



For the love of money and the planet: Experimental evidence on co-benefits framing and food waste reduction intentions

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ABSTRACT

This randomized control trial examines the effect of informational nudges highlighting the monetary or environmental benefits, or co-benefits, of food-saving behaviors on intentions to reduce food waste within the framework of the Extended Theory of Planned Behavior (ETPB). A representative sample of Spanish participants ($N = 1008$) were exposed to control, monetary, environmental, or co-benefits conditions and asked to indicate their intentions to reduce household fruit and vegetable waste. Psychological, behavioral, and situational ETPB factors affecting food waste behavior were also measured. Only co-benefits framing was found to have a significant effect. Participants who were highly concerned about the environmental impact of wasting food were more strongly influenced by the co-benefits and monetary framings. Further, perceived behavioral control and food waste habits were positively associated with food-saving intentions. Thus, co-benefits framing in informational nudges can strengthen consumer intention to reduce fruit and vegetable waste, especially among consumers with higher levels of environmental concern.

1. Introduction

Motivating households to reduce food waste is crucial for building environmentally sustainable food systems and addressing climate change. Food systems are responsible for approximately one-third of global greenhouse gas emissions (Sachs et al., 2021; Sala et al., 2017). However, 17% of the food produced for human consumption globally is never consumed (United Nations Environment Programme, 2021). Food waste refers to a decrease in the quantity or quality of food that results from the actions of retailers, food services, and final consumers or households (FAO, 2019). Household food waste accounts for 11% of the food available for human consumption (United Nations Environment Programme, 2021) and is particularly a problem in high-income countries (Parfitt et al., 2010). In the European Union more than half of the total food waste is generated by households (Stenmarck et al., 2016). Wasted fruits and vegetables are important contributors, as they account for 29% – 47% of household food waste (de Laurentiis et al., 2018). The biggest contributors to household food waste in Europe are Portugal (31.8%), Latvia (22.6%), and Spain (22%) (Eurostat, 2022), and household food waste generation in these countries has increased over the last decade. According to recent data, Spain has the highest per capita waste generation at 1.426 kg, while it is 1.328 kg in Portugal and

1.311 in Latvia (Eurostat, 2022). Raw food and fruits and vegetables contribute to 44.9% of food waste, with dairy products and meat contributing to 12.8% and 6.5%, respectively (Ministerio de Agricultura, 2022).

The high level of fruit and vegetable waste (FVW) is costly for both households and the planet, in terms of wasted money and unnecessary emissions (Bravi et al., 2020; FAO, 2015). Therefore, researchers have developed and tested various interventions, such as nudges, to increase motivations, intentions, and behaviors related to food saving. A recent review by Hebrok and Boks (2017) identified several interventions for increasing consumer motivation and food-saving behaviors, including awareness campaigns, informational nudges (e.g., providing social information about how consumers “perform” in relation to their peers and neighbors), environmental nudges (e.g., reducing plate size), and even technologies such as intelligent fridges. However, causal evidence about the effectiveness of such interventions is scarce and more evidence on this topic is required. Consumers may not be sufficiently motivated to reduce food waste because they need to balance multiple, often competing motivations such as maintaining budgets and acting morally (van Geffen et al., 2020a).

The current article presents the results of an online randomized controlled trial (RCT) conducted in Spain that is the first investigation

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into the effectiveness of behavioral interventions in leveraging consumer motivations to save money, the planet, or both money and the planet (i.e., co-benefits). Specifically, informational nudges that frame the monetary versus environmental benefits of saving food, or the co-benefits arising from both, are tested for their effects on intentions to reduce household FVW waste in a representative sample of the Spanish population. The intervention builds on, extends, and empirically tests the Extended Theory of Planned Behavior (ETPB).

1.1. Extended theory of planned behavior

The theory of planned behavior (TPB; Ajzen, 1991) has been widely used to study pro-environmental behaviors. It proposes that each behavior is determined by the intention to perform it, which is, in turn, influenced by the interplay between attitudes toward the behavior, relevant subjective norms, and perceived behavioral control. According to Yuriev et al. (2020), TPB is suitable for the study of pro-environmental decision-making for three reasons. First, it allows for the identification and assessment of beliefs about specific behaviors across several contexts while obtaining easily understandable and comparable results. Second, it “is considered [to be] one of the most effective models for developing behavioral interventions” (Yuriev et al., 2020, p. 2). Third, TPB is a flexible framework as different variables (or factors) can be added, and these can strengthen the explained variance of the model. However, TPB does not explicitly theorize about *habitual* actions, i.e., choices that are repeated nearly automatically in a given context (Klöß, 2013; Visschers et al., 2015). As many food waste and saving practices are habitual, this is a potential setback of using the original TPB framework. However, recent work has adopted and applied the Extended TPB or ETPB model to study household food waste behaviors. ETPB includes behavioral factors, such as past behavior and habits, that are relevant to the household food journey (Principato et al., 2021). Russell et al. (2017) have highlighted the importance of past food waste habits in general, while other researchers have considered more specific habitual behaviors such as food planning, shopping routines, and reuse of leftovers (Stancu et al., 2016; Stefan et al., 2013). The ETPB model also comprises psychological factors, such as personal norms and moral values, that can influence food waste behaviors (Barbera and Ajzen, 2020; Rivas et al., 2009). Specifically, self-perceptions about being a “good provider,” anticipated regret, and routines such as food planning, shopping list making, and leftovers reuse have been identified as predictors of food waste intention (Graham-Rowe et al., 2015; Kaiser, 2006; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2015). Most relevant to the design of the intervention in this study was van der Werf et al.’s (2021) observation that financial, environmental, and ethical attitudes toward food waste also motivate food waste reduction efforts. These past studies, however, do not address which type of motivation is most persuasive in informational interventions (i.e., saving money or the environment), or whether leveraging multiple motivations (i.e., co-benefits of saving money and the planet) is more effective. Understanding the effectiveness of different motivations is important to inform behavior-change campaigns.

The current study builds upon van der Werf et al.’s (2021) observation and expands the ETPB model by including effects of informational nudges such as framing interventions. It also investigates whether attitudinal antecedents, such as financial, environmental, and ethical attitudes, moderate intervention effects. Since food waste reduction efforts are typically composed of multiple behaviors and habits rather than a single action (Quested et al., 2013), the current work also builds on previous research that applied the ETPB framework by measuring psychological, behavioral, and situational factors motivating households to reduce food waste. These factors are also used as covariates to ensure that the estimated effects of the intervention are robust.

Apart from examining the promise of food-saving interventions which aim to make motivations salient and are based on the ETPB framework, this study adds to existing evidence by examining an under-

studied high food waste setting, namely, Spain. To the best of our knowledge, only two works have explored TPB and food waste in Spain. Mondéjar-Jiménez et al. (2016) explored students’ food waste behaviors in Spain (at the University of Castilla-La Mancha) and Italy (at the University of Tuscia in Viterbo) and found that only certain TPB factors, such as perceived behavioral control and moment of purchase, predicted self-reported food waste behaviors. In addition, Fraj-Andrés et al. (2022) used focus groups to explore the intention-behavior gap in food waste among young consumers (20–35 years old). While their findings and proposed model are consistent with the ETPB model for household food waste (Fig. 1), they added that constraints such as perceived monetary costs, time, and effort were important variables. The present work will build on the already published food waste literature in the context of Spain by exploring the ETPB model in the broader Spanish population through a quantitative experimental study.

The modifications to the original model made by the current research are highlighted in bold. The original ETPB model was extended by factoring in behavior-change interventions and exploring the novel moderation effects of the antecedents for intervention effectiveness.

1.2. Environmental and monetary motives and framing effects

“Framing effects” occur when (often small) changes in the presentation of an issue or an event produce (sometimes large) changes of opinion, and possibly behaviors (Chong and Druckman, 2007, p. 111). Changes in opinions and behaviors may occur because how choices are framed can create new beliefs about an issue, make specific beliefs more accessible, or make “stronger” beliefs in people’s evaluations (ibid). As noted by Tversky and Kahneman (2018), the frame that people adopt may be controlled partly by the formulation of the problem (e.g., the benefits of taking action) and partly by their norms, habits, and personal characteristics. Thus, it is often possible to frame a given behavior in multiple ways, and the framing effects may be dependent on which frame is used.

The effectiveness of using monetary versus environmental framing in promoting pro-environmental behaviors has been much debated. Framing effects typically emerge from making either the environmental benefits or the financial gains of a target behavior salient in informational interventions and nudges. In the Netherlands, Dogan et al. (2014) found that feedback on environmental savings (i.e., reduced greenhouse gas emissions) significantly increased intentions to adopt eco-driving behaviors, whereas feedback on financial savings (i.e., reduced monetary cost) had a significant but weaker effect. Likewise, two studies in Germany consistently showed that framing electricity-saving tips with environmental and monetary appeals could promote electricity-saving intentions; however, only environmental framing increased people’s willingness to take other pro-environmental actions such as using public transportation rather than driving (Steinhorst et al., 2015; Steinhorst and Klöckner, 2018). In the USA, Asensio and Delmas (2015) found that tailored health and environmental feedback led to greater household energy conservation than monetary feedback. However, they combined two non-monetary benefits, i.e., health and environment, so it is not clear whether the results were driven by environmental or health motives.

In the domain of food waste interventions, a limited number of previous studies have attempted to compare environmental framing with monetary framing, and reported mixed results. Chen and Jai (2018) demonstrated that the environmental message “Reduce Waste for a Sustainable Future” led to more positive consumer attitudes toward preventing food waste in a restaurant than the monetary message “We Charge \$5 per Pound for Food Waste.” However, no significant difference was observed in consumer intentions. Since their monetary message contained a threat and the implication of punishment, the observed attitudinal difference could have been induced by negative emotions. Similarly, Nisa et al. (2020) found that messages highlighting the environmental consequences of food waste increased consumer

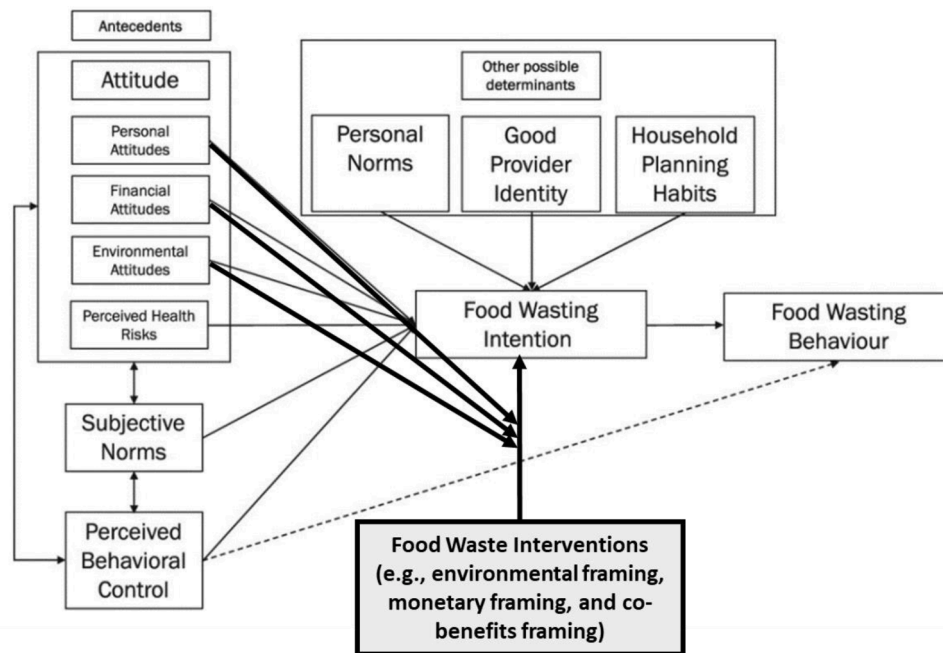


Fig. 1. The ETPB model for household food waste (adapted from van der Werf et al. (2021, p. 155)).

awareness, while messages about economic costs resulted in lower consumer awareness. Unfortunately, in their study, neither framing impacted the willingness to tackle food waste in the future; this is probably because their framing messages did not target any specific food waste behaviors. Therefore, the framing effects of environmental versus monetary motives on food waste reduction intentions remain unclear. The current research builds on the past studies and overcomes their limitations by comparing only environmental and monetary benefits in the context of food waste intentions, by maintaining positive framing across messages (i.e., emphasizing the benefits of saving food rather than the cost of wasting food), and targeting the specific action of saving fruits and vegetables at home.

No experimental studies to date have considered combining both environmental framing and monetary framing in a single intervention to reduce household food waste. Co-benefits typically refer to wider benefits to an individual, household, or community that do not necessarily depend on environmental costs or benefits (Bain et al., 2016). In this case, benefits to consumers that can be accrued from saving money by reducing food waste need not hinge on saving the planet. Thus, a clear advantage of co-benefits is that they can appeal to people concerned about the planet as well as to those who are unconcerned or even skeptical about eco-issues (Bain et al., 2016; Shreedhar and Galizzi, 2021). Thus, co-benefits framing may increase food saving intentions among those who already care about the environment as well as those without a high level of environmental awareness.

Appealing to multiple motivations is especially important because food waste behaviors are affected by how people balance multiple motivations and goals. Qualitative studies using focus groups conducted in four European countries, including Spain, showed that people balance multiple motives, such as eating within a budget, being healthy, enjoying food, and acting morally and ethically, and that waste is the unintended result of balancing multiple goals that are perceived as competing with each other (van Geffen et al., 2020). We are not aware of other studies that have evaluated the impact of co-benefits versus single benefits on food waste intentions or behavior per se. With regards to co-benefits framing, Shreedhar and Galizzi (2021) found that people tended to consume vegetarian food for a longer period when they were exposed to a co-benefits informational intervention that stated the health and environmental benefits (as compared to a control group). However,

Bernauer and McGrath (2016) found that co-benefits framing had no effect on policy support for climate change. It is unclear whether these observed effects (or lack of any effect) of co-benefits framing can be applied to the context of food saving intentions. That is, co-benefits framing could increase food saving intentions, have no effect, or even backfire.

One reason that co-benefits framing could backfire is due to “motivation crowding out” (Frey and Oberholzer-Gee, 1997). Motivation crowding out refers to the idea that monetary incentives can unexpectedly reduce (rather than increase) a desired behavior. This can occur because reminding people of the transactional, monetary benefits to themselves may crowd out self-transcendental norms and concern for other parties including the environment (Bolderdijk et al., 2013; Ling and Xu, 2021a). For example, Ling and Xu (2021a) found that an incentive-based recycling program crowded out pro-environmental motivation. Thus, the conventional wisdom of appealing to self-interested monetary gains may not be the best way to secure behavior change. Moreover, it is not evident that combining monetary and environmental benefits is more effective than focusing on either self-interested monetary or public environmental benefits, or how these dynamics play out in the context of food waste intentions. The current study addresses this gap in the literature by including a co-benefits framing condition and explicitly comparing its causal effect with that of monetary framing and environmental framing alone. Furthermore, this approach is novel because it accommodates framing interventions within the ETPB model (Fig. 1). Apart from randomizing exposure to different conditions, all the ETPB factors will be controlled for in subsequent regression analyses to ensure that the results are robust. Further, the study examines the moderating effect of certain attitudes, i.e., environmental attitude, financial attitude, and ethical considerations, that are congruent with the chosen framing interventions and likely to moderate the intervention effects.

To summarize, this research examines how environmental, monetary, and co-benefits framings affect intentions to reduce FVW. Since it is difficult to infer from previous empirical literature which framing is more likely to have the strongest positive effect, we hypothesize that each framing has a positive effect and compare it to a control condition with no intervention:

H₁: Exposure to monetary framing increases intentions to reduce

fruit and vegetables waste at home compared to the control condition.

H₂: Exposure to environmental framing increases intentions to reduce fruit and vegetable waste at home compared to the control condition.

H₃: Exposure to co-benefits framing increases intentions to reduce fruit and vegetables waste at home compared to the control condition.

We have also explored whether attitudinal constructs from the ETPB model, i.e., financial, environmental, and ethical attitudes, moderate any of the estimated treatment effects, irrespective of the direction of the moderated effects.

2. Material and methods

2.1. Experimental design and procedures

An RCT embedded in an online survey was conducted in Spain from April 29 to May 10 2022. A between-participants design was used, with each participant randomly allocated to the control (no intervention), monetary framing, environmental framing, or co-benefits framing condition.

To estimate the sample size per group, a power analysis was conducted using G*power (version 3.1.9.6). The calculated sample size was 253 participants per group, under the assumption of a small-to-medium effect size ($d = 0.25$) and 80% power (Faul et al., 2007).

The research team designed the questionnaire, which was implemented with the help of a panel and a data collection firm, NetQuest. They recruited participants through their online panel based on the following behavioral and demographic criteria: participants had to be above 18 years old, be responsible for household purchases, and usually waste at least one food item at home (including FVW, among other food items). The sample was representative of the Spanish population with

regard to age, sex, and regional distribution. The topic of the study was “Food waste behaviors and attitudes in Spain.” The study received ethics approval from the university.

A structured questionnaire with closed questions was administered. The respondents first provided their informed consent to participate. This was followed by assessment of items from the ETPB model based on past work carried out on food waste and fruit and vegetable waste (Coşkun and Yetkin Özbük, 2020; Graham-Rowe et al., 2014; Thompson et al., 2020). The respondents were then exposed to the experimental condition they had been allocated to (see Fig. 2).

2.2. Experimental interventions

In each of the treatment groups, the framing message was presented as an informative display in the fruit and vegetable aisle of a supermarket. This setting was used because reducing overspending on fruits and vegetables is an important indirect way to reduce waste, and because prompts work best “at the location where the behavior takes place” (van Geffen et al., 2020b, p. 43). Following the FAO’s (2013) recommendation, the message invited consumers to buy only what was needed and to consider the monetary benefits, or environmental benefits, or co-benefits of avoiding buying food that will not be eaten and will be thrown away. Waste figures were calculated based on published household panel data (Ministerio de agricultura, 2022). A photo of the fruit and vegetable aisle of the most important retailer in Spain (Mercadona) was chosen to portray the purchase context. Framing the message by using a picture of this location was expected to increase realism and improve the effectiveness of all the framing messages. To ensure consistency across conditions, the control group saw the fruit and vegetable aisle photo but was not exposed to any framing message.

After exposure to the interventions, the participants in all groups but

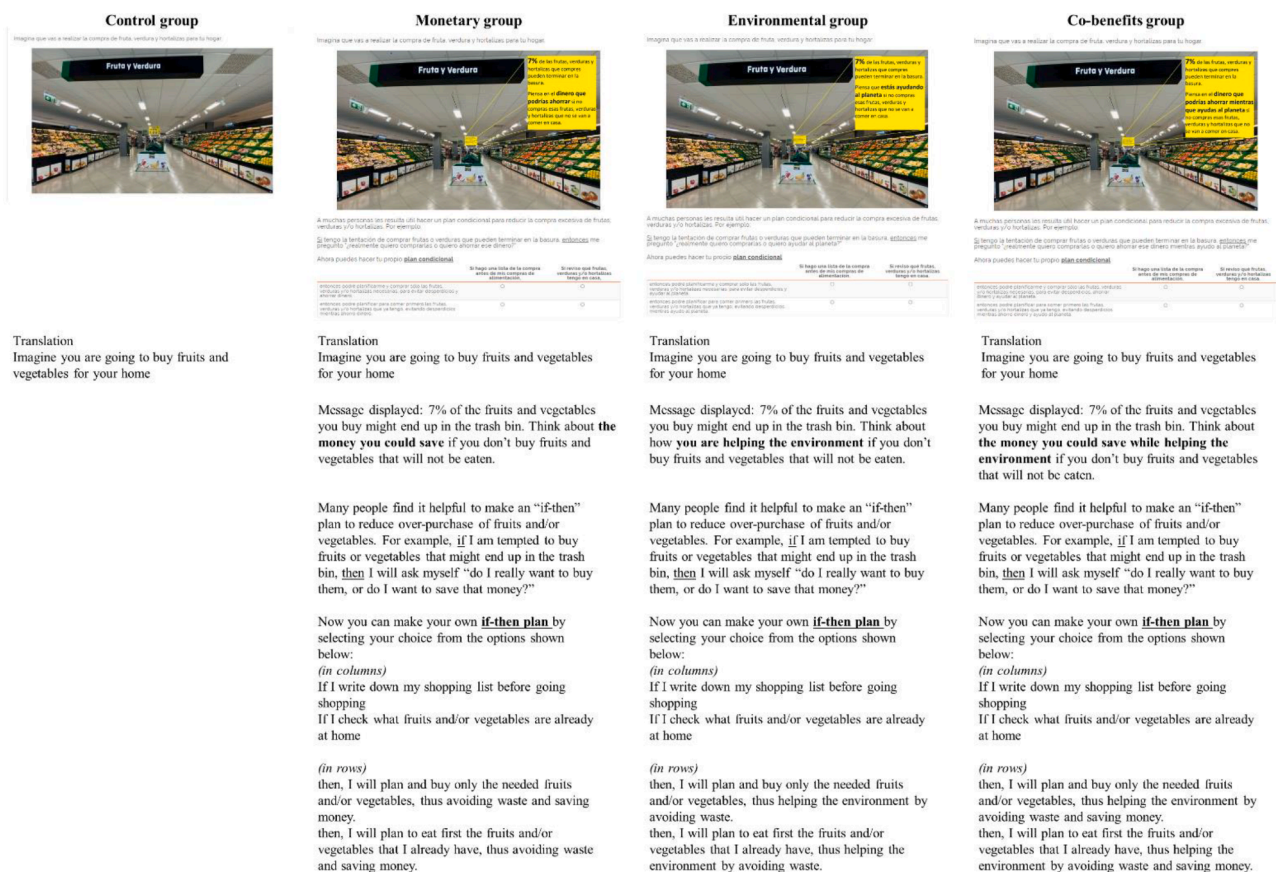


Fig. 2. The four groups were presented with an image of the fruit and vegetable aisle. Three of the groups were exposed to a framing message (monetary, environmental, and co-benefits), followed by an implementation intentions task.

the control completed a short implementation intentions task adapted from Shreedhar and Galizzi (2021), in which implementation intentions take the form of an “if–then” plan (see Fig. 2). The task required the individual to imagine a specific situation (*when* and *where*) and think about how to act in order to achieve a specific objective. The underlying principle is that by creating a plan, the intended behavior can be modified. In addition, motivational cues are relevant in complex and habitual behaviors such as food waste (Adriaanse et al., 2009). Implementation intentions have been proven to improve the efficacy of interventions for other pro-environmental behaviors, such as choosing vegetarian foods and reducing meat consumption (Rees et al., 2018; Shreedhar and Galizzi, 2021), as well as waste sorting (Wang and Mangmeechai, 2021). In the present survey, the main outcome variable, i.e., intentions to reduce FVW, was measured immediately after the task was completed.

2.3. Main variables

The questionnaire was based on past work carried out on food waste and FVW in which items from the ETPB model were measured (Coşkun and Yetkin Özbük, 2020; Djekic et al., 2019; Graham-Rowe et al., 2015; Thompson et al., 2020; Visschers et al., 2015). Questions were grouped according to psychological constructs. A five-point Likert scale was used to assess the responses, as implemented by Russell et al. (2017). The scale ranged from 1 (least positive) to 5 (most positive), unless otherwise indicated. The questionnaire was identical across all conditions, except for the framing message (questionnaire in Appendix A).

The main outcome was intentions to reduce FVW, based on Russell et al. (2017), according to the TPB framework (Ajzen, 1991). It was assessed using two items measuring how likely participants were to reduce waste over the next week and the strength of the intention: “Thinking about the next week, how likely are you to reduce fruits and/or vegetables WASTE in your home?” (Response options: 1 = very unlikely, 5 = very likely); and “And would you say that in the next week, my intention to reduce fruits and/or vegetables WASTE at home is...” (Response options: 1 = very weak, 5 = very strong). These two items were combined to form a composite FVW measure (Cronbach’s alpha = 0.66). The questions were placed after the framing messages and implementation intention task. Additionally, the intention to reduce food waste overall and the intention to reduce the purchase of fruits and vegetables were measured.

2.4. Other variables

Three attitudinal moderators—ethical considerations (EC), environmental attitudes (EA), and financial attitudes (FA)—were adapted from the works of Djekic et al. (2019) and Visschers et al. (2015). EC included two items measuring bad conscience and guilty feelings when wasting food (Cronbach’s alpha = 0.77). EA was based on five items measuring how responsible participants feel about acting on environmental issues and their perception of food waste as an environmental issue (Cronbach’s alpha = 0.39). FA was measured using two items related to the extent to which people link wasting food to wasting money (e.g., “I rarely think about money when I throw away food”) and reversing the attribute scale (Cronbach’s alpha = 0.47).

Two ETPB covariates—perceived behavioral control (PBC) and fruit and vegetable attitudes (ATT)—were measured. The measurement of PBC was adapted from Russell et al. (2017) and included three items related to the degree of control over the behavior, the perceived level of difficulty, and the perception that it is mostly up to the participant to reduce FVW. Six items, from Russell et al. (2017) and Thompson et al. (2020), were used to measure ATT: the extent to which engaging in FVW behavior at home is bad/good, harmful/beneficial to the environment, unpleasant/pleasant, unsatisfying/satisfying, unnecessary/necessary, and inappropriate/appropriate. The scale was reversed for consistency in the analysis: the higher the score, the higher the overall concern about FVW.

Next, subjective norms (SN), descriptive norms (DN), and personal norms (PN) were assessed. SN was measured using two items from Russell et al. (2017), namely, the approval of engaging and the degree of desirability of engaging in food waste behavior of “people who are important to me.” DN was measured by one item evaluating self-understanding about the extent to which the respondent thought most people they know were trying to reduce the amount of food they throw away at home (Graham-Rowe et al., 2015). Two items were used to measure PN, namely, the extent to which the respondent feels obligated not to waste food, and how much they care about what others might think about the respondent caring for the environment (Graham-Rowe et al., 2015).

The next two variables were household planning habits (HPH) and purchase behavior (PBH). HPH was measured based on four items that evaluated whether the respondent made a shopping list for groceries, planned meals, checked their inventory, and allocated a budget to food (Djekic et al., 2019; Stefan et al., 2013; van der Werf et al., 2021; Visschers et al., 2015). Five items were used to measure PBH, based on an understanding of the extent to which people buy only products on their shopping list, buy food that they already have at home, buy fruits and vegetables in bulk, buy extra food in preparation for unexpected circumstances, and buy more when food items are on sale (this scale was reversed) (Djekic et al., 2019; Stefan et al., 2013; Visschers et al., 2015). Other measured variables included self-perceptions about being a good provider and a good host (GP) (Visschers et al., 2015).

The participants then answered questions about their own behaviors, such as food items wasted last week, frequency of wastage, estimated percentage of food wasted, stores where fruits and vegetables are purchased, and frequency of purchase (Djekic et al., 2019; Graham-Rowe et al., 2015; Visschers et al., 2015). They also answered questions about other pro-environmental behaviors and sociodemographic characteristics (see the detailed list of ETPB variables in Appendix B and Cronbach’s alpha in Appendix C).

To ensure the quality of the data collected, NetQuest automatically removed respondents who answered the attention question incorrectly, the attention question being a simple math task that was inserted into the middle of the questionnaire. The quality of the responses was also verified by NetQuest based on the average time taken to answer the survey; any outliers were removed. Furthermore, NetQuest monitored participation frequency, double opt-in, captcha, and IP addresses. It follows international standard ISO 20,252, which regulates and monitors social, opinion, and market research.

2.5. Data analysis

Ordinary least squares regression with robust standard errors was used to analyze the framing effects. The outcome variable was FVW, and the intervention variable was a categorical variable with three categories corresponding to the three treatment conditions, and another variable for the control condition (the control group was omitted, as being considered as the comparison category). This technique was used because it allows for comparison of estimated treatment coefficients between models with different sets of predictors (e.g., models with and without ETPB covariates), and because it corrects for potential heteroskedasticity. To analyze moderation effects, simple slope analysis was used to shed light on the direction of the treatment effects at different levels of the moderator, and for ease of interpretation and visual presentation. Furthermore, simple slope tests are complementary to significance tests of interaction terms because they can reduce Type II errors while maintaining Type I errors at a similar rate (Robinson et al., 2013). The data were analyzed using Stata 16.

3. Results

A total of 1008 respondents successfully completed the questionnaire, including 515 females (51.09%) and 493 males, with the average

age being 45.62 years old (SD = 14.79). The regional distribution is shown in Table D.1 (see Appendix D). Our sample is, on average, one year older than the general population of Spain, and Castilla-La Mancha is slightly underrepresented (Instituto Nacional de Estadística, 2022). Despite this, the overall patterns in terms of sex, age, and regional distribution are representative of the Spanish population.

The sample size for each condition was as follows: control = 250, monetary = 250, environmental = 252, and co-benefits = 256. Since this was an RCT, all the groups were matched in terms of sex, age, region, social class, household composition, and employment status (see Appendix E).

3.1. Main effects of framing on intentions to reduce FVW

Compared with the control group, only the co-benefits framing had a significant and positive effect on intentions to reduce FVW ($\beta = 0.18$, SE = 0.06, $p = 0.008$), whereas the monetary framing ($\beta = 0.03$, SE = 0.06, $p = 0.587$) and the environmental framing ($\beta = 0.09$, SE = 0.06, $p = 0.154$) had a positive but statistically insignificant effect. These results do not support Hypotheses 1 and 2, but they do support Hypothesis 3. The results did not change substantially when the ETPB and socio-demographic covariates were controlled for in Models 2 and 3, respectively (see Models 2 and 3 in Table 1). In terms of the ETPB constructs, PBC, norms, and EC were identified as important predictors of intentions, as was HPH. In terms of other behavioral factors, food-saving intentions were also positively associated with past pro-environmental behaviors and the number of stores from which fruits and vegetables were purchased.

3.2. Environmental attitudes as a moderator

A moderation analysis was conducted on intentions to reduce FVW by using framing conditions, EA (centered), and the interaction terms as predictors. The model revealed that EA significantly moderated the effects of co-benefits framing ($\beta = 0.29$, SE = 0.13, $p = 0.026$) and monetary framing ($\beta = 0.35$, SE = 0.12, $p = 0.003$), but not the effects of environmental framing ($\beta = 0.16$, SE = 0.12, $p = 0.194$). Simple slope analyses further demonstrated that for those with a high EA score (1 SD above the mean), co-benefits framing ($\beta = 0.34$, SE = 0.09, $p < 0.001$) and monetary framing ($\beta = 0.21$, SE = 0.08, $p = 0.016$) significantly increased intentions to reduce FVW, while environmental framing had only a marginally significant impact ($\beta = 0.18$, SE = 0.09, $p = 0.052$). For those with a low EA score (1 SD below the mean), none of the three framings significantly influenced intentions to reduce FVW (monetary framing: $\beta = -0.17$, SE = 0.09, $p = 0.079$; environmental framing: $\beta < 0.01$, SE = 0.09, $p = 0.979$; co-benefits framing: $\beta = 0.02$, SE = 0.10, $p = 0.793$; also see Fig. 3). See Table G.1 (in Appendix G) for detailed results.

3.3. Ethical considerations as a moderator

When framing conditions, EC (centered), and interaction terms were used as predictors, the model revealed that EC significantly moderated the effects of co-benefits framing ($\beta = 0.21$, SE = 0.08, $p = 0.016$) and monetary framing ($\beta = 0.16$, SE = 0.07, $p = 0.035$), but not those of environmental framing ($\beta < 0.01$, SE = 0.07, $p = 0.998$). Simple slope analyses showed that for those with a high EC score (1 SD above the mean), co-benefits framing ($\beta = 0.34$, SE = 0.09, $p < 0.001$) and monetary framing ($\beta = 0.19$, SE = 0.09, $p = 0.033$) significantly increased intentions to reduce FVW, while environmental framing did not have a significant impact ($\beta = 0.08$, SE = 0.08, $p = 0.316$). For those with a low EC score (1 SD below the mean), none of the three framings significantly influenced intentions to reduce FVW (monetary framing: $\beta = -0.10$, SE = 0.09, $p = 0.303$; environmental framing: $\beta = 0.08$, SE = 0.09, $p = 0.369$; co-benefits framing: $\beta = -0.03$, SE = 0.10, $p = 0.741$; also see Fig. 4). See Table G.3 (in Appendix G) for detailed results.

Table 1
Framing effects on intentions to reduce FVW.

Ordinary least squares regression models	1: No covariates	2: ETPB covariates	3: ETPB & SD covariates
Treatment 1 = Monetary framing	0.0380 (0.0698)	0.0289 (0.0587)	0.0416 (0.0589)
Treatment 2 = Environmental framing	0.0943 (0.0661)	0.0939 (0.0571)	0.104* (0.0569)
Treatment 3 = Co-benefits framing	0.183*** (0.0685)	0.134** (0.0572)	0.129** (0.0570)
Perceived behavioral control (PBC)		0.237*** (0.0281)	0.235*** (0.0279)
FVW attitudes (ATT)		0.0422 (0.0405)	0.0473 (0.0393)
Total norms (TN)		0.171*** (0.0470)	0.181*** (0.0461)
Ethical considerations (EC)		0.139*** (0.0358)	0.133*** (0.0359)
Environmental attitudes (EA)		0.0457 (0.0466)	0.0448 (0.0456)
Financial attitudes (FA)		0.0300 (0.0344)	0.0195 (0.0342)
Good provider/host identity (GP)		0.0335 (0.0278)	0.0352 (0.0273)
Household planning habits (HPH)		0.0834*** (0.0317)	0.0772** (0.0313)
Household purchase behaviors (PBH)		0.0419 (0.0450)	0.0488 (0.0451)
No. of stores for purchasing F&V		0.0623** (0.0278)	0.0576** (0.0275)
Pro-environmental behavior (PEB)		0.0153* (0.00809)	0.0161** (0.00812)
No. of F&V purchases per week		-0.00723 (0.0178)	-0.00983 (0.0177)
No. of items wasted overall		0.00380 (0.0105)	-0.00286 (0.00999)
No. of items wasted in the last 4 weeks		0.0101 (0.0159)	0.00917 (0.0154)
Constant	3.864***	0.609**	0.406 (0.00133)
F-statistic	2.70	22.86	16.52
Prob > F	0.044	0.000	0.000
Observations	1008	1008	1008
Sociodemographic and household covariates	No	No	Yes
R-squared	0.008	0.311	0.328
Mean Variance Inflation Factor	1.51	1.39	1.35

Notes: The robust standard errors are shown in parentheses and *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Omitted categories for categorical variables: Treatment for the control condition, male for Gender.

ETPB covariates: Extended Theory of Planned Behavior covariates; SD covariates: sociodemographic covariates. See Table F.1 (in Appendix F) for detailed results.

3.4. Financial attitudes as a moderator

When framing conditions, FA (centered), and interaction terms were used as predictors, the model revealed that FA significantly moderated the effects of monetary framing ($\beta = 0.23$, SE = 0.08, $p = 0.008$), but not those of co-benefits framing ($\beta = 0.06$, SE = 0.08, $p = 0.440$) or environmental framing ($\beta = 0.02$, SE = 0.08, $p = 0.810$). Since the interaction terms were significant, simple slope analyses were conducted to

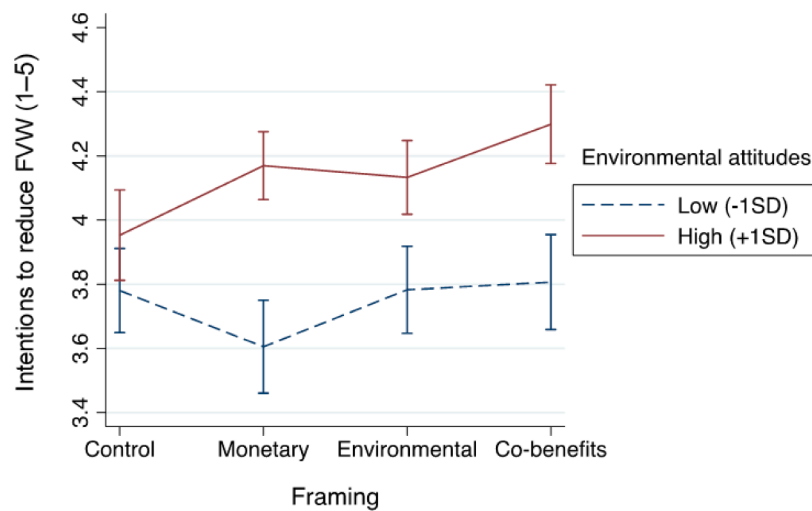


Fig. 3. Environmental attitudes as a moderator of treatment effects on FVW reduction intentions.

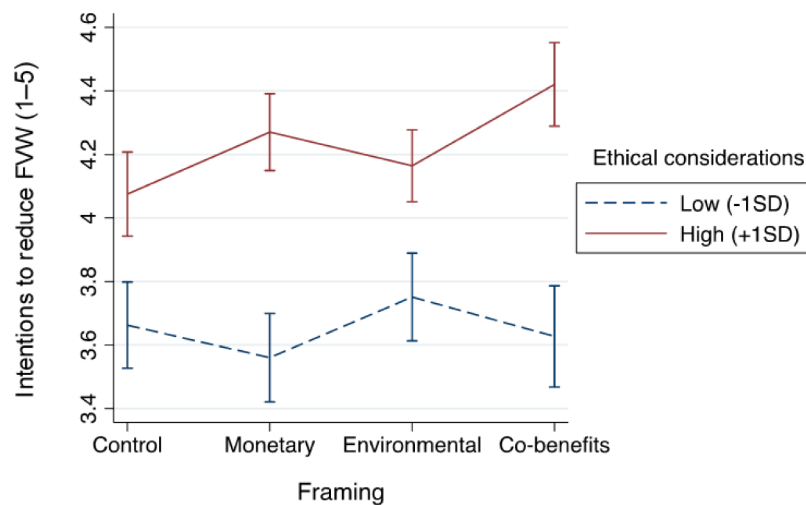


Fig. 4. Ethical considerations as a moderator of treatment effects on FVW reduction intentions.

reduce Type II errors (Robinson et al., 2013) and determine the direction of the treatment effects at different levels of the moderator. For those with a high FA score (1 SD above the mean), co-benefits framing ($\beta = 0.25$, $SE = 0.09$, $p = 0.007$) and monetary framing ($\beta = 0.23$, $SE = 0.08$, $p = 0.009$) significantly increased intentions to reduce FVW, while environmental framing did not have a significant impact ($\beta = 0.13$, $SE = 0.09$, $p = 0.157$). For those with a low FA score (1 SD below the mean), none of the three framings significantly influenced intentions to reduce FVW (monetary framing: $\beta = -0.16$, $SE = 0.10$, $p = 0.138$; environmental framing: $\beta = 0.09$, $SE = 0.10$, $p = 0.335$; co-benefits framing: $\beta = 0.14$, $SE = 0.10$, $p = 0.173$; also see Fig. 5). See Table G.4 (in Appendix G) for detailed results.

4. Discussion and conclusion

The current study employs an RCT design to examine the causal effects of monetary, environmental, and co-benefits framings on household FVW reduction intentions in Spain. The results reveal that only co-benefits framing significantly increased Spanish consumers' intentions to reduce household FVW. This is the first experimental study to report that co-benefits framing works better than monetary and environmental framings in promoting household food waste reduction intentions. Yet, consistent with previous research (Chen and Jai, 2018; Nisa et al.,

2022), there was no evidence that monetary or environmental framing by itself increases household food waste reduction intentions.

The present findings have valuable practical implications for policymakers and organizations, as co-benefits framing has a great deal of potential for use in informational and behavior-change campaigns that aim to reduce household food waste and in the development of food waste feedback technologies. As previous works have shown that consumers often need to balance competing motivations when making food waste decisions, highlighting the co-benefits both to individual consumers and households, via monetary savings, and to the planet, via public environmental benefits, is important. The need to harness these multiple synergistic motivations has also been highlighted in other pro-environmental domains, such as increasing vegetarian food choices (e. g., in Shreedhar and Galizzi, 2021), and reducing active transport and air pollution, all of which are crucial to achieving sustainability transitions (Karlsson et al., 2020).

The present study also demonstrates that intervention effects can be moderated by past attitudes, sometimes in unexpected ways. In contrast to the common belief that each framing treatment has a stronger effect among participants with congruent attitudes (i.e., environmental framing is more effective among those with high environmental motivation), the monetary framing effect was strong not only among participants who were sensitive to the financial costs of wasting food but

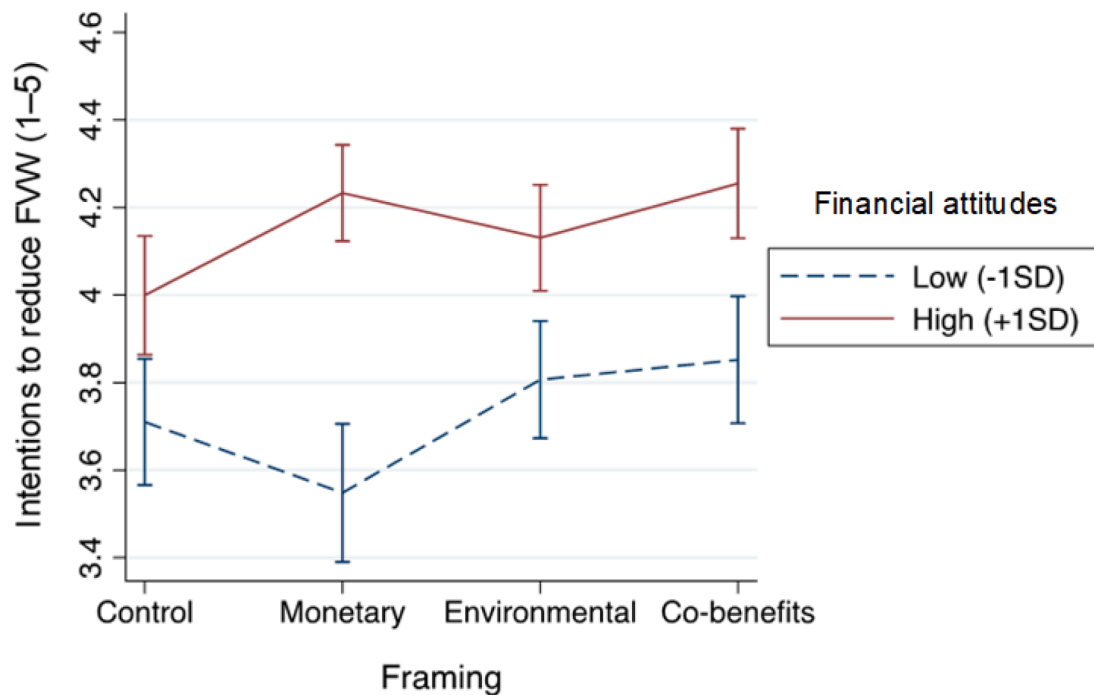


Fig. 5. Financial attitudes as a moderator of treatment effects on FVW reduction intentions.

also among those who were more concerned about the environmental impacts and the ethical issues associated with food waste. The effect of co-benefits framing was also more pronounced among participants with a high level of environmental and ethical concerns. This implies that financial framing can be persuasive for those who already care about the environment by giving them additional reasons to care; conversely, co-benefits framing may not be persuasive enough for those who are less concerned about the environment (Bain et al., 2016). Future research should examine which interventions are likely to successfully motivate the skeptics, i.e., those who are not concerned about the financial, environmental, or ethical consequences of wasting food.

The present findings contribute to the broader debate about pro-environmental interventions operating through intrinsic and extrinsic motives. The results imply that monetary and environmental co-benefits framing is the most persuasive intervention as it had a significant positive effect on waste savings intentions relative to the control group. Since the effects of the co-benefits framing were not lesser than those of the environmental framing, we did not find evidence of motivation crowding out (Frey and Oberholzer-Gee, 1997). This finding contradicts those of studies that have suggested that monetary motivations may result in motivation crowding out when combined with environmental appeals (Bolderdijk et al., 2013), or in isolation (Ling and Xu, 2021b). For example, Ling and Xu (2021b) found that incentivizing household recycling with money decreased personal commitment to pro-environmental goals and reduced support for waste prevention and disposal policies in China. By contrast, in the present study, the money-environment co-benefits framing increased Spanish people's intentions to reduce household food waste. The present findings are consistent with another UK study that showed that co-benefits framing helped motivate a broader range of pro-environmental actions (Shreedhar and Galizzi, 2021). This inconsistency might be due to regional variations in preexisting environmental attitudes.

The effects of co-benefits and monetary framing were stronger among individuals who were already more concerned about environmental issues in this study. One reason for this is probably that these individuals had stronger attitudes because they had been exposed to more pro-environmental messages (perhaps of a similar type) in everyday life, already had a stable environmental identity, and had not

paid attention to the monetary benefits of saving food. This could mean that in regions where pro-environmental communications and policies are newly introduced, emphasizing the monetary aspects might harm consumers' intrinsic motives to save the planet. Thus, it is recommended that policymakers carefully choose the framing type according to the target population's environmental attitudes and adjust the communication strategy at different stages.

From a practical perspective, our treatment interventions focused on "buying less" to mitigate FVW and can be easily deployed by consumer, citizen-oriented, and public policy organizations in food waste reduction campaigns. While these interventions can also be deployed by businesses, there could be some degree of hesitance. For example, if supermarkets are motivated solely by increasing sales and monetary profits, they may be reluctant to publicize messages such as "buy less" on account of the perceived conflict of interest with their business model. Nonetheless, for brands with pro-environmental norms that are committed to, and want to address, food waste and climate change, green demarketing (i.e., strategies encouraging consumers to buy less to be more sustainable) can yield both reputational and environmental benefits and should be considered (Armstrong Soule and Reich, 2015). Messages such as "Buy only what you need" or "Buy less" have, for instance, been deployed by companies such as Ikea and Patagonia. Centering sustainability in businesses models and exploring waste reduction campaigns is important in order that the responsibility of transitioning to sustainable food systems is spread across individuals and businesses, rather than just the former. Indeed, other studies show that corporate food recycling behaviors are associated with pro-environmental values and norms, apart from incentives (Maki et al., 2021). Therefore, the potential of co-benefits framing to motivate food waste reductions—among both customers and employees—could be explored for higher-order entities such as businesses and corporations.

The present research has limitations as well. First, the dependent variable was intentions to reduce food waste rather than actual food waste reduction behavior. However, behavioral intentions do not always translate into actual behavior changes, as indicated by the intention-behavior gap (Hebrok and Boks, 2017). Further research with measurement of actual household food waste is, thus, needed to confirm the effectiveness of co-benefits framing on actual food waste reduction

(Wang et al., 2022). Another limitation is the use of self-reported data, which required people to be fully aware of their own food waste behaviors. It is possible that people underestimated their past behaviors or overestimated their engagement in food-saving activities in the future. However, we do not expect this to interact with the treatment conditions. In addition, we controlled for past behaviors in our analyses and found that they did not affect the results.

The ETPB variables were assessed before the experimental manipulation, and this could have primed participants with a waste-reduction mindset and resulted in a positive bias in the outcome estimates. Nonetheless, the questionnaire flow was the same for every participant. Therefore, if any biases were introduced, they would have been consistent across all conditions and would not have confounded the treatment effects. Future work may consider exposing participants to the framing message at the beginning of the questionnaire in order to determine whether it affects the results.

There are also certain constraints to the ETPB framework adopted by the current research. First, it can be used to explore only one type of behavior and, hence, may not adequately explain complex behavioral dynamics such as habit formation. Second, the core assumption of the model raises questions about its validity, as behaviors could also be influenced by other factors (e.g., emotions, socioeconomic circumstances, and affect) that are not considered. Although we used pre-validated questions that were tested in other settings, the internal reliability of some of the ETPB constructs is lower than 0.60 (see the Cronbach's alpha values in Appendix C). Constructing more context-specific attitudinal variables may increase internal reliability and could be the topic of further work. Researchers may also consider testing other ETPB factors as moderators when employing this framework to study other food waste interventions. For instance, if the intervention manipulates dynamic norms, the most relevant moderators would be subjective norms and personal norms. Third, the self-reported data could have caused a potential bias and, subsequently, driven the intention-behavior gap. Another limitation, as highlighted by Block et al. (2024), is "that much of consumer food waste occurs for reasons that consumers may not be consciously aware of," even though the ETPB model assumes that consumer behavior is under control.

In conclusion, this study provides the first piece of empirical evidence that co-benefits framing, rather than environmental or monetary framing alone, is likely to promote household food waste reduction. In addition, some psychological factors included in the ETPB model, such as environmental attitudes, were shown to moderate the framing effects. While this theoretical framework can be useful for studying specific behaviors and incorporating the role of behavioral interventions, it does not explicitly address dynamics such as habit formation and relies on self-reported data. Changing habitual behaviors, however, can go hand-in-hand with changing motivation, and co-benefits framing may be promising in this regard.

CRedit authorship contribution statement

Juliana Prelez: Conceptualization, Methodology, Validation, Formal analysis, Resources, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Feiyang Wang:** Conceptualization, Formal analysis, Writing – original draft. **Ganga Shreedhar:** Supervision, Conceptualization, Methodology, Writing – review & editing.

Declaration of Competing 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

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.resconrec.2023.106904](https://doi.org/10.1016/j.resconrec.2023.106904).

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