




# Design and validation of the perception of risk towards environmental unsustainability scale (PREUS)

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## Abstract

No validated scales are available to assess the perception of risk towards environmental unsustainability (PREU), which is a key construct for the adoption of sustainable behaviors. To fill this literature gap, the objective of this study was to develop and validate the PREU scale (PREUS). To this end, a total of 519 Spanish participants answered a survey composed of the PREUS and other psychosocial variables. The exploratory and confirmatory factor analyses ratify the bifactorial structure of the scale. The two factors refer to perceived risk to oneself and one's own family (anthropocentric view of risk), and risk for the planet (ecocentric view), respectively. The structural equation modelling analyses confirmed (1) the expected relationships between both factors and other constructs of their nomological network, and (2) the mediating role of the ascription of responsibility in the relationship established between risk perception and sustainable behavior, offering empirical support for the external validity of the scale. Finally, both metric and scalar gender invariance were granted and, as expected, women showed higher PREU than men. The study provides a brief, easy-to-complete, reliable, valid, and sex-invariant instrument that can be useful for researchers and educators to assess the extent to which individuals perceive the risk that environmental unsustainability can pose.

**Keywords** Risk perception · Environmental unsustainability · Scale design and validation · Responsibility · Sustainable behavior

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# 1 Introduction

Environmental problems represent one of the most important threats to the survival of humanity and a whole myriad of species. These challenges include pollution, climate change, deforestation, extinctions (reducing biodiversity), and the depletion of natural resources (Ripple et al., 2021). Their consequences also include droughts, floods, heat waves, rising sea levels, health problems, and declining flora and fauna, among others. Given this scenario, the situation of environmental unsustainability emerges not only as a problem for future generations, but also as an imminent risk to today's societies. The scientific community has concluded and declared on multiple occasions that this situation is largely the result of the extractive and transformative activities of humankind (IPCC, 2021), whose ecological footprint is surpassing the planet's limits (Rockstrom et al., 2009).

At the root of these problems, it is possible to identify psychological determinants that partially explain the negative changes suffered by the terrestrial biosphere, since, ultimately, human inclinations, decisions and behaviors that lead to ecological degradation constitute psychological variables. These variables can lead people towards a position of caring for the environment (Clayton and Myers, 2015). Thus, it becomes necessary to develop and/or apply psychological theories that explain why, when and how humans act in ways that destroy the planet's resources, or, alternatively, ones that protect them, which could make an invaluable contribution to solving the serious environmental problems affecting the planet (Akintunde, 2017). Thus, at this time, it is necessary to raise awareness not only among young people, but also among adults, since climate change has emerged as the main environmental problem identified by citizens (European Union, 2022).

One of the variables that the scientific literature has linked to pro-environmental and sustainable behavior is risk perception (Heath & Gifford 2006; O'Connor et al., 2002; Sundblad et al., 2007; Bradley et al. 2020), with studies indicating that individuals who are aware of the negative effects of a given threat (i.e., those who perceive the risk of that threat) take greater responsibility for its potential negative consequences and, in response, accept a greater moral obligation to act with the aim of reducing the risk (de Groot & Steg, 2009; Radic et al., 2021; Rui et al., 2021). In other words, individuals' awareness of the possible negative consequences of a given situation—that is, their perception of the risk of that situation—leads them to assume greater responsibility for it and, as a result, to act accordingly. In this regard, in the area of pro-environmental behavior, one variable of interest seems to be the perception of risk towards environmental unsustainability (PREU).

Although PREU seems to be a relevant variable that influences our decision-making and behaviors related to the environment, it should be noted that, to our knowledge, there are no validated scales on this construct. Therefore, the aim of this study was to design and validate the PREU Scale (PREUS), which is a brief tool that could be useful for both researchers and professionals.

## 2 Literature review

### 2.1 The concept of risk perception associated with environmental unsustainability

Risk perception refers to the process of discerning and interpreting signals from various sources regarding uncertain events and forming a subjective judgment of the

likelihood and severity of current or future harm associated with them (Grothmann & Patt, 2005; Slovic, 2016; Wachinger et al., 2013). The literature on risk perception reveals that this construct is multidimensional, as highlighted by the TRIRISK model (Ferrer et al., 2016). In this regard, Ferrer et al. (2016) stress that risk perception encompasses deliberative, affective, and experiential aspects, although other studies combine the affective and experiential ones into a single component (Riedinger et al., 2022; Savadori & Lauriola, 2021, 2022). In fact, most studies describe risk perception as a two-dimensional construct with a more cognitive aspect, referring to the perception of the likelihood of the threat occurring, and another, more affective one, referring to the perception of the potential negative consequences of that threat (Savadori & Lauriola, 2022; Slovic et al., 2004). It seems important to emphasize that, according to the literature, the affective aspect of risk perception has a greater impact on human behavior than the cognitive aspect (Ferrer et al., 2018; Savadori & Lauriola, 2022), which is why we decided to consider the affective dimension of risk perception in our scale. This study is focused on PREU, which, based on the above definitions, could be defined as the extent to which individuals perceive that environmental unsustainability has the potential to yield negative outcomes. Thus, PREU is a subjective construct that can differ widely from one individual to another. According to the World Commission on Environment and Development (1987), any sustainable development must address environmental, social and economic objectives (The Three Ps: Planet, People and Profit), thus it was important to consider these three objectives for the design of PREUS. The aspects of environmental unsustainability which PREUS is based on cannot ignore any of these three objectives of sustainable development, about which several authors (e.g., Kopnina, 2020; Washington, 2018) concur: environmental sustainability must effectively address these three target areas. However, precisely one of the aspects that we must consider is that numerous environmental risk perception scales have only focused on the environmental aspect per se, ignoring the other two elements involved in sustainability. Thus, the PREUS' object of design and validation in this study considered these three areas. This consideration of the Three Ps is one of the novel aspects of our scale, which is intended to be both brief and more comprehensive in terms of the environmental unsustainability construct measured.

It should be noted that we conceive PREU as including two distinct dimensions: risk to oneself and one's family members, and risk to the planet. These two dimensions are defined by anthropocentric and ecocentric dimensions. In this regard, studies on the relationship between the environment and people indicate that beliefs and concerns about the environment feature two dimensions: an anthropocentric dimension, which includes selfish and socio-altruistic subdimensions, and an ecocentric dimension, in which people and the environment are equally important (Palavecinos et al., 2016). Therefore, it is believed that those who view a deteriorating environment as a threat to themselves (their health or lifestyle, for example) will base their beliefs on selfish values; those who view a deteriorating environment as having a deleterious impact on the community will base their beliefs on altruistic values; and, finally, people who embrace biospheric values will see the consequences of environmental decline as threats to animals, plants and ecosystems (Palavecinos et al., 2016). Both selfish and altruistic values are part of the anthropocentric dimension, while biospheric values represent the ecocentric dimension.

Thus, based on these two major dimensions, we conceive PREU as a two-dimensional construct comprising, on the one hand, the more anthropocentric perception of risk to oneself and one's family, and, on the other hand, the more ecocentric perception of risk to the planet. Therefore, we propose the following first study hypothesis (H):

H1. The scale of risk perception associated with environmental unsustainability is composed of two differentiated factors: the perception of risk to oneself and one's family, based on the anthropocentric dimension; and the perception of risk to the planet, based on the ecocentric dimension.

## 2.2 Scales of risk perception in the environmental field

To measure the perception of risk associated with the situation of environmental unsustainability, one of the most widely used scales has been that included in the General Social Survey–SAQ (GSS–SAQ; NORC University of Chicago), whose versions date from 1972 to the present day. This scale focuses on very specific elements that influence environmental unsustainability, and it also considers the two risk factors on which we based our study: risk to oneself and one's family (anthropocentric) and risk to the planet (ecocentric). However, in addition to being relatively long, it focuses only on environmental aspects (e.g., pollution caused by vehicles, nuclear power plants, pollution from industry, pesticides and chemicals used in agriculture, pollution of rivers, lakes, and streams, increase in global temperature by the greenhouse effect, etc.), not encompassing the social and economic aspects that are also part of sustainability. Moreover, it has not been subject to validation, thus it is not possible to ensure that it reliably and validly measures the construct it is intended to.

After an exhaustive review of the literature, we did not find any validation study of a scale about PREU, although we did find different studies that measure this construct for use in their research, although without any validation of their scales. Thus, among some studies that used scales on risk perception, we can cite those by Hidalgo et al. (2010), Heath and Gifford (2006) and Sundblad et al. (2007). To measure the perception of risk associated with climate change (a very specific aspect related to environmental unsustainability), these authors created their own scales, dividing the items into two factors. One of the constituent factors of these scales represented the perception of the probability that climate change is occurring (focusing in this case on the more cognitive dimension of risk perception), while the other represented the perception of the consequences that this phenomenon may have (emphasizing the affective dimension of risk perception). However, once again, these scales did not include an analysis of their reliability and validity, and sometimes they were even described in such a way that they could not be replicated, as only a few examples of the items used in each of the two dimensions were referred to. Another study worth pointing out is that by Thompson and Barton (1994), who measured risk perception through a single open-ended question; rather than a risk perception scale per se, it was a scale measuring the extent to which individuals presented higher or lower levels of anthropocentric or ecocentric environmental concerns.

In a similar study, Linden (2014) used a total of 8 items to create an assessment of the perception of risk associated with climate change, although it did not include any factors with a more ecocentric viewpoint, in which it was possible to assess whether the individual perceived that climate change may pose a risk not so much to oneself (selfish, anthropocentric view) or to society as a whole (altruistic, anthropocentric view) but rather to the planet itself (biosphere value-oriented, ecocentric view). Once again, this scale was created specifically for the uses of the study and was not subject to validation.

Kellstedt et al. (2008) used a scale that assesses the degree to which respondents perceive climate change as a threat to their own health, financial status, or environmental

well-being (3 items), and to public health, the economy, and environmental integrity within their region (3 items), which is a fairly comprehensive and simple scale that is focused on climate change rather than environmental unsustainability.

In summary, it should be noted that, after analyzing different scales gauging risk perception related to the environment, although some of them have covered the two factors on which we focus in our study (the anthropocentric and the ecocentric dimensions), we can see that they are specifically focused on the perception of risk associated with climate change, and not on environmental unsustainability. Thus, it seems relevant to validate a more global scale, one that does not focus on a very specific aspect of environmental unsustainability, but rather on environmental unsustainability itself. Moreover, those scales that are not focused specifically on climate change, but on more general aspects of environmental unsustainability, are only focused on the environmental aspect, per se, of sustainability, overlooking its other two constituent dimensions: the social and economic dimensions. Furthermore, these previous scales have not been subjected to a validation study to determine whether they really measured what they intended to in a valid and reliable manner. Therein lies the novelty, relevance, and necessity of our study, in which we aimed to design and validate a brief scale that allows evaluating the affective dimension of PREU in a systematic way in terms of the two risk factors (ecocentric and anthropocentric), while considering the three aspects of environmental sustainability (Planet, People and Profit).

### **2.3 Constructs related to the perception of risk associated with environmental unsustainability**

To verify the external validity of the scale, it is essential to corroborate the relationships that PREUS establishes with other constructs and scales which it should, theoretically, be related to. Among the factors that have shown a certain predictive relationship with risk perception are level of knowledge and attitudes towards the environment. Thus, according to different authors (O'Connor et al., 2000; O'Connor et al., 1999; Sundblad et al., 2007), knowledge of the causes and consequences of climate change increases the subsequent risk perception of this phenomenon, as well as the willingness to act in order to tackle it. Thus, it can be expected that PREUS is related to the knowledge that individuals have about environmental sustainability, and that the more knowledge they have about what environmental sustainability is, and what it entails, the more they will perceive that environmental unsustainability poses a risk to themselves, their families, and the planet.

Different studies allow us to conclude that there is a relationship between PREU and the attitudes that individuals have towards the environment and environmental sustainability. Heath and Gifford (2006) found that pro-environmental attitudes are related to perceptions of risk associated with climate change. More specifically, they ascertained that both ecocentrism and environmental apathy are good predictors of risk perception associated with climate change; that is, people who have more ecocentric values and have less apathetic ones towards the environment perceive the risks associated with climate change to a greater extent. In the same vein, the work of Brody et al. (2008) also found that people who have more pro-environmental concerns and attitudes perceive greater risks associated with climate change. Thus, we can expect PREUS to be related to attitudes towards environmental sustainability, such that people who have a more positive attitude towards environmental sustainability will see, to a greater extent, environmental unsustainability as a risk to themselves, their family, and the planet.

Several studies have attempted to understand the social perception of this risk, the specific knowledge, attitudes, and beliefs regarding this problem, and, perhaps most importantly, possible individual and collective actions to address it (Brody et al., 2008; Heath & Gifford, 2006; Sundblad et al., 2007; Whitmarsh, 2009). Thus, there are several studies that allow us to relate PREU to pro-environmental intentions and behaviors. The perception of risk posed by climate change has been associated with a willingness to carry out individual actions to mitigate the effects of this phenomenon on the environment (Heath & Gifford, 2006; O'Connor et al., 1999). Several articles show that risk perception is a good predictor of intention to engage in behaviors that address climate change (Heath & Gifford, 2006; O'Connor et al., 1999; O'Connor et al., 2002; Bradley et al., 2020). In addition, O'Connor et al. (2002) demonstrated that individuals who perceive climate change as a substantial risk are more supportive of policy initiatives entailing a change in the energy model, as well as voluntary actions, such as buying green products, driving less, or choosing energy that is considered cleaner. Therefore, we expect to find that PREUS is related to environmental sustainability behavior, such that the more individuals perceive the risks associated with environmental unsustainability, the more they will behave in an environmentally sustainable manner.

Finally, based on the Norm Activation Model (NAM) of Schwartz (1977), according to whom altruistic behaviors occur due to the activation of norms and the ascription of personal responsibility, which is triggered by the individual's awareness of the negative consequences of a problem and the possibility of mitigating those negative consequences through one's own actions, we propose that PREU will be related to perceived responsibility. More specifically, following NAM (Schwartz, 1977) and subsequent work by other authors (de Groot & Steg, 2009; Onwezen et al., 2013; Radic et al., 2021; Rui et al., 2021), we propose that PREU will influence the ascription of responsibility, which, in turn, will influence the individual's pro-environmental behavior, with perceived responsibility, thereby emerging as a mediating variable in the relationship between risk perception and pro-environmental behavior.

Thus, based on the literature reviewed and the relationships found in the scientific literature, we propose the following hypotheses:

H2. Higher levels of PREU are related to (1) higher levels of knowledge of environmental sustainability, (2) more positive attitudes towards environmental sustainability, (3) greater perceived responsibility towards environmental sustainability, and (4) more environmentally sustainable behaviors.

H3. Perceived responsibility towards environmental sustainability mediates the relationship between PREU and sustainable behavior.

## 2.4 Gender perspective

Studies must be conducted duly accounting for gender. Accordingly, we must ensure that the instruments designed and validated are suitable for use with both male and female populations. For this reason, this study also evaluated the invariance of PREUS as a function of gender. Moreover, the ways men and women address environmental issues are different. In this vein, it has been shown that women are more environmentally conscious, perceive higher levels of environmental awareness, and adopt more environmentally-friendly behaviors (Gökmen, 2021; Hampel et al., 1996; Mifsud, 2012; Singh & Gupta,

2013). Furthermore, men and women do not perceive risk in the same manner. In this sense, several studies have shown that women tend to rate risk higher than men (Finucane et al., 2000; Gustafson, 1998). Therefore, considering the higher awareness of women towards environmental issues and their tendency to evaluate higher risk, we expected women to show higher levels of PREU than men.

H4. The PREUS is invariant for gender, being valid for both men and women.

H5. Women perceive higher risk towards environmental unsustainability than men.

## 3 Methodology

### 3.1 Participants

This study was conducted on a sample of 519 adults (68.8% women) residing in Spain with a mean age of 36.80 (age range=[18, 81], SD=14.70). More sociodemographic characteristics can be found in Supplementary Table 1.

### 3.2 Procedure

The questionnaire was publicized through different media, via social media, posters, and teaching platforms. Before completing the questionnaire, the participants were requested to give their informed consent. The study was approved by the Ethics Committee of the University of Córdoba through code CEIH-22-52.

### 3.3 Measures

#### 3.3.1 Perception of risk towards environmental unsustainability

PREUS, which is the object of validation in the present study, was designed based on the 13 items related to perceived risk associated with environmental pollutants included in the 1994 version of the General Social Survey–SAQ (GSS–SAQ; NORC University of Chicago), making use of the similarities between these instruments.

The 13 items of the original GSS–SAQ focused on six very concrete pollutants that influence environmental unsustainability: pollutants caused by vehicles (three items), industries (two items), nuclear energy (two items), pesticides and chemicals used in agriculture (two items), pollution of rivers, lakes, and streams (two items), and global warming (two items). Thus, these 13 items only addressed the ecological dimension, ignoring the social and economic dimensions of environmental sustainability. For each of those six evaluated elements, participants had to evaluate, firstly, the risk of this element for the environment, and, secondly, for themselves and their families, thus covering both the most ecocentric dimension of risk perception related to environmental problems and the most anthropocentric dimension. The final scale was very long, as it included 13 items to carry out a double evaluation, first from the ecocentric perspective and then from the anthropocentric perspective.

For PREUS, which was designed to be shorter and to encompass not only the ecologic aspects of environmental unsustainability but also the social and economic aspects, we decided

to join the first five elements of the original GSS–SAQ scale in one unique element called “contamination”, as well as to keep the element that refers to global warming. Moreover, to include and encompass the economic and social dimensions, two new elements were included: one referring to the despoliation of natural resources due to consumerism (economic aspect of environmental sustainability), and the other related to social inequalities (social aspect of environmental sustainability). Therefore, four elements constitute PREUS: contamination, global warming, consumerism, and social inequalities.

Then, as in the case of the original 13 items related to perceived risk associated with environmental pollutants of the GSS–SAQ scale, the participants were asked to evaluate, in a 5-point Likert scale, the risk posed by the four elements included in PREUS from a double perspective: (1) an ecocentric perspective, asking them about the risk for the environment; and (2) an anthropocentric perspective, asking them about the risk of those 4 elements for themselves and their family. As a result, the final scale consisted of 8 items, which are presented in Table 1.

### 3.3.2 Perceived responsibility towards environmental sustainability

To assess the extent to which individuals assume partial responsibility for environmental sustainability, the scale of perceived responsibility towards climate change (Authors) was abbreviated and adapted, modifying the items in a way that they did not only refer to climate change, but to unsustainability as a whole. Participants responded to the four designed items in a 5-point Likert scale. The reliability of the scale was high ( $\alpha=0.84$ ).

### 3.3.3 Knowledge, attitudes, and behaviors towards environmental sustainability.

To measure the participants’ knowledge of sustainability and their attitudes and behaviors towards it, we used the abridged version of the Sustainability Consciousness Scale (SCQ-S; Gericke et al., 2019). The participants responded to the 27 items on a 5-point Likert scale. Nine items correspond to knowledge about sustainability, another nine to attitudes towards sustainability, and another nine refer to behavior regarding sustainability. The reliability of the sustainability-related knowledge, attitudes, and behavior factors were all adequate ( $\alpha=0.87$ ,  $\alpha=0.83$ , and  $\alpha=0.74$ , respectively).

## 4 Results

### 4.1 Exploratory factor analysis

When conducting the exploratory factor analysis (EFA) with Direct Oblimin rotation and the maximum likelihood method with the first randomized split sample ( $n=252$ ), the Kaiser–Meyer–Olkin index (0.789) and Bartlett’s Test of Sphericity ( $X^2=1219.573$ ;  $df=28$ ;  $p<0.001$ ) supported the use of the EFA. The results showed the two factors expected, which explained 64.08% of the variance. As can be seen in Table 1, all the items loaded correctly in their proposed dimension. The first factor, corresponding to the perception of risk to oneself and the family, explained 49.85% of the variance. The second factor, corresponding to the perception of risk to the planet, explained 14.23% of the variance.



**Table 1** Results of the exploratory factor analysis of the perception of risk towards environmental unsustainability scale (PREUS)

	F1: Individual risk	F2: Planetary risk
Item 1. To what extent do you think that air, land and water contamination from automobiles, industry and agriculture pose a risk? [To you and your family]	.782	
Item 2. To what extent do you think that air, land and water contamination from automobiles, industry and agriculture poses a risk? [To the planet]		-.866
Item 3. To what extent do you think that the increase in global temperature caused by climate change poses a risk? [To you and your family]	.763	
Item 4. To what extent do you think that the increase in global temperature caused by climate change poses a risk? [To the planet]		-.907
Item 5. To what extent do you think that the plundering of natural resources due to consumerism poses a risk? [To you and your family]	.951	
Item 6. To what extent do you think that the plundering of natural resources due to consumerism poses a risk? [To the planet]		-.798
Item 7. To what extent do you think social inequalities pose a risk? [To you and your family]	.609	-.469
Item 8. To what extent do you think that social inequalities pose a risk? [To the planet]		.854
Cronbach's Alpha	.859	.906
Coefficient H	.929	
Mean (SD)	4.11 (0.76)	4.59 (0.63)

F Factor; SD Standard deviation

## 4.2 Internal reliability of the perception of risk towards environmental unsustainability scale (PREUS)

### 4.2.1 Multigroup confirmatory factor analysis

The bifactorial structure of the scale was tested by performing a confirmatory factor analysis (CFA) with the second randomized split sample. The results of the CFA revealed a good fit (see Table 2) of the bifactorial model (see Fig. 1).

### 4.2.2 Internal reliability and standard error of estimation

The values of the standard error of estimation (SEE) analysis for each of the scale factors and for the overall scale met the criterion, demonstrating evidence for adequate measurement precision (see Table 3). In addition, internal reliability was adequate for both factors, and for the overall sample, as shown by Cronbach's Alpha and H coefficient values.

## 4.3 External validity

### 4.3.1 Discriminant validity of the perception of risk towards environmental unsustainability scale (PREUS)

To obtain evidence of the instrument's validity, the correlations established by the scale with other related constructs were analyzed, thereby exploring the scale's convergent validity. As can be seen in Table 4, both the global scale and its factors presented the expected relationships with the other study variables.

In addition, the structural equation model created, including the correlations between the PREUS factors and the other related constructs analyzed, confirmed the expected results (Fig. 2); model fits were adequate ( $X^2 = 86.605$ ,  $df = 39$ ,  $p < 0.001$ ;  $CFI = 0.982$ ,  $TLI = 0.970$ ;  $RMSEA [95\% CI] = 0.054 [0.039, 0.069]$ ).

To provide evidence of the scale's discriminant validity with the other constructs explored, we compared its square root of the average variance extracted (SRAVE) with the correlation values between the two factors of the scale and the other constructs explored. The results showed that the SRAVE of the risk factor for self and family ( $SRAVE = 0.81$ ) was higher than the correlations established by that factor with any of the other variables. Similarly, the SRAVE value of the risk factor for the planet ( $SRAVE = 0.82$ ) was also higher than the correlations established by that factor with any of the other variables.

These results provide evidence of the divergence of PREUS from the other constructs explored.

### 4.3.2 Mediation analysis

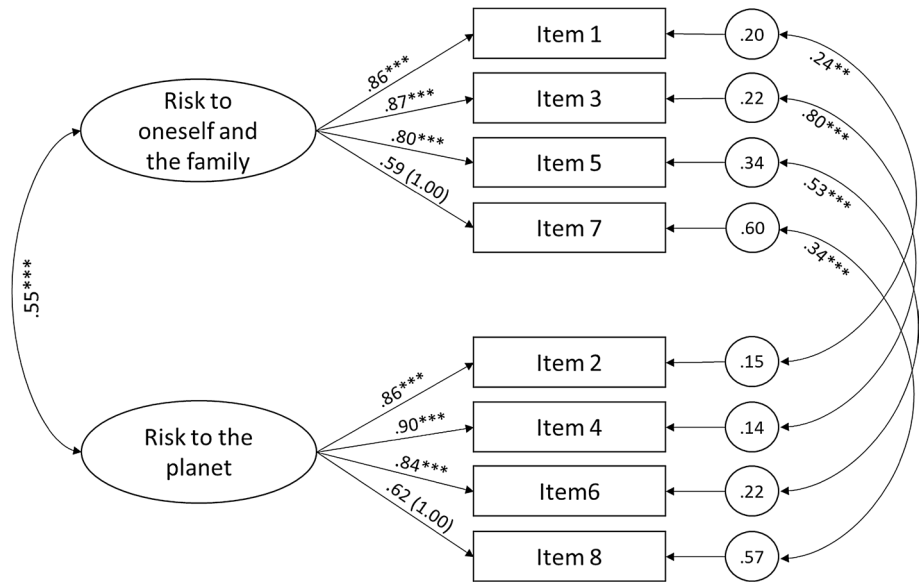
As can be observed in Fig. 3, the structural equation analysis confirmed the relationships between the two PREUS factors with responsibility and sustainable behavior. The results confirmed the indirect effect of the risk factor for oneself and family on sustainable behavior through perceived responsibility (Indirect effect = 0.033,  $p < 0.01$ ). In addition, the total effect of the risk factor for oneself and family on sustainable behavior, and perceived responsibility,

**Table 2** Confirmatory factor analysis and multi-group factor analysis goodness-of-fit indices

	$\chi^2$	df	CFI	TLI	RMSEA	RMSEA [90%CI]	SRMR	$\Delta CFI$	$\Delta\chi^2$
<i>Confirmatory factor analysis indices</i>									
Model with the second randomized split sample (N = 267)	19.500	15	.997	.994	.034	[.001; .071]	.034		
<i>Multi-group confirmatory factor analysis indices</i>									
Base model for multigroup CFA, with total sample (N = 519)	56.763**	15	.990	.981	.042	[.025; .058]	.042		
Female sample, with total sample (N = 356)	28.850*	15	.992	.985	.051	[.021; .079]	.042		
Male sample, with total sample (N = 160)	27.913*	15	.986	.974	.074	[.027; .116]	.056		
Metric invariance	63.576**	36	.989	.984	.039	[.022; .054]	.042	.001	6.813
Scalar invariance	76.986***	42	.987	.982	.040	[.026; .054]	.041	.002	20.223

$\chi^2$  Chi-Square test of model fit; *df* Degrees of freedom; *CFI* Comparative fit index; *TLI* Tucker Lewis Index; *RMSEA* Root mean square error of approximation; *SRMR* Standardized root mean square residual;  $\Delta CFI$  Difference between the comparative fit indexes of the two models (tested model *minus* base model);  $\Delta\chi^2$  Difference between the  $\chi^2$  of the two models (tested model *minus* base model)

\*\*\*  $p < .001$ ; \*\*  $p < .01$



**Fig. 1** Bifactorial model resulting from the confirmatory factor analysis. Note \*\* $p < .01$ , \*\*\* $p < .001$

**Table 3** Standard error of estimation (SEE) of the perception of risk towards environmental unsustainability scale (PREUS). Complete sample ( $N = 519$ )

	Risk factor for me and my family	Risk factor for nature	Global scale
Standard deviation ( $dt$ )	0.78	0.69	0.65
Reliability coefficient ( $\alpha$ )	0.86	0.87	0.88
Reliability coefficient ( $H$ )	0.92	0.94	0.92
SEE	0.29*	0.25*	0.23*
SD/2	0.39	0.35	0.33

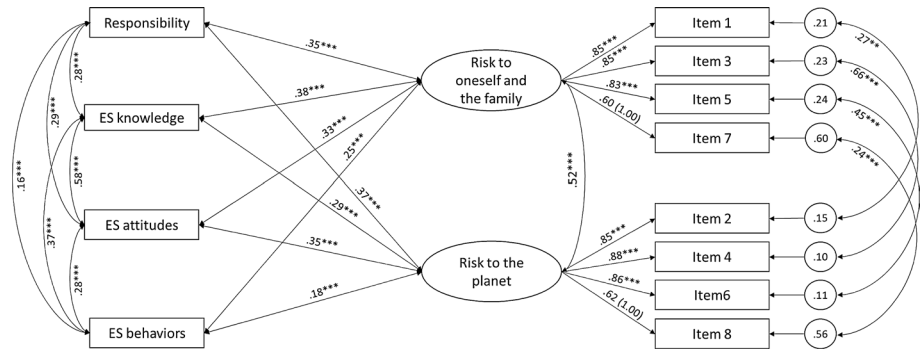
$\alpha$  Cronbach's alpha;  $H$   $H$  coefficient;  $SD$  Standard deviation

\* $SEE < SD/2$

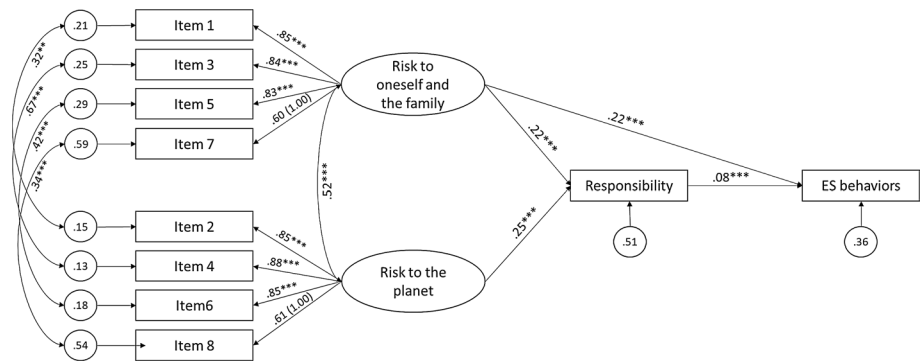
was also significant (Total effect = 0.31,  $p < 0.001$ ). In the same line, the results confirmed the indirect effect of the risk factor for the planet on sustainable behavior through perceived responsibility (Indirect effect = 0.027,  $p < 0.05$ ). However, although a direct relationship was observed between risk to oneself and family and sustainable behavior, no such direct relationship was observed between risk to the planet and sustainable behavior.

#### 4.4 Gender perspective

The invariance of the scale as a function of gender was explored through a multigroup CFA. As can be seen in Table 2, the bidimensional model showed adequate fits for both the female and male samples. The results were acceptable for both samples for most of the indices. As



**Fig. 2** Structural equation model resulting from the correlation between the studied variables and the bifactorial structure of the perception of risk towards environmental unsustainability scale (PREUS). Note \*\*\* $p < .001$ . ES = environmental sustainability



**Fig. 3** Mediation analysis. Note \*\*\* $p < .001$ . ES = environmental sustainability

for the multigroup analysis, the results confirmed both metric and scalar invariance, indicating that the scale is invariant as a function of gender.

Moreover, gender differences in PREUS and in its factors were explored through  $t$  test with the general sample ( $n=519$ ). The results confirmed higher rates for women in comparison with men in PREUS ( $M_{women}=4.36, SD=0.58; M_{men}=4.17, SD=0.75, t=df(514)=3.171, p=0.002$ ) and in both the factor of risk for themselves and their family ( $M_{women}=4.13, SD=0.74; M_{men}=3.94, SD=0.84, t=df(514)=2.559, p=0.011$ ) and the factor of risk for the planet ( $M_{women}=4.59, SD=0.59; M_{men}=4.39, SD=0.86, t=df(514)=3.051, p=0.002$ ).

## 5 Discussion

Although the perception of risk associated with environmental issues is recognized as an influential variable that impacts the environmental behavior of individuals (Heath & Gifford, 2006; O'Connor et al., 1999; O'Connor et al., 2002), a review of the literature reveals that there is no exhaustive validation of the scales used for this purpose. Moreover,

many of such scales focus on extremely specific aspects of environmental sustainability, or focus exclusively on environmental aspects, overlooking the social and economic dimensions, in addition to being, in general, relatively long. Therefore, this study was focused on the design and validation of a brief scale of the affective dimension of PREU that takes into consideration the three dimensions comprising environmental sustainability.

The results of the study confirm the validity of PREUS, which consists of two distinct factors that take into consideration the environmental, social and economic dimensions of environmental sustainability. One of the factors of the scale refers to the perception of risk to oneself and one's family, assessing risk from a more anthropocentric perspective, while the other refers to the perception of risk to the planet, assessing risk from a more ecocentric perspective. In addition, the scale demonstrated the expected relationships with variables in its nomological network, thus exhibiting external validity, and proved to be gender invariant, thus being applicable to both men and women.

### 5.1 PREUS: a scale with a reliable bifactorial structure

Both the EFA and the CFA confirm that the scale is comprised of two factors, showing that the PREU construct is two-dimensional, which indicates that beliefs and concerns about the environment have these two dimensions: an anthropocentric dimension, comprising selfish and socio-altruistic dimensions, and an ecocentric dimension, in which people and the environment are equally important (Palavecinos et al., 2016).

Thus, we can confirm the acceptance of our first hypothesis (H1), which allows us to conceive PREU as a two-dimensional construct, since it comprises the perception of risk to oneself and one's family (anthropocentric dimension), and the perception of risk to the planet (ecocentric dimension).

Regarding reliability and internal validity, the results indicate that PREUS features good internal reliability both for the overall construct and for each of the two factors separately, with the values for both Cronbach's Alpha and the H-index being adequate. In addition, the results of the SEE show that the scale exhibits adequate measurement precision. Thus, as a whole, the results confirm the internal validity of the scale.

### 5.2 PREUS: a valid scale

Regarding the external validity of PREUS, the correlation analyses by means of structural equation analysis and the mediation analyses reveal that PREU is related, as expected, to other variables of its nomological network, which provides evidence of the scale's convergence with related constructs, thus confirming the external validity of the scale. Thus, PREUS correlates adequately with the variables of knowledge, attitudes and perceived responsibility towards environmental sustainability, and sustainable behaviors. Likewise, although the correlation and structural equation analyses show that PREUS is positively and significantly related to the explored constructs, the SRAVE analyses show that each of the two factors of PREUS diverge from these constructs, indicating that they are not equivalent, and measure different elements, which provides evidence for the divergent validity of the scale.

Focusing on the convergent validity of the scale, the results confirm that both the perception of risk to oneself and one's family and the perception of risk to the planet correlate with knowledge of environmental sustainability. These results are in line with previous studies reporting that knowledge of the causes and consequences of

climate change increases the perceived risk posed by this phenomenon, as well as the willingness to act with the aim of addressing it (Bord et al., 2000; O'Connor et al., 1999; Sundblad et al., 2007). Thus, our H2a is corroborated, with the results providing evidence of the external validity of the scale.

The results confirm the relationship expected between PREUS' two factors and attitudes towards environmental sustainability in H2b, thus revealing what has already been asserted by different studies regarding general attitudes towards the environment: people who have positive attitudes towards the environment perceive the risk of different phenomena associated with environmental problems. Heath and Gifford (2006), for example, found that pro-environmental attitudes are positively related to the perception of risk associated with climate change.

Furthermore, it was also possible to confirm, as proposed in H2c, that people who perceive that environmental unsustainability poses a greater risk to themselves and their families, as well as to the planet, assume greater responsibility for environmental sustainability. These results are congruent with Schwartz's (1977) NAM, according to which awareness of the negative consequences of a problem triggers certain behavioral norms by implying a greater ascription of responsibility, which, in turn, will mean that people act accordingly, adopting the appropriate altruistic behaviors to mitigate these negative consequences through their own actions.

The last relationship between variables that was also corroborated is H2d, referring to the relationship expected between risk perception and sustainable behavior. Thus, our results allow us to confirm that the more individuals perceive risk to themselves, their families and the planet, the more sustainable their behavior becomes. These results are consistent with those of previous studies in which risk perception has been associated with the willingness to carry out individual actions to mitigate the environmental effects of this phenomenon (Heath & Gifford, 2006; O'Connor et al., 1999). Furthermore, several studies have demonstrated that risk perception is a good predictor of behavioral intention to address climate change (Heath & Gifford, 2006; O'Connor et al., 1999; O'Connor et al., 2002). Moreover, O'Connor et al. (2002) showed that those individuals who perceive climate change as a substantial risk situation are more supportive of initiatives that involve a change in the energy model. Thus, once again, the relationship established with PREUS provides evidence of the external validity of the scale. Moreover, the results indicate that the relationship established by PREU with sustainable behaviors is stronger when individuals perceive risks to themselves and their family members (a more anthropocentric view of environmental risk) than when they perceive risks as threatening the planet (a more ecocentric view of environmental risk). Thus, the results of our study seem to indicate that human behavior has a certain selfish component, according to which we tend to adopt sustainable behaviors if we perceive that unsustainability directly affects us. This was confirmed by Palavecinos et al. (2016), who pointed out that those who see the consequences of the environment's deterioration as something that impacts them personally, their health, and their lifestyles, base their beliefs on values of self-interest; people who focus on the consequences of environmental damage on the community base their beliefs on altruistic values; and, finally, people who embrace biospheric values, focus on the consequences of environmental deterioration for animals, plants and ecosystems.

Finally, the mediation results also allowed us to confirm H3, according to which PREU influences the ascription of responsibility, which, in turn, influences the individual's pro-environmental behavior, with perceived responsibility emerging as a mediating variable in the relationship between risk perception and pro-environmental behavior. Thus, the mediation model provides further evidence for the external validity of PREUS, confirming

the relationships between risk perception, responsibility and pro-environmental behavior based on NAM (Schwartz, 1977) and subsequent work (de Groot & Steg, 2009; Onwezen et al., 2013; Radic et al., 2021; Rui et al., 2021). According to Schwartz's theory, risk perception influences sustainable behavior indirectly through responsibility. That is, when individuals perceive that Environmental Unsustainability may pose a risk, this makes it easier for them to feel responsible, and to ascribe to themselves a responsibility to act, which, in turn, is what will ultimately influence them to behave in a sustainable manner by activating behavioral norms towards mitigating negative consequences. However, the pattern varies depending on whether we perceive environmental unsustainability as a risk to ourselves or to the planet. If we perceive environmental unsustainability as posing a risk to ourselves, there is not only an indirect relationship between risk perception and behavior through perceived responsibility, but also a direct relationship. Thus, when we perceive that environmental unsustainability may pose a risk to ourselves and to our relatives, this risk perception may lead us to behave in a sustainable way, regardless of our sense of responsibility. However, if we perceive that environmental unsustainability may not pose such a risk for us, but for the planet, sustainable behavior will only take place if we feel responsible, with no direct relationship between the perception of risk for the planet and sustainable behavior.

Therefore, we once again confirm the greater importance of the perception that environmental unsustainability poses a risk to ourselves and our family, from a more anthropocentric view, compared to the perception that such unsustainability may pose a risk to the planet, from a more ecocentric view. This seems to indicate that individuals adopt ecological behaviors mainly in search of a benefit for themselves, seeking to reduce potential negative impacts on themselves and their family members rather than on the planet. In terms of practical implications, this seems to indicate that interventions aimed at encouraging pro-environmental behavior among individuals and groups should focus more on making individuals perceive the risks of not adopting such behaviors at a more individual level, rather than for the planet as a whole. If individuals show a more sustainable behavior when they themselves are affected by the negative effects of environmental unsustainability, the design of interventions should make people see not so much the effects that environmental unsustainability has on nature or the environment (although this is also the case) but, above all, the effects it has on themselves, on human beings, focusing interventions more on the self-interested and anthropocentric view than on the ecocentric perspective. In this regard, different models of pro-environmental behavior based on the "economic models" argue that sustainable behaviors occur when the individual perceives that engaging in them is beneficial for them, from a paradigm of self-interest, spurred by more selfish motives (Andreoni, 1990; Brekke et al., 2003; Halvorsen, 2008; Turaga et al., 2010). Nevertheless, since real sustainable behaviors need people to be engaged with nature, and a real change about sustainability needs to be holistic, socio-educational interventions aimed at fostering pro-environmental behaviors should focus not only on the self-interest and risk for humans, but also on the risk for the planet (which, on the other hand, is intrinsically related to the risk for humanity). Thus, an interesting focus for interventions would be to first intervene and emphasize the negative effects of unsustainability on the planet and the environment—from an ecocentric view—since individuals are usually more aware of the effect of unsustainability on the planet than on humans. In this sense, our data show that the perceived risk for the planet ( $M=4.53$ ,  $SD=0.78$ ) is significantly ( $t(SD=518)=-15.03$ ,  $p<.001$ ) higher than the perceived risk for themselves and their families ( $M=4.07$ ,  $SD=0.69$ ). It is crucial that, when approaching the risks that unsustainability entails for the planet, we work with sufficient depth to



understand its seriousness, consequences and risk to society. Therefore, after starting thoroughly with what they are more aware of—the risk of unsustainability for the planet—it would be necessary to enlarge the focus by emphasizing the fact that the risks posed by unsustainability for the planet are intrinsically linked to the risks it poses for human beings, since the planet is our livelihood. This would enable educators to then focus on the risk for human beings, for themselves and their family—from an anthropocentric view—thereby making people fully aware of the impact of unsustainability as a whole, for the planet and for themselves, as they are part of the planet. Finally, in order to be comprehensive and holistic, once individuals are fully aware of the impact of unsustainability for the planet and for themselves, interventions should point out the relevance of sustainability, of taking care of the planet as a whole, which will have an effect on the planet and on all living beings that inhabit it, including themselves.

### 5.3 PREUS: a gender-invariant scale

Lastly, the invariance results show that the scale is invariant with respect to gender, confirming both metric and scalar invariance. Metric invariance allows us to confirm that the relationships established between the PREUS factors and other variables can be compared between men and women, and scalar invariance allows us to deduce that the values obtained on the scale and its factors will be comparable between men and women. Thus, the scale showed to be valid for use in both men and women, allowing researchers and professionals to compare the results of PREU of men and women, as well as the relationships of PREU with other variables that are established for men and women.

Moreover, as expected, the results demonstrated that, in comparison with men, women perceive higher risk regarding environmental unsustainability as a whole and regarding both the risk for themselves and their family and the risk for the planet. These results are coherent with previous studies reporting that women are more concerned with sustainability than men (Gökmen, 2021; Hampel et al., 1996; Mifsud, 2012; Singh & Gupta, 2013), and that women generally tend to perceive higher risks than men (Finucane et al., 2000; Gustafson, 1998), giving additional support to the validity of the scale.

### 5.4 Study limitations and future lines of research

After analyzing the main results of this study, we must consider the main limitations that we may encounter. On the one hand, this is a correlational and cross-sectional study, i.e., at a single point in time; therefore, it does not allow us to establish causal relationships between variables. Thus, a possible future research line would be to replicate the study with a longitudinal sample, in order to observe whether the relationships are maintained at different points in time.

Moreover, although it was decided to develop a scale focused on the most affective dimension of risk perception, leaving aside the more cognitive dimension, which refers to perceived probability that the risk becomes a reality, it should be noted that future studies could aim to expand the present scale by including the cognitive dimension. This would allow researchers and professionals to measure both dimensions in a single instrument and thus study the potentially differential relationship established by these two dimensions of risk perception in variables as relevant as sustainable behavior.

Additionally, although we included the three dimensions of sustainability (the three Ps) in PREUS, as we intended to generate a short scale, we only included a few items regarding

each of those dimensions. Nevertheless, a tool with at least three items regarding each of the three dimensions of sustainability in both the ecocentric and the anthropocentric factors could have resulted in a bifactorial scale with three subfactors each, allowing researchers and professionals to explore which of those three sub-factors people perceive as riskier for themselves and for the planet. This inclusion of more items regarding the three dimensions of sustainability in each factor of the scale could be an interesting topic for future lines of research.

## 5.5 Policy recommendations

Finally, regarding policy recommendations, PREUS could be useful not only for researchers, but also for practitioners of the environmental education field, who could use the scale to assess the level of PREU in the general population in order to better encompass the psychosocial interventions oriented to foster sustainable behaviors. Moreover, it would be interesting to test the level of PREU of environmental educators, since this level could be related to their specific actions and policies regarding environmental sustainability.

## 6 Conclusions

We are currently immersed in a glaring environmental crisis that affects not only our natural environment, but basically everything on the planet, including ourselves, as its inhabitants. At present, climate change has become the main environmental problem identified by citizens (Kull, 2007; Moyano-Diaz and Palomo-Velez, 2007; Directorate-General for Communication of the European Union, 2008). We are at a crucial crossroads to become aware of the environmental problems we face, which is why it is necessary and relevant to take up the perception of risk associated with environmental unsustainability as an object of study.

With this in mind, this study designed and validated a scale to measure the perception of risk associated with environmental unsustainability. The validation of PREUS confirmed the expected relationship between knowledge of environmental sustainability, attitudes towards sustainability, perceived responsibility towards environmental unsustainability, and the population's relationship with sustainable behavior, all this considering the bifactorial nature of our scale, encompassing the dimension of risk perception towards oneself and one's family, and, on the other hand, the dimension of risk perception for the planet.

This study provides a brief, easy-to-complete, reliable, valid and gender-invariant instrument that can be useful to researchers and educators to assess the extent to which individuals perceive the risk of environmental unsustainability to themselves and their families, and to the planet.

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**Author contributions** JA-M and EC conceived and designed the study, analyzed, and interpreted the data, wrote the paper, and supervised the study. They have full access to all the data and take responsibility to the integrity of the data and the accuracy of the data analysis. EMM-J took an active part in the drafting of the manuscript and the data collection. JT-P helped to conceive and design the study and to interpret the data and revised the manuscript. IMM-G helped to conceive and design the study and to collect the data and revised the manuscript.

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**Data availability** Data are available at Mendeley Data (<https://doi.org/10.17632/8p866htg4.1>).

## Declarations

**Conflict of interest** No potential conflict of interest was reported by the authors

**Ethical approval** The study was approved by the Ethics Committee of the University of Córdoba through code CEIH-22–52. All participants gave their consent to participate.

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