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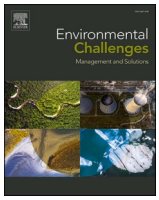

Consumers' perceptions and willingness to pay for a hypothetical microplastics-free labelled bottled water: an empirical study in Italy

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ABSTRACT

The surge of global plastic production has led to the rise of microplastics that have contaminated primary terrestrial ecosystems and various food sources, including bottled water. This study explores consumers' perceptions of microplastic contamination in bottled water and assesses their willingness to pay (WTP) for a hypothetical "microplastic-free" label. Data were collected from a sample of 344 Italian consumers using an online questionnaire and analysed with a single-bounded dichotomous choice method to determine respondents' purchase intentions for a 1.5-litre water bottle with a hypothetical microplastic-free label. Surveyed participants were given the choice between a standard water bottle priced at €0.42 and a water bottle labelled microplastic-free priced randomly between €0.43 and €2.00. A probit model was used to analyse factors that influence the respondents' WTP. The results of the study indicate that consumers prefer microplastic-free water, which is reflected in their WTP a premium price for such a product. A positive correlation was found between the WTP and the awareness of the microplastic issue, consumers' pro-environmental attitudes and their concerns about potential negative health effects associated with microplastic ingestion. However, consumers remain price sensitive, and a higher price negatively impacts the WTP. This study contributes to the economic literature by describing implications for marketing strategies, manufacturing practices, and policy design.

1. Introduction

Microplastics are defined as solid plastic particles composed of mixtures of polymers and functional additives with size ranging from 1 μm to 5 mm. Those particles can be unintentionally formed through the decomposition of larger plastic pieces, but they can also be deliberately manufactured and added to products for specific purposes (e.g. exfoliating beads in facial or body scrubs) .[1] Microplastics have been detected in primary terrestrial ecosystems, affecting marine life and organisms and entering the human food chain (Hakim et al., 2023; Wang et al., 2019; Mercogliano et al., 2020). Consequently, they have been also found in human bodies (Thompson et al., 2004). One of the main channels through which microplastics can enter the human food chain is through the consumption of drinking water (Chen et al., 2025). In fact, for both tap and bottled water, in plastic or glass recipients, previous research has indicated the existence of microplastics (Guo et al., 2024; Zhang et al., 2020), leading to concerns about potential health risks associated with the polymer composition, additives and other compounds or microorganisms (Chaïb et al., 2025; Welle and Franz, 2018; Samandra et al., 2022).

As regards the risk to humans from the consumption of microplastics in bottled water, a comprehensive understanding of the potential health effects remains elusive (Li and Liu, 2024), and further research is needed to develop risk management strategies, mainly related to the industrial bottling and packaging process (Eerkes-Medrano et al., 2019; Praveena and Laohaprapanon, 2021).

This issue is particularly relevant as consumption of bottled water has been progressively increasing worldwide over the last decades, even in countries with high tap water quality (Grebitus et al., 2020). Among these countries, Italy is an interesting case study as it shows high and increasing per capita consumption of bottled water. Data underline the importance of the mineral water market in Italy: 89 % of surveyed people, aged 14 and over, stated that they drink mineral water (ISTAT, 2018). As the Italian National Institute for Statistics shows, the consumption of bottled water is influenced by the lack of trust in tap water, reported by 35 % of respondents nationwide (ISTAT, 2018).

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[1] https://echa.europa.eu/hot-topics/microplastics accessed on 03/07/25.

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However, in recent years, increased public awareness about microplastics and emerging concern for public health and food safety (Jadhav et al., 2021) might have influenced consumers' preferences for bottled water and increased the perception of risks related to its consumption. Thus, it could be interesting to understand how Italian consumers' beliefs could contribute to forming their preferences for a hypothetical microplastic-free certification label on water bottles. This "microplastic-free label" should guarantee that the bottled water does not contain any microplastics. Nowadays, although the scientific research has recently developed biodegradable filters for the removal of microplastics from water (Han et al., 2023), these approaches are not yet available for large scale application in the market and, thus, there is not a certification scheme that allows making this credence attribute known to consumers. Therefore, for the purpose of this study, this label is considered hypothetical.[2]

Against this background, the present analysis aims to understand consumer perceptions and willingness to pay (WTP) for a hypothetical microplastic-free certification on bottled water labels. The study seeks to understand the influence of consumers' attitudes, knowledge and perceptions of microplastics, on their purchasing decisions. To the best of our knowledge, only one other study in the literature has investigated consumers' WTP for a hypothetical microplastic free labelled bottled water (Misund et al., 2020). The authors investigated the issue sampling consumers from Norway, Germany and Portugal. The present study adds to the previous literature in two main ways: *i*) it investigates the topic for another country (namely, Italy) and, *ii*) most importantly, it evaluates the relationship between customers' perceptions and attitudes with their eventual WTP for a hypothetical water bottle label, thus allowing better explore their behaviour. The research questions it aims to answer are the following: (1) Is there a premium price for water labelled microplastic-free? (2) Which factors among socio-demographic and attitudinal characteristics influence purchasing behaviour for a hypothetical microplastic-free label?

Data used to answer these research questions are derived from the responses of 344 Italian consumers to an online survey with a questionnaire distributed via social channels. The Single-Bounded Dichotomous Choice Contingent Valuation method is applied to determine the WTP for bottled water labelled as microplastic-free. By utilizing this method, it is aimed to provide a solid foundation for understanding the economic dimensions associated with the environmental aspects of microplastics. This approach provides a structured framework for assessing consumers' preferences and monetary valuations related to the perceived benefits of a water bottle labelled which is microplastic-free. Randomized pricing within the dichotomous choice format allowed for a nuanced exploration of price sensitivity and economic considerations influencing consumer choices. The results of the study could provide insights to facilitate the adoption of the product offering to evolving consumer products that meet their expectations and environmental awareness.

The rest of the paper proceeds as follows: Section 2 analyses the policy background and reviews the pertinent literature; Section 3 presents the data and method used; Section 4 shows the results; Section 5 discusses them, and Section 6 concludes.

2. Background of the analysis and literature review

The increasing production of plastics in recent decades has led to a surge in environmental pollution, particularly in the form of marine litter, where plastic has emerged as the main anthropogenic pollutant (Law et al., 2010). In the last 50 years, global plastic production has increased from 5 million to over 280 million tonnes, with an annual production of around 20 million tonnes and a growth rate of 47 % in the last 13 years (Walker et al., 2023; Biswas et al., 2023). Part of this volume dispersed in the environment is transformed into smaller fragments by atmospheric and/or biological influences, leading to the worrying phenomenon of microplastics (Wei et al., 2023).

Research on microplastics began in the early 21st century (Thompson et al., 2004), and the attention paid to microplastics has risen exponentially in the past few years (Klingelhöfer et al., 2020). For instance, Thompson et al. (2024) have recently reviewed twenty years of microplastics pollution research and found extensive evidence of significant environmental accumulation, toxicological effects and evidence of possible impacts on human health, as well as growing public interest and early policy reactions. However, the authors acknowledge that despite a growing knowledge base, there are still many information gaps to cover, for example with reference to risk assessments for human exposure.

In recent years, heightened public awareness regarding microplastics and growing apprehension for public health and food safety (Jadhav et al., 2021) have stimulated a significant regulatory action in the European Union to alleviate the contamination caused by microplastics and safeguard both the environment and human well-being. Among these regulatory interventions, the Circular Economy Action Plan (Europea Commission, 2020), launched in March 2020, aims to reduce microplastics in the environment by restricting the use of intentionally added microplastics in products (Regulation EU No. 2023/2055) and tackling the unintentional release of microplastics. Besides, the Zero Pollution Action Plan (COM/2021/400) has set a 30 % reduction target for microplastic releases by 2030. As regards the quality of water for human consumption, the EU Directive 2020/2184 stated that within 3 years of its entry into force the European Commission should have adopted a methodology to measure microplastics in drinking water, with the view to including them on a watchlist. This methodology has been recently developed by the Joint Research Centre of the European Commission (Belz et al., 2024), that has proposed a system to standardize the measuring process, providing a consistent approach to sampling, analysis, and data reporting. This will contribute to generate more uniform and inter-comparable data, which is a first and most important step towards comprehensive understanding environmental pressures on water resources (Rocchi et al., 2024) and the subsequent establishment of exposure levels in European drinking water. This regulatory framework reflects the EU's concerted efforts to combat the proliferation of microplastics and promote a sustainable and eco-conscious future.

However, the change in the regulatory framework is not enough to tackle the microplastics challenge. A fundamental step in developing effective solutions to this global issue is in fact linked to citizens understanding of microplastics and their eventual commitment in changing their consumption patterns (Heidbreder et al., 2019; Henderson and Green, 2020; Deng et al., 2024). Current literature advises that individuals' attitudes and awareness of microplastics can serve as indicators of their engagement in activities to curb associated production (Deng et al., 2020). Studying public opinion and knowledge about plastic waste is therefore crucial for the effective implementation of measures to combat plastic pollution (Forleo and Romagnoli, 2021).

According to a pan European survey, in 2020 88 % of EU citizens declared to be worried about the environmental impact of microplastics (European Commission, Directorate-General for Environment, 2020). For Italy, figures are similar: 87 % of Italians are worried about the environmental impact of microplastics. Indeed, the worry of microplastic, if considered alone, does not bring by itself a change in consumption patterns, as this latter is the result of different concurring aspects that could affect consumer behaviour. These aspects thus need to be investigated with proper approaches. In this respect, as the surge of microplastics pollution has become relevant only in recent years, also the literature analysing consumers attitudes towards microplastics pollution is quite recent. As regards consumers' awareness, Charitou

[2] The only products in the market that nowadays are labelled "microplastic free" are those whose bottle is not made with plastic, but this does not prevent that the water has not been contaminated before being bottled.

et al. (2021) found that Greek consumers were not informed about the issue of marine plastic pollution nor of the EU Single-Use Plastics Directive; however, they still showed a positive WTP and intention to act against plastic pollution. Gannon et al. (2025) asked to consumers in Oregon about their general knowledge and concerns about microplastics and their WTP for washing machine filters with different effectiveness and related prices. Results revealed that respondents had moderate to limited knowledge on microplastics and a small fraction of them would be willing to pay the full filter price. Borriello and Rose (2022), investigated the preferences for management policies tackling the issue of microplastic in the ocean of New South Wales (Australia) by means of a stated preference experiment. They found that citizens would support policies that focus on microplastic pollution reduction and would be willing to contribute financially paying a yearly household levy. King (2023) analysed a representative sample of UK consumers eliciting their WTP by using contingent valuation methods. The author showed that respondents prefer resolving irreversibility (i.e., to reduce the release of microplastics to the marine environment) over resolving uncertainty of the potential adverse consequences of microplastic pollution.

Looking at studies that specifically addressed food consumption, Moon et al. (2023) investigated consumer behaviour in choosing microplastic contaminated seafood across US, China and Korea. They observed that 90 % of respondents that were given microplastic information, viewed microplastics as harmful in all countries. They also found positive WTP for microplastic safer salmon, although with significant differences across examined nations. Recently, Nagy et al. (2024) conducted an experiment using pasta products with varied packaging and labelling attributes. Their results show that consumers' valuations were influenced by information about microplastics' negative environmental effects, especially for females, higher-income individuals, and those who were more concerned about the environment. Barrientos et al. (2024) analysed Chilean consumers' preferences for technology aimed at mitigating microplastic levels in mussels. They found that information treatments increased consumers' WTP for mussels and the provision of health impact information increased the price premium by 56 %, while the provision of environmental information increased it by 21 %.

Regarding consumers' WTP for products hypothetically certified as microplastic-free, only Misund et al. (2020) made an experimental online panel survey. They investigated consumers' preferences in Norway, Germany and Portugal and, as food products, they analysed both salmon and bottled water. Their results showed that, although with some geographical differences, consumers that were very conscious about the problem, would generally prefer products that are microplastics free, but would seldom pay a price premium. For bottled water, the authors found the lowest shares of consumers willing to pay a price premium for a microplastic-free label, compared to the other products. Norway showed the lowest percentage, with only 37 % of respondents declaring a positive WTP for the "microplastic free" labelled bottled water. Portugal showed the highest share, with 64 % of respondents declaring a positive WTP for the product.

None of these studies has however focussed on how customers' perceptions and attitudes influence their preferences for a hypothetical water bottle label that states that the product is free of microplastics. Thus, the present study aims to fill this gap in the existing literature by exploring how Italian customers' attitudes, knowledge, and perceptions of microplastics affect their purchasing decisions.

3. Methods and data

3.1. Contingent valuation method

In this study, the Contingent Valuation Method (CVM) was used. This method, which is used to determine the value individuals place on a particular good or attribute, is categorized as a stated preference method because it requires direct questioning of respondents' WTP (Thiene and Meyerhoff, 2021; Vecchiato et al., 2021). Its main objective is to determine the amount necessary to compensate for changes in the quantity or quality of the specified goods while maintaining the current level of utility. To ensure meaningful responses and avoid biased estimates, respondents are presented with a realistic and comprehensible scenario (Canavari and Coderoni, 2020). In particular, the single-bounded dichotomous choice CVM was used. The WTP techniques used included both a closed-ended question with a dichotomous choice that served as a discrete indicator, and an open-ended question that yielded a continuous value. The dichotomous choice contingent valuation, characterized by a "take it or leave it" valuation question, is considered better suited to reflect real individual purchase decisions. In addition, this survey format has been shown to be less prone to strategic bidding behaviour compared to open-ended questions (Lusk and Hudson, 2004).

In a binary format, respondents indicate whether they are in favour or against the proposed changes. The dichotomous structure improves the accessibility of the method and helps respondents to navigate complex evaluation scenarios. Nevertheless, in the agri-food industry, where there are complex interactions between environmental quality and food production, careful consideration of bias and strategic behaviour is of paramount importance (Tuan et al., 2006). There is ample evidence in the literature of hypothetical bias in contingent valuation estimates (Lusk and Hudson, 2004). This bias arises because, on average, people tend to overstate their preferences in hypothetical contexts. These techniques are thus usually not incentive compatible, especially in scenarios involving the introduction of a new private good in a hypothetical context (Lusk and Hudson, 2004). However, a notable advantage of agribusiness, as opposed to environmental applications, is the private and deliverable nature of the goods. In fact, when people are asked about their WTP for a novel product, the valuation framework can often be non-hypothetical, which improves the incentive compatibility of the survey method (Lusk and Hudson, 2004).

3.2. Data gathering

The data collection tool consisted of an online questionnaire developed with the Qualtrics platform; R software was used for both descriptive statistics and inferential analysis. The data collection was conducted between February and August 2019. Prior to the start of data collection, a pilot study was conducted with eleven participants to test and validate the questionnaire.

The study was based on a convenience sampling technique; a non-probability sampling method was used, and units were selected for inclusion in the sample based on their ease of access. Participants were selected using a combination of a random and snowball system via the internet and social networks. Consumers were selected by means of screening questions before the start of the questionnaire. These screening criteria were: (1) being at least 18 years old, and (2) consuming bottled water regularly; respondents were excluded from the survey if only one of these conditions was not met. Each participant received information about the purpose of the study and a brief overview of microplastic contamination in bottled water.

The questionnaire was divided into several sections, each of which was designed to collect specific information related to the objectives of the study. Information gathered included:

- Dichotomous yes/no question in which they had to choose between a conventional water bottle with a fixed reference price of €0.42 and a water bottle with the microplastic-free label at a randomly suggested price between €0.43 and €2.00. The price range was defined based on actual market prices for bottled water recorded in the major supermarkets in Bologna city, ensuring realistic and relevant values for respondents.
- Open-ended question that yielded a continuous value to elicit comprehensive responses;

- Health attitude measured using the Health Consciousness Scale (HCS) by Gould (1988), that measures the respondent's general attitude and concern for their overall physical health measured using a 7-point Likert scale (from 1-low to 7-high health consciousness level);
- Environmental attitude measured using the Green Consumer Values scale (GCV) developed by Haws et al. (2014), measured using a 7-point Likert scale;
- Consumption frequency, measuring the frequency of consumption of bottled water per week, with values ranging from 1 to 20;
- Awareness about microplastics, measured using a 7-point Likert scale;
- Worry about health consequences of ingesting microplastics: respondents' concerns about health related to the ingestion of microplastics, measured using a 7-point Likert scale;
- Lack of control over ingesting microplastics: extent to which the interviewee fears a lack of control over the ingestion of microplastics, measured using a 7-point Likert scale;
- Knowledge of microplastics: measuring the knowledge of the environmental issues related to microplastics, appraised using replies to specific questions (see Table A1);
- Sociodemographic characteristics (i.e., sex, age, income level and education).

Table A1 in the Annex provides a detailed description of the items used in the questionnaire. It is worth mentioning here that different questions have been used to appraise separately the mere awareness of the microplastics issue and its real knowledge. In fact, as found by Janzik et al. (2024), even if in recent years the topic of microplastics is associated with higher awareness (EFSA, 2019; 2022), there is also limited knowledge of origins and properties of microplastics (Cammalleri et al., 2020; Deng et al., 2020) and a low level of understanding of scientific findings (Henderson and Green, 2020). Thus, it is preferred here to ask for simple awareness of the topic (with a yes/no answer) and to investigate separately the level of concrete knowledge using the replies to a series of 13 scientifically based sentences about microplastics (see Table A.1 for details).

A between-subjects design was used to evaluate the effects of different information treatments on the choice of water labelled as microplastics-free; this allowed comparing groups that are made different through the assignment of treatment conditions. The sample was thus randomly divided into two groups, each of which received different information. The first group, which was considered persuasive, was intended to interest participants in the topic under consideration (treatment group, n.178 respondents). The second group received neutral information (control group, n.166 respondents). The information provided to participants is reported in Table 1.

4. Results

4.1. Main characteristics of the sample analysed

Fig. 1 describe the socio-economic characteristics of the sample. The final sample consist of 344 Italian consumers. The sample consists of 153 males (45.1 %) and 189 females (55.7 %), with only 2 respondents (0.6 %) preferring not to disclose their sex. The majority of respondents (56.4 %) are from Generation Y (Millennials, i.e. born in 1980–1994; 40.4 %) and Generation Z (Centennials, 1995–2012; 16.0 %) combined, indicating a predominantly younger demographic composition. Middle-aged participants from Generation X (1965–1979) account for 25.3 %, while older generations (Baby Boomers, 1946–1964, and Silent Generation, 1928–1945) make up a smaller portion (18.53 % combined). The underrepresentation of the Silent Generation (0.9 %) reflects broader demographic trends. Most respondents (63.7 %) have a university degree or higher, indicating a highly educated sample. Smaller proportions have completed high school (27.0 %) or secondary school (7.8 %), and only 1.5 % have elementary education. No respondents declined to disclose their education level. This educational profile may reflect a sample that is more informed or opinionated on certain topics, which could influence their responses. The sample is diverse in household composition, with 4-person households being the most common (34.7 %), followed by 3-person (23.3 %), more than 4 members (18.1 %), 2-person households (16.9 %) and only 7.0 % composed of a single component. Larger households (5 or more members) are less frequent (17.5 %), while single-person households make up 6.4 % of the sample. Most respondents (83.1 %) have no children, while only a small fraction (11.3 %) has one child, and fewer still have two or more (5.6 % combined). A significant portion of the sample reports earning more than 2000€ per month (45.9 %), while 29.1 % earns less than this amount. A notable 25.0 % of respondents prefer not to disclose their income, which is typical in surveys addressing sensitive topics like financial status. This income distribution indicates a moderately affluent sample but leaves some uncertainty due to non-responses.

Table 1
The treatment conditions.

Treatment	*"Microplastics (small fibres and fragments of plastic) are not only filling the ocean but are already present in drinking water around the world. Approximately 80 % of the samples collected, on five continents, have plastic fibres in them. Why should you care? Plastic is nearly indestructible, meaning that plastic waste does not biodegrade, rather, it only breaks down into smaller parts, even into nanoscale particles so small that they can migrate through the intestinal wall and travel toward the lymph nodes. Microplastics can be present in bottled water, and special filtration systems are needed to eliminate them".*
Control	*"Microplastics can be present in bottled water, and special filtration systems are needed to eliminate them".*

Fig. 2 reveals various aspects of respondents' attitudes and past behaviour toward microplastics. The *HCS* and *GCV* have relatively high mean scores (5.244 and 5.141, respectively), indicating that respondents generally prioritize health and environmental concerns in their consumption decisions. Interestingly, bottled water consumption has a mean of 4.117 bottles per week, reflecting a consistent but not excessive frequency of consumption. Regarding microplastic awareness, respondents have a moderate score (4.541), while their health concern is significantly higher (mean of 5.485), indicating significant concern about the health risks associated with microplastics. Despite this concern, the *Lack of Control* variable shows a lower mean (3.663), suggesting that respondents do not feel a strong sense of helplessness regarding the ingestion of microplastics. Furthermore, respondents show a relatively low level of knowledge about microplastics (average of 1.983), indicating that most are unaware of the environmental problems related to this topic.

To assess potential multicollinearity issues among the predictors, the Variance Inflation Factor (VIF) was calculated for each independent variable included in the model. The results in Table 2 show that all VIF values are well below the commonly accepted threshold of 5, ranging between 1.07 and 1.62. This indicates that multicollinearity is not a concern in this analysis and that the regression coefficient estimates can be considered stable and reliable. Therefore, all predictors were retained in the model without further adjustments.

To check whether the treatment group showed differences in knowledge and perceived risk after the information intervention, the replies to the survey questions measuring factual knowledge about microplastics were compared between the treatment and control groups. The results show that, overall, knowledge was significantly higher in the treatment group than in the control group (Wilcoxon $W = 18.313$, $p < 0.001$; Table A.2 in the Annex). Several individual knowledge questions also showed significant differences, confirming the validity of the treatment manipulation. For example, item K12, which included a question related to the information provided in the treatment and was placed in the questionnaire temporally after the information provided in the treatment, is significantly different for the two groups. Furthermore,

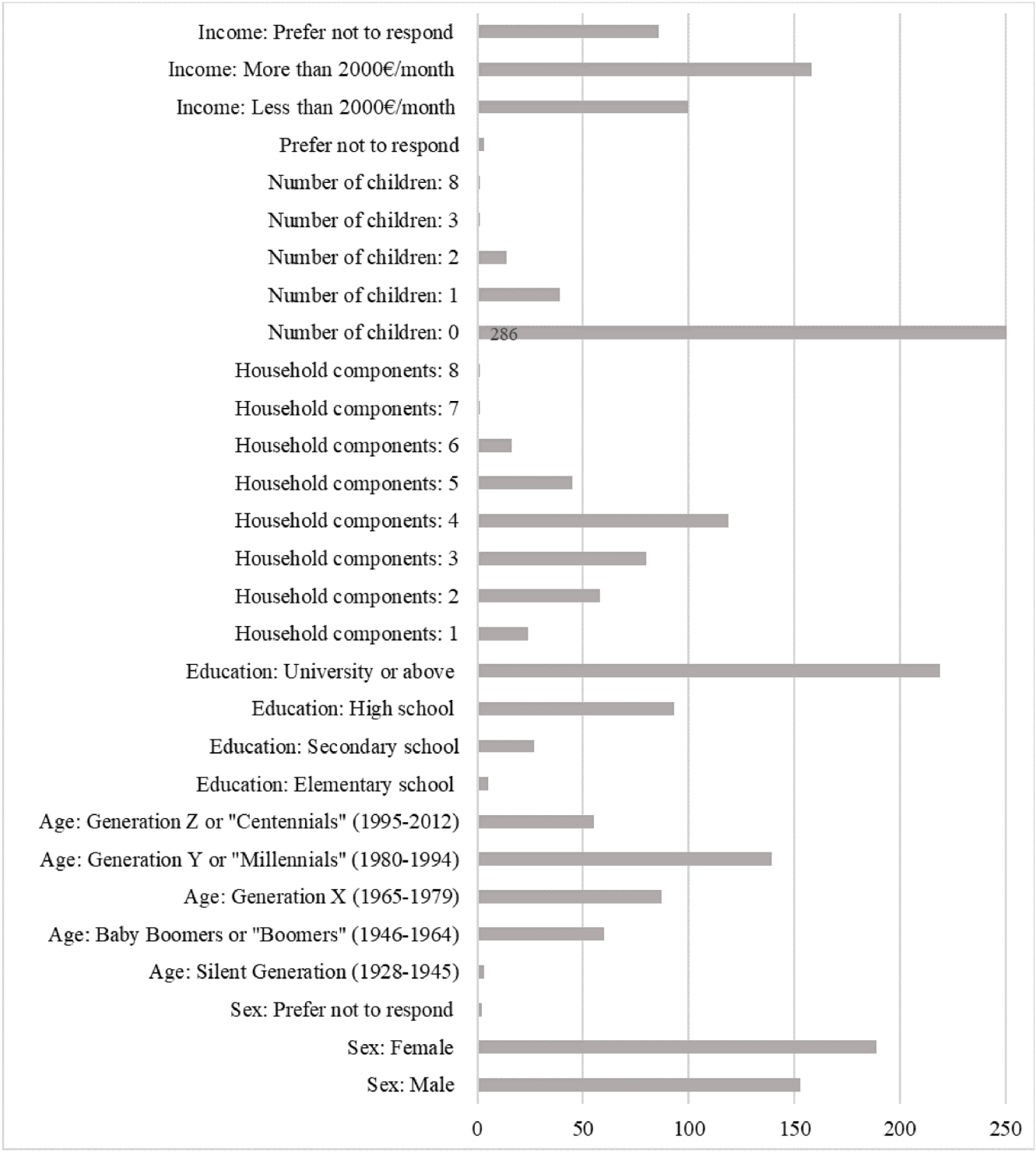

Fig. 1. Socio-demographic characteristics of the sample ($n = 344$).

differences in key attitudinal variables were analysed. The treatment group reported significantly higher levels of worry ($W = 11.214$, $p < 0.001$; Table A.3–A.4 and Fig. A.1) and awareness ($W = 12.978$, $p = 0.046$; Table A.5–A.6 and Figure A. 2) than the control group, further confirming the effectiveness of the treatment in increasing both factual knowledge and perceived risk.

4.2. Model estimations

A probit model was used to examine the factors influencing WTP for a 1.5-liter water bottle labelled “microplastic free”. To determine the WTP distribution, the sample was presented with monetary amounts ranging from €0.43 to €2.00 and binary responses (accept/reject) were recorded. This procedure aimed to determine the probability that a person would respond in one way or another to a particular offer and then to construct a cumulative probability distribution curve of the responses to the closed question using appropriate procedures. To assess the marginal influence of the microplastic-free attribute, the known cost of the corresponding product without this label was subtracted from the expressed mean of the open WTP variable. Assuming that respondents

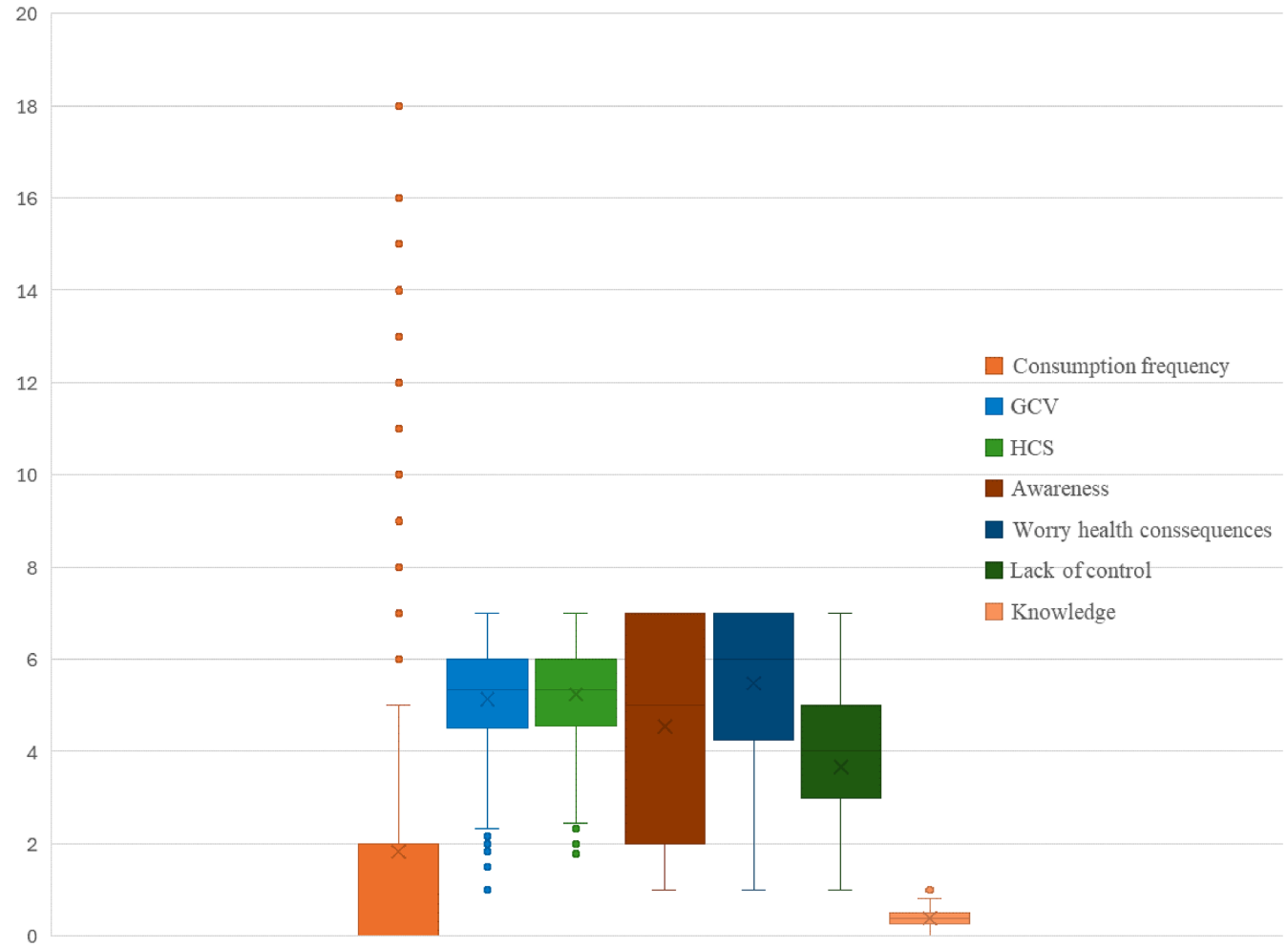

Fig. 2. Mean and standard deviation values for attitudinal characteristics of the sample.

Table 2
Multicollinearity Diagnostics (VIF).

Variable	VIF
Consumption frequency (bottled water)	1.07
GCV	1.81
HCS	1.12
Awareness	1.62
Worry for health consequences	1.36
Lack of control	1.09
Knowledge	1.14

know exactly their utility function, derived from the consumption of the proposed good, when asked whether they are willing to pay a certain amount to maintain their current well-being, they will accept the offer if the proposed sum of money is less than, or equal, to their maximum WTP, according to the principle of utility maximization (Hanemann, 1984). Specifically, it is estimated a model where the dependent variable is the binary response (accept/reject) indicating whether the respondent is willing to pay the proposed price premium. The model takes the form:

$$P(Y=1|X) = \Phi\ (X^t\beta) \quad (1)$$

where P is the probability and Φ is the cumulative distribution function of the standard normal distribution (Pindyck and Rubinfeld, 1998). X represents the vector of regressors assumed to influence the outcome Y variables. The regressors include consumers' pro-environmental and pro-health attitudes, knowledge and awareness of microplastics, frequency of purchasing behaviour, perceived worry and lack of control over health consequences, as well as sociodemographic characteristics such as sex, income, age, and the proposed price.

Table 3
Estimations' results.

Variable	Coefficients	Standard Error	Marginal Effects	Standard Error
Premium price	−1.056***	0.210	−0.280***	0.048
HCS	0.019	0.089	0.005	0.023
GCV	0.255***	0.092	0.067***	0.023
Worry Health Consequences	0.197***	0.067	0.052***	0.017
Knowledge	−0.440*	0.261	−0.117*	0.068
Awareness	0.077	0.047	0.020*	0.012
Treatment	0.146	0.189	0.039	0.050
Lack of control	−0.005	0.058	−0.001	0.015
Consumption frequency	−0.019	0.018	−0.005	0.005
Sex	0.293	0.191	0.079	0.052
Income	0.073	0.195	0.019	0.052
Age	0.006	0.006	0.001	0.001
Intercept	−1.091	0.908	-	-

log Lik. −122.4324 (df=13).
McFadden 0.2892437.
McFaddenAdj 0.2137748.
Coxsnell 0.3203881.
Nagelkerke 0.4347626.
***, **, * Indicate significance at 1 %, 5 % and 10 % level.

Table 3 presents the maximum likelihood estimates of the parameters and the marginal effects. The model demonstrates a good overall fit, with a McFadden's R^2 of 0.289, indicating that the model explains approximately 29 % of the variance in the data. This value, according to McFadden (1979: 307) is typical of fairly fitting models. The adjusted version of McFadden's R^2 (0.214) and the Nagelkerke R^2 (0.435) further confirm the robustness of the model. The log-likelihood value is −122.4324.[3]

Consumers' preference for a microplastic-free water bottle is reflected in their WTP a premium price for this product. The most important factor influencing the acceptance by respondents is the variable premium, which represents the difference between the randomly suggested price and the known price of €0.42 for a conventional water bottle. This is the strongest predictor in the model: the coefficient is significant and negative (−1.056), indicating that the higher the proposed price, the less likely it is that respondents will accept the offer. The marginal effect shows that, holding other variables constant, a one-unit increase in premium price reduces the probability of choosing the microplastic-free alternative by 28 %, highlighting the price sensitivity of consumers.

The coefficient estimated indicates that the stronger the pro-environmental attitude of respondents (GCV), the more willing they are to accept a higher price for water labelled as microplastic-free. The positive significant relationship was observed with a coefficient of 0.255. The marginal effect confirms that greater environmental values increase the probability to choose the product by approximately 6.7 %. This finding underscores the importance of environmental awareness in shaping pro-environmental behaviours. Conversely, a statistically significant negative effect on WTP was observed for consumer knowledge of microplastics (−0.440). The marginal effect suggests that greater factual knowledge about the topic slightly reduces the likelihood of choosing the microplastic-free alternative by about 11.7 %.

The coefficient associated to the *worry for health consequences* is positive and significant (0.197). The marginal effect indicates that higher levels of concern about health risks are associated with a 5.2 % increase in the probability of choosing the microplastic-free alternative. This result suggests that emotional responses related to perceived health threats effectively motivate protective choices.

The coefficient for health attitude (*HCS*) is positive (0.019), but not statistically significant. Likewise, the marginal effect indicates no meaningful impact on the probability of choosing the proposed alternative. This suggests that a general health attitude does not directly influence the adoption decision. Although people with a stronger health attitude are slightly more likely to choose the product, this effect is not robust enough to rule out randomness.

The coefficient for *awareness* is positive (0.077), but not significant; however, the marginal effect is slightly significant, implying a modest positive effect. Specifically, an increase in awareness is associated with an approximately 2 % increase in the probability of choosing a water bottle labelled as microplastic-free, although the evidence is weak.

Frequency of water consumption has no significant effect on WTP for the hypothetical water labelled free of microplastics as confirmed even by marginal effects. Also, the coefficient for the *treatment* is positive (0.146) but not statistically significant. The marginal effect also shows no significant results. This indicates that there is no clear relationship between the treatment and the likelihood of the outcome.

The coefficient for *lack of control* is very close to zero (−0.005) and is not statistically significant. The marginal effect is also negative and statistically insignificant. This indicates that the feeling of helplessness in the face of possible microplastic ingestion has no measurable effect on the decision.

Socio-economic characteristics of respondents, sex (0.293), income (0.073) and age (0.006), are not statistically significant. Marginal effects also indicate that sex, income, and age levels do not significantly influence the adoption decision.

The marginal WTP histogram in Fig. 3, shows a skewed distribution, with most data points between 0.0 and 0.5, meaning that most observations have low marginal WTP values. As the values increase above 0.5, the frequency decreases significantly and there are very few observations above 1.5, advising that higher values are rare or could be outliers.

5. Discussion

This study provides insights into the complex interplay of factors that influence consumer preferences for a hypothetical microplastic-free label on bottled water. Despite growing concerns about microplastic contamination, consumers' purchasing decisions are still influenced by several factors, including price sensitivity, environmental attitudes, and health concerns. A key finding of this study is that consumers show a strong preference for bottled water labelled as microplastic-free. Nevertheless, price remains a decisive factor in the decision-making process. The negative and statistically significant coefficient of the premium price variable indicates that the higher the price, the less likely consumers are to choose microplastic-free bottled water. Therefore, while consumers value health and environmental claims, affordability plays a crucial role in their purchasing behaviour.

The marginal WTP analysis reveals that the WTP estimated has low positive values. Nevertheless, considering the small initial price of the product, the estimated marginal WTP are still of relevance (for instance, 0.50€ of marginal WTP with a price of 0.42€ means a 119 % increase in price). This positive WTP estimates are in line with many findings in the literature, that, although in different context, find that consumers would be willing to pay more for safer, i.e., microplastics-free, products (Moon et al., 2023; Charitou et al., 2021; Misunda et al., 2020; Barrientos et al., 2024) or would be willing to contribute paying a yearly household levy for microplastic pollution reduction (Borriello and Rose, 2022).

A pro-environmental attitude was also found to have a significant and positive influence on the purchase choice, similarly to what found by Nagy et al. (2024). The positive and significant effect of the GCV variable shows that consumers with stronger environmental values are more likely to accept a premium for a microplastic-free product. This finding supports the idea that environmental concern translates into higher WTP. Consumers with strong environmental attitudes may likely be more aware of the environmental risks of plastic pollution and more motivated to choose products that align with their values. This result is also consistent with the literature on consumers' preferences for food products with environmental attributes (Canavari and Coderoni, 2020).

Interestingly, awareness and knowledge about microplastics have both an influence on the WTP, but if awareness has a positive impact on it, the effect of the knowledge is negative. As regards the influence of the awareness, results are in line with Forleo and Romagnoli (2021) who

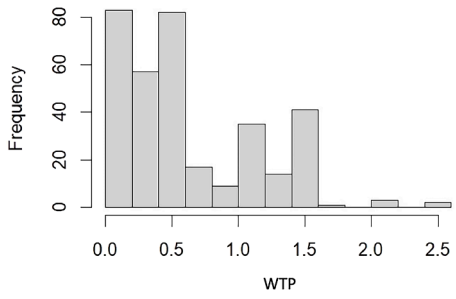

Fig. 3. Histogram of marginal WTP (€).

[3] To conduct a robustness check, the model was split in two sub-samples: one for the treatment and one for the control group. Results confirm the stability of the probit models for both the groups, with signs of coefficient that remain coherent. However, as expected, due to the smaller sample size, the significance of some coefficients is reduced.

found that, what they define as "knowledge" leads to increased consumer action against plastic pollution. The authors, in fact, use a definition of knowledge that is based on self-assessment made by the respondents,[4] that is the same approach used in this study for assessing awareness. Thus, the variable knowledge, as it is defined by Forleo and Romagnoli (2021) is like what is here defined as "awareness of microplastics", that has a slightly positive impact on WTP, confirming what found by the authors. These results would thus highlight the need to raise awareness of the microplastics problem among the public and may provide useful suggestions to decision makers who want to plan interventions aimed at limiting their spread, as indicated also by previous studies (Forleo and Romagnoli, 2021; Charitou et al. 2021). In addition, in the present study, it is measured also the real knowledge about microplastic as the literature has stressed that, in general, there is a difference between self-reported and objective knowledge concerning microplastics (Charitou et al., 2021). This discrepancy could be explained by the fact that the topic of microplastic is included among the most recent emerging issues (Gall and Thompson, 2015), thus its awareness is high, but a real, objective knowledge of the environmental issues related to microplastics is yet lower (Charitou et al., 2021). The findings of the present study confirm this difference as awareness and knowledge are slightly correlated (Table A.7). Nevertheless, while awareness somewhat rises the probability to be willing to pay more for microplastics-free bottled water, knowledge decreases this probability. One possible explanation of the fact that the knowledge decreases the probability to be willing to pay more, could be that informed consumers may question the effectiveness or credibility of a microplastic-free label, given the widespread and therefore uncontrolled presence of microplastics in the environment. This means that knowledge, when present, is a limiting factor because people are likely to be aware that the problem of microplastics is difficult to control. So, more informed consumers understand that the problem of microplastic contamination is pervasive and cannot be easily eliminated. This can lead also to some level of scepticism about the realism or feasibility of the "microplastic-free" label, decreasing consumers' trust for such kind of labels, that may depend heavily on perceived legitimacy. This highlights the importance of clear, verifiable labelling standards and transparent information for building credibility and trust, especially among more informed consumer groups. These findings highlight the importance of informed choice and sustainability-oriented communication strategies. Sustainable food system transitions, in fact, increasingly rely on active consumer engagement and shared responsibility models, especially in contexts where individual consumption choices intersect with collective environmental challenges (Brunori et al., 2024).

The significant and positive effect of worry for health consequences indicates that concern about the potential health risks associated with microplastics also plays a role. This demonstrates that concern about ingesting plastic particles can increase the propensity to opt for safer, i.e., microplastic-free, options. This result is somewhat coherent with what found by Barrientos et al. (2024) that estimated that the provision of health impact information increased the price premium by 56 %. In this sense, consumer information campaigns about health risks could strengthen demand for microplastic-free products.

On opposite, general health attitude (HCS) was not found to be significant, suggesting that specific fears related to microplastics (i.e. "worry for health consequences variable") play a bigger role than general health awareness in influencing the WTP. Indeed, the two variables measure different consumers' attitudes (as shown also by their low correlation level, see Table A.7), thus results tell us that people that have higher health consciousness do not necessarily associate microplastics to a potential danger for their health and thus are not prone to pay more for microplastics-free water.

[4] Respondents in the study were asked "*Have you ever heard about microplastics in the marine environment?*".

The lack of control over microplastics may act as a necessary but not sufficient underlying factor to influence behaviour. In other words, this variable leads to action only when combined with other motivating factors such as attitudes or incentives.

Interestingly, treatment information did not have a statistically significant effect. This result contradicts what found by Nagy et al. (2024) that estimate that consumers' attitude is influenced by information about microplastics' negative environmental effects. As shown in Section 4.1, the information provided seems to have influenced both factual knowledge and perceived risk between the treatment and control group. However, it is maybe possible that it the information provided was not effective enough, as the treatment was a quite "neutral" statement on what microplastics are, and not a "warning message" on their consequences for environment and human health.

Finally, the study found no significant effects for socio-demographic characteristics such as sex, age and income level. This means that WTP for microplastic-free bottled water is relatively consistent across demographic groups, with attitudes and concerns being stronger determinants than socioeconomic characteristics. This result is not in line with previous studies, as for example Nagy et al. (2024) found that sex, education and income are good predictors, but only in the treatment group, meaning that the only socio-economic characteristics are not relevant even in that study, if not linked to information on environmental impacts of microplastics.

5.1. Limitations of the study

The main limitations of this study are related to the sample, for its composition and for the year of sampling, and to the method used, for the anchoring effects in open-ended follow-ups and the hypothetical nature of the experiment.

As regards the sample composition, the use of web-based tools usually allows reaching a higher number of respondents, thus is preferred for convenience sampling techniques, but is it also raises issues regarding the representativeness of the exercise. The nature of web-based sampling tends to attract self-selected respondents and can lead to a bias towards younger and more educated respondents than the targeted population (Canavari et al., 2005). Therefore, the sample cannot be considered fully representative of the total population of Italian consumers and results are not generalizable, limiting the scope of their inference. Besides, as the data were collected in 2019, it could be argued that this could further limit the insights from the results, as consumers' awareness about microplastics has evolved due to ongoing media coverage and policy discussions. Indeed, as showed by the special Eurobarometers by the European Food Safety Authority (EFSA), the share of Italians that declared to have heard about microplastics found in food rose only of 5 % from 2019 (25 %) to 2022 (30 %). Also, Italy showed the lowest share among EU countries (average EU 27 value was 55 %, with a 7 % increase) (EFSA, 2019; 2022), thus highlighting a still relative low awareness in the country. Although in presence of a low level of awareness of Italian consumers, the use of data surveyed in 2019 could point to an underestimation of Italians consumers WTP, thus findings must be taken with caution in this respect. Actually, the link between consumers' awareness and consumption choices is not straightforward: besides the level of awareness, what really matters in determining the consumption choices and proactive protection against exposure, is risk perception, that in this study, is captured by the worry for health consequences. This complex link makes studies like the present, despite their limitations, very useful to gain insights into consumers' behaviour understanding.

Another limitation of the work is that the study design does not explicitly address the potential anchoring effects that could arise from using an open-ended follow-up question after the initial dichotomous choice in the contingent valuation framework. This is a known limitation of CVM studies, as respondents could be influenced by the offer presented in the closed-ended question, potentially distorting open-

ended WTP values (Van Exel et al., 2006; Carson and Groves, 2007).

Finally, it must be acknowledged that the hypothetical nature of the study, might limit results validity. In fact, the approach used involves assessing WTP for a product that is not currently available on the market. Therefore, a hypothetical bias might arise, as individuals may tend to overstate their preferences in hypothetical contexts. This bias arises because no actual payment is made or received in exchange for a change in an attribute of the exchanged good (Moukam and Atewamba, 2023). As a result, contingent valuation techniques, such as the unconstrained dichotomous choice question, lack incentive compatibility, especially in scenarios involving the introduction of a new private good in a hypothetical context. Although hypothetical approaches are widely used in the literature, caution should be exercised when interpreting their results and it is recommended that the study is repeated to verify its reliability. The literature on the topic has extensively discussed and emphasized the importance of interpreting contingent valuation estimates carefully (Hensher, 2010). However, some aspects of the approach used in this study would suggest that the magnitude of hypothetical bias could be less than for other types of approaches. As shown by List and Gallet (2001), that applied a meta-analysis to assess any systematic relationships between various methodological approaches and hypothetical bias, the magnitude of the bias was statistically less for WTP as compared to willingness-to-accept applications, and for private as compared to public goods. Besides, as regards the method, Murphy et al. (2004) also report the results of a meta-analysis and found that a choice-based elicitation mechanism, such as dichotomous and multiple choice, is important in reducing the hypothetical bias. As the present study is based on a WTP application for a private good using a dichotomous choice method, it is assumed that these aspects could have help mitigating the eventual hypothetical bias.

6. Conclusion and policy implications

This study provides insights into consumers' preferences for a water bottle with a hypothetical microplastic-free label that does not yet exist in the market. Consumers show a strong preference for bottled water labelled as microplastic-free; the awareness of the problem, the environmental attitude and the worry for health concerns positively influences their WTP. Companies and policymakers can use this information to refine marketing strategies, develop targeted awareness campaigns and create products that align with consumer values, encouraging more sustainable consumption patterns. Nevertheless, while consumers value health and environmental claims, affordability still plays a crucial role in their purchasing behaviour, as consumers showed to be highly price sensitive. Companies introducing microplastic-free bottled water should thus consider pricing strategies that balance convenience and perceived value of the product. Additionally, marketing efforts should emphasize environmental benefits and health safety to attract consumers willing to pay extra. Policy makers could finally explore regulations to standardize microplastic-free labelling, ensuring transparency and increasing consumer trust.

Future research should address the main limitations of the study, by analysing more recent data for larger and more representative samples, allowing also for cross-countries comparisons. Besides, the survey design should consider adopting alternative elicitation formats or debiasing techniques to minimize anchoring effects and strengthen the validity of WTP. Also, using non hypothetical methods could reduce overestimating the WTP. Nevertheless, as products like the one analysed in this study are not yet available in the market, considering less hypothetical setting could be done by framing a more realistic purchase situation. These approaches will contribute to a more comprehensive understanding of consumer preferences and behaviours related to microplastic-free products.

CRediT authorship contribution statement

Giulia Maesano: Writing – original draft, Writing – original draft, Writing – review & editing, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maurizio Canavari:** Conceptualization, Methodology. **Silvia Coderoni:** Writing – original draft, Writing – review & editing, Visualization, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization.

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.

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Annexes

Fig. A1, Fig. A2
Table A1, Table A2, Table A3, Table A4, Table A5, Table A6, Table A7

Table A1
Variable and items in the survey.

Variable	Items
Health attitude (HCS)	I often reflect on my health
	Right now, I am fully aware of my state of health
	I am generally attentive to the sensations coming from my body
	I frequently check my health condition
	I am alert to changes in my state of health
	I am usually aware of my health
	I realise my state of health during the day
	I notice how I feel physically during the day
	I care a lot about my health
Environmental attitude (GVC)	It is important to me that the products I use do not harm the environment

(*continued on next page*)

Table A1 (*continued*)

Variable	Items
	I consider the potential environmental impact of my actions when making many of my decisions
	My purchasing habits are influenced by my concern for the environment
	I am concerned about wasting our planet's resources
	I would call myself an environmentally responsible person
	I am willing to suffer discomfort in order to take actions that are more environmentally friendly
Awareness about microplastics	I was aware of the problem of microplastics even before participating in this survey
Worry about health consequences of ingesting microplastics	I am afraid that ingesting microplastics through water and food will harm my health
Lack of control over ingesting microplastics	I cannot do anything to avoid ingesting microplastics
Water consumption	How many bottles of water do you normally consume in a week
Knowledge	K1. Once fragmented, primary plastics, dispersed in the environment, transform into micro- and nano-plastics, losing the chemical and structural characteristics of the material from which they are derived.
	K2. The micro- and nano-plastics dispersed in the environment, after fragmentation, are ingested by fish, birds, etc., entering the food chain and thus reaching our tables.
	K3. Micro and nano plastics if ingested could interfere with our endocrine system to the point of generating genetic mutations.
	K4. Using hygiene products containing microbeads (e.g. toothpaste, face and body scrubs, etc.) contributes to the release of microplastics into the environment.
	K5. Washing synthetic clothes does not lead to any dispersion of plastic material into the environment.
	K6. All plastics (polyethylene, polyurethane, etc.) are recyclable.
	K7. Micro and nano plastics have also been found in table salt around the world.
	K8. No scientific studies are yet available to determine the health risks of ingesting microplastics.
	K9. According to current knowledge, the ingestion of micro- and nano-plastics, per se, certainly poses an objective risk to human health.
	K10. The recycling process of PET (polyethylene terephthalate), the most widely used type of plastic for bottles, involves the emission of many pollutants.
	K11. The UNEP (United Nations Environment Programme) currently considers the problem of plastics dispersed in the environment (seas, oceans, etc.) among the most serious environmental emergencies.
	K12. Based on current knowledge, a large proportion of ingested microplastics could be eliminated from our bodies without causing consequences.
	K13. Micro and nano plastics can act as a transport medium for various pollutants, invasive species and pathogens, pesticides, etc.

Table A2
Knowledge difference between T and C groups.

Knowledge	W statistic	p-value	Significance
1	16,567	0.0362	Significant
2	16,034	0.0171	Significant
3	17,777	0.0003	Significant
4	15,516	0.3664	Not significant
5	15,861	0.1759	Not significant
6	15,024	0.7567	Not significant
7	17,114	0.0012	Significant
8	16,989	0.0079	Significant
9	15,421	0.3870	Not significant
10	17,068	0.0050	Significant
11	16,084	0.0540	Significant
12	16,940	0.0087	Significant
13	15,228	0.5875	Not significant
Overall Knowledge	18,313	0.0001	Highly significant

Table A3
Worry difference between T and C groups.

Descriptive statistics	Treatment	Control
Min	1.000	1.000
Median	6.000	5.500
Mean	5.787	5.163
Max	7.000	7.000

Table A4
Wilcoxon test.

Test (W)	11,214
p-value	0.0000

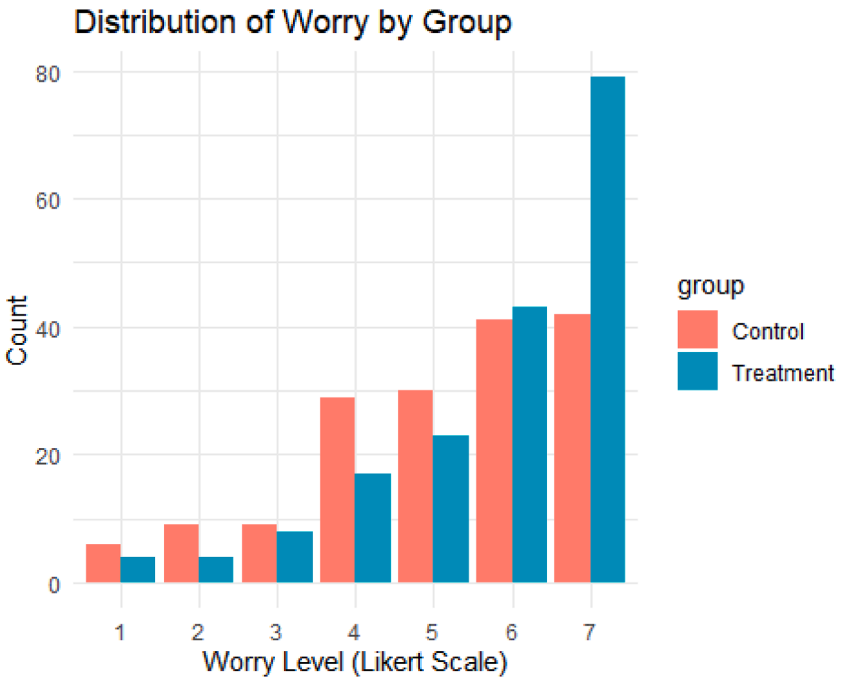

Fig. A1. Distribution of Worry by Group.

Table A5
Awareness difference between T and C groups.

Descriptive statistics	Treatment	Control
Min	1.000	1.000
Median	5.000	5.000
Mean	4.764	4.301
Max	7.000	7.000

Table A.6
Wilcoxon test.

Test (W)	12,978
p-value	0.0462

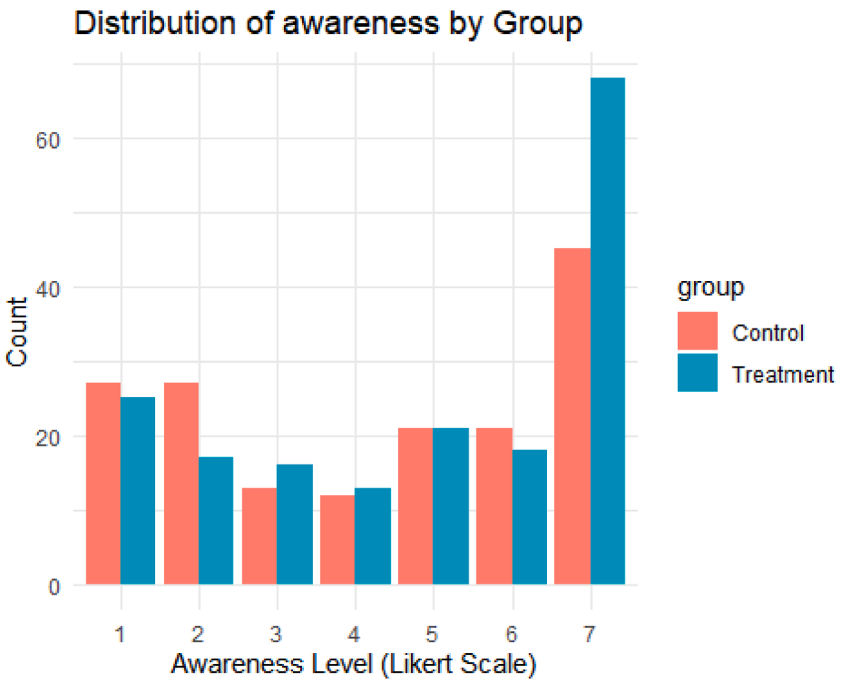

Fig. A2. Distribution of awareness by Group.

Table A7
Correlation matrix.

Variable	Water consumption	GCV	HCS	Awareness	Worry Health	Lack of Control	Knowledge
Water Consumption	1	0.105848	0.008577	0.131980	0.151707	-0.08697	-0.000820
GCV		1	0.279463	0.475369	0.408097	-0.01147	0.163472
HCS			1	0.207435	0.303221	-0.07196	0.104062
Awareness				1	0.370964	0.079805	0.241961
Worry Health					1	0.069079	0.217166
Lack of Control						1	-0.03906
Knowledge							1

Data availability

Data will be made available on request.

References

Barrientos, M., Lavín, F.V., Oliva, R.D.P, Nayga Jr, R.M., Gelcich, S., 2024. Microplastics in seafood: consumer preferences and valuation for mitigation technologies. Food Res. Int. 187 (114342). https://doi.org/10.1016/j.foodres.2024.114342.

Belz, S., Cella, C., Geiss, O., Gilliland, D., La Spina, R., Mëhn, D., Sokull-Kluettgen, B., 2024. Analytical Methods to Measure Microplastics in Drinking Water. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/109944. JRC136859.

Biswas, T., Pal, S.C., 2023. Emerging threats of microplastics on marine environment: a critical review of toxicity measurement, policy practice gap and future research direction. J. Clean. Prod., 139941

Borriello, A., Rose, J.M., 2022. The issue of microplastic in the oceans: preferences and willingness to pay to tackle the issue in Australia. Mar. Policy 135, 104875.

Brunori, G., Prosperi, P., Rovai, M., Zollet, S., 2024. Sustainable food systems and consumer engagement: challenges and opportunities for inclusive transitions. Bio-based Appl. Econ. 13 (1), 87–101. https://doi.org/10.36253/bae-14003.

Cammalleri, V., Marotta, D., Antonucci, A., 2020. A survey on knowledge and awareness on the issue "microplastics": a pilot study on a sample of future public health professionals. Ann. Ig. Med. Prev. Comunità 5, 577–589. https://doi.org/10.7416/ai.2020.

Canavari, M., Nocella, G., Scarpa, R., 2005. Stated willingness-to-pay for organic fruit and pesticide ban: an evaluation using both web-based and face-to-face interviewing. Food Prod. Mark. 11 (3), 107–134. https://doi.org/10.1300/J038v11n03_07.

Canavari, M., Coderoni, S., 2020. Consumer stated preferences for dairy products with carbon footprint labels in Italy. Agric. Food Econ. 8 (1), 1–16.

Carson, R.T., Groves, T., 2007. Incentive and informational properties of preference questions. Environ. resour. econ. 37, 181–210.

Chaïb, I., Doyen, P., Merveillie, P., Dehaut, A., Duflos, G., 2025. Microplastic contaminations in a set of beverages sold in France. J. Food Compos. Anal. 144, 107719. https://doi.org/10.1016/j.jfca.2025.107719.

Charitou, A., Aga-Spyridopoulou, R.N., Mylona, Z., Beck, R., McLellan, F., Addamo, A.M., 2021. Investigating the knowledge and attitude of the Greek public towards marine plastic pollution and the EU Single-Use Plastics Directive. Mar. Pollut. Bull. 166, 112182.

Chen, Y., Wang, Y., Hu, B., Su, L., 2025. Drinking water network as a potential pathway for micro- and nanoplastics exposure to human: a mini review. Water 17 (8), 1188. https://doi.org/10.3390/w17081188.

Deng, L., Cai, L., Sun, F., Li, G., Che, Y., 2020. Public attitudes towards microplastics: perceptions, behaviors and policy implications. Resour. Conserv. Recycl. 163, 105096. https://doi.org/10.1016/j.resconrec.2020.105096.

Eerkes-Medrano, D., Leslie, H.A., Quinn, B., 2019. Microplastics in drinking water: a review and assessment. Curr. Opin. Environ. Sci. Health 7, 69–75.

Europea Commission, 2020. A new Circular Economy Action Plan. For a cleaner and more competitive Europe, Brussels, 11.3.2020, COM(2020) 98 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN.

European Commission, Directorate-General for Environment, 2020. Special Eurobarometer 501. Attitudes of Europeans towards the environment. Eur. Union 2020. https://doi.org/10.2779/902489.

EFSA, 2019. Special Eurobarometer – April 2019: food safety in the EU. Eur. Food Saf. Auth. (EFSA). https://doi.org/10.2805/661752.

EFSA, 2022. Special Eurobarometer – April 2022: food safety in the EU. Eur. Food Saf. Auth. (EFSA). https://doi.org/10.2805/729388.

Forleo, M.B., Romagnoli, L., 2021. Marine plastic litter: public perceptions and opinions in Italy. Mar, Pollut, Bull 165, 112160. https://doi.org/10.1016/j.marpolbul.2021.112160.

Gall, S.C., Thompson, R.C., 2015. The impact of debris on marine life. Mar. Pollut. Bull 170–179. https://doi.org/10.1016/j.marpolbul.2014.12.041.

Gannon, A., Granek, E.F., Nielsen-Pincus, M., Harkins, L., 2025. Perceptions about potential microplastic interventions: a study on knowledge, concerns, and willingness to pay. Microplastics Nanoplastics 5 (1), 11. https://doi.org/10.1186/s43591-025-00119-8.

Gould, S.J., 1988. Consumer attitudes toward health and health care: a differential perspective. J. Consum. Aff. 22 (1), 96–118.

Guo, X., Dai, H., He, L., 2024. Migration testing of microplastics from selected water and food containers by Raman microscopy. J. Hazard, Mater 462, 132798.

Grebitus, C., Roscoe, R.D., Van Loo, E.J., Kula, I., 2020. Sustainable bottled water: how nudging and internet search affect consumers choices. J. Clean, Prod 267, 121930. https://doi.org/10.1016/j.jclepro.2020.121930.

Han, G., Oh, S., Yeo, S.J., Lee, J., Lim, H., 2023. Eco-friendly polycaprolactone-bound diatomite filter for the removal of metal ions and micro/nanoplastics from water. Sci. Total Environ. 905, 166956. https://doi.org/10.1016/j.scitotenv.2023.166956.

Hakim, L., Asmara, A.A., Priambodo, R.Y., Wong, Y.J., 2023. Microplastic pollution profile in the Indian Ocean of the Southern Java Island, Indonesia. Environ. Chall. 13, 100786. https://doi.org/10.1016/j.envc.2023.100786.

Haws, K.L., Winterich, K.P., Naylor, R.W., 2014. Seeing the world through GREEN-tinted glasses: green consumption values and responses to environmentally friendly products. J. Consum. Psychol. 24 (3), 336–354. https://doi.org/10.1016/j.jcps.2013.11.002.

Heidbreder, L.M., Bablok, I., Drews, S., Menzel, C., 2019. Tackling the plastic problem: a review on perceptions, behaviors, and interventions. Sci. Total Environ. 668, 1077–1093.

Henderson, L., Green, C., 2020. Making sense of microplastics? Public understandings of plastic pollution. Mar. Pollut. Bull. 152, 110908. https://doi.org/10.1016/j.marpolbul.2020.110908.

Hensher, D.A., 2010. Hypothetical bias, choice experiments and willingness to pay. Transp. Res. Part B: Methodol. 44 (6), 735–752.

ISTAT, 2018. Multipurpose survey on households: aspects of daily life - microdata for research purposes. available at https://www.istat.it/en/microdata/multipurpose-survey-on-households-aspects-of-daily-life/. accessed on 1st January 2025.

Jadhav, E.B., Sankhla, M.S., Bhat, R.A., Bhagat, D.S., 2021. Microplastics from food packaging: an overview of human consumption health threats and alternative solutions. Environ. Nanotechnol. Monit. Manag. 16, 100608.

Janzik, R., Koch, S., Zamariola, G., Vrbos, D., White, M.P., Pahl, S., Berger, N., 2024. Exploring public risk perceptions of microplastics: findings from a cross-national qualitative interview study among German and Italian citizens. Risk Anal. 44 (3), 521–535. https://doi.org/10.1111/risa.14184.

King, P., 2023. Willingness-to-pay for precautionary control of microplastics, a comparison of hybrid choice models. J. Environ. Econ. Policy 12 (4), 379–402.

Klingelhöfer, D., Braun, M., Quarcoo, D., Brüggmann, D., Groneberg, D.A., 2020. Research landscape of a global environmental challenge: microplastics. Water Res. 170, 115358.

Law, K.L., Morét-Ferguson, S., Maximenko, N.A., Proskurowski, G., Peacock, E.E., Hafner, J., Reddy, C.M., 2010. Plastic accumulation in the North Atlantic subtropical gyre. Science 329 (5996), 1185–1188.

Li, P., Liu, J., 2024. Micro (nano) plastics in the Human body: sources, occurrences, fates, and health risks. Environ. Sci. Technol. 58 (7), 3065–3078. https://doi.org/10.1021/acs.est.3c08902, 2024.

List, J., Gallet, G., 2001. What experimental protocol influence disparities between actual and hypothetical stated values? Environ. Resour. Econ. 20 (2), 241–254, 2001.

Lusk, J.L., Hudson, D., 2004. Willingness-to-pay estimates and their relevance to agribusiness decision making. Appl Econ Perspect Policy 26 (2), 152–169.

McFadden, D., 1979. Quantitative methods for analyzing travel behaviour on individuals: some recent developments. Behav. Travel Model.

Mercogliano, R., Avio, C.G., Regoli, F., Anastasio, A., Colavita, G., Santonicola, S., 2020. Occurrence of microplastics in commercial seafood under the perspective of the human food chain. A review. J. Agric. Food Chem. 68 (19), 5296–5301.

Misund, A., Tiller, R., Canning-Clode, J., Freitas, M., Schmidt, J.O., Javidpour, J., 2020. Can we shop ourselves to a clean sea? An experimental panel approach to assess the persuasiveness of private labels as a private governance approach to microplastic pollution. Mar. Pollut. Bull 153, 110927.

Moon, D., Wang, H.H., Hao, N., 2023. Consumer behavior in choosing microplastic contaminated seafood across different countries: the role of cultural and attitudinal factors. Econ Anal Policy 78, 290–306.

Moukam, C.Y., Atewamba, C., 2023. Incorporating expert knowledge in the estimate of farmers' opportunity cost of supplying environmental services in rural Cameroon. Bio-Based Appl. Econ. 12 (3), 197–220. https://doi.org/10.36253/bae-13534.

Murphy, J., Allen, P., Stevens, T., Weatherhead, D., 2004. A Meta-analysis of Hypothetical Bias in Stated Preference Valuation. Department of Resource Economics, University of Massachusetts, Amherst. January.

Nagy, L.B., R.M.Jr, Nayga, Temesi, A., 2024. Nudging consumers about the issue of microplastics: an experimental auction study on valuation for sustainable food packaging. Sci Rep 18993 (24). https://doi.org/10.1038/s41598-024-69962-8, 14.

Pyndick, R.S., Rubinfeld, D.L., 1998. Econometric Models and Economic Forecasts. McGraw-Hill International Editions. Fourth edition.

Praveena, S.M., Laohaprapanon, S., 2021. Quality assessment for methodological aspects of microplastics analysis in bottled water–a critical review. Food Control 130, 108285.

Rocchi, B., Viccaro, M., Sturla, G., 2024. An input-output hydro-economic model to assess the economic pressure on water resources. Bio-based Appl. Econ. 13 (2), 203–217. https://doi.org/10.36253/bae-14957.

Samandra, S., Johnston, J.M., Jaeger, J.E., Symons, B., Xie, S., Currell, M., Clarke, B.O., 2022. Microplastic contamination of an unconfined groundwater aquifer in Victoria, Australia. Sci. Total Environ. 802, 149727.

Thiene, M., Meyerhoff, J., 2021. Eliciting preferences using stated choice experiments. Bio-Based Appl. Econ. 9 (3), 223. https://doi.org/10.13128/bae-10443.

Thompson, R.C., Olsen, Y., Mitchell, R.P., Davis, A., Rowland, S.J., John, A.W., Russell, A.E., 2004. Lost at sea: where is all the plastic? Science 304 (5672). https://doi.org/10.1126/science.1094559, 838-838.

Thompson, R.C., Courtene-Jones, W., Boucher, J., Pahl, S., Raubenheimer, K., Koelmans, A.A., 2024. years of microplastic pollution research—what have we learned? Science 386 (6720). https://doi.org/10.1126/science.adl2746.

Tuan, F.C., Bai, J., Huang, J., Lin, W., & Somwaru, A. (2006). Consumers' willingness to pay for biotech foods in China: a contingent valuation approach.

Van Exel, N.J.A., Brouwer, W.B., van den Berg, B., Koopmanschap, M.A., 2006. With a little help from an anchor: discussion and evidence of anchoring effects in contingent valuation. J. Socio Econ. 35 (5), 836–853. https://doi.org/10.1016/j.socec.2005.11.045.

Vecchiato, D., Torquati, B., Venanzi, S., Tempesta, T., 2021. The role of sensory perception in consumer demand for tinned meat: a contingent valuation study. Foods 10 (9), 2185.

Walker, T.R., Fequet, L., 2023. Current trends of unsustainable plastic production and micro (nano) plastic pollution. TrAC Trends Anal. Chem., 116984

Wang, J., Liu, X., Li, Y., Powell, T., Wang, X., Wang, G., Zhang, P., 2019. Microplastics as contaminants in the soil environment: a mini-review. Sci. Total Environ. 691, 848–857.

Wei, J., Chen, M., Wang, J., 2023. Insight into combined pollution of antibiotics and microplastics in aquatic and soil environment: environmental behavior, interaction mechanism and associated impact of resistant genes. Trends Anal. Chem., 117214

Welle, F., Franz, R., 2018. Microplastic in bottled natural mineral water–literature review and considerations on exposure and risk assessment. Food Addit. Contam.: A 35 (12), 2482–2492.

Zhang, Q., Xu, E.G., Li, J., Chen, Q., Ma, L., Zeng, E.Y., Shi, H., 2020. A review of microplastics in table salt, DrinkingWater, and air: direct Human exposure. Environ. Sci. Technol. 54, 3740–3751.