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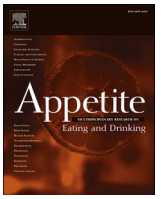

Health or environment? Understanding which informative message is more effective in replacing red meat with mushroom-based alternatives

Rachele De Cianni [a], Teresina Mancuso [a], Giuseppina Rizzo [b,*], Giuseppina Migliore [b]

[a] Department of Agricultural, Forest, and Food Sciences, University of Turin, Largo Paolo Braccini 2, Grugliasco, 10095, Italy
[b] Department of Agricultural, Food and Forest Sciences, University of Palermo, Viale delle Scienze, Ed. 4, 90128, Palermo, Italy

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ABSTRACT

Current concerns regarding the health and environmental consequences associated with excessive meat consumption have underscored the importance of guiding consumers towards more sustainable diets. Given this perspective, this study seeks to evaluate the effectiveness of tailored informative messages in shaping consumer behaviour, particularly within the framework of replacing meat with mushroom-based alternatives. Additionally, it explores the factors influencing informative message effectiveness. An experimental online survey was conducted on a sample of 951 Italian consumers. Specifically, the sample was divided into three groups, of which 309 individuals formed the control group, 311 participants received informative messages on the health risks associated with red meat consumption, and 331 participants received informative messages emphasizing the environmental damages linked to red meat consumption. In both treatments, there was support for mushroom-based alternatives. Analyses included subgroup assessments, tests to verify treatments effectiveness, along with OLS regression to pinpoint variables influencing message effectiveness. The results underscore a fair positive impact of the two informative messages (mean scores: 8.75 for health message; 7.01 for environmental message). Noteworthy psychosocial variables, including lifestyle patterns, nutritional perceptions, and ecological attitudes, emerged as determinants in shaping consumers' food choices. While health-related messages exhibit marked influence, the nuanced landscape of diverse drivers and barriers necessitates judicious communication strategies. These insights bear significance for policymakers, health professionals, and marketers, offering guidance for interventions that effectively influence consumer behaviour toward more sustainable and healthier food practices.

1. Introduction

Excessive consumption of red and processed meat has been conclusively linked to adverse health effects, significantly increasing the risk of conditions such as type 2 diabetes, cancer, and cardiovascular diseases (Domingo & Nadal, 2017; Maukonen et al., 2023; Naghshi et al., 2020). Furthermore, livestock farming plays a substantial role in climate change, contributing significantly to global greenhouse gas emissions (GHG), accounting for 12%–18% of these emissions (Allen & Hof, 2019; Gomez-Zavaglia et al., 2020; González et al., 2020).

Given this evidence, it is essential to comprehensively review food production and consumption systems to promote sustainable development, aiming to reduce or replace red and processed meat consumption, especially in countries where it is most prevalent (IPCC, 2019; UN, 2019). One proposed solution is the adoption of various plant-based meat alternatives (PBMAs) (Andreani et al., 2023; Rizzo et al., 2023), as diets emphasizing lower consumption of red and processed meat and higher consumption of plant-based foods are recognized as advantageous both for individual health and environmental sustainability (Godfray et al., 2018; Willett et al., 2019). Among the various alternatives, mushroom-based protein products are increasingly interesting, because of the outstanding nutritional content of mushrooms and the presence of a high-quality protein profile in certain species. Indeed, mycoproteins derived from fungi like Fusarium venenatum can be utilized to produce fibre-rich products such as QuornTM, boasting both high protein content and a high-quality protein profile, as they encompass all the essential amino acids (EAAs) for human dietary needs (Finnigan et al., 2019; Hashempour-Baltork et al., 2020; Khan et al.,

* Corresponding author.
E-mail addresses: rachele.decianni@unito.it (R. De Cianni), teresina.mancuso@unito.it (T. Mancuso), giuseppina.rizzo03@unipa.it (G. Rizzo), giuseppina.migliore@unipa.it (G. Migliore).

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2024). It has also been proven that replacing red and processed meat with Fusarium-based mycoprotein increases the abundance of microbial genera with potential health benefits in the gut (Farsi et al., 2023). Furthermore, mushroom cultivation demands relatively modest economic and environmental resources and can thrive on various organic substrates derived from food industry by-products, thus rendering their production environmentally sustainable (Chang & Miles, 2004; Chang & Wasser, 2017; Colunga et al., 2020; Stoffel et al., 2019). They also require relatively limited space to grow and are considered 'fast-growing organisms with a high yield' (Pérez-Montes et al., 2021). Additionally, a study has developed a model for assessing the environmental advantages of fermentation-derived microbial proteins (mycoproteins), indicating that replacing 20 percent of per capita ruminant meat consumption with mycoproteins by 2050, could result in a 50 percent reduction in annual deforestation and associated CO2 emissions (Humpenöder et al., 2022).

However, despite the clear need for a shift in dietary habits towards sustainable options, such as including mushrooms in the diet as a substitute for red and processed meat, consumers continue to struggle to embrace this path (Carfora et al., 2020). This can be attributed to factors such as entrenched habits, gustatory pleasure, social influences, and availability. The combination of these factors can make it difficult for some consumers to change their dietary habits, despite being aware of the potential risks (Ruby & Heine, 2011).

Therefore, to guide consumers towards more sustainable options, could be crucial to intervene in the psychological mechanisms that shape the decision-making process (Buttlar & Walther, 2018).

Among the various strategies available to achieve this goal, policy interventions in the form of nudging could prove to be a viable alternative as they gently encourage individuals to adopt desired behaviours without imposing direct restrictions or sanctions (Ensaff et al., 2015; Zickfeld et al., 2018).

This research focuses on the intention to adopt a more sustainable diet, suggesting the substitution of red meat with mushroom-based protein products and examining the impact of nudging as informative messages on such substitution. It explores both the content of the messages and their presentation (framing message).

2. Current scenario analysis and aims

The concept of informative messages entails the utilization of persuasive communication techniques designed to educate individuals on a particular issue or topic with the aim of influencing their intentions and behaviours (Carfora et al., 2022). However, it is important to note that the literature on the topic yields conflicting results (Cadario & Chandon, 2020). Indeed, if on one hand, some authors argue that providing relevant information can steer individuals toward more sustainable choices, tapping into their emotions, motivations, and personal identity (Demartini et al., 2019; Thaler & Sunstein, 2009). Other authors have highlighted that this approach may have a small or no effectiveness in changing individuals' behaviours (e.g., Maier et al., 2022; Mertens et al., 2022). Despite these contrasting views, this innovative technique has sparked a revolution in behavioural science research (Mertens et al., 2022; Thaler & Sunstein, 2009).

Furthermore, in the context of food choices, it seems that the type of informative messages with the potential to trigger changes in consumers' intentions is those concerning the consequences of their dietary choices on their health and the environment (Vainio et al., 2018). However, it is still unclear which of the two topics (environmental or health-related) has a greater impact. For example, some studies have found that health-related issues are significantly effective (Caso et al., 2023; Myers et al., 2012; Nisbet, 2009); consequently, these studies highlight that emphasizing public health aspects in informative messages has the potential to be a more effective approach in guiding consumers towards a more sustainable diet. On the contrary, other studies have highlighted the effectiveness of informative messages focused on the impact of one's diet on the environment (Harguess et al., 2020; Kwasny et al., 2022; Sogari et al., 2022).

Additionally, an intriguing aspect emerging from the literature analysis concerns the formulation of the message itself, which is the framing message. Indeed, to communicate the same concept, it is possible to tailor the message in the form of loss or gain framing (Dolgopolova, Li, Pirhonen, & Roosen, 2022). In loss framing, attention is focused on the negative consequences of not adopting a certain behaviour or not following a certain course of action (Caso et al., 2023). On the other hand, in gain framing, the emphasis is placed on what could be achieved or the benefits derived from adopting that behaviour or following the subsequent course of action (Carvalho et al., 2022; Binder et al., 2020; Gallagher and Updegraff; 2012).

Overall, loss framing seems to be more effective than gain framing (Dolgopolova et al., 2022). However, Gallagher and Updegraff (2012) found that when it comes to health and environmental benefits, encouraging positive behaviours by invoking loss aversion is not necessarily a guiding principle.

Given the preceding discussion on both the type of informative message and framing to use, this study aims to further investigate the effectiveness of informative messages in directing consumers' intentions towards more sustainable diets. The current study employs two informative messages that delineate the consequences, both on health and the environment, stemming from substituting a portion of meat with proteins derived from mushroom-based alternatives. Specifically chosen for their environmental and health significance, mushrooms have been selected as the focus, since despite their importance, no study has yet examined how informative messages might influence this substitution, underscoring the need to fill this research gap. Additionally, it was decided to incorporate both loss and gain framings in each message: the health-centric message initially emphasizes the detrimental effects of excessive meat consumption on health, followed by the benefits of substitution with mushroom-based alternatives. Similarly, the environmental message follows a parallel structure but emphasizes environmental impacts. This approach was chosen as we recognize that there is no one-size-fits-all approach to encouraging positive behaviours for health and the environment.

Finally, this study is intended to explore barriers related to values, usage, and risk (Tandon et al., 2021), which have been deemed significant in previous literature on mushroom consumption (De Cianni et al., 2023) but have so far been overlooked in this context of informative messages.

3. Materials and methods

3.1. Data acquisition

In the spring of 2023, an experimental online cross-sectional survey was conducted by a professional market research agency on a sample of Italian consumers. The questionnaire was distributed through the agency's online platform and sent to pool participants via e-mail, using a mass online delivery system. Involvement of participants responsible for household food shopping and red meat consumers, who must be adults (minimum 18 years old), was requested, with guaranteed demographic stratification. The study respected the requirements of the Helsinki Protocol, so, it did not collect sensitive information (political and sexual orientation, etc.). All information was anonymous, and the data were stored in a protected mode. The study was approved by the Bioethics Committee of the University of Palermo. All participants provided informed consent before participating in the online survey.

3.2. Experimental protocol

The experimental investigation utilized both a within-subject and a between-subjects design. The questionnaire remained consistent across the entire sample, except for the informative message section, where each subgroup was exposed to a distinct message (e.g., Vainio et al.,

2018). This study employs a sample of 951 participants divided into three groups. Specifically, 309 individuals formed the control group, 311 participants received informative messages on the health risks associated with red meat consumption, and 331 participants received informative messages emphasizing the environmental damages linked to red meat consumption. This participants' group size is deemed appropriate since Cohen (1992) stated that, to detect differences between groups, a minimum sample of 150 participants per condition is required, considering the medium and expected effect size, an alpha level of 0.05, and 80% power.

One subgroup received a message highlighting the potential environmental damages caused by livestock farming, while another subgroup received a message focused on the health risks associated with meat consumption. In both cases, the message concluded by emphasizing that these issues could be alleviated by substituting meat with mushroom-based alternatives. Specifically, the questionnaire reported a note explaining that mushroom-derived proteins refer to microbial proteins obtained through fermentation, commonly known as mycoprotein. Meanwhile, the third subgroup, designated as the control group, did not receive any messages.

About the within-subject design, the informative message effectiveness was tested both before and after exposure to the treatment, and all participants answered an identical question about their future intention to reduce meat consumption in favor of mushroom-based alternatives. The question read as follows: '*Considering your current consumption, what is the likelihood that you might replace some of the red meat you consume with a portion of mushroom-based protein burgers, patties, or other mycoprotein products in the next* 6 months*? Please respond considering a range from 0% to 100%, where 0% means you will not be willing to replace it in the next* 6 months *and 100% means you that will be willing to replace it completely*'. Consequently, comparing the responses before and after exposure to the informative message it was possible to assess the effectiveness of the two treatments. Regarding the treatment group, it was expected that there would be no significant differences between the responses given before and after the exposure to the informative treatment. Appropriate tests were conducted to verify this.

As regard the between-subjects design, a comparison was also made between the values obtained in the two subgroups that received the two informative messages.

In addition, participants responded to a series of inquiries regarding dietary habits, meat, and mushroom consumption, and purchasing patterns. Subsequently, interviewees provided psychographic and sociodemographic information to complete the survey. Multiple randomization techniques were employed during survey administration to mitigate common method biases and enhance response validity (e.g., the exposure to the informative messages was randomized).

3.3. Informative message section

The used informative messages aimed to promote the replacement of a full portion of meat with mushroom-based alternatives, emphasizing two distinct aspects: the environmental benefit and the health benefit of mushrooms. The aim was to understand which of these two messages had a greater impact on consumer choice and how it influenced different meat consumption frequencies.

The two messages are detailed in Table 1.

3.4. Questionnaire measures

The questionnaire began with two preliminary screening questions. The first question asked, '*How often have you consumed red meat on average in the past six months*?' The response options ranged from 'every day' to 'never'. Those who chose the latter option were excluded from the study. This variable was subsequently transformed into a dummy variable named 'Frequent red meat consumer' where the value 1 denotes a consumption of meat exceeding the WHO's recommendations, while the value 0 indicates lower consumption. This approach mirrors the methodology employed by Caso et al. (2023). This process allowed us to investigate whether the effects of informative messages could vary between the two different subsamples of consumers.

As for mushroom consumption, participants were asked the following question: '*Have you ever consumed fresh or processed mushrooms?*' with the options for an affirmative or negative response. In this last case as well, those who responded negatively were excluded from the study. In addition to the screening questions, participants were asked about their dietary preferences, choosing between being omnivores (i.e., consuming all animal products except those excluded for preference, allergy, or religious reasons) and semi-vegetarians (i.e., consuming only some of the following food items: red meat, poultry, and fish). Finally, participants were asked about the frequency of consuming plant-based meat substitutes (such as veggie burgers or meatless meatballs) in the previous six months, with response options ranging from 'every day' to 'never'.

In the second section of the questionnaire, psychosocial variables were examined. Initially, the concept of 'Lifestyle of Health and Sustainability', commonly known as LOHAS (Pícha & Navrátil, 2019), was explored. LOHAS consumers are generally perceived as environmentally conscious, socially engaged, and possessing a worldview that considers personal, community, and planetary impacts. The goal was to identify the relationship between participants' purchasing behavior and LOHAS categories (Sustainable Economy, Healthy Lifestyle, Ecological Lifestyles, and Personal Development). Following the same reasoning, the questionnaire also included a scale gathering information about participants' perceptions of the nutritional content of mushrooms (Escobar-López et al., 2017) and convenience (Pula et al., 2014). This allowed us to determine whether the choice to substitute meat with mushrooms was influenced by participants' beliefs about the healthiness of mushrooms and whether a potential barrier to change could be their willingness to experiment in the kitchen, for example, by trying new recipes. Furthermore, the questionnaire examined the significance of safeguarding and preserving the natural environment to ensure the long-term well-being of both human society and terrestrial ecosystems, a concept commonly referred to as 'ecological welfare' (Tandon et al., 2021). Participants' general attitudes toward mushrooms (Sogari et al., 2022) and meat (Banovic et al., 2022) were also examined.

Subsequently, barriers related to value, use, and risk were examined, as prior research had suggested that consumers may face several challenges that limit their buying involvement (e.g., Tandon et al., 2021). Finally, socio-demographic characteristics of the sample, including sex at birth, age, level of education, and income, were collected.

Please display Table 8 in the Supplementary material, to see the descriptions of the various variables used.

Table 1
Informative messages.

Informative message on health consequences
Diet has a significant impact on health. Studies have shown that red meat is a possible carcinogen responsible for increasing the risk of type II diabetes and cardiovascular diseases. On the contrary, if you reduce the amount of meat, you consume and substitute it with mushroom-derived proteins, you could contribute to reducing this risk.
Informative message on environmental consequences
Diet has a significant impact on the environment. Studies have shown that beef cattle farming is among the contributors to global deforestation and greenhouse gas emissions. On the contrary, if you reduce the amount of red meat, you consume and substitute it with mushroom-derived proteins, you could contribute to mitigating these negative environmental impacts.

3.5. Data analysis procedures

The collected data were analyzed using the statistical software STATA 16. Initially, descriptive analyses were conducted on all variables included in the questionnaire. We estimated the mean, median, and standard deviation for all continuous variables, and the frequency for discrete variables. This allowed us to gain insight into the sample. The Hotteling test confirmed successful randomization, proving homogeneity between the subgroups in socio-demographic terms. Subsequently, the Cronbach's alpha reliability index was calculated to assess the internal consistency among the items of the psychographic scales used. For each scale, the Cronbach's alpha exceeded the threshold of 0.70, indicating substantial consistency in participants' responses. Consequently, the average value of each scale was used in subsequent analyses.

The analyses were conducted both on the entire sample and separately on various subgroups. Homogeneity among groups was assessed using tests such as ANOVA, the Mann-Whitney test, and the Kolmogorov-Smirnov test. Non-parametric tests (Wilcoxon tests) were also employed to identify any statistical differences among subgroups and to assess the effectiveness of the nudge strategies applied. Using a paired *t*-test for each subgroup, we assessed the statistical difference between the mean likelihood of reducing meat in favor of mushroom-based alternatives obtained before and after the treatments. Additionally, the two-samples *t*-test was conducted between the means obtained in the two treated groups. Furthermore, an ordinary least squares (OLS) regression was carried out to verify potential biases in the previous analyses and thus validate the effectiveness of the information messages. Specifically, the dependent variable was the likelihood of selecting a mushroom-based alternative obtained after the treatment, with dummy variables for the health message group and the environmental message group as independent variables. Additionally, the likelihood of selecting a mushroom-based alternative obtained before the treatment was included as a covariate in the model. Following that, correlation analyses were performed to explore relationships among potential independent variables to be used in the economic modeling.

Finally, two OLS regression models were implemented to understand which variables influenced the effectiveness of the informative messages. The two dependent variables employed in the two regressions represent, respectively, the impact of the health and environmental treatments on the likelihood of choosing a mushroom-based protein burger as an alternative to red meat. Additionally, each regression presents a set of independent variables derived from the literature that could influence this likelihood. These encompass socio-demographic variables, consumption habits, and psychographic variables (see section 3.4.). Statistical significance was considered with a p-value up to 10%.

To accurately quantify the effect of health and environmental messages, a mathematical difference was computed as follows:

$$Differential_{\text{Health message}} = (Likelihood\ after\ treatment - Likelihood\ before\ treatment)$$

$$Differential_{Environmental\_message} = (Likelihood\ after\ treatment - Likelihood\ before\ treatment)$$

These calculations allow us to measure the change in response likelihood associated with health and environmental messages. A positive difference indicates an increase in the likelihood of response, while a negative difference suggests a decrease. This quantitative analysis method helps us gain a better understanding of the specific impact of the treatments on participants' responses, enabling us to assess their overall effectiveness.

These two variables have been designated as the dependent variables in the regressions conducted to explore the factors that could potentially impact treatment effectiveness.

4. Results

4.1. Sample characteristics

The final sample consists of 951 individuals. The socio-demographic characteristics, consumption habits, and psycho-attitudinal aspects of the sample have been examined. Regarding socio-demographic characteristics, the sample was divided based on various parameters, including age, sex at birth, level of education, and monthly income. A notable predominance of female participants is observed across all three groups. Additionally, while the mean ages are relatively similar among the groups, the health treatment group exhibits a slightly higher average age. This demographic detail may have relevance in understanding how age influences responses to treatments. Notably, approximately 40% of participants hold a bachelor's degree or higher, with no significant differences between the groups in terms of education. Lastly, the distribution of monthly income reveals that the majority of participants fall into the 'very low' or 'medium' income categories, with some distinctions noted between the treatment groups. Data are reported in Table 2.

As regard consumption habits, there is a clear diversity in the frequencies of red meat, plant-based meat alternatives, and mushroom consumption, reflecting the variety of dietary habits within the sample. Weekly red meat consumption is more prevalent, with the majority of participants consuming it at least once a week.

As regard plant-based meat alternatives, they are consumed less frequently but exhibit significant variations among participants. Mushroom consumption is widespread, with the majority of participants consuming them at least once a week, although the environmental treatment group shows a slightly lower frequency. Additionally, the distribution of dietary types reveals a predominance of omnivorous diets. Finally, participants' attitudes were examined. It resulted that participants exhibit a strong environmental consciousness and prioritize ecological well-being. Additionally, they place significant emphasis on personal health and well-being. However, there is a wide range of attitudes regarding personal development. Nutritional content consideration is prevalent among participants. Barriers to adopting alternative dietary habits are consistent across treatment groups, indicating common concerns in this regard. Favorable attitudes towards mushrooms suggest a positive predisposition, while participants do not heavily rely on meat as their primary source of nutrition. These findings shed light on participants' perceptions, potential challenges in dietary choices, and the impact of the study's strategies. Please refer to Tables 9 and 10 in the Supplementary material for more details.

4.2. Impact of informative messages

The paired *t*-test analysis on the means obtained from consumers' responses regarding the question about the likelihood of reducing meat consumption in favor of mushroom-based alternatives (made before and after treatments, and at the beginning and end of the questionnaire for the control group) reveals a significant difference between the control group and the treated groups (Table 3). In the control group, the test did not detect any statistically significant changes compared to the two responses provided to the identical questions, while about the likelihood of reducing red meat consumption in favor of consuming mushroom-based protein burgers. While, in the health and environmental treatment groups, it emerged that the average response after the informational treatment was significantly higher compared to the control group. This suggests that the provided information had a positive impact on the participants' responses in these two groups, resulting in an increase in average responses post-treatment. Considering the between subject design, the two-sample *t*-test revealed that no treatment prevails over the other as there is no statistical difference. (Table 4).

Since in the control group, the initial likelihood of selecting a mushroom-based protein burger as an alternative to red meat was already higher (45.27) compared to the intervention groups (39.80 and

Table 2
Demographic characteristics of study participants.

Variables	Description	Total	Control group (n = 309)	Health treatment (n = 311)	Environmental treatment (n = 331)
		Sample (N = 951)			
Sex at birth	Female	723 (76.03%)	250 (80.91%)	228 (73.31%)	245 (74.027%)
	Male	228 (23.97%)	59 (19.09%)	83 (26.69%)	86 (25.98%)
Age	Mean ± S.D.	46.11 ± 11.10	45.04 ± 10.27	47.18 ± 11.48	46.11 ± 11.40
Education	Graduate or higher	374 (39.33%)	122 (39.48%)	134 (43.09%)	118 (35.65%)
	Not graduated	577 (60.67%)	187 (60.52%)	177 (56.91%)	213 (64.35%)
Monthly income	Very low	348 (36.59%)	116 (37.54%)	111 (35.69%)	121 (36.56%)
	Low	99 (10.41%)	23 (7.44%)	32 (10.29%)	44 (13.29%)
	Medium	398 (41.85%)	140 (45.31%)	125 (40.19%)	133 (40.18%)
	High	106 (11.15%)	30 (9.71%)	43 (13.83%)	33 (9.97%)

Table 3
Comparison of pre- and post-treatment responses (within test) - Responses regarding the likelihood of replacing red meat with mushroom-based protein burgers.

	Control group (*n* = 309)	Health treatment (*n* = 311)	Environmental treatment (*n* = 331)
Ha: diff ! = 0	Pr(|T| > |t|) = 0.2591	Pr(|T| > |t|) = 0.0000	Pr(|T| > |t|) = 0.0197
Mean	Before = 45.27 After = 47.76	Before = 39.80 After = 48.55	Before = 38.13 After = 46.28

Table 4
Comparison of the two treatments (between test) - Responses regarding the likelihood of replacing red meat with mushroom-based protein burgers.

	Health treatment (*n* = 311) Environmental treatment (*n* = 331)
Ha: diff ! = 0	Pr(|T| > |t|) = 0.5387
Mean	Health treatment = 48.55 Environmental treatment = 46.28

36.54), a linear regression analysis was also performed. Thus, a mean difference between the intervention groups and the control group was calculated. Following this approach, the higher initial score observed in the control group is considered, and the estimated outcome reflects a mean difference within and between subjects in the intervention groups compared to the control group in the likelihood of selecting a mushroom-based alternative. The coefficient values for the health and environmental treatments of 5.249 and 2.924, respectively, indicate the average increase in likelihood compared to the control group. Specifically, participants who received the health treatment showed a 5.249 unit increase, while those receiving the environmental treatment had a 2.924 unit increase. These results confirm that both treatments have affected the likelihood of reducing red meat in favor of mushroom-based alternatives (Table 5).

Table 5
OLS regression analysis - Likelihood of selecting a mushroom-based protein burger as an alternative to red meat.

Likelihood after treatment	Coef.	St.Err.	t-value	p-value	Sig
Likelihood before treatment	1.825	1.02	41.42	0.000	[a]
Health treatment	5.249	1.308	4.01	0.000	[a]
Environmental treatment	2.924	1.296	2.26	0.024	[b]
Constant	10.395	1.291	8.05	0.000	[a]

[a] p < .01.
[b] p < .05.

4.3. OLS regressions

The regression analysis on the 'Differential in health treatment' (Table 6) reveals important factors influencing the impact of health-related messages. Specifically, sex at birth and education level play a marginal but significant role, suggesting that both may modulate the response to health messages. However, it is worth noting that education level shows a negative relationship with the dependent variable. The frequency of red meat consumption emerges as a key factor, emphasizing the significance of dietary habits in determining the impact of health message. Additionally, the perception of nutritional content is marginal but significant, underscoring the importance of participants' opinions regarding the nutritional aspects of their diet. Finally, the value barrier is another relevant factor, highlighting the role of perceived barriers in promoting health-oriented dietary changes.

The regression analysis concerning the 'Differential in environmental treatment' (Table 7) reveals important factors that influence the impact of environmentally centered messages. It has emerged that the frequency of PBMA consumption is a significant factor, with a positive relationship. This suggests that dietary habits related to the consumption of plant-based meat alternatives can influence responses to environmental messages. Similarly, 'Ecological Lifestyles' and 'Attitudes towards Mushrooms' were found to be significant, with positive relationships, indicating that an orientation toward an ecological lifestyle

Table 6
OLS Regression - Effect of the health treatment on the likelihood of selecting a mushroom-based protein burger as an alternative to red meat.

Differential in health treatment	Coef.	St.Err.	t-value	p-value	Sig
Sex at the birth	4.351	2.268	1.92	0.056	[b]
Age	0.062	0.092	0.67	0.503	
Education	−3.557	2.153	−1.65	0.099	[b]
Monthly income	1.126	0.974	1.16	0.249	
Frequent red meat consumer	−4.308	2.433	−1.77	0.078	[b]
Mushroom consumption frequency	−0.207	1.137	−0.18	0.855	
PBMA consumption frequency	−0.207	0.8	−0.26	0.796	
Healthy lifestyle	1.466	1.81	0.81	0.419	
Personal development	−0.956	1.073	−0.89	0.374	
Nutritional content	3.084	1.618	1.91	0.058	[b]
Attitudes towards mushroom	0.919	1.046	0.88	0.381	
Neophobia scale	−1.608	1.151	−1.40	0.164	
Convenience	−0.423	1.11	−0.38	0.703	
Dependence	−1.796	1.867	−0.96	0.337	
Value barrier	−2.35	1.181	−1.99	0.048	[a]
Usage barrier	1.805	1.234	1.46	0.145	
Risk barrier	−0.851	1.189	−0.72	0.474	
Constant	2.784	10.893	0.26	0.798	

Number Obs = 311, Prob > F = 0.0000.
p < .01.
[a] *p < .05.*
[b] *p < .1.*

Table 7
OLS Regression - Effect of the environmental treatment on the likelihood of selecting a mushroom-based protein burger as an alternative to red meat.

Differential in environmental treatment	Coef.	St.Err.	t-value	p-value	Sig
Sex at the birth	4.511	2.515	1.81	0.077	[c]
Age	−0.129	0.102	−1.32	0.192	
Education	−3.756	2.425	−1.56	0.122	
Monthly income	1.184	1.112	1.03	0.286	
Frequent red meat consumer	−1.032	2.470	−0.0	0.677	
Mushroom consumption frequency	−2.560	1.123	−2.30	0.024	[b]
PBMA consumption frequency	1.951	0.791	2.47	0.015	[b]
Ecological lifestyles	3.776	1.881	2.00	0.044	[b]
Ecological welfare	0.441	1.628	0.30	0.786	
Sustainable economy	0.412	1.406	0.25	0.767	
Attitudes towards mushroom	3.071	1.170	2.67	0.009	[a]
Neophobia scale	−1.636	1.10	−1.50	0.137	
Convenience	0.755	1.097	0.70	0.499	
Dependence	−1.431	1.921	−0.75	0.467	
Value barrier	0.778	1.397	0.51	0.578	
Usage barrier	−2.169	1.470	−1.48	0.141	
Risk barrier	1.228	1.245	0.99	0.327	
Constant	−4.09	13.063	−1.09	0.283	

Number Obs = 331, Prob > F = 0.0000.
[a] $p < .01$.
[b] $p < .05$.
[c] $p < .1$.

and a positive view of mushrooms may enhance the effectiveness of environmental messages. On the other hand, the 'Neophobia Scale' was marginally significant with a negative relationship. This could suggest that a greater aversion to new or unfamiliar foods might reduce the impact of environmental messages. Finally, 'Convenience' showed a marginal but non-significant relationship, implying that convenience may play a minor role in responses to environmental messages.

5. Discussion

The results indicate that informative messages centered around health and the environment have led to a significant increase in the intention to reduce meat consumption in favor of mushroom-based alternatives. These findings validate prior discoveries, highlighting that employing such messages can positively impact sustainable dietary habits (Bertolotti et al., 2016; Sogari et al., 2022; Vainio et al., 2018). This supports the notion that communication through informative messages can effectively drive changes in dietary habits (Downs et al., 2009; Vainio et al., 2018; Vermeir & Verbeke, 2006).

However, studies on reducing meat consumption have yielded conflicting results. While some suggest that a health perspective may diminish future intentions to consume meat (Caso et al., 2023; Palomo-Vélez et al., 2018), others indicate that solely informing about negative health impacts might not be effective in altering dietary habits (Vainio et al., 2018). Others still claim that addressing environmental issues or animal welfare is necessary to guide the consumers towards more sustainable diets (e.g., Graham & Abrahamse, 2017; Whitley et al., 2018).

It was found that certain factors played a significant role in the initiative's success. One of the factors to examine is the sex at birth. In this study it resulted that female demonstrated greater sensitivity to informative messages, aligning with Reisch et al. (2017) and Sanchez-Sabate and Sabaté (2019), where female consumers showed higher health awareness than men. Again, our results highlight that a higher level of education can compromise the effectiveness of informative messages. This obstacle might stem from the tendency of individuals with a more advanced educational background to hold firmer positions on specific topics. Indeed, Howley and Ocean (2022) stated that individuals with relatively lower levels of education appear to be the group most impacted by these nudges. In addition, literature also indicates that individuals with higher education level tend to adopt a sustainable vegetarian diet more frequently (Rosenfeld et al., 2020).

Additionally, detailed characterization revealed that about a third of the sample consumes red meat beyond the WHO recommendations, consistent with similar findings in other European countries (Carfora et al., 2022; Guyomard et al., 2021). Being habitual red meat consumers seems to diminish interest in a balanced and healthy diet, disregarding its associated consequences and reducing the inclination to consume mushrooms instead of meat (Caso et al., 2023). Conversely, attention to nutritional content, an ecological lifestyle, and consumption of sustainable foods such as plant-based proteins and mushrooms increase this inclination. Similar outcomes were found in previous studies where respondents preferred avoiding red meat in favor of more sustainable and healthier alternatives (Cheah et al., 2020; Malek et al., 2019).

Finally, value barriers appear to decrease the likelihood of consumers modifying their diet to include mushroom-based alternatives. Price represents a common barrier, confirmed by similar findings in other studies (Kushwah et al., 2019; Szaban & Stefańska, 2023).

Despite there being no differences in the effectiveness of the two treatments, this study found variations in the drivers and barriers associated with each of them. In the health-focused treatment, the key variables showing a significant association with the intention to change behavior are primarily related to personal evaluation factors and individual perceptions. The importance placed on the nutritional content of the diet and the perception of the value of dietary choices appear to be more influential. This might indicate that when it comes to persuading people to change their dietary habits for health reasons, focusing on specific information about nutrition and the perception of value can be more effective.

On the other hand, in the environment-focused treatment, variables more directly linked to behavior and sustainable lifestyle emerge. The frequency of mushroom consumption, PBMA consumption, and the practice of an ecological lifestyle are significant factors. This suggests that in influencing dietary choices towards more environmentally sustainable options, it is more effective to focus on sustainable behaviors and lifestyle practices, in addition to adopting specific dietary alternatives.

6. Conclusion

The current study's findings suggest that utilizing informative messages can serve as a potent tool to encourage health and sustainable dietary choices. By imparting relevant information regarding the health and environmental advantages of consuming mushrooms, it becomes possible to positively shape consumers' attitudes and intentions towards reducing red meat consumption. However, results showed that there are various drivers and barriers that influence the intention to substitute the red meat with mushroom-based alternatives. Health-related messages have a positive impact on individuals who consume meat less frequently and have lower level of education, whereas the effectiveness of informative messages about the environment remains unchanged regardless of how often individuals consume meat and the level of education. In essence, this difference in effective messaging suggests that persuading individuals to change their dietary habits may require different approaches depending on the message's objectives. When the focus is on health, detailed information about nutrition and enhancing the perceived value of choices may be more convincing. Conversely, if the goal is to promote a more environmentally sustainable diet, it might be more effective to link the message to sustainable behaviors and lifestyle practices rather than solely focusing on the dietary alternative itself. For this reason, it is necessary to find alternative strategies to shape the behaviour of those who consume meat beyond recommended levels and those with higher levels of education, as they seem to be less responsive to informative messages. Furthermore, since price is the primary barrier to replacing meat with mushroom-based alternatives, implementing

offers and discounts on these products could be a good marketing strategy to encourage their consumption.

In summary, the results underscore the potential of informative messaging as a strategic approach to foster sustainable food choices, contributing to the realization of Sustainable Development Goals, and the need to employ different approaches based on the objectives that the informative message aims to achieve. Such health messages could be disseminated through media advertising, such as social networks and social media announcements, to raise public awareness about the benefits of a balanced, plant-based diet. Using health and environmental informational messages could provide consumers with helpful guidance for making more informed choices during their purchases. Additionally, educational campaigns in schools and community events represent significant opportunities to instruct consumers on healthy eating habits and promote healthier, more sustainable lifestyles. Through the adept use of persuasive communication techniques, policymakers, health professionals, and marketers can play a pivotal role in influencing consumer behaviour towards more sustainable and healthier dietary practices.

7. Limitations and future research

The study suffers from some limitations. Firstly, although our sample is representative of Italian population, the predominance of females in the sample might warrant further investigation into sex at birth balance in the study and the potential impact of such imbalance on the results. Moreover, this study focused on the stated intention to change behaviour rather than measuring the actual modification of behaviour as a consequence of the informative messages. Thus, subsequent research could delve into the enduring effects of informative messaging on real consumption patterns and assess the sustainability impact of such shifts in dietary choices. Furthermore, the present research examined the immediate and short-term outcomes of messages, emphasizing the importance of assessing the long-term impact of such techniques. Lastly, this study relies on Italian consumers, making it challenging to generalize the results to other populations. Future research could attempt to apply the methodology to measure the effectiveness of informative messages in substituting meat with mushroom-based alternatives in other countries.

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CRediT authorship contribution statement

Rachele De Cianni: Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Teresina Mancuso:** Visualization, Validation, Project administration, Funding acquisition, Conceptualization. **Giuseppina Rizzo:** Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation. **Giuseppina Migliore:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, 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.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107405.

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