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RESEARCH ARTICLE

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Consumer practices regarding the purchase, use, willingness to repair, and disposal of small electric and electronic equipment

A Spanish survey on kettles

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Abstract

Repair is one of the main strategies to extend the lifetime of products in the circular economy framework. With the aim of identifying current consumer practices toward the purchase, use, and end of life of electric and electronic equipment (EEE), including willingness to repair, maintenance, and final disposal, a survey is designed and implemented online, taking kettles as an application case. Regarding current strategies for extending the lifespan of these items, a general lack of maintenance and low levels of reparability or reuse have been detected. Disposal patterns show that nearly half of all kettles disposed of were still functioning. Nevertheless, a future willingness to repair these items has been identified, either by users themselves or at repair centers, if the manufacturer provides the means to do so. Finally, the results reveal that when consumers purchase a kettle, the price and then the energy efficiency score are the main priorities affecting their purchasing decisions, taking priority over the reparability score. These results can help in the design of more focused and direct strategies to promote the reparability of small household appliances, encourage the authorities to regulate the new reparability score in a more efficient way, and improve the way that information is transmitted to users/consumers.

KEYWORDS
circular economy, consumer attitude, EEE, end of life, industrial ecology, repair

1 | INTRODUCTION

The New Circular Economy (CE) Action Plan (European Commission, 2020a) is the main pillar of the European Green Deal (European Commission, 2019). Its objective is to ensure that products, materials, and resources are kept in circulation for as long as possible, taking electric and electronic equipment (EEE) as one of the priority product groups. To address this challenge, the Ecodesign Working Plan (European Commission, 2016) derived from the Directive 2009/125/EC (European Parliament and the Council, 2009) highlighted product groups with significant opportunities to improve their energy efficiency and durability, reparability, upgradability, maintenance, reuse, and recycling. Among them, the product group "electric water

kettle" was selected due to its potential for energy and water consumption savings (European Commission, 2020b). In addition, they are considered non-fashion products (Cox et al., 2013); that is, they are mainly replaced only when they cease to function (Hennies & Stamminger, 2016). Even though kettle use is lower in Spain than in other European countries (Statista, 2021), sales have significantly increased in recent years: from 42,903 kettles sold in 2018 to 206,651 kettles sold in 2021 (MINCOTUR, 2022).

The literature specifically related to the environmental issues of kettles is very limited and is mainly related to their energy efficiency and consumer use practices: Murray et al. (2016) identified usage patterns and potential scenarios for energy savings through the observation of kettle usage in 14 UK homes over 2 years; Marcinkowski and Zych (2017) compared electric kettles and stovetop kettles to improve the eco-effectiveness of both appliances; Gallego-Schmid et al. (2018) compared the environmental impact of three kettle models, considering the influence of ecodesign requirements proposed at the European level on the environmental impact of kettles; and Durand et al. (2022) reviewed user-related, technical, and economic aspects of kettles in order to establish policy measures aimed at reducing energy consumption. However, CE strategies applied to sustainable product design (European Commission, 2020a) also include requirements that mainly affect the end of life (EoL) of EEE and the possibility of extending the lifespan of these products by applying maintenance, repair, or reuse strategies. Therefore, the incorporation of these aspects driven by a CE perspective requires the active collaboration of users, since it is users who are responsible for the various decisions that affect the EoL of EEE. Understanding user attitudes and practices toward the purchase, usage, and EoL decisions regarding EEE is key to achieving a more circular design of these appliances, and particularly of kettles.

To obtain user information related to the purchase, use and EoL of EEE various techniques can be applied, with surveys being most common means (Floyd & Fowler, 2010). Several studies focused on obtaining user attitudes during the purchase, use and EoL of EEE, including repair, can be found in the literature. Wieser and Tröger (2016) applied online questionnaire and semi-structured face-to-face interviews to analyze insights into consumers' motivations and considerations regarding mobile phone repair, reuse, and replacement in the United Kingdom. Pérez-Belis et al. (2017) and Bovea et al. (2018) applied telephone surveys to obtain consumer attitudes toward the repair and second-hand purchase preferences for 10 categories of small household EEE and for 10 information and communication technology (ICT) product categories, respectively, in Spain. Rodrigues et al. (2020) applied an online survey in Brazil to identify barriers and motivations regarding the repair of several categories of EEE. Jaeger-Erben et al. (2021) used face-to-face interviews in Germany to ascertain the general patterns that influence long-lasting product consumption and repair practices. Woidasky and Cetinkaya (2021) analyzed the results from two online surveys conducted in 2015 and 2018 to obtain users' decisions and attitudes regarding the lifespan of the laptops of German University students. Finally, Sonego et al. (2022) performed a systematic review of surveys and case studies on the repair of electronic products published during the last decade, identifying barriers that discourage consumers from repairing them and suggesting ways how reparability should be focused. All these studies obtained information on user attitudes and behaviors related to small EEE (sEEE) categories through surveys. These surveys posed questions related to the products' lifespans, the willingness to repair, the cost or efficiency of the repair, the frequency of use and the reasons for discarding the products. In addition, Woidasky and Cetinkaya (2021) also analyzed the costs of repair, while Russell et al. (2022) analyzed how the passing of time directly and indirectly affects the likelihood of repair activities.

The surveys cover a wide range of product categories, including clothes and furniture (Cox et al., 2013; Rogers et al., 2021), large household appliances such as washing machines or refrigerators (Boldoczki et al., 2020; Song et al., 2012), brown goods (Pérez-Belis et al., 2017; Rogers et al., 2021; van der Velden, 2021), and ICT products (Bovea et al., 2018; Sabbaghi & Behdad, 2018; Wieser & Tröger, 2016). Analyzing the countries covered in the surveys and use patterns, it can be seen that information on the use and disposal of kettles is primarily derived from studies conducted in the United Kingdom and Germany (European Commission, 2020b; Gallego-Schmid et al., 2018; Hennies & Stamminger, 2016). Although Engelking et al. (2019), Bovea et al. (2017), and Hennies and Stamminger (2016) included kettles in their survey along with some other small household EEE, no previous study has specifically focused on the current practices and future perceptions of users regarding the reparability of kettles.

In addition, the European regulatory framework encourages the reporting of reparability aspects on product labeling to empower consumers (European Parliament, 2022). France was the first European country to implement repair labeling (Ministère de la Transition Écologique, 2021). Studies such as Van den Berge et al. (2023) or Bovea et al. (2018) analyze consumers' responses to repair/lifetime product labels. The former focused on analyzing the possible utility and content of a label related to the lifetime of the product, while the latter was focused on designing icons for different circular aspects of a product. However, understanding user perceptions regarding combining this labeling with other product labels (e.g., price or energy efficiency) in relation to purchase decisions remains an unexplored field, and one which holds significant potential from the perspective of the circular economy.

Therefore, in view of this context, the aim of the present study is to identify Spanish consumer attitudes toward the purchase, use, and EoL of kettles, with a special emphasis on identifying the current practices and future perceptions of users toward their reparability as a strategy to extend their useful life in the CE context. To this end, four research questions (RQ) are proposed: RQ1—What are the purchase patterns of kettles in Spanish society? RQ2—What are the usage patterns of kettles in Spanish society? RQ3—What are the EoL and disposal patterns of kettles in Spain? And finally, RQ4—Is there a willingness and predisposition to repair small household EEE, especially kettles, in Spanish society? To answer these questions, this paper is structured as follows: Section 2 describes the proposed four-step method followed to design the survey and analyze the results; Section 3 describes the application of the method and presents the survey and the statistical analysis responses; Section 4 provides a discussion of the results; and finally, Section 5 details the conclusions and suggests avenues for future research.

2 | METHOD

A survey was designed to obtain the current patterns of Spanish consumers regarding the purchase, use, and EoL strategies of kettles, including their reparability. Following the recommendations of Krosnick and Presser (2010), a pilot survey was designed and validated by conducting it with a control sample (15 people in total, some with and some without kettles). Specifically, the comprehensibility of the questions, the validity of the proposed alternative answers for each question, and the time required to fill out the survey were verified and adjusted. Based on the feedback received, a final version of the survey (questions and alternative answers) was created, with the questions grouped according to their relationship with each research question, as shown in Table 1. This final version was approved on July 15, 2021 by the Ethical Commission of the Universitat Jaume I (reference CD/83/2021). The survey was modeled using the Qualtrics platform (Qualtrics, 2020) in a nonlinear way, which means that not all the questions were asked to all the respondents.

The survey was distributed online, the target group being Spanish households and individuals aged over 18. In order to calculate the representative sample size needed for the study, the method proposed by Bartlett et al. (2001) was applied, by using Equation (1).

$$n = \frac{(t)^2 (p)(1-p)}{(d)^2} \quad (1)$$

where n is the sample size, t is the Z value for a specific confidence level, p is the proportion of respondents who selected a specific choice, and d is the confidence interval or margin of error. It should be ensured that the sample reproduces the characteristics of the real population. Considering a 98% confidence level ($t = 2.32$) and the maximum possible proportion of 50% ($p = 0.5$), which gives the largest sample size, and a 10% margin of error ($d = 0.1$), a minimum sample size of 135 was defined.

The survey was disseminated online through a web link which was available for 3 months, from July 2021 to September 2021. A total of 156 valid responses (higher than the required minimum sample size) were obtained. In order to maximize the representativeness of the survey, the quota sampling method was applied, calculating the characteristics of the sample proportionally to the characteristics of the population in terms of household size, according to the Spanish National Statistics Institute (INE, 2022). Once the survey had been answered, the responses were statistically analyzed using Jamovi (The Jamovi Project, 2022) and R (The R Project, 2022).

3 | RESULTS

3.1 | Characteristics of the sample

The survey was conducted in a sample (156 households) representative of the Spanish population in terms of household sizes. Figure S1 of the Supporting Information shows the comparison made between the characteristics of the real population (INE, 2022) and of the sample.

The socio-economic characteristics of the sample are presented in Table 2, along with the descriptive data analysis. All those surveyed were aged over 18, with a mean age in the range of 35–49 years old. A total of 61.5% of those surveyed were females from a medium-sized household of 2.94 people, had an average level of education between completing secondary and higher education, and a mean family income of around €2500/month.

As the questionnaire was organized as a nonlinear survey, according to the questions answered by the respondents, five user profiles were identified, depending on whether or not they have had a kettle (QA.1), the number of kettles they have had (QD.1), and if they still have one (QD.2). All profiles began by answering the introductory questions in Block A and ended with the socio-economic questions. The question block path followed by each profile was established according to the question blocks marked with a tick (✓) in Table 3. Question blocks marked with an asterisk (*) in Table 3 means that the questions in that block may or may not have been asked depending on the response to a previous question. For instance, Block C was only asked if questions QB.2 or QE.3 were answered with the "new" option, depending on the characteristics of the kettle purchased.

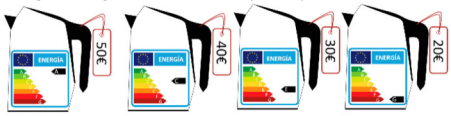
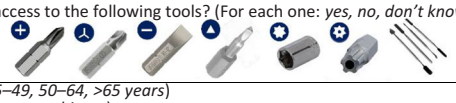
3.2 | Response analysis

3.2.1 | Purchase patterns of kettles (RQ1)

Block A (see Table 1) was intended to introduce the subject of the questionnaire and to discriminate between those who own or have owned a kettle (50.0% of respondents) from those who have not (50.0% of the respondents). The questions in Blocks B–E are focused on obtaining the users' kettle purchase preferences.

The respondents included in Profile 1 were asked why they have never owned a kettle. More than half of respondents (53.8%) stated that it is due to their lack of usefulness, followed by 15.4% due to lack of space in the kitchen, while 3.8% were not aware of their existence. Respondents included

TABLE 1 Questions included in the final version of the survey and their relationship with the research questions.

RQ	BLOCK	Question (Q)
RQ1 – PURCHASE	A	QA.1. Do you own or have you ever owned a kettle? (*yes, no*)
	B	QB.1. Why do you not have a kettle? (*not useful, I don't know, not enough space, I don't like them, economic reasons, others)* QB.2. If you were considering buying a kettle, would you buy new or second-hand? (*new, second-hand*)
	C	QC.1. Why would you not buy a second-hand kettle? (*reasons of hygiene, being able to afford a new one, distrust of second-hand products, lack of knowledge of where to buy them, less guarantees)*
	D	QD.1. How many kettles have you owned? (*one, more than one*) QD.2. Do you currently have a kettle? Regardless of whether it is used or not *(yes, no)*
	[1,2]E	QE.1. How much did you pay for the last kettle you purchased? *(€0–100)* QE.2. How many years ago was the kettle purchased? (Only asked to Profile 3). *(0–20 years)* QE.3. Was the last kettle you owned new or second-hand? (*new, second-hand)* QE.4. What material was the last kettle you owned made from? (*plastic, steel, glass*) QE.5. Did the last kettle you owned have a base that was separate from the container (base with 360° rotation)? *(yes, no)* QE.6. Did the last kettle you owned have a temperature control? (*yes, no*) QE.7. Did the last kettle you owned have a water volume indicator in the container? (*yes, no*) QE.8. What was the capacity of the last kettle you owned? *(<1 L, 1–1.5 L, >1.5 L)*
RQ2 – USE	F	QF.1. Currently, when you need to heat or boil water (for herbal teas, cooking water, hot water bottles, etc.) at home, where do you heat it? (*gas, electric, induction, glass ceramic stove, microwave)*
	G	[3]QG.1. Do you currently use the kettle? (*yes, no*) QG.2. What do you use it for? (*multiple choice: drinks, instant food, hot water bottles, food, baby bottles, other)* QG.3. How many days a week do you use your kettle at home? (*0–7*) QG.4. How many times a day do you use your kettle at home? (*1–4*) QG.5. On average, to what level do you usually fill your kettle when you use it? (*maximum, half, only the volume I need*) QG.6. How many times a year do you descale your kettle? (*1, 2, 3, …, 12*) QG.7. How do/did you descale your kettle? (*vinegar, chemical products, other*) QG.8. Do you think that descaling the kettle increases its lifetime (makes it last longer)? (*yes, no*) QG.9. Has your kettle ever broken? (*yes, no*)
	H	QH.1. You have indicated that you do not use the kettle you own. Why not? (*broken, prefer other means, other)*
RQ3 – EoL	I	QI.1. How many years have your kettles lasted on average? (*0–20 years)* QI.2. What did you do with the kettles? (*general waste, electrical goods recycling centre, plastic recycling container, keep it at home)* QI.3. Why did you change the kettle? (*stopped working, aesthetic reasons, efficiency, better performance, other)*
	[4]J	QJ.1. How many years did the kettle last you? (*0–20 years)* QJ.2. What did you do with it? (*general waste, electrical goods recycling centre, plastic recycling container, keep it at home)* QJ.3. Was the kettle working when you disposed of it? (*yes, no)*
RQ4 – REPAIR	[5]K	QK.1. What went wrong? (*Multiple choice: on/off switch, lid, electrical components, others or I don't know*) QK.2 For the *component/s selected in QK.1*, was repair attempted or carried out? (*no; yes — at a repair centre during the guarantee period; yes — at repair centre out of the guarantee period; yes — at home)* QK.3. For the *component/s selected in QK.1*, was it repaired? (*yes, no)*
	[6]L	QL.1. If the manufacturer provided a guaranteed safe way to repair your kettle by means of manuals, videos or instructions, would you try to repair it if it broke? *(yes — at home; yes — at a repair service; no)* QL.2/3/4. If your kettle cost €25/€50/€75, how much would you spend on the repair, depending on the year in which it breaks? (*nothing, maximum €5/€10/€15, maximum €10/€20/€30, maximum €15/€30/€45)*  QL.5. Considering the energy efficiency score and purchase price of the kettle, for the same kettle model given the following labelling, which one would you buy?  QL.6. Considering the reparability score and purchase price of the kettle, for the same kettle model given the following labelling, which one would you buy?  QL.7. Considering the energy efficiency score and the reparability score, for the same kettle model given the following labelling, which one would you buy? (QH = 4)  QL.8. For the same kettle, order (by dragging) the purchase criteria: price, repairability and energy consumption. QL.9. Do you have access to the following tools? (For each one: *yes, no, don't know*) 
Socio-economic data		Age (*<18, 18–34, 35–49, 50–64, >65 years*) Gender (*woman, man, non-binary*) Level of education (*no studies, primary, secondary, higher education*) Household size (*1, 2, 3, 4, ≥5*) and number of children under 5 years of age (*1,2, ≥3*) Household income (*<€1,000; €1,000–2,500; €2,500–4,000; >€4,000*)

(Continues)

TABLE 1 (Continued)

[a]If QD.1 = one and QD.2 = yes: From this point on, please answer the rest of the questionnaire with the data of your current kettle.
[b]If QD.1 = more than one and QD.2 = yes: From this point on, please answer with the data on your kettles, on average. When there are several options, please indicate that which corresponds to your last kettle.
[c]Asked only if QD.2 = yes.
[d]The following questions refer to your experience with kettles, all the kettles you have owned.
[e]If QG9 = yes. Both questions, QK.2 and QK.3 are repeated as many times as things have been indicated to fail in QK.1.
[f]In the following questions, we are going to ask you about different scenarios related to the "right to repair" regulation that will soon be implemented in Spain, and about the tools you have access to. Please answer on a personal level.

TABLE 2 Descriptive statistics of the socio-economic characteristics.

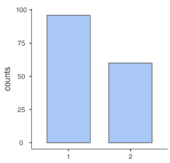
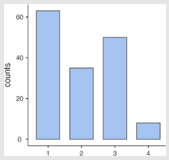
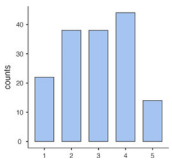
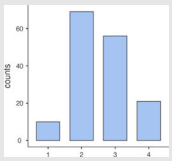
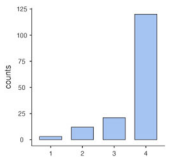
Variable	Range	Proportion of the total (%)	Bar chart
Gender	1. Female 2. Male	61.5 38.5	
Age	1. 18–34 years 2. 35–49 years 3. 50–64 years 4. >65 years	40.4 22.4 32.1 5.1	
Household size	1. 1 2. 2 3. 3 4. 4 5. >5	14.3 24.2 24.2 28.2 9.0	
Household income	1. <€1000 2. €1000–2500 3. €2500–4000 4. >€4000	6.4 44.2 35.9 13.5	
Level of education	1. No studies 2.Primary education 3. Secondary education 4. Higher education	1.9 7.7 13.5 76.9	

TABLE 3 User profiles identified, depending on the answers to the survey questions.

Respondent profile	Have you ever had a kettle?	Do you currently have a kettle?*	Quota # participants (% participants)	RQ1					RQ2			RQ3		RQ4	
				A	B	C	D	E	F	G	H	I	J	K	L
Profile 1: People who have never owned 1 kettle.	NO	NO	78 (50.0%)	✓	✓	*			✓						
Profile 2: People who have owned 1 kettle, but now they do not own any.	YES (1)	NO	15 (9.6%)	✓		*	✓	✓	✓				✓	*	✓
Profile 3: People who have owned 1 kettle, and they still own it.	YES (1)	YES	37 (23.7%)	✓		*	✓	✓	*	✓	✓				✓
Profile 4: People who have owned >1 kettle, but now they don't own any.	YES (>1)	NO	2 (1.3%)	✓		*	✓	✓	✓	✓		✓			✓
Profile 5: People who have owned >1 kettle, and they still own 1.	YES (>1)	YES	24 (15.4%)	✓		*	✓	✓	*	✓	✓	✓		*	✓

Note: The * denotes this block may or may not be answered, depending on the answer to a previous question.

in Profiles 2 to 5 (those who have owned a kettle) were asked about the characteristics of the kettle they own or have owned. The characteristics of the owned kettles are presented in Figure S2 of the Supporting Information. The year of acquisition ranged from 2002 to 2020, the average purchase price being €27.50 (±12.96) for new kettles and €11.00 (±11.20) for second-hand kettles (prices were not adjusted for inflation).

Finally, all the respondents ($n = 156$) were asked about the type of kettle they would buy (new or second hand) in the event of having to make a purchase. A total of 93.6% of respondents would buy a new kettle, and only the remaining 6.4% would purchase a second-hand one. The reasons for not buying second-hand kettles are reasons of hygiene (32.2%), being able to afford a new one (26.0%), and a lack of confidence in the quality of second-hand products (21.2%).

3.2.2 | Use patterns (RQ2)

The questions in Blocks F–H (see Table 1) were designed to ascertain how and how often kettles are used in Spanish households. These blocks were answered by respondents belonging to Profiles 2 to 5 (those who have owned a kettle).

A total of 84% of the respondents who still own a kettle (Profiles 3 and 5 [$n = 51$]) currently mainly use it for preparing drinks such as tea or coffee (60.2%), boiling water for cooking (18.1%), or for preparing instant food (12.0%). On average, it is determined that kettles are used 8.7 times per week. In addition, 64.2% of the respondents boil the amount of water that they need for the specific use, while 20.8% boil half of the capacity of the kettle and 15.1% boil the total capacity of the appliance. Regarding the maintenance of the appliance, 26.4% of the respondents never descale the kettle, while 39.6% and 20.8% do it once or twice per year, respectively. Only 1.9% descale it monthly. The method of descaling is with vinegar and water (60.4%) or with a chemical product (7.5%). Despite the low descaling rate, 77.4% of respondents believe that this practice increases the service life of the kettle.

The remaining 16% of the respondents who still own a kettle (Profiles 3 and 5 [$n = 10$]) no longer use it, mainly because they prefer to boil water by other means (66.7%). For those who do not currently own a kettle (Profiles 1, 2, and 4 [$n = 95$]) as well as those who own one but do not use it, the main means of boiling water is in the microwave (55.4%), followed by induction (15.8%), glass ceramic (12.9%), and gas (12.9%) cooktops.

3.2.3 | EoL and disposal patterns (RQ3)

The questions in Blocks I and J (see Table 1) were focused on identifying the disposal practices of users when they consider that their kettles have reached their EoL. Therefore, only respondents included in Profiles 2, 4, and 5 (those who have owned at least one kettle and had discarded it or replaced it) answered these questions ($n = 41$). The main reasons for changing or disposing of a kettle were because it failed/stopped working (69.2%), or because a new one that was more efficient/with better performance was bought (11.5%). Regarding the lifespan of kettles, the average lifespan was 5.4 years, although this varies slightly with the profile (5.15 ± 2.57 years for Profiles 4 and 5, and 4.73 ± 2.46 for Profile 2). However, the differences between responses from Profiles 2, 4, and 5 were not statistically significant, as can be observed in the results from the Student's *t*-test presented in Table S1 of the Supporting Information.

A total of 57.7% of the respondents belonging to Profiles 4 and 5 (those who have discarded more than one kettle [$n = 26$]), stated that they discarded the kettle upon its EoL at an electrical goods recycling facility, while 26.9% kept it at home and 15.4% threw it into the general household waste. For respondents belonging to Profile 2 (those who have discarded or replaced just one kettle [$n = 15$]), 60.0% of them kept the kettle at home, while 26.7% disposed of it at an electrical goods recycling facility, and 13.3% threw it to the general household waste. A total of 53% of the respondents from Profiles 2, 4, and 5, indicated that the kettle was still working when it was disposed of. A Student's *t*-test was run in order to check if there were significant differences between responses from Profiles 2, 4, and 5 related to the EoL and disposal patterns. However, no significant differences were detected between the responses of Profiles 2, 4, and 5 (see Table S2 of the Supporting Information). Figure S3 of the Supporting Information shows on average the EoL and disposal patterns for these profile groups.

3.2.4 | Repair patterns (RQ4)

The questions in Block K (see Table 1) were focused on identifying current kettle repair practices. Profiles 2 to 5, those who currently own or have owned a kettle ($n = 78$), were asked if the kettle they own (or owned) has (or had) ever broken. A total of 88.2% of respondents have had a kettle break. Related to the type of failure, 34.4% of the respondents did not know which part had failed. Of those who did know, the components that fail most frequently are the electric/electronic components (46.9%), the lid (15.6%) and the on/off switch (3.1%). On average, as shown in Table 4, 73.9% of the respondents with a broken kettle did not take it for repair. Of the remaining 26.1% who tried to repair their kettle, 66.65% did so at a repair center (professional repair store), while 33.35% did it themselves. Of those who took the kettle to a repair center, the repair success rate was 100% for all broken parts except for the electronic ones.

TABLE 4 Percentage of broken parts, whether taken to repair or not, and the repair success rate ($n = 78$).

		Type of failure							
Taken to repair?		On/off switch (3.1%)		Lid (15.6%)		Electronic parts (46.9%)		Other (34.4%)	
No		0.0%		60.0%		80.0%		81.8%	
Yes		Without success	With success	Without success	With success	Without success	With success	Without success	With success
	Under guarantee, at a repair center	0.0%	100.0%	0.0%	0.0%	6.7%	0.0%	0.0%	0.0%
	Out of guarantee, at a repair center	0.0%	0.0%	0%	20.0%	6.7%	0.0%	0.0%	9.1%
	Domestic repair	0.0%	0.0%	0%	20.0%	0.0%	6.7%	0.0%	9.1%

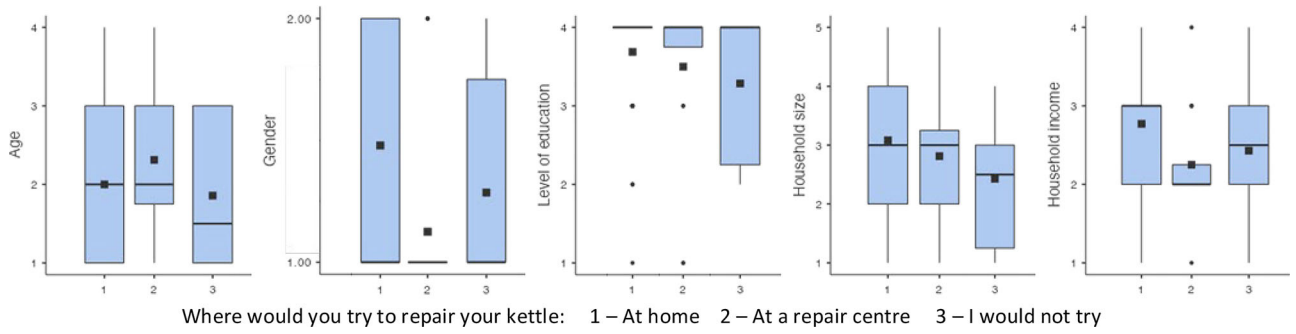


FIGURE 1 Relationship between willingness to repair and socio-economic variables ($n = 78$). Underlying data for this figure are available in Table S01 of the Supporting information.

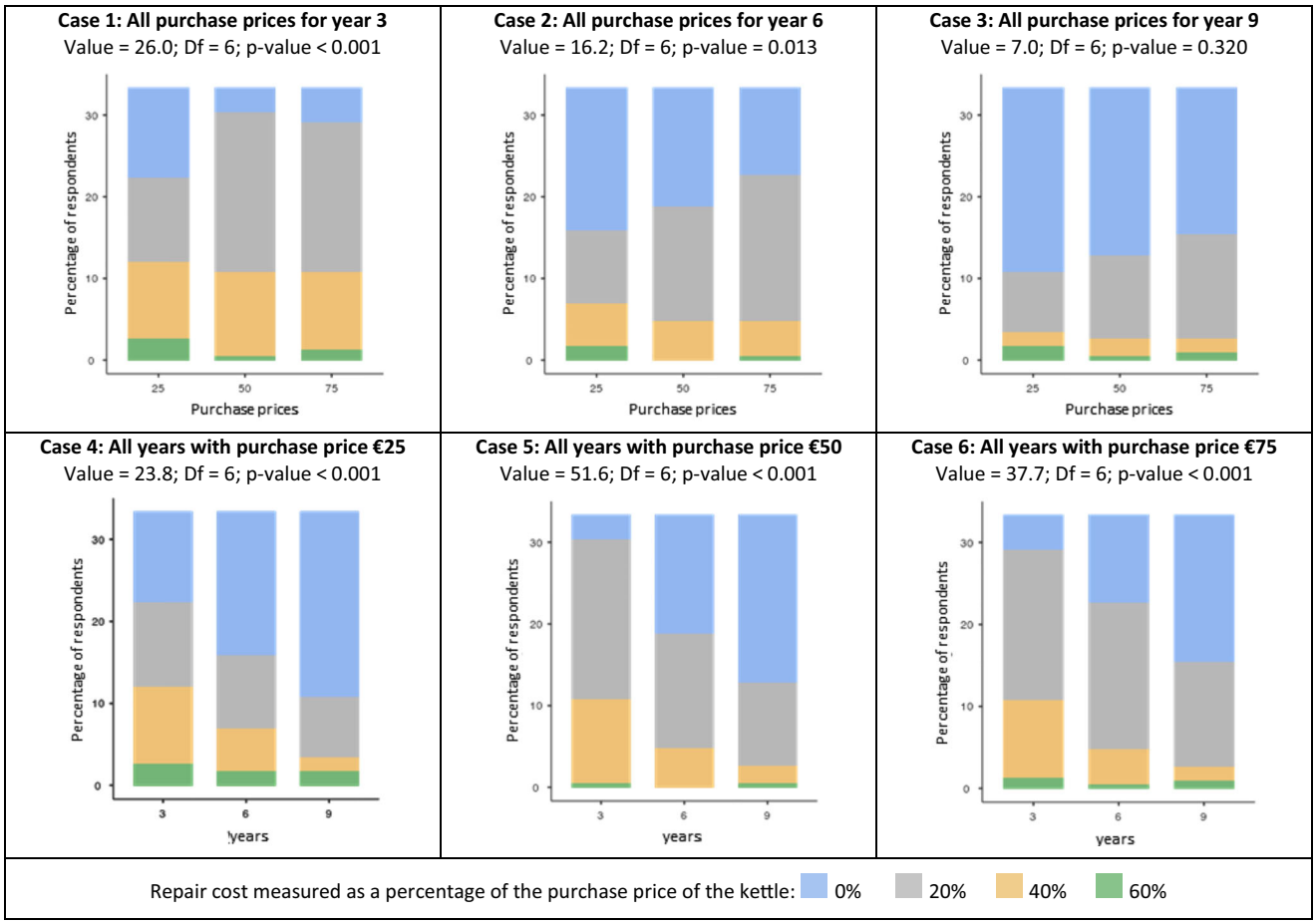
Once the current practices on kettle repair had been ascertained, the willingness to repair was assessed by means of hypothetical situations presented in the questions of Block L (see Table 1). First, in the hypothetical case of having a broken kettle, if the manufacturer provided a safe way to repair the kettle by means of manuals, videos, or instructions (QL.1), 82.3% of the respondents would repair it (63.3% at home and 19.0% at a repair center), while the remaining 17.7% would not. A descriptive analysis of the responses according to each socio-economic variable was run (Figure 1). Variability with respect to the mean was observed for all the socio-economic variables, so a multinomial logistic regression model was performed to analyze whether any of the socio-economic variables were significant or not.

The results are presented in Table S3 of the Supporting Information for the complete model and in Table S4 of the Supporting Information for the comparison of each pair of socio-economic variables. It can be seen that gender and the level of education are significant socio-economic variables. Regarding the gender variable, it was observed that men would try to repair the item, preferably at home but also by taking it to a repair center, whereas women tended not to try to repair it. Regarding the level of education, it can be observed that as people have higher education, they display a higher willingness to attempt repair.

In questions QL.2, QL.3, and QL.4 (see Table 1), respondents were asked about their willingness to pay (nothing, 20%, 40%, or 60% of the purchase price) for the kettle repair depending on its purchase price (€25, €50, and €75) and the year in which it breaks (at 3, 6, and 9 years old). Table S5 of the Supporting Information shows the results obtained. For example, if the purchase price of a kettle was €25, 30% of the respondents would spend €5 (20% of the purchase price) on repair if it broke before the third year of use, 28% if it broke before the sixth year of use, and 22% if it broke before the ninth year of use. In other words, for a kettle of the same purchase price, the percentage of respondents who are willing to pay for the repair decreases as the number of years of use of the kettle increases. In addition, for the same number of years of use of the kettle, the percentage of people who are willing to pay for the repair decreases as the cost of the repair increases.

A chi-squared test was run to analyze whether there were significant variables between the purchase price, the year the kettle breaks, and the repair cost that respondents are willing to pay. The results are presented in Table 5, where each cell shows the percentage of respondents who have chosen how much they would pay for the repair for all purchase prices, in Cases 1 to 3 (first row); and for all the variables of the years the kettle can break, in Cases 4 to 6 (second row). For instance, Case 1 shows the percentage of consumers who would pay to repair the kettle if it broke in year 3, in relation to the price it cost. Cases 2 and 3 show the percentage of people who would pay to repair the kettle if it broke in years 6 and 9, respectively, in relation to the price it cost. It can be seen that price is a significant variable in relation to the decision to repair if the kettle breaks in the third or sixth year (regardless of the price of the kettle), but not in the ninth year.

TABLE 5 Chi-squared test results for each analyzed case in QL.2-4 ($n = 78$).



The second row shows the results of how much the respondents would pay if the kettle cost €25, €50, and €75 (Cases 4 to 6 respectively). For questions QL.2 (purchase price €25) and QL.3 (purchase price €50), the purchase price variable is significant; but it is not significant in the third case, where the purchase price is €75. Analyzing the significance of the purchase price regardless of when the kettle breaks, it is observed that there are significant differences for all cases (Cases 4 to 6).

In questions QL.5, QL.6 and QL.7 (see Table 1), respondents had to choose which kettle they would buy based on a pairwise combination of the following parameters: kettle purchase price (€50, €40, €30, and €20), energy efficiency (A, C, D, and E) and reparability score (9.5, 6.5, 3.5, and 0.5). As can be observed in Figure S4 of the Supporting Information, 54.4% of the respondents would choose a more expensive kettle if the energy efficiency score were higher (Figure S4a of the Supporting Information), as well as one with better reparability score (Figure S4b of the Supporting Information). However, when it comes to comparing the energy efficiency score against the reparability score, 72.2% of the respondents would prefer a kettle with better energy efficiency score than one with a higher reparability score (Figure S4c of the Supporting Information).

To observe if there are significant differences in the choice of the kettle according to its labeling depending on the socio-economic characteristics of the respondents, a multivariate analysis was carried out (see Table S6 to S8, S9 to S11, and S12 to S14 in the Supporting Information, for QL.5, QL.6, and QL.7, respectively). For question QL.5 (purchase price vs. energy efficiency score), significant differences were observed for the socio-economic variables level of household income and age: the higher the household income level is, and the older the purchaser is, the higher the preference for a more expensive kettle. While for the significant variable level of education, the higher the level of education, the greater the tendency to prefer a more energy-efficient kettle. In question QL.6 (purchase price vs. reparability score), significant differences appear for the socio-economic variables household size, level of household income, and age when people are over 50 years of age compared to the range of 18 to 34 years of age, as well as the level of studies when it comes to comparing people with a secondary and higher education with people without studies. When there is a high difference between the price and the reparability score (€0.5/20 vs. €6.5/40 or €9.5/50), the tendency is to buy the cheaper kettle. However, if the difference is not high, the tendency when comparing all groups of the socio-economic variables is to choose the kettle based on the reparability score. Finally, in QL.7 (energy efficiency score vs. reparability score) significant differences appear for the socio-economic

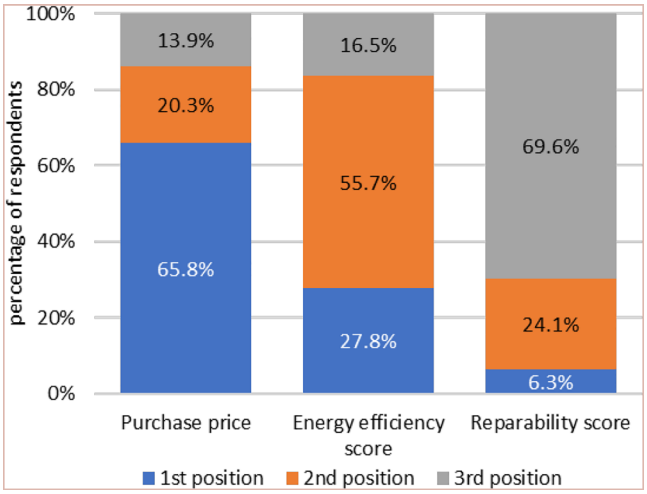


FIGURE 2 Order of preference between sale price, energy efficiency score, and repairability score ($n = 78$). Underlying data for this figure are available in Table S02 of the Supporting information.

variables of household income and the level of studies, as well as the age, when people are over 50 years of age compared to the range of 18 to 34 years of age, where for all the significant variables the main choice is the kettle with a better energy efficiency performance.

Finally, respondents were asked to rank the aspects of purchase price, energy efficiency score, and reparability score in order of importance when buying a kettle (QL.8). Figure 2 shows the percentage of respondents who chose each variable in first, second, and third positions. Comparing the socio-economic variables against the first option chosen by the participants, significant differences can be found mainly in the socio-economic variables education level and income level which define the profile of the participants who chose each variable (price, energy efficiency, or reparability score) as their first option (see Figure S15 of the Supporting Information).

In order to test the internal consistency reliability of the questions used in the survey to answer RQ4 (willingness to repair), Cronbach's alpha was used (Revelle, 2017). The results show a coefficient of 0.86 and 0.70 for the test between the reliability of questions QL.1 to QL.4 and QL.1 to QL.8, respectively. Since the coefficients equal or exceed the value of 0.7, it is determined that the choice of questions measure the willingness to repair, thereby answering RQ4.

In the same line, the answers from the questions QL.1 until QL.8 (see Table 1) were statistically analyzed to determine whether there is a significant association between two variables by applying contingency table tests. The frequencies of the variables were compared and a chi-squared test was run to determine whether there was a significant relationship between the variables. In the first place, the consistency was analyzed of the participants who answered that they would not repair in the hypothetical situation presented in QL.1, who, in 90% of cases, also indicated that they would not invest in repair in questions QL.2, QL.3, and QL.4 (how much would you invest in repair if your kettle purchase price were €25, €50, and €75, respectively). Full results can be seen in Table S16 of the Supporting Information.

In parallel, the same tests (contingency tables and chi-squared tables) were run between the first purchase criteria variable (price, energy efficiency, and repairability score [QL.8]) to analyze whether there was a consistency within the results obtained from the questions of the proposed kettle labeling (QL.5 to QL.7). So, the consistency was tested between the first option chosen in QL.8 through to questions QL.5 and QL.6 for the price variable, QL.5 and QL.7 for the energy efficiency variable, and QL.6 and QL.7 for the repairability score variable. The results reflect a consistency between their first option rated in QL.8 and the previous choices made in questions QL.5, QL.6, and QL.7, especially for the variables of energy efficiency and reparability score. It should also be noted that in all cases there is a significant relationship between the variables in which the p-value is significant (p-value <0.05). Full results can be found in Table S17 of the Supporting Information.

Finally, in QL.9 (Table 1), the respondents were asked about the availability of tools for repair. As presented in Figure 3, the most common screwdriver is the slotted screwdriver (93.7%), followed by the Phillips screwdriver (83.5%), socket wrenches for removing nuts (64.6%), and the tri-wing screwdriver (63.3%).

4 | DISCUSSION

The survey presented in this study collected data related to the life cycle of kettles (purchase, use, repair, and EoL) from the Spanish users' perspectives. The 156 valid responses collected accurately represented the distribution of household sizes in the Spanish population. Although only 50% of households in Spain have a kettle, in countries like Germany, Denmark, or the United Kingdom the percentage rises to 97% (Energy Saving Trust, 2006). However, the characteristics of the kettles bought in Spain coincide with those of the rest of Europe in terms of materials (plastic and

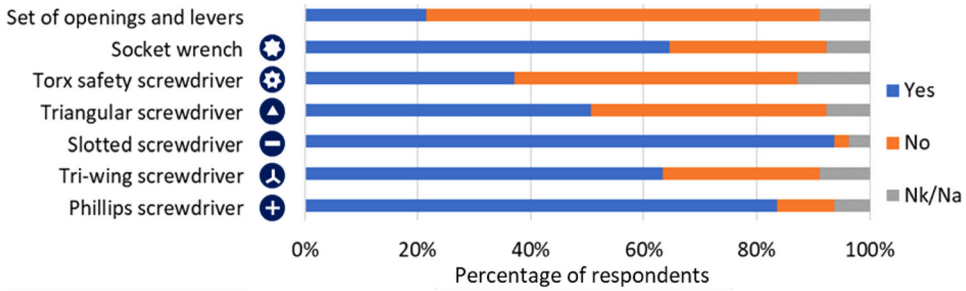


FIGURE 3 Availability of tools for repair ($n = 78$). Underlying data for this figure are available in Table S03 of the Supporting information.

steel: 52.6% and 44.8%, respectively, in Spain; and 46% and 44%, respectively in Europe), according to Statista (2021) and their lifespan. Specifically, the declared average lifespan in the survey was between 4 and 6 years, which is in line with that specified in Gallego-Schmid et al. (2018) (4.4 years), Prakash et al. (2020) (5.7 years), or Hennies and Stamminger (2016) (6 years).

The main appliance used in Spain as an alternative to the kettle is the microwave. Therefore, in further research, it would be interesting to compare the environmental and economic benefits of both alternatives for Spain, where the volume of boiled water is lower (1.2 L/day) compared to the European average (2.1–2.8 L/day), according to the European Commission (2020b) and Gallego-Schmid et al. (2018). From the survey, a tendency to boil only the amount of water to be used was observed, this being one of the improvement proposals promoted by the Preparatory Studies for kettles (European Commission, 2020b) in the framework of the Ecodesign Working Plan (European Commission, 2016). The low use of kettles in Spain may be due to the low instance of tea drinking, since the most common drink is coffee (Sotos-Prieto et al., 2010).

Regarding kettle maintenance, only 1.9% of the respondents reported descaling it on a monthly basis. However, 77.4% of users believe that regular descaling would enhance the appliance's lifespan. This pattern of neglecting maintenance is not exclusive to kettles but extends to other appliances like vacuum cleaners, resulting in a diminished sense of attachment to the appliance (Fisher et al., 2015). Consequently, this lack of maintenance contributes to premature appliance replacement (van den Berge et al., 2021).

Most of the kettles are bought new (32.2%), mainly for hygiene reasons. This is in line with the results obtained from Bovea et al. (2018) and Pérez-Belis et al. (2017), who concluded that Spanish small household EEE items are bought second hand and taken to be repaired by only 0.75% and 9.56% of consumers, respectively; while for ICT EEE items this percentages increases to 12.4% for second-hand purchases and 34.5% for repair by Spanish consumers. Therefore, to fulfil the objectives upheld by the New CE Action Plan (European Commission, 2019) and the "Right to Repair" (European Parliament, 2022), awareness campaigns should be promoted by public and private initiatives. These should be directed at people with medium and low levels of education, and at women, since the results show that men have a greater tendency to repair, while women tend not to repair small household EEE items, which are conclusions that are shared by other studies such as van der Velden (2021). Further studies should focus on this difference to ascertain why women are less willing to repair. Regarding the level of education, it is observed that people with a higher level of education have a higher willingness to repair.

According to the Directive 2012/19/EU (European Parliament and the Council, 2012), the target collection rate for waste EEE (WEEE) should be 65% of the average weight of EEE placed on the market in the three preceding years, or alternatively 85% of the WEEE generated, while the minimum recovery target for the category of small WEEE should be 55% for preparation for reuse and recycling and 75% for global recovery. From the survey, it has been obtained that 60% of respondents stored unused and broken kettles at home, 53.3% discarded their kettle while it still worked, and 26.7% disposed of the appliance at electrical goods recycling facilities, while 13.3% discarded the appliance with the general household waste. However, Hennies and Stamminger (2016) found notable differences in their study since they concluded that kettles are mainly discarded and disposed of when they are defective. The first two practices go against the CE objective of keeping products in circulation for as long as possible, while the last one prevents WEEE from being recovered, as Wieser and Tröger (2016) and Bovea et al. (2018) had previously also highlighted. To fulfil the targets proposed by the Directive 2012/19/EU (European Parliament and the Council, 2012) and the New CE Action Plan (European Commission, 2019), awareness campaigns and incentives should be promoted.

The reparability of kettles was analyzed in the survey from two different perspectives: what consumers are currently doing, and what they would do in various hypothetical situations. Among the respondents who owned kettles, the percentage of those who reported having had one break was extremely high, nearly 9 out of 10 (88.9%). However, only 22.1% of them tried to repair it, even though most of the respondents had the necessary tools to carry out the repair. Again, this behavior goes against the basic principles of the circular economy (European Commission, 2020a; European Commission, 2019). Nevertheless, the respondents declared they would be willing to repair if manufacturers provided all the information to safely repair the appliance (82.3%). This percentage is consistent with findings from Eurobarometer 388 (European Commission, 2014), in which the most common strategy to improve the lifespan of EEE in Spain is through reparability (89.0%).

In addition to the previously discussed barriers related to knowledge and repair abilities, the economic aspect presents another barrier for users when it comes to making repairs. The statistical analysis of the survey highlights the purchase price as a significant factor: if a kettle is expensive, there is a greater possibility that the money spent on its repair would be higher than that for a cheaper kettle, albeit with a limit. The amount of

time that has passed before the kettle breaks is also a significant variable, as Russell et al. (2022) also concluded. So, once the energy efficiency label has been regulated for water kettles, an interesting avenue of further research could be to analyze these variables, the life cycle analysis of the product and, especially, the life cycle cost analysis from the user perspective. This analysis should take into account the survey results regarding the willingness to invest in the reparability of kettles. A further question to ask would be whether there is a correlation between the price paid and the expected quality, this being why consumers with an expensive kettle are more likely to pay for the repair. All in all, the economic aspect is also principally a barrier, since the majority of the respondents would spend nothing on the repair, regardless of the price and year of purchase. This tendency can also be seen across all the main significant variables: most consumers would not spend money on repairing the appliance, regardless of their level of income, household size, or age.

Finally, regarding the kettle labels of purchase price and the forthcoming energy efficiency and reparability scores, more than 50% of the respondents chose the kettle labeled with a better energy efficiency score or better reparability score, even though they were the most expensive kettles. However, when it comes to comparing both variables (energy efficiency and reparability), 72.2% of the respondents chose a kettle with better energy efficiency score, while the remaining 27.8% preferred a kettle with a better reparability score. Further research could be conducted in investigating why this occurs. Eurobarometer 388 (European Commission, 2014) states that the energy efficiency label is well known by 71% of Spanish society and 79% of Europeans, and it influences 74% of Spanish consumers (and 79% of Europeans) when it comes to buying a new EEE item. This is in agreement with results obtained and may be due to society having already been educated on the importance of the energy efficiency of household appliances, whereas the reparability score has not yet been explained, or perhaps it is due to a more generalized lack of willingness or intention to repair in society at present. All in all, when comparing the three variables together, the first option for the majority of the respondents was the price, followed by the energy efficiency rating, and lastly the reparability score. For those who chose the price in first place, most chose energy efficiency in second place and vice versa. The reparability score was the last option considered when choosing a kettle for nearly 70% of the respondents. For further research, it may be interesting to verify the results with a greater range of prices between the kettles, since the price variation was not that great in the present study. Similarly, it would be interesting to understand how the labeling related to energy efficiency and repairability influences the purchase of a new kettle, and which takes preference.

Additionally, it is noted that Spanish households possess the main tools to make basic repairs and disassemble most of the kettles. It was also observed that in most cases the user had not attempted to repair the kettle, even when the fault had been identified. Except for electrical faults, all those who had tried to repair their kettles had succeeded in doing so. On the other hand, the willingness to repair small EEE items, especially kettles, is high. New directives related to labeling information are being worked on, so there will be a wide range of further aspects to investigate.

5 | CONCLUSIONS

Current consumer practices have been identified in this study, and the analysis of the results has accurately answered the four research questions. The results revealed that the use of kettles in Spain is considerably lower on average than in other European countries, although their lifespans and purchase patterns remain similar. Regarding the current strategies for extending the lifespan of kettles, a general lack of maintenance and low rates of reparability or reuse were observed. The disposal patterns showed that nearly half of the kettles disposed of were still working. Nevertheless, an open future willingness to repair was detected, both by users themselves or at repair centers if the manufacturer facilitated the means to do so.

While relevant information has been obtained from the survey, the study is not free of limitations. While the results present consistency, their representativeness could be improved by increasing the sample size. In order to determine whether there are differences between the use and disposal habits of small electrical and electronic appliances, future lines of research could focus on replicating the survey with other categories of sEEE. In addition, a more detailed analysis could be made of the stage of use, with the aim of determining patterns and habits of using the kettle and evaluating whether, given the limited use of kettles in Spain, it is the optimal method for boiling water. Finally, the user's predisposition and training for self-repairing their appliances could be analyzed in depth.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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