000**

*Significant relationships between groups (bold values = *p*-value < .05); *n* = 162.

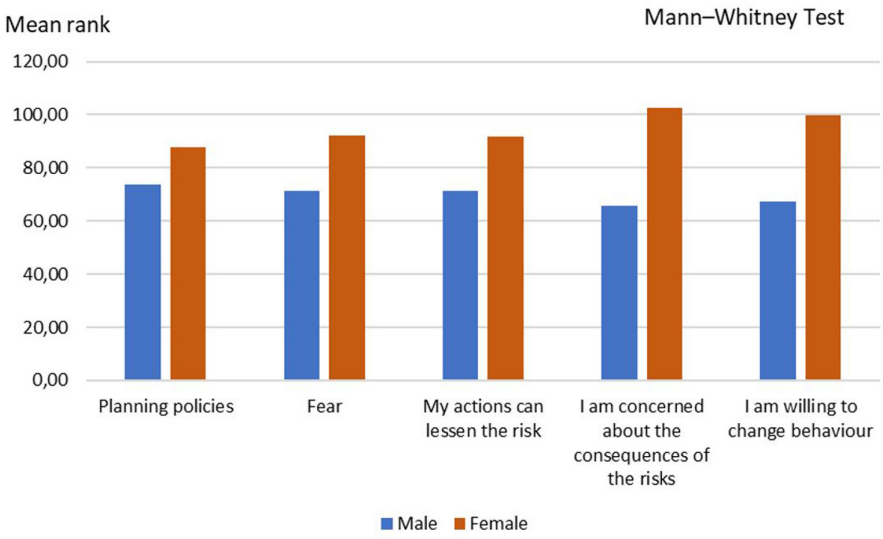

FIGURE 5 Mean rank for gender.

TABLE 3 Cronbach test.

Dimension	Cronbach's α	Percentage of variance	Percentage of cumulative variance
1	.822	33.354	33.354
2	.661	15.699	49.053
3	.359	12.138	61.191
Total	.956[a]		

[a]Total Cronbach's α is based on the total eigenvalue.

Nevertheless, the perception of the risks considered is low to moderate, both nationally and in Madeira, and is slightly lower in the municipalities where the respondents live. These results corroborate some studies where the perception of risk is lower in the municipalities of residence than it is at the national scale (Martins et al., 2019; Nunes et al., 2020). According to Mitchell (2009), there is a common perception that a serious event always happens somewhere else and not here, and that it affects someone else and not oneself, thus contributing to a differentiated perception according to the scale. This perception seems to be related to direct experience with crisis situations (Dosman et al., 2001; Wachinger et al., 2013) or even to result from media influence. In fact, the media have proved to be an important vehicle of information, seeing themselves as an important factor in perception (Biernacki et al., 2008). News of disasters elsewhere thus seems to influence perception, suggesting that risk events tend to occur outside the area of residence.

Forest fire risks are perceived as the most likely to occur. This result was similar to other perception studies in Portugal, applied in primary schools, even in urban areas where this risk is low (Martins et al., 2019). In Portugal, forest fires are

TABLE 4 Component loadings.

Variables	Dimension 1	2	3
Risks are the result of unforeseeable natural events	0.306	−0.119	0.467
Risks are divine punishment	−0.119	0.564	0.582
Risks are nature's revenge	0.002	0.71	0.437
Risks result from poor land-use planning policies	0.17	0.582	−0.249
Risks make me afraid	0.24	0.563	−0.402
My actions can contribute to reducing risk	0.677	0.206	−0.024
Education is a means of contributing to risk information	0.837	−0.06	−0.022
The media (TV, radio, newspapers) are means of contributing to risk information	0.804	−0.229	0.205
The Internet is a means of contributing to risk information	0.777	−0.211	0.211
In the event of a disaster, the State has plans to support families	0.435	−0.311	0.315
The consequences of disasters are worrying	0.838	0.057	−0.007
I am willing to change behaviour to reduce the risks	0.676	0.3	−0.184

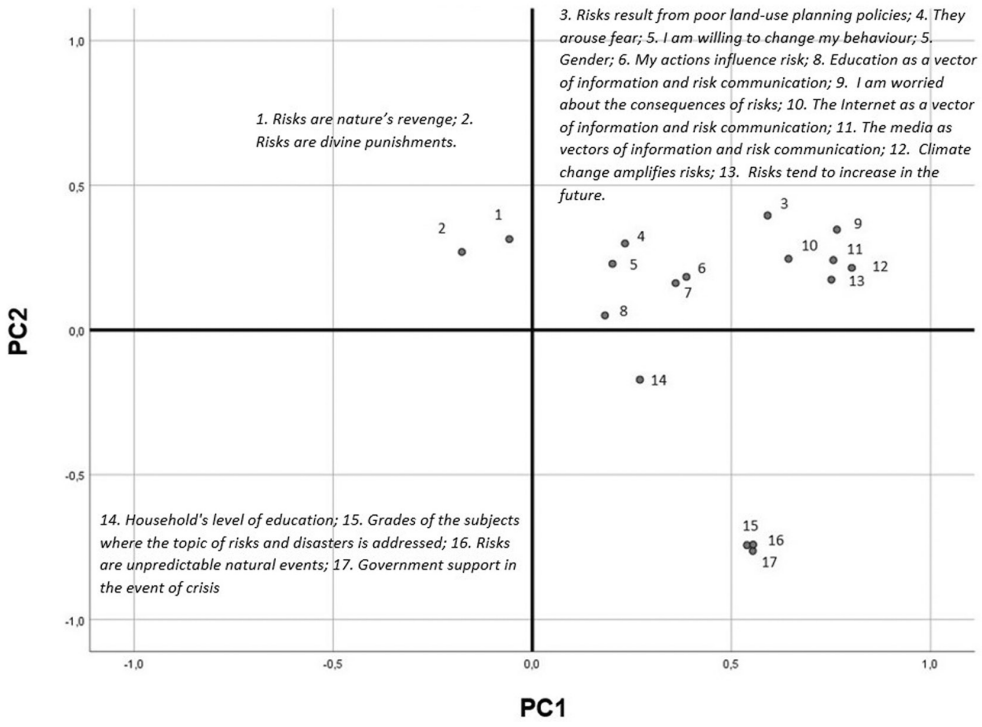

FIGURE 6 Biplot considering the structure of the data and the factorial loadings of the first two components.

a significant source of news every year (television, newspapers, etc.), associated with visible economic losses. The more attention given to this type of catastrophic event by the media together with the involvement of experts in risk analysis serve to create an indirect experience that influences its perception. Converse to forest fires, risks of floods and landslides, with a very high recurrence in Madeira, are underestimated since their occurrence is perceived as reduced. These findings agree with works suggesting that perceptions are shaped by the media rather than knowledge-based, and that confusion between risk-related concepts, confusing or incomplete ideas, and misunderstandings about the causes and consequences of risk are common (Babik & Gardner, 2021). On the other hand, the last catastrophic event that occurred on Madeira, associated with floods and landslides, was in 2010 when the respondents were still children, so memory and direct experience may be non-existent. Lechowska (2018) considers that in risk perception studies experience is most often taken into account first, followed by social, economic, and demographic factors.

In general, risks are understood as potentially dangerous because they can lead to the loss of human life and material damage. Forest fires and tsunamis stand out in this group. Risks are also perceived as phenomena that tend to increase in the future, especially water and air pollution and meteorological risks, such as heatwaves and cold spells. In fact, there are several works that point to risks of an atmospheric nature with a tendency to increase in the future (Gaffney & Ludwig, 2015; Garschagen et al., 2020), especially related to climate change and extreme hydrometeorological phenomena (Jovarauskaite & Böhm, 2020; Kelman & Næss, 2019; Lee et al., 2020; Poortinga et al., 2019; Salama & Aboukoura, 2018; van Eck et al., 2020) and pollution (Altunoğlu et al., 2017).

In the current study, no statistically significant correlations were found between risk perception and the grades obtained in geography, natural sciences, and physical and chemical sciences, or even with the socio-economic background of the students, inferred here from the parents' academic levels. However, statistically significant differences were obtained between genders, in which male respondents revealed a greater perception of the occurrence of air and water pollution, soil degradation, and coastal erosion risks, both at national level and in the municipality where they lived. In the presented work a set of risks is considered rather than an isolated risk, which to some extent limits the impact of gender on the perception of a certain risk. However, the results corroborate other works that identify gender impacts on risk perception for a set of considered risks (Brown et al., 2021; Flynn et al., 1994; Kellens et al., 2011; Poortinga et al., 2011; Sjöberg, 1998).

It was found, however, that it is female students who perceive the consequences of disasters with greater concern, raising more fear in them. This result is similar to other studies that suggest that women feel more fear and concern about the consequences of risks than men do (Brody, 1984; Lujala et al., 2015). They consider that their behaviours influence risk and they are more willing to change behaviours in order to lessen risk. This finding suggests that gender appears to be strongly related to risk judgements and attitudes (Brown et al., 2021; Slovic, 2010). A number of studies (Brown et al., 2021; Ho et al., 2008; Martins & Nunes, 2020; Yang et al., 2017) suggest that, on average, men have lower levels of risk perception than women, although other studies suggest the opposite (Botzen et al., 2009), in direct association with the cultural and social characteristics intrinsic to each region. For example, in countries where there is greater gender equality, differences in perceptions between men and women are less noticeable (Olofsson & Rashid, 2011). However, differences in analysis methods, variables of control, and the risk concepts and paradigms make it difficult to define patterns of perception considering gender.

Regarding causal attributions, climate change stands out as a very important factor. The strong media coverage of the topic and its relationship with some risks, particularly associated with hydroclimatic extremes, could justify this perception, thus corroborating several studies that suggest the same results (Lee et al., 2020; Wamsler et al., 2012). However, there are frequent misconceptions regarding the causes and consequences of various risks in relation to climate change, a conclusion that is consistent with other work (Frappart et al., 2016; Lee et al., 2020; Puttick et al., 2015). This study suggests that students reveal some difficulties in understanding the causes and consequences of some natural hazards, a conclusion that is reinforced by works conducted in Portugal and students of the same age group and grade level (Martins & Nunes, 2020; Nunes et al., 2020). In this regard, there are several studies that identify that a limited knowledge in the face of a set of risks can mean that behaviours central to risk reduction are less adjusted (Braun & Dierkes, 2016; Frick et al., 2004). Although this study was carried out on the island of Madeira, the conclusions seem to be in line with other studies suggesting that perception is very conditioned by the role of the media, delegating to the background a vision more focused on the scientific analysis of natural and human-made disasters. This study also seems to confirm the importance of adapting the choice of the syllabus to regional specificities to the detriment of the more generalist option, in this case, mainland of Portugal. The results suggest a relatively weak perception towards a recurrent set of risks such as landslides and flash floods, which in a certain way may compromise a more effective behaviour towards risk reduction.

The importance of education was also clear in our work, especially the school, which serves as a channel of information and communication on risks, along with the media. Our research agrees with the results reported by Biernacki et al. (2008), where the most frequently mentioned source of information about extreme phenomena and natural and human-made disasters was mass media. Wachinger et al. (2013) consider that risk perception can also be enhanced or impaired by an indirect experience, for example through social media information and social networks communication. Of the various media, the Internet is regarded as the most effective channel, as suggested in several studies on risk communication (Roth & Brönnimann, 2013). Although the Internet contributes very effectively to the wider dissemination of information, this does not mean that it contributes to a greater correlation between risk perception and technical knowledge (Krimsky, 2007; Lee et al., 2020; Weber, 2010).

The results also suggest that the causes of the occurrence and severity of risks are related to inadequate development and planning policies. They also suggest that individual actions intensify risk and consequently they claim, especially

the female respondents, to be willing to change behaviours with a view to mitigating such risk. Several studies (Miceli et al., 2008; Siegrist & Gutscher, 2008; Terpstra, 2011) also demonstrated a positive relationship between emotional elements such as fear or worry and the willingness to implement measures aimed at mitigating the impacts of risk occurrence.

Although the present study is locally confined to Madeira Island, various studies reinforce the importance of knowledge of local inhabitants' perceptions as a factor of disaster risk reduction (Amaratungaa et al., 2018; Stojanov et al., 2016). It has also been suggested that, to help increase knowledge and understanding of disaster risks, the curricular programme can be modified based on each school's local context through its implementation throughout the primary and secondary school years. In fact, school-based disaster education programmes have been seen as a promising approach for children and youth (Amri et al., 2022; Gokmenoglu et al., 2021; Seddighi et al., 2021) and therefore to community members outside schools.

5 | CONCLUSIONS

Risk perception is inherently personal and subjective, and results from a combination of science and judgement with significant social, psychological, cultural, and political factors. Age, gender, education, and culture context influence risk perceptions and behaviour when faced with risk, as well as the trustworthiness of government response and risk acceptance. In this study, the analysis in light of this multiplicity of factors is very limited and mainly focuses on gender, the socio-cultural background of the household (here based only on the household educational qualification), and the marks obtained by the students in the subjects that cover the topic of risks and disasters. Gender proved to be the variable with the greatest influence on perception, particularly in terms of risk occurrence and personal perception of risk. Female respondents were found to be more worried about risks, as they are more afraid and concerned because they think that risks will be more frequent in the future. Male students, however, tend to perceive more risks on the basis of occurrence. Nevertheless, additional investigation is needed to confirm this conclusion and also to include more variables in order to better understand how gender influences perception.

Nevertheless, the work suggests that the perception of the risks considered at a national, indeed mainly local, scale, is low to moderate, with the most likely risks being forest fires, heatwaves, air and water pollution, and floods. The students surveyed are willing to change their behaviours in order to reduce the consequences of the risks, showing a high degree of concern about their consequences. Most students ascribed a very important role to the Internet, education, and the media as channels for risk communication and information, respectively. As this is a mainly exploratory study, additional empirical work is required to better assess how to integrate risk topics and content into formal education, aiming at furthering knowledge on triggering and amplification mechanisms rather than general information on risks. This will encourage the improvement of risk managing and enhance the effectiveness when responding to crisis situations and mitigating their consequences for the type of disasters that presently impact, with greater frequency, the Portuguese territory, and the Madeira island in particular.

It should be noted, however, that in Portugal the introduction of the subject in the school curriculum is still recent. How the topic of 'risks and disasters' influences the students' perceptions requires monitoring over several years, which will necessarily require undertaking further research, implying that more robust conclusions will only be reached in the next few years. Risk management will certainly benefit from improved teaching methods and better educational materials and pedagogical resources used in the teaching-learning process – very important factors in the education of students and their learning outcomes.

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DATA AVAILABILITY STATEMENT

The authors declare that the data contained in the work is available.

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