Journal of Outdoor Recreation and Tourism 37 (2022) 100486

Contents lists available at ScienceDirect

Journal of Outdoor Recreation and Tourism

journal homepage: www.elsevier.com/locate/jort

Do risk perception and safety of sites influence rock climbing destination choices?

Maria De Salvo [a,b,*], Gianluca Grilli [c,d], Sandra Notaro [e], Giovanni Signorello [a,b]

[a] University of Catania, Department of Agriculture, Food and Environment, Catania, Italy
[b] Centre for the Conservation and Management of Nature and Agroecosystems (CUTGANA), Catania, Italy
[c] Economic and Social Research Institute, Dublin, Ireland
[d] Trinity College Dublin, Dublin, Ireland
[e] University of Trento, Department of Economics and Management, Trento, Italy

ARTICLE INFO

Keywords:
Rock climbing
Risk
Safety
Hybrid discrete choice experiment

ABSTRACT

The risk of incurring an injury may affect climbers' destination choices for rock climbing, depending on their perceptions about the associated risk and the likely gravity of injuries, and the extent to which they regard the level of protection as a key feature in determining the climbing site's attractiveness. In this study, we conducted a discrete choice experiment and employed a hybrid discrete choice econometric model to investigate whether climbers correctly perceive climbing risks; whether the perceived probability of incurring a slight, severe, or fatal injury affects their choice of climbing site; and whether their preferences for a destination and their risk perceptions are heterogeneous. Further, we estimated monetary preferences for marginal changes in the protection level and when subjective risks equal objective risks. The results indicate a difference between perceived and actual risks in cases of slight or severe injury and a negative relationship between willingness to climb and perceived risk, such that individuals prefer to avoid climbing when perceived risks are high and are willing to pay a reasonable amount for marginal increases in the level of protection of sites. Further, their preferences for site safety are heterogeneous.

Management implications: This study highlights critical aspects that need to be considered by natural site managers to prevent accidents and ensure the safety management of outdoor climbing recreation. The main findings are as follows:

- Actual and perceived risks in rock climbing generally diverge, but with a modality that depends on the type of injury anticipated (i.e., slight, severe, or fatal). On average, climbers underestimate the risk of incurring slight injuries and overestimate the risk of incurring severe injuries.
- The choice of site at which to climb depends on risk perception, and this relationship (on average) is negative. Further, attitudes to risk decrease with increased stated risks of being slightly, severely, or fatally injured.
- Across climbers, preferences and risk perception are heterogeneous. Heterogeneity depends on the gender, age, and experience of the climbers.
- Climbers are willing to take risks. However, they also are willing to pay to reduce risk.

* Corresponding author. University of Catania, Department of Agriculture, Food and Environment, Catania, Italy.
E-mail address: maria.desalvo@unict.it (M. De Salvo).

https://doi.org/10.1016/j.jort.2022.100486
Received 20 May 2021; Received in revised form 27 December 2021; Accepted 2 January 2022
Available online 7 January 2022
2213-0780/

1. Introduction

Rock climbing[1] is an extreme outdoor recreation activity that typically occurs in unique environmental settings, such as cliffs, talus, glaciers, and boulder fields (Pyke, 2001). The growing popularity of this activity in several countries[2] presents a new challenge for local natural resource managers: they must not only strike a balance between the value provided by sites for different groups in society, by identifying trade-offs between providing access for climbing purposes and preserving the natural character of the sites, but also need to ensure reasonable conditions that will prevent injuries or harm to climbers (Athearn, 2005; Draper et al., 2011; Grijalva & Berrens, 2003; Kovacs et al., 2021; McMillan & Larson, 2002).

To manage hazards in rock climbing effectively, as well as in any other recreation activities, possible risks should be identified, assessed, and mitigated (Haddock, 2004). Managers have a responsibility to provide safe natural assets, from both an ethical and a legal perspective (Ghelichipour & Muhar, 2008; Gstaettner et al., 2017; Lalasz, 2013; McDonald, 2003). Thus, they are involved in defining policies, procedures, and guidelines for operation, and in identifying training and equipment that can either help prevent accidents in the future or improve leaders' ability to respond to any accidents that may recur (Gstaettner et al., 2017; Visitor Safety Group, 2011).

To fulfill these commitments, managers usually rely on information related to the occurrence of accidents, their severity, and associated costs. Numerous studies have addressed these issues (e.g., Athearn, 2005; Schoffl et al., 2010). However, to align the needs of climbers with actions that make wilderness sites safer, managers should also be aware of the effects of risk perception and safety aspects on climbers' behavior (Haegeli & Probstl-Haider, 2016; Jones & Yamamoto, 2016), the factors that influence climbing destination choices, and the economic benefits accruing to climbers from the reduction of injury risk in rock climbing.

Further, rock climbing is considered a typical "sensation-seeking" outdoor recreation activity (Zuckerman & Kuhlman, 2000). Sensation seeking has been defined as the "the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience" (Zuckerman, 1994, p. 27). According to Zuckerman (2007), sensation seeking has a multidimensional articulation. It includes the following traits: (i) thrill and adventure seeking, which represents the desire to engage in physical activities or sports that are sometimes risky but provide unusual sensations of speed or defiance of gravity; (ii) experience seeking, which involves seeking sensations and experiences through the mind and the senses, such as through music, art, or travel, and social nonconformity and unconventionality; (iii) disinhibition, which considers seeking sensations through social activities, sex, and drinking, and associating with people who share these hedonistic preferences; and (iv) boredom susceptibility, which represents an intolerance for repetitious experience or predictable and unexciting people. The literature has demonstrated that sensation seeking, in general, and its thrill and adventure-seeking dimension, in particular, significantly explain participation in risky sport (Woodman et al., 2020).

As with other risky activities, in rock climbing, sensation seeking depends on the individual's risk perception and risk-taking behavior. Taylor et al. (2006) investigated factors influencing physical risk-taking behavior in rock climbing and demonstrated that this behavior has a significant positive relationship with both total sensation seeking and its thrill and adventure-seeking dimension. Moreover, it appears that risk-taking and disinhibition are strongly related, since it has been found that the latter leads to engagement in physical risk. However, Taylor et al. (2006) demonstrated that sensation-seeking dimensions differ between groups of climbers with low and high risk-taking levels.

In addition, Llewellyn and Sanchez (2008) suggested the existence of a circular risk–motivation mechanism, which implies that as climbing experience increases, there is a progressive involvement in risk-taking and the further development of the skills and ability to assess risks. Increased capacities create a better perception of control in the climber and decrease the chance of serious risk associated with climbing. Expert climbers show a controlled cycle of mastery, rather than reckless risk-taking behavior, which is, instead, the typical behavior of less expert climbers, demonstrating that rock climbing is a safe activity when the climber has received appropriate training and correctly practices climbing.

An array of empirical research has examined injuries caused by rock climbing. The risk of incurring slight injuries seems to be high, ranging between 60% and 74% (Gerdes et al., 2006; Neuhof et al., 2011), whereas the risk of incurring severe injuries appears to be less significant. Schoffl et al. (2003), for instance, estimated that a severe injury rate is almost nonsignificant (0.8%). Nevertheless, data on fatality risks are conflicting. Bowie et al. (1988) reported a case fatality rate of 6%. Addiss and Baker (1989) and Schussman et al. (1990), by analyzing data regarding mountaineering and traditional climbing, estimated a higher risk of fatalities, ranging from 23% to 28%. In contrast, Schoffl et al. (2010), through an epidemiological analysis of sport-specific injury in rock, indoor, and competition climbing, documented that the death rate in rock climbing approximates to zero, even though the risk of death persists, and that accidents in snow and ice activities are more likely to be fatal.[3]

Nevertheless, Kraus et al. (1992), Covello et al. (2012), and Charlton et al. (2014) have indicated that the levels of perceived (subjective) risk and actual (objective) risk significantly differ. Campbell et al. (2002), Mu and Nepal (2016), and Cavasos and Bhat (2020) have also shown this gap in studies on risks in outdoor recreational activities.

Many studies have provided evidence on the way climbers perceive risk and the effects of this perception on their climbing destination choices and their welfare gains from reduced injury risk. However, the literature does not provide unified knowledge on all these issues. Llewellyn and Sanchez (2008), Martha et al. (2009), and Caber and Albayrak (2016) examined climbers' awareness and attitudes toward risks and showed that perceived risk among climbers varies, and the heterogeneity depends on the climber's profile, experience, and capacity in climbing, and personal injury experience. Demirhan (2005), Robinson (2008) and Riddel and Kolstoe (2013) reported on factors that affect climbers' risk perception. Hanley and Wright (2003), Grijalva et al. (2002), Scarpa et al. (2003), and Scarpa and Thiene (2005) investigated the site attributes that affect climbers' destination choice. Nicita et al. (2018) showed that the benefits of rock climbing depend on site safety.

In this study, we focus on climbers' awareness of, and attitudes

[1] Rock climbing embraces four distinct disciplines. In order of risk factor, from the lowest to the highest, they are as follows: (i) bouldering; (ii) sport climbing (iii) traditional (trad) or alpine climbing(iv) free solo (Rugg et al., 2020).

[2] During 2016–2019, the number of climbing participants in the United States rose from 6.21 million to 9.89 million. Similar trends have been recorded in the United Kingdom and Japan (https://www.statista.com).

[3] Data on actual risks provide proof that other extreme sports are more dangerous than rock climbing, even if the related risk appears to be lower. According to statistics for the United Kingdom, for instance, the annual risk of death because of climbing is equal to 1 in 320,000 climbs, whereas it is much higher in hang gliding flights (1 in 116,000) or in scuba diving (1 in 200,000; UK Health & Safety Executive, 2009). Schoffl et al. (2010) proved that hockey is much more dangerous than all climbing subdisciplines: In hockey, the number of injuries per 1000 h ranges between 150 and 283, and in ice climbing, which is the most dangerous climbing subdiscipline, the number of injuries per 1000 h equals 4.07. However, recently, Gatterer et al. (2019), after reviewing the literature on the mortality rate in different mountain sport activities, reported average annual death rates per 1000 people at risk, ranging between 0.3 and 0.6; the risk increases significantly for high-altitude climbing, reaching peak mortality rates of 6–45 per 1000 people at risk.

Table 1
Attributes and levels.

Attributes (site characteristics)	Levels
Crowding on the climbing route	Not crowded/crowded
Travel distance from your home (in kilometres)	50 - 100–150 - 200 - 250
Number of routes you can climb	10 - 30–50 - 70 - 90
Protection	- 30% less protection than your expectation; - 15% less protection than your expectation; - your expectation[a]; - 15% more protection than your expectation; - 30% more protection than your expectation.

[a] Please consider "your expectation" as the average protection level you expect when you go climbing.

2. Materials and methods

2.1. Experimental design and data

Data were collected through a questionnaire[4] that entailed a DCE. The DCE was designed and implemented as far as possible according to best practice protocols (Riera et al., 2012). The questionnaire had two parts. The first part contained questions on the attitudinal and socio-economic characteristics of the climbers. The second presented the choice experiment. Attributes and levels describing sites for rock climbing were identified by referring to previous studies (Hanley & Wright, 2003; Scarpa et al., 2003; Scarpa & Thiene, 2005) and were tested in focus groups.

Four attributes were used to define rock climbing site characteristics: (i) crowding on the climbing route; (ii) travel distance from home; (iii) number of routes, that is, the paths from the ground up to the top available to climb the cliff; and (iv) the level of protection. The fourth attribute refers to the average safety level of the site that climbers expect when they climb. The levels were set as equal, lower, or higher than the respondents' safety expectations. In the econometric analyses, the travel distance from home was converted to travel cost (e.g., out-of-pocket expenses)[5] by applying a coefficient of €0.18/km. Table 1 reports the attributes and the levels used to identify alternatives.

Given the characteristics of site A and B, which one would you prefer to visit?

Site Characteristics	Site A	Site B
Crowding on the climbing route	Not crowded	Crowded
Travel distance from your home	200 km	150 km
Number of routes you can climb	30 routes	10 routes
Protection	15% less protection than your expectation	30% more protection than your expectation
I would prefer site A	I would prefer site B	None

Fig. 1. Example of choice card.

toward, risks to detect whether and how much climbers' risk perception affects their choice of climbing site and the benefits accruing to them from climbing in safer places. To accomplish these goals, by using an integrated and simultaneous framework, we analyzed climbers' stated preferences in a discrete choice experiment (DCE) through a hybrid discrete choice (HDC) model (Alvarez-Daziano & Bolduc, 2011; Ashok et al., 2002; Ben-Akiva, McFadden et al., 2002; Ben-Akiva, Walker, et al., 2002; Bolduc et al., 2005; Tam et al., 2010; Vredin-Johansson et al., 2006). The HDC model allowed us to investigate choices by climbers among sites with several different characteristics, including the level of protection; whether climbers correctly perceived climbing risks in the hypothesized occurrence of a slight, a severe, and a fatal injury; whether, and to what extent, the perceived probability of incurring an injury affected the choice of site to climb; the factors related to climbers' experience, ability, and socioeconomic characteristics that significantly explain risk perception; the size and sign of monetary preferences for marginal changes in the level of protection; and the value of welfare measures when subjective risk coincides with a real risk of injury.

To combine attribute levels into profiles of alternatives, we used a sequential D-efficient design (Bliemer et al., 2008; Ferrini & Scarpa, 2007). We identified the priors for a first D-efficient design to use in the final survey from the literature on rock climbing motivations and risk perceptions (Hanley and Wright; 2003; Scarpa & Thiene, 2005). We used this design to generate the choice cards included in the questionnaire completed by the first subsample (N = 223). We used the priors estimated using the data of this subsample to improve the efficiency of the design, and therefore to build new and more efficient level combinations, which we presented to the second subsample (N = 223). We prepared all experimental designs using Ngene software (ChoiceMetrics, 2014).[6] The design generated 15 combinations (choice cards), which we

[4] Incentives were not used in the experiment.
[5] This value corresponds to estimates of vehicle operating costs per km per person (Italian Automobile Association, 2020).
[6] The final D-error, widely considered as a measure of efficiency (see Mariel et al., 2021) was equal to 0.069.

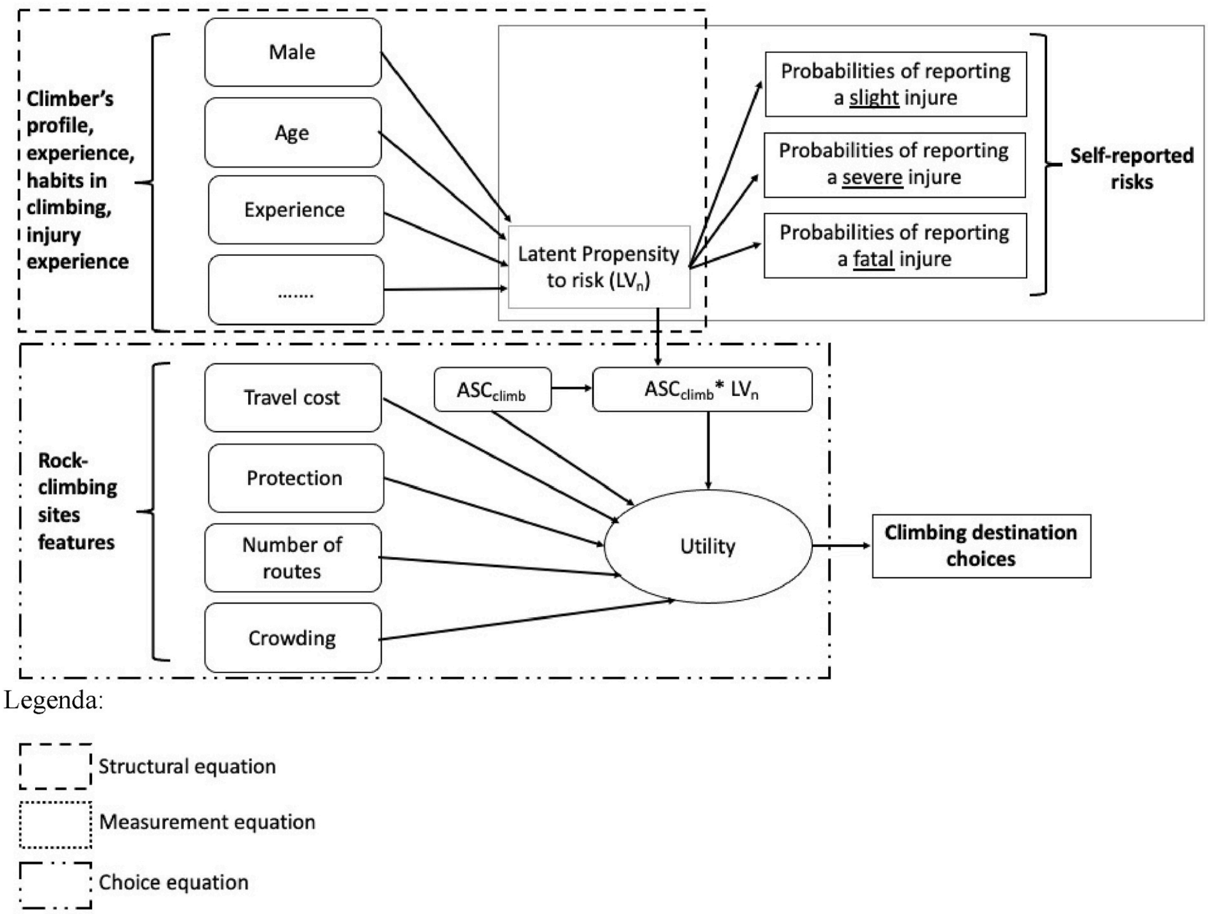

Fig. 2. Structure of the HDC model.
Source: adapted from Giansoldati et al. (2020).

separated into five blocks. We asked respondents to complete three choice cards, choosing each time among three alternatives, two hypothetical alternatives, and one opt-out option. Fig. 1 provides an example of the choice cards used.

The final data used in this study were provided by 446 respondents: 223 respondents were intercepted through a self-administered survey in 2016 during the San Vito Climbing Festival, an annual international festival held in Sicily (Italy) that brings together hundreds of climbers from all over Europe. The remaining half of the sample was intercepted by means of online interviews in 2019 using a LimeSurvey tool. We recruited online participants from Facebook climbers' groups visiting Italian sites. During the first stage of the interviews, each interviewer introduced the survey to each respondent by reading a survey presentation. Then, each climber self-completed the questionnaire (self-administered survey). The same survey description was used to introduce the online survey. All information was collected from the respondents' declaration through the questionnaire, including about demographics, abilities, and perceptions. We conducted multiple analysis of variance to test the statistical equivalency between the two subsamples for all the variables related to the climbers' profiles, experience, capacity in climbing, injury experience, and perceived risk.

To analyze the stated preference data, we built and estimated an HDC model. The HDC model is used widely for several purposes in different fields. For example, recently, it was used to integrate individual characteristics and situational characteristics in the context of prospective visits to a wild reindeer center (Lindberg et al., 2019); to explore the role of the theory of planned behavior in the context of preferences for the decentralized governance of natural resources (Grilli & Notaro, 2019); to explore the influence of general environmental attitudes and place identity perceptions on the willingness to pay (WTP) for ecosystem services (Faccioli et al., 2020); and to investigate preferences for COVID-19 vaccines in the United Kingdom (McPhedran & Toombs, 2021).

The HDC model is increasingly popular owing to its ability to incorporate psychological and attitudinal information in traditional discrete choice modeling using latent variables. Indeed, the HDC model is able to solve potential biases due to the inclusion in the utility function of attitudinal factors measured through self-reported indicators (Hensher et al., 2015). In this study, we used the HDC model to account for the fact that risk propensity is a latent attitude of individuals. When respondents were asked to rate the expected risk in terms of the probability of occurrence of a certain dangerous event while climbing, what was captured was a proxy of their "real" perceived risk and not the risk itself. Therefore, these indicators of the risk are subject to measurement errors, which makes them correlated with the error term and endogenous with respect to the dependent variable. For this reason, the common solution adopted in standard econometric models, such as the multinomial logit model or random parameter models, of including self-reported risk in the deterministic component of utility through the interaction with the alternative specific constant (ASC) was not appropriate (Boyce et al., 2019; Faccioli et al., 2020). Hensher et al. (2015) referred to self-reported indicators as "soft" variables, and recent developments in choice analysis indicate that HDC models are more appropriate for incorporating the effects of these indicators on stated preferences (Bolduc et al., 2005; Vij & Walker, 2016).

The HDC model is based on three sets of simultaneous equations: the choice, structural and measurement equations (Ben-Akiva, McFadden et al., 2002). These three components are connected through latent variables that enter as predictors of both the choice equation and the measurement equation, and as dependent variables in structural equations.

As Fig. 2 shows, our HDC model relies on a set of three structural equations that include three indicators, which are respectively related to the self-rated probabilities of reporting a slight, a severe, or a fatal injury. The discrete choice equation and structural equations are linked by a latent variable that captures individual propensity for risk, which is assumed to be dependent on the climber's profile, experience, and habits in climbing, and injury experience. The propensity for risk affects the self-reported risks of the occurrence of a slight, severe, and fatal injury, as determined by the measurement part of the HDC model. To identify the climber's utility for alternatives that does not depend on characteristics, we interacted the latent variable with the ASC related to the climbing experience (ASC_{climb}).

In our HDC framework, the equation related to the choice part of the model follows the random utility model approach (McFadden, 1974). To account for the latent perceived risk of an injury, we specified the determinist component of utility ..as follows:

$$V_{int} = \beta^{'} X_{int} + \beta_0 ASC_{climb} + \beta_1 ASC_{climb} * \ LV_n \tag{1}$$

where the deterministic component is a linear combination of a matrix of attributes of a climbing site X_{int}, a vector of coefficients to be estimated $\beta^{'}$, and the ASC that identifies choices that imply climbing (ASC_{climb}). Moreover, we included the interaction between the ASC_{climb} variable with LV_n, where LV_n is the value of the individual-specific latent (not observed) variable.

For the utility function, we assumed a fixed coefficient for the travel cost variable and normally random distributed coefficients for the other variables related to site characteristics, for the ASC_{climb}, and for the ASC_{climb} interacted with LV_n. We expect that when the latent perceived risk is high, respondents are less likely to go climbing. Therefore, the interaction coefficient β_1 should be negative.

The structural equation assumes that the latent variable depends on a set of sociodemographic characteristics:

$$LV_n = l(\boldsymbol{Z}_n, \boldsymbol{\gamma}) + \eta_n \tag{2}$$

where LV_n is the value of the latent variable for the n-th individual, $\boldsymbol{Z}_n$ is a set of sociodemographic characteristics, $\boldsymbol{\gamma}$ are coefficients to be estimated that represent the effect of $\boldsymbol{Z}_n$ on LV_n, and η_n is the error term, assumed to be normally distributed with zero mean and unit variance. Sociodemographic characteristics are related to the climbers' profile, experience, habit, and so on, as Fig. 2 shows. These covariates were assumed to linearly affect LV_n.

Last, the measurement part of the model was composed by M equations, one for each indicator of self-reported risk of an injury (risk of being slightly, severely, or fatally injured), where LV_n enters as a predictor. Each equation was specified as:

$$I^*_{nm} = \rho_m LV_n + \rho_0 + \upsilon_{nm}, m = 1,2,3 \tag{3}$$

where I^*_{nm} is the value of the m-th indicator of risk for the n-th climber, ρ_m is the coefficient expressing the influence of LV_n on the m-th indicator, ρ_0 is a constant, and υ_{nm} is the error term.

Indicators were collected as probabilities in the (0,1) range, for which the beta regression model is appropriate. Beta regression assumes that the dependent variable ranges in the standard unit interval, and it is particularly useful for rate and proportion data because it naturally accommodates heteroscedasticity and asymmetries, which are typical of these data types (Ferrari & Cribari-Neto, 2004). Following Cribari-Neto and Zeileis (2009), the log-likelihood of a beta regression model was specified as follows:

Table 2
Summary statistics.

Variable	N = 446	
	Mean	Standard deviation
Age (in years)	36.21	10.73
Male (1 if yes)	0.55	0.50
Body Mass Index (BMI)[a]	22.43	6.28
Educational level (in years)	15.04	3.41
Climbing experience (in years)	9.59	10.38
Engaged in climbing training courses (1 if yes)	0.62	0.49
Grade generally leaded is higher than 6c (1 if yes)	0.30	0.46
Alone (1 if yes)	0.04	0.20

[a] BMI is calculated as the person's weight in kilograms divided by the square of height in meters. The "normal range" is 18.5–24.9 kg/m^2.

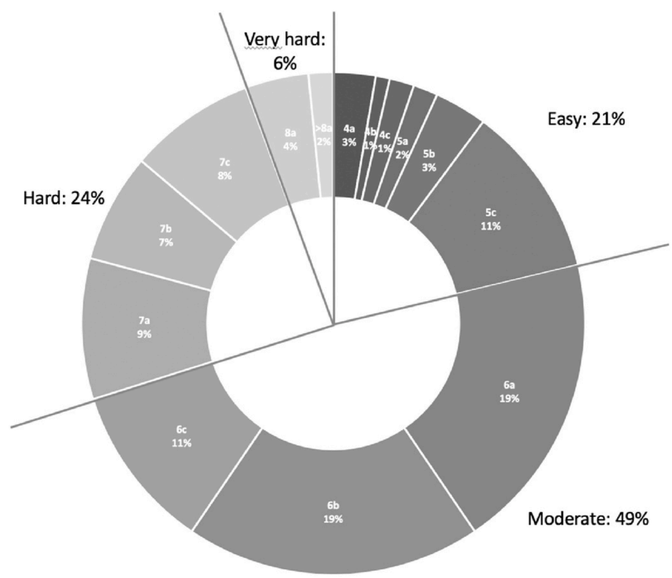

Fig. 3. Grade normally climbed by respondents.

$$LL(I^*_{nm})_{beta} = \log \Gamma(\varphi) - \log \Gamma(\mu_n \varphi) - \log \Gamma((1-\mu_n)\varphi) + (\mu_n \varphi - 1)\log(I^*_{nm}) + \{(1-\mu_n)\varphi - 1\} log(1 - I^*_{nm}). \tag{4}$$

where Γ is the gamma function, φ is the precision parameter that indicates the variance of the data,[7] μ_n is the mean of the distribution, which is parameterized using the logit link $\mu_n = 1/(1 - \exp(\rho_m LV_n + \rho_0)$, and I^*_{nm} is the answer to the m-th risk indicator.

To obtain a consistent and simultaneous estimation of the three parts of the HDC model, the following joint likelihood function was formulated:

$$LL = LL(RPL)_{ni} + LL(I^*_{nm})_{beta}. \tag{5}$$

The HDC model was programmed in R (R Core Team, 2013) using 5000 Sobol draws to simulate random parameters and the error term of LV_n.

The values for marginal willingness to pay (MWTP), which represents the additional amount that climbers are willing to pay for one more

[7] The variance of the distribution of the response variable is smaller (larger) for large (small) values of φ.The inverse parameter φ^{-1} is instead a dispersion parameter.

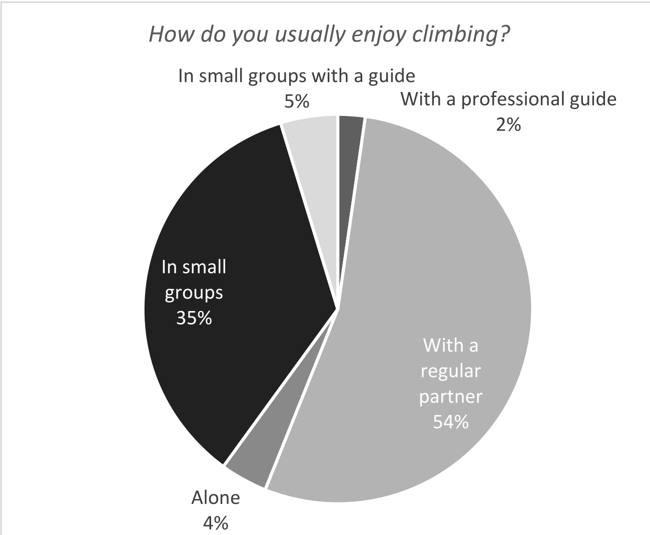

Fig. 4. Respondents' habit in enjoying climbing between alone vs. others modalities.

groups (35%) (see Fig. 4). The presence of a guide was appreciated only by a minority of respondents (2%), even when climbing in a small group was considered (5%). The possibility of practicing climbing in the alone modality was not particularly attractive (4%).

A high percentage of respondents (82%) stated they had acquaintances with experience of slight or severe injuries while rock climbing, and approximately half of them (42%) had been slightly or severely injured. Respondents who stated they had been in a very dangerous situation while rock climbing comprised approximately one-third of the sample (28%) (see Fig. 5).

In terms of the subjective perception of injury risks, the probability of being slightly injured while rock climbing in an average year is judged to be 36% (SD: 26%) and decreases respectively to 15% (SD: 18%) and 5% (SD: 11%) in the case of severe or fatal injury (see Fig. 6).

Estimates of the HDC model are presented in Table 3, in which the first panel includes coefficients of the choice equation. As expected according to economic theory, the cost coefficient is negative and statistically significant, which indicates that the utility of a certain climbing site decreases with increasing cost of travel. The number of climbing routes is positive and significant, suggesting that respondents prefer a larger number of routes. The coefficient associated with crowding is negative but not significant, whereas the standard deviation is signifi-

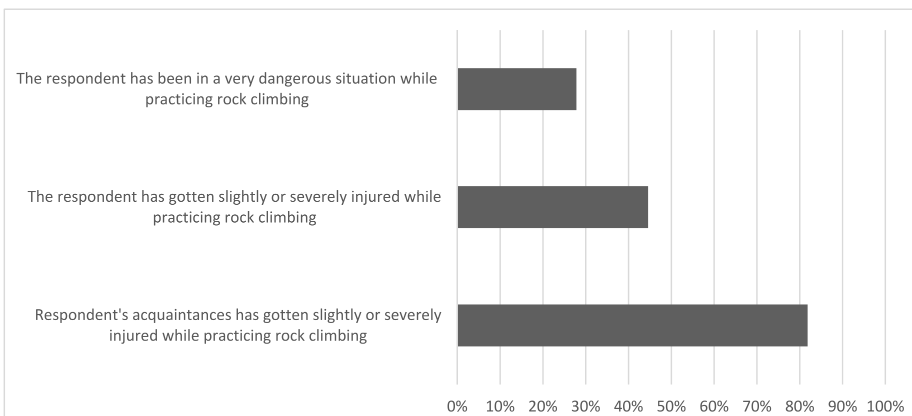

Fig. 5. Injury experience.

unit of a particular feature, were estimated along with 95% confidence interval using the Krinsky–Robb procedure (Krinsky & Robb, 1986).[8]

3. Results

The sample predominantly consisted of male (55%), educated, and "in health" climbers. A large majority (62%) of the climbers engaged in training courses and had practiced this sport for approximately 10 years. Table 2 reports the sample summary statistics.

The reached grade, measured with the Fontainebleau grading scheme[9] (see Fig. 3), was moderate (49%), ranging between 6a and 6c. The rest of the sample is split between easy level (e.g., lower than 6a; 21%) and hard or very hard level (e.g., higher than 6c; 30%). Generally, the climbers preferred climbing with a regular partner (54%) or in small

cant. This result indicates that respondents' preferences are heterogeneous with respect to crowding on the climbing route. The attribute capturing preferences for protection is positive and significant, which means that climbers' utility increases as the level of protection increases, even though the standard deviation indicates preference heterogeneity across respondents. The ASC_{climb} variable, which is the main variable of interest for the analysis of risk preferences, is positive for the main effect. This result indicates that respondents are better off with the alternatives that include climbing options not contained in the described alternatives. The coefficient associated with the interaction of ASC with LV_n, as expected, is negative. Because the variable LV_n captures the latent perception of climbing risk, its negative sign indicates that respondents are less likely to choose climbing options at increasing levels of perceived risk, given that perceived risk reduces satisfaction.

The second panel of Table 3 reports the estimates of the structural part of the equations related to personal variables that affect the latent propensity for risk. The estimates indicate that LV_n is explained by gender, age, and experience (i.e., if the climbing grade normally achieved is higher than 6), which reveals that there are several sources of heterogeneity across climbers in risk perception. Interestingly, knowing people injured while climbing does not affect the latent individual risk perception. The third panel of Table 3 reports the estimates of measurement equations. The coefficient of LV_n is negative and statistically

[8] The procedure implies taking a large number of draws from the multivariate normal distribution represented by the variance and covariance matrix of the estimated coefficients. Here, we relied on 10,000 draws to obtain an equal number of simulated values of MWTP. We sorted these values in ascending order and dropped the top and bottom 2.5% of the distribution to estimate the 95% confidence interval around the mean.

[9] This grading is the most widely used in Europe and adopts an open-ended numerical system that ranges from 1a to 9a.

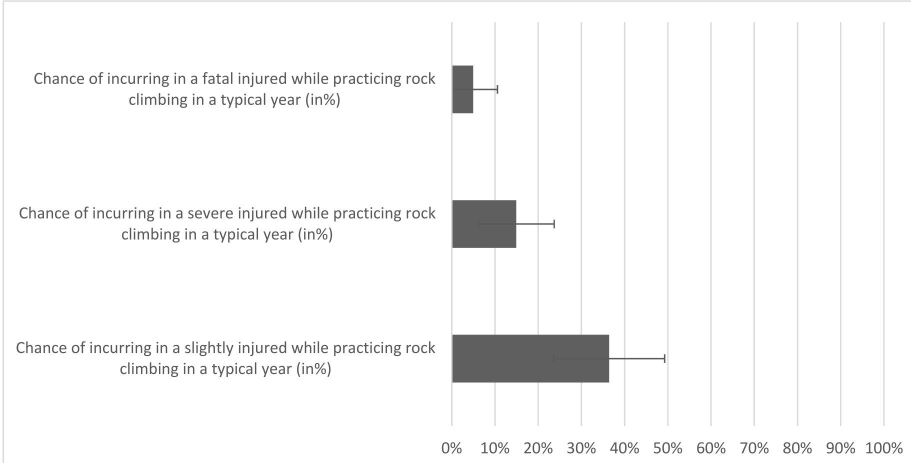

Fig. 6. Subjective perception of injury risks.

Table 3
Estimates of the HDC model.

	Mean	Standard Error	Standard Deviation	Standard Error
Choice model				
Fixed parameter in the utility function:				
Travel Cost	−0.02972***	(0.003)		
Random parameters in the utility function:				
Number of routes	0.01615***	(0.002)	0.00009	(0.004)
Crowding	−0.07802	(0.149)	1.92004***	(0.214)
Protection	1.8796***	(0.307)	1.86273***	(0.699)
ASC_{climb}	7.10583***	(1.274)	0.00133	(0.923)
ASC_{climb} x LV_n	−0.07714***	(0.020)	0.00008	(0.006)
Choice model LL	−1092			
AIC	2207			
BIC	2264			
Structural equation (LV_n)				
Constant	33.40075***	(1.738)		
Male	4.30205**	(2.059)		
Age	0.34522***	(0.114)		
Accidents of friends	−0.16091	(1.632)		
experience6+	8.02669***	(1.604)		
LV_n error	−22.47895***	(4.368)		
Measurement equations (I^*_{nm})				
Risk of a slight injury:				
LV_n	−0.03381***	(0.007)		
Constant	1.38779***	(0.419)		
Φ	3.24113***	(0.215)		
Risk of a severe injury:				
LV_n	−0.06808***	(0.013)		
Constant	1.42048*	(0.770)		
Φ	54.76147***	(3.675)		
Risk of a fatal injury:				
LV_n	−0.02096***	(0.005)		
Constant	−1.48377***	(0.270)		
Φ	5.12298***	(0.437)		
Observations	1338			
Respondents	446			

* p-value <.1, ** p-value <.05, *** p-value <.01.

Table 4
Estimates of Marginal Willingness to Pay (MWTP) for the attributes of sites.

Attribute	MWTP (€)
Number of routes	0.54 (0.40–0.70)
Crowding	−2.68 (-12.5–7.5)
Protection	63.1 (43.37–87.13)
ASC_{climb}	238.9 (157.7–326.3)
ASC_{climb}*LV_n	133.9 (65.9–204.4)

Note: 95% confidence interval in parenthesis.

significant in all three equations. This result signals that the attitude to risk decreases with increasing stated risk of being slightly, severely, and fatally injured.[10]

Table 4 contains the values of MWTP for the attributes of rock-climbing sites based on the coefficient estimates provided by the HDC model. The MWTP for the interaction term ASC_{climb}* LV_n was estimated by considering the individual values of LV_n for each respondent. The MWTP is positive and high for protection, negative for crowding, and slightly positive for the number of routes. In particular, if the level of protection improves by 1% with respect to the climbers' expectations, the MWTP, on average, rises by €63.1 (confidence interval at 95%: [43.37, 87.13]); whereas if the site is crowded compared with an un-crowded site, the MWTP, on average, decreases by €2.68 (confidence interval at 95%: [−12.5, 7.5]). Last, if the number of routes improves by one, the MWTP, on average, increases by €0.54 (confidence interval at 95%: [0.40, 0.70]).

The WTP for climbing is very high when considered without LV_n, whereas the inclusion of LV_n lowers the WTP considerably: the MWTP, on average, decreases from €238.9 (confidence interval at 95%:

[10] We also estimated a latent class model, in which we fixed the TC coefficient estimate among classes, and included the ASC for climbing, its interactions with the individual perception of occurrence of a slight, severe, and fatal risk, and those covariates that were significant in the hybrid model (experience6+, Age, Male, Accidents of friends) to investigate class membership. Although the theoretical framework of the LC model differs from that of the HDC model and comparisons have to be made with caution, the results highlight preference heterogeneity between classes for all random attributes in terms of magnitude, sign, and significance.

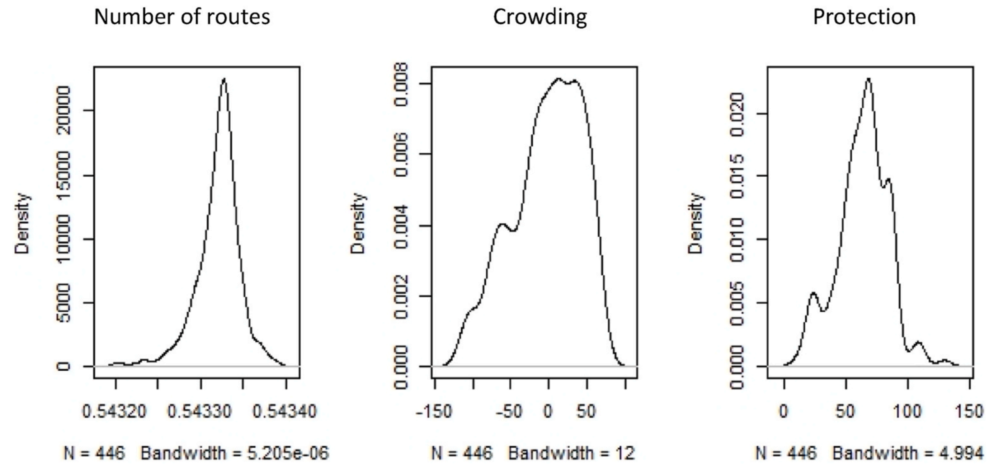

Fig. 7. Individual-specific MWTP distributions.

[157.7–326.3]) to €133.9 (confidence interval at 95%: [65.9, 204.4]). This result suggests that subjective risk probabilities play a significant role in preferences for climbing because they negatively affect the MWTP.

Fig. 7 displays the posterior MWTP distributions for the random attributes. For the "number of routes," the posterior MWTP distribution is located totally in the positive range and is unimodal with a longer tail on the left. The attribute "protection" also shows a positive posterior MWTP distribution even if it is multimodal with several peaks. Last, the graph related to "crowding" shows both positive and negative MWTP values. This distribution is multimodal and presents a higher density in the negative range of the MWTP.

Fig. 8 displays the MWTP distribution for ASC_{climb} and for the interaction term $ASC_{climb}* LV_n$. The distribution assumes a level of LV_n equal to one. Both distributions are unimodal, and their skewness differs. The distribution of ASC_{climb} is skewed to the left, whereas the interaction with LV_n is skewed to the right. The mean of ASC_{climb} is positive, which indicates that respondents are willing to pay for climbing. The negative mean of the interaction between ASC_{climb} and LV_n indicates that the WTP decreases when the latent subjective risk increases. The distribution of ASC_{climb} is leptokurtic compared with the distribution of the interaction with LV_n. This result suggests that preferences for climbing are generally similar across the sample, but when the latent subjective risk is taken into account, preferences tend to be more heterogeneous. In other words, the impact of subjective risks while climbing is unequal across the sample of respondents: different subjective risks lead to different effects on the MWTP.

Table 5 reports the WTP values associated with some probabilities of being injured while climbing. We relied on probability assessments provided by previous studies. Gerdes et al. (2006) and Neuhof et al. (2011) estimated a risk of a slight injury in the range of 60%–74%. Using this range, the WTP for climbing varies, on average, between €101 and €52. Schoffl et al. (2003) estimated a risk of a severe injury of 0.8%. At this probability level, we estimated that the WTP equals €368. Last, when the subjective risk of death of the sample is in the 0%–6% range, as indicated by Bowie et al. (1988), the WTP ranges between €1277 and €763. In general, lower risk values are associated with higher WTP values.

4. Discussion and conclusion

To assure reasonable safety at natural sites used for rock climbing, natural resource managers should have information concerning how climbers, when selecting their destination, perceive risk and take safety attributes into account. To provide this type of information, we implemented an HDC model to analyze data generated by a DCE. In the model, we addressed the difference between subjective and objective risks in rock climbing, the relationship between the perceived probability of incurring an injury and the choice of the site at which to climb, and how experience, ability, and climbers' socioeconomic characteristics explain individual risk perception heterogeneity. We also estimated the values of MWTP for sites' attributes, including the level of protection, and the WTP for climbing when the subjective risk is assumed to be equal to the actual risk.

As Slovic (1987) pointed out, the basic conceptualization of risk among users is much richer than that of experts' risk assessment based on statistics. Riskiness for people means more than the expected number of fatalities, and to be effective, risk communication and management strategies cannot ignore the knowledge of both objective and subjective risks given that, as the literature suggests, these risks differ significantly (Campbell et al., 2002; Kraus et al., 1992). Our empirical analysis confirms that for rock climbing, actual and perceived risks also generally diverge, but with a modality that depends on the type of anticipated injury (i.e., slight, severe, or fatal). Our findings suggest that, on average, climbers underestimate the risk of incurring a slight injury (sample average subjective risk: 36%; objective risk suggested by the literature—Gerdes et al., 2006; Neuhof et al., 2011: 60%–74%), whereas they overestimate the risk of incurring a severe injury (sample average subjective risk: 15%; objective risk suggested by the literature—Schoffl et al., 2003: 0.8%). Conversely, the sample average subjective risk (5%) of incurring a fatal injury shows a value that is more coherent with the range (0%–6%) suggested by the literature for actual risk (Bowie et al., 1988). These findings may depend on the efficacy of communication, which is obviously more incisive in the case of death. When an accident occurs with slight or severe consequences for climbers, the information flows less effectively. It follows that climbers have a distorted perception of the levels of risk they face for the latter two typologies of injury. This is an interesting result, although it needs further verification. In fact, it could be affected by the method used to measure subjective risks. Nevertheless, if confirmed in other studies, this distorted perception should be communicated to both users and climbing site managers, especially when the risk is underestimated, and be part of a safety management system that ensures minimal actual risk to climbers' safety.

In addition, our study demonstrates the influence of perceived risk of incurring an injury on the choice of site to climb, and its variability among climbers. The relationship between the choice and the risk perception, on average, is negative, meaning that respondents are less likely to choose climbing options at increasing levels of perceived risk (Cong, 2020). Further, the attitude to risk decreases at increasing stated risk of being slightly, severely, and fatally injured. Our investigation also reveals that there are several sources of heterogeneity across climbers, both in preferences (see, for instance, Carter, 2020; Borden &

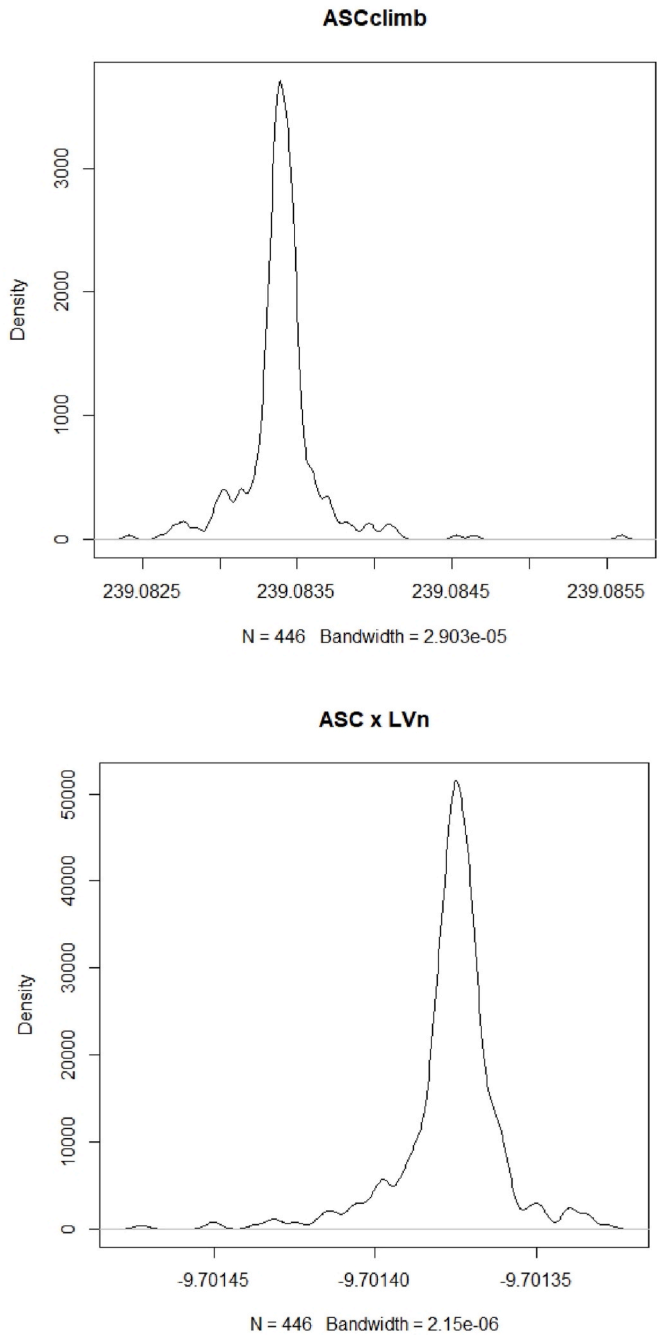

Fig. 8. Individual MWTP for ASC_{climb} and for the interaction term $ASC_{climb} * LV_n$.

Table 5
WTP associated with risk probabilities.

Risk	Probability	Reference	WTP (€)
Slight	60%	(Gardes et al., 2006; Neuhof et al., 2011)	101.32 (83.3–122.7)
Slight	74%	(Gardes et al., 2006; Neuhof et al., 2011)	52.2 (34.85–71.31)
Severe	0.8%	Schoffl et al. (2003)	368.6 (223.9–522.6)
Death	0%	(Bowie et al., 1988)	1277.28 (683–1897.2)
Death	6%	(Bowie et al., 1988)	763.1 (423.6–1120.75)

Mahamane, 2020; Kulczycki, 2014; Scarpa & Thiene, 2005) and risk perception. Numerous factors explain heterogeneity in risk perception, and many of them are associated with individual variables, such as gender, age, and experience (Probstl-Haider et al., 2016; Robinson, 2008). Other variables seem not to be relevant, such as knowing people who have been injured while climbing. However, other aspects related to a subjective dimension, not accounted for in this analysis, could play a key role in explaining climbers' risk perception. At any rate, our results are consistent with those of Demirhan (2005) for years of experience but not for gender variables. In terms of age differences in recreational risk-taking, our findings suggest that older climbers perceive risk more than younger ones do. This result contrasts with those of Rolison et al. (2014) on age differences in risk-taking behaviors in multiple risk domains. These authors find that recreation risk perception reduces toward middle age as a reflection of adults' changing attitudes toward risk of potential harm.

The study also demonstrates that the level of protection affects climbers' destination choices, as do other site characteristics, such as crowding, the number of routes, and the travel costs. Coefficient estimates for the last climbing site features are coherent with those obtained in similar studies on users' destination choices for climbing or for other specialized outdoor recreation activities (De Salvo et al., 2021; Hanley & Wright, 2003; Kohlhardt et al., 2018; Scarpa & Thiene, 2005; Vedel et al., 2017).

Regarding the monetary preferences for safety, our estimates reveal that climbers are willing to pay, on average, €63 for an increase of 1% in the expected level of protection. However, preferences for site safety are heterogeneous, and the individual MWTP ranges between €43 and €87 with a probability of 95%. The posterior distribution of the MWTP for protection is multimodal with several peaks. This result suggests the presence of segments in climbing when safety preferences are considered, as already demonstrated by Jones and Yamamoto (2016). Moreover, the monetary values we found in this study are consistent with those found by Nicita et al. (2018), who, however, used a different approach based on revealed preferences and a corner solution recreation demand model.

Our analysis also confirms prior evidence that climbers are willing to take risks when climbing but are, simultaneously, willing to pay to reduce them (Riddel & Kolstoe, 2013). Another interesting result arises when the subjective risk equals actual risk. In this case, the WTP values vary significantly among climbers. The variability was proved but not deeply explored. This point will be further investigated in a future analysis.

However, the rationale suggested by our results is that, independently of the gravity of injury, higher perceived level of risk corresponds with lower risk propensity and lower MWTP for climbing. For each level of real risk of injury, we calculated the corresponding WTP. Such estimates should be considered by natural site managers when they try to regulate demand through an access fee policy based on advertising and educational campaigns designated to communicating the real level of risks faced by climbers. However, this evidence also deserves further empirical investigation by exploring, for instance, the role of recreation specialization, in terms of skills and knowledge, commitment, and behavior, and its influence on travel intention (Scott & Shafer, 2001). In specialized recreational sport, such as rock climbing, the study of users' segmentation can be particularly decisive for supporting stakeholders in the management of injury risks (Jones & Yamamoto, 2016). Our study does not explicitly address this topic, and thus, our results can only partially support the existence of segments that perceive risks differently and do or do not appreciate the level of protection at the climbing site. This aspect also deserves further investigation to support management and prevention initiatives tailored to the intended target audiences.

Overall, despite these limitations, this study reveals how climbers' behavior varies at the individual level according to risk perception and indicates the factors that affect this relationship. For these reasons, we believe that it can be usefully employed for regulating the demand for rock climbing at natural sites, building effective safety management systems that provide the means for avoiding or reducing climbing risks, and promoting successful advertising risk campaigns, because communication of the objective risks of climbing cannot disregard a deep understanding of how climbers perceive risks.

CRediT authorship contribution statement

Maria De Salvo: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Supervision, Project administration. **Gianluca Grilli:** Methodology, Software, Validation, Formal analysis, Data curation, Writing – original draft. **Sandra Notaro:** Formal analysis, Writing – original draft. **Giovanni Signorello:** Conceptualization, Investigation, Resources, Data curation, Writing – original draft, Supervision, Project administration.

Acknowledgement

We thank Dr. Lea Nicita for her valuable assistance during the questionnaire design phase and the first stage of data collection. This study is supported by the research project MEGABIT – PIAno di inCEntivi per la RIcerca di Ateneo 2020/2022 (PIACERI) – linea di intervento 2, and by the research project NATURE (Cutgana), University of Catania.

References

Addiss, D. G., & Baker, S. P. (1989). Mountaineering and rock-climbing injuries in US national parks. *Annals of Emergency Medicine, 18*(9), 975–979. https://doi.org/10.1016/S0196-0644(89)80463-9

Alvarez-Daziano, R., & Bolduc, D. (2011). Incorporating pro-environmental preferences towards green automobile technologies through a Bayesian hybrid choice model. *Transportmetrica, 9*(1), 74–106. https://doi.org/10.1080/18128602.2010.524173

Ashok, K., Dillon, W. R., & Yuan, S. (2002). Extending discrete choice models to incorporate attitudinal and other latent variables. *Journal of Marketing Research, 39* (1), 31–46. https://doi.org/10.1509/jmkr.39.1.31.18937

Athearn, L. (2005, May 19). *Climbing rescues in America: Reality does not support "high-risk, high-cost" perception* [White paper]. American Alpine Club http://www.traditionalmountaineering.org/AAC_Rescues.pdf.

Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Bolduc, D., Boersch-Supan, A., Brownstone, D., Bunch, D. S., Daly, A., De Palma, A., Gopinath, D., Karlstrom, A., & Munizaga, M. A. (2002a). Hybrid choice models: Progress and challenges. *Marketing Letters, 13*(3), 163–175. https://doi.org/10.1023/A:1020254301302

Ben-Akiva, M., Walker, J., Bernardino, A. T., Gopinath, D. A., Morikawa, T., & Polydoropoulou, A. (2002b). Integration of choice and latent variable models. In H. S. Mahmassani (Ed.), *In perpetual motion: Travel behavior research opportunities and application challenges* (pp. 431–470). Emerald. https://doi.org/10.1016/B978-008044044-6/50022-X.

Bliemer, M. C. J., Rose, J. M., & Hess, S. (2008). Approximation of Bayesian efficiency in experimental choice designs. *Journal of Choice Modelling, 1*(1), 98–126. https://doi.org/10.1016/S1755-5345(13)70024-1

Bolduc, D., Ben-Akiva, M., Walker, J., & Michaud, A. (2005). Hybrid choice models with logit kernel: Applicability to large scale models. In M. E. H. Lee-Gosselin, & S. T. Doherty (Eds.), *Integrated land-use and transportation models: Behavioural foundations* (pp. 275–302). Elsevier. https://doi.org/10.1016/B978-008044669-1/50015-1.

Borden, D. S., & Mahamane, S. (2020). Social marketing and outdoor recreational advocacy groups: Lessons from a rock climbing campaign. *Journal of Outdoor Recreation and Tourism, 29*. https://doi.org/10.1016/j.jort.2019.100262. Article 10026.

Bowie, W. S., Hunt, T. K., & Allen, H. A., Jr. (1988). Rock-climbing injuries in Yosemite National Park. *Western Journal of Medicine, 149*(2), 172–177.

Boyce, C., Czajkowski, M., & Hanley, N. (2019). Personality and economic choices. *Journal of Environmental Economics and Management, 94*, 82–100. https://doi.org/10.1016/j.jeem.2018.12.004

Caber, M., & Albayrak, T. (2016). Push or pull? Identifying rock climbing tourists' motivations. *Tourism Management, 55*, 74–84. https://doi.org/10.1016/j.tourman.2016.02.003

Campbell, K. R., Dickey, R. J., Sexton, R., & Burger, J. (2002). Fishing along the Clinch River arm of Watts bar reservoir adjacent to the Oak Ridge reservation, Tennessee: Behavior, knowledge and risk perception. *The Science of the Total Environment, 299* (1–3), 145–161. https://doi.org/10.1016/S0048-9697(02)00276-0

Carter, D. P. (2020). Research note: Examining differences in the bolting preferences of climbers along Utah's Wasatch Front. *Journal of Outdoor Recreation and Tourism, 29*. https://doi.org/10.1016/j.jort.2020.100277. Article 100277.

Cavasos, K. E., & Bhat, M. G. (2020). Impact of risk perception on household willingness-to-pay to restock the threatened staghorn coral. *Ocean & Coastal Management, 193*. https://doi.org/10.1016/j.ocecoaman.2020.105244. Article 105244.

Charlton, S. G., Starkey, N. J., Perrone, J. A., & Isler, R. B. (2014). What's the risk? A comparison of actual and perceived driving risk. *Transportation Research Part F: Traffic Psychology and Behaviour, 25*, 50–64. https://doi.org/10.1016/j.trf.2014.05.003

ChoiceMetrics. (2014). Ngene 1.1.2 User manual and reference guide. http://www.choice-metrics.com/NgeneManual120.pdf.

Cong, L. C. (2020). Perceived risk and destination knowledge in the satisfaction loyalty intention relationship: An empirical study of European Tourists in Vietnam. *Journal of Outdoor Recreation and Tourism, 33*. https://doi.org/10.1016/j.jort.2020.100343. Article 100343.

Covello, V. T., Flamm, W. G., Rodricks, J. V., & Tardiff, R. G. (Eds.). (2012). *The analysis of actual versus perceived risks* (Vol. 1). Springer Science and Business Media.

Cribari-Neto, F., & Zeileis, A. (2009). Beta regression in R. *Journal of Statistical Software, 34*(2), 1–28. https://doi.org/10.18637/jss.v034.i02

De Salvo, M., Cucuzza, G., & Signorello, G. (2021). Using discrete choice experiments to explore how bioecological attributes of sites drive birders' preferences and willingness to travel. *Environmental Economics and Policy Studies, 1–28*. https://doi.org/10.1007/s10018-021-00314-w. Advance online publication.

Demirhan, G. (2005). Mountaineers' risk perception in outdoor-adventure sports: A study of sex and sports experience. *Perceptual & Motor Skills, 100*(3), 1155–1160. https://doi.org/10.2466/PMS.100.3.1155-1160

Draper, N., Canalejo, J. C., Fryer, S., Dickson, T., Winter, D., Ellis, G., Hamlin, M., Shearman, J., & North, C. (2011). Reporting climbing grades and grouping categories for rock climbing. *Isokinetics and Exercise Science, 19*(4), 273–280. https://doi.org/10.3233/IES-2011-0424

Faccioli, M., Czajkowski, M., Glenk, K., & Martin-Ortega, J. (2020). Environmental attitudes and place identity as determinants of preferences for ecosystem services. *Ecological Economics, 174*. https://doi.org/10.1016/j.ecolecon.2020.106600. Article 106600.

Ferrari, S., & Cribari-Neto, F. (2004). Beta regression for modelling rates and proportions. *Journal of Applied Statistics, 31*(7), 799–815. https://doi.org/10.1080/0266476042000214501

Ferrini, S., & Scarpa, R. (2007). Designs with a priori information for nonmarket valuation with choice experiments: A Monte Carlo study. *Journal of Environmental Economics and Management, 53*(3), 342–363. https://doi.org/10.1016/j.jeem.2006.10.007

Gerdes, E. M., Hafner, J. W., & Aldag, J. C. (2006). Injury patterns and safety practices of rock climbers. *Journal of Trauma and Acute Care Surgery, 61*(6), 1517–1525. https://doi.org/10.1097/01.ta.0000209402.40864.b2

Ghelichipour, Z., & Muhar, A. (2008). Visitor risk management in core zones of protected areas: First results from a survey of European park administrations. In A. Raschi, & S. Trampetti (Eds.), *Proceedings of Management for protection and sustainable development conference* (pp. 107–111). Montecatini Terme.

Giansoldati, M., Rotaris, L., Scorrano, M., & Danielis, R. (2020). Does electric car knowledge influence car choice? Evidence from a hybrid choice model. *Research in Transportation Economics, 80*. https://doi.org/10.1016/j.retrec.2020.100826. Article 100826.

Grijalva, T. C., & Berrens, R. P. (2003). Standing: Institutional change and rock climbing in wilderness areas. *Society & Natural Resources, 16*(3), 239–247. https://doi.org/10.2307/3146926

Grijalva, T. C., Berrens, R. P., Bohara, A. K., Jakus, P. M., & Shaw, W. D. (2002). Valuing the loss of rock climbing access in wilderness areas: A national-level, random-utility model. *Land Economics, 78*(1), 103–120.

Grilli, G., & Notaro, S. (2019). Exploring the influence of an extended theory of planned behaviour on preferences and willingness to pay for participatory natural resources management. *Journal of Environmental Management, 232*, 902–909. https://doi.org/10.1016/j.jenvman.2018.11.103

Gstaettner, A. M., Rodger, K., & Lee, D. (2017). Visitor perspectives of risk management in a natural tourism setting: An application of the theory of planned behaviour. *Journal of Outdoor Recreation and Tourism, 19*, 1–10. https://doi.org/10.1016/j.jort.2017.04.001

Haddock, C. (2004). *Outdoor safety: Risk management for outdoor leaders*. New Zealand Mountain Safety Council.

Haegeli, P., & Probstl-Haider, U. (2016). Research on personal risk in outdoor recreation and nature-based tourism. *Journal of Outdoor Recreation and Tourism, 13*, 1–9. https://doi.org/10.1016/j.jort.2016.02.001

Hanley, N., & Wright, R. E. (2003). Valuing recreational resources using choice experiments: Mountaineering in Scotland. In N. Hanley, W. S. Shaw, & R. E. Wright (Eds.), *The new economics of outdoor recreation* (pp. 59–73). Edward Elgar. https://doi.org/10.4337/9781781950319.00012.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2015). *Applied choice analysis: A primer*. Cambridge University Press. https://doi.org/10.1017/CBO9781316136232

Italian Automobile Association. (2020, June 01). https://www.aci.it.

Jones, T. E., & Yamamoto, K. (2016). Segment-based monitoring of domestic and international climbers at Mount Fuji: Targeted risk reduction strategies for existing and emerging visitor segments. *Journal of Outdoor Recreation and Tourism, 13*, 10–17. https://doi.org/10.1016/j.jort.2016.01.002

Kohlhardt, R., Honey-Roses, J., Fernandez Lozada, S., Haider, W., & Stevens, M. (2018). Is this trail too crowded? A choice experiment to evaluate tradeoffs and preferences of park visitors in Garibaldi Park, British Columbia. *Journal of Environmental Planning and Management, 61*(1), 1–24. https://doi.org/10.1080/09640568.2017.1284047

Kovacs, B., Marquez-Linares, M. A., Rodriguez-Espinosa, P. F., Gutierrez-Yurrita, P. J., & Perez-Verdin, G. (2021). Analysis of cultural ecosystem services of rock climbing settings in Mexico City: The case of Los Dinamos Recreational Park. *Ecosystems and People, 17*(1), 370–382. https://doi.org/10.1080/26395916.2021.1946594

Kraus, N., Malmfors, T., & Slovic, P. (1992). Intuitive toxicology: Expert and lay judgments of chemical risks. *Risk Analysis, 12*, 215–232. https://doi.org/10.1111/j.1539-6924.1992.tb00669.x

Krinsky, I., & Robb, A. L. (1986). On approximating the statistical properties of elasticities. *The Review of Economics and Statistics, 68*(4), 715–719. https://doi.org/10.2307/1924536

Kulczycki, C. (2014). Place meanings and rock climbing in outdoor settings. *Journal of Outdoor Recreation and Tourism, 7*, 8–15. https://doi.org/10.1016/j.jort.2014.09.005

Lalasz, C. B. (2013). Risky behaviors in Yellowstone National Park: The potential role of decision-making and justice on visitors' behavior. *Human Dimensions of Wildlife, 18* (3), 181–193. https://doi.org/10.1080/10871209.2013.751637

Lindberg, K., Veisten, K., & Halse, A. H. (2019). Analyzing the deeper motivations for nature-based tourism facility demand: A hybrid choice model of preferences for a reindeer visitor center. *Scandinavian Journal of Hospitality and Tourism, 19*(2), 157–174. https://doi.org/10.1080/15022250.2018.1482565

Llewellyn, D. J., & Sanchez, X. (2008). Individual differences and risk taking in rock climbing. *Psychology of Sport and Exercise, 9*(4), 413–426. https://doi.org/10.1016/j.psychsport.2007.07.003

Mariel, P., Hoyos, D., Meyerhoff, J., Czajkowski, M., Dekker, T., Glenk, K., Jacobsen, J. B., Liebe, U., Olsen, S. B., Sagebiel, J., & Thiene, M. (2021). *Environmental valuation with discrete choice experiments: Guidance on design, implementation and data analysis*. Springer Nature. https://doi.org/10.1007/978-3-030-62669-3

Martha, C., Sanchez, X., & Goma-I-Freixanet, M. (2009). Risk perception as a function of risk exposure amongst rock climbers. *Psychology of Sport and Exercise Journal, 10*, 193–200. https://doi.org/10.1016/j.psychsport.2008.07.004

McDonald, J. (2003). The financial liability of park managers for visitor injuries. In R. Buckley, C. Pickering, & D. B. Weaver (Eds.), *Nature-based tourism, environment and land management* (pp. 35–50). CABI.

McFadden, D. (1974). The measurement of urban travel demand. *Journal of Public Economics, 3*(4), 303–328. https://doi.org/10.1016/0047-2727(74)90003-6

McMillan, M. A., & Larson, D. W. (2002). Effects of rock climbing on the vegetation of the Niagara Escarpment in southern Ontario, Canada. *Conservation Biology, 16*(2), 389–398. https://doi.org/10.1046/j.1523-1739.2002.00377.x

McPhedran, R., & Toombs, B. (2021). Efficacy or delivery? An online discrete choice experiment to explore preferences for COVID-19 vaccines in the UK. *Economics Letters, 200*. https://doi.org/10.1016/j.econlet.2021.109747. Article 109747.

Mu, Y., & Nepal, S. (2016). High mountain adventure tourism: Trekkers' perceptions of risk and death in Mt. Everest Region, Nepal. *Asia Pacific Journal of Tourism Research, 21*(5), 500–511. https://doi.org/10.1080/10941665.2015.1062787

Neuhof, A., Hennig, F. F., Schoffl, I., & Schoffl, V. (2011). Injury risk evaluation in sport climbing. *International Journal of Sports Medicine, 32*(10), 794–800. https://doi.org/10.1055/s-0031-1279723

Nicita, L., Shaw, W. D., & Signorello, G. (2018). Valuing the benefits of rock climbing and the welfare gains from decreasing injury risk. *Risk Analysis, 38*(11), 2258–2274. https://doi.org/10.1111/risa.13170

Probstl-Haider, U., Dabrowska, K., & Haider, W. (2016). Risk perception and preferences of mountain tourists in light of glacial retreat and permafrost degradation in the Austrian Alps. *Journal of Outdoor Recreation and Tourism, 13*, 66–78. https://doi.org/10.1016/j.jort.2016.02.002

Pyke, K. (2001). *Climbing management: A guide to climbing issues and the production of a climbing management plan*. The Access Fund.

R Core Team. (2013). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.r-project.org/.

Riddel, M., & Kolstoe, S. (2013). Heterogeneity in life-duration preferences: Are risky recreationists really more risk loving? *Journal of Risk and Uncertainty, 46*(2), 191–213. https://doi.org/10.1007/s11166-013-9161-0

Riera, P., Signorello, G., Thiene, M., Mahieu, P.-A., Navrud, S., Kaval, P., Rulleau, B., Mavsar, R., Madureira, L., Meyerhoff, J., Elsasser, P., Notaro, S., De Salvo, M., Giergiczny, M., & Dragoi, S. (2012). Non-market valuation of forest goods and services: Good practice guidelines. *Journal of Forest Economics, 18*, 259–270. https://doi.org/10.1016/j.jfe.2012.07.001

Robinson, V. (2008). *Everyday masculinities and extreme sport: Male identity and rock climbing* (Berg).

Rolison, J. J., Hanoch, Y., Wood, S., & Liu, P. J. (2014). Risk-taking differences across the adult life span: A question of age and domain. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 69*(6), 870–880. https://doi.org/10.1093/geronb/gbt081

Rugg, C., Tiefenthaler, L., Rauch, S., Gatterer, H., Paal, P., & Strohle, M. (2020). Rock climbing emergencies in the Austrian Alps: Injury patterns, risk analysis and preventive measures. *International Journal of Environmental Research and Public Health, 17*(20). https://doi.org/10.3390/ijerph17207596. Article 7596.

Scarpa, R., Tempesta, T., & Thiene, M. (2003). Non-participation, demand intensity and substitution effects in an integrable demand system: The case of day trips to the North-Eastern Alps. In N. Hanley, W. Douglass Shaw, & R. E Wright (Eds.), *The new economics of outdoor recreation* (pp. 98–122). Edward Elgar. https://doi.org/10.4337/9781781950319.00014.

Scarpa, R., & Thiene, M. (2005). Destination choice models for rock climbing in the Northeastern Alps: A latent-class approach based on intensity of preferences. *Land Economics, 81*(3), 426–444. https://doi.org/10.3368/le.81.3.426

Schoffl, V., Hochholzer, T., Winkelmann, H. P., & Strecker, W. (2003). Pulley injuries in rock climbers. *Wilderness and Environmental Medicine, 14*(2), 94–100. https://doi.org/10.1580/1080-6032(2003)014[0094:PIIRC]2.0.CO;2

Schoffl, V., Morrison, A., Schwarz, U., Schoffl, I., & Küpper, T. (2010). Evaluation of injury and fatality risk in rock and ice climbing. *Sports Medicine, 40*(8), 657–679. https://doi.org/10.2165/11533690-000000000-00000

Schussman, L. C., Lutz, L. J., Shaw, R. R., & Bohnn, C. R. (1990). The epidemiology of mountaineering and rock climbing accidents. *Journal of Wilderness Medicine, 1*(4), 235–248. https://doi.org/10.1580/0953-9859-1.4.235

Scott, D., & Shafer, C. S. (2001). Recreational specialization: A critical look at the construct. *Journal of Leisure Research, 33*, 319–343. https://doi.org/10.1080/00222216.2001.11949944

Slovic, P. (1987). Perception of risk. *Science, 236*(4799), 280–285. https://doi.org/10.1126/science.3563507

Tam, M. L., Lam, W. H. K., & Lo, H. P. (2010). Incorporating passenger perceived utility service quality in airport ground access mode choice model. *Transportmetrica, 6*, 3–17. https://doi.org/10.1080/18128600902929583

Taylor, M. K., Gould, D. R., Hardy, L., & Woodman, T. (2006). Factors influencing physical risk taking in rock climbing. *Journal of Human Performance in Extreme Environments, 9*(1), 15–26. https://doi.org/10.7771/2327-2937.1044

UK Health, & Safety Executive. (2009). http://www.hse.gov.uk/education/statistics.htm.

Vedel, S. E., Jacobsen, J. B., & Skov-Petersen, H. (2017). Bicyclists' preferences for route characteristics and crowding in Copenhagen: A choice experiment study of commuters. *Transportation Research Part A: Policy and Practice, 100*, 53–64. https://doi.org/10.1016/j.tra.2017.04.006

Vij, A., & Walker, J. L. (2016). How, when and why integrated choice and latent variable models are latently useful. *Transportation Research Part B: Methodological, 90*, 192–217. https://doi.org/10.1016/j.trb.2016.04.021

Visitor Safety Group. (2011). In *Managing visitor safety in the countryside – principles and practices* (3rd ed.) (Author).

Vredin-Johansson, M., Heldt, T., & Johansson, P. (2006). The effects of attitudes and personality traits on mode choice. *Transportation Research, 40A*, 507–525. https://doi.org/10.1016/j.tra.2005.09.001

Woodman, T., Hardy, L., & Barlow, M. (2020). High-risk sports. In G. Tenebaum, & R. C. Eklund (Eds.), *Handbook of sport psychology* (pp. 177–189). Wiley. https://doi.org/10.1002/9781119568124.ch9.

Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking*. Cambridge University Press. https://doi.org/10.1016/j.paid.2007.03.021

Zuckerman, M. (2007). The sensation seeking scale V (SSS-V): Still reliable and valid. *Personality and Individual Differences, 43*(5), 1303–1305. https://doi.org/10.1111/1467-6494.00124

Zuckerman, M., & Kuhlman, D. M. (2000). Personality and risk-taking: Common biosocial factors. *Journal of Personality, 68*(6), 999–1029.