

Paying for Nature-based Solutions: Do Valencians prefer voluntary or mandatory contributions for forest restoration in Spain?

Sameh Missaoui^{ab}, Zein Kallas^{ab}, Antonio del Campo^c & Javier Pérez^c

ABSTRACT: The Mediterranean Forest faces increasing pressures from climate change, including wildfires, land abandonment, and biodiversity loss. Nature-based Solutions (NbS) are sustainable strategies that address these challenges. This study examines how voluntary and mandatory payment mechanisms affect citizens' willingness to pay (WTP) for forest restoration through NbS in Valencia, Spain. A discrete-choice experiment evaluated 603 respondents' preferences for ecosystem services' improvement. Results show stronger support for voluntary payments (WTP values of €58.96 for moderate improvements and €113.07 for substantial ones) compared to mandatory payments (€32.48 and €71.97). These findings provide insights for designing socially acceptable and effective forest restoration policies.

Pago por soluciones basadas en la naturaleza: ¿Prefieren los valencianos contribuciones voluntarias u obligatorias para la restauración forestal en España?

RESUMEN: El bosque mediterráneo enfrenta presiones del cambio climático, incendios forestales, abandono del territorio y pérdida de biodiversidad. Las Soluciones Basadas en la Naturaleza (SbN) son estrategias sostenibles que abordan desafíos. Este estudio examina mecanismos de pago voluntarios y obligatorios afectan la disposición a pagar (DAP) por la restauración forestal mediante SbN en Valencia, España. Un experimento de elección discreta evaluó preferencias de 603 participantes mejora de servicios ecosistémicos. Resultados muestran apoyo a pagos voluntarios (58,96 € y 113,07 €) frente a obligatorios (32,48 € y 71,97 €). Estos hallazgos aportan información para políticas de restauración forestal eficaces y socialmente aceptadas.

KEYWORDS / PALABRAS CLAVE: Choice behavior, discrete choice experiment, payment vehicle, forest restoration / Comportamiento de elección, Experimento de Elección Discreta (DCE), Vehículo de pago, restauración forestal.

JEL classification / Clasificación JEL: Q01, Q20, Q28, Q57, Q58.

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1. Introduction

Mediterranean forests provide various valuable ecosystem services, including wood production, carbon sequestration, water regulation, biodiversity, and cultural services such as recreation and tourism (Morán-Ordóñez *et al.*, 2021; Nocentini *et al.*, 2022). However, they face substantial risks due to climate change and related disruptions, such as wildfires (Valbuena-Carabaña *et al.*, 2010; Varela *et al.*, 2014).

Recent studies have shown that climate change is causing a drastic reduction in the regulating ecosystem services (ES) from Mediterranean forests (Suratman *et al.*, 2020), including decreased carbon storage and water regulation. Furthermore, it is projected to result in rising temperatures, decreased precipitation, and increased aridity, leading to longer, drier summers, raising the risk of severe and frequent forest fires (Ministry for the Ecological Transition and the Demographic Challenge, 2022). The consequences of forest fires extend beyond ecological damage; the substantial decrease in the provision of ES for society also impacts human life and infrastructure negatively. For instance, wildfires are expected to become more frequent and severe, with a median 62 % increase of burnt areas by 2100 (Bou Dagher-Kharrat *et al.*, 2022; Schwörer *et al.*, 2024). The frequency of forest fires, which significantly threaten Mediterranean ecosystems, has already more than doubled since the 1970s. This staggering increase is largely attributed to land abandonment (Otero *et al.*, 2015; Pausas & Fernández-Muñoz, 2012; Palombo *et al.*, 2013; Rey Benayas, 2005; Varela *et al.*, 2018), as the accumulation of dead plant material and other flammable debris can cause a buildup of fuel, increasing the likelihood and severity of wildfires (Anaya-Romero *et al.*, 2016; Suratman *et al.*, 2020; Varela *et al.*, 2014).

However, wildfires are only one of several interrelated pressures threatening Mediterranean forest ecosystems. The expansion of intensive irrigated agriculture, urbanization and real estate development, and the proliferation of uncontrolled recreational and leisure activities also conduce the degradation and fragmentation of forest landscapes (Gómez-Baggethun & Naredo, 2015; Lasanta *et al.*, 2017). These activities exacerbate soil erosion, water scarcity, and biodiversity loss, further reducing the capacity of forests to deliver critical ecosystem services (Palahi *et al.*, 2008; San-Miguel-Ayán *et al.*, 2018). Therefore, the deterioration of Mediterranean forests and their ES results from combined climatic, ecological, and socio-economic drivers.

The consequences of both fires and climate change have also been perceived on biodiversity and the social values of forests, including recreational facilities. Czajkowski *et al.* (2009), Zhang *et al.* (2021), and Gajendiran *et al.* (2024) examined the multifaceted impacts of wildfires on forests, including alterations in vegetation, threats to biodiversity, and the release of greenhouse gases that conduce climate change. Starbuck *et al.* (2006), building on the work of Vaux *et al.* (1984), were the first to address changes in forests' recreational values due to climate change and forest fires.

The economic impact of forest fires is staggering, with billions of euros lost annually in firefighting, property damage, and reduced tourism. For instance, total government expenditure on fire-protection services in the EU amounted to €31.2 billion in 2017 (Eurostat, 2019). Such staggering figures emphasize the need for immediate and collaborative action (Kumar *et al.*, 2022; Suratman *et al.*, 2020). However, these financial costs represent only a small fraction of the total economic damage wildfires cause; conventional market assessments primarily account for direct expenditures, such as firefighting operations, infrastructure loss, and post-fire rehabilitation but systematically overlook broader social and environmental costs. This limitation arises because several benefits provided by forest ecosystems, including carbon sequestration, soil erosion control, hydrological regulation, recreational services, and biodiversity conservation, are public goods without explicit market prices (Costanza *et al.*, 1997; Kumar, 2011). Therefore, their degradation during wildfires is not captured in standard economic valuations, leading to a persistent market failure. The loss of these ESs impose substantial social costs, such as increased CO₂ emissions, reduced soil fertility, degraded water quality, and loss of habitat, which are borne collectively by society rather than reflected in private land management decisions (Organisation for Economic Co-operation and Development, 2016; Reid, 2005). Recent studies have shown that the economic value of non-market losses from wildfires, such as ES loss, can exceed direct suppression costs, leading to a systematic underestimation of wildfire damages and chronic underinvestment in prevention and resilient forest management (Farley, 2012; González-Cabán, 2013; Mavsar *et al.*, 2013; Pagiola *et al.*, 2004a; Venn & Calkin, 2011).

Addressing the undervaluation of forests requires an economic framework that captures the full range of forest-related benefits. One effective approach is to determine the total economic value (TEV) of forests, which provides a comprehensive framework for assessing both market and non-market benefits. The TEV framework includes use values such as timber, firewood, and recreation, as well as non-use values, which encompass biodiversity conservation, carbon storage, and landscape preservation (Taye *et al.*, 2021).

Researchers have extensively applied this framework to Mediterranean forests, highlighting the significance of non-market ES in their overall value. Croitoru & Merlo (2005) proposed a foundational TEV framework specifically for Mediterranean forest ecosystems, while Croitoru (2007) demonstrated that timber production constitutes only a small portion of their total value, emphasizing the importance of non-use benefits. Similarly, Durán-Medraño *et al.* (2017) estimated the economic value of forest management measures intended to reduce wildfire impacts on marine and terrestrial ecosystems in northern Spain. Valente *et al.* (2024) also found strong willingness among citizens in southern Portugal to contribute financially or volunteer time for fire prevention programs.

In recent years, Nature-based Solutions (NbS) have emerged as holistic approaches to address the diverse challenges in Mediterranean forest landscapes. NbS integrate

ecological restoration, sustainable forest management, and adaptive practices to enhance resilience, biodiversity, and the delivery of multiple ecosystem services simultaneously: not only fire prevention but also soil conservation, carbon sequestration, and water regulation (Cohen-Shacham *et al.*, 2016; Eggermont *et al.*, 2015; Seddon *et al.*, 2021). Therefore, forests are non-excludable and non-rivalrous public goods, which can cause market failure unless their social benefits are accounted for (Pagiola, 2008; Pagiola *et al.*, 2004b; 2007). Building on this existing literature, the present study evaluates whether similar societal support exists in the Valencian community by assessing public willingness to share the costs of adaptive forest management and NbS for wildfire prevention. We employ stated preference methods to gauge individual willingness to pay for hypothetical scenarios of forest management and restoration.

2. Existing Literature on Payment Vehicles in Stated Preference Studies

The existing literature illustrates how to capitalize on the economic advantages of ecosystem restoration and environmental public goods and services. Many ES remain undervalued or overlooked in conventional economic decision-making, leading to their overuse and degradation. In this regard, The Economics of Ecosystems and Biodiversity (TEEB) framework offers a structured approach to recognizing, demonstrating, and capturing the value of ES by emphasizing their economic and social contributions (Kumar, 2011). Assigning a monetary value to these services through economic valuation enables policymakers to integrate ecological considerations into public policy and resource management. To determine the monetary worth of such unquantified advantages, researchers often employ stated preference methodologies, such as choice experiments (CEs; Louviere *et al.*, 2000). A key question arises regarding how society can ensure a long-term supply of such goods and services: How should funding for environmental management be collected (i.e., voluntarily or mandatorily)? Answering this question necessitates making careful assumptions and comparing preferences under different monetary contribution mechanisms, as these influence public policy decisions.

The literature has explored the impact of payment vehicles on economic valuation estimates on stated preference methods, specifically the CE (Carson & Groves, 2007; Pagiola *et al.*, 2004b; Roesch-McNally & Rabotyagov, 2016). A persistent issue in the literature is the accurate disclosure of respondents' preferences, which can significantly impact a survey's applicability to real-world situations. Numerous research initiatives have comprehensively examined diverse payment methods, replicating authentic circumstances to guarantee truthful and reliable results (Akcura, 2015; Carson & Groves, 2007; Champ *et al.*, 1997; Cunha-e-Sá *et al.*, 2023; Roesch-McNally & Rabotyagov, 2016; Wiser, 2007;). Modes of payment are generally classified as either voluntary and mandatory (coercive; Akcura, 2015), but each has consequences.

Voluntary payments, such as charitable funds and donations, are easier to adopt than coercive payments, as individuals feel their contributions signify personal choice rather than a mandated obligation. However, they can easily induce respondents to behave strategically and overstate their true WTP, which can impact the reliability of their preferences and decisions (Carson *et al.*, 1997; Nunes & Schokkaert, 2003). A free-riding concept has been used to describe the discrepancy between stated attitudes and weak actions when a voluntary mechanism is used (Carson *et al.*, 1997; Wiser, 2007).

Beyond these economic and strategic explanations, recent behavioral studies have emphasized that voluntariness interacts with deeper psychological and social drivers of pro-environmental behavior. Voluntary mechanisms can boost individuals' intrinsic motivations to act in favor of the environment (Brekke *et al.*, 2003; Deci & Ryan, 2000) and can enhance feelings of autonomy and moral satisfaction when contributing to collective goals (López-Mosquera & Sánchez, 2012). Moreover, voluntariness is closely linked to citizens' trust in institutions (Rode *et al.*, 2015): people are more willing to contribute when they perceive the managing organization as transparent, fair, and effective. In such cases, WTP is expected to be higher for voluntary payment. However, the opposite can also occur: coercive payment mechanisms may weaken these intrinsic motivations by creating perceptions of obligation or distrust, reducing overall social support for conservation programs, including WTP.

Some citizens may assume that it is inequitable if others do not pay while receiving benefits. Carson *et al.* (2006) suggested that voluntary payment is likely to lead to strategic behaviors as long as the good or service is potentially important to an individual, who will then support the fund-raising effort. Nonetheless, the majority of the literature portrays a lower WTP under voluntary payment compared to obligatory (e.g., Akcura, 2015; Jianjun *et al.*, 2016; Roesch-McNally & Rabotyagov, 2016; Stithou & Scarpa, 2012; Wiser, 2007). Carson and Groves (2007) and Johnston *et al.* (2017) concluded that the payment vehicle in a non-market valuation study must be binding (coercive) to ensure incentive compatibility and to avoid free-riding.

While coercive payment (i.e., taxation) may be more credible than voluntary because everyone pays (Akcura, 2015), its effectiveness depends on the degree of institutional trust and perceived fairness (Lind & Tyler, 1988; Rode *et al.*, 2015). When citizens distrust public authorities, coercive payments can elicit psychological reactance or resistance, lowering stated WTP despite higher credibility. Additionally, it may diminish the intrinsic motivation to contribute, resulting in higher WTP estimates than charitable donations (Svenningsen & Jacobsen, 2018). Moreover, it may influence decision-making by eliciting negative reactions if people do not trust that their monetary contributions will be utilized for the specified purposes. Furthermore, some studies did not find any difference between payment mechanisms, and others found WTP to be unaffected by the payment vehicle (Bergstrom *et al.*, 1985; Kragt, 2013).

This paper contributes to the literature by examining how the payment vehicle influences willingness to pay (WTP) for effective forest management strategies, focusing on the restoration of Calderona's forests (Valencia, Spain) through Nature-based Solutions (NbS). A hypothetical tax and a hypothetical donation were used to gauge citizens' WTP: a one-time payment for a 3-year program. Mandatory payments would be administered by the Spanish authorities, principally the municipality responsible for combatting fires, while voluntary payments would be collected by charitable pro-environmental associations in Valencia. Assuming that individuals facing obligatory payment would not pay taxes and thus would not perceive it as consequential payment, we hypothesized that WTP estimates would be higher in voluntary payments. To investigate this, a discrete choice experiment (DCE) survey was conducted in Valencia to seek Valencian preferences toward forest ecosystem restoration and to determine whether payment mechanisms matter.

The following sections describe the case study and the attributes collection. Section 3 presents the methodology and the econometric specification. Section 4 reports the results and discussions, and Section 5 concludes the study.

3. Materials and Methods

3.1. Case Study

This case study was conducted in Valencia, Spain, where forests cover 57 % of the total area of the region, while the national average is 35.9 % (Giuffré *et al.*, 2021). Notably, the forests of Calderona, situated in the eastern part of the Valencia region, are considered vital and possess distinctive characteristics that contribute to their individual and diverse biodiversity. Figure 1 depicts Aleppo pine forests that have been impacted by the Mediterranean Sea's proximity and have regenerated following the 1992 wildfire (Del Campo *et al.*, 2018).

The region faces challenges related to water availability and forest fire risk, and there is a clear need for adaptive forest management practices to address climate change impacts and ensure sustainable forest ecosystems. Many dryland forests are located in the wildland-urban interface, which can immensely impact hydrological cycling (hydrological balance of watershed) and increase fire risk. In July 2022, a fire ripped through approximately 800 hectares of Valencia, leading to the loss of 662 hectares of natural forest (equivalent to 313 kilotons of CO₂). This situation endangered lives and caused widespread damage to global biodiversity, underscoring the urgent need for action.

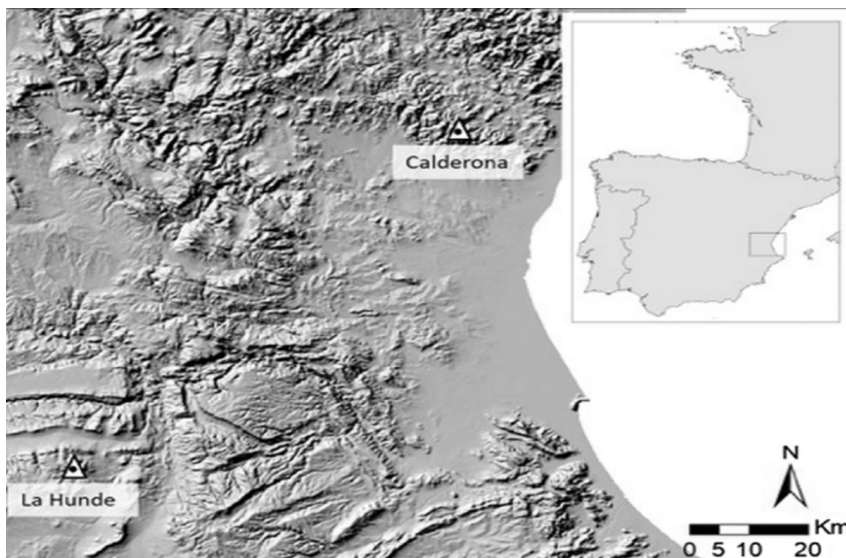
In terms of terminology, NbS are defined as “*actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits*” (International Union for Conservation of Nature, 2016). In forest ecosystems, NbS include interventions such as reforestation with native

species (Chazdon, 2008), fuel load reduction and fire-resilient forest management to prevent wildfires (Fernandes *et al.*, 2013), restoration of degraded forest landscapes (Lamb *et al.*, 2005), and the creation of ecological corridors to enhance biodiversity and climate resilience (Bennett, 2003). In this case study, the NbS is defined by developing a multifunctional plan collaboratively designed with stakeholders using the CAFE (Carbon, Aqua, Fire, Eco-Resilience) tool. This multi-objective decision support system for forest management quantifies and optimizes various ES while highlighting the additional benefits generated. It combines multi-criteria optimization with genetic evolutionary algorithms. This approach determines the necessary management actions, such as silvicultural activities (e.g., thinning or planting), along with how to perform them (e.g., how much, where, or when to repeat the intervention), according to the needs of decision-makers, while optimizing multiple ES such as biomass production, carbon sequestration, fire risk reduction, water provisioning, climate resilience, and biodiversity (Pérez-Romero *et al.*, 2022; Pérez-Romero *et al.*, 2025).

The case study uses a 30-year simulation, with inputs calibrated and validated against real data from experimental plots. The effects of management on the system can be observed in carbon and water flows, as well as how these diminish over time and require further intervention (Del Campo *et al.*, 2018).

FIGURE 1

Location of Case Studies



Source: from Del Campo *et al.* (2018).

3.2. Method and Preferences Modelling

DCEs are a stated preference research method relying on Lancaster's (Lancaster, 1966) theory of value and Thurstone's (Thurstone, 1927) random utility theory (RUT). The process entails generating sets of options (cards) that consist of hypothetical alternatives characterized by different levels of attributes. Participants select their favored option from each set of choices, thereby implicitly considering the trade-offs between the different attribute levels. The overall utility of an alternative is determined by assessing the relative significance of each attribute and calculating its utility. Essentially, respondents' choices reveal their preferences; the choices are then summarized by the utility function. Individuals choose among the alternatives according to a utility function with two main components: a systematic (observable/deterministic) component and a random error term (non-observable):

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad [1]$$

Where U_{nj} is the utility of alternative j to subject n , V_{nj} is the systematic component of the utility, and ε_{nj} is a stochastic term. Assuming linearity, the utility function for an alternative j can be expressed as:

$$U_{njt} = \beta X_{njt} + \varepsilon_{njt} \quad [2]$$

Where β denotes the $K \times 1$ vector of unknown utility parameters and, X_{nj} represents the attribute levels.

To predict participants' preferences for an alternative, we define the "probability of choice" that individual n chooses alternative i rather than alternative j (for any i and j within choice sets T). McFadden (1974) developed the DCE base model, which is often referred to as the multinomial logit (MNL) model. According to this model, the probability that a respondent n chooses an alternative j is:

$$Prob\{j \text{ is chosen}\} = \frac{e^{\mu V_{jn}}}{\sum_{k=1}^J e^{\mu V_{kn}}} \quad \forall k \in T \quad [3]$$

Where μ is a scale parameter that is inversely related to the variance of the error term. For the MNL, the scale parameter is fixed at one for estimation reasons (Louviere *et al.*, 2000; Swait *et al.*, 1994). In this model specification, the condition of independent and identically distributed (IID) error term must be met according to a Gumbel distribution. Such a distribution in the error term enables the verification of a restrictive property within the MNL, which is the independence of irrelevant alternatives (IIA) property. Consequently, the MNL imposes a strict structure on cross-price elasticities, avoiding the possibility of analyzing substitutability between the alternatives (Hensher *et al.*, 2015).

Thus, we considered the mixed logit model (RPL), which relaxes the IIA assumption and extends the MNL model by allowing for unobserved heterogeneity through random coefficients on attributes (Ben-Akiva *et al.*, 1997; Hensher & Greene, 2003.; Hensher *et al.*, 2015; Louviere *et al.*, 2000).

According to this model, the coefficient vector for a respondent n is $\beta_j = \bar{\beta} + \sigma\lambda_n$, where $\bar{\beta}$ is the estimated mean, σ is the standard deviation of the marginal distribution of β , and λ_n is a random term assumed normally distributed with mean zero and unit standard deviation for all the attributes except for the monetary attribute. Thus, the term $\sigma\lambda_n$ is the vector of person n specific deviations from the mean value of the β_j .

WTP is determined as follows:

$$WTP = -1 \left(\frac{\beta_n}{\beta_c} \right) \quad [4]$$

Where β_n represents the estimated utility weight associated with the attribute level, and β_c denotes the marginal utility of income. This specification assumes linear utility in cost and follows the conventional approach in discrete choice modelling for converting preferences into monetary values.

The multivariate normal distribution, $MVN(0, \Sigma)$, is a common choice in many applications. We assumed all attributes other than cost to be normally distributed in the population. The RPL model results were generated with 2000 draws to ensure stable maximum likelihood estimation of the non-price coefficients (Dennis *et al.*, 2021; Glenk *et al.*, 2019). Moreover, we considered the price coefficients as fixed¹ (i.e., non-random) to ensure that the estimated total WTP would be normally distributed.

As the primary objective of this paper is to identify which payment vehicle is more effective in motivating Valencians to contribute to forest management programs, the willingness to pay (WTP) was compared under voluntary and obligatory schemes. The comparison followed the procedure outlined by Swait *et al.* (1994), which tests for differences in preference structures between the two treatments. According to these steps, H_1 determines whether two groups have the same preference structure.

$$H_1: \mu_j^1 \beta_i^1 = \mu_j^2 \beta_i^2$$

Where μ_1 and μ_2 are the scale parameters, β_i^1 and β_i^2 for the two treatments.

¹ This approach has been criticized (Daly *et al.*, 2012). If the price coefficient is allowed to vary randomly, it becomes challenging to identify the distribution of WTP for the non-price attributes because the price coefficient acts as a scale parameter, and its variation confounds the estimation of the distribution.

If $-2(L_R - (L_1 + L_2)) > \chi^2$, H_1 can be rejected, implying that the difference in payment vehicles influenced the modelled preference structure. Subsequently, a Poe test has to be conducted using the convolution approach proposed by Poe *et al.* (1994; 2005) to test whether the estimated distributions of WTP differed significantly between the two payment groups. In this context, the null hypothesis (H_0) states that there is no statistically significant difference between the mean WTP values derived from the two groups (i.e., $H_0: WTP_1 = WTP_2$), while the alternative hypothesis (H_1) assumes that the WTP distributions differ ($H_1: WTP_1 \neq WTP_2$). Notably, the estimated coefficients from each split sample cannot be directly compared due to potential differences in scale parameters across models (Poe *et al.*, 1994). Therefore, the Poe test was applied to the simulated WTP values rather than to the model coefficients. By emphasizing WTP, the comparison accounts for individual preferences and population heterogeneity, providing a normalized and interpretable metric to assess whether the payment vehicle influences respondents' valuation patterns.

3.3. Empirical Application

To implement the DCE, a survey was designed to assess Valencians' preferences for forest ecosystem restoration and conservation measures based on NbS. The empirical application involved designing choice sets, developing the questionnaire, and administering the survey to a representative sample of residents in Valencia.

Choice Sets

In the literature, citizens' preferences for environmental management practices have traditionally been highlighted by applying stated preference methods such as choice modelling techniques (Johnston *et al.*, 2017). In this study, the DCE attributes were carefully selected based on the literature review (Broch & Vedel, 2012; Christie & Gibbons, 2011; Nijnik & Bizikova, 2008; Zhang & Pagiola, 2011) and after concertation and consultation with researchers working on the Valencia Forest ecosystem at the Polytechnic University of Valencia (UPV). A living lab was established in Valencia using a bottom-up participatory approach. It directly engaged 20 stakeholders, including representatives from local communities, government agencies, and private sector entities, in creating solutions adapted to their needs and generating ideas to shape innovation, leading to more relevant and widely accepted outcomes. Within this participatory environment, the stakeholders participated in in-depth discussions and deliberations on the ES. Following these discussions, they voted to prioritize and refine the attributes based on their relevance and importance to the ecosystem and the larger community. This co-design approach ensured that the final set of attributes reflected various perspectives. Additionally, the collaborative process, which combined insights from stakeholders and specialists, provided valuable perspectives on the current situation and the status quo in the study context, reflecting real-world conditions and priorities. The attributes were categorized into three levels: baseline (status quo or current situation), medium (indicating a moderate

improvement), and high (indicating significant improvement). To conclude, the DCE attributes were “availability of water,” “biodiversity,” “wildfire risk,” and “carbon sequestration”.

The availability of water attribute refers to the amount of water available in forest areas, which is typically measured by the level of aquifer recharge (expressed in millimeters per year). If the rate of aquifer recharge increases, a greater quantity of water will be available for more individuals.

The biodiversity attribute refers to the structural diversity of a system, including the richness and variability of forest masses, such as species, habitats, flora, fauna, and decay. The Index of Biodiversity Potential (IBP; expressed as a percentage) is commonly used to measure local area biodiversity. An increase in this index indicates an improvement in biodiversity, which is crucial for the health and resilience of the ecosystem. A diverse ecosystem can better withstand environmental changes and provide more ES.

The wildfire risk attribute was influenced by several factors. A crucial risk factor was fuel load, which is determined by dry vegetation. The risk levels are indicated by the amount of fuel load available per hectare in terms of milligrams per hectare (mg/ha), and a decrease in fuel load can reduce the risk of forest fires.

The carbon sequestration attribute refers to capturing and storing atmospheric CO₂ to reduce the CO₂ concentration in the atmosphere and mitigate global climate change. The Annual Soil Productivity Index is often used to quantify carbon sequestration and is typically expressed in milligrams per hectare. An increase in this index indicates an improvement in carbon sequestration.

Regarding the cost of improvement attribute, two types of payment options were offered. The first was a mandatory tax: respondents were asked if they would pay a tax for restoration improvements managed by the government or municipality. The second option was a voluntary donation: respondents were asked if they would make a voluntary contribution to a pro-environmental organization. The same price vector was associated with both voluntary and coercive payments: €20, €40, €60, €80, and €100. The cost was determined based on other studies conducted in Spain (Varela *et al.*, 2014; Varela *et al.*, 2018), then validated by focus group and pretests with citizens. Table 1 summarizes the attributes and their levels.

The number of choice sets was $6^1 \times 3^4 = 486$ cards². We then used a D-efficient design using the Ngene software (ChoiceMetrics, 2025) to optimize and reduce this number with a D-error = 0.24. Finally, 18 choice cards were generated and blocked evenly into two blocks and randomly distributed between treatments. Those who were assigned voluntary payment and coercive payment were both asked to evaluate nine choice sets each, which shared the same price vector.

² This number represents the attribute combinations for one alternative.

TABLE 1
Attributes and Their Levels

Attributes	Levels	Variable description in model estimation (continuous variable)
Water Quality	High (Green)	Refers to a notable improvement in the level of aquifer recharge; levels achieved: 30 mm/year
	Medium (Amber)	The level of aquifer recharge has slightly improved; levels achieved: 28 mm/year
	Low (Red)	Current level of the aquifer 27 mm/year
Biodiversity	High (Green)	Refers to a significant enhancement in biodiversity, with a target of achieving a 20 % increase in species from the current state
	Medium (Amber)	Indicates a slight increase in the number of species, corresponding to a 5 % rise from the current state
	Low (Red)	Indicates a biodiversity level defined by the variety of existing species, that remains stable (0 % change), meaning current biodiversity is maintained without improvement or decline
Wildfire	High (Green)	Represents a low risk of wildfires, and the fuel load target has been further reduced to 31.8 mg/ha
	Medium (Amber)	Indicates a moderate risk of forest fires, with a slight reduction in fuel load required to be attained at 45.2 mg/ha
	Low (Red)	The risk of forest fires in the Calderona region is currently at a high level, with a substantial fuel load of 72 mg/ha.
Carbon Sequestration	High (Green)	Represents a moderate annual increase in carbon fixation by managed forest masses, achieving 3.1 mg/ha compared to the current state
	Medium (Amber)	Indicates a slight annual increase in carbon fixation by managed forest masses, reaching 2.1 mg/ha compared to the current state
	Low (Red)	The system annually fixes an additional 1.5 mg/ha of carbon at the current low level.
Cost of Improvement (Voluntary or Coercive Payment)		€0 (no payment), €20, €40, €60, €80, €100

Source: Own elaboration based on literature, focus groups & data from Valencian partners.

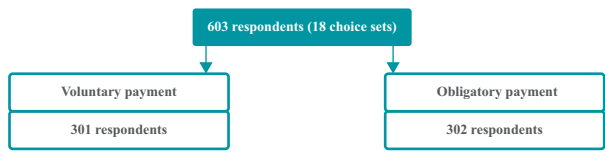
The key difference was the entity responsible for managing the collected funds. In the coercive payment treatment, the question was framed as: *“Are you willing to pay for this management plan restoration improvement, knowing that the government, specifically the municipality, will manage the funds?”* In contrast, respondents in the voluntary payment treatment were asked: *“Are you willing to pay for this management plan restoration improvement, knowing that a pro-environmental association will manage the funds?”*

The choice cards in both treatment groups presented an identical option reflecting the current situation. Moreover, two alternatives represented potential improvements. These improvement alternatives could involve enhancements across all attribute levels or improvements in only some attributes while the others remained unchanged. The respondents were randomly distributed among the treatments while controlling for gender, age, and residence location. Figure 2 represents a simplified diagram.

The attributes and their levels were visually presented to respondents through labels and visual aids. This approach helped streamline the representation of attribute levels, enhancing respondents’ comprehension of the option scenarios. The goal was to provide a clear and, more importantly, rational representation of the changes in ES and forest conditions (DeLong *et al.*, 2021; Guilfoos *et al.*, 2023). An example of choice sets is presented in Figure 3.

FIGURE 2

Sample Description



Source: Own elaboration based on the split-sample survey.

FIGURE 3

Example of Choice Cards

	Option 1	Option 2	Current Situation
Water Availability	 High improvement level 30 mm/year	 Current level 27 mm/year	 Current level 27 mm/year
Wildfire Risk	 High improvement (low risk) 31.8 Mg/ha	 Medium improvement (medium risk) 45.2 Mg/ha	 Current (high risk) 72 Mg/ha
Biodiversity	 Current level 0 %	 Medium improvement 5 %	 Current level 0 %
Carbon Sequestration	 Medium improvement 3.1 Mg/ha	 High improvement 2.1 Mg/ha	 Current level 1.5 Mg/ha
Proposed improvement cost (euros) voluntary	80	20	0
I prefer			

Source: Ngene-generated cards.

Questionnaire and Data Collection

The survey was created using Qualtrics, employing a quota sampling method stratified by gender, age, and region. Questionnaires were evenly and randomly distributed among the 665 participants in February 2024; after eliminating those that did not meet the inclusion criteria (abandoned or incomplete), the final sample was 603.

A pilot test involving 50 respondents was conducted to validate the survey design, ensuring representativeness by gender (50 % male, 50 % female) and age (40 % young, 30 % middle-aged, 30 % older). Using the priors estimated from the pilot model, a Bayesian D-efficient design was generated in Ngene (ChoiceMetrics, 2025). The algorithm iteratively optimizes the allocation of attribute levels and alternatives to minimize the determinant of the asymptotic variance–covariance matrix (D-error), thereby maximizing parameter estimates' precision and statistical efficiency.

Cheap talk –“Please read each option carefully before selecting your preferred one, and please keep in mind that if the present options you will see following do not appeal to you and/or the prices are higher than what you think you will pay, you should choose the actual situation. Each improvement will cost society additional money. This cost would have to be paid to contribute to the cost of a natural-based solution implementation. The alternatives we ask you to choose may cost you per year. Please remember that pro-environmental associations will manage the donation, to be voluntarily paid”– and reminders were used before each choice set to reduce hypothetical bias.

The questionnaire had four main sections. It introduced the framework and explained the context of the survey and its non-commercial aspect to ensure that respondents felt secure and not exploited. A consent section followed, which included a screening question (respondents were asked to provide or withhold consent to participate in the questionnaire). This segment was followed by a description of the attributes and the experimental design. The final part of the questionnaire included attitudinal questions that collected information about the respondents' socio-economic characteristics.

Data Treatment

Survey responses were first screened for completeness and quality. Respondents³ who abandoned the questionnaire or provided inconsistent answers were eliminated, resulting in a final sample of 603 participants. All the attributes were treated as continuous variables, and choice alternatives were coded consistently across both payment treatments to ensure comparability.

³ Protest responses –participants who refused to state a WTP for reasons unrelated to the attribute levels– were identified and excluded from the WTP estimation.

Data were analyzed using random utility models, including conditional logit and mixed logit models, estimated in N-logit. WTP for each attribute was derived from the ratio of the attribute coefficient to the cost coefficient. To account for sampling variability and obtain robust confidence intervals, bootstrapping with 1,000 replications was applied.

Finally, exploratory analyses were conducted to verify the random distribution of respondents across treatment groups with respect to socio-demographic variables, confirming the absence of significant imbalances in gender, age, or residence location.

4. Results

4.1. Descriptive Results

The final sample of 603 respondents were randomly divided into two groups based on the modality of the non-hypothetical payment: Group 1 included 301 respondents who received a CE and voluntary payment, while Group 2 comprised 302 respondents who were assigned obligatory payment. There were no statistically significant differences between the two groups in terms of control variables (e.g., gender, educational level, age, and income), which could have impacted the WTP analysis results. Table 2 summarizes a comparison of the two samples concerning the control variables.

TABLE 2

Demographic Characteristics of Group 1 (Voluntary Payment) and Group 2 (Obligatory Payment)

Variable	Type	Description	Test	Value	Hypothesis
Income	Categorical	6 categories	Chi-squared test	0.443	We failed to reject the H0 (there was a relation between income and groups)
Gender	Bivariate	0 = Male, 1 = Female	Chi-squared test	0.904	We failed to reject the H0 (there was a relation between gender and groups)
Educational level	Categorical	7 categories	Chi-squared test	0.611	We failed to reject the H0 (there was a relationship between educational level and groups)
Age ⁴	Categorical	3 categories	Chi-squared test	0.592	We failed to reject the H0 (there was a relation between age and groups)

Source: SPSS results from Data analysis.

⁴ 1 = [18-34], 2 = [35-54], 3 = > 55

RPL Results

Table 3 shows that both RPL models had a pseudo–McFadden R-square of greater than 0.20. Bu *et al.* (2020) and McFadden (1974) suggested that logistic regression models typically have a good fit with values ranging from [0.2 - 0.4].

TABLE 3
RPL Results

β s	RPL	
	Voluntary payment	Obligatory payment
Random β s		
Water availability β_1	0.148 *** [0.05–0.241]	0.397*** [0.162–0.577]
Forest fire resistance β_2	0.022*** [0.030–0.015]	0.024*** [0.03–0.014]
Biodiversity β_3	0.004 [-0.013–0.013]	0.181*** [0.003–0.030]
Carbon sequestration β_4	0.207*** [0.058–0.355]	0.368*** [0.161–0.573]
Non-random α s		
Cost of improvement	-0.015*** [-0.017–0.012]	-0.034*** [-0.040–0.028]
ASC_SQ	-0.6122 [0.473–0.665]	-0.761*** [-1.030–0.548]
Standard deviation of means		
Water availability	0.56 *** [0.471–0.661]	0.927*** [0.751–1.042]
Forest fire resistance	0.053*** [0.045–0.060]	0.064*** [0.056–0.076]
Biodiversity	0.079* [0.063–0.096]	0.047*** [0.031–0.069]
Carbon sequestration	0.7674*** [0.058–0.948]	0.885*** [0.655–1.045]
Log-Likelihood (θ)	-2,404.37	-2,263.84
Pseudo R2	0.20	0.23

(***, **, * ==) Significance at 1 %, 5 %, and 10 %.

Source: Results from N-logit.

Table 4 offers insights into the utility of the various attributes in the CE (based on 2000 simulation draws). The voluntary payment model yielded significant positive coefficient estimates for water availability, forest fire risk, and carbon sequestration,

while biodiversity showed no statistical significance. The alternative specific constant of the status quo (ASC_SQ) was insignificant, suggesting that citizens are unconcerned about the current situation of forest management and believe that it does not provide them with either utility or disutility. In the mandatory payment group, all attribute levels exhibited significant positive coefficients. The negative sign associated with the cost attribute highlights Valencian citizens' sensitivity to the monetary contribution to forest management. The ASC_SQ was also negative, indicating a preference among respondents to improve the current state.

TABLE 4
Valencian Citizen's WTP for NbS

Attributes	WTP (€)		
	[Confidence Interval]		
	Voluntary Payment	Obligatory Payment	α -Poe test
WTP_Water availability	10.04*** (per unit) [5.02-16.04]	11.41 *** (per unit)	0.552
	10.04 *** (WTP for increasing 1 mm/year)	11.41 *** (WTP for increasing 1 mm/year)	
	30.12 *** (WTP for increasing 3 mm/year)	34.23 *** (WTP for increasing 3 mm/year)	
WTP_Forest fire resistance	1.52*** (per unit) [1.07-2.01]	0.695*** (per unit)	0.99
	40.73 *** (WTP for reducing 26,8 mg/ha of fuel load)	18.62 *** (WTP for reducing 26,8 mg/ha of fuel load)	
	61.10 *** (WTP for increasing 40,2 mg/ha of fuel load)	27.94 *** (WTP for increasing 40,2 mg/ha of fuel load)	
WTP_Biodiversity	0.025 (per unit) [(-0.84)-8.8]	0.491*** (per unit)	0.706
	NS	2.45*** (WTP for increasing 5 %)	
	NS	9.8*** (WTP for increasing 20 %)	
WTP_Carbon sequestration	13.66** (per unit) [4.08-22.67]	10.58** (per unit)	0.073
	8.19 ** (WTP for increasing 0.6 mg/ha)	6.35 ** (WTP for increasing 0.6 mg/ha)	
	21.85 ** (WTP for increasing 1.6 mg/ha)	16.95 ** (WTP for increasing 1.6 mg/ha)	

(***, **, * ==) Significance at 1 %, 5 %, 10 % level

Source: Results from Nlogit.

Notably, coefficients from each split sample cannot be compared due to differences in scale parameters (Poe *et al.*, 1994). However, WTP estimation can explain the impact of the payment vehicle on preference patterns. By normalizing the data and accounting for individual preferences and population heterogeneity, WTP estimation provides a standardized metric that facilitates meaningful comparisons across datasets from each sample.

Table 4 demonstrates Valencians' WTP for forest restoration. The participants are willing to pay up to €30.12/year to ensure high water availability, up to €61.10/year to improve forest fire resistance, and up to €21.85/year to support carbon sequestration. However, their WTP for biodiversity was not significant. These results mostly align with the literature, with one notable exception regarding biodiversity, which could be explained in two ways. According to Martín-López *et al.* (2007), non-economic motives, such as familiarity and biophilia, can significantly influence an individual's WTP for biodiversity conservation. Individuals' likelihood of engaging in conservation projects may decrease if they lack a personal connection with or admiration for the natural world. With increased awareness of the benefits of biodiversity, individuals may perceive it as valuable enough to warrant financial support. Thiene *et al.* (2012) and McFarlane (2005) found that many respondents were unwilling to pay for forest biodiversity conservation and that cognitive and social-cultural factors influenced perceived risk to forest biodiversity.

Respondents under the obligatory treatment were willing to pay for all attributes, aligning with expectations. They were willing to pay up to €34.23 for water availability, €27.94 for forest fire resistance, 9€ for biodiversity, and €16.95 for increasing carbon sequestration rate. Such behavior reflects a strategic approach, with individuals seeking to optimize the outcomes of their mandatory contributions by supporting all CE attributes. Specifically, the obligatory nature of the payment incentivizes individuals to prioritize comprehensive improvement, leading to WTP for all attributes included in the decision-making process (Meginnis *et al.*, 2021). Therefore, mandatory payments significantly impact individuals' decision-making strategies and preferences for overall improvement.

To investigate whether the payment vehicle influenced the respondents' forest ecosystem restoration valuation, we followed Swait *et al.*'s (1994) steps, where the H_1 considers whether two groups have the same preference structure.

We first estimated a pooled model ($LR^5 = 4700.69$) across the two choice treatments. A typical $LR^6 - 2 (L_R - (L_1 + L_2))$ test was used to test the null hypothesis $=$, where the test value was 38.07 with a critical $= 18.31$, allowing for the rejection of the null hypothesis (equal preference structure between the two treatments). This result

⁵ LR refers to the loglikelihood.

⁶ Chi-squared for $((K+1) = 10) = 18.31$.

suggests that the difference in payment vehicles influenced the modelled preference structure.

A Poe test was then estimated. Table 5 reveals the results of the Poe test based on a 10 % ($\alpha = 0.1$) significance level only for carbon sequestration. The null hypothesis is rejected for the remaining attributes, affirming a significant difference in WTP between citizens who were assigned voluntary payment and those assigned obligatory payment for all four attributes except carbon sequestration. Participants were willing to pay €32.48 for the moderate improvement scenario and €71.97 for the important improvement scenario for obligatory payment, while they were willing to pay €58.96 for the moderate improvement scenario and €113.07 for the important improvement scenario for voluntary payment.

5. Discussion

The findings of this study confirm that the payment mechanism significantly affects citizens' WTP for forest ecosystem restoration in Valencia. While both voluntary and obligatory schemes yielded statistically significant preferences for environmental attributes, the magnitude and direction of these preferences varied across treatments. This section offers a more in-depth theoretical and empirical interpretation of the results, comparing them to similar works and drawing relevant implications.

The results align with our hypothesis that citizens in Valencia are willing to pay more under voluntary payment. Empirically, the higher WTP values observed under the voluntary payment mechanism align with findings from previous studies indicating that voluntary contributions can trigger a “warm-glow” effect (Andreoni, 1990; Brouwer *et al.*, 2008). This effect is linked to the intrinsic satisfaction derived from prosocial actions, particularly when individuals feel a sense of autonomy and moral fulfillment (Spash, 2000). For instance, Champ *et al.* (1997) and Löschel *et al.* (2013) found that voluntary contribution mechanisms often produce higher valuations because respondents feel more directly connected to the cause and perceive greater control over their decisions.

From a behavioral economics perspective, this result supports self-determination theory, which posits that individuals derive higher utility when decisions are self-directed rather than externally imposed (Deci & Ryan, 2000). This theoretical perspective explains why respondents in the voluntary treatment expressed higher WTP: without coercion, individuals align financial contributions with their internal motivations and perceived environmental responsibility. Conversely, mandatory payments may activate psychological reactance, prompting individuals to focus more on cost minimization rather than value maximization (Frey & Jegen, 2001).

In economics, costs are typically considered a negative influence on consumer behavior, with higher costs leading to reduced consumption. Valencians may contribute to restoration through NbS because they are directly affected by ecosystem degradation; for example, some have suffered due to fires and water scarcity. However, it is not guaranteed that citizens will donate the amount they claim if the payment mechanism is implemented. Moreover, people who are more willing to make voluntary payments value the connection they have with their financial contributions. This autonomy can increase engagement and satisfaction, as individuals feel their contributions are a personal choice rather than a mandated obligation.

However, donations frequently produce a warm glow effect, resulting in positive emotional rewards for the donor. This emotional response can make the donation cost appear less burdensome, challenging the conventional economic assumption that costs deter spending, and can lead to seemingly irrational behaviors, with individuals being more willing to incur higher costs because they derive satisfaction from giving. This effect can also influence the results of coercive payment methods, especially if respondents are uncertain whether their monetary contributions will be used for forest restoration.

In comparing attribute-level effects, strong preferences for forest fire resistance, water availability, and carbon sequestration confirm the importance of tangible ecosystem services in Mediterranean regions. These results align with studies by Pascual *et al.* (2014), Bernués *et al.* (2014), and Meyerhoff *et al.* (2009), who demonstrated that respondents tend to prioritize attributes that directly affect local well-being, such as water regulation and fire prevention.

The insignificant ASC under voluntary payments and the negative ASC under mandatory payments indicate that payment framing and perception of freedom of choice strongly shape individuals' choice. Hence, the absence of a statistically significant ASC_SQ in the voluntary payment context suggests that respondents' choices were primarily driven by the specific attributes of the proposed forest management improvements rather than by a general preference regarding maintaining the current situation. When payments are voluntary, individuals may evaluate the characteristics and perceived benefits of each alternative more attentively, while the absence of a mandatory financial commitment reduces the salience of the status quo option. However, under the mandatory payment scheme, the obligation to contribute introduces a more explicit trade-off between cost and environmental improvement, which is reflected in the significant ASC_SQ.

Hanley *et al.* (2009) and Kaczan *et al.* (2013) reported similar findings, emphasizing that coercive contexts can heighten sensitivity to cost while voluntary contexts reduce psychological resistance, allowing more attribute-driven decision-making. This factor underscores the importance of designing policy instruments that balance regulatory effectiveness with perceived autonomy. When individuals feel empowered to decide, they are more likely to internalize environmental objectives and contribute willingly,

leading to higher long-term engagement (Deci & Ryan, 2000; Vlek & Steg, 2007). Conversely, mandatory payment schemes, although efficient for revenue collection, may evoke perceptions of unfairness or lack of agency, potentially undermining public trust and compliance (Frey & Jegen, 2001). Therefore, fostering a sense of voluntary participation within obligatory frameworks, through transparency, feedback mechanisms, or co-decision processes, could enhance both the legitimacy and effectiveness of environmental policy instruments.

6. Conclusions

Using two hypothetical payment methods, this study provides a relevant perspective on assessing citizens' preferences for and willingness to pay for forest ecosystems. From our understanding, no research has been conducted on the impact of payment methods on individuals regarding forest management in Spain. The findings revealed that, except for biodiversity in the voluntary payment group, individuals in both groups exhibited interest in the attributes presented. This finding indicates substantial and statistically significant preferences. When comparing the WTP estimates within the same treatment, the most valued attribute was fire resistance, followed by water availability.

The results showed a difference in participants' WTP between the two payment vehicles, indicating that citizens may be willing to pay more under a voluntary payment option than an obligatory one. Importantly, the findings suggest that voluntary payments foster a sense of goodwill and community involvement, potentially leading to more enthusiastic participation and support for specific causes or services, thereby painting an optimistic picture for the future. This sense of social belief in donations and charities for forest restoration in Valencia, demonstrating a strong attachment to this good and its services, is inspiring and encouraging.

However, public strategy decisions rely on consistent and adequate funding to function effectively. If ES are funded through voluntary payments, they may become underfunded, leading to diminished service quality that will affect low-income communities in particular. Voluntary contributions need to be more stable and sufficient to meet the entire population's needs. Otherwise, taxation must be applied to implement the best forest management practices.

From a policy perspective, the results of this study provide relevant implications beyond the Valencian context. They suggest that voluntary and hybrid funding mechanisms could effectively complement the current instruments under the *European Green Deal* (European Commission, 2019), the *EU Biodiversity Strategy for 2030* (European Commission, 2020), and the *Common Agricultural Policy 2023-2027* (European Commission, 2021), which emphasize community participation and the sustainable use of natural resources. Integrating voluntary citizen contributions into Payment for Ecosystem Services (PES) schemes (Organisation for Economic

Co-operation and Development, 2025; Wunder, 2015) or local NbS initiatives could enhance the financial resilience of restoration programs while fostering civic engagement. Moreover, trust in institutions and perceived fairness are key determinants of citizens' WTP for environmental programs (Binder & Blankenberg, 2017; Kaczan et al., 2013). Strengthening transparency and accountability in fund allocation could increase the acceptability of voluntary and coercive mechanisms. These findings align with broader European efforts to promote participatory and socially inclusive approaches to ecosystem restoration, as reflected in the new *Nature Restoration Law* (European Parliament, 2024) and *Horizon Europe Missions on Soil Health and Food* (Giuffrè et al., 2021).

Caution must be exercised when interpreting these results, as this study does have limitations. Although cheap talk and reminders were used before each decision to reduce hypothetical bias, its absence cannot be guaranteed. More research is required to investigate additional factors that influence decision-making. For instance, incorporating real monetary incentives could provide a more accurate reflection of payment behaviors. Moreover, longitudinal studies could assess how preferences and behaviors evolve. Examining more diverse social morals and norms among groups would help understand WTP variations across different populations on both payment mechanisms. Finally, while the cheap talk script was cognitively validated during the pilot phase to ensure clarity and realism, no formal Attribute Non-Attendance ANA or dominance test was applied; respondents were instructed to consider all attributes carefully. The absence of explicit ANA validation is a study limitation, and future research should include ANA models to address potential attention biases.

Authorship Contributions

Sameh Missaoui: Writing – original draft, Data curation, Formal analysis, Methodology, Writing – review & editing. **Zein Kallas:** Supervision, Methodology, Writing – review & editing, and Funding acquisition. **Antonio del Campo:** Writing – original draft, Writing – review & editing, Validation. **Javier Perez:** Writing – original draft, Writing - review & editing, Validation.

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Declaration of Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The database supporting this study's findings is available from the corresponding author upon reasonable request.

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